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EVALUATION

of the

EXPERIMENTAL

RURAL CLEAN WATER PROGRAM

National Water Quality Evaluation Project
NCSU Water Quality Group
Biological and Agricultural Engineering Department
North Carolina Cooperative Extension Service
North Carolina State University, Raleigh, North Carolina 27695-7637

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The report was edited by Gale and Line.

EXECUTIVE SUMMARY

This publication presents the results of a comprehensive evaluation of the ten-year experimental Rural Clean Water Program (RCWP). The evaluation was conducted by the National Water Quality Evaluation Project (NWQEP) at North Carolina State University in cooperation with the U.S. Department of Agriculture (USDA), the U.S. Environmental Protection Agency (USEPA), and the 21 RCWP projects.

The Rural Clean Water Program

The Rural Clean Water Program, a federally-sponsored nonpoint source (NPS) pollution control program, was initiated in 1980 as an experimental effort to address agricultural NPS pollution problems in watersheds across the country. The objectives of the RCWP were to: 1) achieve improved water quality in the approved project area in the most cost-effective manner possible in keeping with the provision of adequate supplies of food, fiber, and a quality environment; 2) assist agricultural landowners and operators to reduce agricultural NPS water pollutants and to improve water quality in rural areas to meet water quality standards or water quality goals; and 3) develop and test programs, policies, and procedures for the control of agricultural NPS pollution.

The RCWP was administered by the USDA-Agricultural Stabilization and Conservation Service in consultation with USEPA. The Soil Conservation Service, Extension Service, Economic Research Service, Agricultural Research Service, U.S. Geological Survey, Forest Service, and many other state and local agencies also participated in the RCWP. Programmatic and project-level decisions were made by national, state, and local RCWP inter-agency coordinating committees.

With a total appropriation of $64 million, the RCWP funded 21 experimental watershed projects across the country. The projects represented a wide range of pollution problems and impaired water uses. They were located in Alabama, Delaware, Florida, Idaho, Illinois, Iowa, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Nebraska, Oregon, Pennsylvania, South Dakota, Tennessee/Kentucky, Utah, Vermont, Virginia, and Wisconsin.

Each project involved the implementation of best management practices (BMPs) to reduce NPS pollution and water quality monitoring to evaluate the effects of the land treatment. Land treatment in each project was targeted to critical areas or sources of nonpoint source pollutants identified as having significant impacts on the impaired water resource. These areas were referred to as critical areas. Landowner participation was voluntary, with cost sharing and technical assistance offered as incentives for implementing BMPs. Landowners receiving cost-share assistance were contracted to implement BMPs, with the length of the contract depending on the practice being implemented.

While water quality monitoring was performed in all 21 projects, five projects (Idaho, Illinois, Pennsylvania, South Dakota, and Vermont) were selected to receive additional federal funding for more extensive monitoring and evaluation. These projects are referred to as the Comprehensive Monitoring and Evaluation (CM&E) projects.

Significance and Contributions of the RCWP

The Rural Clean Water Program is one of the few national NPS control programs that has combined land treatment and water quality monitoring in a continuous feedback loop to document NPS control effectiveness. Water quality monitoring results have also been used to adjust and refine land treatment practices designed to control agricultural NPS pollution.

The experience gained through the RCWP provides valuable information for personnel involved in current and future NPS control programs and projects. Many of the RCWP projects have made significant contributions to the body of knowledge regarding nonpoint source pollution, NPS control technology, BMP effectiveness, and the effectiveness of voluntary cost-share programs aimed at assisting producers in reducing agricultural NPS pollution.

The producers and project personnel who participated in the 21 RCWP projects benefited not only their communities, but also those who are and will be engaged in subsequent NPS control programs. The RCWP projects resulted in the development of closer and more effective cooperation and communication among federal, state, and local agencies involved in NPS pollution control. The program achieved extensive adoption of BMPs in critical areas (and often beyond project boundaries) and provided valuable insight into the effectiveness of these practices in improving water quality. Possibly the most important contribution made by the RCWP is the advancement of our understanding of how to plan, implement, manage, and monitor voluntary agricultural NPS pollution control efforts.

The following are examples of contributions and accomplishments of the RCWP projects:

- *Delaware*: Water quality monitoring in the Appoquinimink River project documented a 60% decrease in phosphorus and a 90% decrease in sediment reaching an impaired water body as the result of implementation of conservation tillage and animal waste management BMPs. Improved fertilizer management cut the pre-project phosphorus application rate in half.

- *Iowa*: The Prairie Rose Lake project demonstrated that a very high rate of implementation is possible in a voluntary NPS control project. Ninety-two percent of the producers in the project area participated in the project, which was aimed at reducing sediment yield from excessively eroding cropland around a recreational lake. Fertilizer management and Integrated Pest Management were implemented on 60% of the critical acreage.

- *Maryland*: The Double Pipe Creek project team took advantage of the experimental nature of the RCWP to learn more about the best designs for animal waste storage systems. RCWP funds were used to hire a nutrient management specialist to assist farmers in using manure as a source of nutrients. This approach was so successful that the position was continued after the RCWP.

- *Florida*: Fencing, water management, and animal waste management systems in the Taylor Creek-Nubbin Slough RCWP project have reduced phosphorus concentrations in water entering Lake Okeechobee by more than 50%.

- *Oregon*: Innovative animal waste management systems installed on dairies in the Tillamook Bay project reduced bacterial contamination of oyster beds in the bay, resulting in the re-opening of shellfish beds to harvesting.

- *Idaho*: Water management and sediment control BMPs reduced sediment and phosphorus concentrations in return flows from irrigated land in the Rock Creek project. Improvements in the ability of the stream to support designated uses were documented through monitoring of in-stream habitats, benthic macroinvertebrates, and fish populations. Techniques to evaluate trout spawning habitat were developed by RCWP project personnel.

- *South Dakota:* The Oakwood Lakes - Poinsett CM&E project made significant contributions to the science of NPS control through three major water quality studies: 1) monitoring to determine inputs to ground water from fields; 2) evaluation of nutrient inputs to the lakes from surface and ground water; and 3) evaluation of the transient movement of agricultural chemicals in the vadose zone. Innovative techniques to monitor in the vadose zone and in the lakes were developed.

- *Nebraska*: Farmers participating in the Long Pine Creek RCWP project addressed cropland erosion by implementing irrigation water management BMPs and reduced streambank erosion by installing cedar revetments. This combination of BMPs significantly reduced the sediment load to a trout stream. Biological and fish habitat monitoring in streams demonstrated improvements in the quality of recreational fishing in the creek.

- *Utah*: Animal waste management systems decreased phosphorus concentrations in Snake Creek, thereby reducing the impact of agricultural activity on Deer Creek Reservoir, an important water supply for Salt Lake City.
- *Alabama*: All of the Lake Tholocco project critical area was treated with BMPs to reduce sediment and fecal coliform bacteria levels in runoff from surrounding cropland. Reductions in fecal coliform levels made possible the re-opening of the lake to fishing, boating, water skiing, and other recreational uses.
- *Vermont*: The St. Albans Bay project successfully employed a paired watershed study to document the pollutant export reduction associated with changing from the practice of spreading manure on frozen ground to the manure management BMP in association with waste storage structures. Significant reductions in indicator bacteria levels were documented in tributaries. Violations of water quality standards at the public swimming beach declined.
- *Pennsylvania:* The Conestoga Headwaters project and Pennsylvania State University developed a "quick" nitrogen test and deep-soil nutrient analysis technique. The quick test provided rapid feedback on soil nitrogen content and the amount of additional fertilizer needed to achieve optimum plant growth. The deep-soil analysis indicated the depth to which soil nitrogen and phosphorus were infiltrating, providing a tool for more effective long-term planning and management based on the nutrient reserve in the soil.

In some RCWP projects, it was not possible to document water quality benefits because: 1) impacts of changes in agricultural activities were masked by non-agricultural pollutant sources, 2) the water quality problem was not correctly defined, 3) the extent (area) and strength of land treatment was inadequate, 4) monitoring designs were not adequate to document water quality improvements, 4) an insufficient period of time had elapsed since initiation of land treatment to allow measurement of water quality changes, or 5) export from pollutants accumulated in lake sediments resulted in an inability to document improved water quality despite documented reductions in pollutant loading from a watershed.

However, each project did make progress toward achieving water quality or program objectives, including: 1) development of cooperative relationships among federal, state, and local agencies necessary to implement an effective nonpoint source control program; 2) achievement of significant adoption of cost-shared BMPs to improve water quality under an assistance program; and 3) public perception of water quality improvement associated with the implementation of land treatment.

Selected Highlights: Lessons Learned from the RCWP

Findings

- The most effective information and education approach to gaining producer participation is one-to-one contact between project personnel and farmers.
- The cost of water quality monitoring is relatively low compared to the benefits of such monitoring to the advancement of the science of NPS pollution control.
- A minimum of two years of water quality monitoring is required before land treatment is initiated in order to identify critical pollutant sources and establish baseline water quality conditions.
- The availability and attractive level of cost-share assistance is the most important factor in obtaining producer participation in voluntary NPS control programs.
- Farmer involvement in project planning and problem identification often results in greater participation in voluntary NPS pollution control projects.

Findings (continued)

- Awareness of the impacts of agriculture on water quality does not necessarily translate into ownership of water quality problems by farm operators.
- The fertilizer and pesticide management and conservation tillage BMPs are the most cost-effective practices in terms of requiring the least cost share for the greatest potential water quality benefit.
- Detection of water quality trends is most effective when samples are collected at a consistent frequency and analyzed for a small number of relevant variables.
- Careful planning, including selection of appropriate indicator variables and data management systems, is required to link water quality changes to land treatment.
- A consistent improving trend in water quality after the implementation of BMPs provides evidence needed to attribute water quality improvements to land treatment. Similarly, documented post-BMP implementation water quality improvements in multiple watersheds provides strong evidence that water quality improvements resulted from land treatment.
- A planned program that offers strong guidance yet encourages innovation can motivate the staff of the individual projects and direct them toward achievement of successful projects.

Recommendations

- A national-level inter-agency coordinating committee should be assigned to carry out the main objectives of future NPS pollution control programs. The committee should oversee all program-level functions, such as formulation of regulations; selection of projects; review of monitoring plans; and establishment of minimum reporting requirements, standards of performance, and time frames.
- Federal funds for experimental NPS pollution control programs and projects should be committed up-front and for the entire project period.
- First priority should be given to projects with a high probability for reversing a water use impairment or containing highly valued resources threatened by NPS pollution. This requires clearly documented use impairment or threat; clearly defined, measurable water quality objectives; local support; and adequate technical assistance and information and education.
- The water quality problem must be well defined and documented. A water quality problem statement that includes the pollutant constituents and the impact on designated uses should be written.
- Sufficient and dedicated funding for project activities should be made available. These activities may include information and education, technical assistance, administration, cost share, water quality and land treatment monitoring and evaluation, and economic evaluation, depending on the objectives of the project.
- Monitoring is the primary and most defensible means for evaluating the effectiveness of an experimental NPS pollution control program. Sufficient financial and technical resources must be available to support adequate water quality monitoring and evaluation when the purpose of the project is to document the effect of land treatment on water quality. Funding must include financial support for sufficient pre- and post-BMP implementation water quality monitoring.
- Selection of projects as experimental projects in federally-funded nonpoint source programs should be contingent upon demonstration that matching funds will be available to cover a portion of the project costs.
- Matching federal funds for pre-project planning and assessment should be made available to strong potential projects.
- Project goals must be realistic, specific, and measurable. Monitoring programs should be designed to determine progress toward established goals.
- The critical area must be well defined and must encompass the major pollutant sources. Land treatment must be targeted to critical areas where BMPs will have the greatest effect on the primary pollutants of concern and water quality.

Recommendations (continued)

- Projects should be flexible in modifying land treatment plans based on water quality monitoring results.
- Projects should form a core staff of personnel on detail from participating agencies.
- Projects should designate or hire a project manager.
- Voluntary agricultural NPS pollution programs should place more emphasis on targeting farm operators least likely to participate in such programs. For example, farmers operating smaller and/or less profitable farms and part-time farmers should receive special attention in terms of recruitment when their farms are located in an area identified as critical to water quality.
- Educational programs should be initiated to encourage farm operators to accept responsibility for the effect of their farming operations on water quality.
- Emphasis should be placed on educating farmers about implementation of less familiar BMPs, such as animal waste management systems and pesticide and fertilizer management.
- Emphasis should be placed on the management and maintenance components of BMPs, especially structural BMPs.
- The flexibility to try innovations or modifications to make BMPs more adaptable to specific situations, while maintaining effectiveness, should be incorporated into NPS programs.
- Projects must be flexible in modifying land treatment implementation plans based on water quality monitoring results. Modifications may include types of BMPs cost shared, location of the critical area, level of cost share, and information and education strategies.
- Watershed-scale NPS pollution control projects designed to document water quality changes due to BMP implementation should be funded only when there exists a firm long-term commitment to water quality monitoring and evaluation.
- Significant land use activities should be accounted for in the monitoring program.
- A good experimental design for water quality and land treatment monitoring is essential to clearly document a relationship between land treatment and water quality changes. The paired watershed approach should be encouraged.

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Chapter 1
INTRODUCTION

This publication presents the results of a comprehensive evaluation of the ten-year experimental Rural Clean Water Program (RCWP). The evaluation was conducted by the National Water Quality Evaluation Project (NWQEP) at North Carolina State University (NCSU) in cooperation with the United States Department of Agriculture (USDA), the United States Environmental Protection Agency (USEPA), and the 21 RCWP projects.

1.1 The Rural Clean Water Program

The Rural Clean Water Program is a federally-sponsored nonpoint source (NPS) pollution control program begun in 1980 as an experimental effort to address agricultural NPS pollution problems in watersheds across the country. The enabling legislation was the Agriculture, Rural Development, and Related Agencies Appropriations Act (P.L. 96-108).

The objectives of the RCWP (45 *Federal Register* 14006, March 4, 1980) were to:

- Achieve improved water quality in the approved project area in the most cost-effective manner possible in keeping with the provision of adequate supplies of food, fiber, and a quality environment.
- Assist agricultural land owners and operators to reduce agricultural NPS water pollutants and to improve water quality in rural areas to meet water quality standards or water quality goals.
- Develop and test programs, policies, and procedures for the control of agricultural NPS pollution.

RCWP was administered by the USDA - Agricultural Stabilization and Conservation Service (ASCS), in cooperation with USEPA and the following USDA agencies: Soil Conservation Service (SCS), Extension Service (ES), Economic Research Service (ERS), Forest Service (FS), and Agricultural Research Service (ARS). The U.S. Geological Survey (USGS), universities, and many state and local agencies also participated.

A National Coordinating Committee (NCC) was established to provide oversight and guidance to the RCWP. The NCC was chaired by ASCS; members included USEPA, SCS, ES, ERS, FS and the USDA-Council on Environmental Quality. Programmatic and project-level decisions were made by the NCC and state and local inter-agency coordinating committees.

Each agency's responsibilities within the framework of the RCWP were specified in the *Federal Register* (45 *Federal Register* 14006, March 4, 1980). The roles of the agencies having primary responsibility for administering and implementing the RCWP (ASCS, USEPA, SCS, and ES) are summarized in the following paragraphs.

ASCS was responsible for: 1) chairing the NCC, state coordinating committees (SCCs), and local coordinating committees (LCCs); 2) administering the RCWP; 3) recommending projects for selection as RCWP projects; 4) entering into agreements with other agencies as needed for support to be provided in an approved project; 5) providing administrative support in all RCWP projects (such as accepting applications, preparing and approving contracts, issuing cost-share payments, providing compliance oversight, maintaining records); 6) working with landowners and operators to encourage participation; 7) developing cost-share rates for best management practices (BMPs); 8) coordinating the RCWP and other related programs; and 9) allocating project funds.

USEPA's role included: 1) participating in the NCC, SCCs, and LCCs; 2) participating in project selection; 3) assisting in critical area identification; 4) participating in approval of BMPs to be cost shared; 5) assisting in program evaluation; and 6) assisting in development and evaluation of monitoring for Comprehensive Monitoring and Evaluation projects (RCWP projects that received additional funds for water quality and land treatment monitoring and evaluation).

SCS was responsible for: 1) participating in the NCC, SCCs, and LCCs; 2) coordinating technical assistance and recommending the appropriate agency to provide technical

assistance in each project; 3) providing technical assistance for appropriate BMPs; 4) assisting the LCCs in developing criteria for determining priorities for assistance among individual applicants for RCWP cost-share funds; and 5) providing technical assistance in developing and certifying the technical adequacy of participants' water quality plans.

The role of ES was to: 1) participate in the NCC, SCCs, and LCCs; 2) develop, implement, and coordinate informational and educational (I&E) programs for agricultural nonpoint source pollution control; 3) encourage state and county Extension Services to develop and carry out comprehensive I&E programs; and 4) provide technical assistance for appropriate BMPs, including, but not limited to pest management, conservation tillage, and crop nutrient management, as appropriate.

With a total appropriation of $64 million, the RCWP funded 21 watershed projects across the country. These projects represented a wide range of pollution problems and impaired water uses. The RCWP projects were selected from state lists of priority watersheds developed during the Section 208 planning process under the 1972 Clean Water Act. Projects were located in Alabama, Delaware, Florida, Idaho, Illinois, Iowa, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Nebraska, Oregon, Pennsylvania, South Dakota, Tennessee/Kentucky, Utah, Vermont, Virginia, and Wisconsin.

While water quality monitoring was performed in all 21 projects, five of the RCWP projects (Idaho, Illinois, Pennsylvania, South Dakota, and Vermont) were selected to receive additional funding for comprehensive monitoring and evaluation. These projects are referred to as the Comprehensive Monitoring and Evaluation (CM&E) projects.

Each RCWP project involved both land treatment and water quality monitoring. Landowner participation was voluntary, with cost sharing and technical assistance offered as incentives for implementing best management practices. Landowners were contracted to implement BMPs, with the length of the contract depending on the practice being implemented -- typically a minimum of three years and a maximum of ten years. Most RCWP project contracts began in 1980-81 and ended in 1986. Although the Rural Clean Water Program terminated in 1992, a few individual projects have been extended until 1995.

1.2 Contributions and Successes of the Rural Clean Water Program

The Rural Clean Water Program is one of the few national NPS pollution control programs that has combined land treatment and water quality monitoring in a continuous feedback loop to document the effectiveness of NPS pollution controls. Water quality monitoring results have also been used to adjust and refine land treatment practices designed to control agricultural NPS pollution.

The experience gained through the 21 RCWP projects provides valuable information for personnel involved in current and future NPS control programs and projects. The RCWP projects have made significant contributions to the body of knowledge about NPS pollution, NPS pollution control technology, BMP effectiveness, and the effectiveness of voluntary cost-share programs aimed at assisting producers in reducing agricultural NPS pollution. Some of these accomplishments are listed below:

- *Delaware*: Water quality monitoring in the Appoquinimink River project documented a 60% decrease in phosphorus and a 90% decrease in sediment reaching an impaired water body as the result of implementation of conservation tillage and animal waste management BMPs. Improved fertilizer management cut the pre-project phosphorus application rate in half.

- *Utah*: Animal waste management systems decreased phosphorus concentrations in Snake Creek and, as a result, reduced the impact of agricultural activity on Deer Creek Reservoir, an important water supply for Salt Lake City, Utah.

- *Florida*: Fencing, water management, and animal waste management systems in the Taylor Creek-Nubbin Slough project have reduced phosphorus concentrations in water entering Lake Okeechobee by more than 50%, exceeding project goals.

- *Oregon*: Innovative animal waste management systems installed on dairies in the Tillamook Bay project reduced bacterial contamination of oyster beds in the bay, resulting in the re-opening of shellfish beds to commercial and recreational harvesting.

- *Iowa*: The Prairie Rose Lake project demonstrated that a very high rate of implementation is possible in a voluntary NPS control project. Thirty-four producers (92%) in the project area participated in the project, which was designed to reducing sediment yield from excessively eroding cropland surrounding a recreational lake. Fertilizer management and Integrated Pest Management were implemented on 27 farms (60% of the critical acreage).

- *Idaho*: Water management and sediment control BMPs reduced sediment and phosphorus concentrations in return flows from irrigated land in the Rock Creek CM&E project. Improvements in the ability of the stream to support designated uses were documented through monitoring of in-stream habitats, benthic macroinvertebrates, and fish populations. Techniques to evaluate trout spawning habitat by directly measuring substrate oxygen were developed by project personnel.

- *Maryland*: The Double Pipe Creek project team took advantage of the experimental nature of the RCWP to learn more about the best designs for animal waste storage systems. RCWP funds were used to hire a nutrient management specialist to assist farmers in using manure as fertilizer. This approach was so successful that the position was continued after the RCWP.

- *Pennsylvania:* The Conestoga Headwaters CM&E project staff helped Pennsylvania State University develop a "quick" nitrogen test and deep-soil nutrient analysis technique. The quick test provided rapid feedback on the nitrogen content of soil and the amount of additional fertilizer needed to achieve optimum plant growth. The deep-soil analysis indicated the depth to which soil nitrogen and phosphorus were infiltrating, providing a tool for more effective long-term planning and management based on the nutrient reserve in the soil.

- *South Dakota:* The Oakwood Lakes - Poinsett CM&E project made significant contributions to the science of NPS control through three major water quality studies: 1) monitoring to determine inputs to ground water from fields; 2) evaluation of nutrient inputs to the lakes from surface and ground water; and 3) evaluation of the transient movement of agricultural chemicals in the vadose zone. Innovative techniques to monitor in the vadose zone and in the lakes were developed as part of these intensive studies.

- *Vermont*: The St. Albans Bay CM&E project successfully employed a paired watershed study to document the pollutant export reduction associated with changing from the common practice of spreading manure on frozen ground to the manure management BMP in association with waste storage structures. Significant reductions in indicator bacteria levels were documented in tributaries. Violations of water quality standards at the public swimming beach decreased.

- *Alabama*: One hundred percent of the critical area treatment goals of the Lake Tholocco project was achieved with BMPs designed to reduce sediment and fecal coliform bacteria delivery in runoff from surrounding cropland. The resulting reductions in fecal coliform levels made possible the re-opening of the lake to fishing, boating, water skiing, and other recreational uses.

- *Nebraska*: Farmers participating in the Long Pine Creek project addressed cropland erosion by implementing irrigation water management BMPs and reduced streambank erosion by installing cedar revetments. This combination of BMPs significantly reduced the sediment load to a trout stream. Biological and fish habitat monitoring in streams demonstrated improvements in the quality of recreational fishing in the creek. The project's strong information and education program resulted in reduced fertilizer and pesticide use.

In some RCWP projects, it was not possible to document water quality benefits because: 1) impacts of changes in agricultural activities were masked by non-agricultural pollutant sources, 2) the water quality problem was not correctly defined, 3) the extent (area) of land treatment was inadequate, 4) monitoring designs were not adequate to assess water quality trends, 4) an insufficient period of time had elapsed since initiation of land treatment to allow measurement of water quality changes, or 5) internal (accumulated) sources of pollutants in a lake resulted in an inability to document improved water quality despite documented reductions in pollutant loading from a watershed.

However, each project did make progress toward achieving water quality or program objectives in different ways, including:

- Development of more cooperative relationships among federal, state, and local agencies necessary to achieve an effective nonpoint source control program;
- Achievement of significant adoption of cost-shared BMPs to improve water quality under an assistance program; or
- Public perception of water quality improvement associated with the implementation of land treatment.

1.3 The Evaluation Process

Throughout the decade of RCWP implementation, NWQEP served as a technical support team for the projects and the NCC, performing technical evaluations of projects, analyzing NPS pollution abatement progress, and providing technical assistance on monitoring and data analysis systems. NWQEP performed a comprehensive evaluation of the ten-year RCWP in cooperation with USDA, USEPA, and the 21 projects. The comprehensive evaluation, results of which are reported in this publication, was based on findings from mid- and post-project on-site evaluations of the 21 RCWP projects as well as information drawn from a mail survey of project personnel (Coffey and Hoban, 1992), a telephone survey of farm operators in the project areas (conducted by Hoban and Wimberley of NCSU), project reports, and technical assistance provided by NWQEP to the projects between 1980 and 1992.

A major component of the comprehensive evaluation was information gathered during on-site evaluations conducted by NWQEP during 1991 and 1992. Each project was visited and key project personnel at the federal, state, and local levels were interviewed by evaluation teams composed of NWQEP staff and personnel from SCS, ES, and USEPA.

The objectives of the on-site evaluations (Coffey and Smolen, 1990) (see Appendix VIII) were to:

- Assess cooperation among project team members, committees, and agencies;
- Evaluate agreement between the documented water quality problem and the choice of solutions;
- Assess achievements of the project and individuals in relation to RCWP objectives;
- Evaluate project impacts and progress toward improving water quality; and
- Compile lessons learned in each project.

1.4 Purpose and Contents of this Report

Learning from past experiences and building on successes is vital to the development of effective and efficient NPS control programs. The experience gained through the RCWP and its 21 projects provides valuable information for personnel involved in current and future nonpoint source control programs and projects. Toward this goal of sharing this valuable information, the present document provides a summary of lessons learned from the RCWP.

Chapter 2 summarizes the lessons learned about the design, organization, funding, management, implementation, monitoring, and evaluation of agricultural nonpoint source pollution control projects. Specific project examples are given to illustrate the lessons.

Chapter 3 presents an analysis of responses to a project personnel survey and results of a telephone survey of farm operators in the project areas.

Individual project profiles for each RCWP project are presented in Chapter 4. Each profile includes a project synopsis; project findings, successes, and recommendations; and a description of important aspects of the project (such as water resource type, information and education activities, land treatment implemented, and water quality monitoring program design and results).

The appendices include brief descriptions of the BMPs used in the RCWP (Appendix I), a list of abbreviations (Appendix II), and a glossary of terms used in the text (Appendix III). A complete list of general RCWP publications and lists of project documents and other relevant publications, organized by project, may be found in Appendix IV. Appendix V contains a detailed discussion of sample design and implementation for the farm operator survey. Finally, copies of the farm operator survey questionnaire, the project personnel questionnaire (and a data summary), and the methodology for on-site project evaluation are given in Appendices VI, VII, and VIII, respectively.

References

Coffey, S.W. and T.J. Hoban. 1992. Rural Clean Water Program Methodology for Evaluation: Short Answer Questionnaire. North Carolina State University, Raleigh, NC.

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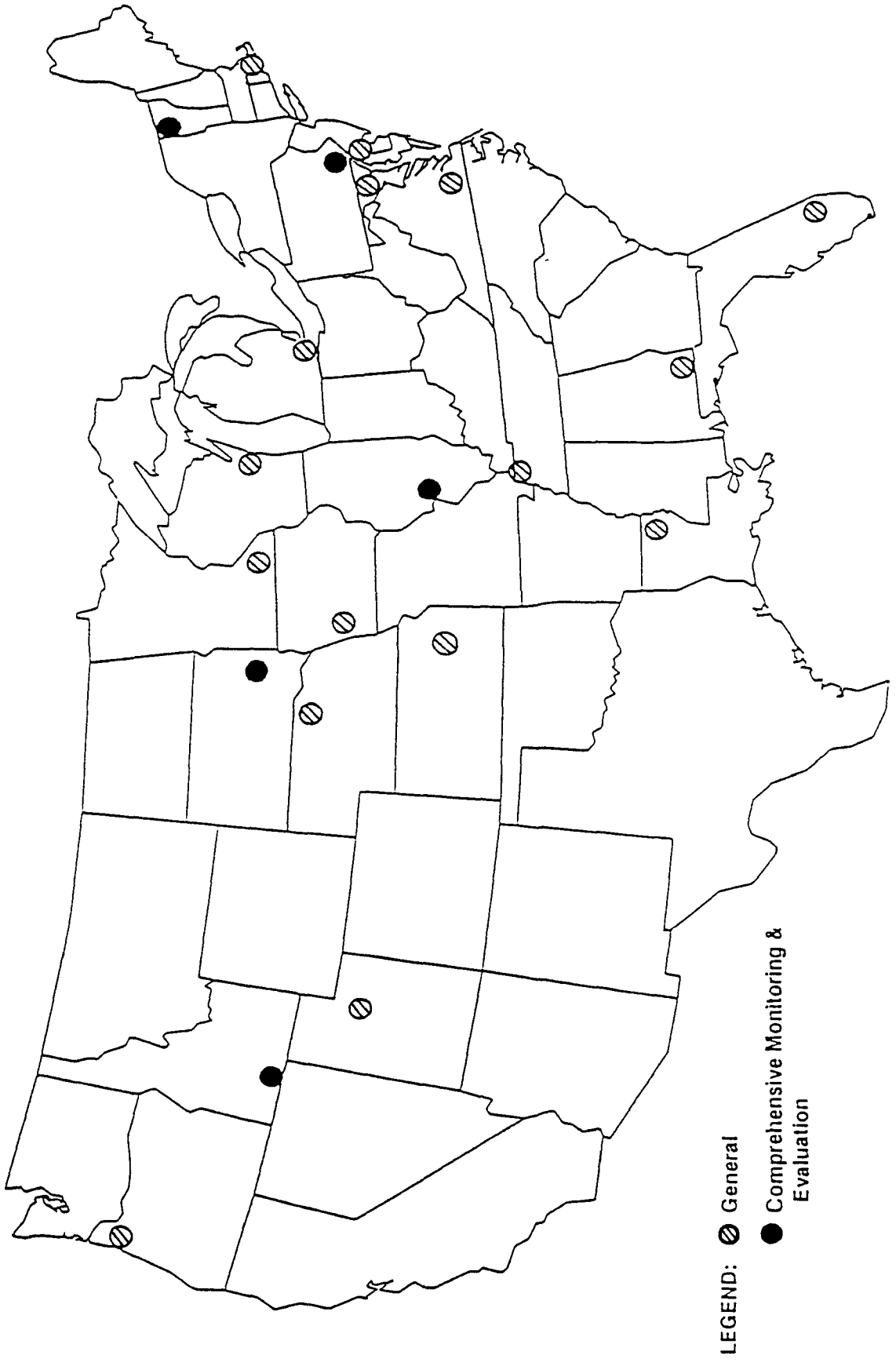

Figure 1.1: Locations of RCWP projects.

Chapter 2
PROGRAM ANALYSIS

The following summary of findings and recommendations from the Rural Clean Water Program (RCWP) was developed from information gained from 10 years of technical assistance to the 21 projects. Primary information sources were on-site evaluations of each of the RCWP projects. A questionnaire developed by Coffey and Smolen (1990) (see Appendix VIII) was used as a guide for conducting over 200 post-project interviews with project staff and producers during 1990 and 1991. Additional sources of information included a telephone survey of farm operators (see Chapter 3), a written survey of project staff (see Chapter 3), and project reports. The results of analysis of this information have been condensed into a series of lessons learned applicable to other nonpoint source (NPS) pollution control efforts. Where applicable, specific examples from RCWP projects are included to illustrate the lessons.

The lessons included in this chapter do not comprise an exhaustive list of all the knowledge gained from the RCWP, but are rather a compilation of recommendations organized around relatively broad themes. (Details on findings and recommendations for each project are given in Chapter 4.) The lessons included here are meant to provide guidance for decision-makers at the national, state, and project levels in developing, implementing, and evaluating NPS pollution control programs and projects.

This chapter focuses primarily on lessons relating to experimental NPS pollution control projects. Experimental refers to projects designed to scientifically evaluate the effectiveness of land treatment strategies (NPS control best management practices (BMPs) and BMP systems) in bringing about water quality improvements. Such projects will, of necessity, involve targeted land treatment and water quality monitoring and evaluation programs sufficient to provide meaningful feedback on the relationship between BMP implementation and water quality changes.

All NPS pollution control projects will not require the high level of land treatment and water quality monitoring discussed in this analysis. However, many of the concepts and lessons should also be kept in mind when planning and implementing NPS projects intended to achieve objectives other than documentation of water quality - land treatment linkage. Such projects would include, for example, educational projects designed to demonstrate specific BMPs and BMP systems. For this and other types of projects, intensive monitoring would probably not be essential.

The program analysis is divided into two sections focusing on program- or national-level topics (section 2.1) and project- or local-level topics (section 2.2). The program-level analysis includes lessons relating to definition of program objectives; national program organization, administration, and management; program funding; project selection criteria; water quality monitoring and evaluation; and program evaluation. Although not always specifically stated, many of these topics contain assessments of the rules and regulations (45 *Federal Register* 14006, March 4, 1980) which established the foundation for successful implementation of the RCWP.

The project-level analysis includes evaluations and recommendations concerning definition of project objectives and goals; project planning, administration, and management; information and education; producer participation; land treatment implementation and tracking; water quality monitoring, evaluation, and reporting; and linkage of land treatment and water quality changes.

2.1 Keys to a Successful Nonpoint Source Pollution Control Program

2.1.1 Definition of Program Objectives

Definition of program objectives is one of the most important tasks in water resource management programs. Although the terms *objective* and *goal* are often used interchangeably, in this report, an objective refers to a focus and overall framework or purpose, while a goal is a more narrowly-focused measurable or quantitative milestone used to assess progress toward attainment of an objective.

■ *Lesson*: **Carefully defined objectives should relate to the designated or expected use of the water resource. The entire set of objectives should be comprehensive such that no important issue related to management of the water resource is missing. Objectives should be clearly defined and attainable within a realistic time frame. To minimize overlap, each objective should focus on a single issue, so that evaluating progress toward one objective will not be contingent upon progress toward another.**

Example: The objectives of the RCWP (45 Federal Register 14006, March 4, 1980) were to:

a) Achieve improved water quality in approved project areas in the most cost-effective manner possible in keeping with the provision of adequate food, fiber, and a quality environment;

b) Assist agricultural landowners and operators to reduce agricultural NPS water pollutants and to improve water quality in rural areas to meet water quality standards or goals; and

c) Develop and test programs, policies, and procedures for controlling agricultural NPS pollution.

Overall the RCWP objectives were comprehensive. However, a) and b) overlapped in that both focused on improving water quality.

■ *Lesson:* **The objectives of future watershed-scale agricultural NPS pollution control programs should be to:**

a) Achieve improved water quality in approved project areas to restore or protect the designated use of surface or ground water resources;

b) Reduce agricultural NPS pollutants and habitat impairment in approved project areas by creating incentives for better management;

c) Minimize economic and social costs of implementing NPS controls; and

d) Develop, implement, and evaluate policies and technologies to control agricultural NPS pollution.

The revised objectives are comprehensive such that no major concepts are missing. Objective a) is broadly stated. Objectives b) - d) support objective a) by focusing on the major issues of pollution reduction, minimizing costs, and program development.

2.1.2 National Program Organization, Administration, and Management

National level organization, administration, and management affect all activities involved in a NPS pollution control program and are vital to the success of the program. The way the projects are to be carried out, the type of management practices to be used, and the overall tone and enthusiasm for the program are set at the national level. A planned program that offers strong guidance yet encourages innovation and unique solutions can motivate the staff of the individual projects and direct them toward achievement of successful projects.

2.1.2 National Program Organization, Administration, and Management (continued)

- *Lesson*: **A well-defined structure with clearly stated roles for participating agencies is an essential component of a successful NPS pollution control program.**

  Example: The programmatic structure of the RCWP was sound, the National Coordinating Committee (NCC) functioned well, and the program demonstrated that the U.S. Department of Agriculture (USDA) and the U.S. Environmental Protection Agency (USEPA) can work well together. At the national level, the RCWP was administered by the USDA - Agricultural Stabilization and Conservation Service (ASCS) in consultation with USEPA. Other USDA agencies, including the Soil Conservation Service (SCS), the Extension Service (ES), the Agricultural Research Service (ARS), the Economic Research Service (ERS), contributed in numerous ways. The U.S. Geological Survey (USGS), universities, and many state and local agencies also participated in the RCWP. Programmatic and project-level decisions were made by the national, state, and local RCWP inter-agency coordinating committees (the National, State, and Local Coordinating Committees).

- *Lesson*: **NPS control programs should involve all federal agencies concerned with NPS pollution control. Participating agencies should include USEPA, USDA, USGS, NOAA, and other interested agencies. Key agencies within USDA whose participation is important include ASCS, SCS, ES, ARS, FS, ERS, and FmHA.**

  Example: In the RCWP, ASCS provided leadership in program administration; SCS in technical assistance for land treatment; USEPA in water quality monitoring; and ES in information and education. In addition, ARS and USGS provided technical assistance at the project level for evaluating the effectiveness of best management practices (BMPs), water quality sampling, and data management.

  Example: The structure of the RCWP at the national level has demonstrated that the involvement of multiple federal agencies strengthens a NPS control program. The various agencies can and must collaborate to produce effective and efficient NPS control programs.

- *Lesson*: **A national-level inter-agency coordinating committee, chaired by a lead agency, should be assigned to carry out the main objectives of future NPS pollution control programs. The committee should oversee all program-level functions, including formulation of program regulations; establishment of maximum cost-share levels; selection of projects; review of land treatment and water quality monitoring and analysis plans; and establishment of minimum reporting requirements, standards of performance, and time frames. The committee should have the authority to place a project on provisional status, revise a project, or terminate a project if it does not meet minimum performance standards.**

  Example: RCWP was administered by the USDA - Agricultural Stabilization and Conservation Service (ASCS), in cooperation with USEPA and the following USDA agencies: Soil Conservation Service (SCS), Extension Service (ES), Economic Research Service (ERS), Forest Service (FS), Agricultural Research Service (ARS), and Farmers Home Administration (FmHA). The U.S. Geological Survey (USGS), universities, and many state and local agencies also participated.

  Example: A National Coordinating Committee (NCC) was established to provide oversight and guidance to the RCWP. The NCC was chaired by ASCS. NCC members included the USDA-Office of Environmental Quality, USEPA, SCS, ES, ERS, FmHA, and FS. Programmatic and project-level decisions were made by the NCC and state and local inter-agency coordinating committees.

  Example: The ASCS was well suited to chair the National Coordinating Committee and manage a program with monetary incentives; ASCS provided capable leadership in administering the RCWP.

2.1.2 National Program Organization, Administration, and Management (continued)

- *Lesson:* **Roles and responsibilities of participating agencies should be clearly defined, and should include inter-agency cooperation and communication as primary responsibilities of each agency. Guidelines should be established to ensure manageable agency workloads.**

  Example: Clearly defined agency roles (45 *Federal Register* 14006) at the program and project levels contributed to a high degree of inter-agency cooperation in the RCWP.

  Example: The requirements of the 1985 Food Security Act (Farm Bill) utilized much of the limited resources of USDA-ASCS and USDA-SCS, making it difficult for some projects to maintain sufficient attention to the RCWP.

- *Lesson:* **The national coordinating committee should establish a realistic time frame and sequence for project activities that ensures a proper sequence for pre-project problem assessment, planning, and monitoring; implementation; and post-project monitoring and evaluation.**

  Example: Because of its relatively long duration, the RCWP is one of few NPS programs that allowed for adequate pre- and post-BMP implementation monitoring of land treatment, land use, and water quality to assess, on a watershed scale, water quality changes resulting from NPS controls. Projects that achieved proper sequencing of activities and adequate critical area land treatment had the highest probability of documenting water quality improvements (Idaho, Oregon, Utah, Florida, Vermont).

  Example: Initially, the Illinois project lacked specific data to characterize water quality impairments and identify pollutant sources. Later, suspended sediment originating from natric soils was identified as the primary pollutant, the land treatment focus was narrowed to natric soils, and critical area was redefined.

  Example: In 1983, the Kansas project was terminated, primarily due to a national-level inter-agency team determination that the water quality problem was not adequately documented.

- *Lesson*: **The national coordinating committee should provide technical assistance to projects throughout the program. This can be achieved by establishing a technical support group to assist project personnel in assessing water quality problems, developing realistic objectives, delineating critical areas, and developing effective water quality and land treatment monitoring and evaluation programs. The technical support group should also assist the national-level coordinating committee by recommending projects for inclusion in the program, project reporting requirements and formats, and an appropriate plan for program and project evaluation.**

  Example: The National Water Quality Evaluation Project (NWQEP) at North Carolina State University (NCSU) provided technical assistance to each RCWP project and performed on-site project evaluations. NWQEP staff assisted in the final RCWP evaluation by articulating lessons learned, identifying water quality improvements, and making recommendations for future programs.

  Example: The NCC, with assistance from NWQEP and project representatives, held nine annual RCWP workshops from 1982 to 1991. Workshop topics included project start-up, progress assessment, data management, mid-program evaluation, technology transfer, ten-year reporting, and program evaluation. Representatives from ASCS, SCS, ES, the state water quality agency, and USGS were encouraged to attend and the NCC provided travel funding to assist many project participants. (See Appendix VII, Question 33 for the number of people attending). A survey of project personnel (see Chapter 3) indicated that 76% of the participants believed that the workshops helped projects meet their objectives. Comments indicated that projects would have benefited from more workshops held earlier.

  Example: Thirty-three percent of the personnel survey respondents identified insufficient technical assistance as an impediment to the attainment of RCWP project goals. Specific areas identified as lacking sufficient technical assistance were I&E, structural and management BMPs, development of farm plans, and land treatment and water quality monitoring design.

2.1.2 National Program Organization, Administration, and Management (continued)

- *Lesson*: **A member of the technical support group should be designated by the national-level coordinating committee to act as a support person to one or more projects. The role of the support person should include evaluating project requests for assistance, providing additional information to the national-level coordinating committee, and offering technical assistance to designated projects.**

- *Lesson*: **Criteria for project selection should be established and publicized well in advance of the application period. This will improve project applications and help the national coordinating committee to select and fund only those projects with the highest potential for water quality restoration, improvement, or protection.**

- *Lesson:* **NPS programs should require a minimum of two years of water quality monitoring before land treatment is initiated in order to ensure identification of critical pollutant sources, establishment of baseline water quality conditions, and planning of an appropriate land treatment strategy to control critical pollutant sources.**

2.1.3 Program Funding

Funding mechanisms, logistics, and allocations can have a profound impact on the effectiveness of NPS pollution control programs and projects. The RCWP experience offers a number of lessons that can assist policy makers and program managers in effectively using limited resources to increase the probability of meeting water quality objectives and to advance technology development and transfer.

- *Lesson*: **Federal funds for NPS control programs and projects should be committed up-front and for the entire project period.**

  Example: RCWP funding was made available at the initiation of each project, facilitating long-term planning and budgeting. In contrast, budgets for the current USDA Demonstration and Hydrologic Unit Area projects must be approved each year. The associated annual delays and uncertainties adversely affect long-range planning and commitments by the agencies involved. Funding uncertainties have delayed implementation of information and education activities in some current NPS projects.

  Example: The majority of project personnel and RCWP participants surveyed were satisfied with the financial assistance that farm operators received through the RCWP.

- *Lesson*: **Selection of projects to participate in federally-funded nonpoint source programs should be contingent upon the availability of matching funds from local, state, or other federal sources to cover a portion of the project costs. Such cost sharing between the federal and local or state levels can serve to stretch increasingly limited resources and help insure that there is a strong commitment to projects at the local and state level. However, it should be noted that a high matching requirement may be an obstacle to some projects. Flexibility will be needed in determining a feasible level for local and state matching funds.**

  Example: The RCWP was designed to include a substantial level of matching state and local funding to supplement federal funds supporting the program. This sharing of project costs helped insure that sufficient local and state support for some projects existed. However, in many cases matching funds, particularly for water quality monitoring, could not be obtained. This resulted in many RCWP projects being unable to establish viable water quality and land treatment monitoring programs and unable to document a link between BMP implementation and water quality changes.

2.1.3 Program Funding (continued)

- *Lesson*: **Matching federal funds for pre-project planning and assessment should be made available to strong potential NPS projects. Such funds should be used for documentation of the water quality problem; identification and quantification of major pollutants and their sources; refinement of project objectives and goals; identification, quantification, and targeting of critical areas; identification of the most cost-effective BMPs; estimation of the cost of achieving project water quality objectives; assessment of socio-economic benefits of attaining water quality objectives; and data collection. Results of pre-project activities should be factored into final project selection decisions.**

  Example: In the Westport River RCWP project (Massachusetts), the community was not involved in the definition of project objectives. The relative contributions of agriculture and residential development to the NPS problem were not well documented. As a result, consensus about both the need for the project and the source of the problem was lacking among the general community, the dairy farming community, and local agencies involved in the project. The result was lack of local support for the project and poor producer participation. Pre-project planning and assessment funds would have assisted the project team in documenting the source of the water quality problem and involving the farm community and general public in discussions of the problem, its causes, and possible approaches to it. These activities would have provided critical information to both the Local and State Coordinating Committees and the members of the NCC about appropriate land treatment strategies and even the advisability of selecting the Massachusetts project for RCWP funding.

  Example: The Reelfoot Lake RCWP project in Tennessee and Kentucky also could have benefited from pre-project support for water quality problem documentation. During the project period, a number of studies were conducted in an attempt to understand the lake as a system and the impacts of pollutants on it. If the information from these studies had been available before the project was initiated, it is possible that the water quality problem would have been addressed by different, more effective BMPs and that the critical area would have been defined more accurately and effectively.

  Example: Critical area definition was difficult in the Illinois project because the water quality problem was incorrectly identified at the start of the project. Originally, the project developed implementation goals to reduce lake sedimentation and turbidity by targeting for treatment all critical area cropland with high runoff and erosion rates. Monitoring studies conducted during the project period indicated that suspended sediments originated from natric soils on slopes of less than 2%. If the project team had had this information at the beginning of the project, the critical area would have been more narrowly defined based on treatment of natric soils. Pre-project funding for problem definition and assessment would have assisted this project in more accurately defining the critical area from the beginning of the project. It is possible that as a result of such pre-project problem identification and assessment, this project would not have been selected due to a low probability of decreasing turbidity in Highland Silver Lake.

  Example: Although no matching federal funding was available for pre- project planning and assessment prior to project selection under the RCWP, a few project teams (Idaho, Florida, Iowa, Oregon, Utah, Vermont) successfully developed well-defined water quality problem information, excellent pre-project work plans, and land treatment implementation programs clearly focused on the water quality problem. This early work significantly strengthened the projects and enabled the project teams to conduct projects that contributed to the science of NPS pollution control.

2.1.3 Program Funding (continued)

- *Lesson*: **Sufficient and dedicated funding for each project activity should be made available, including: information and education, assessment and targeting, technical assistance, administration, cost share, water quality monitoring and evaluation, land treatment tracking and evaluation, and economic assessment.**

  Example: Federal funds were available to all RCWP projects for technical assistance, cost share, and I&E activities. Comprehensive Monitoring and Evaluation (CM&E) projects received extra water quality monitoring funds.

  Example: In several projects (Massachusetts, Wisconsin), lack of sufficient funds specifically earmarked for I&E resulted in delays or gaps in activities essential for informing and involving the farm community in the project.

  Example: The Michigan LCC attempted to obtain local funding for water quality monitoring, with limited success. If the Great Lakes Environmental Research Laboratory had not volunteered such services, there would have been no water quality monitoring program.

  Example: Several general RCWP projects were able to obtain local and state resources to develop strong water quality monitoring programs which contributed to successful evaluation of BMP effectiveness (Florida, Oregon, Utah).

- *Lesson*: **Financial and technical support is needed for effective systems (including geographic information systems (GIS)) for tracking BMP implementation on a field-by-field basis and documenting changes in factors such as land use, animal numbers, and cropping patterns to evaluate effects of land treatment on water quality.**

  Example: Projects with financial resources and expertise to implement effective land treatment tracking systems were better able to link BMP implementation with water quality changes than other projects. For example, the combination of a SCS computerized data base documenting land treatment and GIS maps in the Vermont project proved invaluable for linking BMP implementation to water quality changes. The Idaho project compiled similar data bases and used a GIS to evaluate water quality changes.

- *Lesson*: **Monitoring is the primary and most defensible means for evaluating experimental NPS pollution control program effectiveness. Sufficient resources must be available to enable all projects to meet minimum land treatment and water quality monitoring requirements. Federal and/or state funding is needed to encourage consistent, continuous monitoring. Adequate and stable staffing for project monitoring and evaluation is critical.**

  Example: The five CM&E projects (Idaho, Illinois, Pennsylvania, South Dakota, Vermont) received funding specifically for water quality monitoring and evaluation. In general, these projects were more successful than other RCWP projects in collecting water quality data, documenting water quality trends, and linking water quality changes to land treatment. Many of the non-CM&E projects (Iowa, Maryland, Delaware, Michigan, Minnesota, Nebraska) would have benefited from additional funds to support monitoring activities.

  Example: Several CM&E projects made significant contributions to nonpoint source pollution control. The Vermont project successfully employed a paired watershed study to document pollutant export reduction associated with changing from the common practice of winter spreading of manure to the animal waste management BMP. The South Dakota project conducted three major studies: ground water monitoring of field sites to determine inputs to ground water from fields, evaluation of nutrient inputs to lakes from surface and ground water, and evaluation of transient movement of agricultural chemicals in the vadose zone. Innovative techniques for vadose zone and lake monitoring were developed. The Idaho project developed techniques to directly measure trout spawning habitat by using simulated trout redds to measure substrate dissolved oxygen. Since the technique is applied where fish eggs and fry live, it gives a more accurate measure of fish habitat than would the same variables in the water column.

  Example: Although all projects were required to assure a minimum level of water quality monitoring, non-CM&E projects generally were less successful in carrying out effective monitoring programs. Non-CM&E projects that established meaningful monitoring programs usually received significant support from state water quality agencies or other federal agencies (Minnesota, Florida, Oregon, and Utah).

2.1.3 Program Funding (continued)

- *Lesson*: **Funding for water quality monitoring and evaluation in projects whose purpose is to document land treatment - water quality linkage must include financial support for sufficient pre- and post-BMP implementation water quality monitoring to facilitate collection of baseline water quality data (if such data do not already exist) and to measure the long-term impacts of land treatment on water quality.**

  Example: The Taylor Creek - Nubbin Slough RCWP project in Florida had access to several years of excellent pre-project and pre-BMP monitoring data collected by the ARS and the South Florida Water Management District. Coupled with several years of post-BMP monitoring, these pre-project data made it possible for the project team to document the water quality improvements achieved through the RCWP.

  Example: The Utah project clearly demonstrated fecal coliform and nutrient reductions from animal waste management by comparing pre- and post-BMP monitoring data. The Nebraska project has a pre-BMP water quality data base of biological, chemical, and physical variables that will be useful for comparison to their post-BMP monitoring data. The Idaho, Oregon, and Vermont projects also effectively used pre- and post-BMP implementation monitoring to document water quality improvement.

  Example: In the Massachusetts, Wisconsin, and Louisiana projects, there was a significant lack of involvement of the state water quality agency in the water quality monitoring program . Federal funds for monitoring might have encouraged the active participation of these agencies.

  Example: An initial baseline data set for water quality was established in the Virginia project due to previous state-sponsored monitoring of project area water supply reservoirs and shellfish beds. This pre-project monitoring was followed by monthly sampling to detect water quality trends included as part of the RCWP project. However, lack of funds caused the cancellation of the proposed final monitoring effort. In addition, there was a critical lack of direct monitoring of land treatment to determine the effects of BMPs on water quality. Additional RCWP funds made available specifically for water quality monitoring could have strengthened this project's efforts to document water quality changes attributable to land treatment.

2.1.4 Project Selection Criteria

Selection of projects that have a high probability of documenting both water quality changes and a correlation between land treatment and water quality improvement is crucial for experimental NPS pollution control programs. Selecting projects based on the criteria outlined below is the first step in a successful NPS control program.

- *Lesson:* **Projects where there is a high probability for reversing a water use impairment, or that contain highly valued water resources threatened by NPS pollution, should be given highest priority in the selection process. Projects addressing water resources with high public value, many users, high visibility, clearly documented impairment of beneficial use, adequate staff and expertise for technical assistance, and I&E support generally have the highest probability of producing economic and social benefits.**

  Example: Many RCWP projects had well-documented water quality problems. The Florida, Oregon, Pennsylvania, Utah, and Vermont RCWP projects addressed high fecal coliform and nutrient levels. In Idaho, Iowa, and Nebraska, sediment was identified as the primary pollutant.

  Example: Lake Okeechobee in Florida is a high priority water resource threatened by phosphorus NPS pollution. The lake serves as a primary water source for five cities and as a secondary water resource for southern Miami. It also supports recreational and commercial fishing and provides habitat for large migratory fowl. Protecting this resource from further impairment will be much more cost-effective than trying to restore it once it is further impaired.

  Example: The Prairie Rose Lake Project in Iowa and St. Albans Bay project in Vermont revolved around local recreational resources highly valued by producers farming the surrounding land. The result was high motivation to participate.

  Example: Tillamook Bay in Oregon supports a commercially important shellfish industry. There was a high probability of reducing fecal coliform numbers in the bay with sufficient land treatment. The RCWP project, aimed at reducing fecal coliform entering the Bay from dairies, received a high level of local support.

2.1.4 Project Selection Criteria (continued)

- *Lesson:* **Clearly defined and realistic water quality objectives and goals improve a project's probability of success. Objectives and goals for water quality and land treatment should be directly related to the water quality impairment or conditions threatening designated uses.**

  Example: The Florida, Idaho, Oregon and Utah projects had well defined objectives and quantitative water quality goals that were obtainable given their planned land treatment goals.

  Example: Iowa project land treatment goals were control of soil erosion on at least 80% of the cropland in the project area and 83% of the critical area. These goals were realistic given the small size of the watershed, the relatively small number of producers, the highly-visible water quality problem, and strong community support.

  Example: Initially, the Nebraska project lacked clearly defined water quality and land treatment goals. However, during the project, quantitative water quality and land treatment goals were developed; these contributed to a high level of landowner participation in the critical area.

- *Lesson:* **A critical area should be delineated to identify and encompass the major pollutant sources that have a direct impact on the impaired water resource. Planned BMP implementation should be targeted to the critical area and primary pollutants.**

  Example: The Alabama, Florida, Idaho, Iowa, Utah, and Vermont projects had well-defined critical areas, facilitating targeting of specific BMPs to effectively reduce pollutant delivery.

  Example: The Vermont critical area was defined as farmsteads contributing excessive manure and fecal coliform to waterways. Critical area farm numbers remained essentially the same throughout the project. By targeting appropriate farms and applying the right BMPs, fecal coliform levels were significantly reduced.

  Example: Although the number of farmers targeted for participation in the Alabama project was reduced, the critical area acres remained the same throughout the project. All of the critical acres were treated and the project reduced fecal coliform levels to the point where water contact sports could be resumed in the lake.

- *Lesson:* **Inter-agency cooperation and institutional coordination are important in successful project initiation and implementation. Only projects that have demonstrated strong inter- agency and institutional relationships and commitment to the project should be selected.**

  Example: Inter-agency cooperation in the Tennessee/Kentucky project encompassed agencies from two states and three counties. The cooperation and coordination among these groups was outstanding and could be used as a model for other projects.

  Example: The Oregon project was able to accommodate, utilize, and organize many different types of agencies: federal, state, local, private, and commercial. Project success was heavily dependent on the cooperation and coordination of all of these groups. Inter-agency cooperation and coordination was also exemplary in the Alabama, Delaware, Florida, Idaho, Iowa, Maryland, Pennsylvania, South Dakota, Utah, and Vermont projects.

  Example: The Virginia project had excellent cooperation and coordination during the implementation phase of the project which was concluded in 1985. After implementation, meetings between the groups ceased. As a consequence, the land treatment and water quality groups were unaware of the results of each group's efforts.

  Example: There was a significant lack of consensus among the local agencies involved in the Massachusetts RCWP project about the importance of the project, the major source of the coliform problem, and the value of the BMPs being recommended to producers. The resulting lack of inter-agency cooperation and coordination resulted in mixed messages sent to project area dairy farmers by the different agencies and, consequently, poor producer participation.

2.1.4 Project Selection Criteria (continued)

- *Lesson*: **Nonpoint source pollution programs restricted to addressing agricultural sources should avoid watersheds that contain significant point sources because pollutant loadings from point sources often mask water quality changes associated with NPS controls. Other approaches, such as total watershed management, which include both point and nonpoint sources of pollution can be effective if adequate resources are available.**

  Example: In Michigan, a sewage treatment plant, which had a dominant effect on nutrients in the water, masked the effects of the nonpoint source controls. In the Vermont project, the upgrading of a wastewater treatment plant improved the water quality, thereby rendering analysis of water quality trends associated with the NPS land treatment program more difficult.

  Example: Although producer participation was high in the Virginia project, project personnel were unable to distinguish between lowered trends in phosphorus content caused by project activities from a continuing down trend due to the cessation of point source pollution in the late 1960's.

  Example: In the Massachusetts project area, extremely large dairy herds located on very small acreages adjacent to an estuary containing a commercially important shellfish resource as well as heavy residential development both factored into the serious water quality problem in the Westport River estuary. Lack of clear data documenting the relative contributions of these sources on the pollution of the shellfish beds contributed to the perception by dairy farmers that they were being unfairly singled out as the source of the problem. For this and other reasons, participation in the project was poor.

  Example: Point source feedlots and a sewage treatment plant in the Nebraska project area contributed to high bacteria and nutrient loadings. These point sources could not be treated under the RCWP, making changes in water quality due to RCWP nutrient management BMPs difficult to detect.

  Example: The Florida, Idaho, Iowa, Pennsylvania, and Utah RCWP areas were ideal for documenting water quality improvements resulting from NPS controls because the major pollution sources in the watersheds were agricultural.

- *Lesson*: **Small watersheds (critical area of roughly 30,000 acres or less) are easier to treat and monitor and should, therefore, be given special consideration in the selection process. However, size should not be the only criterion for selection.**

  Example: Most of the projects considered successful in reducing NPS pollution contained fewer than 30,000 critical area acres (Alabama, Delaware, Iowa, Maryland, Utah, Vermont, and Oregon). Small critical areas contributed to a high rate of producer participation and ability to achieve land treatment and water quality goals. However, the two projects with the largest critical areas, Florida and Idaho, were also able to significantly reduce NPS pollution.

  Example: An equal number of projects with critical areas of less and more than 30,000 acres were unable to verify a NPS pollution reduction.

- *Lesson*: **Projects with high potential for documenting significant pollution reduction as a result of BMP implementation should be selected for experimental NPS programs. The pollutant transport system should be characterized such that appropriate water quality and land treatment goals can be formulated and effective monitoring strategies developed. Useful tools include water quality models and water and nutrient budgets for predicting likely water quality improvements.**

  Example: Use of the AGNPS model caused a redefinition of the Minnesota project critical area, allowing targeting of essential areas.

  Example: A very small watershed containing only seven dairies and one horse farm, with concerned owners, resulted in high potential for Utah project water quality improvements.

  Example: The Taylor Creek (Florida) project modeled nutrient budgets to predict reductions in annual phosphorus loads from the basin using a hypothetical maximum BMP scenario.

  Example: Although potential was high for achieving a significant phosphorus reduction in St. Albans Bay, existing high levels of phosphorus prevented attainment of a significant decrease in inner bay waters during the Vermont project period.

2.1.4 Project Selection Criteria (continued)

- *Lesson*: **There should be a potential for high level of landowner participation in the critical area and landowners should be willing to implement the most effective BMPs and adopt alternative agricultural systems that are integrally tied to water quality improvements and project goals.**

  Example: In the Lower Kissimmee River project (Florida), the BMP emphasis and farm operations were modified to enhance recycling of all nutrients produced on the dairy farms. Additional structural and management BMPs necessary to meet phosphorus reduction goals were incorporated into land treatment plans when this basin was added to the Florida project in 1988.

  Example: The Idaho project had a high level of landowner participation throughout the project period. The emphasis was changed from sediment trapping at the edge of the field to more cost-effective management practices (such as conservation tillage) during the second half of the project.

  Example: Excellent I&E programs were instrumental in ensuring a high level of landowner participation in the Alabama, Delaware, Florida, Idaho, Iowa, Maryland, Nebraska, Oregon, Utah, and Vermont projects.

- *Lesson:* **Experimental projects should develop water quality and land treatment monitoring plans that can adequately document changes in land treatment, land use, and water quality.**

  Example: The Florida, Idaho, Oregon, Pennsylvania, Utah, and Vermont projects had good monitoring designs for documenting changes in water quality in subwatersheds and entire project areas. These projects monitored 1) throughout the project time frame with consistent sampling and 2) before and after BMP implementation at multiple sites. They were able to isolate the effects of BMPs by monitoring explanatory variables, including season, stream discharge, precipitation, and land use changes.

  Example: Although successful in most other project aspects, the Delaware, Iowa, Maryland, and South Dakota projects lacked pre-project water quality monitoring data, which impeded their ability to make quantitative statements regarding water quality improvements.

2.1.5 Water Quality and Land Treatment Monitoring and Evaluation

Water quality monitoring is essential for determining project results and evaluating the effectiveness of land treatment. The RCWP projects required water quality monitoring and provided valuable documentation of water quality improvements due to land treatment. However, some RCWP projects lacked the water quality data necessary to determine the effectiveness of BMPs in reducing NPS pollution to meet water quality goals or water quality standards.

Because financial assistance is required to encourage consistent and continuous water quality and land treatment monitoring throughout the project period, funding for water quality monitoring should be authorized as part of NPS pollution control programs. Effective land treatment and water quality monitoring for NPS control projects, and clear, well-documented reporting of the results of such monitoring are required to:

a) Document progress toward water quality goals;
b) Determine needs for further or different treatment;
c) Maintain the interest of project participants and staff;
d) Develop and transfer technology;
e) Reduce the number of inconclusive studies conducted;
f) Sustain Congressional support;
g) Assure credibility; and
h) Address increasing information needs.

2.1.5 Water Quality and Land Treatment Monitoring and Evaluation (continued)

- *Lesson*: **Land treatment, land use, and water quality monitoring guidance for experimental NPS programs should be established by USEPA in consultation with other federal, state, and local agencies. Minimum monitoring standards should be established to facilitate technically valid evaluations of projects. The overall purpose of such monitoring is to collect water quality and land treatment data simultaneously to determine if water quality changes can be documented and associated with changes in land treatment.**

  Example: Only a few projects (Idaho, Florida, Vermont, Utah, Oregon) had water quality monitoring designs adequate to determine the impact of BMPs on water quality. Minnesota and South Dakota used vadose zone monitoring to show a relationship between field practices and water quality, but were unable to demonstrate an overall change in water quality. Likewise, the Pennsylvania project did some good small-scale sampling, but was unable to show overall changes in water quality. The majority of the projects could have benefited from guidance in water quality monitoring design.

- *Lesson:* **Experimental projects designed to establish water quality - land treatment relationships require sufficient funding for consistent, minimum monitoring and evaluation throughout the project period.**

  Example: The Vermont, South Dakota, Idaho and Pennsylvania (selected to receive CM&E funds) and the Florida, Oregon, and Utah projects were successful in securing funds for project water quality monitoring and evaluation during and at the end of the project period. Although resource intensive, these evaluations and analyses contributed new insights into the relationship between water quality and land treatment.

  Example: Many projects (Virginia, Tennessee/Kentucky, Alabama, Louisiana, Massachusetts, Michigan, Minnesota, Wisconsin) were unable to secure consistent funding for monitoring and, as a consequence, had difficulty documenting water quality changes.

- *Lesson:* **The cost of water quality monitoring is relatively low compared to the benefits of monitoring to the advancement of effective NPS pollution control.**

  Example: The cost of monitoring for the RCWP was approximately 16% of total program costs; the technology development and technology transfer benefits of monitoring in the RCWP have been substantial. Likewise, the 5 - 10% of the Clean Lakes Program budget spent on monitoring has contributed significantly to more effective treatment of lake problems. On the other hand, lack of effective monitoring programs has limited the value of the Model Implementation Program, some RCWP projects, and, based on current indications, USDA Hydrologic Unit Area, Demonstration, and Management Systems Evaluation Areas water quality projects.

  Example: Water quality monitoring provided good feedback on the extent of impacts that RCWP land treatment efforts had on water quality in the Florida (Taylor Creek - Nubbin Slough), Idaho, Vermont, South Dakota, Pennsylvania, Utah, Oregon, and Nebraska projects. The cost of water quality monitoring ranged from 2 to 51% in these projects, with an average of 31%. The relative cost was highest for the Vermont, South Dakota, and Pennsylvania CM&E projects (approximately 50% of their total budgets). The Idaho CM&E project spent 26% of its funds on water quality monitoring and evaluation. In addition to trend monitoring, monitoring performed by these eight projects involved extensive experimental research addressing monitoring techniques and land use effects on biota and habitat, surface water chemistry, ground water, and vadose zone.

2.1.6 Program Evaluation

Program and project evaluation are key components of any effective NPS pollution control program. Evaluation results can be used during the project to call attention to the need for adjustments that will result in a more successful project. Overall program evaluation is essential if federal and state program managers and decision makers are to incorporate lessons learned from NPS projects into future programs. Feedback in the form of program evaluation and technology transfer is also crucial for legislators and others involved in funding decisions so that limited resources are used as effectively as possible to address NPS pollution problems.

2.1.6 Program Evaluation (continued)

- *Lesson:* **A thorough program evaluation by a technical support group with NPS expertise should be planned, funded, and scheduled at the beginning of the program. The evaluation should include periodic on-site evaluations of all projects with clear provisions for feedback to each project team. This feedback would ideally be used by the project team to make mid-course refinements in project direction, emphasis, monitoring, and implementation. Such an evaluation can also provide important information for policy makers and the public about the successes of individual projects and the program as a whole. This information is essential to ensure that lessons learned from experimental programs are shared with others working in the nonpoint source pollution control field, the public, and federal and state government officials responsible for making decisions about water quality management policy and funding.**

  Example: Technical assistance to and occasional on-site evaluations of RCWP projects were provided through the ten-year RCWP period by the National Water Quality Evaluation Project. Technical assistance emphasized providing feedback to project teams and facilitating sharing of lessons learned by projects with all RCWP project personnel, the NCC, professionals and producers involved in other NPS pollution control efforts, federal and state program managers, and legislators. Workshops were held throughout the ten-year period in an attempt to bring together project staff from the 21 RCWP projects for information sharing. A bi-monthly newsletter, *NWQEP NOTES*, has been published by NWQEP since 1983. The newsletter has provided a vehicle for the exchange of information about the RCWP and other nonpoint source pollution control programs and efforts. Several reports on the RCWP have also been published, presenting general and specific information about the RCWP as well as detailed descriptions of each RCWP project (Smolen et al., 1989; Spooner et al., 1991). This evaluation report is an example of program evaluations that have been performed by the NWQEP, with an emphasis on disseminating lessons learned to current and future NPS control program managers and personnel.

- *Lesson:* **Annual and end-of-project reporting by each project should be required. Reporting requirements and the format for required data should be clearly specified at the beginning of the program.**

  Example: Each RCWP project was required to submit an annual report documenting the water quality problem and progress toward achieving the project's information and education, land treatment, and water quality goals. Some guidance was provided to the project teams relating to the required narrative sections. Standard RCWP forms were also required for documenting annual land treatment progress. However, these standardized data were not adequate by themselves to enable projects to link land treatment and water quality improvements (for further discussion of this issue, please refer to sections 3.2.5, 3.2.6, and 3.2.7).

  Example: Some projects lacked a clear understanding of the land treatment and land use data required so that a seasonal or annual summary could be prepared and that eventual linkage with the water quality data would be possible. The common problem encountered was the lack of documentation of acres affected by both land treatment implementation and land use changes on a drainage subwatershed basis for BMPs for a given year. The definition of acres affected (served), delineation of drainage basins, effect of overlapping BMPs serving the same acres, and dates of implementation and effectiveness needed to be more clearly defined for each project.

  Example: End-of-project reporting was performed by each project submitting a ten-year report that summarized project objectives and goals, land treatment, information and education, water quality monitoring, and other aspects of the RCWP projects. These reports were valuable in providing summary documentation of each project, summarizing project results, and contributing significantly to effective and comprehensive program evaluation.

  Example: A number of projects noted in their ten-year and other reports that while appropriate reporting is necessary to provide feedback to project staff, funding agencies, and the public and to motivate agency staff to meet project goals, paper work requirements need to be streamlined. Reporting requirements and formats for the entire project period should be clearly outlined at the beginning of the program.

2.2 Keys To A Successful Nonpoint Source Pollution Control Project

2.2.1 Definition of Project Objectives and Goals

Properly defined objectives and goals (see also section 2.1.2 or glossary) are essential because they provide the criteria upon which the project will be evaluated.

Objectives define the overall direction or purpose of the project. They should be narrow enough so that the project is well-focused on achieving water quality changes or meeting water quality standards. An objective should contain a measurable end point.

Goals provide milestones to be met during the course of a project. Goals must be quantitative and should provide a means of measuring progress toward achieving an objective.

Project objectives and goals should be critically reviewed to ensure consistency with overall program objectives and goals. In order to establish reasonable water quality objectives and goals, it is necessary to have an accurate assessment of the water quality problem(s) as well as land resources. Other information that should be considered when setting water quality objectives and goals include appropriate boundaries for the critical area and the lag time between BMP installation and detectable results.

- *Lesson*: **The establishment of objectives and goals should result from a process that includes participation of both project agencies and representatives from the community. Guidance in this process should be provided by the national technical support group.**

  Example: Coordinated goal setting among farmers, oyster fishermen, and cooperating agencies was critical in the high rate of farmer participation in the Oregon RCWP project.

  Example: Inter-agency cooperation was instrumental in establishing attainable goals in the Idaho project.

  Example: The lack of community involvement in the selection and planning of the Massachusetts RCWP project resulted in poor producer participation and lack of consensus about the source of the water quality problem.

- *Lesson:* **Specific objectives and goals should be set at the beginning of a project.**

  Example: Initially, in the Nebraska project, some personnel wanted to build large water retention structures, while others wanted to emphasize on- site erosion control BMPs. The latter was more in line with the objectives of the RCWP and was established as the primary project objective in the mid-1980s.

- *Lesson:* **Land treatment objectives and goals need to be directly linked to water quality goals.**

  Example: For most projects, water quality and land treatment objectives and goals were not directly linked and therefore were not monitored such that the effects of BMPs on water quality could be established. However, a few exceptions existed. In Vermont, a paired watershed study documented that winter manure spreading resulted in significantly higher concentrations of phosphorus and nitrogen in field runoff than BMP manure management. In Minnesota, results from a vadose zone monitoring study demonstrated the effects of different cropping practices on soil nitrogen levels.

2.2.1 Definition of Project Objectives and Goals (continued)

- ***Lesson*: Project objectives and goals should reflect the desired outcome.**

  Example: Water quality objectives should reflect the designated use of the water resource. In Idaho, one of the objectives of the RCWP project was to improve the trout fishing in Rock Creek. Thus, the goals for nutrient and sediment reduction had to be set at a level that would restore the creek to a habitable trout stream.

  Example: Because RCWP projects did not receive good early guidance on establishing objectives, objectives were often combined with goals or overall objectives were set but clear quantitative, measurable goals were not established.

- ***Lesson:* Project goals need to be realistic, specific, and measurable. Project monitoring programs should be designed to evaluate progress toward the goal(s).**

  Example: Each project had a land treatment goal of treating 75% of the critical area. This policy contributed to the success of many projects.

  Example: The Utah project set a goal of reducing phosphorus input to a downstream lake by 1000 kg/yr, a realistic, attainable, and measurable goal.

  Example: In Oregon, the fecal coliform reduction goal was 70%, an unrealistic goal for the level of BMP implementation originally planned. As a consequence, the target level of participating dairy farms was increased by over 30% to better meet the water quality goal.

  Example: The Florida, Idaho, and Iowa projects had quantitative water quality goals that were realistic given their planned level of land treatment. The Florida project (Taylor Creek - Nubbin Slough) set and achieved a goal of a 50% reduction in phosphorus concentrations in water flowing into Lake Okeechobee as measured at the watershed outlet. Idaho and Iowa set and met quantitative goals for sediment reduction.

  Example: Original land treatment goals in Louisiana of treating 124,840 acres (75% of the critical area) were unrealistic due to inadequate resources; a significant downsizing of the project and critical areas resulted.

- ***Lesson:* Models can be used in setting quantifiable project goals and in targeting land treatment if the models have been calibrated and validated.**

  Example: Few pollutant runoff and water quality models were available for use in 1980 when the RCWP projects started. As the models became available, they were used. For example, in Minnesota, AGNPS was used to redefine critical area. The increased availability and accuracy of models now makes them a more valuable tool in quantifying water quality goals.

  Example: A modification of the Vollenweider Model was used in the Florida project to estimate that a 40% reduction in phosphorus loadings to Lake Okeechobee from the entire lake basin would be needed to protect the lake's long-term water quality. From a management perspective, phosphorus loadings for the Taylor Creek - Nubbin Slough basin would need to be reduced by 75 to 95% to achieve this objective. Based on this watershed loading reduction goal, the project refined their land treatment objectives and goals by estimating the amount and location of land treatment that would be required to achieve this level of phosphorus reduction.

- ***Lesson:* Goals can be modified during the project as more information or improved technology becomes available.**

  Example: In Idaho, land treatment goals were modified in the mid-1980s to encourage the use of conservation tillage to prevent soil erosion.

  Example: Due to ground water information and AGNPS modeling, the critical area was redefined in the Minnesota project to include ground water sources and to reduce the size of the surface water critical area. As a result, the goals and objectives for water quality and water quality monitoring had to be modified to include objectives and goals for ground water.

  Example: In South Dakota, the goals were modified after results from intense monitoring indicated that animal operations were an important pollutant source.

  Example: The Pennsylvania project staff redefined project goals to reflect results on subwatershed and field levels after they realized that the large number of farms in the project area (approximately 1,250) and low producer participation would make it impossible to detect water quality improvements at the regional level.

2.2.2 Project Planning, Administration, and Management

Planning, administration, and management are important elements of a NPS pollution control project. It is important that project staff perform their responsibilities within a supportive and open structure that encourages their work and allows room for creative solutions. Inter-agency cooperation at the national, state, and local levels was key to the success of the RCWP.

The RCWP experience has shown that strong, enthusiastic state and local committees played important roles in the more successful projects. The participation of the farming community and general public in the Local Coordinating Committee was critical. Although direction, goals, and management were handled at the local level, a number of projects, especially the more successful ones, had active support from the State Coordinating Committee.

Central to any voluntary nonpoint source control programs are incentives for participation. The primary incentive for a producer to participate in the RCWP was that the program offers to pay for a portion of the cost to install or implement the BMPs. In general, the RCWP allowed up to 75% cost share for approved BMPs and a maximum total payment of $50,000 to each participant. Local funds were available in some projects to increase cost-share levels.

2.2.2.1 State Coordinating Committee

- *Lesson:* **A State Coordinating Committee (SCC) should be established in each state in which a project is to be implemented. The SCC should be comprised of representatives of those federal, state, and municipal agencies involved in carrying out the project.**

  Example: In RCWP projects, the SCC was usually comprised of representatives from ASCS, SCS, ES, and the agency responsible for water quality monitoring.

- *Lesson:* **Successful projects must have strong support at the state level to provide a link to the national level and to exercise the authority to carry out the project. An active, interested, and responsive SCC can prove invaluable to the local project.**

  Example: In the Pennsylvania project, the SCC solved many local problems, obtained funding, and supported innovations designed to enhance the success of the project.

  Example: The SCC in the Double Pipe Creek RCWP project (Maryland) successfully advocated for supplemental RCWP funds to support a nutrient management specialist. This approach to providing technical assistance was so successful that the state Department of Agriculture continued the position when the RCWP funds ran out.

  Example: The Oregon SCC worked closely with the LCC to assess the animal waste management systems needed to reduce fecal coliform (bacterial) pollution. The SCC requested that the NCC approve additional cost-share funding for waste management BMPs and the request was approved. The SCC provided essential administrative and technical support.

- *Lesson:* **It is imperative that the SCC foster open communication and willing cooperation among the agencies involved to support the local staff responsible for carrying out the program. The state level agencies must take the lead in cooperation to maintain enthusiasm and initiative at the local level.**

  Example: The Pennsylvania SCC helped solve many local problems and supported innovations to enhance the success of the project. Excellent leadership from ASCS and strong inter-agency cooperation were provided in this project.

- *Lesson:* **SCCs should meet regularly (several times per year) throughout the life of the project to ensure proper support.**

  Example: In all RCWP projects, the SCC met annually to review and approve annual reports prepared by the LCC and approve proposed changes in the plan of work prior to forwarding a copy to the NCC. Annual meetings may have been adequate, but active SCCs met more frequently and upon the request of the LCC.

2.2.2 Project Planning, Administration, and Management (continued)

2.2.2.2 Local Coordinating Committee

- *Lesson:* **A Local Coordinating Committee (LCC) should be established to assure coordination at the project level. The LCC should serve to assure adequate public involvement, to enlist the assistance of needed agencies, to oversee informational and educational activities, to determine priorities for water quality plans, and to develop plans for technical tasks and project reporting. Plans for technical tasks include critical area selection, targeting BMPs for specific pollutant sources, and linking land treatment and water quality data and analysis. The LCC should seek guidance and receive support in accomplishing these tasks through national level workshops and assistance from participating agencies. The LCC should consist of producers, agency personnel, and community leaders.**

  Example: The RCWP required that the LCC be chaired by the County ASC Committee chairperson and that the LCC should assist the County Agricultural Stabilization and Conservation (ASC) Committee in establishing the amount of cost-share funding and in approving BMPs for use in the project area. This scheme worked very well for the RCWP.

  Example: The local coordinating committees in Florida, Vermont, Idaho, South Dakota, Pennsylvania, Oregon, Delaware, Utah, Maryland, and Iowa were strong sources of support and contributed greatly to the success of their projects.

  Example: RCWP funding for national workshop participation by LCC members was extremely limited. This reality made it difficult for LCC members, especially those involved in land treatment, to attend national workshops.

- *Lesson:* **Local leadership for direction and oversight of the administrative and management tasks should be provided by the Local Coordinating Committee.**

  Example: The LCC was the key element in several projects, taking advantage of the leadership of community members and economic and social ties. In Iowa and Maryland, community leaders active on the LCC contributed greatly to good project participation and BMP acceptance.

  Example: In Oregon, the LCC capitalized on a common commodity market and social ties of producers. Here, all local producers sold milk to a cooperative whose directors were active members and supporters of the RCWP project. The cooperative had the ability to discount milk prices paid to producers who did not correct pollution problems. Peer pressure was also effective in encouraging participation.

- *Lesson:* **The Local Coordinating Committee should establish close ties with the County Agricultural Stabilization and Conservation (ASC) Committee. The County ASC Committee is composed of members elected by the farming community, provides local leadership, and can lend support and credibility to a NPS control project.**

  Example: The County ASC Committee was especially active in the Maryland project and the LCC, one factor in enabling the Double Pipe Creek project to achieve BMP implementation in 87% of the project critical area.

2.2.2.3 Cost Share Administration

- *Lesson:* **Primary administration of cost-share activities at the state and local levels should be a responsibility of ASCS. Producers already deal with this agency for other cost sharing programs and this agency is the best suited to administrative efforts and distributing government funds.**

  Example: ASCS has a long history of managing federal price support and commodity programs. Their handling of the RCWP cost-share funding and administration of producer contracts was done in an excellent manner.

2.2.2 Project Planning, Administration, and Management (continued)

- *Lesson*: **To ease the burden placed on producers of dealing with multiple agencies, projects should incorporate a single application form and inter-agency computer linkages. All information from the application form would be entered into a computerized system linked to all involved agencies, giving each agency rapid and convenient access to essential information.**

2.2.2.4 Project Manager

- *Lesson:* **Projects should designate or hire a project manager with a background in water resources and project management to coordinate the team effort. The level of effort required should be determined by local needs. Duties should include coordinating all project activities, tracking and reviewing progress, ensuring that efforts are directed toward project goals, and coordinating project report preparation.**

  Example: Designation of a project manager contributed to greater participation and better coordination in several projects.

  Example: The South Dakota project used both a part-time coordinator, who coordinated activities between the RCWP and CM&E teams, and a full-time technical planner, who conducted individual visits with farmers.

  Example: A half- time manager was hired in Minnesota. A respected area farmer, the manager encouraged farmers to participate through one-to-one visits, well testing, and newsletters.

  Example: The Vermont project personnel functioned effectively as a team without a formally-designated project manager. Close geographic proximity of all participating local and state level organizations, as well as agreement of all participants on project objectives and goals, facilitated this teamwork.

  Example: Responding to survey, 42% and 27% of RCWP staff stated that a half- or full-time, project coordinator, respectively, should have been hired to assist their project.

2.2.2.5 Project Advisory Committees

- *Lesson:* **Project advisory committees (PACs), specialized subcommittees for all project functional areas, such as I&E, land treatment, water quality monitoring and evaluation, water quality modeling and other technical areas, should be established. Decision making is often improved by the delegation of specific aspects of the project to smaller, more focused groups. Advisory committees can be formed, disbanded, or regrouped as needed. PACs handling related tasks (such as water quality monitoring and land treatment) should meet regularly to ensure coordination of efforts.**

  Example: In Vermont, a subcommittee of the LCC and the SCC composed of land treatment and water quality monitoring teams met quarterly throughout the project. The quarterly meetings kept the two teams in touch so that the two efforts could be coordinated. Vermont's strong water quality monitoring program resulted mainly because the PAC was active.

  Example: A technical advisory committee in the Idaho project, composed of representatives from SCS, ASCS, and the State Department of Environmental Quality, provided valuable guidance for local coordination, innovative activities, water quality monitoring, and analysis of results.

  Example: A key to the success of the Florida project was the implementation of an administrative subcommittee made up of members from the ASCS, SCS, ES, and the South Florida Water Management District . The subcommittee met regularly to coordinate project activities and each member participated in all phases and activities of the project.

  Example: The majority of RCWP project staff (over 75%) responding to the project personnel questionnaire believed that the four standing subcommittees (administration, I&E, land treatment, water quality monitoring) were necessary. Seven additional temporary advisory subcommittees were identified by staff: technical, report writing, cost sharing, point sources, water quality modeling, inter-agency, and farmer advisory subcommittees.

2.2.2 Project Planning, Administration, and Management (continued)

2.2.2.6 Project Technical Support

- *Lesson:* **Future projects should form a core staff of personnel who are on detail to the project from participating agencies. Assigning personnel to the project for a specified time period of two to three years during BMP implementation helps assure that they give the project proper attention, are accountable for progress, and feel a sense of ownership in the project. Participating agencies must ensure that adequate staff time is allocated for each aspect of the project, including follow-up and report preparation, both key components of effective technology transfer.**

  Example: In the Florida, Idaho, Nebraska, Oregon, Pennsylvania, South Dakota, and Vermont projects, one or more full-time water quality monitoring specialists were assigned to the projects throughout its duration. These projects benefited greatly from these personnel dedicated to the monitoring and evaluation of their water resources. Agencies from which these specialists were detailed included universities, state agencies, USGS, and the South Florida Water Management District.

  Example: A county extension agent was instrumental in encouraging producer participation in the Alabama RCWP where over 100% of the targeted critical area was treated with BMPs.

  Example: USDA-ARS and the University of Idaho provided valuable research and recommendations regarding development and evaluation of conventional and new BMPs, particularly conservation tillage and no-tillage to the Idaho project.

  Example: A nutrient management specialist position (funded through the RCWP in the Maryland project) was so effective that the state Department of Agriculture has provided funds to continue the position.

  Example: Although not on detail, a temporary half-time administrator was hired by the local ASCS office to handle ASCS duties in the Pennsylvania project. This arrangement provided continuity for producers and relieved permanent employees of added duties.

2.2.3 Information and Education

Information and education activities were essential to encourage participation in the RCWP. I&E was also an important component in convincing producers to implement management-intensive BMPs (such as fertilizer and pesticide management). Finally, I&E served to inform the public about project activities. The focus of I&E efforts often changed over time from initially developing general awareness of the water quality problem and public support, to informing producers about NPS controls (BMPs) and why they should implement them, to assisting farmers in the management and maintenance of the implemented BMPs.

- *Lesson:* **The most effective I&E approach to gaining producer participation is one-to-one contact between project personnel and farmers.**

  Example: In Alabama, where 100% of the targeted critical area was treated with BMPs, the local extension agent's personal visits to many farmers were instrumental in gaining high producer participation.

  Example: Producers in the Louisiana and Vermont projects stated that on-farm visits by project personnel to answer specific questions and concerns helped convince them to participate in the project.

  Example: The South Dakota and Iowa project teams reported that one-to-one contacts with producers and follow-up visits were important in gaining producer participation.

  Example: Project personnel in Pennsylvania transported individual farmers to participating farms so that the farmer could see implemented BMPs and discuss their effectiveness with the owner.

2.2.3 Information and Education (continued)

- ***Lesson*: Effective I&E efforts increase producer participation.**

  Example: All RCWP projects had I&E activities. Generally I&E was the responsibility of the ES; however, when ES was unable to take the lead role, SCS often assumed I&E responsibilities. Project personnel responding to a questionnaire administered by NWQEP ranked I&E efforts somewhat to very effective in achieving project goals 90% of the time. Most farmers (96%) agreed that NPS water pollution could be controlled by educating farmers about water quality problems and the on-farm solutions to these problems. However, only 66% of project personnel believed that education alone would lead to the necessary on-farm solutions.

  Example: A wide variety of I&E activities were conducted to promote projects such as Double Pipe Creek in Maryland, St. Albans Bay in Vermont, Rock Creek in Idaho, Long Pine Creek in Nebraska, Tillamook Bay in Oregon, and Taylor Creek-Nubbin Slough in Florida. The result was that the objectives and activities of the project were effectively communicated, thereby contributing to relatively high producer participation.

- ***Lesson:* Although one-to-one contact appears to be a necessary condition for project success, it is not sufficient if producers do not support the objectives and goals of the project.**

  Example: In the Tennessee/Kentucky project, although each farmer received at least one, and often three, visits from project personnel, producer participation was only fair (less than 60% of the critical acreage was contracted), primarily because farmers were not convinced that they were the major cause of the water quality problem.

- ***Lesson:* Because of their importance as a means of encouraging producers to participate, I&E efforts should start in advance of land treatment implementation and should convey to farmers the importance of obtaining baseline water quality data prior to implementing BMPs.**

  Example: In Virginia, advance I&E was so effective that more than 50 producers were waiting to sign-up at the start of the project. Consequently, BMP implementation was completed early in the project.

  Example: Iowa project personnel began informing the farming community about the project even before funding was received. Public meetings were held to discuss the RCWP before the project application was submitted. This advanced I&E effort significantly enhanced producer participation.

  Example: Preliminary community meetings (and general community concerns) led all operators in the small Utah watershed to agree to participate even before the project was funded.

  Example: The Massachusetts project would have benefited from advanced information and education programming to resolve conflicting views on the source of the water quality problem and the utility of the RCWP project approach.

  Example: Producer involvement in the selection and planning of the Appoquinimink River project in Delaware contributed to the strong producer interest and participation in project.

- ***Lesson*: Awareness about water quality issues and the impacts of agriculture on water quality does not necessarily translate into ownership of water quality problems on the part of farm operators. Effective educational programs must be initiated to encourage farm operators to accept responsibility for the effects of their farming operations on water quality.**

  Example: Results of the farm operator survey indicated a fairly high general awareness about water quality issues among RCWP project area producers. However, when farmers were asked specifically if there was a water quality problem in their area, 33% stated they did not believe agriculture was a major problem in their area and even fewer believed that their own farm contributed to NPS pollution.

2.2.3 Information and Education (continued)

- *Lesson:* **In many projects, it is essential that I&E efforts be conducted by trusted local community members.**

  Example: A respected area farmer hired as the Minnesota project coordinator enhanced producer participation through one-to-one contacts that reassured skeptical area farmers.

  Example: In Pennsylvania, ES hired local nutrient management specialists to perform soil tests on farmers' fields and recommend fertilizer application rates. Their community membership gave these specialists credibility with farmers.

  Example: The existing strong positive working relationships and good credibility of ASCS, SCS, and ES in the Maryland, Delaware, and Iowa projects contributed to high producer participation rates.

  Example: After an initial period in which few farmers signed contracts, the Wisconsin project hired a retired SCS district conservationist who, by using primarily one-to-one contact, was able to significantly increase producer participation.

- *Lesson:* **Management-intensive best management practices (such as fertilizer and pesticide management) or structural BMPs that involve storage, management, and disposal of manure require more intensive and continuous I&E efforts than do practices constructed and maintained annually.**

  Example: Oregon project I&E personnel continued to advise farmers on nutrient management techniques several years after introducing them.

  Example: Alabama farmers who installed pit lagoons had to be taught how to clean lagoons and time manure applications to minimize pollution and maximize crop nutrient supplies.

  Example: I&E was identified by project personnel more important for the adoption and maintenance of management-intensive BMPs than for structural-type BMPs.

  Example: In Pennsylvania, structural BMPs were not readily accepted by farmers; therefore, project activities were redirected toward the more acceptable fertilizer management BMP and two ES agents were hired to help farmers continue proper nutrient management.

- *Lesson:* **Many RCWP projects that had effective I&E programs were led by Extension Service personnel. However, the agency providing leadership for I&E activities is not as important as are a well-defined work plan, good inter-agency cooperation and communication, technical capability, and stable funding.**

  Example: In some projects, such as Alabama, I&E was accomplished primarily by one agency. In other projects (Tennessee/Kentucky), I&E responsibilities were shared among several agencies. In still other projects (Oregon), the responsibility for I&E shifted from one agency to another as conditions changed. Yet, all three of these projects had a workable I&E program.

  Example: In the Florida RCWP project, close cooperation among the four local agencies (ASCS, SCS, ES, and South Florida Water Management District) was essential to ensuring the success of the I&E program.

- *Lesson:* **I&E efforts were most successful in reaching those farm operators who were most likely to cooperate and easiest to influence.**

  Example: In general, farm operators who participated in RCWP projects reported higher economic indicators (farm income, property and equipment values) than non-participants. RCWP project participants also were more likely to work their farms full-time, receiving most of their income from farming, than non-participants.

- *Lesson*: **ASCS, SCS, and ES personnel are all important sources of water quality information received by farmers.**

  Example: When water quality information sources utilized by participants and non-participants were analyzed, particular sources were used much more often by project participants than by non-participants. The greatest discrepancy between those who chose to participate and those who did not was utilization of information supplied by SCS. ASCS and ES were also used more frequently by RCWP participants than non-participants as sources of water quality information

2.2.3 Information and Education (continued)

- ***Lesson*: The I&E effort is not as effective when agencies stop communicating on I&E efforts, conflicting I&E messages are sent from the agencies to the farmer, or funding for I&E activities is insufficient.**

  Example: During the time that funding was withdrawn from the local ES in Oregon, I&E efforts were switched to the ES at Oregon State University. This diluted I&E activities by the ES during this period. Fortunately, other groups involved in the I&E effort (such as the SCS and the Tillamook County Creamery Association) were able to continue project I&E activities until funding was restored.

  Example: In Louisiana, agencies generally promoted only the type of BMPs for which they had implementation responsibility (management or structural). The ES, which ordinarily would have been responsible for promoting management BMPs such as pesticide management, did not play a role in the project. Because SCS had a larger field staff and was primarily responsible for structural BMPs, the I&E effort favored structural over management-intensive BMPs.

  Example: Although the Idaho project had a strong I&E effort led by SCS, many I&E components could have been strengthened if a more significant role for the ES had been incorporated into the project work plan. The initial BMP emphasis was toward structural BMPs, the primary expertise of SCS personnel. However, the major strengths of ES personnel were in the areas of irrigation water use and fertilizer and pesticide management; these components should have received more attention.

  Example: Local Coordinating Committee members stopped meeting in Virginia after land treatment was completed (about mid-project). As a consequence, I&E efforts were significantly reduced and information about the project was no longer disseminated.

  Example: In Massachusetts, the ES and SCS gave conflicting information to area producers about the source of the water quality problem and the value of the BMPs being used to address animal waste runoff. As a consequence, producer participation was extremely low.

- ***Lesson:* Non-governmental organizations can carry out useful components of an I&E program.**

  Example: The local creamery cooperative in Oregon provided information about the RCWP project through its newsletter and through the personal contacts between its field representative and area dairy producers.

  Example: An agrichemical dealer in Alabama conducted pesticide calibration training for area farmers, supporting implementation of the pesticide management BMP.

  Example: Farm cooperatives in the Wisconsin and Illinois project areas began to promote soil testing in support of the RCWP projects. These tests were provided free of charge. The soil tests, along with information about the nutrient value of manure, helped producers decrease mineral fertilizer use as they began applying manure as a fertilizer rather than just disposing of it as a waste product.

  Example: In Nebraska, an Integrated Pest Management (IPM) association was formed by farmers to provide weekly pest scouting for all members. The association published a newsletter through the ES and broadcast a radio program on insect activity. These efforts supported the pesticide management component of the project's I&E program.

- ***Lesson:* Specific services provided through I&E programs can encourage producer participation and enhance technology transfer.**

  Example: The I&E program included soil testing in Pennsylvania and Vermont, well water testing in Minnesota, and pest scouting in Nebraska and South Dakota. In addition, the Delaware and Minnesota projects loaned minimum tillage equipment to producers so that they could try the equipment before purchasing it.

  Example: A particularly creative program was established by the ES in the Pennsylvania RCWP project. The ES office created an animal waste trading exchange to enable farmers who wanted animal manure to locate farmers who had excess manure.

2.2.3 Information and Education (continued)

- ***Lesson:*** **Research plots and field demonstrations in the project area are important sources of information.**

  Example: Plot studies in Minnesota project convinced producers to participate and gave them confidence in the fertilizer management BMP.

  Example: Field days, demonstration sites, and farm tours effectively promoted land treatment and presented Florida project accomplishments.

  Example: Field demonstrations communicated the effectiveness of BMPs, such as fertilizer, pesticide, liming, and water management, to producers in the Nebraska project. A 50-acre demonstration farm run by the Nebraska CES displays, tests, and demonstrates BMPs. Fertilizer management, implemented on the demonstration farm, was widely adopted as producers realized they could save money by reducing application rates without sacrificing yields.

  Example: On-farm demonstrations of pesticide and nutrient management BMPs convinced many Louisiana producers to implement them.

  Example: Initial animal waste storage structures provided demonstrations of the animal waste management BMP in the Vermont, Oregon, and Florida projects. This "show and tell" approach was useful in gaining producer participation.

- ***Lesson:*** **I&E programs should use all information delivery methods to promote a project, even those that may not be the *most* effective methods (letters, newsletters, radio spots, videos) but which serve as ongoing reminders of project activities.**

  Example: The Idaho, Nebraska, and Vermont projects produced videos documenting project activities and progress.

  Example: Project personnel indicated that although newsletters and other media were not as effective as one-to-one contacts in obtaining producer participation, these media were important for disseminating information about RCWP.

  Example: Farm operators reported that their primary sources of water quality information were farm magazines, SCS, ASCS, ES, and newspapers, in that order.

2.2.4 Producer Participation

Obtaining a high level of producer participation is a major factor in voluntary NPS control projects because pollutant sources are distributed over relatively large areas; therefore, many farms in the critical area must be treated with BMPs to significantly reduce overall pollutant loadings to water resources.

2.2.4.1 Incentives to Participation

- ***Lesson:*** **The availability and attractive level of cost-share assistance is the most important factor in obtaining producer participation in voluntary NPS control programs.**

  Example: Idaho, Louisiana, South Dakota, Maryland, and Nebraska project personnel reported that the availability and attractive level of cost-share assistance was the most important incentive for producer participation.

  Example: Project personnel suggested that the three most important factors involved in a farmer's decision to implement a new BMP to help protect water quality were cost, effects on profits, and ease of use of the practice.

  Example: In the Alabama project, farmer participation was initially close to zero because the cost-share rate was only 60% of the total cost of BMP implementation and average farmer net income was very low. When the rate was increased to 75%, overall participation increased significantly. Participation was also enhanced by the availability of technical assistance.

  Example: The Tennessee/Kentucky project had difficulty convincing absentee landlords and area farmers to seed cropland to pasture because they would experience a loss of income. When the project started paying 100% of the cost for seeding alfalfa, and an additional one-time $70/acre payment for converting cropland to pasture for 10 years, participation increased.

  Example: In the Massachusetts project, incentives for farmers to participate in the project did not outweigh other factors tending to motivate them not to participate, such as extremely high construction costs (which diminished the value of the $50,000 payments available to farmers) and high land prices (which discouraged farmers from making long-term financial investments in their dairy operations).

2.2.4 Producer Participation (continued)

- *Lesson:* **The availability of cost-share assistance for BMPs that are perceived to increase land productivity or decrease farmer inputs can be an added incentive for producers to participate in a project that requires them to implement other BMPs that they perceive as less desirable.**

  Example: The Louisiana and Idaho projects found that the availability of cost-share funds for practices such as irrigation and drainage improvements was a very important incentive for producer participation.

  Example: In the Vermont project, the benefits of reducing daily equipment wear and labor needs associated with the animal waste management system BMP were important incentives in gaining project participation, but they were not strong enough incentives to induce implementation of the BMP without cost share.

  Example: The Minnesota project reported that the savings from lower fertilizer application rates associated with the fertilizer management BMP, in addition to cost-share assistance, was an important incentive for producer participation.

  Example: Project personnel identified the availability and attractive rate of cost-share funds as the primary incentive for farmer participation in the RCWP. Farm operators identified this source of assistance as second to their concern for water quality as a reason for their decision to participate in the program.

- *Lesson*: **Awareness of and concern about the ways in which their agricultural practices affect water quality motivates some farm operators to participate in voluntary NPS pollution control programs.**

  Example: A survey of farmers disclosed that their primary reason for participating in the RCWP was concern about water quality. Availability of cost-share funds to assist them in implementing BMPs was listed by farmers as their second most important reason for participating in RCWP projects.

- *Lesson*: **Availability of technical assistance perceived as valuable can motivate farmers to participate in a NPS project.**

  Example: Free technical assistance, along with additional cost share from state funds, increased producer participation in the Florida project.

  Example: In the Pennsylvania project, the excellent technical assistance and educational efforts convinced some producers to implement BMPs without the incentive of cost-share assistance.

- *Lesson:* **Environmental regulation or the threat of regulation can provide incentives for participation.**

  Example: In Florida, state law required animal operations to maintain a farm nutrient mass balance, thereby compelling producers to implement BMPs. Regulation played a major role in defining land treatment and water quality goals. BMPs implemented through the RCWP project are directed toward recycling nutrients produced on farms to comply with the state's 1987 Dairy Rule, which requires dairies to collect and dispose of runoff from milking barns and high animal intensity areas through spray irrigation.

  Example: The Virginia and Oregon projects reported that perceived threat of state regulation was instrumental in obtaining participation.

- *Lesson:* **Pre-project publicity, peer pressure, public relations, and organizational incentives increase participation.**

  Example: In Maryland, Soil Conservation District Board of Supervisors leadership was important to producer participation. One Board member was the first dairy farmer to sign a contract and implement a BMP.

  Example: In the Oregon project, the support of the local creamery was instrumental in obtaining a high (96% of critical area farms) producer participation rate. The creamery had the ability to discount milk prices paid to producers who did not correct pollution problems.

  Example: Pre-project community meetings and intense peer pressure contributed to 100% participation of Utah project critical area producers.

2.2.4 Producer Participation (continued)

- *Lesson:* **Participation often increases when producers recognize and understand the water quality problem, the value of the impaired water resource, and the source(s) of the pollutants.**

  Example: In the Iowa project, sedimentation problems and the presence of cornstalks in a highly valued recreational lake surrounded by project farmland helped clarify the water quality problem and source of pollutants. The high visibility of the water quality problem helped farmers realize that they could significantly improve the lake's water quality by participating in the project.

  Example: After a major revision in emphasis from surface to ground water, producer participation in the Minnesota project increased because farmers understood the value of the targeted water resource (ground water) and the primary source of pollution (pesticides and nitrates).

  Example: In the Nebraska project, lack of a sense of ownership in the off-site water quality problem hindered farmer participation.

  Example: In the Tennessee/Kentucky project, producers did not think they were the main cause of the water quality problem, so they were less willing to participate.

  Example: In the Massachusetts project, where both intensive dairy farming on small acreages and booming residential development adjacent to an estuary were occurring, the primary source of pollutants was not clearly documented. As a result, dairy farmers felt unfairly singled out as the source of the problem. This contributed to low participation in the project.

  Example: In the Oregon and Vermont projects, a long-standing commitment to keep the local community and its natural resources clean was a strong impetus for participation.

  Example: The belief that water pollution was not a problem was the major reason for not participating in RCWP projects cited by farm operators interviewed. Conversely, twice as many RCWP participants as non-participants stated that they believed water quality was a problem.

- *Lesson:* **Producers' willingness to change practices to improve the water quality of the local environment is an important factor in determining the level of effort or incentive required to convince them to participate.**

  Example: Pennsylvania project personnel reported that concern for the quality of the area's streams brought many producers to participate in the project even without the added incentive of cost-share assistance.

  Example: Delaware and Maryland project personnel reported that the willingness of producers to change their farming practices to improve water quality was an important factor contributing to the project's high level of producer participation.

  Example: In the Minnesota project, farmers' desire to implement the fertilizer management BMP to improve and protect area ground water (the source of their drinking water) was an important factor in gaining their participation.

- *Lesson:* **On-farm demonstrations of BMPs can increase participation by allowing producers to evaluate how well the BMP works and how it affects farm productivity.**

  Example: In the Maryland project, the on-farm demonstrations of BMPs by a few farmers helped other producers to understand the practices and the benefits associated with them, thereby increasing producer participation.

  Example: Louisiana project personnel reported that cost sharing small-scale demonstrations of the pesticide management BMP on a local farm was an effective method of convincing many producers to implement the BMP and thus, to participate in the project.

  Example: Demonstration plots of conservation tillage proved to be effective means of gaining participation in the South Dakota and Idaho projects.

  Example: Results from the farm operator survey indicated that almost twice as many RCWP participants as non-participants gained water quality information from tours and demonstrations.

2.2.4 Producer Participation (continued)

- ***Lesson*: Producer involvement from the beginning of the project helps foster a feeling of ownership which often increases participation.**

  Example: Iowa and Delaware project personnel reported that both pre-project meetings to discuss the water quality problem and producer involvement in planning helped develop strong support for and participation in the project by area farmers.

- ***Lesson:* State or local, in addition to federal, cost-share assistance can help increase participation.**

  Example: In Florida, the availability of state cost-share assistance that supplemented RCWP cost-share funds was important to producer participation because the cost-share portion of the total cost of the recommended BMPs often exceeded the $50,000 limit.

  Example: In the Tennessee/Kentucky project, the additional 25% cost share to plant alfalfa fields as well as the one-time 70-dollar payment per acre for conversion of cropland to permanent pasture was needed to convince many producers to participate.

- ***Lesson:* The successful implementation of BMPs on participating farms can serve to influence other producers to implement BMPs even without cost share.**

  Example: The Louisiana and Pennsylvania projects reported that area producers who did not receive RCWP cost-share assistance began implementing BMPs, especially fertilizer and pesticide management BMPs, after seeing them in use on participating farms.

  Example: The example set by farmers in the Appoquinimink River RCWP project area of New Castle County, Delaware has convinced most farmers in other parts of the county to voluntarily adopt no-till as their primary tillage practice.

2.2.4.2 Barriers to Participation

- ***Lesson:* Poor economic status of producers and the high cost of recommended BMPs (primarily animal waste structures) can decrease participation in voluntary NPS control programs. Consequently, where appropriate, the lowest cost BMPs should be recommended.**

  Example: In a survey of project personnel from all projects, economic considerations was cited as by far the most important reason farmers decided against participation while dislike for any government program and not wanting to be told how to farm were selected as the second and third most important reasons why farmers decided not to participate.

  Example: In the Michigan project, the high cost of the animal waste management system BMP deterred many producers from participating.

  Example: In the Louisiana, Wisconsin, South Dakota, and Minnesota projects, the strapped economic condition of producers and the poor farm economy, in general, prevented some producers from participating.

  Example: Results from the telephone survey of farm operators conducted by Hoban and Wimberley (see Chapter 3) indicate that the lower the economic indicator, the less likely the farmer was to participate in the RCWP. Farmers who indicated the following economic condition(s) on their farms were less likely to participate in the RCWP: 1) owned less than 199 acres, 2) worked off their farm more than 200 days, 3) had no rental land, 4) received less than 25% of their income from their farm, 5) had gross farm sales of less than $39,999, 6) owned less than $40,000 worth of farm equipment, and 7) owned less than $99,999 in farm land and buildings. Farmers who chose to participate in RCWP projects generally owned more land, worked on the farm full-time, derived most of their income from their farm, and had a higher level of investment in their farm and their equipment.

2.2.4 Producer Participation (continued)

- ***Lesson*: Dislike of government programs, as well as not wanting to be told how to farm, sometimes deters farmers from participating in projects.**

  Example: The conservative nature and general unwillingness of Pennsylvania project area farmers to participate in federal programs decreased cost-share program participation. However, many farmers participated informally by implementing BMPs without cost share.

  Example: Tennessee/Kentucky project personnel reported that dislike of federal programs and not wanting to be told how to farm were primary factors in the relatively low participation rate.

  Example: The third major reason stated by farm operators who chose not to participate in the RCWP was dislike of government programs.

- ***Lesson:* Inconvenience involved in filling out forms and following complicated procedures can deter project participation.**

  Example: Several Vermont producers indicated that filling out separate forms for ASCS and SCS was redundant and time-consuming and that streamlining this process might increase participation.

2.2.5 Land Treatment Implementation and Tracking

Land treatment, through implementation of BMPs to reduce NPS pollution and improve water quality, was the basis for the RCWP. Land treatment tracking (recording where, when, and how fully BMPs were implemented and maintained) was necessary to assess treatment strength in time and space. In addition, land use tracking or monitoring (such as, recording the mass, location, and timing of manure applications) was needed in order to correlate water quality changes to land treatment.

2.2.5.1 Land Treatment Implementation

- ***Lesson:* Land treatment should be targeted to critical areas contributing the greatest pollutant load to the receiving water resource. This approach is more effective than implementing BMPs in a widespread, random manner. Targeting land treatment begins with assessing BMP effectiveness and emphasizing implementation of BMPs that effectively address the primary pollutants.**

  Example: In Vermont, Oregon, Florida, Wisconsin, and Maryland, pollutant movement to receiving waters was reduced by targeting manure storage facilities to critical areas. Storage of dairy manure reduced pollutant movement during wet weather. Timing of manure spreading was scheduled to maximize its use as a fertilizer to meet crop needs.

  Example: The fertilizer management BMP was emphasized in Pennsylvania, Florida, and Vermont critical areas to address problems caused by excessive application of fertilizer, rather than lack of storage facilities.

  Example: The Utah project demonstrated that animal waste management BMPs are effective at reducing instream bacteria and phosphorus in watersheds containing many animal operations.

  Example: The effectiveness in reducing pollutant movement of practices such as mini-basins, sediment basins, and vegetative filter strips was evaluated in Idaho, helping project personnel select BMPs that would be the most effective for critical area land treatment.

  Example: Nutrient management BMPs in the Pennsylvania project reduced both ground and surface water nitrogen pollution through reductions of 49% and 42% in excess nitrogen and phosphorus applications, respectively.

  Example: A linear program model was developed for economic analysis of Idaho project BMPs; irrigation water management and conservation tillage were judged most cost-effective.

  Example: In South Dakota, AGNPS was used to estimate annual sediment and nutrient losses and predict BMP effects on excess nutrient loading to surface water.

2.2.5 Land Treatment Implementation and Tracking (continued)

- *Lesson:* **Land treatment implemented to achieve water quality goals must be targeted to critical pollutant source areas where BMPs will have the greatest water quality effect. Pre-implementation water quality monitoring and modeling can be used to identify or refine these critical areas. If the objective is to detect a water quality trend, BMP implementation must be delayed until adequate baseline water quality data are available.**

  Example: Surface and ground water monitoring in the Nebraska project were used to document major pollutant sources in order to prioritize portions of the watershed's critical area.

  Example: Pollutants from manure application were the main problem in Vermont; therefore, the critical area was based on amount and management of manure and distance from streams.

  Example: Suspended sediment from natric soils was the major source of impairment in the Illinois project. AGNPS modeling results and monitoring data were used to redefine the critical area. The AGNPS model was also used by the Minnesota project to identify and target critical nutrient and sediment source areas.

  Example: Depth to ground water and sediment delivery to lakes were used to prioritize subareas within the South Dakota project critical area.

  Example: The Oregon project used a rating system based on pollution potential to prioritize applications from producers in the critical area.

  Example: In the Florida project, pre-project monitoring and modeling (CREAMS) was key to identifying critical phosphorus sources.

  Example: The BASIN model was used in Florida to estimate the long-term average annual response to a hypothetical "maximum" BMP scenario. The model predicted annual phosphorus load reductions of about 50%.

  Example: In Alabama, the CREAMS model was used to estimate edge-of-field sediment losses for predicting sediment delivery reductions; however, the model did not account for a compacted soil layer 6-10 inches below the soil surface, which project personnel felt would cause significantly higher runoff values.

- *Lesson:* **Within critical areas, significant pollutant sources (such as animal operations, fields) should be prioritized for BMP implementation based on the expected impact of the source on the impaired water resource(s). This process can maximize water quality benefits of BMPs and expedite achievement of pollutant reduction goals.**

  Example: Vermont SCS personnel used computer models to estimate that, by treating sources of phosphorus in order of their predicted contribution to watershed streams, the same level of load reduction could have been achieved five years sooner and, by treating 16 fewer farms.

- *Lesson:* **Fertilizer (nutrient) and pesticide management and conservation tillage BMPs are the most cost-effective in terms of requiring the least cost share for the greatest potential water quality benefit.**

  Example: Management type BMPs, such as dairy wastewater utilization, nutrient management, and feedlot runoff control, had the greatest water quality impact in the Florida project.

  Example: Iowa farmers who implemented nutrient management BMPs decreased their average phosphorus application rates between 1982 and 1984 from 44 to 20 and from 55 to 6 pounds per acre for corn and soybeans, respectively.

  Example: In Minnesota, demonstrations of the effectiveness of nutrient management and the nutrient value of manure were instrumental in convincing both the LCC and farmers that the nutrient management BMP would reduce NPS pollution and was economically attractive.

  Example: Fertilizer use by Nebraska producers was greatly reduced by the adoption of nutrient management, thereby addressing ground and surface water pollution simultaneously.

  Example: In the Pennsylvania project, conservation tillage, fertilizer management, and contour stripcropping were the lowest cost and probably most effective BMPs for reducing agricultural NPS pollution. A 55-acre field study documented 8 - 32% decreases in shallow ground water nitrate concentrations after implementation of fertilizer (manure) management.

  Example: After 1985, the emphasis in the Idaho project was shifted to conservation tillage, resulting in effective erosion control on crop fields and associated long-term sediment reduction.

2.2.5 Land Treatment Implementation and Tracking (continued)

- *Lesson:* **Greater emphasis should be placed on the management and maintenance components of BMPs, especially if the BMP is basically structural.**

  Example: Vermont project personnel reported that water quality does not significantly improve after the construction of a waste storage structure, if manure application rates on individual fields continue to exceed crop needs or significant manure application occurs during winter months.

  Example: The Idaho project team reported that significant reductions in sediment loads due to sediment retention devices will be lost if the devices are not properly maintained.

  Example: In the Alabama project, the extra effort expended to train and follow-up on producers implementing lagoons was critical in getting producers to pump their lagoons regularly and utilize the waste properly, thereby increasing the long- term effectiveness of the lagoon systems.

  Example: Florida project personnel found that explicit guidance for animal waste management practices needed to be written into contracts to ensure the practices were operated and maintained according to specifications.

  Example: The Michigan project team reported that the absence of an established method for ensuring producer adherence to manure spreading plans or other BMPs decreased the effectiveness of some of the implemented BMPs.

- *Lesson:* **The flexibility to try BMP innovations or modifications to make them more adaptable to specific situations, while maintaining or improving their effectiveness, is important to the success of some projects.**

  Example: The Wisconsin project team developed an effective method for settling animal waste solids. Drilled holes in a filter wall at the downslope end of improved barnyards allowed liquid waste to flow through into a grass filter strip, while solids were trapped behind the wall.

  Example: The Delaware project used rock pads during construction of waterways to reduce gully movement up the waterway.

  Example: The Florida project found that providing shade and watering facilities along with fencing to keep animals out of waterways was effective in reducing the phosphorus loadings from the project area.

  Example: The Maryland project team reported that the flexibility to try innovative designs and modify unworkable designs of waste storage facilities helped SCS and ES personnel learn which designs were most effective for local conditions.

  Example: In Oregon where rainfall rates are very high, animal waste system BMPs were designed to keep rain and ground water out of the manure both in temporary and longer-term storage. Because of high water tables, lagoons were impractical. Therefore, wet manure storage designs included circular tanks that would not sink or overturn. Dry storage areas were typically roofed pads connected to the milkhouse to facilitate manure scraping and storage while preventing rain water from mixing with the manure. The waste management system for each dairy was based on operator convenience and capability for reducing pollutant transport.

2.2.5 Land Treatment Implementation and Tracking (continued)

- *Lesson*: **Regular visits to farmers by members of participating local agencies help avoid misunderstandings concerning producer responsibilities, provide an opportunity to discuss problems with BMPs, and encourage continued BMP maintenance.**

  Example: The Vermont project team reported that regular contact between producers and project personnel helped avoid misunderstandings and contract disputes such that no contract violations were experienced during the project.

  Example: Constant contact between project personnel and producers helped insure that farmers in the Alabama project maintained their lagoons.

- *Lesson:* **Systems of two or more BMPs are often required to effectively control nonpoint source pollution from critical areas.**

  Example: The animal waste management system BMP was combined with the fertilizer management BMP on farms in Vermont to optimize use of nutrients from dairy manure by plants and minimize the possibility of stream pollution

  Example: A system of both structural and management BMPs to reduce phosphorus movement to receiving waters was used in Florida. BMPs were designed to exclude cows from streams, reduce barnyard and milking parlor waste, reduce fertilizer applications, and improve overall animal waste management.

  Example: The Nebraska project addressed cropland erosion by implementing irrigation water management BMPs and streambank erosion by installing cedar revetments. This combination of BMPs significantly reduced the sediment load of Long Pine Creek.

  Example: In Idaho, excessive streambank erosion masked some significant reductions in sediment loading resulting from BMPs implemented to reduce erosion associated with irrigation return flow. Treating both major sources of sediment was needed to abate the sediment problem.

  Example: The Illinois project reduced erosion and sediment transport with a system including sediment basins and conservation tillage on cropland.

- *Lesson:* **Cost sharing of BMPs that are attractive to producers can be used as an incentive to induce farmers to implement other BMPs that they consider less desirable. Conversely, BMPs that are totally unacceptable to area producers and not essential to controlling major sources of pollution should be avoided.**

  Example: Louisiana and Idaho project personnel reported that cost sharing practices that are perceived as having labor-saving or productivity benefits, such as irrigation improvements, can help induce producers to implement BMPs with primarily off-site water quality benefits such as filter strips and grassed waterways.

  Example: In Minnesota, several of the selected BMPs were either unacceptable (stream protection system) and discontinued or too expensive (animal waste system) and modified. Due to the high cost of large animal waste systems which hold all barnyard runoff, BMP emphasis was shifted to systems that utilized grass filter strips and sediment basins.

2.2.5.2 Land Treatment and Land Use Tracking

- *Lesson:* **Intensive land treatment and land use tracking is required to link land treatment to water quality.**

  Example: The Vermont project determined that detailed land use data such as timing, application rate, and area of manure spreading was required in addition to where and when BMPs were implemented to track land treatment and land use.

- *Lesson*: **A computerized data base, such as a geographic information system (GIS), facilitates BMP implementation tracking, data presentation and accessibility, and aggregation of land treatment and land use data.**

  Example: The Vermont project found that a combination of a computerized database and GIS maps were invaluable for tracking BMP implementation.

2.2.5 Land Treatment Implementation and Tracking (continued)

- ***Lesson*: Frequent staff turnover hinders land treatment tracking and, to some extent, BMP implementation.**

  Example: The Louisiana project found that frequent (about 1 per year) turnover of the soil scientist hired to assist the project hindered land treatment tracking because the new hire required time to become familiar with the area and the project.

  Example: The Minnesota project found that frequent SCS staff changes made the implementation of structural BMPs more difficult and time-consuming because producers would have to spend time familiarizing the new SCS staff member with their farm plans.

- ***Lesson:* Tracking the land use activities of non-cooperators within the critical area can provide valuable data to explain water quality trends.**

  Example: The Vermont project found that tracking some of the activities of non-cooperators in the project critical area helped explain variability in the water quality monitoring data.

- ***Lesson:* Use of aerial photographs can assist the tracking of land use and BMP implementation.**

  Example: Project personnel from the Vermont project stated that aerial photography might be an effective and efficient method of tracking the implementation of some types of BMPs and monitoring various land uses.

2.2.5.3 Extent of Land Treatment Required to Effect Significant Water Quality Change

- ***Lesson:* A high level of critical area BMP implementation is needed to improve water quality.**

  Example: Significant water quality improvement in streams and ditches of the Utah project watershed was due to the participation of all dairy farmers and thus, treatment of the major sources of phosphorus and bacteria.

  Example: In the Louisiana and Minnesota projects, where less than half of the critical areas were treated with BMPs, no significant change in the water quality of surface waters was documented.

- ***Lesson:* To achieve substantial reductions in nutrient loading from animal waste operations, a high percentage of manure must be treated. Where nutrients or bacteria from animal waste cause the impairment, the goal for BMP implementation should be to treat 100% or nearly all of the critical area manure.**

  Example: Treatment of 50% of the critical area in the Michigan project did not result in an improvement in project area nutrient concentrations. Project personnel attribute the lack of water quality improvement to a low level of BMP implementation and a low level of land treatment tracking.

  Example: In the Wisconsin project, which treated 39% of the critical area dairies, no improvement in stream macroinvertebrate populations could be documented.

  Example: The Utah project reduced total phosphorus concentrations in runoff by 75% and total nitrogen concentrations by 40 - 90% by treating 100% of the critical area dairies.

  Example: The Florida (Taylor Creek - Nubbin Slough) project reduced phosphorus concentrations by 45% since 1980, by having nearly 100% participation of critical area farmers.

2.2.6 Water Quality Monitoring, Evaluation, and Reporting

Water quality monitoring, evaluation, and reporting are needed to refine and transfer NPS pollution control technology to future efforts. Monitoring documents water quality changes due to land treatment practices, whereas evaluation and reporting conveys the results. The following lessons provide an overview of the essential elements of a successful monitoring program.

2.2.6.1 Administration

- *Lesson:* **NPS control projects whose primary objective is to document water quality changes resulting from BMP implementation should be funded only when there exists a firm long-term (six to 15 years) commitment to water quality monitoring and evaluation from a responsible agency. Effective and responsible administration is essential to maintain and support such long-term activities.**

  Example: The commitments to water quality monitoring from the South Florida Water Management District in Florida; Division of Environmental Quality in Idaho; Department of Environmental Quality in Oregon; USGS in Pennsylvania; Utah Mountain Land Association of Government in Utah; the University of Vermont in Vermont; Department of Environmental Control in Nebraska; the Minnesota Pollution Control Agency in Minnesota; and the Department of Environment and Natural Resources in South Dakota contributed greatly to the success in water quality monitoring in these projects.

  Example: The Louisiana RCWP project was unable to determine if the implemented BMPs improved the water quality of the bayou because of the seeming lack of funding commitment from the water quality monitoring agency.

  Example: Water quality monitoring funding for the Virginia project ceased at the end of the 10-year project period. As a consequence, scheduled post-project water quality monitoring was canceled due to lack of funds and the effectiveness of the BMPs will remain unanalyzed.

- *Lesson:* **The agency responsible for water quality monitoring should be involved in selection of the project and the preparation of the proposal in order to ensure the on-going commitment of the agency to the project.**

  Example: The Oregon Department of Environmental Quality was instrumental in project planning for the Oregon RCWP project. They provided a high level of commitment, including water quality monitoring and data analysis.

  Example: The USGS in Pennsylvania, using money from a USEPA grant, was involved initially in project planning and continued to be the lead water quality agency for the duration of the project.

- *Lesson:* **For water quality projects, monitoring activities should be coordinated with water resource management activities. Management activities such as biological controls, dredging, or lake drawdown can significantly alter lake chemistry and hydrology, making the detection of trends due to BMPs difficult or impossible to detect.**

  Example: In Virginia, ground water high in phosphorus was pumped into project area reservoirs when the reservoirs were low, thus confounding detection of phosphorus trends.

  Example: In the Iowa RCWP project, lake drawdown and rotenone treatment of carp impeded the detection of lake water quality trends, further complicating the linkage of water quality to land treatment.

  Example: Stocking of trout during the project period in the Minnesota project confounded the detection of trends in monitored fisheries variables that may have been attributable to RCWP.

2.2.6 Water Quality Monitoring, Evaluation, and Reporting (continued)

2.2.6.2 Water Quality Problem Definition and Problem Assessment

■ *Lesson:* **Carefully defining the water quality problem is one of the most important steps for NPS pollution control and water quality monitoring. An effective approach is to implement a problem identification and assessment monitoring program lasting six to 18 months. Problem identification monitoring uses a site-specific plan to identify pollution sources and impacts during both base flow and storm conditions; monitoring may be most effective during the seasons of greatest pollutant loading (spring runoff, snow melt) and during the season when impairments are noted (growing season algal blooms). Clearly identifying the specific pollutant and assessing the problem assists land treatment staff in identifying critical areas and targeting BMPs.**

Example: The Florida, Idaho, Nebraska, Oregon, Pennsylvania, Utah, and Vermont projects had ample visual and analytical evidence of receiving water problems.

Example: In Iowa, heavy sediment and a blanket of corn stalks covering a recreational lake surrounded by farmland helped make the problem and its source especially clear.

Example: In Massachusetts, where both intensive dairy farming on small acreages and booming residential development were taking place adjacent to an estuary containing important shellfish resources, the source of the problem needed to be more clearly documented to generate community support for project activities.

Example: South Dakota's project required several intensive monitoring programs to gain a thorough understanding of the water quality problem and its causes in complex interactions between the surface and ground water sources feeding the target lakes.

Example: In Idaho, streambed quality was reduced by siltation caused by high suspended sediment concentrations, which then contributed to loss of trout reproductive capability. At the onset of the project, agricultural sources were identified as the primary cause of reduced streambed quality. Further analysis showed streambank erosion was also a major contributor of sediment load. Influx of sediment from streambank erosion made documentation of the effectiveness of cropland BMPs difficult. Based on project estimates, sediment contributions from two major sources, streambank erosion and irrigation return flow, were similar in magnitude when the project began. In contrast, from 1987 to 1990, monitoring indicated that streambank erosion contributed 2 - 5 times the amount of sediment added from cropland in the subbasins during the irrigation season. The problem of streambank erosion will continue to mask in-stream benefits from the land treatment.

Example: In the Illinois RCWP project, turbidity, siltation, and nutrients were thought to threaten Silver Lake, the water supply for the city of Highland. Sediment survey results showed that sedimentation rates were low which meant there was little threat of rapid loss of lake storage capacity. An analysis of lake turbidity indicated that algal production was limited more by light than by nutrients. It was found that turbidity, which increased the cost of water treatment, was due mostly to suspended soil particles. Monitoring demonstrated that loading of fine particle natric soils and their resuspension from lake sediments was the primary factor causing lake turbidity. In order to target pollutant sources, the project placed special emphasis on keeping cropland natric soils in place or reducing their delivery into the lake.

Example: To accurately interpret ground water monitoring results, a thorough understanding of project area geology was essential for the Minnesota RCWP project. Project personnel found that performing a geologic investigation was critical even though it was time-consuming, expensive, and occurred after the start of the project. The critical area and BMP emphasis were changed to address the identified ground water problem. Monitoring plans were enhanced to consider ground water and pesticides.

Example: The Florida project benefited greatly from several years of water quality assessment monitoring performed in the late 1970's by ARS and the South Florida Water Management District. These data helped document the water quality problem and sources.

2.2.6 Water Quality Monitoring, Evaluation, and Reporting (continued)

- *Lesson*: **Source of bacteria causing contamination in shellfish or recreational waters are generally not difficult to locate. Die-off for bacteria is relatively rapid and sources can generally be located by monitoring below suspected animal waste sources.**

  Example: The Utah and the Oregon projects monitored above and below dairies to determine the magnitude of the bacterial contamination.

  Example: Subwatersheds with dairy operations in the Vermont project were monitored to determine the relative magnitude of bacterial pollutant sources. Bacteria counts decreased significantly after dairy sources were treated.

  Example: The Alabama project, with few animal operations, documented dramatic decreases in fecal coliform levels in the lake as operators closed or improved animal waste management.

- *Lesson:* **Nutrient sources of pollution can be the most widespread and difficult to identify and quantify. Sources include commercial fertilizer, animal waste, soil reserves, and atmospheric deposition. Streambeds, lake sediments, and ground water can also release stored nutrients.**

  Example: In Vermont, significant phosphorus (P) loading to St. Albans Bay was believed to originate from bay sediment, an adjoining wetland, and agricultural runoff. Area soils also contributed to the total watershed P load. A budget of all major sources was needed to determine potential for reducing lake or bay P levels.

  Example: Sources of high nitrate levels in domestic wells in Minnesota included animal operations and cropland. The topography is karst limestone with extensive sinkhole formations. Sinkholes were thought to be a primary conveyance to ground water until lysimeter studies showed rapid leaching of nitrate from fertilized cropland. Further study indicated that cropland should be targeted for treatment.

  Example: Monitoring in South Dakota showed that animal operations contributed significantly to nutrients in surface water and fertilizers applied to cropland affected ground water.

- *Lesson*: **Sources of sediment are often more widespread and difficult to isolate than bacteria sources. Sediment can originate from cropland, ditches, gullies, roads, forests, and streambanks and can re-enter the water column via scouring in streams and recirculation in lakes. Sediment surveys and budgets are needed to identify sources, determine delivery, and quantify relative contributions of each source.**

  Example: A survey of sediment sources and monitoring of streambanks in the Vermont project indicated that one subwatershed contributed the most sediment to the St. Albans Bay and sediment delivery was not as much of a problem as previously thought.

  Example: The Tennessee/Kentucky project had high erosion rates in areas with steeply sloping cropland and targeted these areas for critical area treatment. Huge gullies were also identified as significant, but sediment delivery from these sources was not estimated. Overall, the effectiveness of the critical area designation is questionable since the relative magnitude of gully and cropland sediment sources is not known.

  The Illinois project found that both the watershed and lake sediments were sources of the turbidity problem in Highland Silver Lake.

  Streambank erosion was a significant source of sediment in the Idaho and Nebraska projects. Identification and treatment of streambank erosion in the Nebraska project was key to documenting and treating the problem. The Idaho project would have benefited from increased emphasis on streambank erosion control.

2.2.6.3 Monitoring Objectives

- *Lesson:* **Objectives should be clear and should provide a general guide for the experimental design of the water quality and land treatment monitoring program. The primary objectives of NPS watershed projects should be evaluation of use support status, trend detection, or impact assessment.**

2.2.6 Water Quality Monitoring, Evaluation, and Reporting (continued)

- *Lesson*: **Monitoring objectives for trend detection or impact assessment should identify the water quality variable and the reason the variable is expected to change with time.**

  Example: The water quality monitoring objective in Florida precisely stated the water quality variable (total phosphorus) being monitored and the changes that should occur in that variable (50% reduction in phosphorus concentration at the project outlet). That variable was to evaluate the effectiveness of agricultural BMPs for reducing phosphorus loads to Lake Okeechobee, as measured by changes in water quality concentrations and loads in the tributaries and basin outlet.

  Example: The Idaho RCWP project had realistic, quantitative goals for reducing sediment. However, water quality goals also should have been developed to achieve the designated uses established by the state for Rock Creek. The lack of goals directly related to use-support hindered the initial establishment of a water quality monitoring design that could directly document progress towards use-support goals. However, the project did establish an extensive biological and habitat monitoring program that documented changes in beneficial use support in Rock Creek.

- *Lesson:* **Trend detection and impact assessment may be the most important objectives for long-term watershed projects. Other objectives, such as storm event sampling for load calculations or hydrograph-pollutant relationships, may be useful; however, these objectives are auxiliary and should be addressed in addition to, not instead of, the predetermined and scheduled sampling for the primary objective(s).**

  Example: In the Tennessee/Kentucky project, the majority of the water quality objectives addressed water quality problems and the sources of the pollutants, not water quality trend detection. As a consequence, the water quality information which was gathered, although useful for identifying pollutants' sources, was unable to demonstrate changes in water quality.

2.2.6.4 Water Quality Monitoring Plan

- *Lesson:* **Projects should invest in the planning and design of the water quality monitoring program. The monitoring plan should be developed based on the monitoring objectives. The monitoring plan should include the monitoring design, agency roles, laboratory procedures, quality assurance and quality control, data storage, reporting requirements, personnel needed, and costs.**

  Example: The Vermont project is a model of how a project can plan and implement a monitoring program. The project implemented short-term, intensive monitoring on a field-scale to document the effectiveness of a specific BMP, while at the same time monitoring for a longer term on a watershed and subwatershed scale to evaluate the effectiveness of a combination of many different BMPs.

2.2.6.5 Water Quality Monitoring Designs

- *Lesson:* **The most (statistically) effective protocol for detecting long-term trends includes collection of samples on a regularly spaced predetermined time schedule.**

  Example: The Idaho RCWP project used regularly-timed sample collection (at 14-day intervals) to document a decrease in suspended sediment concentrations.

  Example: The Utah, Vermont, and Florida projects used regularly-timed sampling to document water quality improvements.

  Example: After changing their water quality design from trend determination to storm sampling, the Oregon RCWP project personnel found that trends were difficult to quantify from storm samples of fecal coliform data. Samples for trend detection should have been collected on a regular, predetermined schedule.

2.2.6 Water Quality Monitoring, Evaluation, and Reporting (continued)

- *Lesson*: **Trend detection is more effective if monitoring focuses on collecting samples at a relatively high frequency and analyzing them for a small number of relevant variables. Use of the entire list of variables employed to measure general conditions in ambient monitoring programs should be avoided. Variables measured should respond directly to the implementation of BMPs and should reflect the water quality problem.**

  Example: Vermont project personnel indicated that they could have saved money, effort, and data storage and management by reducing the number of variables analyzed for at some sampling stations.

- *Lesson:* **The monitoring design should include sampling an experimental control. Controls may be either a site above an installed BMP or a paired watershed in which BMPs have not been implemented.**

  Example: The Utah project used an upstream/downstream comparison before, during, and after BMP implementation to show reductions in phosphorus concentration below a dairy that installed a waste management system.

  Example: The Idaho RCWP project effectively utilized the upstream/downstream strategy with monitoring before, during, and after BMP implementation over a ten-year period to document the effectiveness of sediment reduction BMPs.

  Example: Upstream/downstream monitoring stations were located in the tributaries and on Long Pine Creek (Nebraska project) to document water quality improvements from irrigation water management and streambank stabilization.

- *Lesson*: **The most effective experimental design for documenting BMP impacts on water quality is the paired watershed design, in which two watersheds with similar physical characteristics and, ideally, land use, are monitored for one to two years to establish pollutant- runoff response relationships. Following this initial calibration period, one watershed receives treatment and monitoring continues in both watersheds for one to two years. This experimental design accounts for many factors that may affect response to treatment; as a result, the treatment effect can be more effectively isolated.**

  Example: The Vermont project, which used a paired watershed experimental design, demonstrated the effectiveness of reducing nitrogen and phosphorus concentrations in field runoff by properly timing manure application.

- *Lesson:* **Trend monitoring stations established to collect baseline data for a before-after monitoring approach must remain fixed and must be downstream from sites planned for installation of BMPs. Each station must remain fixed during and after implementation to assure a valid comparison with the pre-implementation baseline data. Baseline data should be collected for a period of time sufficient to characterize pre-BMP implementation conditions.**

  Example: The Virginia RCWP project had access to baseline water quality data that had been collected three years prior to implementation. This allowed for a thorough characterization of the water quality problem and targeting of appropriate BMPs.

  Example: The Florida, Oregon, Idaho, Nebraska, Pennsylvania, Vermont, and Utah RCWP projects had adequate pre-BMP monitoring with fixed stations below sites planned for installation of BMP monitoring, which was essential for documenting water quality conditions before BMP implementation.

2.2.6 Water Quality Monitoring, Evaluation, and Reporting (continued)

- *Lesson*: **Post-BMP implementation water quality data must be collected for at least two to three years in order to assess the effectiveness of BMPs.**

  Example: Post-BMP multiple-year monitoring, along with adequate pre-BMP monitoring, was effective in demonstrating water quality changes that could be associated with land treatment in the Idaho, Florida, Oregon, Vermont, and Utah RCWP projects. It is also expected to be a useful technique in the Nebraska RCWP, which is now conducting its post-BMP water quality monitoring.

  Example: As a consequence of reduced funding, the planned post-project evaluation of the monitoring data in the Virginia project was canceled and the effectiveness of BMPs will not be documented.

- *Lesson:* **Long-term monitoring (six to 10 years) with grab samples taken every two weeks is sufficient to document water quality trends in a stream that exhibits at least a 40% change in pollutant concentrations.**

  Example: The Idaho, Florida, and Utah projects documented greater than 40% change in their pollutant concentrations using grab samples taken two times per month.

- *Lesson:* **Laboratory and field quality assurance and quality control (QA/QC) programs that include data evaluation and verification for precision and accuracy are essential elements of a successful water quality monitoring program.**

  Example: The Alabama and Oregon RCWP projects found that QA/QC for fecal coliform analysis was especially important because of rapid die-off and the high natural variability of the data.

  Example: The Idaho and Florida projects implemented extensive QA/QC procedures for their chemical and biological data field and lab collection and analysis techniques.

- *Lesson:* **Use of constructed wells for monitoring ground water is preferable. If existing wells must be used, and are found to be contaminated, the possibility that the contamination results from poor construction or leaking rather than as a result of general aquifer conditions must be considered.**

  Example: In the Minnesota RCWP project, vadose zone monitoring was used to document that the high level of pesticide contamination in wells was due primarily to point sources of pesticides (commercial pesticide application services).

  Example: Sampling of irrigation and domestic wells in the Nebraska RCWP project resulted in inconclusive results, partially because of local contamination and lack of information about well construction.

  Example: The South Dakota RCWP project utilized wells constructed for the RCWP. Although expensive, the project had an effective water quality monitoring program in which the results were directly related to the RCWP.

2.2.6.6 Spatial and Temporal Considerations for Monitoring

- *Lesson:* **Monitoring is needed at the field, farm, or subwatershed level to assess the effects of BMP systems. Short-term intensive monitoring studies of individual BMPs should be included to help understand physical processes and to provide a basis for assessing the longer-term, overall effectiveness of the project.**

  Example: The Minnesota RCWP project used vadose zone sampling to determine that splitting the application of nitrogen did little to reduce soil nitrate levels.

  Example: South Dakota used a master field site (research) and several farmers' field sites to determine the effectiveness of BMPs.

  Example: The Vermont project used monitoring at the subwatershed level to document that increasing the percentage of animals under BMP waste management decreased fecal coliform levels in the monitored streams.

2.2.6 Water Quality Monitoring, Evaluation, and Reporting (continued)

- *Lesson*: **Reference stations characterizing attainable conditions are needed in order to evaluate the health of aquatic biota and habitat potential.**

  Example: The Idaho RCWP established reference sites in the headwaters of the watershed in order to quantify attainable conditions for trout habitat in the project area.

- *Lesson:* **The start-up date of monitoring should coincide with the beginning of an easily identified annual period to avoid partial and, therefore, nearly useless collection of part of a year of data. However, establishing sampling procedures, QA/QC, and data management systems is encouraged prior to the formal data collection period.**

  Example: The Vermont RCWP project team found that some of their data were unusable because of a partial year of monitoring data that did not coincide with other data.

- *Lesson:* **Grab sampling conducted at seven- or 14-day intervals over a six- to 10-year time period can be used on a watershed scale to document water quality changes and provide valuable feedback.**

  Example: The Utah, Florida, and Idaho projects were able to document water quality improvements using weekly or bi-weekly grab sampling in their water quality monitoring efforts.

  Example: Grab sampling was an integral part of the monitoring program in the Vermont project. Sampling bi-weekly sampling was conducted during the summer months; sample collection frequency decreased to monthly for the winter months.

2.2.6.7 Variables

- *Lesson:* **Significant land use activities should be identified and accounted for in the monitoring program, particularly when such activities are located immediately upstream of a monitoring station.**

  Example: In Alabama, sudden increases in fecal coliform levels were not understood until project personnel located a beaver dam upstream of the monitoring station.

  Example: In Idaho, non-cropland activities in the project area also affected pollutant loading to the impaired water resources. Activities included: expanded fish hatchery production, illegal gravel mining, chaining the irrigation canal systems to remove unwanted vegetation, forest fires, and the construction and operation of a new hydroelectric generating plant.

- *Lesson*: **Direct measures that evaluate how well a water resource supports various uses (water supply, fish spawning, and habitat) should be used whenever possible.**

  Example: In Minnesota, water chemistry and spring adult trout and fall fingerlings were sampled each year at two non-stocked brook locations. Results from the fish sampling demonstrated more improvement in water quality in the fish populations than the water chemistry.

  Example: The Idaho and Nebraska projects utilized biological and habitat monitoring program designs that facilitated documentation of use impairments and water quality improvements. Biological and habitat monitoring included surveys of fish and macroinvertebrates, habitat assessment, and embryo survival for trout spawning.

2.2.6 Water Quality Monitoring, Evaluation, and Reporting (continued)

- *Lesson:* **Explanatory variables (discharge, seasons, upstream pollutant concentrations, precipitation) should be monitored to ensure accurate interpretation of monitoring results. Adjustment for hydrologic and meteorologic variables is important when quantifying impacts of land treatment or land use on regional water quality. This procedure renders water quality values that are closer to those that would have been measured had there been no change in climatic variables over time. In addition, hydrologic and meteorologic explanatory variables can be used to account for water quality variability.**

  Example: Adjustments for precipitation in water quality trend analysis were made by the Florida, Idaho, and Pennsylvania projects.

  Example: Stream discharge measurements were taken concurrently with water quality sampling and accounted for in the data analysis in the Florida, Idaho, Maryland, Michigan, Oregon, Pennsylvania, Utah, and Vermont projects.

  Example: In Oregon, fecal coliform reduction initially seemed to be 70%, and staff believed their water quality goal had been reached. However, saline concentrations strongly affect fecal coliform. After adjustment of data for salinity levels through covariate analysis, fecal coliform levels had only decreased by 40% and personnel realized more dairies needed BMPs.

  Example: Idaho, Florida, and Utah effectively utilized upstream pollutant concentrations to adjust concentrations downstream of land treatment to account for incoming concentrations.

- *Lesson:* **When sediment is a major pollutant, at least some bedload sampling should be performed during high runoff periods to avoid seriously underestimating overall sediment loading.**

  Example: Idaho RCWP project personnel believed that significant sediment movement occurs in the bedload and that they may have underestimated sediment loading by only measuring suspended sediment in the water column.

- *Lesson:* **Changes in land use, difficulties in tracking BMP implementation, and many other factors may hinder documentation of the impact of BMP implementation on water quality within a particular project or watershed area.**

  Example: The Michigan project has been unable to document any real BMP effects due to confounding factors such as low level of BMP implementation, difficulty in assessing the effects of the sub- basin areas that do not have BMPs, large variations in sources and transport of sediment and nutrients over time, and accuracy of estimates of BMP implementation area.

  Example: In the Virginia project, beneficial effects of BMP implementation may not be immediately apparent because the project began after major point sources and some nonpoint sources were removed. An improving trend was already in effect in the estuaries. Manipulation of the water supply lakes for water withdrawal and storage of pumped ground water may have confounded results.

  Example: Draining of Prairie Rose Lake (Iowa project) and direct manipulation of the fish population may have obscured some water quality results. Water clarity was highest in 1982-83, following draining of the lake and restocking of fish in the fall of 1981 in an attempt to improve the fishery. Since then water clarity has deteriorated to pre-RCWP levels. Reduction in sediment delivery due to adoption of conservation practices may have improved water clarity, but algal density has increased, apparently because of greater light penetration. Monitoring data are highly variable. Factors such as desorption of nutrients from bottom sediment and ground water or runoff contributions of soluble nutrients were not addressed. After correcting for both precipitation and chlorophyll *a* there is no significant trend over time.

  Example: There is strong evidence that two dairy closures in the Otter Creek sub-watershed (in September 1980 and 1986) in the Florida (Taylor Creek - Nubbin Slough) project resulted in a decrease in total phosphorus concentrations in Otter Creek and at the main discharge to Lake Okeechobee from the project area (Station S-191). These dairy shutdowns resulted in a masking effect for evaluating impacts of BMPs implemented along this tributary.

  Example: Upon completion of CM&E activities, the Illinois RCWP project recommended no additional field site monitoring because of the large amount of data needed to explain variability attributable to variables other than differences in BMP implementation.

2.2.6 Water Quality Monitoring, Evaluation, and Reporting (continued)

2.2.6.8 Data Management and Analysis

- *Lesson:* **Data management is crucial to the success of a monitoring program. Computerized storage is essential. All data should be stored in a central project file and reviewed frequently for efficient integration and subsequent evaluation of hydrologic, water quality, and land management variables.**

  Example: Much of the RCWP project data was stored in STORET, a data storage and retrieval system used by USEPA.

  Example: Oregon RCWP personnel, after evaluating their data mid-project, re-analyzed their data using covariate analysis. The new results gave them a much better understanding of the effectiveness of BMPs. Subsequently, there was an increase in the number of farms targeted for BMP implementation.

  Example: The Vermont RCWP project reported that quarterly analysis and review of the water quality data helped continually refine both the sampling program and the data storage systems.

- *Lesson:* **Methods of data analysis should be determined early in the project planning process to ensure that data sufficient for the anticipated analysis are collected. Data management, quality assurance, and analysis techniques should be clearly defined prior to monitoring.**

  Example: In Alabama, many water quality indicators were measured. Some of these indicators were dropped (pesticide and nutrient monitoring except for nitrate) and others were sampled erratically. By the end of the project, only two variables (nitrate and fecal coliform) were used in the final data analysis.

2.2.6.9 Feedback

- *Lesson:* **Monitoring information has been very effective in educating the public on water quality and beneficial use support.**

  Example: The Utah, Florida, Oregon, Idaho, and Vermont projects had strong water quality monitoring programs emphasizing pre- and post-BMP monitoring and above- and below-site sampling. Combined with large land treatment efforts, these monitoring programs resulted in documentation of water quality improvements.

  Example: In the Utah project, animal waste management systems reduced phosphorus concentrations by 75% and nitrogen and fecal coliform by 40 to 90%. These BMPs reduced the impact of agricultural activity on Deer Creek, an important water supply for Salt Lake City, Utah. The project served as a model project to protect valued natural resources and stimulated creation of projects in adjacent watersheds.

  Example: Water quality monitoring documented that animal waste management systems installed on Oregon dairies reduced bacterial contamination of oyster beds by about 40 to 50%. Sites in Tillamook Bay restricted to shellfishing based on Food and Drug Administration classification decreased from 12 in 1979-80 to one in 1985-86.

  Example: Vermont project personnel used water quality monitoring to demonstrate that increasing the percent of animals under BMP waste management decreased fecal coliform levels in the monitored streams.

  Example: Biological and habitat monitoring was utilized in Idaho and Nebraska to directly monitor fish habitat in streams. This information was shared with the public in relation to the RCWP projects' impacts on the quality of recreational fishing in the project area water resources.

  Example: Monitoring information was used successfully in Oregon, Alabama, Minnesota, Vermont, Idaho, Utah, and Nebraska to inform local producers and citizens of the impact the RCWP project was having on their environment.

- *Lesson:* **Water quality monitoring can provide feedback in defining critical areas needing priority treatment.**

  Example: Water quality monitoring was utilized in the Utah, Nebraska, and Florida projects to identify critical areas needing high levels of attention for land treatment, water quality monitoring, and evaluation of water quality changes.

2.2.7 Linkage of Land Treatment and Water Quality Changes

Documentation of water quality improvements from NPS pollution controls is necessary to provide feedback to project coordinators and maintain political and economic support for NPS control programs. An important purpose of any experimental NPS control program is to correlate (link) water quality changes and BMP implementation, thereby demonstrating that NPS control efforts can improve water quality and are worthy of federal, state, and local funding and support.

- *Lesson:* **Careful planning, including selection of appropriate indicator variables and data management systems, is required to link water quality changes to land treatment.**

  Example: The Vermont project found that careful planning up front to establish what land treatment and land use information was to be collected, how it was to be collected, the format of the data collection, and the time frame of data collection was critical in determining the ultimate usefulness of the data. The project monitored many land treatment and water quality variables, but found the clearest linkage, on a watershed scale, between increasing numbers of animals under BMP manure management and decreasing bacteria levels in streams.

  Example: The Idaho and Nebraska projects took the initiative to revise their land treatment and land use data bases near the end of the projects in order to more effectively link their land treatment and water quality data bases. These projects found that this after-the-fact data base creation required a lot of effort and that some useful information had been lost.

- *Lesson:* **A good experimental design for water quality and land treatment monitoring is essential to document a relationship between land treatment and water quality changes. The paired watershed approach should be encouraged. This design involves monitoring in two or more similar subwatersheds before and after BMPs are implemented in one of the subwatersheds.**

  Example: The Vermont project found that the paired watershed design was the most effective design for documenting a linkage between land treatment and water quality changes on small watersheds or fields over a relatively short time period (three to five years).

  Example: The Utah project showed marked water quality changes in a very well-controlled, small watershed.

  Example: Projects such as the Idaho, Florida, and Utah projects that monitored upstream and downstream from BMP implementation before, during, and after BMP implementation on a subwatershed scale found that this design was effective in documenting water quality improvements associated with the RCWP land treatment.

  Example: The multiple watershed approach, where BMPs were installed in multiple watersheds simultaneously with water quality monitoring before and after implementation, was used successfully in the Idaho and Florida RCWP projects. Detection of predicted water quality trends and patterns over multiple water quality monitoring stations and drainage areas improves the documentation that the changes in water quality were attributed to the BMPs.

  The Minnesota and South Dakota projects used vadose monitoring to establish the relationship between ground water contamination and agricultural practices, BMPs, and ecological niches.

2.2.7 Linkage of Land Treatment and Water Quality Changes (continued)

- *Lesson:* **Because water quality changes often occur gradually, particularly in large watersheds with lakes, five to 10 years or longer are required to confirm real, consistent changes that can be linked to land treatment. Short-term monitoring is seldom effective because climatic and hydrologic variability can mask water quality changes. However, for small watersheds affected by only a few relatively large pollutant sources, the required monitoring period may be shorter.**

  Example: The Utah project results indicate significant water quality response in drainage ditches and Snake Creek to the implementation of animal waste management systems over a relatively short (five-year) data collection period. These results may be attributed to the small size of the watershed (700 acres) and the relatively small number of pollutant sources that were identified and treated.

  Example: The Oregon, Florida, Idaho, Vermont, and Utah projects have shown that a pre-BMP water quality data base of at least two to three years duration and several post-implementation years of monitoring data is needed to document the water quality effects of BMPs.

  Example: The Vermont project found that using a paired watershed design on a small subwatershed can reduce the time required to obtain a significant linkage between BMP implementation and water quality changes.

  Example: A lag time in response in water quality at the subwatershed and watershed outlets to BMP implementation was demonstrated in the Vermont and Florida projects, emphasizing the need for multiple years of post-BMP implementation monitoring.

- *Lesson:* **Intensive land treatment and land use tracking is often required to link water quality improvements to land treatment. Analysis of the large volume of data collected from this effort usually requires powerful data base management tools.**

  Example: The Vermont project utilized checkbook-style farmer logs of animal waste handling activities (for example, recording timing, mass, area, and location of manure application) along with farm surveys conducted by project personnel to obtain detailed land treatment and land use information. These data were entered into a GIS which was used by the project team to manage, analyze, and present the extensive land treatment and land use data. This extensive monitoring of BMP implementation and agricultural activities allowed the project to establish a link between cows under the manure management BMP and bacteria levels in streams.

  Example: The Idaho project collected land treatment and land use data for each farm field and year. This data was entered into a data base and utilized in GIS applications during the post-project analysis.

  Example: The Utah project obtained 100% participation from dairy farmers in the area and visited them to ensure that they were properly managing animal waste properly. This intensive follow-up ensured that the water quality changes were due to improved waste management.

- *Lesson:* **Water quality monitoring prior to BMP implementation is required to establish baseline data for statistical comparisons with post-BMP water quality data (before/after design).**

  Example: Water quality monitoring pre- and post- BMP implementation was the basic design utilized by most of the RCWP projects. The pre-BMP water quality monitoring in the Idaho, Florida, Oregon, Utah, and Vermont allowed these projects to make valid comparisons between the pre- and post- water quality conditions.

  Example: The Maryland, Delaware, Iowa, and South Dakota projects lacked sufficient baseline water quality data to allow the projects to quantify changes due to BMPs on a watershed scale.

2.2.7 Linkage of Land Treatment and Water Quality Changes (continued)

- *Lesson:* **The ability to match water quality and land treatment data spatially increases the likelihood of attributing water quality changes to BMP implementation. Land treatment and land use changes should be recorded on a hydrologic (drainage) basis such that the land area being monitored corresponds to the drainage area served by the water quality monitoring station. If land treatment data are collected in more detail (for example, at the farm field level), the land treatment data base may need to be aggregated prior to being paired to the water quality data.**

  Example: Monitoring of land treatment and land use on a subwatershed scale was performed in Idaho, Vermont, Utah, Oregon, Pennsylvania, South Dakota, Florida, and Nebraska such that the land treatment data could be matched with the water quality monitoring data from the same subwatersheds.

  Example: The Wisconsin project found that site selection for its chemical monitoring station was inappropriate because the station was influenced by pollution sources outside the project area.

  Example: The Michigan, Vermont, Idaho, Utah, Virginia, Pennsylvania, and Florida projects found that monitoring subwatersheds within the overall project area is a more effective strategy than monitoring only at the watershed outlet. Water quality changes are more likely to be observed at the subwatershed level closer to land treatment areas where the confounding effects of external factors, other pollution sources, and scattered BMP implementation are minimized.

- *Lesson:* **The logistics of pairing water quality, land treatment, and land use data on a temporal basis need to be addressed prior to data analysis. Water quality samples are collected hourly, daily, weekly, bi-weekly, or monthly; in contrast, most land treatment data are collected only seasonally or annually. Some land treatment data must be collected more frequently if the effect on water quality is more short-term (for example, the effects of manure and fertilizer management practices).**

  Example: The Vermont RCWP found that knowing the timing of manure spreading was useful in matching the land treatment data with the water quality data to obtain meaningful interpretations.

  Example: The Vermont RCWP project showed that aggregation of the water quality data to the same temporal scales as the land treatment data (monthly, seasonally) was a useful analysis technique, particularly for exploratory data analyses. Other projects, including Vermont, Idaho, and Florida, paired the land treatment and water quality data bases by repeating the seasonal or annual land treatment values for each water quality grab sample in that season or year.

- *Lesson:* **Reporting of land use variables and BMP implementation in units that reflect treatment strength (acres served, tons of manure, animal units) and that can be paired with water quality data is essential. Land use and land treatment data must often be summed over a relatively large area to match the area influencing the water quality data.**

  Example: The Nebraska, Idaho, Florida, and Pennsylvania projects used variables such as: 1) acres treated by each BMP with consideration for overlapping BMPs, 2) acres treated by BMP systems to minimize double-counting of land on which multiple BMPs were implemented, 3) tons of manure spread, 4) miles of fencing, 5) acres served by fencing, and 6) pounds of fertilizer applied.

2.2.7 Linkage of Land Treatment and Water Quality Changes (continued)

- *Lesson*: **The linkage of land treatment to water quality can be made at the farm field, subwatershed, watershed, or project level. In general, however, the larger the drainage area, the harder it is to establish the linkage.**

  Example: The Vermont, Idaho, Utah, Florida, and Pennsylvania projects linked their land treatment and land use data and water quality data bases at the subwatershed level. This approach was successful at meeting their goal of demonstrating water quality changes on a subwatershed level.

  Example: Projects that linked their land treatment and water quality data bases at the project level met with mixed results. The Oregon, Idaho, and Florida projects were able to demonstrate changes at the project level. Due to substantial land treatment in the watershed, bacteria decreases were demonstrated in Tillamook Bay, Oregon, phosphorus concentrations significantly decreased at the Taylor Creek - Nubbin Slough watershed outlet in the Florida projects, and total sediment decreased in Rock Creek, Idaho. However, it was not possible for the Iowa and Vermont RCWP projects to document a significant change in water quality at their impaired water resources, despite a high level of land treatment.

  Example: The Vermont, Pennsylvania, South Dakota, Idaho, and Minnesota projects had site-specific experiments to demonstrate BMP effectiveness at the farm field and BMP level.

- *Lesson:* **Tracking of operation and maintenance aspects of BMPs is needed to help determine the magnitude of water quality changes associated with BMPs.**

  Example: The Vermont and Wisconsin projects found that installing animal waste storage structures does not improve water quality if the manure application rates exceed crop nutrient needs.

  Example: The Florida project reported that land use changes not associated with project BMPs such as changes in animal numbers or land use due to other programs can also have a large water quality impact and need to be accounted for so that correct interpretations can be made regarding the impact of the BMPs.

  Example: The Idaho and Vermont projects found that non-participants and noncompliance can mask effects of land treatment on water quality.

- *Lesson*: **Pollutants monitored at the water quality monitoring station must correspond to pollutants being treated by the implemented BMPs.**

  Example: The Idaho project monitored sediment because they implemented BMPs to control erosion and sediment loading of Rock Creek.

  Example: The Oregon, Pennsylvania, Utah, and Vermont projects monitored bacteria and nutrients because they implemented many waste management system BMPs. The Florida project monitored phosphorus because this was the primary pollutant of concern from animal waste.

2.2.7 Linkage of Land Treatment and Water Quality Changes (continued)

- *Lesson*: **All sources of significant variability in the land treatment and water quality data should be accounted for. Generally, the greater the ability to account for variability in water quality, land treatment, and land use data, the stronger the possible correlation between water quality changes and land treatment. Monitoring explanatory variables, such as stream discharge, precipitation, ground water table depth, and impervious land surface area, is often important in accounting for variability.**

  Example: The Vermont project team reported that detailed records of when and where BMPs were implemented, timing and location of agricultural activities, location and extent of pollution sources not being controlled by RCWP BMPs, and significant weather changes were all required to link water quality changes to land treatment.

  Example: Changes in dairy cow numbers and water table depth were the most important explanatory variables in the Florida RCWP project. Water table depth provided an indication of seasonality and precipitation. Also, water quality monitoring confirmed that total phosphorus concentrations in the tributaries increased as the water table rose to within two feet of the surface. Incorporation of these variables into the analyses allowed for greater evidence that the BMPs implemented through the RCWP project significantly decreased phosphorus loadings.

  Example: In the Alabama project, a sudden rise in fecal coliform levels could not be accounted for until a beaver dam was discovered upstream of the monitoring station.

- *Lesson:* **A consistent improving trend in water quality after the implementation of BMPs provides evidence needed to attribute water quality improvements to land treatment. Similarly, documented post-BMP implementation water quality improvements in multiple watersheds provides strong evidence that water quality improvements resulted from land treatment.**

  Example: The fact that total phosphorus concentrations continue to decrease at the Florida (Taylor Creek - Nubbin Slough) project outlet as the length of time after BMP-implementation increases supports the argument that BMPs were effective in reducing total phosphorus concentrations.

  Example: Subwatersheds in the Taylor Creek - Nubbin Slough project with a large amount of BMP implementation have shown significant decreases in total phosphorus concentrations. In contrast, subwatersheds with little BMP implementation or increased cattle densities have exhibited increases in total phosphorus concentrations. These observations support the conclusion that the BMPs have decreased total phosphorus concentrations.

  Example: Monitoring results indicate that the BMPs implemented under the RCWP decreased the delivery of sediment and phosphorus to the agricultural drains and improved water quality in Rock Creek (Idaho RCWP project). This conclusion was drawn from the association that eight of 10 subbasins have documented reduced loadings over the same time period in which BMP implementation occurred.

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Chapter 3
PERSPECTIVES ON THE RURAL CLEAN WATER PROGRAM: SURVEY RESULTS

3.1 Introduction

Farm operator participation was an essential component of the Rural Clean Water Program (RCWP) projects. Closely linked to participation were information and education (I&E) efforts that sought to inform farmers about the project, encourage potential participants to enroll in the project, and then provide technical assistance on best management practice (BMP) implementation and maintenance.

In order to gain as clear an understanding as possible about the motivations and perceptions of both participants and non-participants toward the RCWP, water quality, and nonpoint source (NPS) pollution, a telephone survey of farm operators within the 21 RCWP project areas was conducted in early 1992. Results of the survey are reported in section 3.2.

Perceptions of local, state, and federal agency personnel who served as staff for the RCWP projects were assessed through a mail survey (Coffey and Hoban, 1992). Responses to the project personnel survey provided additional information on farm operators' motivations for participating in the RCWP projects, adoption and maintenance of BMPs by farmers receiving RCWP cost-share funds, project management and coordination, project effectiveness, I&E, and RCWP workshops. Results from the personnel survey are presented in section 3.3.

In combination, the results from the farm operator and personnel surveys provide a valuable profile of RCWP participants and the perceived effectiveness of the different projects. This information will be useful to those responsible for designing future NPS pollution projects. Farm operators who are least likely to participate in voluntary nonpoint source (NPS) pollution control programs can be specifically targeted for I&E activities designed to encourage them to evaluate their own role in contributing to NPS pollution and to participate in programs designed to reduce agricultural NPS pollution. The information gathered through the farm operator and personnel surveys also provides valuable information for NPS managers involved in designing and implementing future agricultural NPS pollution control programs.

3.2 Farm Operator Survey

3.2.1 Rationale and Objectives

The RCWP was designed to provide financial and technical assistance to farm operators who voluntarily installed BMPs to control water pollution in 21 watershed projects across the United States and to increase public awareness of the impact of agricultural practices on water quality. Because participation in the RCWP was voluntary, adoption of BMPs designed to improve water quality depended on changes in farm operators' skills, knowledge, attitudes, and behavior. An evaluation of the RCWP, therefore, needed to include analysis of farm operators' knowledge, attitudes, and behavior. For this reason, factors influencing farmer participation in the RCWP were assessed.

The objectives of the farm operator survey were to:

- Analyze factors that influenced participation in the RCWP and adoption of recommended BMPs, including both positive incentives and barriers. Factors examined included: farm operator characteristics (age and education); farm structure characteristics (farm size and type); attitudes about water quality problems; and use of information (see Figure 3.1).
- Analyze attitudes about the benefits and costs of participation in the RCWP, including assessment of farm operators' perceptions of BMPs.

- Determine farmers' perceptions of the effectiveness of technical and financial assistance programs, as well as education and information efforts, associated with the RCWP.

3.2.2 Background Research

Water quality improvements from NPS pollution control depend on changes in farm operators' attitudes and behavior. Development, implementation, and evaluation of any NPS control program should, therefore, include analysis of factors that influence farm operators' knowledge, attitudes, and behavior. A framework (or model) for analyzing farmer adoption of BMPs and participation in the RCWP was developed and tested (Figure 3.1). The model incorporates a number of characteristics that could influence RCWP participation and BMP adoption, including farm operator characteristics, farm structure characteristics, and farm operators' awareness of and attitudes about water quality, BMPs, and the RCWP. The relationships between these characteristics and farm operators' participation and adoption are analyzed later in this chapter (section 3.2.4).

For the past 50 years, social scientists have studied the process by which farm operators and others accept and use new practices (Rogers, 1983). During the past 15 years, research has focused primarily on farmers' adoption of soil conservation practices (Buttel et al., 1990). A small, but significant, subset of this work has specifically considered farm operators' use of BMPs for controlling NPS pollution. Research has shown that decisions about using BMPs represent an ongoing process for most farm operators. The farm operator survey was used to evaluate the role of the RCWP in promoting farm operator adoption of BMPs.

Many factors can influence farm operators' willingness and ability to use BMPs or participate in government programs such as the RCWP. These include characteristics of the individual and farm operation, as well as institutional support mechanisms and public policies. However, relatively little work has systematically examined the influence of such support mechanisms and policies on use of BMPs. This brief review focuses mainly on farm operator adoption of BMPs rather than on participation in government programs.

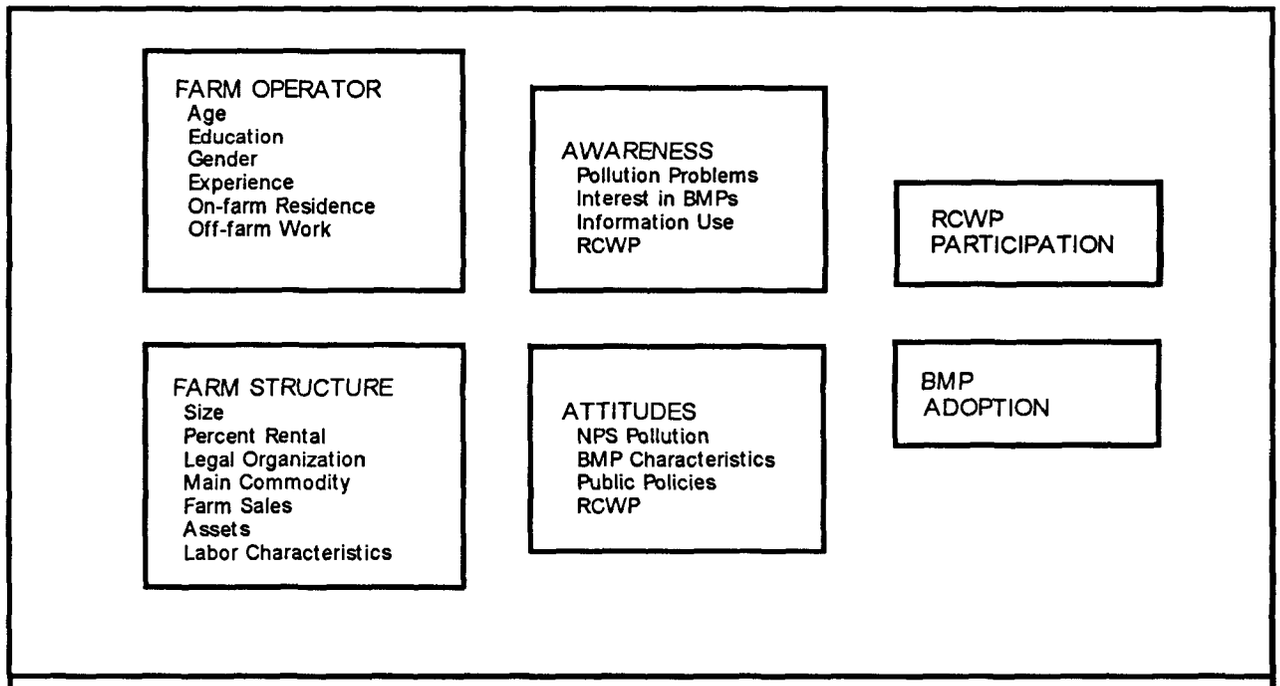

Figure 3.1: Framework for evaluating participation in the Rural Clean Water Program and adoption of best management practices.

3.2.2.1 Farm Operator Characteristics

Farm operators' personal characteristics can influence decisions to use BMPs. It has been consistently shown that educational level is positively related to BMP adoption (Carlson and Dillman, 1986; Buttel et al., 1990). Most studies have found that farm operators who practice conservation tend to have more formal education than farm operators who do not use conservation measures (Carlson and Dillman, 1986; Swanson et al., 1986). This probably reflects farm operators' management ability to handle the additional complexity associated with conservation practices (Nowak, 1984). Bultena and Hoiberg (1986) found that farm operators using U.S. Department of Agriculture (USDA) sources of assistance were better educated than those not using such assistance.

Age has an unclear influence on conservation decisions. Carlson and Dillman (1986) found that no-till users tended to be somewhat younger than average. Swanson et al. (1986) hypothesized that younger farm operators, with greater exposure to information sources, were more likely to adopt conservation practices. They found, however, that age proved relatively unimportant as a predictive variable. Bultena and Hoiberg (1986) found that those farm operators using USDA sources tended to be younger than those who had never used USDA sources of assistance.

Innovation is another personal characteristic that has been found to be positively related to an individual's receptivity to change (Korsching and Nowak, 1983; Rogers, 1983). More innovative farm operators are more likely to practice conservation.

Availability and use of information and assistance can be an important determinant of farm operators' willingness and ability to adopt new practices (Bultena and Hoiberg, 1986; Rogers, 1983). Mass media sources are important for building awareness of an innovation. Farm operators tend to rely on farm organizations and their peers to evaluate an innovation and decide whether to adopt it. Contact with the USDA - Extension Service (ES), USDA - Soil Conservation Service (SCS), and other agencies can be particularly influential. Organizational contact also indicates integration into institutional assistance and communication networks.

Information about new public policies and programs is especially important because of the uncertainty and complexity often associated with changes required by new programs (Bultena and Hoiberg; 1986; Hoban and Cook, 1988). Nowak (1984) argues that farm operators need education to recognize erosion problems and learn how available BMPs can be used to reduce the severity of erosion problems. Napier et al. (1986) found that farm operators who used more numerous institutional sources of information, on a more frequent basis, tended to be more concerned about environmental issues in their decision making.

3.2.2.2 Farm Structure Characteristics

Research has clearly shown that farm structure characteristics have a very important influence on farm operators' adoption of conservation practices (Buttel and Swanson, 1986; Korsching and Nowak, 1983). Larger-scale farm operators have been found to be more willing and able to adopt new practices. Farm size tends to be directly related to greater availability of resources, greater flexibility in decision making, higher status in the local community, and better ability to deal with risk.

Smaller-scale, limited-resource farm operators have been shown to be less willing and able to practice conservation. Heffernan and Green (1986) found that larger farms had lower soil loss than smaller farms, primarily because the land had lower erosion potential. Farm characteristics may also influence farm operators' use of sources of conservation information. Those with the largest operations are most likely to use public agencies for farm information (Bultena and Hoiberg, 1986).

Economic conditions have an important influence on farm operators' willingness and ability to adopt conservation practices (Buttel and Swanson, 1986). Farm income is an indicator of the scale of the farm operation. Farm income and sales are positively related to conservation because they are an indication of ability to pay for BMP investments. Money available for

investment is probably even more important than gross farm income. Many farm operators have incurred high debt levels during the past decade. At the same time, the value of their farm assets has been reduced. Farm operators with higher debt-to-asset ratios may, therefore, be less willing and able to invest in conservation practices.

Off-farm employment is becoming increasingly important for many smaller-scale farm operators. Past research has not specifically examined the influence of off-farm employment on the adoption of conservation. Farm operators who work off-farm may have a different orientation toward farming and conservation. They may be more integrated into non-farm communication networks and, as a result, may make less use of farm-related information sources.

Another common hypothesis is that rented land usually receives less conservation attention than owned land. Results, however, are not conclusive. Ervin (1986) argues that it is unclear whether rented land receives less, more, or the same amount of erosion control than owner-operated land. Carlson and Dillman (1986) found that farm operators who used no-till tended to farm more rented land. Using actual field measurements, Korsching and Nowak (1983) found that the more rental land in a farm operator's operation, the more erosive were the tillage practices and crop rotation. Rental arrangements can limit conservation use if neither tenants nor farm operators take responsibility for conservation investments (Dillman and Carlson, 1982; Ervin, 1986).

Type of farm enterprise can also influence farm operators' willingness and ability to adopt BMPs (Heffernan and Green, 1986; Korsching and Nowak, 1983). Certain types of crop and livestock enterprises are more or less compatible with different types of BMPs. Public policies are also interrelated with the influence of farm type on use of BMPs. For example, farm operators who raise certain crops (such as corn) have the most to lose if they are not in compliance with the 1985 and 1990 farm bill provisions (such as swampbuster or conservation compliance) (Food Security Act of 1985 and Food, Agriculture, Conservation and Trade Act of 1990). Those farm operators who mainly raise livestock or non-program crops (for example, soybeans, fruits, or vegetables) have less to lose if they are not in compliance with conservation measures required by the acts.

Government policies and programs have been shown to have an important influence on farm operators' adoption of BMPs (Batie, 1983; Buttel and Swanson, 1986). Awareness and perceptions of government policies and programs directly affect farm operators' willingness to participate in the programs, as well as their BMP adoption (Korsching et al. 1985; Napier, 1987). Korsching and Nowak (1983) examined farm operators' attitudes toward four conservation policies: economic incentives, economic penalties, legal regulations, and educational programs. They found the most positive attitudes toward economic incentives and educational programs.

Several implications can be drawn about the research to date on farm operator use of BMPs. Buttel et al. (1990) paint a fairly consistent picture of the types of farm operators who are most likely to adopt soil conservation practices. These are "large-scale, well-educated, non-risk-averse farm operators who have access to public cost-sharing and conservation information programs." However, it is unclear whether decisions about the use of BMPs to control NPS pollution are the same as decisions about soil conservation. Farm operators may hold quite different attitudes about the use of soil conservation practices to maintain farm productivity and provide other on-site benefits compared to the adoption of BMPs to provide off-site water quality benefits. Buttel et al. (1990) argue that "to the degree that soil erosion is primarily a problem because of off-site costs, farm operators cannot be expected to conserve because the long-term benefits of conservation are small." Certain types of positive (cost sharing, education) and negative (regulations) incentives are generally recognized as necessary to promote farm operators' use of BMPs that are mainly in the public interest.

3.2.3 Farm Operator Survey Research Techniques

The farm operator survey was designed and conducted by Drs. Thomas J. Hoban and Ronald C. Wimberley, faculty of the Department of Sociology and Anthropology at North Carolina State University (NCSU). An inter-agency advisory committee composed of agency officials, project personnel, social scientists, and others was assembled to provide advice on most phases of this project, including sampling design, survey content, and analytical strategy.

The survey instrument was developed based on comments from the advisory committee, a review of previous research, and insights gained from the interviews with project personnel conducted during the on-site evaluations of all RCWP projects (see Chapter 1, section 1.3). All attempts were made to keep the survey instrument as succinct as possible. A copy of the questionnaire is included in Appendix VI.

A detailed discussion of sample design and implementation may be found in Appendix V. Data were collected through a standardized telephone survey. Telephone interviews were selected for data collection because they provide the most effective and efficient means to systematically collect comparable information from a large sample, especially when the populations are widely dispersed geographically. Data were collected by the Applied Research Group at NCSU.

Completion of at least 1,000 telephone interviews with a representative sample from the RCWP project areas was planned. Only farmer operators in project critical areas, and therefore eligible to participate in the RCWP, were interviewed. The sample was selected so that approximately equal numbers of RCWP participants and non-participants were surveyed. Interviews (averaging 20 minutes each) were conducted during November and December of 1991. The overall response rate for the survey was almost 85%. This involves the proportion of respondents contacted who actually completed the survey. In general, the response rate was higher for farm operators who had participated in the RCWP than for those who were eligible but did not participate.

3.2.4 Farm Operator Survey Results

In this section, the farm operators are described in terms of their demographic and farm structure characteristics. Next, the univariate descriptive statistics for most of the major questions included on the survey are presented. RCWP participation is also analyzed in terms of the significant differences between participants and non-participants. Finally, factors that influenced adoption of different BMPs are assessed. Data were processed using SPSS computer software.

3.2.4.1 Farm Operator and Farm Structure Characteristics

Farm operator and farm structure characteristics for all respondents to the telephone survey are presented in Tables 3.1 and 3.2. In some cases (age and total farm acreage) information was collected as quantitative data, but has been recoded into several categories to simplify presentation and later analysis. For some variables, the means and ranges are also presented in the text.

Individual farm operator characteristics are shown in Table 3.1. Most of the respondents were male. Formal education varied considerably from a minimum of third grade to a maximum of a PhD degree (mean: 13.3 years). Fewer than one in five had less than high school education, while slightly more than one in five reported having a college degree or higher.

Considerable variation was also found in terms of age and experience. The respondents' ages ranged from 16 to 87, with a mean of 50.3 years. About one quarter were under 40. Almost half were between 40 and 59. Farming experience ranged between less than one year and 66 years (mean: 25 years). Almost half the respondents had between 16 and 35 years of farming experience.

Most respondents appeared to have a fairly close connection to agriculture. The majority reported that they lived on the farm they operated. Almost two-thirds said they did not work off the farm at all. Under one-quarter said they worked off the farm nearly full time (200 days or more a

Table 3.1: Characteristics of farm operators interviewed.

GENDER		ON FARM RESIDENCE	
Female	7%	No	12%
Male	93%	Yes	88%
EDUCATION		OFF-FARM WORK	
11 Years or Less	17%	None	58%
High School Graduate	45%	Up to 200 Days	17%
Some College	18%	200 Days or More	25%
College Graduate	21%		
		PERCENT INCOME FROM FARMING	
AGE		25 or Less	31%
Under 40	24%	26 to 75	21%
40 to 59	47%	76 to 99	15%
60 or Older	28%	All	33%
YEARS FARMED			
15 or Less	29%		
16 to 35	48%		
36 or More	24%		

year). Over one-third said that all their household net income came from farming, whereas just over a quarter received 25% or less of their net farm income from farming. The mean net household income from farming for all respondents was 64.7%.

Farm structure characteristics for all the farm operators interviewed are presented in Table 3.2. For some of these characteristics, means and ranges are also presented.

Considerable variation in farm size was evident. About one-fifth of all respondents had under 100 acres, while 16% had 1,000 acres or more. The remainder were relatively evenly divided among the other four categories. Total farm acreage ranged from three acres to 70,000 acres, with a mean size of 694.4 acres. The amount of rental land in their operations varied between none for 43% of the respondents to all rental land for 11%.

In terms of legal organization, most were either individual or family operations. The rest were either partnerships or incorporated.

Considerable variation was evident in terms of gross farm sales; almost as many respondents reported gross farm sales under $40,000 as reported sales over $100,000.

The type of commodities produced by farmers interviewed in the survey are also presented in Table 3.2. About one-third of all respondents reported that none of the gross farm sales came from livestock, poultry, or animal products. Almost one-quarter said that all their sales came from such products. The mean percent was 47.0 percent. Respondents were also asked to specify which product or commodity produced the most gross sales or income on their farms.

To determine real property values, respondents were asked to estimate the total market value of all their land and buildings, including rented or leased land. Less than one-quarter reported property assets below $100,000. About one-third said their property was worth $500,000 or more. Respondents were also asked to estimate the total market value of

Table 3.2: Farm structure characteristics for farm operators interviewed.

TOTAL FARM ACREAGE	
Under 100	21%
100 to 199	19%
200 to 299	14%
300 to 399	17%
500 to 999	15%
1000 or More	14%
PERCENT RENTAL LAND	
None	44%
1 to 25	10%
26 to 50	17%
51 to 99	18%
All	11%
LEGAL ORGANIZATION	
Family/Individual	86%
Partnership	10%
Incorporated	4%
GROSS FARM SALES	
Under $10,000	20%
$10,000 - $39,999	23%
$40,000 - $99,999	19%
$100,000 - $499,999	33%
$500,000 or More	6%
PERCENT SALES FROM LIVESTOCK	
None	34%
1 - 25	12%
26 - 75	17%
76 to 99	15%
All	21%
MOST IMPORTANT COMMODITY	
Dairy	24%
Beef Cattle	14%
Hogs	5%
Other Animal	2%
Corn	17%
Soybeans	13%
Peanuts	6%
Cotton	4%
Other Crop	13%
FARM PROPERTY VALUE	
Under $40,000	8%
$40,000 - $99,999	14%
$100,000 - $499,999	48%
$500,000 or More	30%
FARM EQUIPMENT VALUE	
Under $40,000	31%
$40,000 - $99,999	31%
$100,000 - $499,999	33%
$500,000 or More	5%
USE OF LABOR ON FARM	
Custom Work	47%
Hired Labor	39%
Contract Labor	15%

all the machinery, equipment, and implements kept and used on their farm. In this case, over one-quarter reported that these assets were less than $40,000. Only six percent had equipment assets of $500,000 or more.

A final set of farm structure characteristics involves the use of labor on the farm. About one-half reported using custom work, machine hire, or rental equipment on their farms. Forty-two percent reported the use of hired labor and just under one-fifth reported that they used contract labor on their farms.

3.2.4.2 Awareness and Attitudes

Water Quality Awareness and Information. Awareness of water quality problems are likely be related to farm operators' adoption of BMPs and participation in the RCWP. In general, farm operators expressed quite a bit of awareness. When asked how much they had heard or read about how agriculture might affect water quality, half (50%) reported a lot. Another third (32%) had heard some. Another 15% had only heard a little, while only two percent claimed to have heard nothing.

Interest in learning more about water quality was relatively low, compared to awareness. When asked how much more information they needed about what they could do on their own farm to help protect water quality, only 10% of the farm operators said they wanted a lot more information. Just over a third (36%) said they needed some more information. Almost a third (28%) wanted a little information while

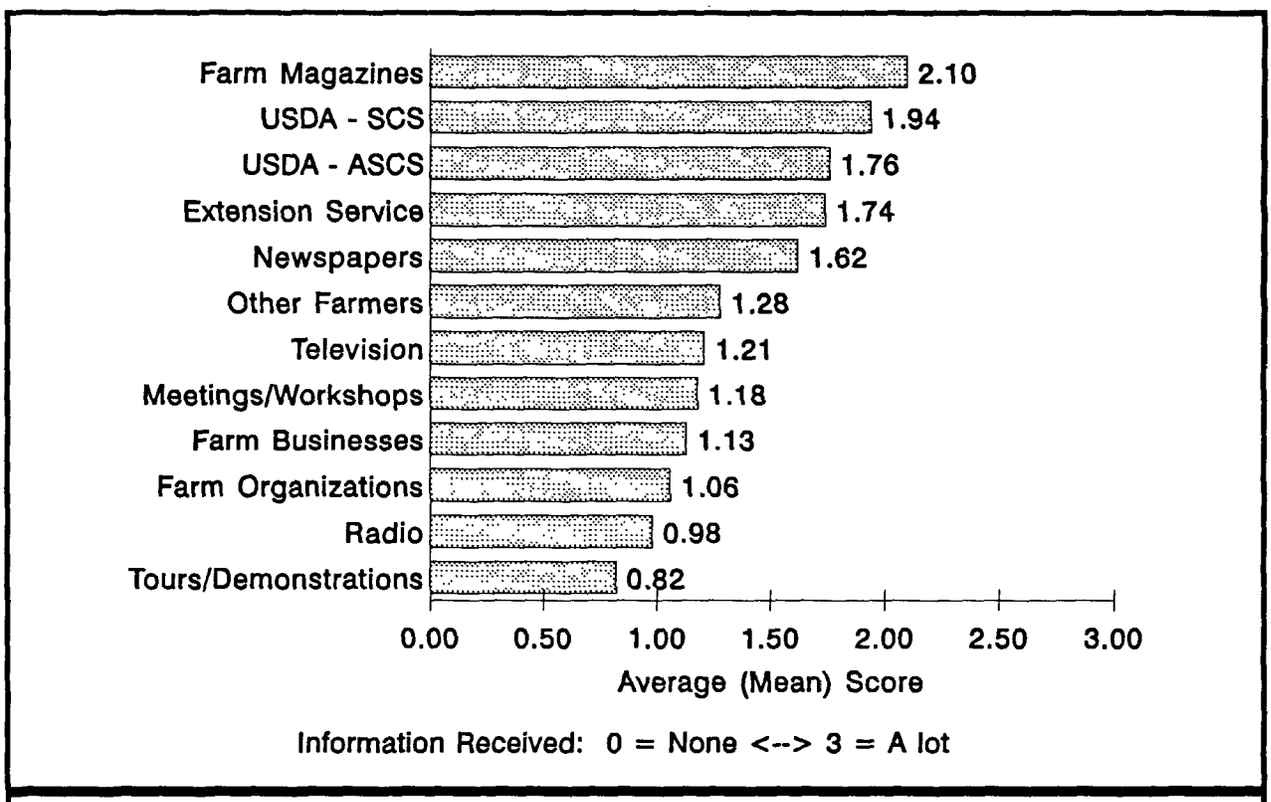

Figure 3.2: Farmers' sources of water quality information.

one-fourth (25%) said they did not need any more information about protecting water quality. This apparently low level of interest may be due, in part, to the relatively high level of awareness.

Respondents were also asked about their use of various information sources. Results for the 12 different information sources are shown in Figure 3.2. The most frequently used source of information was farm magazines. Government agricultural and conservation agencies were the next most important sources, with the Soil Conservation Service being somewhat more widely used. Newspapers were the fifth most commonly used source.

There was a substantial drop in frequency of use for the remaining seven information sources (other farm operators, television, meetings or workshops, pesticide or fertilizer dealers and other farm organizations, radio, and tours and demonstrations).

Attitudes about Water Quality Problems. Attitudes about the causes and severity of water quality problems should relate to adoption of BMPs and participation in the RCWP. Only 12% of the farmers interviewed said water pollution was a serious problem in their area. The remainder were almost evenly divided between those who felt pollution was somewhat of a problem (42%) and those who felt it was not a problem (46%). Problem perception was even lower when respondents were asked if water pollution was a serious problem on their own farm. Only one percent said pollution was a serious problem. Over three-quarters (81%) claimed there was no problem with water pollution on their farms, despite the fact that these farms had been targeted for land treatment because project personnel believed they were contributing to a water quality problem.

Concerns for specific impacts of water pollution appear moderately high. Approximately 32% were very concerned about pollution of their own drinking water, 33% were somewhat concerned, and 35% were not concerned. On another matter, two-thirds of all respondents either strongly agreed (11%) or agreed (56%) that agricultural water pollution is a serious threat to fish and wildlife.

The survey also determined if respondents felt that agriculture represented a serious cause

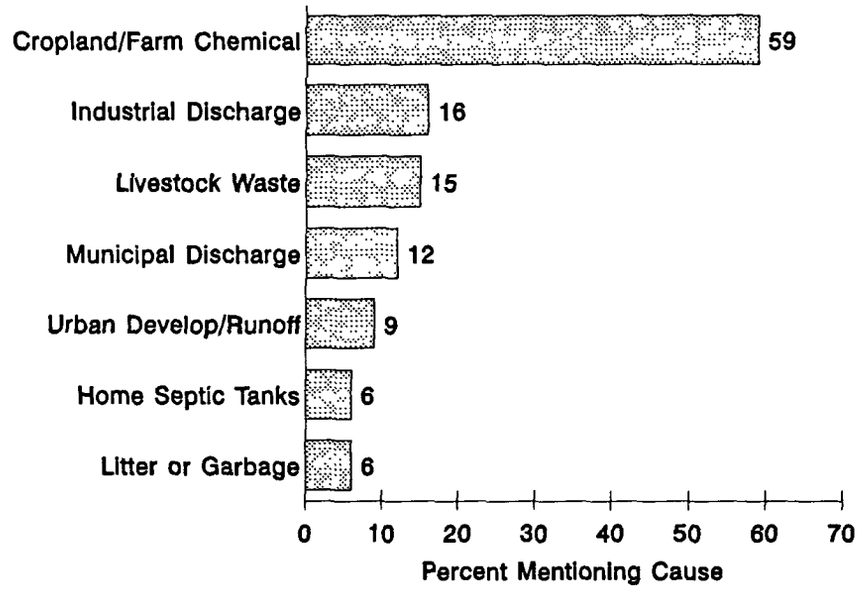

Figure 3.3: Farmers' perceptions of major causes of water pollution.

of water pollution. Near the start of the interview, respondents were asked what they thought were the major causes of water pollution in their area (respondents could give more than one answer to the question). Results are shown in Figure 3.3.

The most frequently mentioned cause of water pollution (over a third of respondents) was "runoff from cropland." Almost a quarter specifically mentioned pesticides, including herbicides or insecticides. One in five (20%) mentioned fertilizers or specific nutrients (such as nitrogen). To account for respondents who reported two or more of these responses, these three categories were combined into one indicator of pollution from crop agriculture. Over half (59%) saw cropland as a major cause of pollution. Far fewer respondents (15%) recognized livestock or animal waste as a cause of pollution. Combining crop and livestock NPS pollution, just two-thirds of all respondents believed agriculture to be a major cause of water pollution.

Respondents reported a variety of other non-agricultural causes of water pollution in their areas (Figure 3.3). Over a quarter said that point sources were the major causes of pollution. In this case, 16% said industrial waste or factory discharge were the major sources, while another 12% cited municipal sewage treatment. Other sources of pollution mentioned included urban development or runoff, household septic systems, and litter or garbage.

Several other questions directly address respondents' attitudes about the potential contribution of agriculture to water pollution problems. Over half of all respondents either strongly agreed (9%) or agreed (48%) that the farming practices they were currently using had no significant effect on water quality in their area. In fact, over three-quarters strongly agreed (14%) or agreed (63%) that agriculture is being unfairly blamed as a cause of water quality problems.

Attitudes about Public Policies and Programs. The RCWP represented an experiment in the extent to which agricultural NPS pollution could be adequately controlled by reliance on the voluntary cooperation of farm operators. The key assumption of the RCWP approach was that targeted high levels of education, financial assistance, and technical assistance would be adequate to promote extensive adoption of BMPs designed to improve water quality. Some of the questions in the survey have direct relevance to the issue of voluntary versus mandatory control of agricultural NPS pollution. Many questions also have direct relevance to the effectiveness of the I&E

programs implemented in the RCWP projects and socioeconomic factors affecting BMP adoption.

Most farm operators appeared to support the voluntary approach taken by the RCWP. Almost all respondents either strongly agreed (12%) or agreed (84%) that water pollution can best be controlled through educational programs that encourage farm operators to use BMPs. As further evidence of support for the voluntary approach, over two-thirds either strongly agreed (9%) or agreed (60%) that the government should help pay more for water pollution control on farms.

On the other hand, there seemed to be a recognition by many farm operators that the voluntary approach may not always work. Most seem resigned to the inevitability of government regulations. Almost all either strongly agreed (15%) or agreed (74%) that if farm operators don't do more to protect water quality on their own, the government will force them to through regulation. In fact, most also either strongly agreed (9%) or agreed (76%) that farm operators do not have the right to farm in ways that damage water quality. Almost as many either strongly agreed (6%) or agreed (72%) that land should be farmed in ways that protect water quality even if this means lower profits.

3.2.4.3 Participation in the RCWP

The major objective of the farm operator survey was to determine what factors influenced farmers' decisions to participate or not participate in the RCWP. Farm operators interviewed included both participants and non-participants from each RCWP project. The sampling design was based on the written designation of eligibility and participation provided by the local USDA - Agricultural Stabilization and Conservation Service (ASCS) offices. Participation was also verified by asking the farm operators if they had participated in an RCWP project. Results, however, showed discrepancies of over 10% between the official designation and farmers' reports. Several attempts were made to clear up this uncertainty (see Appendix V).

Reasons for Participation. Depending on whether or not respondents said they had participated in the RCWP, they were asked a different series of questions. Responses of farm operators who said they had participated in the

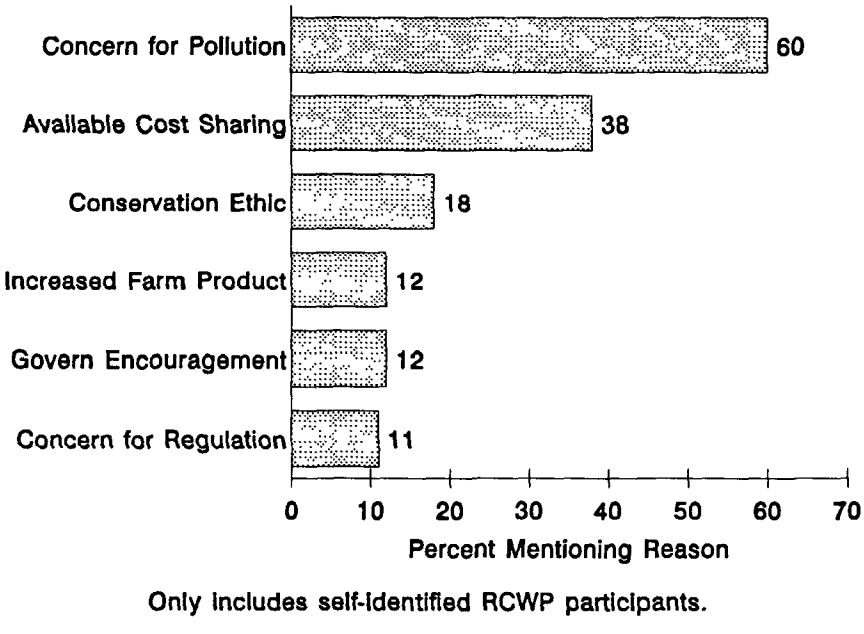

Figure 3.4: Farmers' reasons for participating in the Rural Clean Water Program.

RCWP regarding their reasons for choosing to participate are shown in Figure 3.4.

Three out of five mentioned something related to concern for water pollution or its effects. Just over one-third said that the availability of cost sharing funds was an important reason. Almost one in five said they felt it was "the right thing to do" or in some other way expressed a conservation ethic. Three other reasons were given by a sizable number of respondents: increased farm productivity, assistance or encouragement from government agencies, and concern over future pollution regulations.

Participants were also asked to rate their satisfaction with the RCWP. Overall, satisfaction was very high. Almost all respondents were either very satisfied (51%) or satisfied (42%) with the *technical* assistance and information they received from the RCWP. Satisfaction with the *financial* assistance was just as high with most being either very satisfied (46%) or satisfied (47%).

Another indication of program effectiveness can be evaluated by determining the impact of the RCWP on adoption of BMPs. Respondents were evenly divided when asked if they would have been very likely (14%), likely (35%), unlikely (34%), or very unlikely (17%) to have used all of the BMPs they were currently using if the RCWP had not been available.

Figure 3.5 shows the reasons given by the self-identified non-participants for their decisions *not* to participate in the RCWP (some gave more than one answer) .

Almost one-quarter of the non-participants said they did not participate because they did not believe water pollution was a problem, either on their own farm or in general. The next major reason for non-participation (16%) involved some form of resistance to change. This included the idea that a farmers' present system works well or that changing practices is too much trouble. Over 10% said they simply did not like government programs, including the red tape or complicated procedures. Almost as many (8%) said they had never heard of the RCWP at the time it was available. In addition, seven percent said they were never asked to participate. Another nine percent claimed they had tried to sign up but were ineligible. Only six percent said anything about economic factors, including the belief that the cost-share rates were too low.

Respondents who had not participated in the RCWP were asked about contacts by government agencies asking them to participate. Almost two-thirds (58%) of the non-participants claimed that no government agencies had ever contacted them about participating in the RCWP, despite the fact that the local ASCS had designated them as eligible for participation. On a more positive note, almost two-thirds said they would be either very likely (14%) or likely (48%) to participate if a new program (like the RCWP) were available today.

Impacts of the RCWP. Figure 3.6 reports the results of how participants and non-participants (excluding those who claimed they had never heard of the RCWP) assessed the overall impacts of the RCWP. Most respondents (90%) felt that the RCWP had a positive effect on farm operators' knowledge about water quality. Most (84%) also felt the RCWP had a generally positive effect on surface water quality in their area.

Around two-thirds felt the RCWP had a positive effect on operating costs for farm operators who participated in the RCWP, as well as on farm income for farm operators who participated (Figure 3.6). Less than 10% of the respondents felt that the RCWP had negative effects on these economic conditions. Just over half (56%) believed that the RCWP had a positive effect on drinking water quality in the area. Many (42%) felt the RCWP had no effect on drinking-water quality. This may be explained by the fact that very few RCWP projects specifically targeted drinking water problems.

Earlier in the interview all respondents had been asked if water quality in their area was better, about the same as, or worse than it was ten years ago. Respondents' assessments of water quality trends were divided, with about one-third (34%) believing that water quality had gotten better and almost half (49%) feeling that it had remained about the same. About one-fifth (17%) felt water pollution was now worse.

Statistical Analysis of RCWP Participation. A key goal of the survey was to determine whether farm operators who participated in the RCWP differed significantly from those who were eligible, but did not

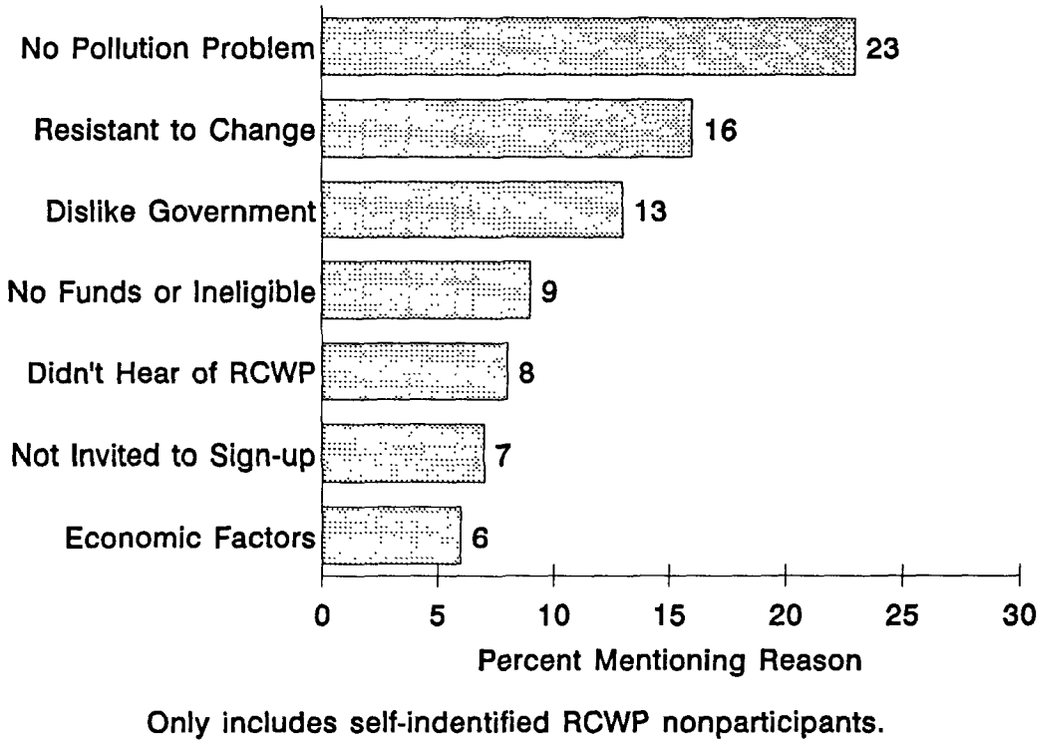

Figure 3.5: Farmers' reasons for not participating in the Rural Clean Water Program.

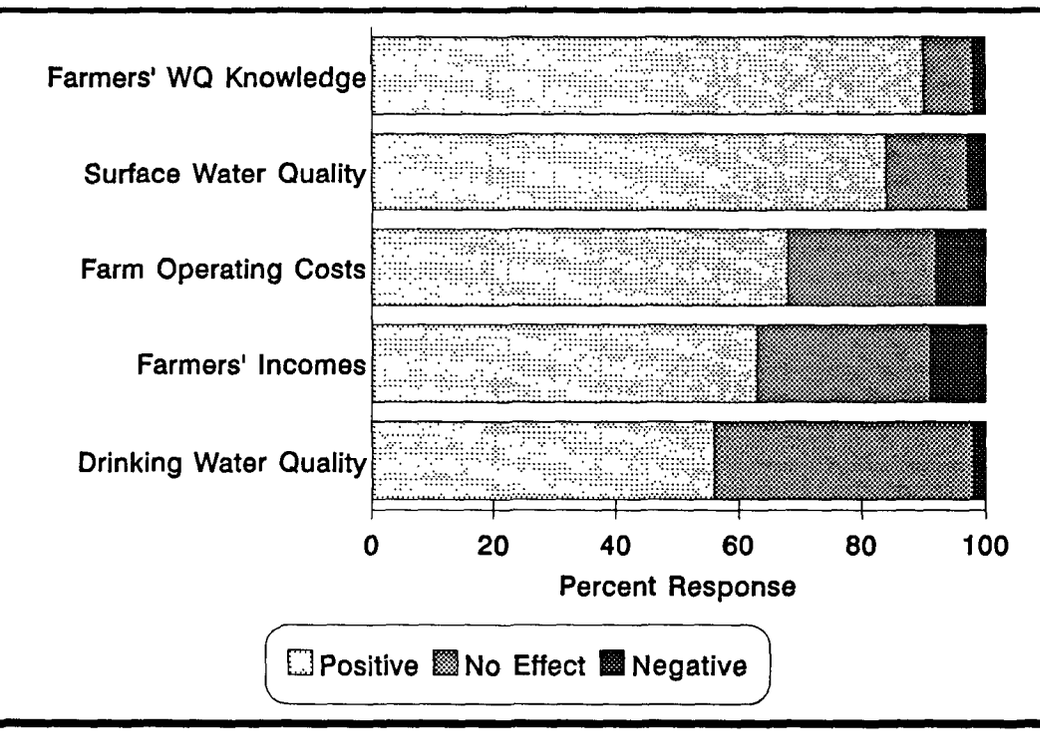

Figure 3.6: Farmers' perceptions of effects of the Rural Clean Water Program.

participate. Analysis in this section therefore focuses on the differences between participants and non-participants in terms of selected variables: farm operator characteristics (Table 3.3), farm structure characteristics (Table 3.4), water quality awareness (Table 3.5), and use of information (Table 3.6). The significant differences are discussed.

The results relating to the possible influence of farm operator characteristics are shown in Table 3.3. No significant difference between participants and non-participants in their level of formal education was found. No significant differences were found in terms of age or years farmed. Individual characteristics seem to have had little influence on participation.

Some differences were evident in respondents' overall orientation toward agriculture. Participants were more likely to report no off farm employment (64%) than were non-participants (54%). Participants also derived a significantly larger amount of their net family income from farming compared to non-participants. Over 40% of participants received all their income from farming compared to just over a quarter of the non-participants.

Table 3.3: Differences between farm operators who did and did not participate in the Rural Clean Water Program in terms of farm operator characteristics.

	PERCENT RESPONDENTS		
	Non-Participant	Participant	Chi-Square (Significance)
FORMAL EDUCATION			
Under High School	19	14	
High School Graduate	45	45	
Some College	17	19	
College Grad or More	19	22	5.88
AGE			
39 or Younger	25	23	
40 through 59	45	51	
60 or Older	30	26	5.04
YEARS FARMED			
15 or Less	30	27	
16 through 35	46	50	
36 or More	24	23	1.47
ON FARM RESIDENCE			
No	13	10	
Yes	87	90	1.65
OFF FARM EMPLOYMENT			
None	54	64	
Up to 200 Days	17	16	
200 Days or More	28	21	10.70**
INCOME FROM FARMING			
25 Percent or Less	36	22	
26 to 75 Percent	21	21	
76 to 99 Percent	14	16	
100 Percent	28	41	28.96***

* = significant at $p \leq .05$ ** = significant at $p \leq .01$ *** = significant at $p \leq .001$

Table 3.4: Differences between farm operators who did and did not participate in the Rural Clean Water Program in terms of farm structure characteristics.

	PERCENT RESPONSE		
	Non-Participant	Participant	Chi-Square (Significance)
TOTAL ACREAGE			
Under 100	27	14	
100 to 199	21	16	
200 to 299	14	15	
300 to 499	15	19	
500 to 999	13	18	
1000 or more	11	19	45.08***
PERCENT RENTAL LAND			
None	46	41	
1 to 25 Percent	10	10	
26 to 50 Percent	14	20	
51 to 99 Percent	16	20	
100 Percent	13	8	19.59**
LEGAL ORGANIZATION			
Family or Individual	86	85	
Partnership	11	8	
Incorporated	3	6	4.60
GROSS FARM SALES			
Under $10,000	26	10	
$10,000 to $39,999	26	19	
$40,000 to $99,999	17	22	
$100,000 to $499,999	26	42	
$500,000 or More	4	8	69.54***
FARM PROPERTY VALUE			
Under $40,000	9	5	
$40,000 to $99,999	17	12	
$100,000 to $499,999	48	48	
$500,000 or More	26	35	17.74***
FARM EQUIPMENT VALUE			
Under $40,000	38	20	
$40,000 to $99,000	30	32	
$100,000 to $499,999	26	43	
$500,000 or More	6	6	48.15***
PERCENT LIVESTOCK SALES			
None	37	31	
1 to 25 Percent	14	10	
25 to 75 Percent	15	20	
76 to 99 Percent	15	15	
100 Percent	19	24	13.85***
HIRED LABOR ON FARM			
No	67	53	
Yes	33	47	23.48***
CONTRACT LABOR ON FARM			
No	88	80	
Yes	12	20	14.84***
CUSTOM WORK ON FARM			
No	57	48	
Yes	43	52	8.10**

* = significant at $p \leq .05$ ** = significant at $p \leq .01$ *** = significant at $p \leq .001$

Differences between participants and non-participants were particularly evident in terms of farm structure characteristics (Table 3.4). Participants had significantly larger operations than did non-participants. While one-quarter of all non-participants had less than 100 acres in their total operation, only 14% of the participants were in this small farm-size category. On the other hand, over a third of the participants had farms at least 500 acres in size, compared to just under one-fourth of the non-participants.

Non-participants were more likely to either have no rental land or all rental land than were participants. Participants were more likely to have a mixture of rental and owned land. No significant differences were found in terms of legal organization.

Differences in economic conditions of participants versus non-RCWP participants appeared to be very significant, with participants being generally better off financially than non-participants. Almost half of all non-participants, but only about one-fourth of participants, reported less than $40,000 in gross farm sales. Over half the participants had $100,000 or more in gross sales, compared to just over a third of the non-participants.

Further indicating that participants were relatively more prosperous than non-participants, assets reported by participants were of significantly higher value for both farm equipment and property. The differences are most striking for equipment assets, where about half the participants reported equipment valued at $100,000 or more compared to under a third of the non-participants.

The type of farm operations also appears different for the two groups. Farm operators who participated in the RCWP were more likely to report a greater percentage of their gross sales from livestock or other animal products. However, this difference may be the result of more intense targeting of critical area farmers with livestock than of cropland farmers for RCWP project participation.

Project participants also tended to have more help with their farm operations as evidenced by their significantly greater use of hired labor, contract labor, and custom work.

Comparisons between participants and non-participants in terms of their water quality awareness are shown in Table 3.5. Almost three out of five participants had heard or read a lot about NPS pollution, compared to under half of the non-participants. No significant differences were found between the groups in terms of their reported need for more information. Participants were much more likely to believe that water pollution was a problem. About two-thirds of all participants said pollution was a problem in their own area, but under half of the non-participants saw area water pollution as a problem. The trend is similar, but less dramatic in the case of pollution problems on their own farms.

Participants were more likely to have received significantly more water quality information from the various sources of information listed in Table 3.6 than were non-participants. The differences were most noticeable for amount of information received from the government agencies or special events (meetings or tours). Participants also reported more information from the various private sector groups (such as other farmers or farm organizations), as well as from farm magazines. However, there was generally less difference between participants and non-participants in terms of the amount of information received from the general mass media (newspapers, television, and radio).

Finally, RCWP participants and non-participants differed in terms of their overall evaluation of the impacts of the RCWP (Table 3.7). In most respects, participants had a much more favorable impression of the effects of the program than did non-participants. Over three-quarters of the participants said that the RCWP had a positive effect on farm operating costs, compared to 59% of the non-participants. Perceived impacts on farm income showed similar patterns. Participants were also much more likely to see the impacts of the RCWP as positive on farm operators' knowledge of water quality, as well as on surface water quality. No differences were found in terms of respondents' evaluation of the impacts of the RCWP on drinking water quality. Almost half the participants felt that water quality in their area had gotten better during the previous ten years, compared to just one-quarter of the non-participants.

Table 3.5: Differences between farm operators who did and did not participate in the Rural Clean Water Program in terms of water quality awareness.

	PERCENT RESPONDENTS		
	Non-Participant	Participant	Chi-Square (Significance)
POLLUTION AWARENESS			
None	3	1	
A Little	17	12	
Some	34	31	
A Lot	46	56	13.71**
INFORMATION NEEDED			
None	27	22	
A Little	26	31	
Some	35	38	
A Lot	11	10	6.14
AREA WATER POLLUTION			
No Problem	53	35	
Problem	47	65	34.96***
FARM WATER POLLUTION			
No Problem	84	77	
Problem	16	23	8.18**

* = significant at p ≤ .05 ** = significant at p ≤ .01 *** = significant at p ≤ .001

Table 3.6: Differences between farm operators who did and did not participate in the Rural Clean Water Program in terms of extent of use of different sources of information .

	MEAN SCORE		
	Non-Participant	Participant	T-Value (Significance)
MEDIA			
Farm Magazines	1.99	2.25	4.77***
Newspapers	1.56	1.70	2.24*
Television	1.14	1.31	2.69*
Radio	0.95	1.01	0.95
AGENCIES			
SCS	1.74	2.24	8.16***
ASCS	1.57	1.97	6.40***
Extension	1.61	1.96	5.64***
EVENTS			
Meetings	1.01	1.43	6.50***
Tours	0.66	1.04	6.24***
GROUPS			
Other Farmers	1.17	1.44	4.58***
Chemical Dealers	1.04	1.27	3.63***
Farm Organizations	0.94	1.24	4.67***

0 = None 1 = Little 2 = Some 3 = A Lot

* = significant at p ≤ .05 ** = significant at p ≤ .01 *** = significant at p ≤ .001

3.2.4.4 Overall Adoption of BMPs

The farm operator survey was also designed to determine whether or not farm operators believed that they had adopted recommended BMPs to control NPS pollution from their own farms. Respondents were asked if they were using any farming practices available to help farm operators protect water quality (BMPs). They were then asked specifically about the 17 BMPs being promoted overall as part of the RCWP (Figure 3.7). In this section, results for all respondents and all BMPs are presented. In the following section (3.2.4.5), two subsets of projects addressing BMP adoption for animal waste management and sediment reduction are analyzed.

The survey results must be interpreted with the following facts in mind: 1) not all BMPs were applicable or approved in all RCWP projects (each project Local Coordinating Committee established a list of applicable BMPs to be cost shared through their RCWP project) and 2) it was not possible to evaluate in a telephone interview whether or not BMPs were implemented in an approved, technically-sound manner.

Nine of the BMPs in question were relatively more popular with all the farm operators interviewed. These BMPs tended to be more management-intensive than structural. About three-quarters of all respondents reported using soil testing, conservation tillage, pesticide management, and grassed waterways. Almost as many were using other management practices: cover crops, hayland or pasture management, permanent vegetative cover, grasses or legumes in rotation, and nutrient management.

The extent to which the RCWP ultimately led to changes in farm operator behavior (as indicated by increased adoption of BMPs) was evaluated by comparing RCWP participants with non-participants in terms of their reported use of each of BMPs approved for use in the RCWP projects (Table 3.8).

Participants were significantly more likely to be using almost all the BMPs than were non-participants. For 11 BMPs, the differences were significant. These comparisons indicate the relative effectiveness of the RCWP in promoting the adoption of some BMPs, which should lead to improved water quality.

Influences on BMP Adoption. The features of a BMP that were important in a farm operator's decision about whether or not to use it were determined by asking respondents how important each of a list of factors would be in decisions about whether to use a new BMP to help protect water quality (Figure 3.8). It is probably most meaningful to consider the percentage of respondents who said a particular factor was "very important" since relatively few said the factors were unimportant

About two-thirds of all respondents said the cost of the practice would be very important. Almost as many believed the potential of the practice to improve water quality would be very important. Over half said that the effects of the practice on profits would be very important. Exactly half of all respondents felt that the ease of using a practice, as well as the labor or time required, would be very important. Just under half said availability of government cost sharing would be very important. About the same number would find the experience of other farm operators to be very important. Two factors appear to be less unimportant for the farm operators in this sample. Less than a third felt information from government agencies and information from farm businesses would be very important.

Several additional questions addressed farmers' attitudes about BMPs. Most respondents either strongly agreed (11%) or agreed (74%) about the need for less expensive farming practices that will help protect water quality. Over half either strongly agreed (5%) or agreed (55%) that farm practices that protect water quality usually require more labor. Economic and labor constraints may thus be important factors that limit the adoption of BMPs.

3.2.4.5 Analysis of Selected BMPs in Specific Types of Projects

Results presented in the previous section included both RCWP participants and non-participants from all 21 RCWP projects. However, all BMPs were not applicable, promoted, or cost shared in every RCWP project. The nature of the water quality problems determined the types of BMPs that each project promoted. Therefore, in order to account for such

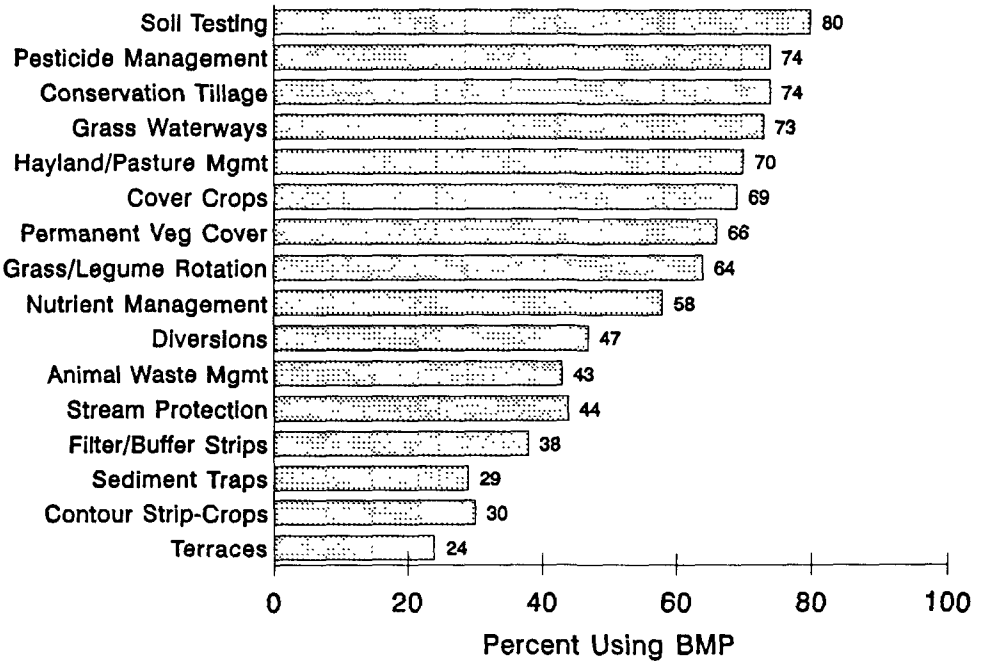

Figure 3.7: Adoption of best management practices by farmers (all respondents).

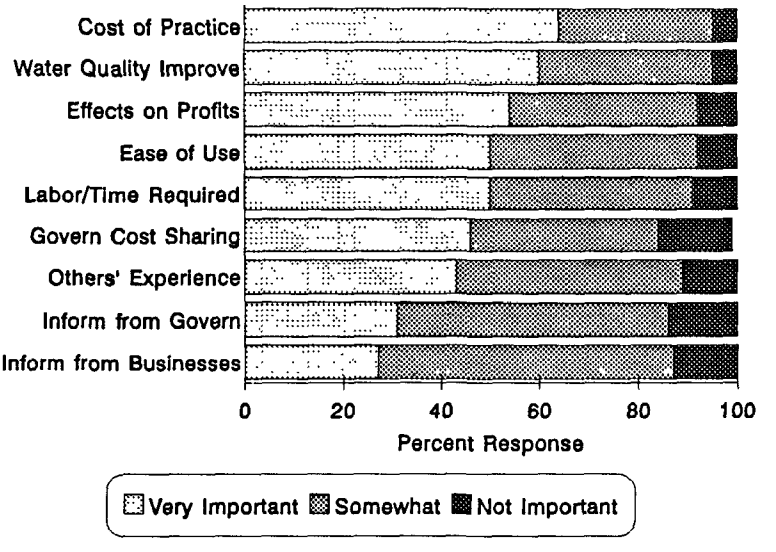

Figure 3.8: Influences on farmers' adoption of best management practices.

Table 3.7: Differences between farm operators who did and did not participate in the Rural Clean Water Program in terms of perceived effects of the RCWP.

	PERCENT RESPONDENTS		
	Non-Participant	Participant	Chi-Square (Significance)
FARM OPERATING COSTS			
Negative Effect	8	6	
No Effect	33	16	
Positive Effect	59	78	37.71***
FARM INCOME			
Negative Effect	11	7	
No Effect	32	24	
Positive Effect	57	69	14.36***
WATER QUALITY KNOWLEDGE			
Negative Effect	4	1	
No Effect	10	5	
Positive Effect	86	94	13.43**
SURFACE WATER QUALITY			
Negative Effect	4	1	
No Effect	20	6	
Positive Effect	76	93	50.12***
DRINKING WATER QUALITY			
Negative Effect	3	2	
No Effect	43	41	
Positive Effect	55	57	0.96
WATER QUALITY TREND			
Worse/Same	76	52	
Better	24	48	70.86***

* = significant at $p \leq .05$ ** = significant at $p \leq .01$ *** = significant at $p \leq .001$

Table 3.8: Differences between farm operators who did and did not participate in the Rural Clean Water Program in terms of adoption of best management practices (all respondents).

	PERCENT RESPONDENTS		
	Non-Participant	Participant	Chi-Square (Significance)
Sediment Traps	22	39	35.24***
Filter/Buffer Strips	33	44	12.80***
Stream Protection/Fencing	39	50	12.36***
Permanent Vegetative Cover	62	72	11.62***
Animal Waste Management	39	49	10.80***
Soil Testing	77	85	10.68***
Pesticide Management	70	79	9.80**
Conservation Tillage	70	79	9.68**
Strip Cropping	33	25	9.17**
Diversions	44	52	7.40**
Grass Waterways	70	77	6.65**
Grass/Legume Rotation	61	67	3.43
Nutrient Management	56	62	3.41
Terraces	26	22	1.76
Cover Crops	68	72	1.65
Hayland/Pasture Management	68	72	1.47

* = significant at $p \leq .05$ ** = significant at $p \leq .01$ *** = significant at $p \leq .001$

differences, this section includes two more focused types of analysis that consider the adoption of only specific BMPs in two different types of RCWP projects. The results are presented first for the adoption of BMPs aimed at controlling pollution from livestock waste and then for BMPs to control pollution from sediment.

Adoption of Livestock Waste Control BMPs. The first type of analysis focuses on six BMPs aimed at controlling pollution from animal waste (Table 3.9). These BMPs were promoted in 13 of the 21 RCWP projects: (Alabama, Delaware, Florida, Massachusetts, Maryland, Michigan, Minnesota, Oregon, Pennsylvania, Utah, Vermont, Virginia, and Wisconsin). This analysis includes the responses from 719 farm operators.

The RCWP efforts seemed to have influenced the use of three of these BMPs. Two-thirds of the RCWP participants in these 13 projects reported that they had animal waste management systems on their farms, compared to less than half of the non-participants. Almost 60% of the participants had adopted stream protection or fencing compared to just 40% of the non-participants. Participants were also more likely to be using filter or buffer strips.

Three other practices showed no significant differences in adoption between participants and non-participants: nutrient management, soil testing, and hayland or pasture management. This indicates that RCWP projects addressing animal waste problems were more successful at promoting the adoption of structural BMPs than management-type practices.

Table 3.10 shows the relationships between adoption of each of the six BMPs to control livestock waste and a number of independent variables (farm operator characteristics, farm structure characteristics, and awareness of water pollution problems). This analysis was done on a bivariate basis using zero-order correlation. Only two of the farm operator characteristics show a relatively consistent relationship with adoption of the livestock waste control BMP. In the case of four of the BMPs, farm operators who used the BMPs tended to be significantly younger than those who did not. There also is a tendency for these farmers to derive a significantly greater amount of their household income from farming.

Farm structure variables appear to have more consistent and powerful relationships with adoption of the BMPs to control livestock waste. The most significant farm structure variables involve the economic strength of the farm operation. For all six BMPs, those who had adopted them reported higher gross farm sales. In all but one case, adopters reported higher values for farm property and farm equipment. In the case of four of these BMPs, farm operators who had adopted them tended to have larger farms. Labor characteristics appear important in the use of four of the BMPs as indicated by the significant relationships noted with use of custom work and use of hired labor.

Awareness of and information about nonpoint source pollution also appears to have an important influence on adoption of livestock waste control BMPs. For all six BMPs, those who adopted the practices had heard or read significantly more about nonpoint source pollution. They also had received much more information from the various sources of information. In this case respondents' scores on all 12 sources of information shown in Figure 3.2 were added to give a composite index of information use. There is a tendency for those who use the various BMPs to consider water pollution to be a more serious problem in their areas and on their own farms than for those who had not adopted the BMPs.

Adoption of Sediment Control BMPs. The second type of analysis focuses on 12 BMPs aimed at controlling pollution from sediment (Table 3.11). These were promoted in 12 of the 21 RCWP projects (Alabama, Delaware, Iowa, Idaho, Illinois, Kansas, Maryland, Minnesota, Nebraska, South Dakota, Tennessee/Kentucky, and Virginia). This analysis includes the responses from 668 farm operators.

The RCWP efforts seem to have influenced the use of six of these BMPs, but had relatively little effect on the use of six others. In fact, although the six relationships are statistically significant, the relationship between RCWP participation and adoption is rather weak for all but one of the BMPs. Only in the case of sediment traps do these results indicate a reasonably strong influence of the RCWP on adoption of BMPs to control sediment. Almost half of the participants reported the use of sediment traps compared to only a quarter of the non-participants. The RCWP also seems to have

Table 3.9: Differences between farm operators who did and did not participate in the RCWP in terms of adoption of BMPs to control animal waste (includes respondents from 13 projects (Alabama, Delaware, Florida, Massachusetts, Maryland, Michigan, Minnesota, Oregon, Pennsylvania, Utah, Vermont, Virginia, and Wisconsin).

	PERCENT RESPONDENTS		
	Non-Participant	Participant	Chi-Square (Significance)
Animal Waste Management (AW)	45	66	27.50***
Stream Protection/Fencing (SP)	40	59	24.76***
Filter/Buffer Strips (FS)	32	45	11.88***
Nutrient Management (NM)	58	66	3.72
Soil Testing (ST)	77	83	3.42
Hayland/Pasture Management (HM)	70	75	2.05

* = significant at p ≤ .05 ** = significant at p ≤ .01 *** = significant at p ≤ .001

Table 3.10: Relationships between independent variables and farm operators' reported use of BMPs to control animal waste (only includes respondents from 13 projects (see Table 3.9 for list of projects and BMP abbreviations)).

	AW	NM	ST	HM	FS	SP
Education	-.04	.06	.02	.05	.09*	.09*
Age	-.16***	-.13***	-.12**	-.05	-.10**	-.07
Years Farmed	-.04	-.03	.00	-.02	-.02	-.06
On-farm Residence	.15***	.02	.04	.05	-.07	.02
Off-farm Work	-.23***	-.04	-.04	.01	-.05	-.02
% Income from Farm	.32***	.15***	.16***	.08*	.08*	.07
Total Farm Acreage	.12***	.18***	.22***	.04	.18***	.04
Percent Rental Land	-.03	.08*	.07	-.01	.07*	-.07
Gross Farm Sales	.42***	.24***	.27***	.07*	.16***	.11**
Percent Sales from Livestock	.45***	.07	.03	.16***	-.02	.11**
Farm Property Values	.32***	.17***	.24***	.10**	.14***	.07
Farm Equipment Values	.33***	.24***	.29***	.16***	.16***	.12**
Use of Custom Work	.12**	.11**	.13***	.02	.13***	.01
Use of Hired Labor	.22***	.10**	.08*	.05	.09*	.04
Use of Contract Labor	.12**	.01	.01	.08	.04	.06
Awareness of Pollution	.14***	.29***	.17***	.15***	.20***	.17***
Area Pollution Problem	.09*	.06	.04	-.02	.16***	.14***
Farm Pollution Problem	.05	.11**	.09*	.00	.05	-.05
Use of Information	.28***	.25***	.21***	.12***	.22***	.23***

* significant at p ≤ .05 ** significant at p ≤ .01 *** significant at p ≤ .001

had a positive, but relatively weak, influence on adoption of: conservation tillage, diversions, grass or legume rotations, and filter/buffer strips. However, participation in the RCWP was negatively related to adoption of strip cropping. Only 29% of the participants reported use of strip cropping compared to 38% of the non-participants.

As in the case of adoption of livestock waste control BMPs, some additional analysis also indicates differences between farm operators who adopted the various BMPs and those who did not along several important dimensions. Table 3.12 shows the relationships between adoption of each of the 12 sediment control BMPs the various independent variables (farm operator characteristics, farm structure characteristics, and awareness of water pollution problems). The analysis was again done on a bivariate basis using zero-order correlations. Results are quite similar, but generally not as consistent or significant as the results for adoption of BMPs to control livestock waste.

In the case of farm operator characteristics, those who use the sediment control BMPs did tend to be younger and they also generally received a greater percent of the net income from farming. Again, farm structure variables appear to be relatively important. Those who used the sediment control BMPs tended to have larger farm operations than their counterparts. They also were better off financially (as indicated by their higher gross farm sales, as well as higher values for farm property and equipment). They also tended to report more of their gross farm sales from livestock. The results also show that greater awareness of nonpoint source pollution and the use of more information sources were relatively significant and consistent predictors of adoption of these sediment control BMPs.

3.3 Project Personnel Survey

3.3.1 Rationale and Objectives

A mail survey of project personnel (Coffey and Hoban, 1992) was designed as a supplement to the in-person interviews. The in-person interviews with project staff were conducted at all RCWP project sites during 1991-92 by inter-agency evaluation teams led by National Water Quality Evaluation Project (NWQEP) staff (see Chapter 1, section 1.3). Objectives of the mail survey were to gather supplemental information on project coordination and committees, project effectiveness, information and education, farm operator participation, and RCWP workshops.

3.3.2 Project Personnel Survey Research Techniques

The confidential questionnaire (Coffey and Hoban, 1992) was mailed to personnel from all 21 RCWP projects, including: employees of ASCS, SCS, ES, state and federal agencies responsible for water quality monitoring, and Soil and Water Conservation Districts.

The questionnaire contained 35 questions, most which could be answered by checking a multiple choice item or writing a short response. Of the 292 questionnaires sent to project staff in early 1992, 62% were returned. The number of questionnaires returned from an individual project ranged from four to eighteen.

Responses were entered into a data base and tabulated using SAS. The questions and responses (given as percentages) to the project personnel questionnaire are presented in Appendix VII. Relevant question numbers are noted in the text. Several of the questions in the questionnaire were identical to questions asked of farm operators during the telephone survey of RCWP participants and non-participants (section 3.2). These identical questions are noted and compared below.

3.3.3 Project Personnel Survey Results

3.3.3.1 Project Coordination and Management

Just over half (52%) of the project personnel responded that their RCWP project had an overall local project manager (Question 1). Within a project, there were differences of opinion as to whether the project had a local manager. For eleven of the projects, respondents within a project were split, with approximately 50% of the personnel believing the project had a local manager and approximately 50% stating that the project did not have a local manager. The difference within projects may be due to how the respondents were defining the term *project manager*. In some projects, an individual was hired specifically to be the project manager. In other projects, the ASCS County Executive Director or another individual may have been considered by project personnel to have been the project manager, although that person was not formally designated as such.

Coordinating project activities was the reason selected most frequently to have a project manager, followed by improved project efficiency (Question 3). The least mentioned reason to have a project manager was to provide a primary contact or spokesperson for project activities.

In projects that had a project manager, 96% of the project personnel responded that the manager had been very effective to somewhat effective (Question 6).

The amount of time actually expended by project managers ranged between full-time to less than one-quarter-time (Figure 3.9). Almost 50% of the respondents stated that their project manager worked full-time to half-time in his or her capacity as project manager.

Of the individuals who said that their project did not have a manager, 64% believed a manager would have been helpful (Question 2). In 13 projects, there was general consensus among participants about the usefulness of a project

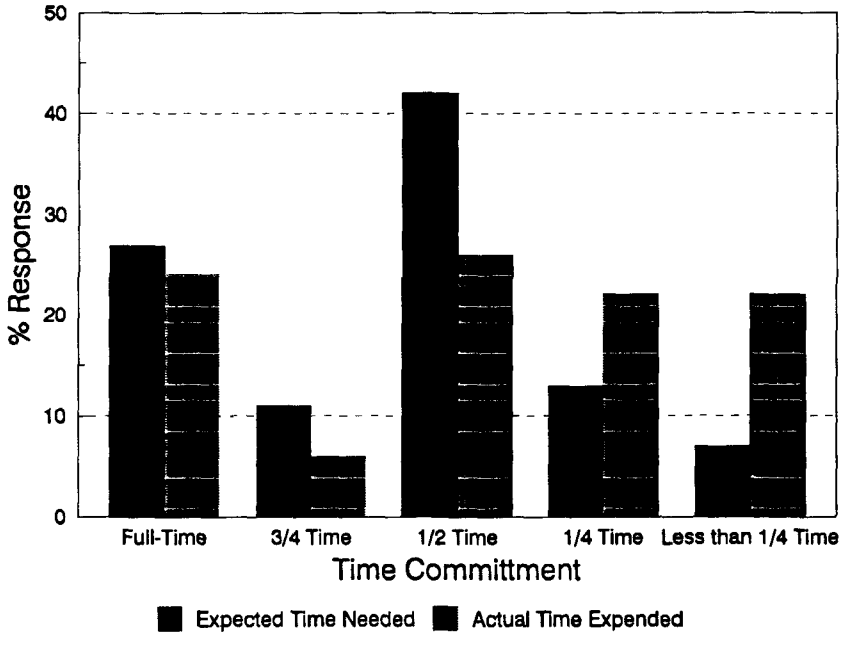

Figure 3.9: Level of effort of project manager (project personnel responses).

Table 3.11 Differences between farm operators who did and did not participate in the RCWP in terms of adoption of BMPs to control sediment (includes respondents from 12 projects (Alabama, Delaware, Iowa, Idaho, Illinois, Kansas, Maryland, Minnesota, Nebraska, South Dakota, Tennessee/Kentucky, and Virginia).

	PERCENT RESPONDENTS		
	Non-Participant	Participant	Chi-Square (Significance)
Sediment Traps (SE)	25	47	33.73**
Conservation Tillage (CT)	78	88	10.63**
Diversions (DV)	49	61	8.66**
Grass/Legume Rotation (GR)	58	67	6.56**
Strip Cropping (SC)	38	29	5.95*
Filter/Buffer Strips (FS)	38	47	5.22*
Permanent Vegetative Cover (VC)	67	74	3.43
Terraces (TR)	36	29	2.79
Grass Waterways (GW)	76	81	2.54
Cover Crops (CC)	71	76	1.76
Hayland/Pasture Management (HM)	72	74	0.49
Stream Protection/Fencing (SP)	43	45	0.27

* = significant at $p \leq .05$ ** = significant at $p \leq .01$ *** = significant at $p \leq .001$

Table 3.12: Relationships between independent variables and farm operators' reported use of BMPs to control sediment (only includes respondents from 12 projects (see Table 3.11 for list of projects and BMP abbreviations)).

	CT	SC	TR	DV	GW	GR	VC	CC	HM	FS	SP	SE
Education	.03	-.05	.02	.12**	.00	.03	.02	-.06	.00	.12***	.06	.06
Age	-.11**	-.05	.01	-.04	-.06	-.10**	.08	-.05	-.07	-.08*	-.02	-.11**
Years Farmed	.00	-.11**	.07	.01	.04	.00	.10**	.05	.04	.03	-.04	-.01
On-farm Residence	.02	.11**	-.02	-.03	.06	.04	.00	.00	.15***	.02	.05	.03
Off-farm Work	-.07	-.07	.09*	.01	-.02	-.10*	.06	-.07	.00	-.07	.11**	.00
% Income from Farm	.15***	.03	-.08*	.02	.10**	.13***	-.07	.09*	.01	.15***	-.10*	.03
Total Farm Acreage	.29***	-.04	.11**	.14***	.16***	.11**	.01	.08*	-.02	.18***	-.02	.14***
Percent Rental Land	.15***	.04	-.04	.06	.06	.08*	-.12**	.11**	-.03	.14***	-.11**	.11**
Gross Farm Sales	.26***	.07	.01	.13***	.18***	.18***	-.01	.12**	-.02	.20***	-.08*	.16***
% Sales from Livestock	.02	.15***	.01	.00	.12**	.19***	.09*	.03	.30***	-.05	.09*	-.05
Farm Property Value	.23***	.09*	.08*	.16***	.11**	.16***	.01	.13***	-.02	.13***	-.04	.09*
Farm Equip Value	.24***	.14***	.01	.14***	.16***	.15***	.05	.09*	.08	.19***	-.01	.15***
Use of Custom Work	.13***	.03	-.09*	.07	.05	.11**	-.01	.04	.06	.10**	.04	.10**
Use of Hired Labor	.05	-.06	-.12**	.02	.03	.07	.00	.06	-.08	.10**	.03	.17***
Use of Contract Labor	.02	-.09	-.06	-.02	-.03	.08*	.04	.05	.05	.04	-.03	.15***
Pollution Awareness	.21***	.12**	-.03	.13***	.14***	.14***	.05	.07	.08*	.17***	.09*	.08*
Area Pollution Prob	.06	.01	.00	.06	.05	.08*	.01	.00	.03	.14***	-.01	.04
Farm Pollution Prob	.02	.02	-.07	.00	.02	.03	-.02	.00	.03	.04	-.07	.07
Use of Information	.33***	.15***	.10*	.25***	.20***	.20***	.14***	.21***	.13***	.26***	.09*	.16***

* significant at $p \leq .05$ ** significant at $p \leq .01$ *** significant at $p \leq .001$

manager. In eight projects, however, project personnel were divided in their opinion as to whether a project manager would have been useful.

When personnel whose RCWP project did not have a project manager but who believed that one would have been useful were asked to estimate the expected time commitment for the position, over 80% indicated that a half- to full-time commitment would be necessary (Figure 3.9).

Responses to Questions 1 through 5 indicate that for many, but not all, projects, a project manager is necessary. The primary responsibility of this individual should be to coordinate project activities. The position should be a half- to full-time position, depending on the requirements of the specific project.

3.3.3.2 Project Advisory Committees

Sixty-six percent of the respondents acknowledged that their project's Local Coordinating Committee (LCC) had one or more subcommittees (Question 8). Four standing subcommittees most commonly referred to were administrative, information and education, land treatment, and water quality monitoring. In ten RCWP projects, personnel were equally divided as to whether or not subcommittees existed, indicating confusion within these projects about project organization at the local level.

The majority of the participants believed that it was important to have separate subcommittees (Question 9). The technical committee was the most frequently mentioned as an additional subcommittee established within the project. Seven additional subcommittees were listed: project advisory committee (PAC), farmer advisory, report writing, cost sharing, point source, modeling, and inter-agency.

Based on the questionnaire, as well as the on-site interviews, the four standing subcommittees mentioned above were very important structurally as a means of assigning project responsibilities.

3.3.3.3 Project Effectiveness

Project personnel were asked to evaluate the effectiveness of project elements, including critical area definition, BMP implementation, land treatment monitoring, and the linkage between water quality and land treatment. Ninety percent of the project personnel rated many of the project elements as being very effective or somewhat effective in achieving project goals (Figure 3.10; Question 10). There were three exceptions: land treatment monitoring, water quality monitoring, and linkage of land treatment data and water quality data. Linkage of land treatment data and water quality data was considered the least effective project element. This result was expected, since few projects had adequate land treatment or water quality monitoring which could be used to document water quality improvement resulting from BMP implementation (see Chapter 2, section 2.2.7) and RCWP project staff received little training or guidance in these areas.

Respondents' ratings of the effectiveness of project elements varied between 65% very effective (for the development of farm plans) to 15% very effective (for water quality and land treatment linkage). The two project elements rated highest in terms of effectiveness (development of farm plans and development of cost-share rates) are standard components of several other USDA farm programs. Several of the project elements receiving lower effectiveness ratings are not standard USDA program procedures, including extensive I&E focused on management-intensive BMPs and animal waste management systems, administration of NPS pollution projects, water quality monitoring, project reports, land treatment monitoring and linkage of water quality with land treatment.

Project personnel (93%) believed that the majority of farm operators were either very satisfied or satisfied with the technical assistance and information they received through the RCWP (Question 11). Responses by participants in the 21 RCWP projects to the same question were identical (93% were satisfied or very satisfied with the program) (section 3.2.4.3).

Twenty-eight percent of the personnel responding believed that their project suffered from insufficient technical support (Question 12), identifying I&E, land treatment, or water quality

monitoring as the elements most lacking support (Question 13).

Insufficient financial resources hindered the project according to 26% of the project personnel (Question 14). The two principal project elements reported to be limited by financial resources were land treatment monitoring and water quality monitoring (Question 17). Many general RCWP projects (projects that did not receive additional federal funds for water quality monitoring) had difficulty securing funds for water quality monitoring.

Only 7% of the project respondents believed that their project suffered because money arrived too late (Question 16). Thus, while the mechanism for transferring money from the federal government to the projects worked well, there just wasn't enough money for water quality monitoring, according to project staff.

According to project personnel, 94% of the farmers were very satisfied or satisfied with the financial assistance (cost share) they received through the RCWP (Question 15). Results from the farm operator survey (section 3.2.4.3), showed that 94% of the RCWP participants interviewed were satisfied or very satisfied with the financial assistance they received.

Project staff were asked to evaluate the effect of the RCWP on water quality, farm economics, and water quality knowledge among farmers (Figure 3.11; Question 18). Surface water quality was perceived as being more positively affected by RCWP activities than ground water. Farm operators and project personnel appeared to perceive the effectiveness of the RCWP in alleviating surface water pollution in a similar manner; however, farmers had a slightly more positive view of the reduction in ground water pollution due to the RCWP than did project personnel. Both farmers and project personnel believed that the RCWP had increased farm operators' knowledge about water quality (Figure 3.11).

Overall operating costs and farm incomes of RCWP participants were positively affected by RCWP cost-share provisions, according to both farm operators and project personnel (Figure 3.11; see also section 3.2.4.3) . The farmers were more positive about the economic benefits derived from participating in RCWP than were the project personnel.

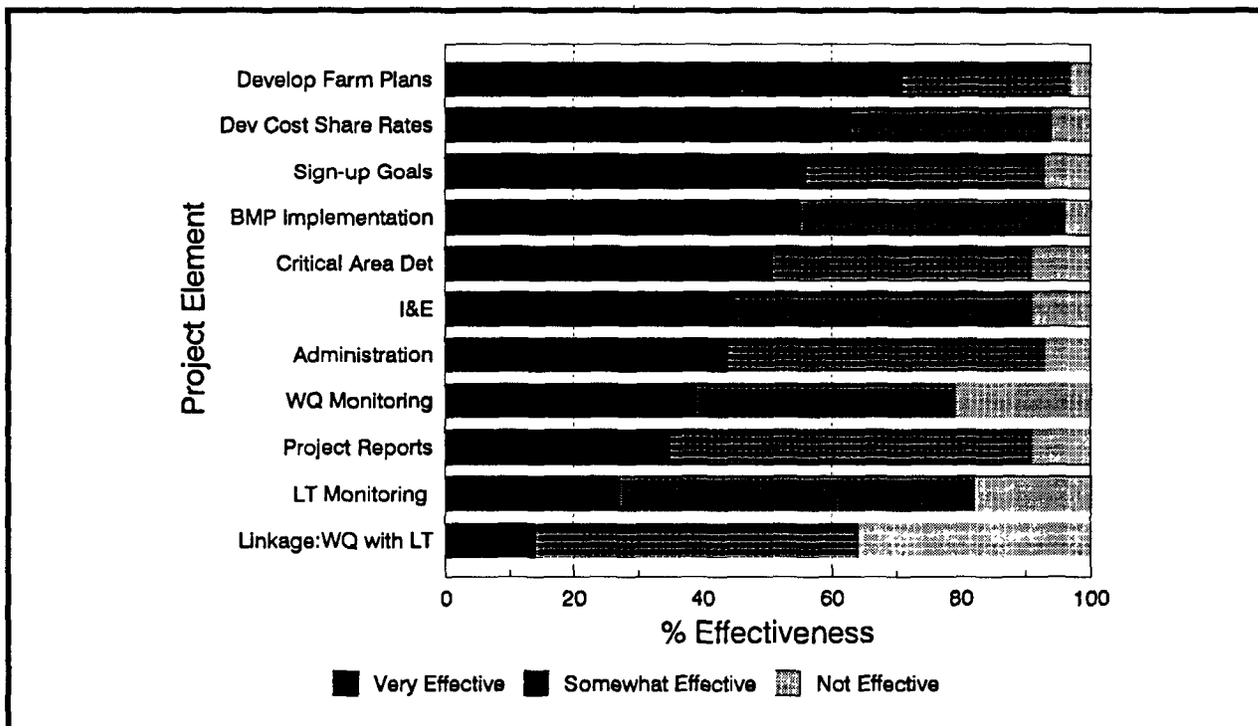

Figure 3.10: Effectiveness of project elements in achieving project goals (project personnel responses).

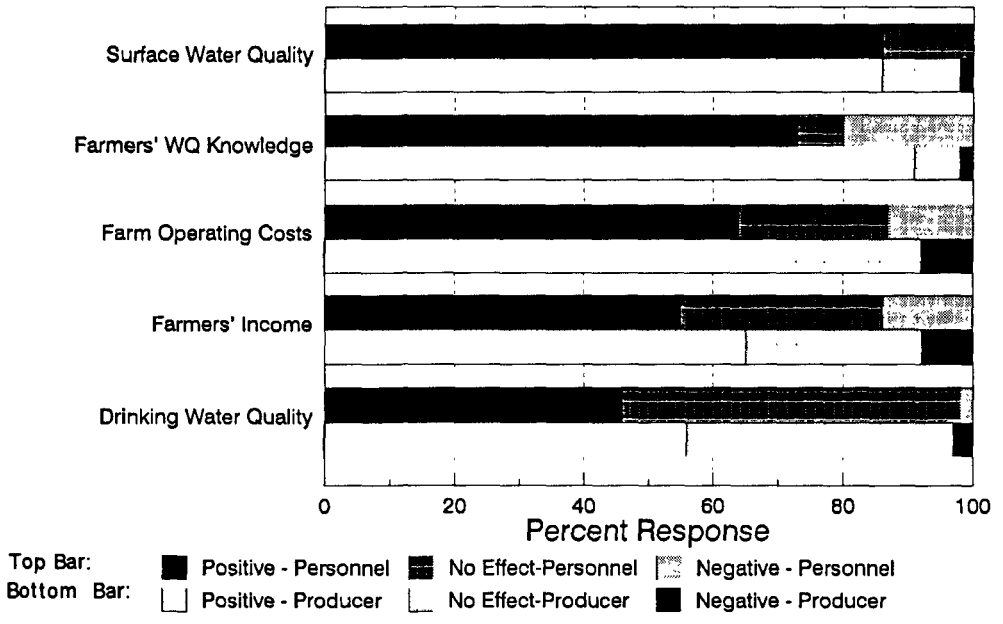

Figure 3.11: Effects of the Rural Clean Water Program. Top bar for each effect reflects project personnel responses. Bottom bar reflects farm operator responses.

In general, for all the categories sampled, farm operators' attitudes towards the RCWP were more positive than were the attitudes of project personnel.

3.3.3.4 Information and Education

The information and education (I&E) program was judged by project personnel to be somewhat to very effective in affecting farm operators' attitudes in all but three areas: interest in tracking project success, development of leaders within the farm community, and education of youth on water quality issues (Figure 3.12; Question 19). This outcome is to be expected, since few projects directed I&E resources toward these three areas.

I&E was judged by project staff to be most effective in alerting farmers to the existence of water quality problems caused by agricultural activities (Figure 3.12). Personnel said that I&E programs were less effective in 1) educating farmers about their individual contribution to the water quality problem, 2) changing attitudes about implementing structural or management BMPs, 3) educating farmers about structural or management BMPs, and 4) motivating them to maintain BMPs for the long term (Figure 3.12).

In order to further analyze I&E effectiveness, the 21 RCWP projects were placed in two general groups (with some overlap): 1) projects addressing animal waste as a pollutant source and 2) those addressing sediment as a source of pollution. Thirteen RCWP projects addressed animal waste problems (Alabama, Delaware, Florida, Maryland, Massachusetts, Michigan, Minnesota, Oregon, Pennsylvania, Utah, Vermont, Virginia, and Wisconsin). Twelve projects addressed sediment (Alabama, Delaware, Idaho, Iowa, Illinois, Kansas, Maryland, Minnesota, Nebraska, South Dakota, Tennessee/Kentucky and Virginia). One project (Louisiana) was excluded from the analysis because it did not fit into either of the groups.

The effectiveness of I&E in affecting the knowledge, attitudes, and behavior of farmers participating in the two types of projects (animal waste management and sediment control), as evaluated by project staff, is presented in Figure 3.13. For all of the attitudes and behaviors listed (except one), I &E was always more effective for

the sediment control projects than for animal waste projects. This finding is not surprising, since I&E outreach to control sediment has been carried out by USDA and others for many years.

Project staff considered I&E efforts more important for the adoption and maintenance of animal waste management systems, conservation tillage, fertilizer management, and pesticide management than other BMPs (Figure 3.14; Question 20). They judged I&E less important for the adoption and maintenance of such conventional BMPs as terracing, stripcropping, grazing land protection, and tree planting. The importance of I&E for the remaining BMPs (cropland and stream protection, waterway systems, sediment retention, and permanent vegetative cover on critical areas) was judged only somewhat important by project personnel.

As discussed in Chapter 2 (section 2.2.3), the RCWP experience indicates that I&E is particularly important for BMPs having a significant management component. This finding is confirmed by the responses to the project personnel questionnaire, since the four BMPs rated most affected by I&E activities were those requiring significant and ongoing management on the part of farm operators.

3.3.3.5 Farm Operator Participation

RCWP project personnel believed that BMPs were, for the most part, established on the farms having the greatest impact on water quality (Question 21). Opinion was split when personnel were asked if the owners of these farms implemented BMPs using cost-share programs other than RCWP. Forty-five percent stated that they thought these farmers had implemented BMPs with assistance from non-RCWP programs, whereas 55% believed that these farmers had not implemented BMPs with assistance from non-RCWP programs.

Based on results from the project personnel questionnaire, the RCWP attracted innovative farmers (Question 23) and leaders within the local farm communities (Question 24).

Overwhelmingly, project staff believed that availability of RCWP cost-share funds was the

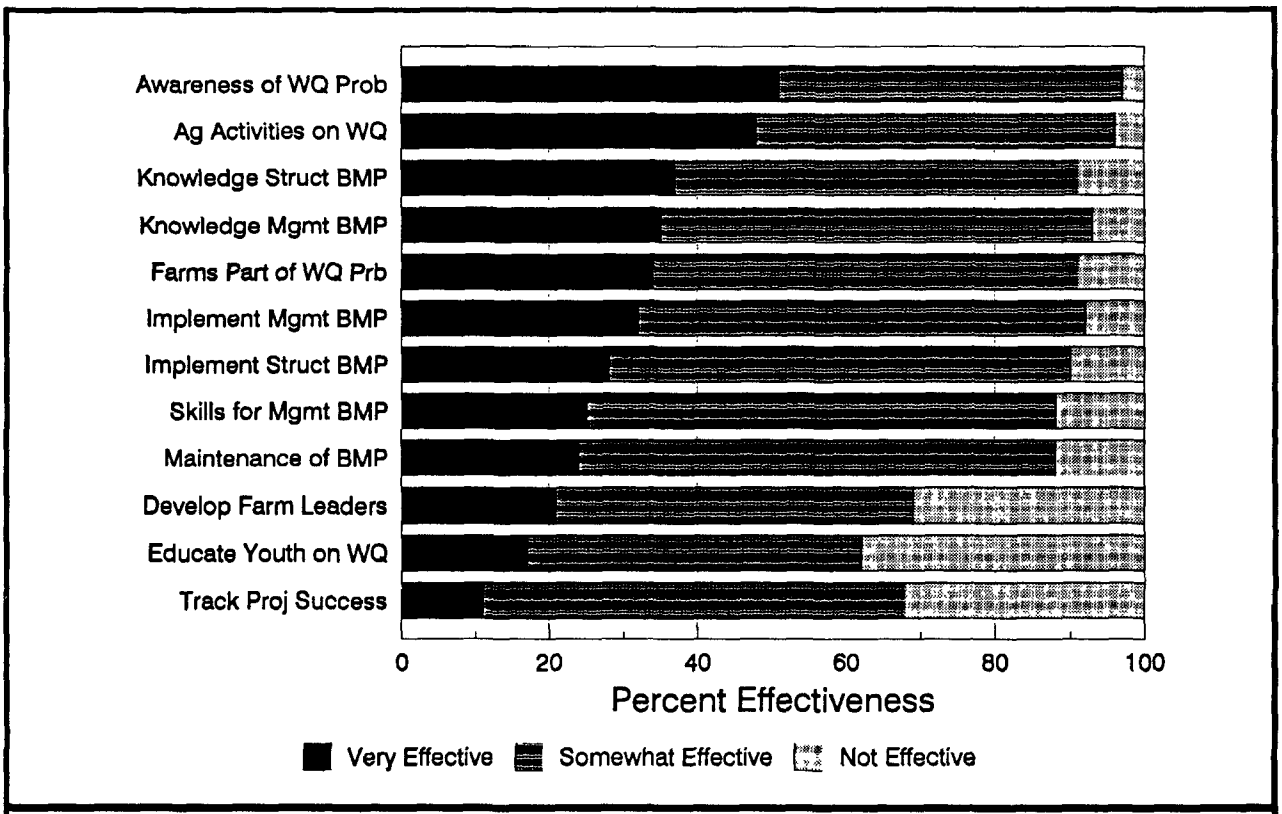

Figure 3.12: Effectiveness of RCWP information and education programs (project personnel responses).

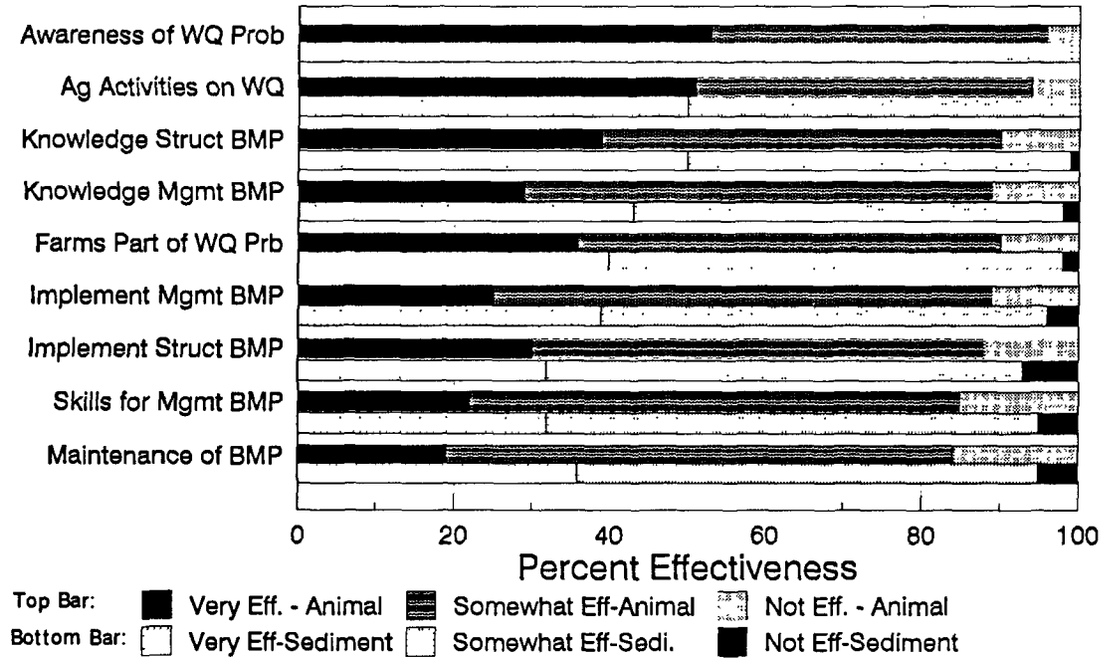

Figure 3.13: Effectiveness of RCWP information and education by project type (project personnel responses). Top bar for each question reflects responses from projects that emphasized animal waste management. Bottom bar reflects responses from projects emphasizing sediment control.

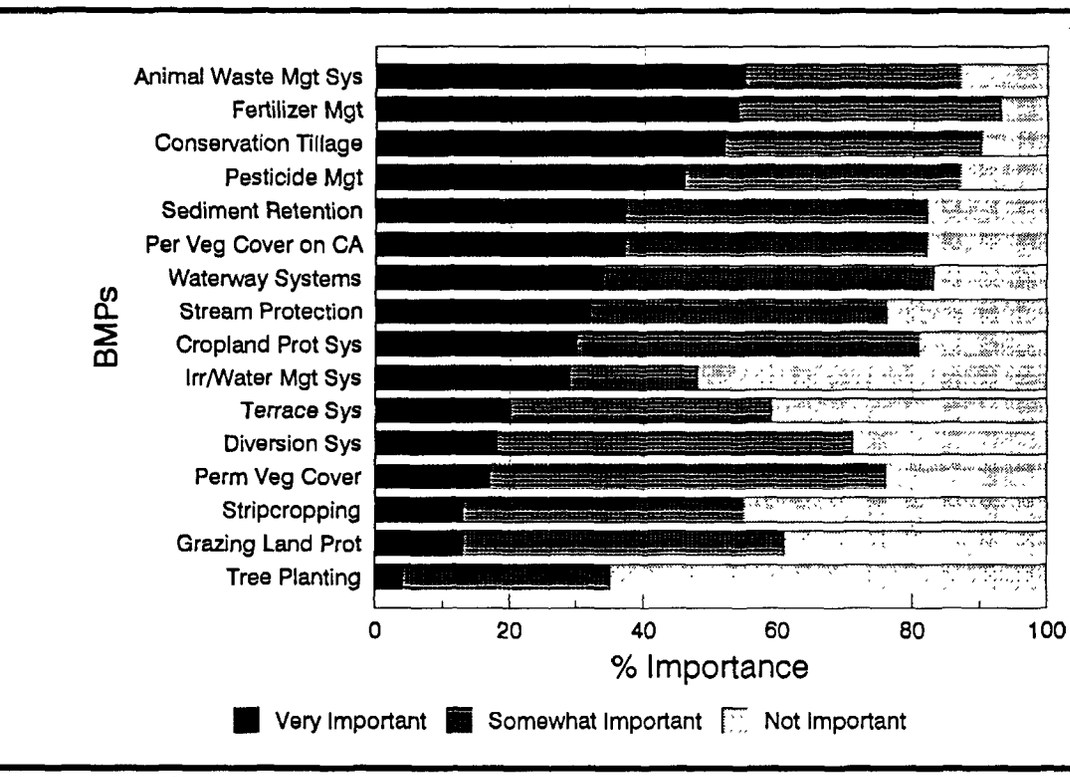

Figure 3.14: Information and education program importance to the adoption and maintenance of implemented BMPs (project personnel responses).

major incentive for farmer participation (Question 25). Of less importance for participation in RCWP, according to personnel, was assistance and encouragement from the government and concern about the effects of water pollution. If the assessment of project staff is correct, without government funds and assistance, farmers are much less likely to implement NPS pollution control BMPs.

These results are in contrast to what the farmers reported, in response to an open-ended question, as their major reasons for participating in RCWP (section 3.2.4.3). They listed concern for pollution as the major reason they participated in RCWP, followed by the availability of cost-share funds. Government encouragement, concern about future regulation, and increased farm production were mentioned less often by farm operators as reasons for participating.

Project personnel believed that the major limitation to RCWP participation was poor economic conditions (Question 26). Other primary factors cited were that farmers did not want to be told how to farm, that they did not know about the RCWP, and that they were not asked to participate.

The farmers, however, reported that their primary reason for not participating in RCWP was that they did not believe that water pollution was a problem, either generally or on their farm (section 3.2.4.3). The other major reason given for non-participation was that they did not want to change practices, either because it was too much trouble or because they felt their own systems worked well enough.

Economic factors were cited least often by project personnel as reasons for non-participation. Farm operators who did not participate also rarely gave economic factors as a reason for not participating.

These results, however are at odds with the economic data collected in the farm operators' survey. Farm operators with more positive economic indicators (farm and machinery value, gross farm income, and larger farm size were, in fact, more likely to participate in the RCWP (section 3.2.4.3)).

3.3.3.6 BMP Implementation

When questioned about the criteria farmers used in deciding whether to install a BMP designed to improve water quality, project personnel stated that the cost factors (cost of the practice, availability of cost share, and effect on profits) and the difficulty of the practice (labor or time required and ease of use) were more important than the farmers indicated (Figure 3.15; Figure 3.8; Question 27). Conversely, farmers believed that the potential to improve water quality and information from government agencies played a more significant role in their decision about whether to install a BMP than did cost or difficulty of implementation (Figure 3.8).

Project personnel considered the discontinuation of BMPs after RCWP contract expiration to be primarily a reflection of the farm economy (Question 28). The next three major reasons cited for discontinuation of BMPs were 1) reduced contact by technical agencies, 2) the BMP was too expensive or costly, and 3) a change in crops that eliminated the need for the BMP.

About three-quarters of the project staff estimated that 75% or more of the BMPs implemented in RCWP project critical areas were being maintained (Figure 3.16; Question 29). The remaining one-quarter of the respondents believed fewer than 71% of the BMPs were being maintained. However, almost none of the farm operators interviewed indicated that they had stopped using any of the BMPs.

Project personnel indicated that many BMPs were being discontinued or not maintained after RCWP contracts expire. Management-type BMPs, such as conservation tillage and fertilizer and pesticide management, appear to be more at risk for discontinuation than structural-type BMPs. The BMPs that are being discontinued (Question 30) or have not been maintained (Question 31) are listed in Appendix VII by BMP, state, and number of respondents per state.

3.3.3.8 Awareness and Attitudes

Project personnel (project personnel survey) and farmers (farm operator survey) were asked to agree or disagree with seven statements

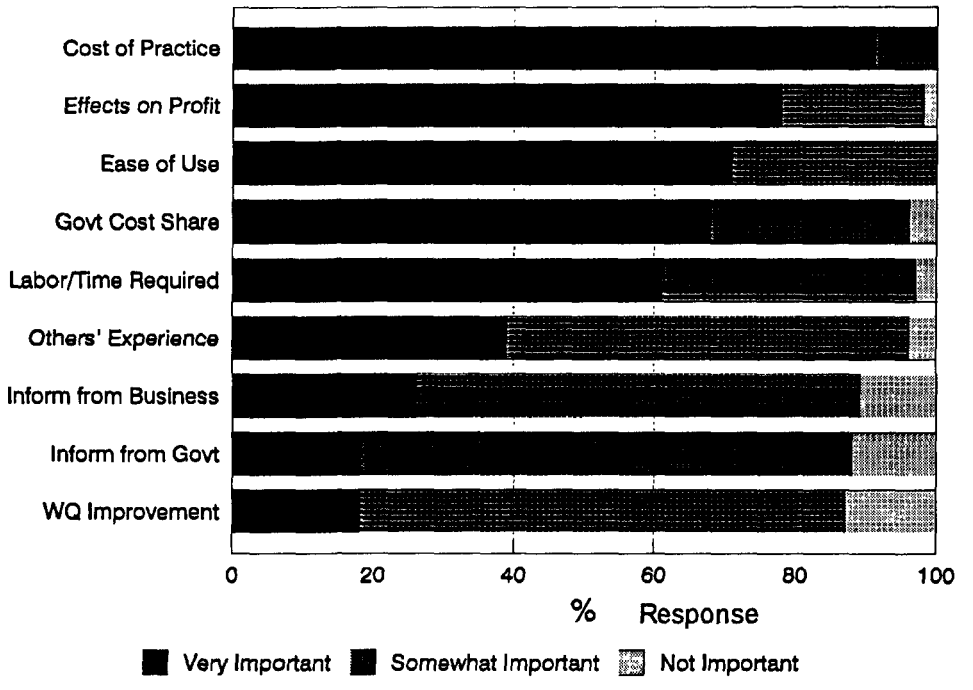

Figure 3.15: Influences on BMP adoption by farm operators (project personnel responses).

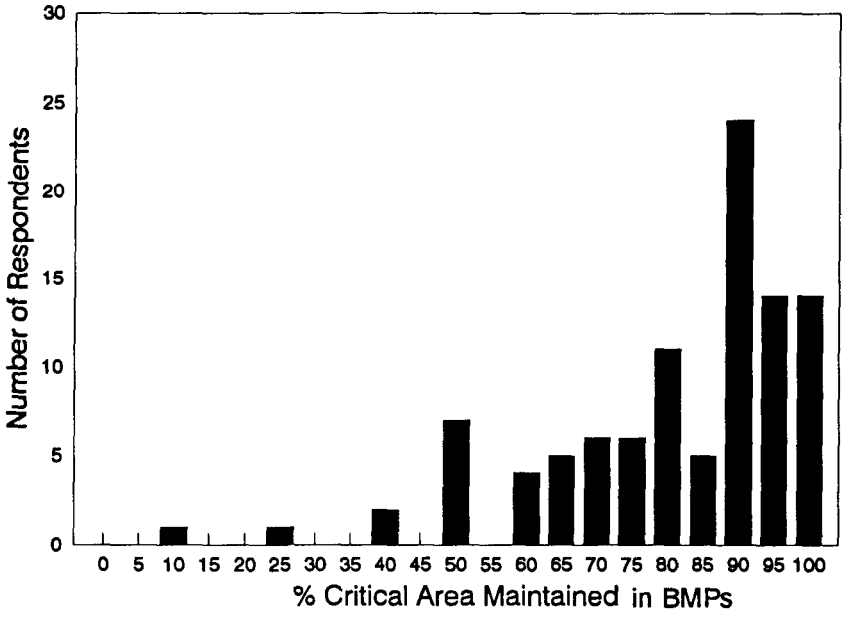

Figure 3.16: Maintenance of critical area in BMPs (project personnel responses).

pertaining to attitudes about agriculture and the environment. More project personnel than farmers agreed that agricultural water pollution is a serious threat to fish and wildlife (Figure 3.17; Question 32; section 3.2.4.2). Many more farmers than project personnel agreed that agriculture is being unfairly blamed as a cause of water quality problems (Figure 3.17; section 3.2.4.2).

Farmers believed much more strongly than did project personnel that farm practices that protect water quality usually require more labor (Figure 3.17).

For the remaining statements, farmers and project staff had similar views about eventual government regulation of farms to control NPS pollution, government payments for BMP installation, the need for less expensive BMPs, and farmers not having the right to damage water quality (Figure 3.17).

3.3.3.9 RCWP Workshops

Nine workshops were conducted (1982-91) for RCWP project personnel. Workshops emphasized the following topics: RCWP start-up, project progress, Comprehensive Monitoring and Evaluation (CM&E) data management, CM&E working session, mid-program progress, technical transfer of NPS pollution control technology, data analysis, and ten-year report preparation. A final National RCWP Symposium was held in September of 1992 to facilitate evaluation of and sharing of lessons learned from the RCWP.

The number of agency personnel who attended each workshops is listed in Appendix VII (Question 33) for seven of the nine workshops. A total of approximately 31 administrative personnel (ASCS), 98 land treatment personnel (SCS), 19 extension personnel (ES), and 127 water quality personnel (state water quality and U.S. Geological Survey) attended the RCWP workshops. The last three workshops (NPS pollution control, data analysis, and the ten-year report) drew the largest number of participants. The workshop addressing linking land treatment and water quality data (data analysis workshop) was cited most frequently as the most helpful of the workshops (Question 34). Over 75% of the respondents believed that the workshops were useful in helping projects meet the objectives of the RCWP. The majority of the comments about the workshops were positive (Question 35; see Appendix VII).

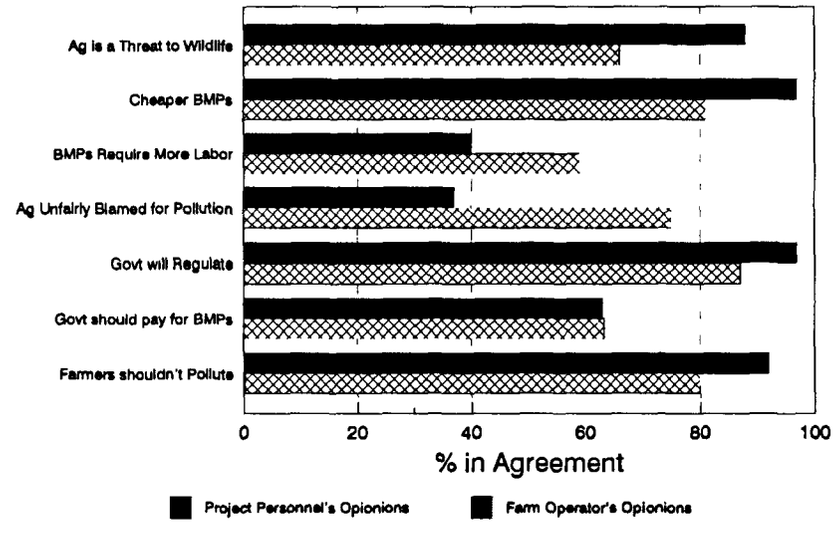

Figure 3.17: Farm operator and project staff attitudes about agriculture and the environment.

3.4 Summary of Lessons Learned

Results of the questionnaire administered to RCWP project personnel, in combination with results from telephone interviews with farm operators in the project areas who did and did not participate in the RCWP projects, provide additional information for evaluating the effectiveness of the RCWP. Key results and their applicability to future NPS pollution control efforts (lessons learned) are summarized below.

3.4.1 Awareness of Agricultural NPS Pollution and Problem Ownership

- *Lesson*: **The results of the farm operator survey illustrate that high awareness about water quality issues and the impacts of agriculture on water quality do not necessarily translate into ownership of water quality problems by farm operators. Educational programs must be initiated to encourage farm operators to deepen their understanding of NPS pollution causes and water quality impacts. Some operators may not have had a documented problem on their farms. However, where problems are identified, farm operators must be motivated to accept responsibility for the effect of their operations on water quality.**

  Example: Farm operators in the 21 RCWP project areas (participants and non-participants) reported fairly high general awareness of water quality. The major sources of information appear to be print media, especially farm magazines, and government agencies. In spite of this high water quality awareness, one-third of all farmers did not see agriculture as a major cause of water pollution in their area. Many farm operators did not believe that their farms were part of the water quality problem. However, when asked to list the major NPS pollution problems, 75% of the listed problems were agriculture-related. Farm operators understood chemical and sediment contamination better than they understood animal waste-related pollution. They were even less likely to perceive impacts of agriculture on drinking water quality. (However, not all RCWP projects specifically addressed drinking water contamination as a water quality problem.)

  Example: Other factors affecting farm operators' sense of ownership of the water quality problems addressed by the RCWP projects include 1) the fact that some farmers may have already implemented measures to reduce NPS pollution from their farms prior to initiation of the RCWP and 2) in some projects, the water quality problem was inadequately documented by the participating agencies.

3.4.2 Participation in Voluntary NPS Pollution Control Programs

- *Lesson*: **Farmers must be informed about water quality and aware that their own farms contribute to water quality degradation. Ownership of water quality problems by farmers is essential to successful NPS control programs.**

  Example: RCWP participation appears to have resulted, at least in part, from farm operators' concerns about water quality. Farmers did not consider economic factors to be an important barrier to participation in the RCWP based on their reasons for participating or not participating. Many farmers who did not participate did not believe that water pollution was a problem or did not want the trouble associated with changing practices. Furthermore, almost one-third of the non-participants said that they had never heard of the RCWP, were never asked to participate, or disliked government programs.

- *Lesson*: **Because farm operators who participate in NPS control programs are likely to be operators of larger and more profitable farms, future voluntary agricultural NPS pollution programs should place more emphasis on targeting farm operators in critical areas based on their social and economic characteristics. For example, farmers operating smaller and/or less profitable farms and part-time farmers should receive special attention via I&E programs.**

  Example: The results of the farm operator survey indicate a strong association between the economic vitality of a farm and a farm operator's willingness or ability to implement conservation measures. The economic indicators assessed indicate that certain groups of farmers are more likely to be reached by and motivated to participate in programs such as the RCWP. In fact, the RCWP appears to have been most successful in reaching those farm operators who were most likely to cooperate and easiest to influence: operators of larger-scale, more profitable farms who have a stronger commitment to and investment in farming (see also section 3.2.2).

3.4.3 BMP Adoption

- *Lesson*: **Well-targeted effective educational efforts can alter farmer behavior. Education and availability of cost-share assistance are key components of voluntary projects.**

  Example: Results of the farmer survey indicate that the RCWP was successful in promoting awareness of and concern about water pollution associated with agriculture. Survey results suggest that the RCWP led to increased adoption of some BMPs. Many participants said they would have been unlikely to adopt as many BMPs if financial assistance had not been available.

  Example: Some BMPs appear to have reached a fairly high level of acceptance by farm operators. More revealing than actual rates of BMP adoption is the difference in adoption rates between participants and non-participants. About two-thirds of the BMPs recommended through the RCWP were used more frequently by RCWP participants than by non-participants. Farm operators interviewed (both participants and non-participants) indicated that the costs and labor associated with certain BMPs would be an important factor in their decision about whether or not to adopt a particular practice. Yet several BMPs that had much higher adoption rates among participants than non-participants were expensive and labor intensive (for example, animal waste management systems and sediment traps). Cost sharing and technical assistance were likely important incentives in these cases.

- *Lesson*: **Convincing farm operators to change farming practices to reduce water pollution will not occur solely through information exchange. Future agricultural NPS control programs must concentrate on either well-targeted voluntary efforts with effective I&E and attractive cost-share or regulation. A combined approach may be needed to achieve full cooperation.**

  Example: Survey results indicate that most farmers, who overwhelmingly prefer voluntary compliance to remediate NPS pollution, recognize that a solely voluntary approach will not be viable much longer. They acknowledge that society has a right to demand higher levels of pollution control from the agricultural sector, but generally believe that it is other farmers who have the problem and need to be more tightly regulated.

3.4.4 Information and Education

- *Lesson:* **In future agricultural NPS pollution control projects, greater emphasis should be placed on educating farmers about the less familiar BMPs that have not been part of USDA's traditional soil conservation program, such as animal waste management systems and pesticide and fertilizer management, when those BMPs are appropriate to address the water quality problem.**

  Example: Information and education was judged by RCWP project personnel to be somewhat to very important in encouraging the adoption and maintenance of BMPs, especially for management-type BMPs (such as fertilizer management) or BMPs with a significant management component (such as animal waste management systems). Although overall I&E effectiveness was rated as somewhat or very effective for many aspects of the RCWP projects, I&E programs in projects that dealt primarily with sediment control were more effective than I&E programs in animal waste reduction projects. This finding is not surprising, given the long history of sediment (erosion) control as the focus of USDA programs. In cases in which BMPs such as animal waste management systems and fertilizer and pesticide management will address the problem pollutant, more active I&E efforts to educate farmers about these newer BMPs will be required. In addition, agency personnel may need specialized training or greater access to technical assistance for these practices.

- *Lesson*: **Both farmers' awareness of how their practices affect water quality and the availability of cost-share funds and cost-effective BMPs are critical components in addressing agricultural NPS pollution.**

  Example: According to project personnel, the 75% cost-share rate allowed for implementing BMPs strongly influenced farmer participation in RCWP projects. The farmers interviewed, however, reported that concerns about water quality were more important than cost-share availability in motivating them to participate in a NPS pollution control project.

- *Lesson*: **Since many farmers believe that agriculture is being unfairly blamed as a cause of water quality problems, a new approach to water quality education will be necessary if new structural and management BMPs are to be installed and existing BMPs are to be continued and maintained in areas critical to maintenance or restoration of water quality.**

  Example: According to project personnel, certain BMPs are being discontinued or are not being maintained after RCWP contracts expire and management-type BMPs are being discontinued more frequently than structural BMPs. (Farm operators interviewed, however, stated that they planned to continue using BMPs implemented to protect water quality.) RCWP project personnel believed that discontinuation or lack of maintenance of BMPs is due primarily to economic considerations. However, discontinuation of low-cost BMPs may also be due to lack of knowledge, skills, or support from technical agencies, especially since concerns about water quality were cited by farm operators as an important factor in their decisions about RCWP participation.

- *Lesson:* **Improved information and education about animal waste management practices is needed. Since current methods for developing skills and modifying behavior of participating farmers have been largely ineffective, USDA agencies should work together to develop a new approach to educating livestock producers about soil testing and nutrient management. While I&E should be the responsibility of the local project coordinating committee, both SCS and ES should be active in planning and supporting the I & E effort regardless of the agency or individual responsible for I&E implementation.**

  Example: Participants in RCWP projects with pollution problems caused by animal waste did not use soil testing, nutrient management, or hayland or pasture management more often than non-participants. These management practices are a necessary component of a system of BMPs for reducing animal waste pollution.

3.4.4 Information and Education (continued)

- *Lesson*: **USDA should develop a cooperative method for comprehensive farm planning and promote appropriate practices to ensure that the most cost-effective and efficient water quality BMPs are installed.**

3.4.5 Water Quality Monitoring

- *Lesson*: **Since water quality monitoring is the primary and most defensible mechanism to determine changes in water quality, monitoring must be adequately funded for the life of the project. Similarly, land treatment monitoring must be comprehensive in order to facilitate documentation of the linkage between land treatment and water quality changes, if such documentation is a project objective.**

  Example: Project staff believed that their projects received adequate and timely funding except for water quality monitoring. In many projects, because of limited funding, water quality monitoring was insufficient to document water quality changes. Land treatment monitoring was ineffective because routine procedures used by SCS to gather information on land treatment implemented were not designed to provide the frequency or quality of data required to link water quality and land treatment data (see section 2.2.5.2). As a consequence of inadequate monitoring, many RCWP projects were unable to document a link between land treatment and water quality changes.

3.4.6 Technical Assistance

- *Lesson*: **The coordinating body for national NPS pollution control programs should provide assistance to projects through the services of a national technical support group. This group should assist project personnel in developing effective water quality and land treatment monitoring and evaluation strategies and designs; identifying and documenting water quality problems; establishing effective project objectives and goals; and other technical tasks.**

  Example: Almost one-third of all project personnel believed that their project did not meet its goals because of insufficient technical support in areas such as land treatment, I&E, and water quality monitoring.

3.4.7 Project Organization

- *Lesson:* **A project manager is necessary for most, but not all, NPS pollution control projects. This should be a half- to full-time position, depending on the complexity and demands of the project. The primary function of the manager should be to coordinate and provide oversight for project activities.**

  Example: Most RCWP project staff believed that a project manager was useful or would have been useful to overall project coordination.

3.4.7 Project Organization (continued)

- ***Lesson:*** **For future NPS pollution control projects, the local inter-agency committee coordinating project activities should establish four permanent subcommittees (administrative, information and education, land treatment, and water quality monitoring). Additional subcommittees should be added or current committees disbanded to address specific short-term project needs (for example, a report writing subcommittee). In order to ensure good coordination and communication between subcommittees, particularly those addressing land treatment and water quality, ongoing interaction such as periodic joint meetings should be formally established for the duration of the project.**

  Example: The local project coordinating committees (LCCs) provided an effective mechanism for multi-agency interaction and coordination at the local level in most of the RCWP projects.

3.4.8 Workshops for Project Participants

- ***Lesson:*** **Project workshops should be adequately funded (including travel for local and state project personnel) and should be held early in the life of the project in order to maximize their usefulness.**

  Example: The RCWP workshops, attended by federal and state government officials involved in RCWP projects, were useful to the majority of project personnel who attended them. These sessions helped the project teams meet their water quality goals.

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Chapter 4
RURAL CLEAN WATER PROGRAM PROJECTS

This chapter contains a profile of each of the Rural Clean Water Program (RCWP) projects, arranged in alphabetical order by state. Each profile begins with a brief project synopsis (section 4.1), followed by a section outlining findings (section 4.2), recommendations, and successes of the project. Finally, section 4.3 in each profile contains detailed information about the project, including project type (general RCWP or Comprehensive Monitoring and Evaluation RCWP), time frame, water resource description, watershed characteristics, project budget, information and education program, producer participation, land treatment, water quality monitoring and evaluation, linkage of water quality and land treatment, the impact of other federal and state programs on the RCWP project, references, and project contacts.

Project budgets have been compiled from the best and most recent information available and have been reviewed by project staff. Where gaps in information existed, the term NA (information not available) has been inserted into the budgets.

For an explanation of how animal units were calculated (section 4.3.2.2.5 in each profile), please refer to the glossary (Appendix III).

In addition to providing detailed descriptions of the individual RCWP projects, the profiles contained in this chapter were used to compile the RCWP program analysis (Chapter 2). Key findings and recommendations from each project were evaluated and, where consistent lessons emerged from several projects, were generalized into the lessons learned (illustrated by specific project examples) given in Chapter 2.

Sources used in compilation of the profiles included in-person interviews conducted during the on-site visits, responses to the project personnel survey, project 10-year reports, and other project documents.

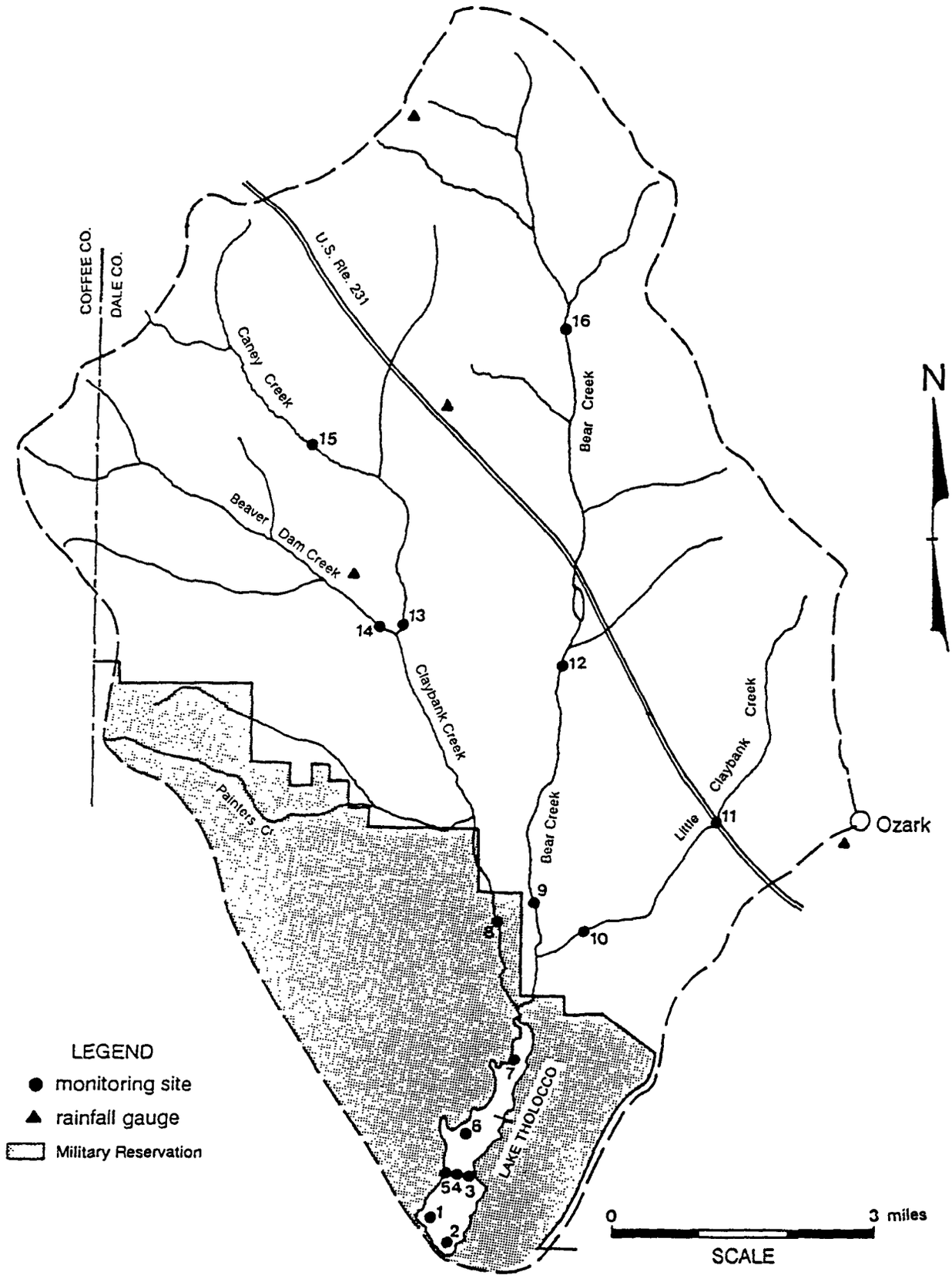
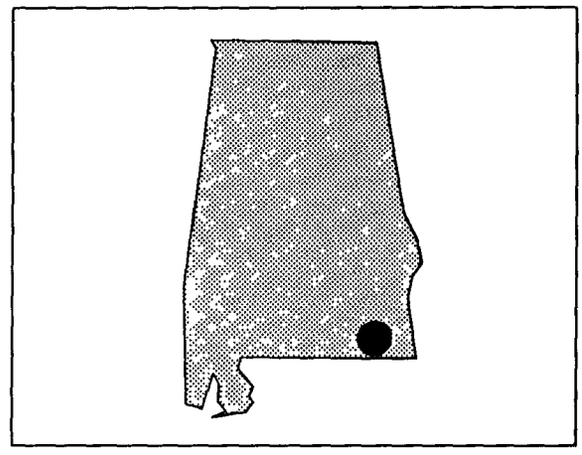


Figure 4.1: Lake Tholocco (Alabama) RCWP project map AL-1.

Alabama
Lake Tholocco

(RCWP 1)



Dale & Coffee Counties
MLRA: P-133A
HUC: 031402-01

4.1 Project Synopsis

Lake Tholocco, a 600-acre recreational lake located on Fort Rucker Army Base, had been closed to contact water sports due to high coliform levels prior to project initiation. Additionally, 200 acres of the lake had been lost to recreational uses due to sediment deposition. The sediment and fecal coliform were primarily from agricultural sources. The primary purpose of the Rural Clean Water Program (RCWP) project was to increase the suitability of Lake Tholocco for contact water sports.

The watershed that feeds Lake Tholocco is situated in southeastern Alabama. Agricultural production consists of row crops, particularly corn and peanuts, and some animal production. Due to the rolling topography and sandy soils, erosion rates are high.

Of this 51,400-acre watershed, all 7,527 acres of cropland were designated as critical. During the project period, over 100% of designated cropland and most of the hog producing farms were treated with one or more best management practices (BMPs). Terraces and other soil conservation systems were the major BMPs installed.

Baseline water quality monitoring was never conducted. Water quality monitoring during the project was originally the responsibility of personnel at Fort Rucker. However, due to problems with quality control and funding, some of the responsibility for monitoring was shifted to other agencies. Although the water quality monitoring program suffered from inadequate resources and personnel, the project was able to show significant decreases in fecal coliform levels, which made resumption of contact body sports in Lake Tholocco possible. Although never measured, sediment loads appeared to be decreasing and fish populations appeared to be increasing.

The choice of this watershed for a demonstration project was ideal. It was small and contained a limited number of animal operators. A very successful information and education (I&E) program and a sufficiently high cost share ratio assured full participation. This was a well-organized project. However, there were never any actual measurements of the effect of land treatment on water quality. Thus even though water quality improved, it is not certain that the improvement was due to a decline in the number of beef and hogs or implementation of BMPs. It will be hard to monitor this project further as a storm in 1990 caused a breach in the dam and the subsequent draining of the lake.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

The original project goal of reducing fecal coliform and sediment delivery to the lake appropriately targeted the two main pollutants.

4.2.1.1 Findings and Successes (continued)

The water quality objectives were appropriate because, in reality, they were water quality monitoring objectives. The water quality goals of reducing or eliminating the discharge of livestock wastes into the streams and reducing sedimentation would have been good objectives but they were not specific enough as goals.

Water quality monitoring objectives of collecting adequate samples in the streams and the lake to establish trends and locating sources of non-point source pollution through stream monitoring were appropriately selected. However, the water quality monitoring goals associated with these objectives did not include sampling for sedimentation changes in the lake. Although reducing sedimentation of the lake was one of the major project objectives, the attainment of this objective could not be documented because sedimentation was not measured.

The land treatment goal of 296 signed contracts was unreasonable since the critical area needing treatment was exceeded with fewer than 100 contracts.

4.2.1.2 Recommendations

Water quality objectives should delineate the general problem that is to be solved. Water quality goals should specify desired numeric reductions in the pollutant source.

Water quality monitoring has to be designed and executed properly if project goals and objectives are to be evaluated and achievement of those objectives and goals is to be documented.

Adequate funding should be provided for technical support so that achievement of goals and objectives can be properly evaluated.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

The State Coordinating Committee (SCC) served as an information facilitator and an oversight group while allowing the local personnel to identify needs and find ways to solve them.

The Local Coordinating Committee(LCC) devised the strategy for I&E activities and coordinated project activities. The LCC met frequently, thereby decreasing any duplication of effort by multiple agencies. In addition, there was considerable informal communication between the different groups participating in the project, which enhanced the project's success.

4.2.2.2 Recommendations

Oversight is needed for water quality monitoring activities. Most LCCs do not have the personnel capable of this oversight. Therefore, the SCC needs to ensure that the water quality monitoring design is satisfactory and that water quality monitoring data and analyses meet quality assurance and control standards.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

Information and education were critical to the success of this project. There was extensive one-to-one contact by the Cooperative Extension Service (CES) to convince the farmers of their need for nonpoint source (NPS) pollution controls. Through personal contacts, the CES did an excellent job of persuading farmers to participate in the program, as evidenced by the meeting or exceeding of all critical area treatment goals.

Personal contacts were found to be the most effective I&E tool, while newsletters and newspaper articles were found to be the least effective.

All the agencies involved used every opportunity possible for I&E endeavors. Agrichemical companies provided some I&E support, resulting in farmers learning proper calibration and application techniques for certain pesticides.

4.2.3.2 Recommendations

There is no substitute for competent local staff who can communicate the goals and objectives of the project directly to the farmer.

Farmers should be educated about the different BMP systems throughout the project. However, information about particular components of BMPs should be timed to correspond with upcoming seasonal agricultural practices.

Agrichemical companies can be a useful component in I&E functions by providing information on chemicals used in conservation tillage practices and by teaching equipment calibration techniques and safe chemical use.

If the local staff is not familiar with water quality goals as related to land treatment, early training, by experienced staff from the U.S. Environmental Protection Agency (EPA) or the state environmental agency, is essential.

Different I&E strategies should be evaluated to determine which strategies are most effective for a particular farming population.

Follow-up education is essential to insure proper maintenance of BMPs.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

The project was conducted in an extremely economically depressed farming area with an average net farm income of only $6,400 in 1974. However, as this project demonstrated, voluntary farmer participation is possible even in an economically depressed area if practices are acceptable, there is enthusiastic one-to-one contact by local agricultural agency representatives, and, most importantly, cost share rates are sufficiently high.

Initially, farmer participation was nonexistent because the cost share ratio was only 60%. Once the rate was increased, participation was greater than expected. Eighty-nine contracts were awarded, representing 30% of the farmers in the project area.

Farmers participated for public relations reasons. In this case, the farmers wanted to improve the water quality of Lake Tholocco to keep the military happy in order to retain the military base in this part of Alabama.

4.2.4.2 Recommendations

Before project commencement, establish a reasonable cost share rate for the local conditions.

Insure that the most effective BMPs have been selected for the project area before initiating the project.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

Eighty percent of the critical area (7,430 acres) and eight out of the eleven critical hog farms were treated. BMPs appropriate to the project goals were selected. Thirteen different BMPs were selected to either decrease erosion or store animal waste.

Follow-up was critical to the maintenance of several BMPs, especially the lagoons where proper cleaning and disposal of lagoon waste had to be taught to the farmers.

4.2.5.2 Recommendations

Computers should be available as tools to aid in tracking land treatment activities.

To make tillage operations easier, an entire field should be treated with the appropriate BMP, even if part of the field drains elsewhere. However, only the critical area portion of the field should be documented; otherwise correlating land treatment and water quality changes will be difficult.

Highly erodible, critical area fields that significantly contribute to the water quality problem should be taken out of production and planted in grass or trees using incentives similar to the Conservation Reserve Program (CRP).

Farmers need flexibility in changing from one BMP to another BMP in order to accommodate to changes in farm economics and weather conditions.

Livestock numbers and types should be tracked in order to separate the effects of changing animal numbers and types from the effects of BMPs implemented.

If decreasing sedimentation is a goal of the project, erosion and sedimentation rates should be monitored.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

Water quality monitoring indicates that fecal coliform concentrations can be reduced significantly by appropriately targeting the operations contributing the most waste. Fecal coliform counts had a downward trend over the life of the project. However, due to inadequate funding for monitoring which caused incomplete monitoring, the relationship between hydrological events and coliform counts could not be assessed.

Several unexpected factors may also have contributed to the variability in fecal coliform counts or increased sediment loads. These include allowing cattle access to streams during drought, an undocumented beaver pond upstream of a sampling point, an undocumented hog farm above an urban area, and high rates of sediment runoff from dirt roads located on Fort Rucker.

Most water quality variables were not consistently monitored due to lack of funding; thus there are insufficient data for determining the extent of water quality improvement.

There was a serious quality assurance and control (QA/QC) problem in the Fort Rucker lab where the water analysis was performed. Although a methodological guide for the water quality analysis existed, very high turnover of laboratory personnel resulted in serious QA/QC problems. On occasion, reported fecal coliform levels were higher than total coliform levels.

4.2.6.2 Recommendations

Water quality analysis should be performed by a certified lab. If it is not possible to contract with a certified lab, ensure that detailed laboratory and field sampling guides exist so that technicians will know exactly how to analyze samples and how and where to sample. In some instances, it would be useful to include pictures in these guides to show exactly where and how water samples were taken.

Adequate funding and personnel for water quality activities must be insured.

A water quality monitoring and analysis plan must be prepared before sampling is initiated. Projects may need outside assistance in designing a water quality and water monitoring plan.

Project managers and staff should be aware of changing agricultural or natural conditions that may affect water quality results.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Finding

The project lacked the resources necessary to develop a relational data base for land use, land treatment, and water quality or to statistically analyze such relationships (Lake Tholocco RCWP, 1991).

4.2.7.2 Recommendations

Water quality and land treatment monitoring must be designed correctly if linkage between the two are to be documented.

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1980 - 1991

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Lake Tholocco (600-acre impoundment) and 27 miles of perennial tributary streams

4.3.2.1.2 Water Uses and Impairments

Lake Tholocco's designated uses are swimming, fishing, and wildlife. The lake is used for recreation by over 100,000 people each year. Boating and fishing account for about 20,000 user-days per year. Watershed streams have a fish and wildlife classification.

The lake was closed to body contact recreation for 85 days during 1979 due to high bacteria levels. The lake has not been closed to contact recreation since then. Sediment is decreasing the capacity of the lake and also impairs boating, fishing, and water-skiing.

4.3.2.1.3 Water Quality Problem Statement

Coliform bacteria impair contact recreation in Lake Tholocco when counts exceed the state standard (200/100 milliliters (ml) as a geometric mean). Annual mean fecal coliform counts observed in Lake Tholocco have not exceeded the state standard since 1982. The standard is still exceeded in the streams during high intensity, spring rainfall events. Animal operations in the upper watershed are sources of bacteriological contamination.

Sedimentation has reduced the surface area of lake that can be used for boating, skiing, and fishing. Eroding cropland in the upper watershed is the source of high sediment loading to project area streams.

4.3.2.1.4 Water Quality Objectives and Goals

Water quality objectives:

Reduce or eliminate the discharge of livestock wastes into the streams of the watershed and, thereby, improve water quality

Reduce sediment buildup in the lake

Water quality goals:

Monitor water quality in Lake Tholocco to determine its suitability for body contact recreation

Measure water quality trends throughout the life of the project

Monitor water quality in the major tributaries to identify significant sources of NPS pollution

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 51,400 acres
Project Area: 51,400 acres
Critical Area: 9,270 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 55 inches

Geologic Factors: The project area is located in the Lower Coastal Plain. Soils range from loamy sands to fine sandy loams and are erosive when unprotected. Topography is rolling to steep. Much of the cropland is on slopes too steep for row crop farming.

4.3.2.2.3 Project Area Agriculture

Average farm size in the project area is 80 acres. When the project started, animal operations included hogs, layers and broilers, feedlot cattle, and pastured cattle. By the end of the project, all cattle feedlots and several hog operations had closed down or switched to poultry production. As livestock numbers declined, there was a shift from mostly corn (4,500 acres) and some peanuts (1,500 acres) to mostly other crops such as sorghum, soybeans (3,400 acres), and some corn (2,000 acres)

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland:	15	90
Pasture/range:	7	-
Woodland:	55	-
Urban/roads:	4	-
Other:		
Military reserve	19	-
Gully and road ditch erosion, unpaved roads		10

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Hogs	20	4,000	1,600

When this project started, four cattle feedlots, two poultry farms, and 14 hog farms were identified as needing waste management systems. During the project, all cattle feedlots and three hog producers went out of business. Further, it was determined that the poultry farms did not need waste management systems.

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other[a]	
ACTIVITY					SUM
Cost Share	1,215,086	0	516,380	0	1,731,466
Info. & Ed.	12,250	0	0	40,000	52,250
Tech. Asst.	355,626	0	0	105,934	461,560
Water Quality Monitoring	62,000	10,000	0	35,000	107,000
SUM	1,644,962	10,000	516,380	180,934	$2,352,276

[a] Soil & Water Conservation District, U.S. Army, Alabama Dept. of Environmental Management and U.S. Army Preventive Medicine Branch

Sources: Lake Tholocco RCWP Project, 1990; Lake Tholocco RCWP Project, 1991

4.3.4 Information and Education

4.3.4.1 Strategy

The I&E strategy was to contact all producers and then "sell" them on the benefits of the RCWP program. The CES was the lead agency coordinating efforts of U.S. Department of Agriculture (USDA) and county agencies.

4.3.4.2 Objectives and Goals

Use education to get voluntary compliance

4.3.4.3 Program Components

Before producers were contacted, the agencies sharing responsibility for project implementation chose the appropriate BMPs and decided on the cost share rates for BMPs. A letter stating the problem was sent to all area landowners, who were invited to attend an introductory meeting. Mass media and letters were then used to solicit further participation. Many personal contacts were also made not only to solicit participation, but also to encourage participants throughout the project period to answer questions.

Additional I&E activities included: radio and TV programs; production letters; field days; meetings; and information about specific practices timed to concur with farm activities.

4.3.5 Producer Participation

4.3.5.1 Level of Participation

Participation was excellent. Eighty-nine participants signed one contract each. Throughout the implementation phase of the project, the number of contracts signed was continually downgraded. Fewer contracts were needed due to a decrease in hog and feedlot cattle operations and because BMP installation goals on critical acres were exceeded.

4.3.5.2 Incentives to Participation

Cost share rate of 75% for most practices

Payment limitation of $50,000

An aggressive and effective I&E program to recruit potential participants

4.3.5.3 Barriers to Participation

Originally, the cost share rate (60%) was too low. At a 75% cost share rate, the project was able to contract 100% of its planned BMPs within the first five years.

Land leases with absentee landowners were too short to enable the farmer to recoup money spent on the BMPs.

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Chances for continued maintenance appear to be poor. Already some conservation tillage systems, terraces, animal waste management systems, and permanent vegetative cover have been discontinued. Other BMPs that have not been maintained by some farmers are cover crops, stream protection systems, pesticide management, fertilizer management, woodland access, and road stabilization. The primary reason for either discontinuation or lack of maintenance of the BMPs seems to be economic considerations and, more importantly, changes in cropping practices that eliminate the need for certain BMPs.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The strategy for land treatment was to treat critical areas within the watershed. Thirteen BMPs were selected for application to the critical areas.

4.3.6.2 Objectives and Goals

The objective of the land treatment was to reduce erosion and sedimentation from critical areas within the watershed.

The goal was to apply BMPs to eroding farmland and all confined animal systems without waste treatment measures, except broiler operations.

4.3.6.3 Critical Area Criteria and Application

Criteria: Confined animal systems without waste treatment measures, sloping cropland without adequate water disposal, pasture adjacent to creeks that was eroding above tolerance, woodland with gullies, eroding road banks, abandoned or active soil mining pits

Application of criteria: The project adhered to the critical area criteria in committing cost share funds.

4.3.6.4 Best Management Practices Used

General Scheme: Treat nearly all cropland; fix gullies; treat hog operations near streams.

BMPs Utilized in the Project*:

Permanent vegetative cover (BMP 1)

Animal waste management systems (BMP 2)

Terrace systems (BMP 4)

Diversion system (BMP 5)

Grazing land protection systems (BMP 6)

Waterway systems (BMP 7)

Cropland protective systems (BMP 8)

Conservation tillage systems (BMP 9)

Stream protection systems (BMP 10)

Permanent vegetative cover on critical areas (BMP 11)

Sediment retention, erosion, or water control structures (BMP 12)

Tree establishment (BMP 14)

Pesticide management (BMP 16)

*Please refer to Appendix I for description/purpose of BMPs.

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

Units of planned and applied BMPs were reported annually by SCS and ASCS. Land treatment was tracked by SCS using the contracts. Charts for signed contracts were taped to the wall and color coded in order to determine stage of completion. By the end of the project, tracking had been computerized, which eased the management burden. Annual on-site status reviews were completed by a technician who had not been responsible for installing the particular BMP.

4.3.6.5.2 Data Management

No data specific to land treatment were collected.

4.3.6.5.3 Data Analysis and Results

The project team estimated that sediment control BMPs have reduced average soil loss on critical acreage from 11 tons/year to 6 tons/year.

Project personnel attempted to use CREAMS to model sediment movement from the field. However, at the time, the CREAMS model did not account for a restrictive plow pan, and, therefore, its use was discontinued. The Universal Soil Loss Equation (USLE) was used to predict a reduction in erosion, but this model could not predict changes in sedimentation rates due to erosion.

4.3.6.5.3 Data Analysis and Results (continued)

Quantified Project Achievements:

Pollutant Source	Units	Critical Area Total	Critical Area % Implemented	Treatment Goals Total	Treatment Goals % Implemented
Cropland	acres	9,270	80%	6,953	107%
Hog Farms	#	11	7%	8	100%
Contracts	#	115	77%	96	93%

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The original strategy was for the Dale County Soil and Water Conservation District (SWCD) to sample the tributaries and for the U.S. Army to sample the lake and analyze all samples. The data were then transferred to the Alabama Department of Environmental Management (DEM) for analysis. Due to problems at the U.S. Army lab, the original strategy was changed and the Dale County SWCD and the Alabama DEM became more involved in sampling and analysis.

4.3.7.2 Objectives and Goals

Water quality monitoring objectives:

Collect adequate samples in the streams and the lake to establish trends

Locate sources of nonpoint source pollution through stream monitoring

Water quality monitoring goals:

Collect grab samples at nine stations on the major tributaries leading to the lake and at seven in-lake stations on a regular basis

Evaluate samples for fecal streptococcus and fecal coliform bacteria and for nitrates, ammonia nitrogen, orthophosphate, total suspended solids, volatile solids, and turbidity

Relate laboratory results to activities in the watershed, including rainfall events

4.3.7.3 Time Frame

1980-1990

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

Monitoring stations:

7 lake stations
9 tributary stations

4.3.7.4.2 Sample Type

Grab

4.3.7.4.3 Sampling Frequency

At the start of the project, sampling was biweekly (June - August) and monthly (September - May). In 1983 and 1984, sampling decreased to seven to nine samples per year respectively. The number of samples collected annually increased to 15 to 16 for the remaining life of the project. Thus, the yearly number of samples were not uniform over the life of the project.

4.3.7.4.4 Variables Analyzed

Fecal coliform (FC), total coliform (TC), total dissolved solids (TDS), total suspended solids (TSS), volatile suspended solids (VSS), turbidity, nitrite nitrogen (NO_2-N), nitrate nitrogen (NO_3-N), ammonium nitrogen (NH_4-N)

Only FC and TC have been monitored throughout the project time frame. NO_3-N and turbidity were measured during the first two years of the project at all sampling stations and then again in 1986,1987, and 1988, but only at tributary stations. Nutrient monitoring was dropped in 1983. In 1986 only tributaries were being sampled for TDS,TSS, and VSS. These variables were dropped in 1987 due to a lack of funding.

4.3.7.4.5 Flow Measurement

Stream gauges at tributary sampling stations were installed in 1983. The number of stream gauge readings varied from three per year to 21 per year. No additional funding or personnel were provided to support the flow measurement effort and thus the effort was dropped.

4.3.7.4.6 Meteorologic Measurements

Precipitation: Four rainfall collection sites were established in 1984.

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

There was an overall problem in lack of initial water quality monitoring design. Additionally, water quality monitoring suffered from lack of continuity of personnel and variables measured. There was a high turnover in the lab at Ft. Rucker which contributed to quality control problems. The lab was only certified to conduct coliform analysis. Many of the originally measured variables were dropped because there were insufficient staff to conduct the analyses. Some of the variables were turned over to Alabama Department of Environmental Management (ADEM) for analysis (such as TDS,TSS, and TVS), but these analyses were also discontinued due primarily to logistics problems (i.e. it was a two-hour drive from the field to the ADEM lab). Turbidity and NO_3 measurements, after being discontinued, were subsequently reinstated when the Dale County Soil and Water Conservation District (SWCD) purchased a spectrophotometer and started analyzing samples. Sampling frequencies were irregular throughout the life of the project. Other variables, such as rainfall and stream flow, were added after the project started. Monitoring ceased after the 1989 sampling year. In March of 1990, water from a storm caused a breach in Lake Tholocco's dam and the subsequent draining of the lake.

4.3.7.5 Data Management

The data from the Army and the SWCD were sent to Alabama DEM for analysis.

4.3.7.6 Data Analysis and Results

Analysis:

The project has performed an analysis of FC observations by comparing pre- and post-treatment data sets.

Comparison 1: first two years (1981-82) versus last two years (1987-88): by the end of 1982 - less than 50% of practices installed / by the end of 1988 - 97% of practices installed. Comparison 1 was also used to compare pre- and post-treatment turbidity and nitrate- nitrogen observations in streams.

Comparison 2: first three years (1981-83) versus last three years (1986-88): by the end of 1983 - 72% of practices installed / by the end of 1988 - 97% of practices installed.

Results:

One of two major goals and objectives were met in this project: Lake Tholocco was returned to a usable water body for contact water sports due to substantial decreases in fecal coliform. Since sediment was never measured, there is no way to determine whether the surface area of the lake was maintained over the life of the project.

Comparison of FC means from 1981-1982 versus 1987-1988 shows a decline in FC means for all tributary stations in the upper watershed. Trends at lake stations are mixed. However, the station nearest tributary inflow shows a decline in FC means.

Comparison of FC means from 1981-1983 versus 1986-1988 again shows declining FC means for all tributary stations. However, all lake stations show higher FC means for the 1986-1988 period compared to 1981-1983. Two possible explanations are: 1) most of the BMP implementation occurred in 1982, suggesting that the greatest reductions in FC counts occurred during 1983; and 2) other sources, in addition to confined animal operations, which directly influence the lake, are contributing to bacterial contamination.

Results of turbidity monitoring are inconclusive. The project notes that all the mean values are low and turbidity levels show a seasonal fluctuation.

Mean nitrate values are also low. The pre- and post- treatment comparison suggests a decrease in stream nitrate concentrations since the project began; however, the relation to NPS controls is unclear.

Biweekly sampling during summer months may not be frequent enough to determine compliance with the swimming use classification (geometric monthly mean 200/100ml).

Consistent ambient monitoring was conducted over the project time frame. Monitoring sites were accurately selected to examine NPS impacts close to sources in the upper watershed and at sites where use impairment occurred in the lake. The data analysis technique used (comparison of pre- and post- treatment data sets) is a good approach; however, some correction for precipitation effects is needed (Spooner et al., 1991).

4.3.8 Linkage of Land Treatment and Water Quality

This project did not have the resources available to develop a relational data base for land use, land treatment, and water quality or to statistically analyze such relationships. However, one objective, lowered fecal coliform levels, was realized.

4.3.9 Impact of Other Federal and State Programs on the Project

None

4.3.10 Other Pertinent Information

Although a point source pollution survey had been completed prior to project initiation, an important source of sedimentation pollution was missed: the unpaved roads on Ft. Rucker Army Reserve. During the project, this source was discovered and there has been an attempt to pave some of these roads.

4.3.11 References

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

Lake Tholocco RCWP Project. 1991. Ten-Year Report.

Spooner, J., J.A. Gale, S.L. Brichford, S.W. Coffey, A.L. Lanier, M.D. Smolen, and F.J. Humenik. 1991. NWQEP Annual Report: Water Quality Monitoring Report for Agricultural Nonpoint Source Pollution Control Projects - Methods and Findings from the Rural Clearn Water Program. National Water Quality Evaluation Project, NCSU Water Quality Group, Biological and Agricultural Engineering Department, North Carolina State University, Raleigh, NC.

4.3.12 Project Contacts

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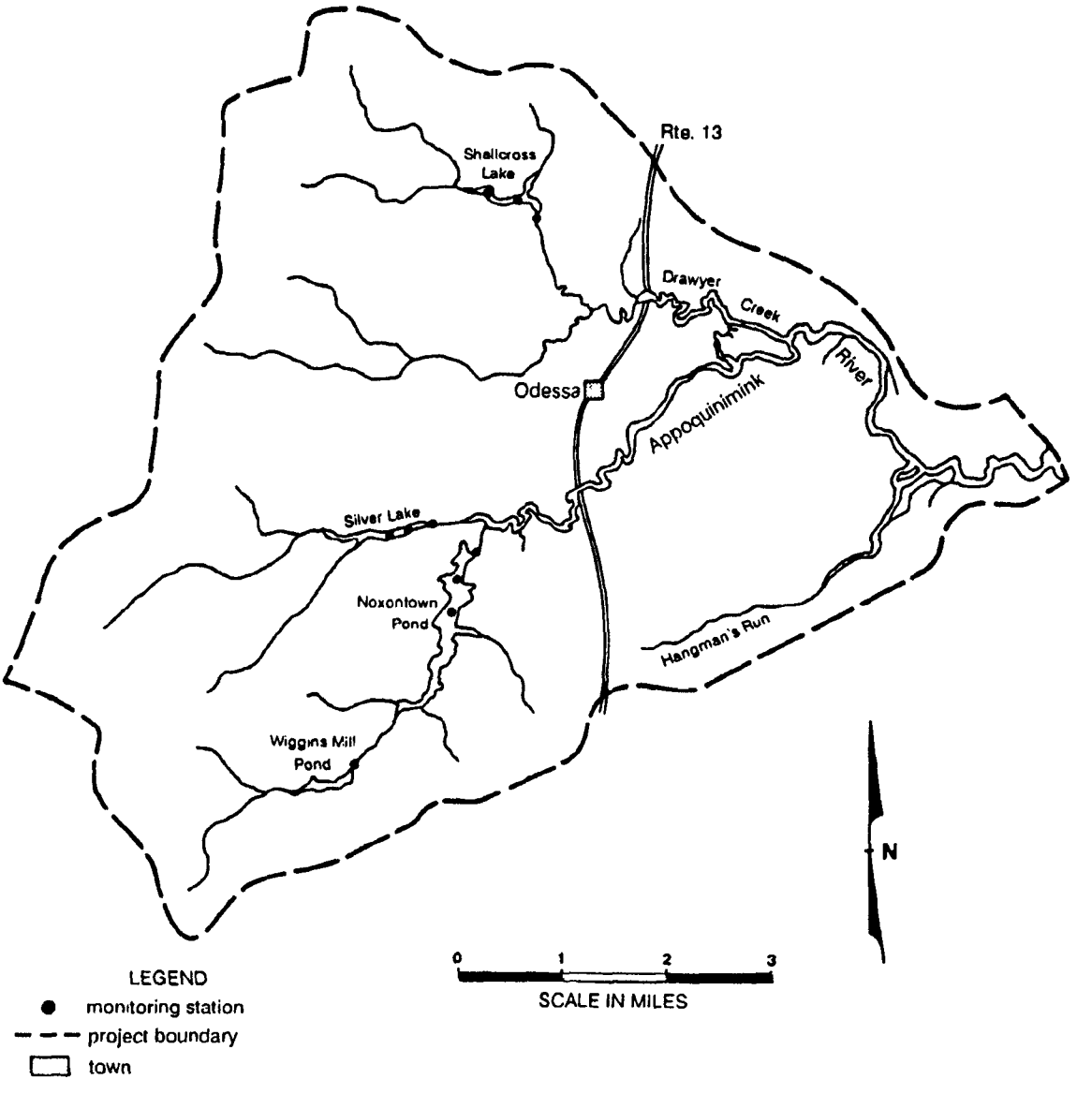


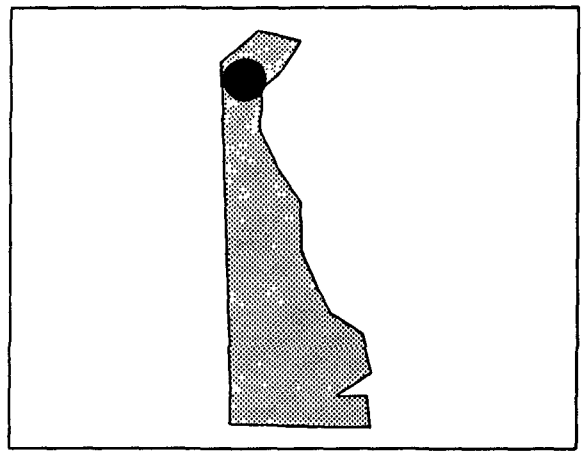
Figure 4.2 Appoquinimink River (Delaware) RCWP project map, DE-1.

Delaware

Appoquinimink River

(RCWP 2)

New Castle County
MLRA: 149A
HUC: 020402-05



4.1 Project Synopsis

The Appoquinimink drainage basin (30,762 acres) lies entirely in the Atlantic Coastal Plain, with much of its 16-mile stream length meandering through tidal marsh. Several ponds and lakes are associated with the river. Nearly two-thirds of the watershed is in active cropland, planted primarily in corn and soybeans.

The project addressed high nutrient concentrations causing advanced eutrophication in Silver Lake, Noxontown Pond, Wiggins Mill Pond, and Shallcross Lake. The principal water uses of these water bodies are primary and secondary contact recreation, maintenance and propagation of fish and aquatic life, industrial and agricultural water supply, drainage, navigation (tidal portion), and passage of anadromous fish. Silver Lake has been closed to primary contact recreation due to bacterial contamination. Noxontown Pond has been impaired by excessive algae growth, inhibiting its use for boating. Algae in Silver Lake has caused a decline in desirable fish species populations. Fish kills have occurred in several of the lakes.

The objective of the Appoquinimink River project was to install best management practices (BMPs) in order to reduce erosion and nutrient transport, decrease nutrient applications to cropland, and properly manage animal waste. The BMP emphasized in the project was the conversion of row crop cultivation to no-till. Pesticide and fertilizer management were also promoted through the RCWP project.

The critical area (13,000 acres) was defined based on soil erosion rates, the presence of gully erosion, concentration of animal wastes 1,500 feet or less from a stream, and the need for better farm management with respect to application of fertilizer, pesticides, and animal wastes. The implementation goal was to treat 9,750 acres of the critical area.

A water quality monitoring program included storm event sampling conducted seasonally in Noxontown Pond, Silver Lake, and Shallcross Lake. However, baseline data for Silver Lake and Noxontown Pond are lacking. Ground water monitoring was added in 1984 to determine to what extent, if any, the installation of BMPs was affecting ground water quality.

Producer participation was excellent, with 60% of the farmers, representing 87% of the critical area, participating in the project. Of the 130 farms in the watershed, 76 were under contract through the RCWP project. Over 11,000 acres in the critical area were treated to reduce nonpoint source (NPS) pollution from agricultural activities.

An unexpected reaction to the project was that farmers outside the project area were upset that they were ineligible to participate in the RCWP project.

Through the RCWP project, no-till acreage was increased from about 50% of the cropland to 90% in the project area. In addition, farmers reduced pesticide use; planted cover crops to reduce winter runoff; and installed grassed waterways, filter strips, and other measures.

Significant reductions in soil erosion and improved fertilizer and pesticide management practices have lowered the level of suspended solids in the river by 60%. In one of the ponds, monitoring showed that sediment levels have declined by 90% and total phosphorus has decreased by 65%.

4.1 Project Synopsis (continued)

The Appoquinimink River project combined excellent inter-agency cooperation and an effective information and education (I&E) program with a farm community having a strong interest in the RCWP project. The water quality monitoring program was handicapped by lack of pre-project baseline data; however, a significant reduction in suspended solids and phosphorus in the lakes was measured.

The benefits of the project have extended into other parts of New Castle County; most farmers in the county have voluntarily adopted no-till as their primary tillage practice. However, the use of no-till in corn production has significantly dropped due to slug damage and lack of a safe and effective pesticide control.

Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

Adequate baseline data is critical in setting effective objectives and goals (Carty et al., 1991).

Original land treatment goals (100% of the critical area) were ambitious, though based on previous high project participation rates in an earlier demonstration project. The goals were later revised to more realistic levels (75% of the critical area).

4.2.1.2 Recommendations

Water quality goals should be set in concert with designated uses established by the state (Carty et al., 1991).

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

Identifying "critical areas" for cost sharing is extremely important in maximizing the project dollars for water quality benefits (Carty et al., 1991).

A disproportionate percentage of project funds was earmarked for cost sharing land treatment, while insufficient funds were available for I&E and water quality monitoring programs.

Early involvement of producers in identifying the water quality problem and its source as well as deciding on and planning the project is key to a successful outcome.

Administration of the project by the Agricultural Stabilization and Conservation Service (ASCS) was effective because: 1) members of the ASC County Committee that worked with the Local Coordinating Committee (LCC) were farmers elected by their peers, bringing a strong community base of support; 2) ASCS had experience administering the Agricultural Conservation Program; and 3) ASCS was able to undertake the project without hiring new staff.

4.2.2.2 Recommendations

The National Coordinating Committee (NCC), or similar organization, should assign each member to monitor and provide support to specific projects. That person should attend the State Coordinating Committee (SCC) and LCC meetings of her/his projects at least once a year to help facilitate inter-project communication and information-sharing nationwide.

Appropriate reporting is necessary to provide feedback to project staff, funding agencies, and the public and to motivate agency staff to meet project goals. However, water quality project paper work should be streamlined to avoid excess reporting and documentation. Reporting requirements for the entire project period should be clearly outlined at the beginning of the program (Carty et al., 1991).

4.2.2.2 Recommendations (continued)

It may be helpful for SCC members to attend the meetings of other project SCCs on occasion to help facilitate sharing of resources and solutions among projects nationwide.

Local and state agencies should receive adequate advance notice of water quality program eligibility to enhance sound planning and selection of projects with a good possibility of success.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

Purchase by the Conservation District of a no-till drill for on-farm workshops and demonstrations promotes the BMP while allowing first-time users to experiment with its use without having to make a major financial investment in the equipment first (Carty et al., 1991).

4.2.3.2 Recommendations

Farmers need assistance in understanding, planning, and implementing nutrient and pesticide management, reduced tillage, and animal waste management practices.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

Sixty percent of the farmers, representing 87% of the critical area, participated in the project.

Plans were completed for 76 farms resulting in 76 contracts covering 13,000 critical acres.

The project has shown that voluntary programs for BMP implementation have resulted in conservation tillage becoming an acceptable practice for many farmers.

The project has demonstrated that farmers are willing to make adjustments in their practices to help improve water quality.

4.2.4.2 Recommendations

None

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

One-to-one contact with farmers by SCS and the Cooperative Extension Service (CES) was critical to the success of the project.

Although producers have experienced some problems with slugs in corn crops under conservation tillage due to a lack of an effective and safe pesticide, conservation tillage is still the BMP of choice for sediment control and nutrient reduction.

Projects that rely on management BMPs need specialists for effective implementation (e.g., pest management, weed control, fertilizer use). Technology transfer of management BMPs from farm to farm is critical for overall project success.

Producers installing conservation measures under the Section 208 program provided a favorable lead-in for the RCWP.

Most farmers report using soil tests to help plan for nutrient crop needs. In addition, most farmers side-band rather than broadcast fertilizer at planting and apply most nitrogen after crops are growing (split application), when crop uptake is greatest.

The use of scouting in association with pesticide management has resulted in a reduction of the amount of pesticides applied in the project area.

An innovation on a BMP developed in this project is the use of rock pads during construction of waterways to keep gullies from moving up a waterway.

4.2.5.2 Recommendations

Maintenance requirements should be clearly defined in the contract with the producer. Follow-up with the participant is necessary to ensure maintenance throughout the practice life span. (Carty et al., 1991)

Additional technical help with management practices (fertilizer, pesticide management, tillage) is very helpful in the field (Carty et al., 1991).

The economics of growing crops and the costs of implementing practices to improve water quality need to be constantly assessed in order to continue the process of identify and implementing practices that both reduce agricultural NPS pollution and are affordable and acceptable to producers.

Use of annual aerial photographs could assist in tracking of land use and BMP installation.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

The water quality monitoring program results show that BMPs have decreased the total phosphorus and total suspended solids concentrations in the Appoquinimink watershed.

Voluntary programs for BMP implementation have resulted in conservation tillage becoming an accepted practice for many farmers. Since BMPs were installed, however, orthophosphate concentrations (as a proportion of total phosphorus concentrations) have increased in the watershed and BMPs have failed to decrease downstream nitrogen loading.

The project lacked strong pre-project baseline data and the monitoring program would have been more useful if extended to 10 to 15 years.

Delivery of suspended solids and nutrients from agricultural lands to surface streams has declined 90% from pre-RCWP levels. The delivery of total phosphorus to the stream has shown a similar decline. Both filtered and unfiltered total phosphorus have been reduced more than 60% from pre-RCWP levels. Orthophosphorus concentrations, however, increased somewhat over the first years of the study before declining to about 65% of pre-RCWP levels. Nitrogen loads to the stream have declined less than 25% from pre-project levels.

Reduced suspended solids concentrations, and hence increased water clarity, have resulted in significant increases in algal growth in the downstream ponds. Nutrient concentrations have not varied significantly over the last four years of the project, indicating that pond sediments contribute sizable quantities of nutrients to pond waters. Water quality in the ponds can still be described as enriched.

4.2.6.2 Recommendations

All land use activities in the watershed should be identified and accounted for in the monitoring program, particularly when such activities are located immediately upstream of a monitoring station (Carty et al., 1991).

Funding should be made available for adequate pre-project monitoring and for an extended during and post-project period in order to maximize chances of documenting the effects of land treatment implemented.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

Changing tillage practices resulted in an estimated decrease of about 90% in the concentration of suspended solids and more than 60% of the concentration of total phosphorus reaching project area water bodies.

Cover crops reduced suspended solids and phosphorus entering project area lakes and ponds.

4.2.7.2 Recommendations

Clear documentation of BMPs implemented prior to initiation of a water quality demonstration project and their water quality effects is important if a link between project-sponsored land treatment and changes in water quality are to be clearly demonstrated.

Pre-project baseline data are essential to document land treatment - water quality linkage.

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1980-1991

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Lakes and streams in the Appoquinimink River basin

4.3.2.1.2 Water Uses and Impairments

The lakes and streams of the Appoquinimink River watershed are used for recreation by approximately half a million people who live within 20 miles of the watershed. Water uses include passive recreation (sightseeing and bird watching) and active recreation (fishing, hunting, and boating). Contact recreational uses such as swimming have been constrained by degraded water quality at Silver Lake in recent years.

4.3.2.1.3 Water Quality Problem Statement

All lakes in the Appoquinimink River basin have eutrophic conditions with dense aquatic vegetation and algal growth due to excessive nutrient concentrations. Fecal coliform bacteria standards (200/100ml) were typically violated throughout the watershed during ambient conditions.

4.3.2.1.4 Water Quality Objectives and Goals

Improve water quality in the Appoquinimink River Basin by controlling nutrient loads, sediment, bacteria, and chemical runoff from agricultural sources

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 30,762 acres
Project Area: 30,762 acres
Critical Area: 13,000 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 45 inches

Geologic Factors: The watershed is underlain by deep sediments covering the bedrock. The surface formation consists largely of medium to coarse sands and gravels. This formation is an important water supply presently used as a potable water source for public and private supplies. The predominant soil type is deep, well-drained and medium to coarse textured. Slopes are nearly level in the uplands and steep near the stream channels.

4.3.2.2.3 Project Area Agriculture

There are about 130 farms in the project area producing primarily corn, soybeans, and vegetables. Eighty-five percent of these farms are located in the critical area. Most dairy, beef and hog operations are located along or near streams. None of the operations had animal waste treatment facilities before the RCWP project was initiated.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	64	62
Pasture/range	4	NA
Woodland	13	NA
Urban/roads	5	NA
Other		
Wetlands/ Open water	14	NA

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	7	945	1,323
Beef	2	293	293
Hogs	1	NA	NA
Poultry	1	70,000	2,310

Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	873,196	0	328,366	0	1,201,562
Info. & Ed.	0	0	0	0	0
Tech. Asst.	NA	0	0	NA	NA
Water Quality Monitoring	225,000	0	0	90,000	315,000
SUM	1,098,196	0	328,366	90,000	$1,516,562*

* Total does not include cost of technical assistance

Source: Carty et al., 1991

4.3.4 Information and Education

4.3.4.1 Strategy

Distribute information about the project sufficient to entice producers to meet the project's participation goals

4.3.4.2 Objectives and Goals

Inform the public of the experimental RCWP project

Inform and educate the public about the solutions to the agricultural nonpoint source problem

Target the audience in the critical area

Disseminate information on the outcome of the RCWP project

Provide demonstration plots to show producers how recommended BMPs work

4.3.4.3 Program Components

One-to-one contact by SCS and CES with the farmers

Public meetings/workshops at which conservation tillage equipment was demonstrated

Fact sheet on proper disposal of agrichemicals

New media articles

ASCS newsletter

Statewide meetings of the No-Till Council, a cooperative organization initiated by CES, agribusiness, and others

Demonstrations by CES of side-band application, in-row tillage, and dairy techniques

Tours of participating farms

4.3.5 Producer Participation

4.3.5.1 Level of Participation

Excellent: Sixty percent of the farmers, representing 87% of the critical area, actually participated in the project. Of the 130 farms in the watershed, 76 were under contract through the RCWP project to implement water quality plans.

4.3.5.2 Incentives to Participation

Cost share rates up to 75%

Payment limit of $50,000

Strong technical assistance programs for fertilizer and pesticide management programs conducted by the CES

Perception on the part of the producers that the recommended BMPs would be economically beneficial

A eutrophication problem visible to the community

4.3.5.3 Barriers to Participation

Resistance to participate in any government program by some producers

Funding limitations: the project stopped accepting applications in 1984 due to lack of funds

Producer's farm not located in the critical area

Inability of some producers to manage their share of the cost of BMP implementation

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Very good because farmers see the economic as well as water quality benefits of the practices. However, there has been some reduction in use of conservation tillage due to slug and weed control problems.

The use of no-till will be modified based on fuel costs (the higher fuel costs, the more no-till), the slug problem, and soil and climatic conditions (no till has a place when it is very wet or very dry).

The spillover from the project area to the rest of the county has been a major success of the project. Many farmers outside the project area wanted to participate in the project but were ineligible. Some of these producers have voluntarily adopted conservation tillage without cost share assistance through the RCWP.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The land treatment strategy was to target management practices that would reduce soil and nutrient losses, in particular, conservation tillage and fertilizer and pesticide management.

4.3.6.2 Objectives and Goals

Reduce soil and nutrient losses from cropland

Reduce the amounts of fertilizer and pesticides applied to cropland

Implement practices to manage manure applications so as to reduce nutrient losses

The original project goal was to have 100% of the critical area (13,00 acres) under contract by the end of FY 1984 with all contracts implemented by the end of FY 1989; this goal was later revised to treatment of 9,750 critical acres.

4.3.6.3 Critical Area Criteria and Application

Criteria:

Soil erosion exceeding T value

Gully erosion (including ephemeral) is present

Concentration of animal wastes 1,500 feet or less from a stream

Need for better farm management with respect to application of fertilizer, pesticides, and animal wastes

Application of Criteria: Critical area designation for individual contracts was determined by soil conservationists using the above criteria on a field by field basis.

4.3.6.4 Best Management Practices Used

The primary BMP emphasis was on conservation tillage, fertilizer management, and pesticide management. There was some implementation of animal waste management systems, primarily manure - holding structures and calibration of manure application equipment.

BMPs Utilized in the Project*:

Permanent vegetative cover (BMP 1)

Animal waste management system (BMP 2)

Diversion system (BMP 5)

Waterway system (BMP 7)

Cropland protection system (BMP 8)

Conservation tillage system (BMP 9)

Permanent vegetative cover on critical areas (BMP 11)

Sediment retention, erosion, or water control structures (BMP 12)

Improving an irrigation and/or water management system (BMP 13) (not cost shared)

Fertilizer management (BMP 15) (not cost shared)

Pesticide management (BMP 16) (not cost shared)

* Please refer to Appendix I for description/purpose of each BMP.

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

BMP installation was tracked and reported through annual reports. A spreadsheet was used to track each contract. Maintenance was tracked through annual status reviews. Land use changes were not formally tracked; however, major land use changes did not occur in the project area during the course of the project.

4.3.6.5.2 Data Management

Details of BMP implementation, cropping (type, acreage, and yield), fertilizer application rates (nitrogen and phosphorus), and pesticide type and application rate are kept in the New Castle County Automated Environmental Resources Information (AERI) System.

4.3.6.5.3 Data Analysis and Results

Improved fertilizer management has cut the phosphorus application rate in half compared to the pre-project period. Installation of manure holding structures allows farmers to store animal wastes for timely application to meet crop needs.

Scouting has decreased pesticide applications as well.

4.3.6.5.3 Data Analysis and Results (continued)

Quantified Project Achievements:

Pollutant Source	Units	Critical Area Total	Critical Area % Implemented	Treatment Goals Total	Treatment Goals % Implemented
Cropland	acres	13,000	87%	9,750	117%
Dairies	#	7	43%	5	60%
Water Quality Plans	#	160	48%	80	96%

Source: Appoquinimink River RCWP Project, 1987. RCWP Progress Summary for Fiscal Year 1987, form RCWP 3

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The water quality monitoring and evaluation program was designed and conducted by the University of Delaware College of Agricultural Sciences under contract to the Water Resources Agency for New Castle County.

Storm event samples were taken seasonally in Noxontown Pond, Silver Lake, and Shallcross Lake.

Ground water monitoring was added in 1984 to determine to what extent, if any, the installation of BMPs was affecting ground water quality.

4.3.7.2 Objectives and Goals

Continue an existing physical, chemical, biological, and hydraulic monitoring program being conducted in the Noxontown Pond headwaters (sub-watershed of the Appoquinimink River basin)

Evaluate the impact of agricultural BMPs on water quality in the Appoquinimink watershed

Evaluate the impacts of improved animal waste handling, erosion and runoff control, fertilizer, and pesticide management on ground water quality

4.3.7.3 Time Frame

Wiggins Mill Pond: 1980 - 1986

Silver Lake, Shallcross Lake, and Noxontown Pond: 1983 - 1986

Ground water: 1984 - 1986

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

Wiggins Mill Pond: 1 station to monitor a 2,200 acre sub-watershed / Approximately 1,200 acres of this sub-watershed are in the critical area

Silver Lake, Shallcross Lake, and Noxontown Pond: 3 stations for each water body (2 within the lake and 1 at the outlet)

4.3.7.4.2 Sample Type

Grab

4.3.7.4.3 Sampling Frequency

Wiggins Mill Pond: Frequency varied from 1 to 7 samples per month / data set includes some storm flow samples

Silver Lake, Shallcross Lake, and Noxontown Pond: Monthly for baseline data / 3 storm event samples per year

4.3.7.4.4 Variables Analyzed

Wiggins Mill Pond: Biological monitoring consisting of periphyton and macroinvertebrates sampled monthly, May-October 1985-86

Silver Lake, Shallcross Lake, and Noxontown Pond: (all stations) water & air temperature, biochemical oxygen demand (BOD), chemical oxygen demand (COD), acidity, alkalinity, hardness, pH, dissolved oxygen (DO), suspended solids (SS), dissolved solids (DS), orthophosphate (OP), total phosphorus (TP), organic nitrogen, ammonia-nitrogen (NH_3-N), nitrite-nitrogen (NO_2-N) and nitrate-nitrogen (NO_3-N), chlorophyll *a*, biota, and coliform, fecal coliform (FC), and fecal streptococci bacteria

Silver Lake, Shallcross Lake, and Noxontown Pond: Biological monitoring consisting of periphyton and macroinvertebrate sampled monthly (April-Nov., 1985-86)

4.3.7.4.5 Flow Measurement

Instantaneous, taken at each pond spillway whenever outflow samples were collected and in stream when samples were collected below Wiggins Mill Pond

4.3.7.4.6 Meteorologic Measurements

Precipitation: US Weather Bureau station at Middletown, near the center of the watershed

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

The monitoring program lacks a baseline period for Silver Lake and Noxontown Pond.

Silver Lake, Shallcross Lake, and Noxontown Pond: Point source monitoring - monthly sampling of point source discharges are conducted to supplement information in NPDES (National Pollutant Discharge Eliminiation System) Compliance Monitoring Reports, particularly for nitrogen and phosphorus discharge loads

Wiggins Mill Pond: The dam washed out in the spring of 1979 and was restored in 1984.

Noxontown Pond was dredged in 1984 through 1985 and may have contributed to increased organic nitrogen concentrations.

4.3.7.5 Data Management

The data are managed locally.

4.3.7.6 Data Analysis and Results

Analysis:

All water quality data were initially reduced to monthly means to reduce bias introduced by variation in sample number and period. Data summaries included univariate descriptive statistics using the SAS MEANS procedure and bivariate statistics using the SAS CORR procedure.

Analyses for trends were conducted by inspection of annual and seasonal mean concentrations and loading rates, and by evaluation of correlation coefficients to determine the significance of water quality changes over time.

Results:

Significant reductions in soil erosion and improved fertilizer and pesticide management practices have lowered the level of suspended solids in the river by 60%. In one pond, sediment levels have declined by 90% and total phosphorus has decreased by 65%.

The project team reports the following water quality trends. Delivery of suspended solids and nutrients from agricultural lands to surface streams has declined 90% from pre-RCWP levels. The delivery of total phosphorus to the stream has shown a similar decline. Both filtered and unfiltered total phosphorus have been reduced more than 60% from pre-RCWP levels. Orthophosphorus concentrations, however, increased somewhat over the first years of the study before declining to about 65% of pre-RCWP levels. Nitrogen loads to the stream have declined less than 25% from pre-project levels. Increased concentrations of organics (biochemical and chemical oxygen demand) are attributable to greater proportions of cropland remaining in vegetative cover from conservation tillage; however, these levels have not increased to a point where they are a concern (Carty et al., 1991).

Reduced suspended solids concentrations, and hence increased water clarity, have resulted in significant increases in algal growth in the downstream ponds. Nutrient concentrations have not varied significantly over the last four years of the project, indicating that pond sediments contribute sizable quantities of nutrients to pond waters. Water quality in the ponds can still be described as enriched (Carty et al., 1991).

4.3.8 Linkage of Land Treatment and Water Quality

Implementation of BMPs existed prior to RCWP, but no records of those accomplishments are available; thus the pre-project level of implementation is difficult to define. This factor, combined with the lack of baseline data in the sampling program, may preclude demonstrating water quality improvements as a direct result of RCWP BMP implementation.

4.3.9 Impact of Other Federal and State Programs on the Project

Superimposing the federal Payment in Kind (PIK) Program on the RCWP project watershed resulted in enhancement of both programs as participation in both programs was high. However, program overlap created some difficulty in assessing pollution abatement attributable to RCWP, especially in 1983, when many farms were left idle and devoted to conservation through PIK (Carty et al., 1991).

The 1980 state sedimentation and erosion control law complemented RCWP in that all land disturbing activities required a plan to control off-site sediment. This included major and minor subdivision activity that occurred in the watershed (Carty et al., 1991).

Delaware's revised septic system regulations also complemented RCWP in that a site evaluation conducted by a licensed soils evaluator was required. The new standards prevent common failures encountered in the old method of total reliance on a percolation test (Carty et al., 1991).

During the project period, the Water Resource Agency developed resource protection area maps that identified recharge areas and wellhead areas in the county. Development in these areas was restricted by the county planning department (Carty et al., 1991).

4.3.10 Other Pertinent Information

None

4.3.11 References

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

Appoquinimink River RCWP Project, 1987. RCWP Progress Summary for Fiscal Year 1987, form RCWP 3.

Carty, C., J.J. Lakatosh, L.R. Irelan, B.L. Dworsky, R. Mulrooney, W. Ritter. 1991. Appoquinimink Rural Clean Water Program Ten Year Report. September 1991. Cooperators: ASCS, SCS, New Castle Conservation District, New Castle County-Water Resources Agency, CES, and the University of Delaware. 56p. plus appendices.

4.3.12 Project Contacts

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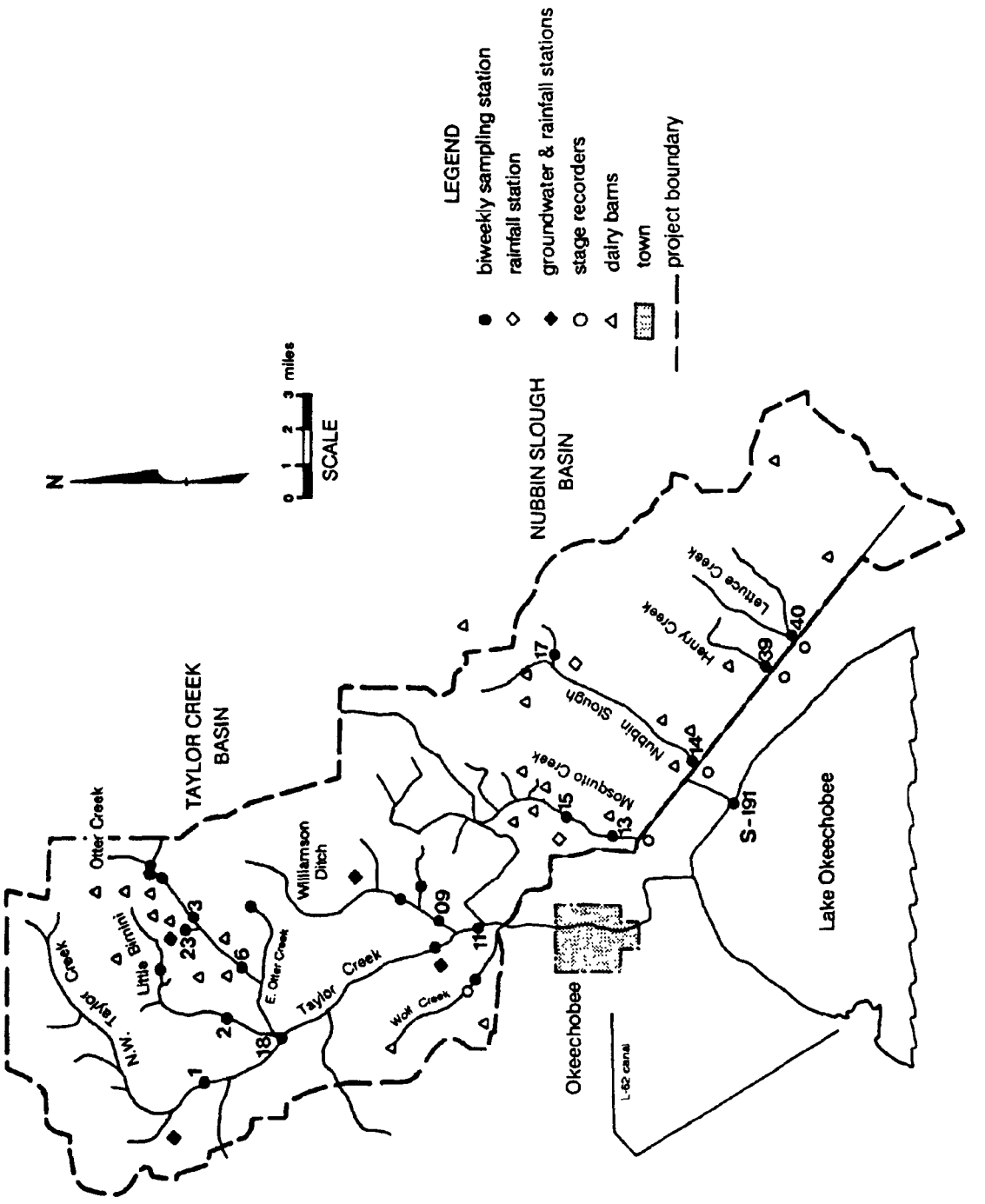
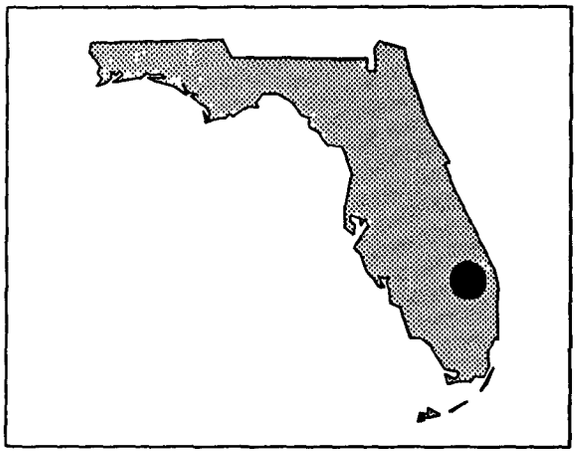


Figure 4.3: Taylor Creek - Nubbin Slough (Florida) RCWP project map, FL-1.

Florida
Taylor Creek - Nubbin Slough

(RCWP 14)



Okeechobee & Martin Counties
MLRA: U-156A
HUC: 030901-02

4.1 Project Synopsis

The Taylor Creek - Nubbin Slough (TCNS) Basin is located in southern Florida, directly north of Lake Okeechobee. The watershed covers 120,000 acres of a typically flat landscape with generally poorly drained, coarse textured soils (Spodosols) that have a low phosphorus retention capacity. Water flow from the basin tributaries enters Lake Okeechobee through a flow control structure (S-191).

Lake Okeechobee provides drinking and irrigation water, supports commercial and sport fishing, and is a habitat for many migratory as well as endemic bird species. High phosphorus (P) concentrations in Lake Okeechobee promote eutrophic conditions that impair all water uses.

Agricultural nonpoint source (NPS) pollution has been documented as a significant water quality problem in the TCNS watershed (Allen et al., 1982). The TCNS Basin contributes 27% of the external P load but only 4% of inflowing water to the lake (Federico et al., 1981).

Land use in the watershed is primarily agricultural, consisting of intensive dairy and beef cattle farms whose animals graze on improved pastures that are surface drained and fertilized. The main sources of high phosphorus loads in the watershed are thought to be runoff from dairy barns and holding areas, direct stream access by large numbers of dairy cattle, and runoff from improved pastures.

About 63,109 acres have been identified as critical areas needing treatment. This includes all dairy farms, all beef cattle pastures that have been extensively ditched for improved surface drainage, and all areas within one-quarter mile of a waterway. Land treatment and water quality goals were established to: 1) reduce phosphorus and nitrogen concentrations from the project area to Lake Okeechobee by at least 50%; 2) contract at least 75% of the critical area; and 3) contract with all dairy farms in the project area (Stanley et al., 1986).

The general treatment strategy was to install best management practices (BMPs) which exclude dairy cows and beef cattle from waterways and to control wastewater runoff from dairy barns. Principal BMPs used were stream protection systems, reduction of barn waste by improving water use efficiency and improving effluent disposal with spray irrigation, animal waste management systems, diversion systems, grazing land protection systems, permanent vegetative cover, sediment retention structures, and water control structures. Stream protection emphasized fencing to keep animals out of the water courses, along with providing shade and alternative water facilities. Dairy closures independent of Rural Clean Water Program (RCWP) activities may also have affected water quality within the basin. The Florida Department of Environmental Regulation (FDER) imposed a Dairy Rule requiring each dairy to collect the runoff from high intensity areas and treat the P through spray irrigation, so that the P in the effluent would be assimilated by plants or absorbed by the soil (nutrient mass balance).

This project has a high level of BMP implementation, most of which occurred in 1985 to 1987. This allowed for a baseline pre-BMP period of four to six years. Contracts were written for 54,709 acres or 87% of the critical area. All critical dairies are under contract. Ninety-nine percent of contracted practices were installed. The two most important reason farmers decided to participate was availability of cost share funds (federal and state) and concern about future pollution regulations. Increased farm production was given by producers as the second most important reason.

4.1 Project Synopsis (continued)

The primary objective of the water quality monitoring network was to evaluate the effectiveness of agricultural BMPs for reducing P concentrations to Lake Okeechobee, as measured by changes in water quality concentrations (particularly phosphorus) in the tributaries and basin outlet.

The TCNS project had extensive water quality monitoring. The monitoring design allowed for comparison of the pre-, during-, and post- BMP implementation periods. Upstream/downstream station pairs were established in a few tributaries to adjust for pollutant concentrations originating above the BMP implementation sites. Ground water table depth was also measured. Biweekly grab samples were taken biweekly at 23 tributary stations; some were monitored since 1978. In 1988, the network was modified to monitor site- specific BMP effectiveness on each dairy. This modification were a result of the FDER dairy rule.

Due to a high level of BMP implementation and dairy closures, the project exceeded its goal for reduction of phosphorus and nitrogen concentrations at the project outlet, despite substantial increases in the numbers of cows. Tracking of BMP implementation by practice and subwatershed allowed the project to link the water quality and land treatment data bases on subwatershed drainage area and annual basis. This contributed to the project's ability to document changes in water quality as a result of land treatment on both subwatershed and project levels. Subwatersheds with a large amount of BMP implementation such as Mosquito Creek and Nubbin Slough have shown significant decreases in phosphorus concentrations. In contrast, in northwest Taylor Creek and Lettuce Creek subwatersheds, increased cattle densities have had a negative effect on water quality. Adjustments of phosphorus concentrations for changing cow numbers, ground water table depth, and upstream concentrations increased the ability of the project to document water quality effects from the RCWP BMPs.

Fencing to keep animals out of the water courses, along with providing shade and water facilities, was effective in reducing the phosphorus concentrations from the project area. However, these BMPs alone were probably not sufficient to meet the water quality goal of a 50% reduction. BMPs that require more active management, such as dairy waste water utilization, reduction, and timing of nutrient applications on dairy and beef operations and controlling the release of high intensity area runoff, seemed to have the greatest impact on water quality.

This project is demonstrating that a large project can be successful, if it is well organized, tightly managed and sufficiently funded. One key to this project's success was the implementation of an administrative subcommittee. This subcommittee was made up of the Agricultural Stabilization Conservation Service (ASCS), Soil Conservation Service (SCS), Cooperative Extension Service (CES), and the South Florida Water Management District (SFWMD). The subcommittee met regularly to coordinate project activities and each member participated in all phases and activities of the project.

In 1988, the Taylor Creek-Nubbin Slough RCWP project was expanded to include dairies in the Lower Kissimmee River Basin. Please refer to the profile on the Lower Kissimmee River, Florida RCWP project for further detail.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

The Taylor Creek - Nubbin Slough (TCNS) RCWP project set realistic quantitative goals for both water quality and land treatment.

Specific goals for BMP implementation were set by the Local Coordinating Committee (LCC) on an annual basis.

4.2.1.1 Findings and Successes (continued)

Water quality modeling was used in setting quantifiable project land treatment goals. Based on a modification of the Vollenweider Model, the Lake Okeechobee Technical Advisor Committee (1986) recommended reducing all phosphorus loadings to the lake by 40% to protect long-term water quality. From a land treatment management perspective, phosphorus loadings from the TCNS basin would need to be reduced by 75 to 90% to achieve this objective. The original project goal was to reduce phosphorus concentrations from the watershed by 50%. Based on this watershed reduction goal, the project refined their land treatment objectives and goals by estimating the amount and location of land treatment that would be required to achieve this increased level of phosphorus reduction.

New state regulations changed the specific land treatment BMP goals. Due to the 1987 FDER Dairy Rule and the 1989 State of Florida Surface Water Improvement and Management (SWIM) Plan, the BMP emphasis for waste management, pasture and hayland management, and irrigation management increased.

The project set land treatment and water quality monitoring objectives and goals that guided the establishment and maintenance of effective monitoring designs. Monitoring provided valuable feedback on progress toward meeting land treatment and water quality goals.

4.2.1.2 Recommendations

Implementation strategy goals need to be flexible for adaptation to watershed conditions and relative BMP effectiveness, but still support the overall strategy of improving water quality. For example, BMP selection and emphasis should include all major sources of pollutants, such as animal and dairy barn waste.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

The local ASCS project administrator also served as the project coordinator. The project coordinator facilitated communication and inter-agency cooperation.

The key to success of the project was the implementation of an administrative subcommittee. This subcommittee was made up of the ASCS, SCS, CES, and the SFWMD. The subcommittee met regularly to coordinate project activities and each member participated in all phases and activities of the project.

Full-time water quality monitoring specialists were assigned to the project throughout its duration, from which the project benefited greatly.

The project was affected by local and state political and regulatory pressures. Regulations that came into effect mid-project forced changes in both land treatment and water quality goals.

4.2.2.2 Recommendations

A local project coordinator is essential to provide coordination among the agencies and keep the project on course to meet its goals.

A core project staff, with low turnover rates, is important to provide for a smooth transition as a project shifts from planning to installation, then to operation and maintenance.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

Close cooperation among the four local key agencies (ASCS, SCS, CES, and SFWMD) was essential to the success of the information and education (I&E) program.

Field days, demonstration sites, and tours were the most effective methods for presenting the accomplishments of the project.

The level of funding for I&E was insufficient and restrictive to accomplish all the I&E goals.

Funding of a laboratory to conduct effluent, manure, tissue, water, and soil sample analysis would have been useful to producers to encourage proper nutrient management.

4.2.3.2 Recommendations

Demonstration projects should be encouraged.

Management booklets describing management of animal waste systems should have been developed.

Projects need sufficient and flexible funding for I&E.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

Technical assistance and increased cost share funds provided by the state increased program participation.

One-to-one consultation with producers improved BMP management and maintenance.

The threat of regulations increased participation.

4.2.4.2 Recommendations

One-to-one contact with potential participants should be emphasized because this is the most effective method in convincing landowners to participate in a water quality project. This technique also improves BMP management and maintenance.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

All land treatment goals were met or exceeded.

The project found that explicit guidance for animal waste management practices needed to be written into the contracts to ensure that both the management and structural components of these systems were operated and maintained according to specifications.

Fencing to keep animals out of the water courses, along with providing shade and water facilities, was effective in reducing the phosphorus concentrations from the project area. However, these BMPs alone were probably not sufficient to meet the water quality goal of a 50% reduction.

BMPs that require more active management, such as dairy waste water utilization, reduction, and timing of fertilizer applications on dairy and beef operations, and controlled release of high intensity area runoff, seemed to have the greatest impact on water quality.

Fencing cattle out of streams did not prevent runoff into the streams of excess waste from the adjacent lands.

Adoption of BMPs, such as improved fertilizer and feeding practices, was observed in surrounding areas.

4.2.5.1 Findings and Successes (continued)

State regulations, implemented in 1987 and 1989, changed the focus of the water quality goals and land treatment. Dairy farmers and others thought that the original BMPs would be insufficient to meet the requirements of these new regulations.

A holistic farm management approach is necessary which considers not only milk production, but also the handling of manure. Improving nutrient management and crop production techniques were essential for a total project success.

Continued improvements in the quality of water leaving the TCNS basin will require more nutrient management, efficient use of dairy waste water, and management of waste storage lagoons.

4.2.5.2 Recommendations

Due to the temptation of contractors to increase the cost of structural BMP installation when government cost share funds are involved, the project (ASCS) should set an average price for each BMP.

Local projects should have flexibility in selecting and modifying BMPs. This will help ensure that the water quality goals will be met, farmers will participate, and needed BMPs can be implemented in a timely fashion. However, oversight should be given from the state and national level to ensure that the BMPs selected are directed at the water quality goals.

Management plans are a key element in the operation and maintenance of BMPs.

All farms in the critical area should have a plan written and a contract signed to ensure the project's success.

Practices with the greatest water quality benefits should be prioritized and implemented first.

Participant involvement in plan preparation is critical in getting a plan suited to the needs of the participant and the project goals; this also increases the probability of successful implementation of the plan.

Sufficient time should be devoted to defining the critical area. The TCNS RCWP project initially designated the entire basin as critical. The critical area was redefined in 1983 based on the major sources of phosphorus to allow for effective targeting.

Close coordination between the project and regulatory agencies is needed in selecting and implementing BMPs.

Follow-up meetings with participants should be held to facilitate completion of BMP implementation.

Phosphorus imports into a watershed can be minimized by purchasing animal feed lower in phosphorus concentration and reducing phosphorus fertilization rates by animal waste management. Practices which encourage exporting of phosphorus should also be incorporated into the overall basin plan when phosphorus production in the basin exceeds phosphorus needs.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

The TCNS project had multiple years of baseline data collect by the Agricultural Research Service (ARS) and the SFWMD. The SFWMD continued to monitor and expand the sampling program. This allowed for a good pre- project assessment and several years of post-BMP monitoring.

The project exceeded its goal for reduction of phosphorus and nitrogen concentrations at the project outlet.

Trend analysis has shown that significant reductions in phosphorus and nitrogen concentrations have occurred in more than half of the subwatersheds.

4.2.6.1 Findings and Successes (continued)

There has been an overall decrease in total phosphorus (TP concentrations at the project's outlet to Lake Okeechobee (S-191)), despite an increase in cow numbers. This decrease is largely a function of the high number of BMPs installed in subwatersheds, especially the Mosquito Creek and Nubbin Slough subwatersheds, and dairy closures in the Otter Creek subwatershed (Ritter and Flaig, 1987; Stanley et al., 1988).

4.2.6.2 Recommendations

As demonstrated by the TCNS project, data management is crucial to the success of a monitoring program. All data should be reviewed frequently and should be stored in a central project file for efficient integration and subsequent evaluation of hydrologic and water quality variables.

Lab and field quality assurance and quality control programs that include data evaluation and verification for precision and accuracy are elements critical in a successful monitoring program.

Flow data should be collected to establish relationship between changes in nutrient concentrations and changes in flow. Some storm event monitoring may be useful to establish this relationship.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

The TCNS project's tracking of BMP implementation by practice and subwatershed allowed the project to link the water quality and land treatment data bases on a drainage and annual basis. This contributed to the project's ability to document changes in water quality as a result of land treatment on both subwatershed and project levels.

The project achieved a high level of BMP implementation, primarily between 1985 and 1987. This allowed for a baseline or pre-BMP period of four to six years. Combined with a high level of land treatment, this type of monitoring increased the ability of documenting BMP effectiveness.

The fact that total phosphorus concentrations continue to decrease as the length of the post-BMP data base increases, supports the argument that the BMPs were effective in reducing TP concentrations. Consistent improving trends over time support the evidence that changes in water quality were attributed to BMPs.

Subwatersheds with a large amount of BMP implementation such as Mosquito Creek and Nubbin Slough have shown significant decreases in total phosphorus concentrations. In contrast, in northwest Taylor Creek and Lettuce Creek sub watersheds, increased cattle densities have had a negative effect on water quality (Ritter and Flaig, 1987; Flaig and Ritter, 1989). Detection of predicted water quality trends and patterns over multiple water quality monitoring stations and drainage areas improves the documentation that the changes in water quality were attributed to the BMPs.

Due to the high degree of variability in the water quality monitoring data and the limited number of monitoring stations, positive changes in water quality cannot be attributed to any one BMP, but can be attributed to a cumulative impact of BMPs implemented in a given watershed or subwatershed.

Fencing cows out of streams is an example of a passive BMP. External factors, such as increased cow numbers, changes in fertilizer applications, and nonpoint sources of runoff from high intensity grazing pastures, seem to mask the short-term effect of fencing.

4.2.7.1 Findings and Successes (continued)

Other factors that confound the interpretation of water quality trend results include variations in rainfall, water quality depth, pollutant concentrations upstream of BMP implementation, soil types, and cow numbers. Changes in ground water table depth and cow numbers were the most important non-RCWP factors affecting phosphorus concentrations. Ground water table depth is thought by the project to be a surrogate for the project area hydrology and season. In addition, a high water table contributes to increased phosphorus concentrations in the tributaries. Increases in cow numbers increases the potential source of phosphorus. Adjustments for these variables have allowed for valid interpretations regarding the observed trends, and have also increased the statistical significance of the decreasing trends (Spooner et al., 1990).

The project team believes that observed decreases on TP concentrations at the watershed outlet to Lake Okeechobee can be attributed to several BMPs such as fencing, water conservation/waste water recycling, drainage improvement, and fertilizer management.

The shutdown of dairy operations is a major factor contributing to significant downward water quality trends. These dairies were a high priority for needing improvements in waste management. Such closures have resulted in a masking effect, making it difficult to quantify the impacts of other BMPs located in the same subwatershed.

4.2.7.2 Recommendations

As this project has demonstrated, several years of pre- and post- BMP monitoring are required to document a consistent trend in water quality and quantify the impact of the BMPs.

Site specific monitoring can enhance the ability of a project to document BMP effectiveness.

Factors that could confound the interpretation of water quality trend results (such as rainfall, water quality depth, soil types, and changes in cow numbers) should be measured. These measurements should be matched on a temporal and spatial scale to water quality and land treatment data to ensure valid interpretations regarding trends in water quality.

BMP implementation and water quality monitoring need to be conducted on similar spatial (i.e., drainage) and temporal scales so that the two data bases can be linked.

Sophisticated data management and integration of all water quality and land treatment / land use variables into a GIS would be useful in future water quality projects.

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1981 - 1991

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Streams, canals, Lake Okeechobee

4.3.2.1.2 Water Uses and Impairments

Lake Okeechobee is a class I water resource covering 480,000 acres. Lake Okeechobee is the primary source of public drinking water for five towns around the lake and the secondary source for the lower east coast of Florida from West Palm Beach to Miami. Water from the lake is also used to irrigate about 500,000 acres of vegetable crops, row crops, sugar cane, and pasture south of the lake. The lake is part of a water management system providing flood protection.

The lake supports commercial fishing, valued at $6.3 million annually; sport fishing, valued at $2.2 million annually (Bell, 1987); a significant tourist industry; and habitat for many migratory as well as endemic bird species.

High phosphorus (P) concentrations in Lake Okeechobee promote eutrophic conditions that promote algae blooms, with associated low dissolved oxygen levels, and impair all water uses.

4.3.2.1.3 Water Quality Problem Statement

The Taylor Creek - Nubbin Slough Basin contributes a disproportionate amount of phosphorus to Lake Okeechobee (~ 28% of the external P load in only 4% of inflowing water to the lake) (Federico et al., 1981).

Dairy and beef agricultural activities are the primary sources of P in the watershed (Allen et al., 1982). The main sources of high phosphorus loads are runoff from dairy barns and holding areas, cattle lounging in and around streams, and runoff from improved pastures (Allen et al., 1982; Stanley et al., 1986). Streambank erosion from animals lounging in the stream is also thought to be significant.

Phosphorus concentrations in the runoff is high because the soils are sandy Spodosols which have low phosphorus retention capacity and rainfall is in excess of evapotranspiration. The water table is usually high, and standing water occurs in low areas during the rainy season, June to October. Total phosphorus concentration in the tributaries are related to the water table depth and antecedent precipitation (Ritter and Flaig, 1987). Because the land is flat and poorly drained, most of the runoff occurs when the ground water table is close to the surface. Therefore, as suspected, total phosphorus concentrations in the tributaries increases as the water table depth rises to within two feet of the surface.

4.3.2.1.4 Water Quality Objectives and Goals

Objective: Measure the success of implementing the selected BMPs in the project area

Goals: Reduce phosphorus and nitrogen concentrations to Lake Okeechobee by at least 50% by 1992 measured at the watershed outlet, S-191

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 120,000 acres
Project Area: 120,000 acres
Critical Area: 63,109 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 50.0 inches (70-80% occurs from June through October)

Geologic Factors: Topography is relatively flat with an elevation range of about 50 feet. Soils are coarse textured, mostly poorly drained with rapid surface permeability and moderate internal drainage. An organic hard pan underlies most of the area, typically within a depth of 30-50 inches from the surface.

Hydrologic Factors: The water table is very shallow. Seasonal ground water fluctuations are closely related to rainfall amount and intensity. Water flow from the basin tributaries enters Lake Okeechobee through a flow control structure, S-191.

4.3.2.2.3 Project Area Agriculture

Land use in the watershed is primarily agricultural. Major land use consists of intensive dairy farming, followed by beef cattle which graze on improved pastures that are surface drained (ditched) and fertilized to improve runoff during the wet season. Citrus groves occupy approximately 1,400 acres and require extensive drainage and irrigation.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland (primarily citrus groves)	2	1.8
Pasture/range		
Dairy	30	50.5
Beef	45	47.7
Woodland (and wet prairies)	18	-
Urban/roads	5	-
Other	-	-

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	24*	37,166*	52,032*
Beef	56	25,000	25,000

* Numbers of cows in 1980. Cow numbers varied by year and subwatershed. The cow numbers generally increased during the project period (1980-90), except during 1983. For example, in 1988, there were 44,365 dairy cows (Stanley and Gunsalus, 1991, p. 52). By 1990 the number of dairies had decreased to 22. In 1991, four additional dairies took advantage of the State Buy-out Programs, with a resulting decrease in cow numbers.

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	957,440	310,119	448,920	0	1,716,479
Info. & Ed.	13,000	0	0	66,044*	79,044
Tech. Asst.	404,952	12,000	0	15,908**	432,860
Water Quality Monitoring	0	0	0	400,000***	400,000
SUM	1,375,392	322,119	448,920	481,952	$2,628,383

* CES ** SCS, state of Florida funds ***SFWMD (probably a conservative estimate)

Source: Stanley et al., 1991

4.3.4 Information and Education

4.3.4.1 Strategy

The Cooperative Extension Service (CES) took the lead role in information and education activities. ASCS, SCS, and the SFWMD also played key roles in the I&E effort.

4.3.4.2 Objectives and Goals

Goals: Inform all farmers located in the project area of their eligibility and obligations to receive federal assistance under the RCWP

Publicize the goals and benefits to be gained from the RCWP to the public

Keep farmers and public informed of the progress being made during the project towards meeting water quality benefits and goals

4.3.4.3 Program Components

Field days, tours, news articles and releases, TV coverage and material for handouts

A 1986 field day, with participation from many different agencies, landowners, public officials, and public groups

Field studies and develop management plans

4.3.5 Producer Participation

4.3.5.1 Level of Participation

This project has a high level of BMP implementation, most of which occurred in 1985 to 1987. Contracts were written for 54,709 acres or 87% of the critical area. All critical dairies are under contract. 99% of contracted practices are installed.

4.3.5.2 Incentives to Participation

Cost Share Rates: (federal) 75% for structural BMPs

Supplemental state funds for cost sharing BMPs in some areas to raise cost share to 100%

Payment Limitation: (federal RCWP) $50,000 per landowner

Assistance Programs: Technical assistance for all contracted BMPs

Regulations: A DER rule has been implemented which requires dairies whose drainage reach Lake Okeechobee to address areas of high cattle intensity on their farms. It has been estimated that on the larger farms it would cost up to $450,000 per barn to comply with this rule.

The two most important reason farmers decided to participate was availability of cost share funds (federal and state) and concern about future pollution regulations. Increased farm production was given by producers as the second most important reason.

4.3.5.3 Barriers to Participation

Some producers took advantage of the federal and state dairy buy-out programs

Lack of perception that the producer was causing a water quality problem

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Excellent for most BMPs

BMPs that were most likely to be discontinued after contract expired included: shade structures (BMP10), diversions, and fences.

BMPs that are most likely not to be maintained after contracts expire included: rotational grazing, shade structures, diversions, and fences.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The nonpoint source management strategy was to decrease the contribution of phosphorus to the lake from pastures located on poorly drained, sandy flatwood (coastal) plain soils that are heavily grazed by dairy cows and beef cattle.

The general treatment strategy was to install BMPs that exclude dairy cows and beef cattle from waterways (such as fencing) and to control wastewater runoff from dairy barns. Fencing to keep animals out of water courses, along with providing shade and water facilities, was emphasized initially. Waste management (including reduction of commercial fertilizer), pasture and hayland management, and irrigation management BMPs were added in 1982.

Water quality modeling was used in setting quantifiable project land treatment goals. Based on a modification of the Vollenweider Model, the Lake Okeechobee Technical Advisor Committee (1986) recommended reducing all phosphorus loadings to the lake by 40% to protect long-term water quality. From a land treatment management perspective, phosphorus loadings from the TCNS basin would need to be reduced by 75 to 90% to achieve this objective. Based on this watershed reduction goal, the project refined their land treatment objectives and goals by estimating the amount, type, and location of land treatment that would be required to achieve this increased level of phosphorus reduction. Consistent with the goal of additional decreases in phosphorus export, the 1987 FDER Dairy Rule and the 1989 State of Florida Surface Water Improvement and Management (SWIM) Plan changed the focus of the water quality goals and the land treatment emphasis. The Regulation (FDER) Dairy Rule requiring each dairy to collect the runoff from high intensity areas and treat the P through spray irrigation, so that all the P in the effluent would be assimilated by plants or absorbed by the soil (mass balance concept).

4.3.6.2 Objectives and Goals

Contract at least 75% of the critical area (47,331 acres) for BMP implementation

Contract with all 24 dairy farms in the project area

4.3.6.3 Critical Area Criteria and Application

Criteria:

All dairy farms in the project area

All beef cattle pastures that have been fertilized and extensively ditched for improved drainage

All agricultural areas within one-quarter mile of major streams, ditches, and channels that hold water year-round

4.3.6.4 Best Management Practices Used

General Scheme: The emphasis of BMP contracts is on stream protection, reduction of barn waste by improving water use efficiency and improving effluent disposal with spray irrigation, animal waste management systems (at the holding areas near the milking barns), and grazing land protection (i.e., RCWP BMPs 1, 2, 6, and 10).

BMPs Utilized in the Project*:

Permanent vegetative cover (BMP 1)

Animal waste management system (BMP 2), added in 1982

Diversion system (BMP 5)

Grazing land protection system (BMP 6)

Cropland Protection System (BMP 8)

Stream protection system (BMP 10)

Permanent vegetative cover on critical areas (BMP 11)

Sediment retention, erosion, or water control structures (BMP 12)

Improving irrigation system and / or water management system (BMP 13)

*Please refer to Appendix I for description/purpose of BMPs

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

Cost shared BMPs were monitored in terms of units installed and acres served. A summary of acres served for each subwatershed and year, by each BMP component and by installed (structural) BMP systems and management BMP systems was calculated. This information was provided on a subwatershed and annual basis in each annual progress project. Cow numbers per subwatershed, per water quality monitoring station, and per year were also estimated by a joint effort between the SFWMD and ASCS.

Non-cost shared BMPs were also included in the contracts so they could be tracked for implementation and costs.

4.3.6.5.2 Data Management

ASCS maintained the land treatment records and prepared reports.

4.3.6.5.3 Data Analysis and Results

Quantified Project Achievements:

Pollutant Source	Units	Critical Area Total	Critical Area % Implemented	Treatment Goals Total	Treatment Goals % Implemented
Cropland	acres	63,109	86%	47,337	114%
Dairies	#farms	22*	100%	22	100%
Cattle	#farms	35	74%	31	84%
Hogs	#farms	2	50%	2	50%
Contracts	#	56	82%	51	90%

* The number of dairies decreased from 24 in 1980.

Source: Stanley and Gunsalus, 1991

Most land treatment goals were met or exceeded. Two beef cattle operations in the critical area declined to sign contracts.

Fencing to keep animals out of the water courses, along with providing shade and water facilities, was effective in reducing the phosphorus concentrations from the project area. However, these BMPs alone were probably not sufficient to meet the water quality goal of a 50% reduction.

BMPs that require more active management, such as dairy waste water utilization, reduction, and timing of fertilizer applications on dairy and beef operations and controlling the release of high intensity area runoff, seemed to have the greatest impact on water quality.

The project found that explicit guidance for animal waste management practices needed to be written into the contracts to ensure that both the management and structural components of these systems were operated and maintained according to specifications.

Adoption of BMPs, such as improved fertilizer and feeding practices, was observed in surrounding areas.

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The water quality monitoring network emphasis was to measure phosphorus reductions over time and associate these changes with BMP implementation. Monitoring was performed before, during, and after BMP implementation. Stations were located in tributaries downstream of BMP implementation and at the project area outlet to document improvements on a subwatershed and project level scale. "Upstream/downstream" station pairs were established in a few tributaries. In 1988, the network was enhanced with monitoring site-specific BMP effectiveness on each dairy. This modification was a result of the FDER Dairy Rule.

The monitoring was performed by the South Florida Water Management District (SFWMD), Okeechobee, Florida. From 1978 to 1981, ARS collected biweekly baseline data, increasing the length of the pre-BMP data base.

4.3.7.2 Objectives and Goals

Objectives:

Evaluate the effectiveness of agricultural BMPs for reducing P concentrations to Lake Okeechobee, as measured by changes in water quality concentrations in the tributaries and basin outlet

Goals:

Identify and quantify trends in pollutant concentrations that occurred due to changes in land use and/or implementation of BMPs

Identify differences in upstream and downstream nutrient concentrations within the major tributaries

Establish nutrient inputs from subtributaries and to Lake Okeechobee

Using the pre-RCWP water quality monitoring data base: 1) document the general water quality throughout the 9 major tributaries in the basin; 2) provide a means for identifying the sources and causes of high episodic P events; and 3) document the need for agricultural BMPs to control P runoff (Ritter, 1988)

Analyze waste water in anaerobic and aerobic lagoons to determine its value for use as a supplemental fertilizer and treatment efficiency

Monitor nutrient runoff from the holding areas around barns into existing ditches that eventually drain into the major tributaries

4.3.7.3 Time Frame

1981 to 1990. Most stations have been monitored for water quality since 1978 and some since the early 1970's. Monitoring is planned to continue after 1990 to support other watershed management programs.

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

Surface: 38 stations originally; 23 instream stations throughout the 9 major tributaries continued after 1984. 3 stations located at dairy waste lagoons. From August, 1988 the monitoring network was expanded to 53 instream grab sample stations including 34 automatic sites to meet non- RCWP regulatory requirements. "Upstream/downstream" station pairs were established in a few tributaries to adjust for pollutant concentrations originating above the BMP implementation sites.

4.3.7.4.2 Sample Type

Grab and automatic sampler

4.3.7.4.3 Sampling Frequency

Surface grab sample sites: until Mid-1988 - biweekly; afterwards - weekly

Surface automatic sample sites: daily

Ground water table depth: weekly at 8 stations; hourly at 4 other stations

Lagoon systems: monthly

4.3.7.4.4 Variables Analyzed

Total phosphorus (TP), orthophosphate-P (OP), Nitrate- nitrogen (NO_3), nitrite-N (NO_2), ammonia-N (NH_3-N), total Kjeldahl-N (TKN), lab pH, lab specific conductivity, chlorides, turbidity, and color

4.3.7.4.5 Flow Measurement

Staff heights for flow have been taken with grab samples at five stations since 1978 and at remaining stations since 1983.

4.3.7.4.6 Meteorologic Measurements

Precipitation and hourly ground water table levels were monitored at four sites in close proximity to stations 01, 03, 06, 09, 11, and 23. Four additional ground water and rainfall sites were installed in the late 1980's.

Temperature and evaporation were also measured.

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

None

4.3.7.5 Data Management

All chemical data are stored locally by the SFWMD. In 1991, the PC-based lotus files were converted to a mainframe ORACLE data base.

The trend analyses for pollutant concentrations were summarized in Ritter and Flaig (1987) and Flaig and Ritter (1989).

The hourly ground water table depth and daily precipitation measurements are stored on a mainframe data base by the USDA-ARS Southeast Watershed Research Laboratory at Tifton, Georgia. A copy is also stored on the SFWMD ORACLE data base system at West Palm Beach, Florida.

4.3.7.6 Data Analysis and Results

Analysis:

Exploratory data analysis included: 1) tabular presentation of the annual means and standard deviations for water quality concentrations at each station and 2) time plots of the entire period of record with pre- , transitional-, and post-BMP periods indicated.

Water quality trend detection techniques include: 1) the nonparametric Seasonal Kendall Tau test to detect linear trends over time; 2) linear regression to detect linear trends over time; 3) double mass curves to compare phosphorus concentrations and cow numbers in each subwatershed over time to account for changes in P concentrations after accounting for changes in cow numbers; 4) linear regression with time series errors to detect trends and adjustments for explanatory variables such as upstream concentrations, precipitation, ground water table depth, and autocorrelation.

Examination of the measured variability in the water quality data is used to determine the amount of change in annual mean concentrations required to be statistically significant (minimum detectable change) (Spooner et al., 1990).

Water quality modeling is being used to develop a watershed phosphorus transport model.

4.3.7.6 Data Analysis and Results (continued)

Results:

Seven out of 14 water quality monitoring stations tested by Ritter and Flaig (1987) exhibited significant decreasing trends over the period of 1978 through October, 1986.

Subsequent trend analysis using the period of data between 1978 though 1989 (adding data from 1987-1989) indicates that an increased number of stations exhibit significant decrease in TP concentrations and that the magnitude of decreasing TP concentrations had increased (Flaig and Ritter, 1989).

There has been an overall decrease in TP concentrations at station S-191, despite a substantial increase in cow numbers. The project has exceeded its goal of a 50% reduction in TP concentrations. It is postulated that this decrease is largely a function of the dairy closures in Otter Creek and the high number of BMPs installed in the other subwatersheds such as the Mosquito Creek and Nubbin Slough subwatersheds (Ritter and Flaig, 1987; Stanley et al., 1988). The closed dairies were thought to have been poorly managed, explaining the significant impact of their closure.

The project team realizes that uncontrollable variables such as weather, changes in land use, and changes in management, greatly affect the water quality data and make it difficult to isolate the effects of BMPs. This fact increases the need for a long post-BMP implementation monitoring period (Stanley et al., 1988). Variations in rainfall, depth to ground water, and flow must be considered when evaluating changes in land use and BMPs and their impact on water quality (Ritter, 1988).

4.3.8 Linkage of Land Treatment and Water Quality

Heatwole et al. (1987) used the BASIN model to give an estimate of the expected long-term average annual response of the Taylor Creek - Nubbin Slough basin to a hypothetical "maximum" BMP scenario. They predicted reductions of about 50% in the annual phosphorus loads from this basin.

The TCNS project's tracking of BMP implementation by practice and subwatershed allowed the project to link the water quality and land treatment data bases on a drainage and annual basis. This contributed to the project's ability to document changes in water quality as a result of land treatment on both subwatershed and project levels.

Site-specific monitoring was found to enhance the ability to document BMP effectiveness.

The fact TP concentrations continue to decrease as the length of the post-BMP data base increases supports the argument that the BMPs were effective in reducing TP concentrations.

Subwatersheds with a large amount of BMP implementation such as Mosquito Creek and Nubbin Slough have shown significant decreases in TP concentrations. In contrast, in northwest Taylor Creek and Lettuce Creek subwatersheds, increased cattle densities have had a negative effect on water quality (Ritter and Flaig, 1987; Flaig and Ritter, 1989).

There is strong evidence that two dairy closures in the Otter Creek subwatershed (in 1980 and 1986) resulted in a decrease in TP concentrations in Otter Creek and at Station S-191 (the main discharge to Lake Okeechobee from the project area). The effect of these closures was so large in part because of their poor waste management. These dairy shutdowns resulted in a masking effect, making it difficult to evaluate impacts of BMP implemented along this tributary (Ritter, 1988).

Other factors that confound the interpretation of water quality trend results include variations in rainfall, water quality depth, pollutant concentrations upstream of BMP implementation, soil types, and cow numbers. Changes in ground water table depth and cow numbers were the most important, non-RCWP factors affecting phosphorus concentrations. Ground water table depth is thought by the project to be a surrogate for the project area hydrology and season. In addition, a high water table contributes to increased phosphorus concentrations in the tributaries. Increases in cow numbers increases the potential source of phosphorus. Adjustments for these variables have not only allowed for valid interpretations regarding the observed trends, but have also increased the statistical significance of the decreasing trends (Spooner et al., 1990).

4.3.8 Linkage of Land Treatment and Water Quality (continued)

The project team believes that observed decreases on TP concentrations at the watershed outlet to Lake Okeechobee can be attributed to several BMPs such as fencing, water conservation/waste water recycling, drainage improvement, and fertilizer management.

Documentation of water quality improvements in Lake Okeechobee may be difficult in the short term. Canfield and Hoyer (1988) suggests that a 40% reduction in phosphorus loadings to the lake may have only a minor impact on the short-term water quality (as reflected by the phosphorus concentration), because the lake has a substantial phosphorus reserve. However, although changes in Lake Okeechobee's phosphorus impairment may be undetectable over a short period, monitoring external concentrations and loadings provides valuable information to use to project long-term effects from land treatment in surrounding watersheds.

4.3.9 Impact of Other Federal and State Programs on the Project

One dairy in the Otter Creek subwatershed participated in the Dairy Termination Program in 1986. Several dairies reduced their cow numbers in 1984 and 1985 by participating in the Federal Milk Diversion Program. A reduction in cow numbers usually resulted in a decrease in P entering the adjacent tributary.

In 1989 and 1990, three dairies participated in the Florida state buy-out program and ceased operation.

The 1987 FDER Dairy Rule and the 1989 State of Florida Surface Water Improvement and Management (SWIM) Plan changed the focus of the water quality goals and the associated land treatment emphasis. The Regulation (FDER) Dairy Rule requiring each dairy perform nutrient management such that minimum phosphorus left the operation. In 1989, the South Florida Water Management District (SFWMD) set standards for P concentrations at tributary discharges and the basin outlet (at S-191) to meet the requirements of the SWIM Plan.

4.3.10 Other Pertinent Information

A new dairy opened in 1986 in the Otter Creek subwatershed.

4.3.11 References

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

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4.3.12 Project Contacts

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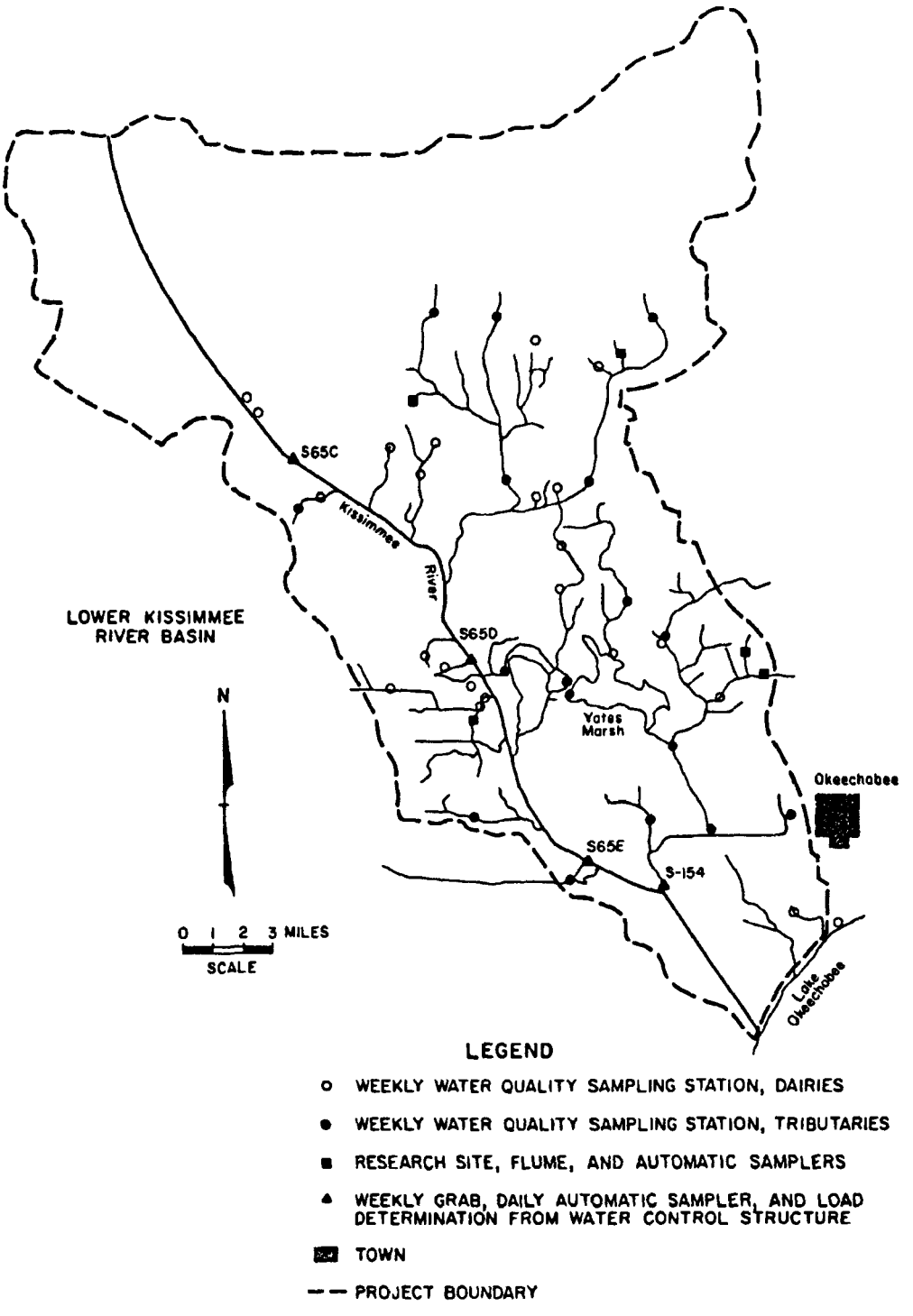
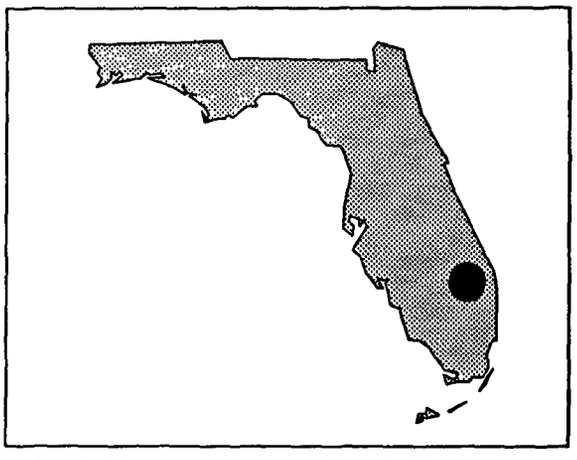


Figure 4.4: Lower Kissimmee River (Florida) RCWP project map, FL-2.

Florida
Lower Kissimmee River

(RCWP 14 A)



Okeechobee, Highlands, and Glades Counties
MLRA: U-156A
HUC:030901-02

4.1 Project Synopsis

In 1988, the Taylor Creek-Nubbin Slough (TCNS) RCWP project was expanded to include the Lower Kissimmee River Basin (LKR). The Lower Kissimmee River Basin is located in southern Florida west and adjacent to the TCNS Basin. Water flow from the LKR and its tributaries enters Lake Okeechobee through two flow control structures (S154 and S65E). The 223,700-acre watershed is a typically flat landscape with poorly drained soils having low phosphorus retention capacity.

Lake Okeechobee provides drinking and irrigation water, supports commercial and sport fishing, and is a habitat for many migratory and endemic bird species. High phosphorus (P) concentrations in Lake Okeechobee promote algal blooms and eutrophic conditions that impair all water uses.

The Lower Kissimmee River Basin is the second largest source of external phosphorus loading to Lake Okeechobee, delivering 20% of the total phosphorus (TP) and 25% of the total nitrogen in 31% of the inflow to the lake. The project seeks to reduce phosphorus loadings to Lake Okeechobee by 43%, as measured at the watershed outlets (S65E and S154).

Over 95% of the land use in the watershed is agricultural. Dairy and beef operations are the primary sources of phosphorus. Runoff from dairy holding areas and milking barns, direct stream access by large numbers of dairy cattle, and runoff from improved pastures are the main contributors. Most of the beef cattle pastures have been fertilized and surface drained to improve drainage during the wet season. The critical area covers 15,500 acres and includes all dairies in the project area. In 1988 there were 19 milking barns with approximately 12,655 milking cows in the project area. The number of milking barns decreased to 11 in 1992; however, the number of milking cows remained in excess of 10,000.

Regulation has played a major role in defining land treatment and water quality goals. The best management practices (BMPs) implemented through the RCWP project are directed toward recycling nutrients produced on the farm to comply with the 1987 Florida Department of Environmental Regulation (FDER) Dairy Rule. This rule requires dairies to collect and then dispose of runoff from milking barns and high animal intensity areas through spray irrigation, so that the phosphorus in the effluent is assimilated by plants or absorbed by soil. In addition, in 1989, the South Florida Water Management District (SFWMD) set standards for TP concentrations at tributary discharges and the basin outlet to meet the requirements of the 1987 Florida Surface Water Improvement Management Act (SWIM-Act).

The RCWP BMP emphasis includes animal waste management, diversion systems to capture effluent from milking barns, stream protection, fertilizer management, grazing land protection, permanent vegetative cover, and pesticide management.

4.1 Project Synopsis (continued)

The Lower Kissimmee River RCWP project has an extensive water quality monitoring program. Baseline water quality data have been collected since 1986. Since 1987, a combination of instream and BMP site-specific water quality monitoring stations have been employed to document long-term trends and the effectiveness of implementing a set of intensive animal waste management BMPs, combined with removing cows from the streams. Grab and time-weighted proportional samples were taken from major tributaries, water control structures, and at the major outflow of each dairy. The weekly grab samples are utilized to document long-term trends; the automated samples are utilized to quantify loads and determine the efficiency of individual management practices.

Beginning in October, 1991, the dairy monitoring program was streamlined to better support the FDER Dairy Rule. Monitoring of all dairy offsite discharges continues with grab samples taken two times per month.

By September, 1990, approximately 97% of the critical area was under contract and BMPs were 45% implemented. As of April, 1992, implementation of BMPs was complete on 100% of critical area, including all dairies. Cost share was available under RCWP and other federal and state programs.

The project did not start BMP implementation until 1988; therefore, changes in phosphorus loadings to Lake Okeechobee have not been quantified. However, BMPs appear to be improving water quality at individual dairies within a year after implementation. Preliminary results indicate that a reduction in TP has occurred on at least 80% of the dairies that have implemented BMPs.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 *Findings and Successes*

The goals and objectives were refined from the experience of the RCWP effort in the Taylor Creek - Nubbin Slough Basin and from recent state regulations.

State regulations were used to establish both the land treatment and the water quality goals. The 1987 Florida Department of Environmental Regulation Dairy Rule requires dairies to collect and dispose of runoff from high animal intensity areas through spray irrigation, so that most of the phosphorus in the effluent is assimilated by plants or absorbed by soil (nutrient mass balance concept). In addition, in 1989, the SFWMD set standards for TP concentrations at tributary discharges, the basin outlet, and various land uses, to meet the requirements of the SWIM-Act. The project calculated its goal to reduce phosphorus and nitrogen loadings by 43% at the LKR Basin outlet by applying the basin discharge concentration standard required by the SWIM-Act (0.18 milligram P per liter, mg P/l) concentration at the watershed outlet to Lake Okeechobee.

From the experience in the TCNS Basin, intensive waste management BMPs, along with fencing to remove cows from the stream, were thought to be required to meet the water quality goals.

4.2.1.2 Recommendations

None

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

The Lower Kissimmee River Basin portion of the Florida RCWP is administered as an expansion to the Taylor Creek - Nubbin Slough Basin RCWP project by the local Agricultural Stabilization Conservation Service (ASCS), in consultation with Soil Conservation Service (SCS), Cooperative Extension Service (CES), and the SFWMD.

4.2.2.2 Recommendations

None

4.2.3 Information and Education

4.2.3.1 Findings and Successes

Close cooperation among the four local key agencies (ASCS, SCS, CES, and SFWMD) has contributed to the success of the information and education (I&E) program.

4.2.3.2 Recommendations

None

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

The majority of landowners are aware of the water quality problems and plan to participate in the RCWP.

The two most important reason farmers decided to participate is the availability of cost share funds (federal and state) and concern about meeting pollution regulations. Technical assistance was also important.

4.2.4.2 Recommendations

None

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

There is a high level of BMP implementation on the dairy farms, most of which occurred after 1988. As of April, 1992, implementation of BMPs was complete on 100% of critical area, including all dairies. By September, 1990, approximately 97% of the critical area was under contract and BMPs were 45% implemented. Not all the contacts are under the RCWP. RCWP contracts cover 57% of the critical acres. The rest are cost shared under state programs or the federal Long Term Agreement (LTA) Program with ASCS's Agricultural Conservation Program (ACP) funds.

Regulation has played the major role in defining land treatment. The BMPs implemented through the RCWP project are directed toward recycling most of the nutrients produced on the farm to comply with the 1987 FDER Dairy Rule. This rule requires dairies to collect and dispose of runoff from high animal intensity areas through spray irrigation, so that phosphorus in the effluent is assimilated by plants or absorbed by soil (nutrient mass balance concept). In addition, in 1989, the SFWMD set standards for TP concentrations at tributary discharges and the basin outlet to meet the requirements of the SWIM-Act.

To meet the objective of substantial decreases in P loadings at the watershed outlet, the BMPs recommended by LOTAC (1986) were more intensive than those used in the Taylor Creek - Nubbin Slough Basin. The emphasis was on a set of expensive animal waste management BMPs to achieve nutrient mass balance, combined with removing cows from the streams.

Using the lessons learned from Taylor Creek - Nubbin Slough, priority of BMP components and implementation is based on expected water quality benefits.

4.2.5.1 Findings and Successes (continued)

Based on the Taylor Creek - Nubbin Slough portion of the project and other studies, the planned land treatment program, although costly, is thought to the be most cost effective method to achieve the desired P reduction. Alternatives for nutrient reduction, such as treatment plants, relocation of dairies, and total confinement operations are considered more costly.

4.2.5.2 Recommendations

Practices with the greatest water quality benefits should be prioritized and implemented first.

Close coordination between the project and regulatory agencies is needed in selecting and implementing BMPs.

Animal waste management and fertilizer management should be used as a complementary set of BMPs.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

The LKR project has an extensive water quality monitoring program. Baseline water quality data has been collected since 1986. Since 1987, a combination of instream and BMP site-specific water quality monitoring stations have been employed to document long-term trends and the effectiveness of implementing a set of intensive animal waste management BMPs, combined with removing cows from the streams. Grab and time-weighted proportional samples are taken on major tributaries, at water control structures, and at each of the major dairies. The weekly grab samples are utilized to document long-term trends and the automated samples are utilized to quantify loads.

Although monitoring the efficiency of individual BMPs was an original goal of the autosampling program, that goal was never realized, primarily due to the inter-relationships of the practices. For example, fencing to exclude cows from streams was implemented at the same time as fertilizer management, reduced phosphorus in the feed, and possibly portable shades or feed/water/shade in the high intensity areas around milking barns. Therefore, the monitoring program is not capable of separating the effects of the individual practices.

The project did not start BMP implementation until 1988; therefore, changes in phosphorus loadings to Lake Okeechobee have not been quantified. However, BMPs appear to be improving water quality at individual dairies within a year after implementation. Preliminary results indicate a reduction in TP has occurred on at least 80% of the dairies that have implemented BMPs.

4.2.6.2 Recommendations

Different spatial and temporal complexities (levels) of monitoring may be useful to address BMP effectiveness on a BMP site-specific location as compared to a subwatershed scale. For example, automatic samplers and load calculations may be required for site-specific BMP effectiveness monitoring.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

Site-specific water quality monitoring in this project has been able to determine farm-level BMP effectiveness.

The project is conducting a study to document the effectiveness of implementing an expensive nutrient mass balance set of animal waste and fertilizer management BMPs, combined with preventing animal access to a stream.

More efficient use of dairy waste water and effective management of waste storage lagoons has resulted in improvements at the individual dairy operations and downstream water quality.

4.2.7.2 Recommendations

Water quality analysis should adjust for variations in flow, ground water, and changes in land use such as changes in cow numbers during the project period. For example, the water table depth was a surrogate for seasonality, in addition to a high water table contributing to increased phosphorus concentrations in the tributaries. Incorporation of these variables into the analyses allowed for greater evidence that the RCWP BMPs significantly decreased the phosphorus loadings.

The use of computer models is useful to predict the fate of nutrients on a field, subwatershed, and watershed scale as well as provide a mechanism for integration of multiple environmental variables such as rainfall, water table, soils, water quality, animal units, land area, topography, cow numbers, and flow.

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP (an expansion of the Taylor Creek-Nubbin Slough RCWP project in 1988)

1988 - 1995

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Streams, canals, Lake Okeechobee

4.3.2.1.2 Water Uses and Impairments

Lake Okeechobee is a class I water resource covering 480,000 acres. The lake is the primary source of public drinking water for five towns around the lake and the secondary source for the lower east coast of Florida from West Palm Beach to Miami. Water from the lake is also used to irrigate about 500,000 acres of vegetable crops, row crops, sugar cane, and pasture south of the lake. The lake is part of a water management system providing flood protection.

The lake supports commercial fishing, valued at $6.3 million annually; sport fishing, valued at $2.2 million annually (Bell, 1987); a significant tourist industry; and habitat for many migratory as well as endemic bird species. A diverse wildlife habitat draws many tourists to the lake area.

High phosphorus (P) concentrations in Lake Okeechobee promote eutrophic conditions that promote algae blooms, with associated low dissolved oxygen levels, and impair all water uses.

4.3.2.1.3 Water Quality Problem Statement

The Lower Kissimmee River Basin is the second largest source of phosphorus (P) loading to Lake Okeechobee, delivering 20% of the total phosphorus and 25% of the total nitrogen to Lake Okeechobee with 31% of inflow to the lake (Lake Okeechobee Technical Advisory Committee, 1986).

Over 95% of the land use in the watershed is agricultural. Dairy and beef operations are the primary sources of P. Runoff from dairy holding areas, milking barns, direct stream access by large numbers of dairy cattle, and runoff from improved pastures are the main contributors. Most of the beef cattle pastures have been fertilized and surface drained to improve drainage during the wet season.

Phosphorus concentrations in runoff are high because the soils are sandy Spodosols with low phosphorus retention capacity and rainfall is in excess of evapotranspiration. Most of the P loss occurs in the dissolved phase as orthophosphate phosphorus (OP). The water table is usually high, and standing water occurs in low areas during the rainy season, June to October. Total phosphorus concentration in the tributaries are related to the water table depth and antecedent precipitation (Ritter and Flaig, 1987). Because the land is flat and poorly drained, most of the runoff occurs when the ground water table is close to the surface. Therefore, total phosphorus concentrations in the tributaries increases as the water table depth rises to within two feet of the surface.

4.3.2.1.4 Water Quality Objectives and Goals

The project seeks to reduce phosphorus loadings to Lake Okeechobee by 43%, measured at the watershed outlets (Flaig and Ritter, 1989).

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 223,700 acres
Project Area: 223,700 acres
Critical Area: 15,500 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 50.0 inches (primarily from June to October)

Geologic Factors: Topography is relatively flat with an elevation range of about 40 feet (17 to 58 feet above mean sea level). Soils are coarse textured, mostly poorly drained with rapid surface permeability and moderate internal drainage. An organic hard pan underlies most of the area, typically within a depth of 30-50 inches from the surface.

Hydrologic Factors: The water table is very shallow. Seasonal ground water fluctuations are closely related to rainfall amount and intensity. In upland areas, the water table seasonally fluctuates from ground surface to three to five feet. In undrained flood plains and low-lying flood prone areas, the water table is above ground surface or very near the surface most of the year. Much of the watershed has been extensively drained for control of high water tables.

The Lower Kissimmee River is channelized (sometimes referred to as Canal 38) with flow control structures such as S-65C, S-65D, and S-65E. Water flow from the Lower Kissimmee River Basin and its tributaries enters Lake Okeechobee through flow control structures S-65E and S-154.

4.3.2.2.3 Project Area Agriculture

There are approximately 175 farms in the project area, mostly beef and dairy. The average size of the farms is 1278 acres.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland (mostly citrus groves)	0.1	-
Pasture/range		
Dairy (milk barns/pasture)	7	100
Beef grazing	91	-
Woodland (and wet prairies)	1	-
Urban/roads	1	-
Other	-	-

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy*	15	18,000	25,200
Beef	155	68,500	68,500

* 1988 numbers (12,655 of the dairy animals were milking cows, the remaining were primarily dry cows and springers). In 1988, there were 19 milking barns. From May, 1989 to August, 1992, 7 milking barns chose to take advantage of the State Buy-out and closed. In January, 1992, another milking barn removed its cows due to participation in the Florida Save Our Rivers Program. In May of 1992, there were an estimated 10,930 milking cows (plus non-milking cows) and 11 milking barns in the LKR Basin.

4.3.3 Total Project Budget

SOURCES / ACTIVITY	Federal	State	Farmer	Other	SUM
Cost Share	835,840	2,570,000	601,030	0	4,006,870
Info. & Ed.	110,000	0	0	0	110,000
Tech. Asst.	504,000	113,000	0	0	617,000
Water Quality Monitoring	0	1,167,422	0	0	1,167,422**
SUM	1,449,840*	3,850,422	601,030	0	$5,901,292

* $1,249,840 of this is RCWP funds; $200,000 in ACP funds were available for cost share to the dairies under the LTA program.

** Water quality monitoring budget only reflects FY87 - FY91 expenditures.

Source: Stanley and Gunsalus (1991) and personal communication, SFWMD staff

4.3.4 Information and Education

4.3.4.1 Strategy

Intensify the ongoing I&E effort currently in effect in the Taylor Creek - Nubbin Slough Basin project. CES is taking the lead role in information and education activities. ASCS, SCS, and the SFWMD also are playing key roles.

4.3.4.2 Objectives and Goals

Make landowners aware of the water quality problem and funding from the RCWP and the state

Keep farmers and public informed of the progress being made during the project towards realizing water quality benefits and goals

4.3.4.3 Program Components

Similar to I&E efforts under the RCWP in the Taylor Creek - Nubbin Slough Basin with:

Field days, tours, news articles

Field studies and development of management plans

4.3.5 Producer Participation

4.3.5.1 Level of Participation

There is a high level of BMP implementation on the dairy farms, most of which occurred after 1988. As of April, 1992, implementation of BMPs was complete on 100% of critical area, including all dairies. By September, 1990, approximately 97% of the critical area was under contract and BMPs were 45% implemented. Not all the contacts are under the RCWP. RCWP contracts cover 57% of the critical acres. The rest are cost shared under state programs or the LTA Program with federal ACP funds.

4.3.5.2 Incentives to Participation

RCWP cost share rate of 75% for structural BMPs

Supplemental federal funds under the LTA and from state funds

RCWP payment limit of $50,000 per landowner

Technical assistance for all contracted BMPs

Regulations: A FDER rule has been implemented which requires dairies whose drainage reach Lake Okeechobee to address areas of high cattle intensity on their farms. It was estimated that the average cost will be $238,000 per barn to comply with this rule. The actual costs were as much as two to three times this estimate.

The two most important reason farmers decided to participate was availability of cost share funds (federal and state) and concern about pollution regulations.

4.3.5.3 Barriers to Participation

High cost of BMPs

The $50,000 per farm cost share limit under RCWP has been a constraint to addressing the waste disposal problems of these dairies.

Implementing the nutrient mass balance concept at the farm level required innovative management strategies on the dairies that were expensive and required major management changes.

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Presently unknown, since the project is ongoing. The FDER Rule requires the continued operation and maintenance of the BMPs.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

Areas with high animal concentrations are targeted for priority treatment. BMPs are directed toward recycling nutrients produced on farm to comply with the FDER Dairy Rule requiring collection of runoff from high intensity areas and treatment of phosphorus (P) through spray irrigation, so that it assimilated by plants or absorbed by soil (nutrient mass balance).

4.3.6.2 Objectives and Goals

Objectives: Keep the nutrients on the farm and employ the nutrient mass balance concept

Goals: Contract 100% of the critical area

Contract all 15 dairy farms with their 19 milking barns in the project area
This objective was modified to include only the 11 milking barns in the project area that did not cease operation as a result of the buyout programs.
Implement BMPs over a three-year period

4.3.6.3 Critical Area Criteria and Application

Criteria: All dairy farms in the project area

4.3.6.4 Best Management Practices Used

Emphasis of BMP contracts is on stream protection, reduction of barn waste by improving water use efficiency, and improving effluent disposal with spray irrigation, animal waste management systems, stream protection, and grazing land management. (BMP priority: 2, 5, 10, 15, 12, 6, 1, 16, and 8.) Emphasis is similar to the Taylor Creek-Nubbin Slough project, with greater emphasis on Waste Management Systems (BMP 2) to capture and recycle nutrients.

BMPs Utilized in the Project*:

Permanent vegetative cover (BMP 1)

Animal waste management system (BMP 2)
Collection and spray irrigation of waste water from milking barns and runoff from intensive holding pastures

Diversion system (BMP 5)
Diversion of runoff from holding pasture areas and milking barns to holding ponds and lagoons, respectively

Grazing land protection system (BMP 6)
Rotational grazing with water available away from streams

Cropland Protection System (BMP 8)
Proper crop rotation to utilize waste effluent

Stream protection system (BMP 10)
Fencing, portable shades, and watering facilities to keep animals away from streams and low areas; filter strips to control runoff from lower animal density pastures

Sediment retention, erosion, or water control structures (BMP 12)
Collect runoff from pastures and irrigation fields

Fertilizer Management (BMP 15)
Split applications; liming to optimize P uptake; soil testing

Pesticide Management (BMP 16)

*Please refer to Appendix I for description/purpose of BMPs

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

Cost shared BMPs are monitored in terms of units installed and acres served (see Stanley et al., 1988). A summary of acres served by each BMP component and by installed (structural) BMP systems and management BMP systems is calculated. ASCS maintains the land treatment records and prepares reports. Cow numbers per subwatershed, per water quality monitoring station and per year are also estimated by a joint effort between the SFWMD and ASCS.

Non-cost shared BMPs were also included in the contracts so they could be tracked for implementation and costs.

4.3.6.5.2 Data Management

ASCS maintains the land treatment records and prepares reports.

4.3.6.5.3 Data Analysis and Results

Quantified Project Achievements (as of 9/30/90):

		Critical Area		Treatment Goals	
Pollutant Source	Units	Total	% Implemented	Total	% Implemented
Pasture/range	acres	15,500	45%*	15,500	45%*
Dairies	#milking barns	13	NA**	14	NA**
Contracts	#	15	NA**	15	NA**

* These numbers reflect installed practices as of 9/30/90. As of this date, 97% of the critical were under contract (9 dairies had RCWP contracts on 8,883 acres or 57% of the critical area and 5 additional dairies had contracts under the LTA and/or state programs on 6,155 acres or 40% of the critical area). By December, 1991, implementation was 100% complete.

** As of 9/30/90, contracts had been made on 13 milking barns (9 under RCWP and 4 with the LTA or state programs). Implementation was in progress on 9 contracts and 1 contract was completely installed. By April, 1992, implementation was 100% complete on 11 milking barns.

Source: Stanley and Gunsalus (1991)

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

A combination of instream and BMP site-specific monitoring stations was used to determine the reduction in phosphorus concentrations as a result of implementation of BMPs. There are three sets (or levels) of water quality monitoring objectives based on three spatial and temporal levels of detail; each set has a corresponding degree of water quality monitoring complexity. Weekly grab samples allow assessment of long-term trends in the tributary and basin outlet. Automated samples are used to calculate loadings. Individual dairies are monitored with grab samples taken two times per month.

The monitoring is performed by the SFWMD, Okeechobee, Florida.

4.3.7.2 Objectives and Goals

Overall Objectives:

Identify the causes of high episodic phosphorus events in the Lower Kissimmee River Basin, specifically in the areas upstream of flow control structures S-65D and S-65E (referred to as Pool D and Pool E)

Document the effectiveness of implementing an expensive nutrient mass balance set of animal waste management BMPs combined with removing cows from streams

Level 1 - Water Quality Assessment:

Assess water quality and provide baseline stream water quality data for support of FDER's Dairy Rule.

Evaluate the effectiveness of agricultural BMPs for reducing P loads to Lake Okeechobee, as measured by changes in water quality concentrations and loads at individual dairies, selected ditched pastures, in key tributaries and basin outlets

Identify episodic high P loads and locate source areas

Level 2 - Phosphorus Assessment and Forecasting:

Quantify P loadings at key dairies, tributaries and structures on the LKR.

Estimate P load reductions resulting from implementation of BMPs

Forecast the movement of phosphorus throughout the LKR Basin, specifically, investigate P movement and retention in soil by monitoring one or more dairies and modeling P-transport.

Level 3 - Evaluation of Specific BMPs:

Determine the site-specific efficiency of specific BMPs (fencing, lagoons, spray irrigation systems) for P load attenuation.

Evaluate the efficiency and long-term effectiveness of individual BMP practices on typical soils and land drainage patterns

4.3.7.3 Time Frame

RCWP monitoring is from 1987 to 1995 for Levels 1 and 3

RCWP monitoring is from implementation date to 1995 for Level 3

Some baseline data has been collected since January 1986 at selected tributary sites

Monitoring is planned to continue after 1995 by the SFWMD

Flow control structure S-154 (on a tributary to LKR) has been monitored since 1973

Flow control structure S-65E has been monitored since 1982

Level 1 monitoring will continue to support the FDER after the RCWP project ends

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

Instream grab and automatic sampler stations

Individual dairy and beef sites with automatic and weekly grab samplers

Ground water: Ground water levels are monitored two times per month at 11 sites

4.3.7.4.2 Sample Type

Grab and event sampling (with automatic samplers)

4.3.7.4.3 Sampling Frequency

Dairy grab samples every two weeks, weekly for tributary, daily for automatic sampler samples, and one dairy spray field. In addition, continuous automated samplers collecting time-proportional water samples are used on major tributaries, at water control structures along major canals (S-65C, D, and E). Initially, automatic samplers were used at each major dairy. Sampling at the dairies was changed to weekly during the first few years and then to every two weeks in November of 1991.

4.3.7.4.4 Variables Analyzed

Total phosphorus (TP), orthophosphate-P (OP), nitrite plus nitrate-N (NO_2 + NO_3-N), ammonia-N (NH_3-N), total Kjeldahl-N (TKN), pH, conductivity, dissolved oxygen, temperature, chlorides, and color.

Dairies are monitored for TP and TKN only.

4.3.7.4.5 Flow Measurement

Stream stage (where available) and flow conditions are recorded with each water quality sample.

4.3.7.4.6 Meteorologic Measurements

Precipitation and ground water table depth are monitored at several sites within the project area.

Temperature and evaporation is also measured.

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

Surface ground water table levels are monitored at key dairies within the project area.

4.3.7.5 Data Management

All chemical data are stored locally by the SFWMD. In 1991, the PC-based lotus files were converted to a mainframe ORACLE data base.

Ground water level data are stored in a PC-based Lotus file by the SFWMD.

4.3.7.6 Data Analysis and Results

Analysis:

Exploratory data analysis includes: 1) tabular presentation of the annual means for water quality concentrations at each station and 2) time plots.

Water quality trend detection techniques includes: 1) nonparametric tests to detect linear trends over time and 2) the double mass curve method to correct the data for changes in hydrologic variation using rainfall and ground water stage data.

Water quality modeling is being used to develop a watershed phosphorus transport model.

Time series analysis will be used to examine trends (step and linear) over multiple years. Changes in ground water table depth and cow numbers will be incorporated to adjust for changes in water quality not directly related to the RCWP.

Load reductions will be estimated based on hydraulic model simulations.

Results:

The project did not start implementation until 1988; therefore, changes in phosphorus loadings to Lake Okeechobee from this watershed due to RCWP have not been quantified.

For most of the dairies, the quality of agricultural runoff from improved pastures and dairies is poor and well above the standards allowed for land uses (Flaig and Ritter, 1989).

BMPs appear to be improving water quality at individual dairies a year after implementation (Flaig and Ritter, 1989; Stanley and Gunsalus, 1991). BMPs appear to be improving water quality at individual dairies within a year after implementation. Preliminary results indicate a reduction in TP has occurred on at least 80% of the dairies that have implemented BMPs.

TP concentrations have decreased at flow control structure S- 65E during the 1980s, possibly from improvements prior to the RCWP project (Flaig and Ritter, 1989).

TP concentrations have increased dramatically over the last 15 years at flow control structure S-154, probably from increased dairy activity in the basin (Flaig and Ritter, 1989).

Phosphorus concentrations in discharges at the outlet from this project area may exceed 1.0 milligram/liter (mg/l). Baseline data are currently being evaluated.

4.3.8 Linkage of Land Treatment and Water Quality

Effectiveness of BMPs: The project is conducting a study to document the effectiveness of implementing an expensive 'nutrient mass balance' set of animal waste management BMPs combined with removing cows from a stream. Implementation was initiated in 1988 and only baseline data are available at this time. A combination of site-specific and tributary monitoring/modeling, along with simultaneous land treatment/use and ground water monitoring, should be effective in evaluating BMP effectiveness.

4.3.9 Impact of Other Federal and State Programs on the Project

The 1987 FDER Dairy Rule and the 1987 State of Florida Surface Water Improvement and Management (SWIM) Plan dictated the focus of the water quality goals and the associated land treatment emphasis for the LKR Basin. The FDER Dairy Rule required that each dairy perform nutrient management such that minimum phosphorus left the operation. In 1989, the SFWMD set standards for TP concentrations at tributary discharges and the basin outlet to meet the requirements of the SWIM Plan. The standard set for the basin discharge was TP = 0.18 mg/l. To comply with this standard, allowable discharge standards were made for runoff concentrations at various land uses (1.2 mg P/l for dairies, 0.35 mg P/l for improved pastures, heifer operations, and beef cattle; 0.18 mg P/l for native range; and 1.2 mg P/l for all other land uses). The P and N loading reduction goal of 43% from the project area to Lake Okeechobee was established by applying the basin discharge concentration standard required by the SWIM-Act to the average annual discharge for each basin (Flaig and Ritter, 1989).

Financial assistance for animal waste management systems is also available through the federal LTA and state cost share programs, in addition to the RCWP. These monies allow for a greater portion of the expensive systems to be cost shared than would be allowed under the RCWP.

State and federal dairy buy-out programs decreased the number of milking barns in the LKR Basin from 19 in 1988 to 11 in 1992. However, the number of milking cows decreased only by 14%.

4.3.10 Other Pertinent Information

None

4.3.11 References

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

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4.3.12 Project Contacts

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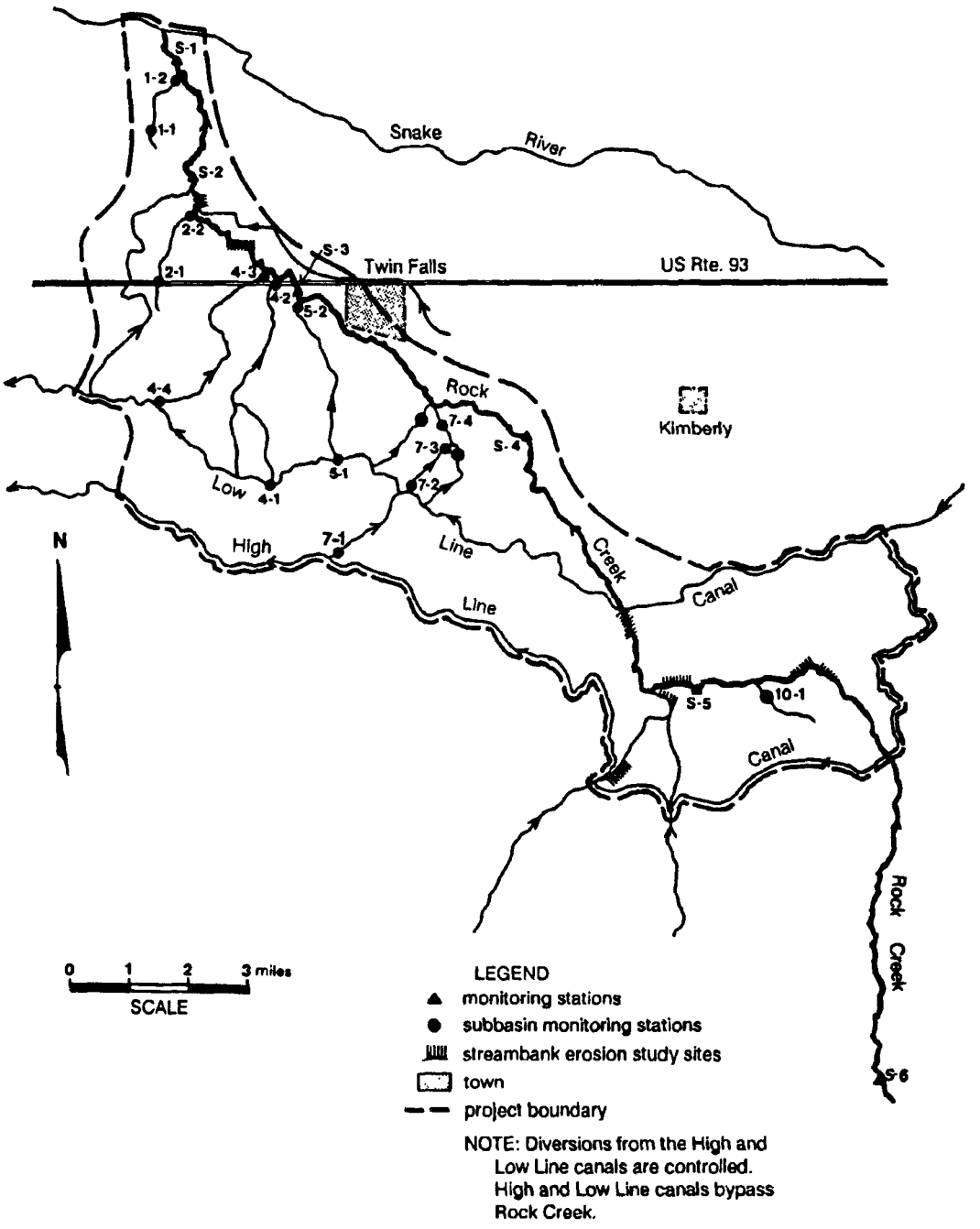
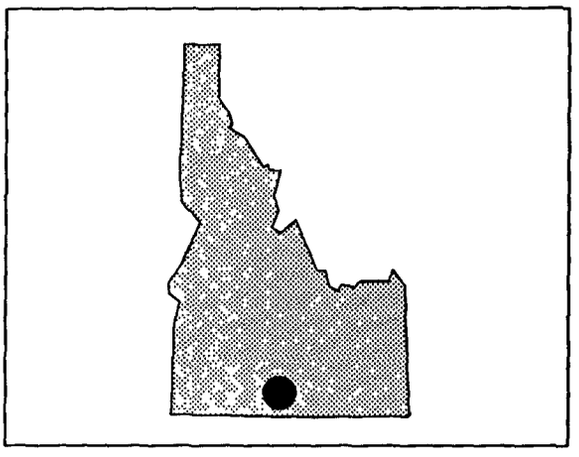


Figure 4.5: Rock Creek (Idaho) RCWP project map, ID-1.

Idaho
Rock Creek

(RCWP 3)



Twin Falls County
MLRA: B-11
HUC: 170402-12

4.1 Project Synopsis

The Rock Creek, Idaho RCWP project, one of five RCWP Comprehensive Monitoring and Evaluation (CM&E) projects, is located in south Central Idaho and covers 45,000 acres within a 198,400-acre watershed. The primary agricultural activities in the project area are irrigated pasture and cropland and rangeland. Irrigation is required for crop production because annual rainfall is low (9 inches/year). Irrigation water diverted from the Snake River is delivered to the farms through a network of canals and laterals (drains or ditches). Irrigation return flows eventually empty into Rock Creek, which discharges into the Snake River.

Rock Creek has poor water quality that impairs beneficial uses, including contact recreation, salmonid spawning, and fishing. In addition, Rock Creek delivers a disproportionate load of sediment to the Snake River. Major sources of nonpoint source (NPS) pollution in the area are sediment and associated pollutants (phosphorus and organic nitrogen) from irrigation return flows. Streambank erosion in the upper reaches of Rock Creek is also a major problem. Animal waste is another contributor to the NPS problem.

The NPS management strategy of the RCWP project was to reduce the amount of sediment, sediment-related pollutants, and animal waste discharging into Rock Creek from agricultural land. All irrigated cropland and animal production facilities were considered part of the critical area (28,159 acres). Best management practices (BMPs) were implemented to prevent sediment from entering the drains by controlling erosion within the farm fields and trapping sediment at field edges. The BMPs used in the project included: sediment retention structures, irrigation water management, vegetative filter strips, cover crops, conservation tillage, and animal waste management. Seventy- five percent of the critical area was treated on a voluntary basis.

The water quality monitoring program objectives included documentation of: 1) beneficial use improvements by monitoring in-stream habitats, benthic macroinvertebrate, and fish populations and 2) changes in pollutant concentrations of sediment and nutrients associated with BMP implementation. The experimental design for the chemical monitoring was an "upstream/downstream" strategy with monitoring before, during, and after BMP implementation over a 10-year period in several subwatersheds. Monitoring stations were located on Rock Creek and at downstream/upstream pair locations in the subwatersheds, with the downstream stations representing outlets from the subwatersheds to Rock Creek.

Grab samples for chemical and physical parameters were taken biweekly during the irrigation season at the Rock Creek stations; the subwatersheds were sampled biweekly at the beginning and end of the irrigation season, and weekly during the middle of the season. Monthly grab samples were taken in Rock Creek during the non-irrigation season. Fish populations were surveyed annually when possible and macroinvertebrates were surveyed on a quarterly basis. Habitat Evaluation Procedures (HEP) analyses were also utilized. Techniques to measure trout spawning habitat studies by using simulated trout redds to directly measure substrate dissolved oxygen were developed by the RCWP project personnel.

Assessment of BMP effectiveness and the importance of slope and crop type conducted by the Agricultural Research Service (ARS) was a successful component of this project. Sediment ponds were effective in demonstrating to farmers the magnitude of the soil erosion / water quality problem. However, the economic evaluation conducted by the Economic Research Service (ERS) indicated that management practices such as conservation tillage and water management were the most cost-effective BMPs for reducing sediment loss on a per acre basis.

4.1 Project Synopsis (continued)

Monitoring results indicate that the BMPs implemented under the project decreased the delivery of sediment and phosphorus to agricultural drains and improved water quality in Rock Creek. Rock Creek contributions to the Snake River showed a 75% decrease in sediment loadings and a 68% decrease in phosphorus loadings.

Beneficial uses have improved, including salmonid spawning and primary contact recreation, but remain impaired on lower Rock Creek. However, if reductions in pollution continue as past trends have indicated, Rock Creek could eventually fully support all designated in-stream uses.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

Having adequate data documenting water quality problems and previous research on BMPs proved invaluable in setting satisfactory goals.

Joint participation in goal setting by agencies participating in the project fostered stronger commitment to and cooperation in the project.

Realistic, quantitative goals for reduction in the primary pollutants (sediment, phosphorus, total nitrogen, and pesticides) were established at the beginning of the project. The goals provided a good focus for project activities.

Initially, not all agencies and landowners agreed upon the BMPs that should be employed to meet the land treatment and water quality goals. For example, the Soil Conservation Service (SCS) favored structural BMPs, the Cooperative Extension Service (CES) thought that water use and nutrient management should be a strong land treatment component, and others favored conservation tillage.

The economic goals were not developed adequately for this project, making collection of economic data and analysis of results difficult.

4.2.1.2 Recommendations

Water quality goals should be designed to achieve the designated uses established by the state. This enables the establishment of a water quality monitoring design that can be directed towards these use- support goals.

All agencies and landowners should agree on the land treatment and water quality goals at the beginning of the project.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

The Local Coordinating Committee (LCC) contributes profoundly to the success of a project. In the Rock Creek project, the LCC was, in essence, the driving force behind the project. Members of the LCC represented Agricultural Stabilization Conservation Service (ASCS), SCS, the Snake River and Twin Falls Soil Conservation Districts (SCD), Agricultural Research Service (ARS) Soil and Water Management Research Unit, Twin Falls CES, Idaho Division of Environmental Quality (DEQ), Idaho Department of Fish and Game, the University of Idaho, the Twin Falls Canal Company, and the county commissioner. However, the project only had a full-time project coordinator during the contracting phase. Employment of a project coordinator throughout the entire project period would have enhanced planning, provided a primary contact, and helped monitor progress.

4.2.2.1 Findings and Successes (continued)

A technical advisory committee composed of representatives from SCS, ASCS, and DEQ provided valuable guidance for local coordination, innovative activities, water quality monitoring, and analysis of results.

A major reason for the success of project administration was the commitment of the ASCS county committee and its staff to the goals of the project and to project administration.

The ARS provided valuable research and recommendations regarding the development and evaluation of conventional and new BMPs, particularly conservation tillage and no-tillage.

The *Food Security Act of 1985* substantially reduced the amount of technical assistance given to farmers in the project due to competing work commitments of SCS staff.

Farm managers from local banks were influential in getting absentee landowners to sign water quality contracts. Local bankers helped farmers identify positive economic assets, such as tax benefits, cash flow, and net assets resulting from the RCWP project.

4.2.2.2 Recommendations

Representatives on the LCC must be willing to dedicate much time and effort to the project. They must also be innovative and creative and have communication, negotiation, and problem-solving abilities.

A full-time project coordinator is essential for optimum project continuity.

Before a project begins, a detailed plan of work should be written, outlining goals and direction as well as defining the role of each participating agency.

If economic evaluations are an objective of the project, a local economist should be included as an active member of the LCC from the beginning of the project.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

Technical assistance was provided by close cooperation among the SCS and Snake River and Twin Falls Soil Conservation Districts and cooperators.

A full time information and education (I&E) staff person was only available for part of the project.

The use of multimedia I&E activities contributed to the high level of participation in this project.

DEQ produced many documents and gave many presentations on the radio, TV, newspaper, and oral presentations.

The I&E components of this project could have been strengthened if a more significant role for the CES had been incorporated into the project work plan. The initial BMP emphasis was toward structural BMPs, the primary expertise of SCS personnel. However, the major strengths of CES personnel were in the areas of irrigation water use, nutrient, and pesticide management; these components should have received more attention.

4.2.3.2 Recommendations

An I&E specialist should be available at the beginning of the project (and continue through the entire project) to help develop strategies for project implementation and to ensure program participants are committed to the project.

I&E activities should be initiated to explain objectives and goals at the project's inception to demonstrate progress throughout the project period, and emphasize successes as the project reaches completion.

A mixture of media is essential since different types of communications reach different people. Both the general public and the farmers should receive information and education, especially regarding the water quality benefits derived from the project.

Water quality monitoring results should be used to provide feedback on project successes to the participants and the public.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

Availability of cost share funds was the most important incentive for farmer participation.

Farm sites were used to demonstrate BMP application. The University of Idaho has demonstration and research plots for conservation tillage. Researchers at the USDA-ARS station at Kimberly, Idaho, have conducted extensive research on conservation tillage as a management practice for southern Idaho.

The economic conditions and costs of BMPs were thought by project staff to be the most important reason farmers decided not to participate in the RCWP.

4.2.4.2 Recommendations

Mechanisms should be established to ensure maintenance of BMPs after the contracting period ends in order to ensure continued pollution control.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

The project's goal of treating 75% of the critical area with BMPs in order to control sediment losses was met.

Management practices are by far the most cost-effective BMPs for reducing sediment loss on a per-acre basis.

Cost sharing of irrigation practices, such as concrete ditches and gated pipe, although not the most cost-effective practices, was highly effective in obtaining farmer participation.

Assessment of BMP effectiveness was a successful component of this project. Sediment reduction coefficients for the sediment retention BMPs were developed by the ARS at Kimberly, Idaho. Mini- basins, I- slots, sediment basins, and buried pipe runoff were effective with coefficients between 75 and 92%. Vegetative filter strips have a coefficient of 50%; irrigation improvements of 5 to 40%; and conservation tillage of 60%.

Sediment retention ponds were effective in demonstrating to farmers the magnitude of the soil erosion / water quality problem.

4.2.5.1 Findings and Successes (continued)

A furrow irrigation sediment yield model based on stream power concepts was developed and tested. The model is sensitive to furrow end slope and furrow roughness. Using actual runoff hydrographs, the model was able to predict annual sediment yields within 10% of measured yields. The model does not account for sediment deposited in drains or on fields due to re-use of irrigation return flows. However, it does adjust sediment yields to account for BMPs installed at field edge by using their sediment removal efficiency. The model was used to estimate sediment yields from various crop types, slopes, and irrigation water management BMPs (Brockway and Robison, 1984). The actual use of the model was limited due to insufficient crop, irrigation system, and BMP data. However, the model was a useful tool in demonstrating that slope was a significant factor in determining erosion. Also demonstrated was that fact that row crops such as beans, corn, and sugar beets had substantially greater erosion potential as compared to alfalfa.

The LQ Drain Project, a project conducted in the 1970's, was designed to control erosion using sediment retention practices (such as sediment ponds, T-slots, and mini basins) and was located near the RCWP project area. Results from the project showed that significant reductions in sediment loads may be lost if sediment retention devices are not property maintained. The RCWP project team is hopeful that the change from the more expensive structural practices to conservation tillage and other inexpensive BMPs will make it easier for farmers to continue practicing soil conservation after the RCWP project ends.

Some landowners have implemented BMPs on their own without RCWP funding.

Originally, the Economic Research Service (ERS), in Corvallis, Oregon, agreed to maintain a land treatment / land use data base. This decision was made because ERS had better data management capabilities than the local project offices. However, the distance from the project area was too great and the land treatment / land use data base was not being effectively maintained. The project has maintained the data locally since 1985.

Streambank erosion was not adequately addressed. In addition, there were several illegal stream alterations due done without permits and/or were done incorrectly that contributed to the problem.

4.2.5.2 Recommendations

Research needs to be ongoing during the project to facilitate definition of BMPs and, if needed, development of new BMPs.

Land treatment / land use data should be maintained and easily accessible to the project personnel to enhance effective storage, maintenance, and utilization. However, technical assistance with the design and implementation of the data management system, such as was provided by the ARS and ERS in the Idaho RCWP, may be needed.

Water quality models are useful tools for the identification and prioritization of critical areas.

BMPs developed to target problems in riparian areas would improve in-stream habitat, increase flow in areas affected by dewatering, and reduce the total pollution entering Rock Creek. More incentives should be developed for the use of streambank protection practices to improve riparian areas.

Sources of pollutants other than sediment that contribute to beneficial use impairments should also be targeted for treatment. Nutrient management should be addressed on cropland, animal grazing, and animal confinement operations. In addition, other sources of nutrients, such as rangeland runoff and fish hatcheries, should be treated. The project team suggested that the fish farms should have been eligible for RCWP cost share funds because such farms contribute to nutrient loading.

For long-term soil erosion and water quality benefits, emphasis should be placed on converting irrigation systems from surface- irrigation to sprinkler irrigation. Concurrent strategies would have to be developed to reduce the energy costs to facilitate this conversion.

Tracking of BMP maintenance is an important component of land treatment tracking.

4.2.5.2 Recommendations (continued)

Quality assurance is needed on all aspects of land treatment implementation, tracking, and evaluation.

Incentives should be provided for conservation of water.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 *Findings and Successes*

The goals of producing significant reductions in the amount of sediment, nutrients, and animal waste entering Rock Creek were met.

Analysis of water quality data from 1980 to 1990 showed significant decreases in suspended sediment concentrations and other pollutants in the agricultural drains and in Lower Rock Creek (Maret et al., 1991).

Rock Creek loading contributions to the Snake River showed a 75% decrease in sediment and a 68% decrease in phosphorus. To a lesser degree, total organic nitrogen and volatile suspended solids concentrations have also declined.

Surface grab samples for suspended sediment used in this project gave comparable concentration and loading estimates to those provided by depth integrated samples and served as a viable method to measure sediment loadings. However, a large amount of sediment originating from streambank erosion and a recently burned watershed is transported in Rock Creek in the form of bedload.

Nitrogen and phosphorus concentrations remain higher than the recommended criteria for protection of cold-water biota, indicating that BMPs targeted at fertilizer management, grazing management, and animal waste management were insufficient to reduce in-stream nutrient concentrations to the extent needed.

Bacteria levels in Lower Rock Creek exhibited a slight decline, but continue to exceed primary contact standards.

Pesticide concentrations in the Rock Creek water column, sediment, and fish tissue were below levels established for public health concerns.

Fish populations in Rock Creek below the agricultural subbasins appear to have improved since the pre-project period (1981). Steelhead were stocked in lower Rock Creek in the fall of 1989 to provide a trophy fishery for local anglers. This activity was well received by area residents and should become an annual event as water quality continues to improve in lower Rock Creek (Maret et al., 1991). Macroinvertebrate analysis has not shown any improving trends.

The project team developed techniques to directly measure trout spawning habitat. The techniques involve the use of simulated trout redds to measure substrate dissolved oxygen. Since these are installed where fish eggs and fry live, they give a more accurate picture of fish habitat than simply measuring the same variables in the water columns.

Substrate analysis using percent composition, embeddedness, habitat evaluation procedures, and artificial egg pocket and intragravel dissolved oxygen methods in Rock Creek reveals that all stations remain degraded by fine sediment. Fine sediment increases from the headwaters to lower reaches and in areas of active streambank erosion.

In-stream monitoring of beneficial uses, including salmonid spawning and primary contact recreation, show that such uses remain impaired on Lower Rock Creek. If reductions in pollution (such as fine sediment) continue, Rock Creek could eventually fully support all designated in-stream uses (Maret et al., 1991).

4.2.6.1 Findings and Successes (continued)

Streambank erosion continues to be a major source of sediment reaching Rock Creek. The influx of sediment from streambank erosion makes it difficult to document the effectiveness of BMPs. From project estimates, the sediment contributions from the two major sources, streambank erosion and irrigation return flow, were similar in magnitude when the project began. In contrast, from 1987 to 1990, monitoring indicated that streambank erosion contributed two to over five times the amount of sediment added from cropland in the subbasins during the May - August irrigation season. The problem of streambank erosion will continue to mask in-stream benefits from the RCWP land treatment.

Ground water monitoring of tunnel drains indicates nitrate concentrations range from 3.3 to 5.4 milligrams/liter (mg/l). Although these concentrations are below the drinking water standard (10 mg/l), there is a large volume of discharge from the drains and the nitrogen load losses are probably large. Pesticides, particularly dacthal, were found in trace amounts in some drains.

In 1987, a fire occurred in the headwaters of the watershed, resulting in increased sediment loading to Rock Creek. The majority of this sediment was coarse bedload material.

4.2.6.2 Recommendations

A monitoring program should be designed only after clear objectives that identify impaired or threatened beneficial uses have been established. A use attainability assessment of the water body being studied should be conducted prior to developing a long-term monitoring program if existing data are not available.

A monitoring plan which clearly defines objectives and agency roles should be written. This plan should include objectives and goals, locations of stations, duration of monitoring, methodology, data storage, frequency of sampling, assessment methods, reporting requirements, costs, and personnel.

Data management systems, quality assurance methods, and analysis techniques should be clearly identified and planned prior to monitoring to ensure that all water quality and land treatment / use data are being collected in a manner that will allow effective trend analysis and valid interpretations.

Monitoring programs must start with an evaluation of water resource quality, which includes habitat quality, biotic integrity, water quality, and water availability. This approach must be interdisciplinary and requires evaluation of chemical, physical, and biological variables.

Several years of background water quality data are needed before any land treatment begins.

Direct measures of use support (aquatic biota, spawning assessments, other biological and habitat variables) should be used. Reference stations characterizing attainable conditions are required to evaluate the health of the aquatic biota and habitat potential.

Covariates such as flow, seasonality, upstream concentrations, precipitation, water use (in irrigated areas), and other variables should be monitored to ensure accurate interpretations of monitoring results.

Selection of monitoring variables should be specific to beneficial uses impaired.

Long-term monitoring (6-10 years) with biweekly grab samples is sufficient to document water quality trends in a water resource that exhibits at least a 40% change in pollutant concentrations.

Sampling bedload in a stream during runoff periods should be performed or sediment loadings may be underestimated. Total sediment loadings need to be measured where bedload is significant.

Funding for monitoring is essential for any water quality demonstration project since monitoring is the primary means for evaluating the effectiveness of land treatment implemented.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

This RCWP project contributed information on the effectiveness of BMPs in an irrigated system.

Monitoring results indicate that the BMPs implemented under the RCWP decreased the delivery of sediment and phosphorus to the agricultural drains and improved water quality in Rock Creek. This conclusion was drawn from the association that eight of ten subbasins have documented reduced loadings over the same time period that BMP implementation occurred.

The long pre- and post-BMP water quality and land treatment monitoring time frames, as well as the high level of land treatment in the critical area, increased the ability to the project to document BMP effectiveness.

This project demonstrated that BMP effectiveness monitoring is important to evaluate implementation programs and their off-site effect on water quality.

The downstream/upstream water quality monitoring data from the subbasins was used successfully to quantify sediment concentrations and loads to Rock Creek and to indicate which subbasins could benefit most from BMPs (Clark, 1985).

Lack of participation and failure to implement BMPs can have a significant negative effect on monitoring results, particularly when the farm is located immediately upstream of a monitoring station.

A post-project analysis is being conducted to further analyze the water quality and land treatment / land use data. The project team has taken the initiative to update and revise land treatment / land use data base such that linkage between the land treatment and water quality data bases could be quantitatively performed. The project would have benefited from 1) updating these data bases annually, 2) verifying that the land treatment / land use and water quality data bases were being compiled such that they could be linked on a drainage basis, and 3) that all pertinent information was being collected and compiled.

Based on project experience and modeling, the two most critical parameters that affect soil erosion (as measured by suspended sediment load) are: 1) percent acres treated with BMPs and 2) the erosion index developed by project SCS personnel which is a function of crop type and field slope. Land use and crop data (on an annual basis for each subbasin) are being compiled to create an erosion index to be matched with water quality monitoring data.

The hydrologic characteristics of each subbasin are currently being entered into a geographic information system (GIS) by SCS and DEQ. A direct spatial (hydrologic) linkage between the land treatment and water quality data bases is currently being established to assist in evaluating land use/water quality relationships.

4.2.7.2 Recommendations

In-stream and field monitoring results should be used as fully as possible to guide resource managers in selecting BMPs and prioritizing land treatment.

Monitoring and data management schemes for both water quality and land treatment should be set up by hydrologic (drainage) units to facilitate evaluation of BMP effectiveness.

Land treatment data should be electronically stored throughout the life of the project.

The evaluation of land treatment and resulting water quality changes must consider non-participants and non-compliance (failure to install and maintain BMPs properly) to explain trends in the monitoring data. Other significant land use activities that would affect pollutant loadings should be documented.

Non-participant land use and cropping patterns should be tracked along with participant land use and cropping patterns and recorded in the land treatment data base. Tracking of land treatment data should not end with expiration of contracts.

4.2.7.2 Recommendations (continued)

Projects should allow ample time and funds for analysis and assessment of monitoring data to adequately document trends in water quality associated with land treatment. Information from the analysis is important to provide feedback to project personnel, policy makers, and the public.

BMP effectiveness monitoring at a few BMP treatment sites have a high probability of documenting and quantifying water quality impacts. These small scale monitoring components of a project should be encouraged because they provide direct and rapid feedback to project participants. This feedback includes the demonstration of pollutant losses from the landowner's operation and the documentation of the relative effectiveness of each practice.

Funding for monitoring of both land treatment and water quality is essential for a water quality demonstration program if it is to be able to provide adequate evaluation of the program.

4.3 Project Description

4.3.1 Project Type and Time Frame

Comprehensive Monitoring and Evaluation (CM&E) RCWP Project

1981 - 1990 for water quality monitoring; BMP implementation will continue until 1995.

1991 - 1992 Post-project water quality / land use data analysis

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Irrigation drains and canals and Rock Creek (approximately 25 miles) flowing into the Snake River

4.3.2.1.2 Water Uses and Impairments

Rock Creek provides diverse habitat for wildlife and salmonid spawning. It is a popular stream for swimming, tubing, and cold water trout fishing. Water skiing, swimming, boating, fishing, and hunting are major recreational activities in the Snake River, 10 to 15 miles downstream from the confluence of Rock Creek with Snake River.

Irrigation water diverted from the Snake River is delivered to farms through a network of canals and laterals (drains or ditches). Irrigation water is available at a near constant flow from about April 15 through October 15. Rock Creek receives irrigation return flow from the RCWP project area. Irrigation return flows eventually empty into Rock Creek, which delivers a disproportionate load of sediment to the Snake River.

The Lower Rock Creek and the Low Line Canal are also used for hydroelectric power generation. Due to plant demands for water, Rock Creek receives additional water before and after irrigation season. During the summer and fall, Rock Creek is completely dry for a short distance near the Rock Creek Town site (between water quality monitoring stations S-5 and S-6).

High sediment loads in Rock Creek have created additional equipment and maintenance costs for filtering sediment and removing gravel at the hydroelectric plant near the confluence of Rock Creek with Snake River. These costs have not been formally documented. In addition, construction of two hydro-plants created large sources of sediment to Rock Creek.

4.3.2.1.2 Water Uses and Impairments (continued)

Large horizontal tunnels, made into the basalt rims above Rock Creek, drain a high water table area in the project area. Four trout hatcheries utilize the outflow for fish production.

The primary use impairments are to fishing, salmonid spawning, and contact recreation in Rock Creek. Impairments also occur in irrigation ditches, canals, and drains, which become clogged with sediment.

Sediment loads entering the Snake River from Rock Creek do not appear to be significantly impairing downstream reservoir capacity or increasing the cost of power generation at downstream power plants that rely on reservoir capacity because the nearest such plant is located 120 miles downstream from the project area. However, there are two river-run hydroelectric dams within 20 miles of the confluence. The slack water pools behind the dams are being filled with sediment.

The muddy color of Rock Creek is an aesthetic impairment which also effects the Snake River.

4.3.2.1.3 Water Quality Problem Statement

The primary pollutants in Rock Creek are sediment, phosphorus, nitrogen, and bacteria.

Uses are impaired by high sediment and nutrient loads originating from furrow-irrigated cropland and streambank erosion. Overgrazing in riparian areas may contribute to streambank erosion. Animal wastes from feedlot runoff also contribute to the water quality impairments.

Non-cropland activities in the project area also affect the pollutant loading to Rock Creek and Snake River. Expanded fish hatchery production has increased the phosphorus, nitrogen, and organic matter loadings to Rock Creek from this industry and decreased water flow in Rock Creek by diversion. The Lower Rock Creek (downstream of monitoring station S-4) is thought to be affected by the hatcheries. Illegal gravel mining and illegal stream alterations have degraded the channel and riparian zone between Rock Creek water quality monitoring stations S-4 and S-5 and have negated many of the RCWP improvements. An example of illegal stream alteration included a landowner who bulldozed the stream banks to allow center-pivot sprinklers to cross Rock Creek.

Other factors that have a detrimental impact on the water quality of Rock Creek by increased delivery of sediment and sediment-related nutrients include: chaining the canal system to mechanically remove vegetation, increased sediment loadings from Harrington Fork (in the headwaters of the watershed) due to a fire in 1987, construction and operation of a new hydroelectric generating plant in 1989, and a 40% increase in row-cropped bean production in 1989.

4.3.2.1.4 Water Quality Objectives and Goals

Objective: Reduce the amount of sediment, sediment related pollutants, and animal waste discharging into Rock Creek from agricultural lands through application of BMPs

Specific goals:

Reduce the subbasin contributions to Rock Creek of sediment by 70%, of phosphorous by 60%, of total nitrogen by 40%, and of pesticides by 65%

Improve the beneficial uses of surface waters in the project area, specifically trout fishing and contact recreation

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 198,400 acres
Project Area: 45,238 acres
Critical Area: 28,159 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 9 inches (supplemental irrigation water is required to grow dry beans, alfalfa, pasture, dry peas, sugar beets, and corn)

Average Growing Season: 120 days

Geologic Factors: The watershed is underlain by limestone, quartzite, shale, sandstone, granite, and metamorphosed sediments. The lower watershed (most of the farmed area) is underlain by deep layers of fractured basalt. This formation yields large supplies of ground water to the northeast. Soils in the project area are highly erosive. Subsoils range from silty to loamy. Surface soils are generally medium textured. Slopes range from nearly level to very steep on hill and mountain sides. The slope on the irrigated crop lands is predominately 0 to 2% with a range from 0 to 8%.

4.3.2.2.3 Project Area Agriculture

The primary agricultural activities are irrigated pasture and cropland and rangeland. The primary crops produced are dry beans, dry peas, alfalfa, sugar beets, corn, small grain, alfalfa, and livestock.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland (Irrigated beans, grain, alfalfa, pasture)	75	100
Other pasture/ range	NA	NA
Woodland	NA	NA
Urban/roads	NA	NA
Other	NA	NA

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	34	6,800	9,520
Beef	21	6,300	6,300
Mink*	1	20,000	~ 200

*Not thought to be a critical farm by the project (personal communication, Bill Clark, Idaho Division of Environmental Quality, August 1986)

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	1,988,757	0	NA	0	NA
Info. & Ed. (CES)	135,458	NA	0	NA	NA
Tech. Asst.	1,729,286	NA	0	NA	NA
Water Quality Monitoring	1,388,966	NA	0	0	NA
SUM	5,242,467	NA	NA	NA	NA

Source: Maret et al., 1991

4.3.4 Information and Education

4.3.4.1 Strategy

The Cooperative Extension Service was charged with developing and coordinating I&E activities. ASCS informed landowners about the cost share opportunities. CES was unable to provide the level of I&E required. The major areas of expertise of CES personnel were irrigation water use, nutrient, and pesticide management. However, the initial BMP emphasis was toward structural BMPs. After 1985, SCS and the SCDs took the lead responsibility for providing technical assistance to the farmers by hiring an I&E specialist. The state water quality agency, Division of Environmental Quality (DEQ), provided feedback to the farmers and the public regarding the water quality monitoring results. Numerous articles about the Rock Creek RCWP project, many in the popular press, were written by project personnel from all participating agencies.

There was a need for more technical assistance for animal waste management.

4.3.4.2 Objectives and Goals

Objectives:

Create and implement an educational program that would aid in accomplishing the project goals

Goals:

Increase public understanding of erosion/water quality problems

Increase public understanding of the solutions to these agricultural water quality problems

Increase public understanding of the RCWP

Target audiences in critical areas

Provide information and educational opportunities necessary to enable farmers in critical area to participate in the RCWP

Disseminate information on project activities, goals, accomplishments, and events with emphasis on conservation tillage and animal waste systems (added as a goal in 1985)

4.3.4.3 Program Components

News releases

Rock Creek Review Project Newsletter

Flyers

Brochures

Slide presentations

Informational meetings

Demonstrations and tours

Posters

Public service announcements on radio and television

Awards programs for participating farmers

Scientific and technical publications and journal articles

4.3.5 Producer Participation

4.3.5.1 Level of Participation

The level of participation was high in this project, particularly for structural irrigation management practices, but it was very low for conservation tillage and animal waste management.

4.3.5.2 Incentives to Participation

Availability of cost share funds was 50% or 75%, depending on the practice. Most farmers were satisfied with the level of financial assistance they received.

Farm sites were used to demonstrate BMP application. The University of Idaho has demonstration and research plots for conservation tillage. Researchers at the USDA-ARS station at Kimberly, Idaho, have conducted extensive research on conservation tillage as a management practice for southern Idaho.

Improving irrigation management decreased landowner's labor.

4.3.5.3 Barriers to Participation

Economics

Cost of BMPs

The limit of $50,000 for large sediment retention structures and animal waste control systems

Inflexibility to design inexpensive systems

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Good, particularly for conservation tillage and other management BMPs. From 50 to 70% of the critical area BMPs are estimated by land treatment personnel to have been continued. BMPs with a life span of one year, such as filter strips, mini-basins, and I-slots, are the BMPs most often discontinued after contracts expire.

Structural components of irrigation water management (BMP 13) are likely to be maintained after contracts expired. Sediment basins were the BMPs most often not maintained after contracts expired.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The strategy used by the project was to implement BMPs designed to reduce the amount of sediment, sediment-related pollutants, and animal waste discharging into Rock Creek from agricultural land.

BMP emphasis during the first five years of the project was towards removal of sediment from runoff at the edge of field. Emphasis shifted for the last half of the project to reduction of erosion within the field (using conservation tillage) and animal waste management.

The original contracting period was 1981 to 1986. Conservation tillage was approved as a cost shared practice in 1985. Amendments to existing contracts to add conservation tillage and fertilizer management were allowed beyond 1986. However, conservation tillage was implemented too late to be useful in reducing pollutants to Rock Creek during the project period.

4.3.6.2 Objectives and Goals

Contract and implement BMPs to serve 75% of the critical area

Improve the use and conservation of irrigation water

Reduce the amount of on-farm erosion

Carry out intensive research on reduced tillage and residue management systems that could be used within the project area

Evaluate and promote the potential for double cropping of grain and beans

Incorporate conservation tillage into existing RCWP contracts (added to the goals in 1985)

Demonstrate new technology, such as conservation tillage, cropping sequences to utilize available nitrogen following legumes, and water management under conservation tillage (added to the goals in 1985)

Accelerate implementation of animal waste systems by planning for and contracting with all operators needing these systems (added to the goals in 1985)

4.3.6.3 Critical Area Criteria and Application

All irrigated cropland and animal production facilities were considered critical. Critically erosive land was given highest priority, including steep slopes, rented land, intensively cropped land, and land with few irrigation management improvements.

Treatment has exceeded goals for cropland operations. The implementation of BMPs has not followed the order of subbasin priority because of economic conditions and the desire to issue contracts in the order that applications were received.

4.3.6.4 Best Management Practices Used

General Scheme:

Focus during 1981-1985 was on sediment retention structures and irrigation management systems with some permanent vegetative cover on critical areas (BMPs 12, 13, and 11). These BMPs prevented sediment from entering the drains by trapping sediment at the edge of the farm fields. Several other practices were approved, but few were implemented (i.e., BMPs 2, 9, 10, 15, and 16).

For the duration of the project emphasis shifted to conservation tillage (BMP 9) and animal waste management (BMP 2). Conservation tillage controlled erosion on-site.

There were a few community-size sediment ponds that served several farms.

4.3.6.4 Best Management Practices Used (continued)

BMPs Utilized in the Project*:

Permanent vegetative cover (BMP 1)
- Fencing
- Pasture and hayland planting

Animal waste management system (BMP 2)
- Waste storage and handling

Conservation tillage system (BMP 9)

Stream protection system (BMP 10)

Permanent vegetative cover on critical areas (BMP 11)
- Filter strips

Sediment retention, erosion, or water control structures (BMP 12)
- Mini basins
- I-slots
- Sediment basins
- Buried pipe runoff control systems

Improving irrigation system and / or water management system (BMP 13)
- Irrigation water management
- Concrete ditch
- Concrete pipeline
- PVC pipeline
- Gated pipeline
- Land smoothing
- Structure for water control

Fertilizer Management (BMP 15)

Pesticide Management (BMP 16)

*Please refer to Appendix I for description/purpose of BMPs.

Source: Maret et al., 1991

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

Cost shared and non-cost shared land treatment / land use activities were monitored in terms of units installed and acres treated. Data were collected on a field, subbasin, and annual basis.

Data on acreages for each crop on a field, subbasin, and annual basis were maintained by ASCS.

Tracking of BMP maintenance was weak. Most of the tracking occurred during the contracting period.

4.3.6.5.2 Data Management

Data are collected by SCS. Originally, the Economic Research Service (ERS) in Corvallis, Oregon, agreed to maintain a land treatment / land use data base. This decision was made because ERS had better data management capabilities than the SCS field office. However, the distance from the project area was too great and the land treatment / land use data base was not being effectively maintained. In 1985, with assistance from ARS and the University of Idaho, the local project SCDs starting maintaining the land treatment and land use records on dBASE (a PC data base). The data are being converted to dBASE and SAS for linkage with the water quality data base for post-project analysis. BMP implementation data from 1981 to 1990 are reported in the project's Ten-Year Report (Maret et al., 1991).

4.3.6.5.3 Data Analysis and Results

Analysis:

Sediment reduction coefficients for the sediment retention BMPs have been developed by the ARS and the University of Idaho at Kimberly, Idaho.

ARS and the University of Idaho also developed and tested a furrow irrigation sediment yield model based on stream power concepts. The model is sensitive to furrow end slope and furrow roughness.

SCS maintained a data base for land treatment which was recorded on a annual, contract, and farm field basis.

Results:

Quantified Project Achievements (as of 12/31/91):

Pollutant Source	Units	Critical Area		Treatment Goals	
		Total	% Implemented	Total	% Implemented
Cropland	acres	28,159	75%	21,119	100%
Conservation Tillage	acres	10,000	65%	10,000	65%
Dairies	#	8	50%	8	50%
Feedlots	#	17	35%	17	35%*
Contracts	#	235	78%	176	104%

* All feedlots have contracts, but implementation is not complete.

Source: Maret et al., 1991; SCS et al., 1989

Assessment of BMP effectiveness was a successful component of this project. Mini-basins, I-slots, sediment basins, and buried pipe runoff were effective, with coefficients between 75 and 92%. Vegetative filter strips have a coefficient of 50%, irrigation improvements 5 to 40%, and conservation tillage 60%.

Sediment ponds were effective in demonstrating to farmers the magnitude of the soil erosion / water quality problem.

4.3.6.5.3 Data Analysis and Results (continued)

Using actual runoff hydrographs, the furrow irrigation sediment yield model was able to predict annual sediment yields within 10% of measured yields. The model does not account for sediment deposited in drains or on fields due to re-use of irrigation return flows. However, it does adjust sediment yields to account for BMPs installed at field edge by using their sediment removal efficiency. The model was used to estimate sediment yields from various crop types, slopes, and irrigation water management BMPs (Brockway and Robison, 1984). The actual use of the model was limited due to insufficient crop, irrigation system, and BMP data. However, the model was a useful tool in demonstrating that slope was a significant factor in determining erosion. Also demonstrated was the fact that row crops such as beans, corn, and sugar beets had substantially greater erosion potential as compared to alfalfa.

Results from the LQ Drain Project, an earlier project also designed to control erosion using sediment retention BMPs (sediment ponds, T- slots, and mini basins) located near the RCWP project area and conducted in the 1970s, showed that significant reductions in sediment loads may be lost if sediment retention devices are not property maintained. The RCWP project team is hopeful that the change from the more expensive structural practices to conservation tillage and other inexpensive BMPs should make it easier for farmers to continue practicing soil conservation after the RCWP project ends.

Some landowners have implemented BMPs on their own without RCWP funding.

Based on a model of the watershed performed by Kasal et al. (1987), modification of contracts to implement 10,000 acres of conservation tillage was expected to reduce sediment loadings substantially beyond reductions resulting from structural controls and provide a low-cost alternative to structural controls. The project increased its emphasis on conservation tillage as an effective, low-cost alternative to structural practices for improving water quality. However, the adoption rate of conservation tillage was low. Many farmers rejected conservation tillage because it was a non-traditional farming method. Custom operators who farm rented land did not have an economic incentive to implement the practice. Most of the crops grown in the project area are dry beans (garden and commercial seed varieties) and sugar beets. Contractors for dry beans know that conventional tillage methods yield good bean crops and they were prone to contract with farmers who practiced conventional methods. While several surface-applied herbicides are registered for use on soybeans, there are no such products registered for dry beans. This was a deterrent to adoption of conservation tillage.

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The project monitored subbasin pollutant contributions to Rock Creek and tracked changes in sediment load and associated pollutants as close to their sources and BMPs as possible. Pollutant concentrations in Rock Creek were also monitored. The basic experimental design was an "upstream/downstream" strategy with monitoring before, during, and after BMP implementation over a 10-year period. The project also had an extensive biological and habitat monitoring program to document changes in beneficial use support in Rock Creek over time.

The water quality monitoring was conducted by Idaho Dept. of Health and Welfare, Division of Environmental Quality (DEQ).

4.3.7.2 Objectives and Goals

Objectives:

Evaluate the RCWP project and BMP effectiveness in meeting water quality goals

Provide water quality information to project managers for use in making adjustments in project implementation to meet the water quality goals

Develop improved water quality nonpoint source monitoring methodologies to be utilized in other Idaho projects

Determine the local quality of the rural drinking water supply and the quantity of ground water entering Rock Creek from the project area

Goals:

Detect trends in water quality variables on a subbasin and project area basis

Document beneficial use improvements by monitoring in-stream habitats, benthic macroinvertebrates, and fish populations

Measure rainbow trout habitat suitability in Rock Creek using Habitat Evaluation Procedures (HEP) analyses

Evaluate salmonid spawning habitat of rainbow and brown trout in Rock Creek using in-stream bioassay to determine survival to emergence, intragravel dissolved oxygen, and percent fines in artificial redds

Develop techniques to directly study fish spawning habitat by using simulated trout redds to measure substrate dissolved oxygen

Demonstrate the water quality effects of conservation tillage, sediment retention structures, irrigation water management, vegetative filter strips, cover crops, and animal waste management for surface water protection

Relate measured water quality changes in the agricultural drains and in Rock Creek to land treatment and changes in land use

Obtain an accurate estimate of water and sediment budgets

Document current ground water quality status and ground water budgets by monitoring drainage tunnels

Assess the effect of conservation tillage on pesticide and nitrogen concentrations in the ground water

4.3.7.3 Time Frame

Surface water: 1980-1990 for Rock Creek and 1981-1990 for subbasin chemical water quality monitoring. Water quality monitoring was initiated at the Rock Creek Stations in 1980; sampling at S-1 became obsolete in 1983 due to the construction of a new hydroelectric plant immediately upstream of S-1; S-2 was initiated as a replacement. BMP implementation will continue until 1995.

Ground water: 1988 - 1990

Streambank erosion: 1986 - 1990

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

Surface Water:

For chemical variables, there were 21 subbasin monitoring stations and five active Rock Creek monitoring stations. Subbasin monitoring occurred on six of the 10 subbasins. The subbasin stations were located on irrigation drains (ditches). Most of the subbasin stations were positioned in pairs, with the downstream stations representing outlets from the subbasins to Rock Creek. The upstream stations monitored pollutant concentrations from natural and agricultural sources upstream from the BMP implemented agricultural areas.

Ground Water:

Discharge from 8 drainage tunnels in the lower watershed was monitored. These tunnels are excavations into basalt that drain localized areas with high water tables to prevent salt accumulations. Samples were taken where the water exits into the Rock Creek canyon.

Streambank Erosion:

8 sites were monitored to evaluate the magnitude of stream bank erosion and effect of streambank stabilization on Rock Creek and Cottonwood Creek.

Harrington Fork was monitored in 1987 to determine the contributions of pollutants resulting from a fire in the watershed.

4.3.7.4.2 Sample Type

Grab (for water column chemistry and bacteriology)

4 step removal for fish

Triplicate Hess samples for macroinvertebrates

4.3.7.4.3 Sampling Frequency

Subbasin surface water sites: Weekly chemical sampling during the irrigation season (the drains are dry during the non-irrigation period)

Rock Creek: Weekly to biweekly chemical sampling during the irrigation seasons; Monthly chemical sampling during the non-irrigation season

Fish populations (game and non-game): Approximately annually (in the spring of 1981, 1985, 1987, 1988, and 1990)

Pesticides in fish tissue: Same frequency as for fish populations

Macroinvertebrate surveys: Quarterly (in March, June, August, and November)

Habitat Evaluation Procedures (HEP) analyses: 1981, 1984, and 1988

Salmonid spawning habitat evaluations: Annual (began in 1989)

Ground water sites: Seasonally (spring, summer, and fall, began in 1988)

Streambank erosion sites: Annually (since 1986)

Creel Survey (Fall, 1988)

4.3.7.4.4 Variables Analyzed

Surface sites: suspended sediment (SS), total phosphorus (TP), orthophosphate-phosphorus (OP-P), fecal coliform (FC), nitrite-nitrogen plus nitrate- nitrogen (NO_2-N + NO_3-N), total Kjeldahl nitrogen (TKN)

Additional variables analyzed at the Rock Creek stations: turbidity, pesticides, trace metals, fish population sampling, fish tissue analyses for pesticides, benthic macroinvertebrates, cobble embeddedness, intragravel dissolved oxygen (IGDO), stream channel substrate sediment, core sampling, Habitat Evaluation Procedure (HEP), and salmonid (trout) spawning habitat evaluations of rainbow and brown trout and in-stream bioassays to estimate survival. Creel Survey to document any increased fishing activity as a result of improved fish populations

The trout spawning habitat studies involve the use of simulated trout redds to measure substrate dissolved oxygen. Since these are installed where fish eggs and fry would live, they give a more accurate picture of fish habitat than simply measuring the same variables in the water columns. This technique of direct habitat measurement was developed by the RCWP project personnel.

HEP (U.S. Fish and Wildlife Services, 1980) analyses to assess the physical features of trout habitat

Stream channel substrate composition and cobble embeddedness to measure substrate suitability for trout spawning. Core sampling to measure the amount of fine sediment in trout spawning habitats

Ground water sites: NO_3-N, pesticides, and FC

Streambank erosion

4.3.7.4.5 Flow Measurement

Stream discharge recorded with all grab samples. A U.S. Geological Survey gauge records continuous flow on Rock Creek at station S-1 (later moved to station S-2). Flow was also collected at the ground water tunnel outlets to determine seasonal changes in discharge.

4.3.7.4.6 Meteorologic Measurements

Daily precipitation was recorded by the National Oceanic and Atmospheric and Administration (NOAA).

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

The project placed major emphasis on quality assurance / quality control for both the laboratory and field portions of its water quality monitoring.

Color photographs were taken of each sample station over time to provide a visual record of seasonal changes, water quality, riparian conditions, and sediment deposits. The photographs and Rock Creek library are on file at DEQ, Boise, Idaho.

4.3.7.5 Data Management

All surface and ground water chemical and biological data are stored locally at the Idaho Department of Health and Welfare, Division of Environmental Quality. The data were also summarized in the project's annual progress reports (such as Maret, 1990) and the 10-Year Report (Maret et al., 1991).

All surface and ground water chemical data are stored on STORET.

4.3.7.5 Data Management (continued)

STORET agency codes: 21IDSURV, 21IDAHO, 112WRD

STORET AGENCY CODE	STORET STATION NO.	PROFILE MAP / STATION (COMMENTS)
Rock Creek Stations (most labeled on project map):		
21IDSURV	2060146	ID-1 / S-1
21IDAHO	151163	ID-1 / S-1
112WRD	13093095	ID-1 / S-1
21IDSURV	2060148	ID-1 / S-2
21IDSURV	2060145	ID-1 / S-3
112WRD	13092747	ID-1 / S-3
21IDSURV	2060144	ID-1 / S-4
112WRD	13092710	ID-1 / S-4
21IDSURV	2060147	ID-1 / S-5
21IDSURV	2060143	ID-1 / S-6
112WRD	13092000	ID-1 / S-6
21IDSURV	2060149	S-6A (Harrington Fork confluence, discontinued)
21IDSURV	2060150	S-6B (below confluence of Fourth Fork Rock Creek, discontinued)
21IDSURV	2060158	S-7 (below confluence of Harrington and Fourth Forks, upstream of project area)
21IDSURV	2060159	S-8 (above confluence of Harrington and Fourth Forks, upstream of project area)
21IDSURV	2060160	HF-1 (Harrington Fore, near mouth, upstream of project area)
21IDSURV	2060142	C-1 (Twin Falls Main Canal near Hansen, discontinued)
Sub-basin Monitoring Stations (most labeled on project map):		
21IDSURV	2060137	ID-1 / 1-1
"	2060138	ID-1 / 1-2
"	2060135	ID-1 / 2-1
"	2060136	ID-1 / 2-2
"	2060139	2-3
"	2060140	2-4
"	2060240	2-5
"	2060131	ID-1 / 4-1
"	2060132	ID-1 / 4-2
"	2060133	ID-1 / 4-3
"	2060134	ID-1 / 4-4
"	2060129	ID-1 / 5-1
"	2060130	ID-1 / 5-2
"	2060123	ID-1 / 7-1
"	2060124	ID-1 / 7-1
"	2060125	ID-1 / 7-3
"	2060126	ID-1 / 7-4
"	2060127	7-6
"	2060128	7-7
"	206014	10-1
"	2060245	CW-3 (Cottonwood Creek near discharge into Rock Creek)

4.3.7.5 Data Management (continued)

STORET AGENCY CODE	STORET STATION NO.	PROFILE MAP / STATION
Tunnel Drains (not labeled on map):		
21IDSURV	2060272	T-1
"	2060273	T-2
"	2060274	T-3
"	2060275	T-4
"	2060276	T-5
"	2060277	T-6
"	2060278	T-7
"	2060279	T-8

4.3.7.6 Data Analysis and Results

Analysis:

Exploratory data analysis included tabular presentation of the data on an annual/subbasin basis, time plots, calculation of means and ranges for the water quality concentrations at each site, and calculation of monthly suspended sediment and TP loads at each site.

Indexes calculated:

Water quality index values were calculated using the STORET program called WQI which weighted values of measured chemical and physical variables from the Rock Creek stations fro 1982 to 1988

Species diversity and biotic indices were calculated from macroinvertebrate data.

HEP values were derived from 17 habitat variables (Maret et al., 1991, p. 112).

Comparison of seasonal sediment loadings from the subbasins from 1982 to 1990 was conducted.

Percent exceedance was calculated by comparing FC, suspended sediment, TP, and turbidity concentrations at the Rock Creek Stations to exceedance criteria.

Seasonal sediment loadings from the subbasins from 1982 to 1990 were compared.

Water quality trend detection techniques include:

Nonparametric trend analyses using monthly median concentration and monthly mean loading values, student's t-test to compare pre- and post- BMP periods

Linear regression to detect a linear trend over time

Covariate analysis that adjusted for upstream concentrations paired with downstream stations.

Examination of the measured variability in the water quality data was used to determine the amount of change in annual mean concentrations required to be statistically significant (i.e. minimum detectable change).

4.3.7.6 Data Analysis and Results (continued)

Results (Maret at al., 1991):

Analysis of water quality data from 1980 to 1990 showed significant decreases in suspended sediment concentrations and other pollutants. Significant reductions in sediment loadings for 8 out of 10 subbasin stations. These reductions are thought to have a direct impact on Rock Creek because approximately 85% of the sediment in lower Rock Creek is wash load or sediment originating from irrigation return flow (Sterling, 1983).

Rock Creek contributions to the Snake River showed a 75% decrease in sediment loadings and a 68% decrease in phosphorus loadings. To a lesser degree, total organic nitrogen and volatile suspended solids concentrations have also declined.

Nitrogen and phosphorus concentrations remain higher than the recommended criteria for protection of cold-water biota, indicating that BMPs targeted at fertilizer management, grazing management, and animal waste management were insufficient.

Bacteria levels in Lower Rock Creek exhibited a slight decline, but continue to exceed primary contact standards. The primary bacteria sources are from cattle in pastures, rangeland, or confinement.

Fish populations in Rock Creek below the agricultural subbasins appear to have improved since 1981.

Substrate analysis for Rock Creek using percent composition, embeddedness, habitat evaluation procedures and artificial egg pocket and intragravel dissolved oxygen methods revealed that all stations remained impacted by fine sediment. Fine sediment increased from the headwaters to lower reaches and in areas of active bank erosion.

In-stream monitoring of beneficial uses, including salmonid spawning and primary contact recreation, showed that uses remain impaired on Lower Rock Creek (below S-6). However, if reductions in pollution (e.g., fine sediment) continue as past trends have indicated, Rock Creek could eventually fully support all designated in-stream uses (Maret et al., 1991).

Streambank erosion continues to be a major source of sediment reaching Rock Creek. The influx of sediment from streambank erosion makes it difficult to document the effectiveness of BMPs. From project estimates, the sediment contributions from the two major sources, streambank erosion and irrigation return flow, were similar in magnitude when the project began. In contrast, from 1987 to 1990, monitoring indicated that streambank erosion contributed two to over five times the amount of sediment added by cropland in the subbasins during the May to August irrigation season. This problem will continue to mask in-stream benefits from the RCWP land treatment.

The domestic wells did not show nitrate contamination, but did indicate possible bacterial contamination (Maret, 1990).

Ground water monitoring of tunnel drains indicated that nitrate concentrations range from 3.3 to 5.4 mg/L. Pesticides, particularly dacthal, were found in trace amounts in some drains.

Macroinvertebrate analysis has not shown any improving trends.

4.3.8 Linkage of Land Treatment and Water Quality

Monitoring results indicated that the BMPs implemented under the RCWP decreased the delivery of sediment and phosphorus to the agricultural drains and improved water quality in Rock Creek. This conclusion was drawn from the association that 8 of 10 subbasins have documented reduced loadings over the same time period that BMP implementation occurred.

The long pre- and post-BMP water quality and land treatment monitoring time frames, along with the high level of land treatment in the critical area, increased the ability to this project to document BMP effectiveness.

4.3.8 Linkage of Land Treatment and Water Quality (continued)

The downstream/upstream water quality monitoring data from the subbasins was used successfully to quantify sediment concentrations and loads to Rock Creek and to indicate which subbasins could benefit most from BMPs (Clark, 1985).

This project demonstrated that BMP effectiveness monitoring is important to evaluate implementation programs and their effects on off-site water quality.

Lack of participation and failure to implement BMPs can have a significant negative effect on monitoring results, particularly when the farm is located immediately upstream of a monitoring station.

A post-project analysis is being conducted to further analyze the water quality and land treatment / land use data.

Based on project experience and modeling, the two most critical parameters that affect soil erosion (as measured by suspended sediment load) are: 1) percent acres treated with BMPs and 2) the erosion index developed by project SCS personnel which is a function of crop type and field slope. Land use and crop data on an annual basis for each subbasin are being compiled to create an erosion index to be matched with water quality monitoring data.

The hydrologic characteristics of each subbasin are currently being entered into a GIS by SCS. A direct spatial (hydrologic) linkage between the land treatment and water quality data bases is currently being established to assist in evaluating land use/water quality relationships.

Multiple BMPs serving the same acres were tracked as individual BMPs. During the post-project analysis phase, the number of critical acres treated per subbasin-year is being calculated from the land treatment data base and the dominate BMP on each field is being identified to estimate sediment reduction leaving each field. The relative dominance of each BMP for this project was estimated by ARS.

4.3.9 Impact of Other Federal and State Programs on the Project

The Food Security Act (FSA) of 1985 had a significant impact. Technical assistance from SCS to the farmers for the RCWP decreased due to competing work commitments required for the FSA.

The General Permit for Confined Animal Feeding Operations in Idaho (U.S. EPA Region X) was passed into law in June 1987. Since by that time the deadline for RCWP contracts had already passed, the new law did not immediately serve to increase producer participation for animal waste management. Fines for violating the state permitting system should now serve to speed implementation of animal waste management. Existing RCWP contracts can still be modified to include animal waste management systems (BMP2).

4.3.10 Other Pertinent Information

None

4.3.11 References

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

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4.3.12 Project Contacts

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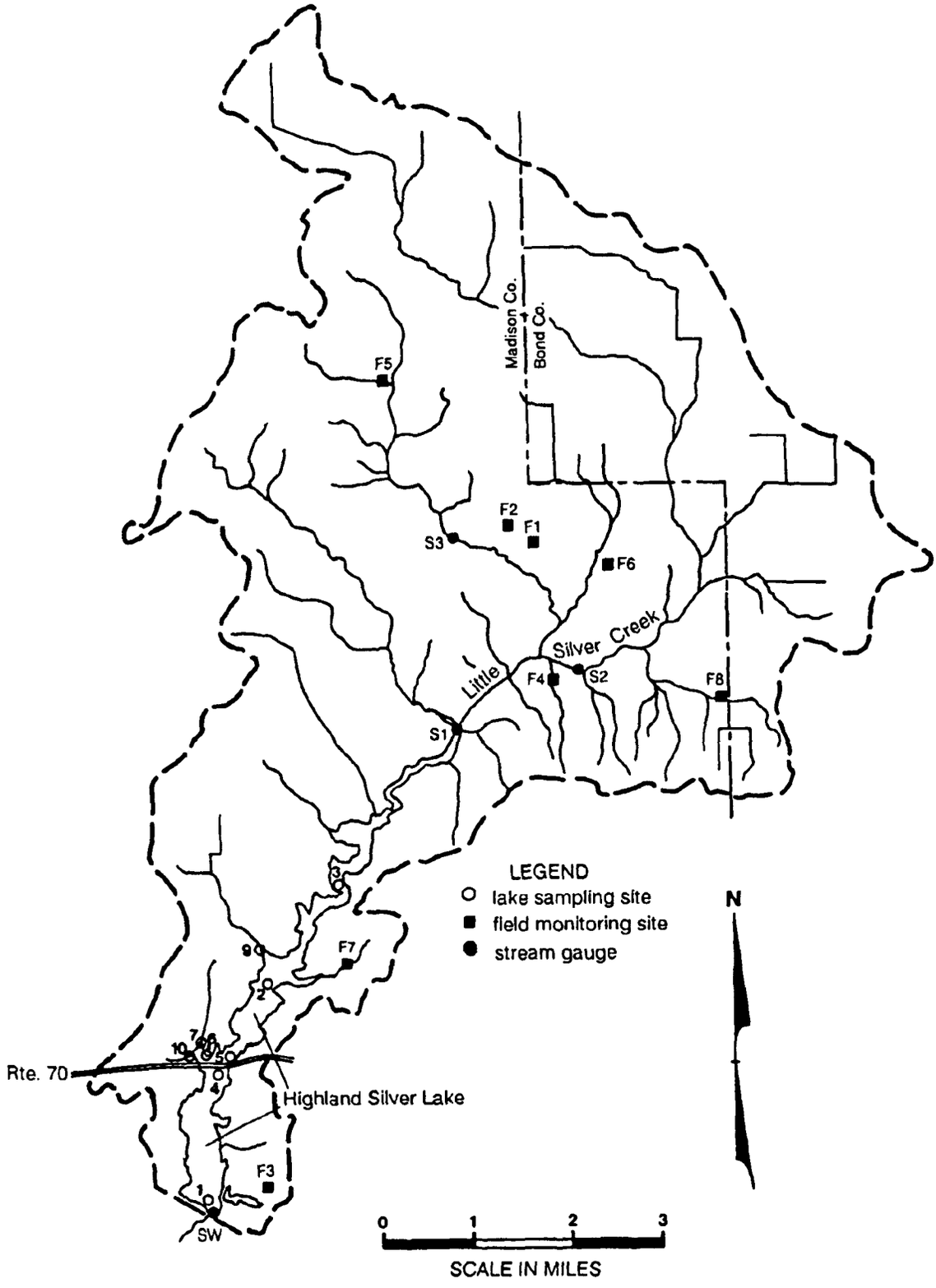
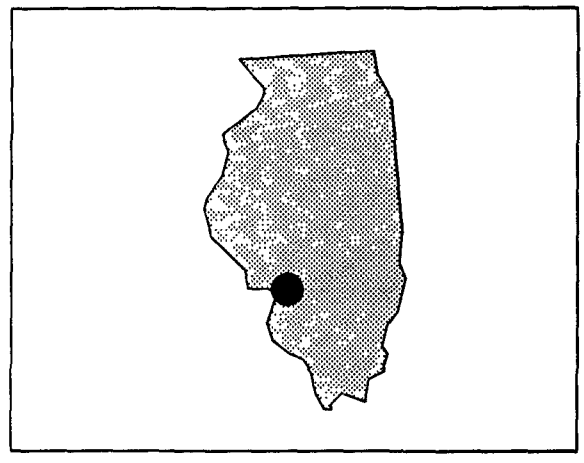


Figure 4.6: Highland Silver Lake (Illinois) RCWP project map, IL-1.

Illinois
Highland Silver Lake

(RCWP 4)



Madison County
MLRA: M-114
HUC: 071402-04

4.1 Project Synopsis

Silver Lake, located in southwest Illinois, was constructed in 1962 to provide a drinking water supply for the City of Highland. Anglers and boaters have also used the lake, but high turbidity levels have resulted in reduced recreational use and increased water treatment costs. Fine natric soil particles from cropland and resuspension of sediment are responsible for the turbidity problem. Project area land use is 82% cropland. Major crops include corn, soybeans, and wheat. There are approximately 20 medium- to small-sized animal operations in the watershed with a total livestock population of approximately 695 beef cattle, 1000 dairy cows, and 440 swine.

Critical areas were composed of crop and pasture lands characterized by fine-particle-size natric soils, high erodibility, and slopes greater than two percent. Also critical were crop and pasture lands of non-natric soils with slopes greater than five percent with high erodibility and close proximity to the water course. Feedlots were designated as critical based on animal units and distance to streams.

The water quality objectives of the project were to: 1) increase the useful life of the reservoir as a public water supply; 2) reduce water treatment costs and taste and odor problems; 3) improve habitat for sport fish by increasing water transparency; and 4) provide better boating, fishing, hunting and other recreational opportunities for users of Highland Silver Lake.

Best management practices (BMPs) emphasized in the project were conservation tillage, sediment retention basins, grassed waterways, animal waste management, and permanent vegetative cover. The land treatment teams were very effective in contracting and implementing BMPs; 83% of the cropland treatment goal was implemented and even a higher percentage was achieved for animal waste implementation. Contracting reached 118% of the goal.

Comprehensive monitoring and evaluation were conducted at the lake, tributary, and field levels. Tributary and field level water quality monitoring was conducted for less than three years and was essentially ineffective for assessing project or BMP effectiveness. However, lake monitoring showed that resuspension of particles was partly responsible for turbidity and that turbidity, not nutrients, was most important for limiting algae production. CREAMS modeling showed that no-till operations reduced sediment yield. AGNPS modeling helped to verify critical areas and to assess relative effectiveness of structural versus management BMPs.

Project management and administration were effective. A high level of land treatment was achieved because the information and education and land treatment teams worked together in reaching farm community leaders and tailoring technical services to match production, land resource protection, and water quality needs. Initially, the water quality problem was not clearly defined, nor was the critical area, creating difficulties for the project team in formulating effective project goals. Monitoring agencies were unable to design the program and organize resources to achieve meaningful experimental results.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

The project had a good set of overall objectives that were comprehensive and reflected the desired state for the designated use of Highland Silver Lake.

Initial project goals were not well formulated because they were based on the incorrect assumption that sedimentation and nutrient delivery had a significant effect on the impairment.

The pre-project sediment delivery ratio was determined to be 25%; however, further investigation revealed that the sediment delivery ratio is closer to 47%. The new ratio may be used to set land treatment goals.

4.2.1.2 Recommendations

Detailed water quality problem analysis should be the first step toward the development of effective goals.

If sedimentation is suspected as a problem, it should be quantified by using a sedimentation survey. This information can then be used to develop a goal of reducing sediment delivery.

If turbidity is the problem, then a detailed analysis of the sources (watershed, resuspension) of the turbidity is needed. This information, along with lake modeling, can be used to determine if setting a turbidity goal is reasonable. If turbidity can be reduced, then a quantitative reduction goal can be set.

A spatially distributed pollutant runoff model should be used to identify critical areas contributing to the sedimentation and/or turbidity problem. The model may also be used to set treatment goals.

Monitoring below suspected critical areas should be used to verify modeling results and should be used to characterize the water quality problem, which in turn makes setting goals more effective.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

The local project staff were successful in gaining participation, providing information and education, and installing BMPs. There was very good coordination of activities related to implementing practices. The local land treatment staff provided valuable land use and land treatment survey data to the water quality monitoring group. The Soil Conservation Service (SCS) and the Soil and Water Conservation District (SWCD) worked well together to complete farm plans, develop practice designs, and install BMPs. Coordination and planning was improved by the participation of the agency responsible for section 208 planning, the S.W. Illinois Metro-Area Planning Commission (SWIMPC).

The project suffered from an inadequate definition of the water quality problem and the critical area. A more complete analysis of lake algal production, nutrient dynamics, and factors affecting turbidity would have helped the project target specific pollutants and their sources in the watershed.

The project team met annually in early years with the State Coordinating Committee (SCC) but needed more meetings and feedback. The project would have benefited from SCC leadership on project direction. The SCC supported the project by requesting cost share for additional BMPs.

The SCC should have devised a land use / land treatment tracking system for use and by all agencies and for input into a geographic information system (GIS).

4.2.2.1 Findings and Successes (continued)

The project would have benefited from more guidance on reporting. In some cases, the local project personnel were unaware of the intended audience for a report or how the information would be used.

The content of the conservation plan and the requirement to complete the plan as determined by the county Agricultural Stabilization and Conservation (ASC) Committee is critical to the overall success of the land treatment program. Some farmers were very interested in treating gullies with grassed waterways, but were reluctant to implement conservation tillage to reduce sheet and rill erosion. Project administration would therefore determine if producers were required to complete the plan or if a change would be made to accommodate the wishes of the farmer and avoid the reduced tillage treatment.

The project was expected to accelerate the adoption of practices prior to having an adequate definition of the water quality problem and the critical area. The pressure to accelerate the adoption of practices meant less effort was spent on setting priorities. Loss of early planning opportunities diminished the project's effectiveness in targeting resources to the greatest need.

Water quality monitoring at field and stream sites was not synchronized with land treatment, providing little feedback to project staff on problem areas. Ninety percent of the contracts were written before there were any useful monitoring results on problem area runoff and the effectiveness of BMPs. Improved management of the water quality monitoring program, including continuation of the tributary and field site monitoring, would have supported critical area redefinition and strengthened the project.

Early in the project, there were some difficulties in selecting construction materials for some BMP components. Problems determining cost share rates on materials and labor were resolved through agency cooperation and communication with producers. Once procedures were established, the cost share payment system functioned smoothly.

4.2.2.2 Recommendations

The SCC should provide technical leadership in the definition of the water quality problem and the critical area before BMPs are adopted. Projects always benefit from a carefully developed problem statement.

The SCC should provide technical leadership in the timing and intensity of water quality monitoring to match the goals of the project. Projects should make individuals accountable for successful implementation of a monitoring program.

Projects should have an overall coordinator with some authority to develop a timetable for land treatment and water quality monitoring consistent with trend detection.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

It was not clear if educational methods or technical assistance for implementation of nutrient management utilized in the information and education (I&E) program were effective.

Pre-project I&E would have reduced the contracting period (Illinois State Coordinating Committee, 1986) by making farm operators aware of the need for adopting structural and management practices.

SCS and the SWCD utilized 95% of the total I&E and technical assistance funds expended for treating the turbidity problem.

The primary activities of the Extension Service (ES) were I&E and technical assistance for nutrient management and conservation tillage.

4.2.3.1 Findings and Successes (continued)

Land treatment technical staff for cropland conservation practices gained the trust of producers despite technical difficulties related to critical area determination, critical area treatment, new BMPs, and soils that made construction difficult.

4.2.3.2 Recommendations

The project would have benefited from having an I&E agent to work with producers nearly full time on conservation tillage and critical area stabilization. The special problems associated with drainage and natric (sodic) soils required special attention.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

Producer participation was very good to excellent. More pre-project I&E would have reduced the contract period, but might not have increased the total number of participants or practices installed.

Factors that motivated producers' adoption of practices included cost sharing, seeing conservation and aesthetic improvements on a neighbor's farm, and interest in natural resource conservation and water quality improvements in the lake.

Economics was the primary barrier to participation. Many farmers waited to see how new practices would affect production and labor before adopting them. Some farmers resented the City of Highland for condemning farmland in 1962 to create the lake and, for this reason, refused to participate in the project. The project also lacked technical assistance in the form of soil conservationists for I&E, which decreased effectiveness of I&E efforts.

The chances of continued maintenance and adoption of practices seems to be good, but they are dependent upon the practice. Structural practices will most likely be maintained. Continued tillage and residue management is less likely due to poorly drained soils. No-till, reduced tillage, and sufficient residue levels may not be maintained. There is also a question as to whether nutrient management will be maintained.

4.2.4.2 Recommendations

This project serves as a model for producer participation. The U.S. Department of Agriculture (USDA) agencies, SWIMPC, and local agencies worked well together and achieved a high rate of contracting and implementation.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

The project team had difficulty defining the critical area because the water quality problem and impairment of designated use were not clearly identified at the start of the project. Project personnel determined implementation goals to treat the lake sedimentation and turbidity problem and the original critical area was selected to target erosion and runoff from cropland. The use of soil maps that did not indicate areas where slopes were less than 2% resulted in overestimation of the actual critical area. Field investigations were used to delineate a revised critical area based on both soils and slope.

Watershed monitoring studies indicated that suspended sediments were from natric soils with slope less than 2%. If the project team had had access to this information at the beginning of the project, the critical area would have been more narrowly defined based on treatment of natric soils. There are some natric soils in the watershed that are not currently in the critical area that should be considered if a new critical area was developed.

4.2.5.1 Findings and Successes (continued)

Many farm fields contained both natric and non-natric soils. Although the land treatment goal was to treat natric soils, farm fields were treated as single units for practical reasons. The result was lower crop productivity on non-natric soils treated with conservation tillage. Management was a key factor in the success of no-till and reduced till for fields where only part was poorly drained.

Farmers should have received more follow-up assistance from the technical agencies on the proper implementation of cost shared fertilizer management. Once a soil test was taken, farmers needed assistance to assure that proper levels of nutrients were being applied to minimize losses. The Extension Service had the responsibility as the technical agency for nutrient management but may not have had the staff to follow up and monitor implementation.

The SCS did a good job of follow-up with assistance to farmers on conservation tillage in order to ensure that farmers continued the practice after the three-year cost sharing period expired.

4.2.5.2 Recommendations

Water quality monitoring should be timed so that results may be used to refine the problem statement or critical area definition. The design of land treatment and water quality monitoring programs should reflect the need for on-going feedback and refinements in both areas.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

The monitoring strategy was developed to quantify important hydrologic factors affecting water quality. The overall design of lake, stream, and field monitoring was appropriate and well supported for comprehensive monitoring. The primary difficulty was too much concentrated monitoring at the start of the project, which exhausted funds for much further work.

The primary impairment of designated uses was turbidity. The respective contributions of algal and nonalgal turbidity to the water quality problem were not known. The Illinois Environmental Protection Agency (ILEPA) indicated that lake productivity is light limited and not nutrient limited, and that the current ratio of nitrogen to phosphorus in the water column may encourage the production of bluegreen algae if transparency improves.

One of the most common mistakes made in monitoring programs is the sampling of many variables (similar to ambient monitoring strategies) Trend detection is very specific and the number of variables monitored is much lower than in monitoring programs designed to assess overall conditions.

Field sampling requires carefully controlled conditions and is essentially research on the effectiveness of individual BMPs or BMP systems.

4.2.6.2 Recommendations

Stream sampling should be implemented for the duration of nonpoint source (NPS) projects, reflecting pre- during- and post- implementation periods. The paired watershed design or the upstream-downstream design is preferred. Stream sampling protocols should follow the USEPA 319 National Monitoring Protocol. Water quality variables and covariates measured should reflect the impairment and should avoid typical ancillary variables that do not support trend detections goals.

Future monitoring of the Highland Silver Lake project should be directed toward trend detection with a smaller number of variables sampled at a greater frequency. Variables measured should be more directly related to characterizing the nonalgal and algal portions of the turbidity problem. The nutrient series does not need to be measured as often and can be reduced to spring turnover, and once during the peak growing season. Sampling at the three stations should be more frequent (e.g. weekly or biweekly) during high precipitation seasons to reflect storm event effects on turbidity.

4.2.6.2 Recommendations (continued)

Water supply reservoir sampling for trend detection should be reduced to three main stem stations: 1) near the water supply intake, 2) mid- lake, and 3) one lake station near the tributary receiving the bulk of turbid inflow. The mid-lake and tributary stations are less important, but can help in analyzing relative contributions of inflows and resuspension to turbidity.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

The monitoring program was ineffective in linking land treatment to water quality. However, the overall strategy of field, tributary, and lake monitoring might have shown a linkage for some variables if the monitoring design had been changed.

4.2.7.2 Recommendations

In order to improve monitoring design to link water quality and land treatment, the number of uncontrolled variables should be reduced; monitoring should be conducted before, during, and after implementation; and changes in treatment and covariates should be quantified throughout the study.

4.3 Project Description

4.3.1 Project Type and Time Frame

Comprehensive Monitoring and Evaluation (CM&E) RCWP Project

1980 - 1990

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Highland Silver Lake (600-acre impoundment) and tributaries

4.3.2.1.2 Water Uses and Impairments

Highland Silver Lake provides a public water supply for about 8,500 residents in the county. Several industrial firms located in the city of Highland also use the lake for water supply. Non-contact recreational use of the lake includes boating, fishing, and waterfowl hunting.

Use of the lake is impaired by suspended sediments, and, potentially, nutrients and contaminants in fish. High turbidity levels are caused by suspension and resuspension of fine natric soil particles. Excessive nutrient concentrations contribute to eutrophic conditions. Agricultural chemicals in surface runoff entering the lake may be a public health concern (Madison County Soil and Water Conservation District, 1979).

4.3.2.1.3 Water Quality Problem Statement & Status

Sedimentation, high turbidity, and eutrophication impair non-contact recreational uses of the lake. High turbidity levels are caused by sediment delivered to the lake and in-lake resuspension of fine natric soil particles. Erosion and runoff from croplands are the primary sources of pollutants.

4.3.2.1.4 Water Quality Objectives and Goals

Water quality objectives for the project include:

Increase the useful life of the reservoir as a public water supply

Reduce water treatment costs and taste and odor problems

Improve habitat for sport fish by increasing water transparency

Provide better boating, fishing, hunting, and other recreational opportunities for users of the Highland Silver Lake resource.

Water quality goals include:

Reduce sediment delivered to the lake by 60% (with parallel reductions in phosphorus and organic nitrogen)

Increase lake transparency to greater than 2 feet and reduce suspended solids to less than an average of 25 milligrams per liter (mg/l)

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 30,946 acres
Project Area: 30,348 acres
Critical Area: 6,525 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Precipitation: annual = 43 inches

Geologic Factors: Soils in the project area are almost entirely glacial in origin. Topography ranges from nearly level to very gently sloping.

4.3.2.2.3 Project Area Agriculture

Major crops grown in the watershed include corn, soybeans, and wheat. Beef cattle, dairy cows, and hogs are also raised.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	82	100
Pasture/range	5	-
Woodland	4	-
Urban/roads	2	-
Other	7	-

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Beef	NA	NA	944
Dairy	NA	NA	760
Hogs	NA	NA	1,178

The project area has 20 animal operations.

4.3.3 Total Project Budget

SOURCES / ACTIVITY	Federal	State	Farmer	Other	SUM
Cost Share	1,502,372	5,000	466,990	0	1,974,362
Info. & Ed.	47,738	0	0	0	47,738
Tech. Asst.	462,560	0	0	109,427	571,987
Water Quality Monitoring	1,479,483	3,846	0	245,963	1,729,292
SUM	3,492,153	8,846	466,990	355,390	$4,323,379

Source: Illinois State Coordinating Committee, 1986

4.3.4 Information and Education

4.3.4.1 Strategy

Control livestock waste through prevention of runoff from livestock operations

Erosion and sediment control to reduce sediment delivery

Nutrient management through fertility programs

Pesticide management through proper application

4.3.4.2 Objectives and Goals

Help people in the watershed area understand the water quality problem

Help people in the watershed understand the impact soil erosion has on water quality

Assist landowners and operators in using plant nutrients in such a way that good water quality can be maintained.

Help landowners and operators use pesticides in a manner that contributes to the maintenance of good water quality

Help livestock operators understand the best methods of handling livestock waste to maintain good water quality

Help landowners learn how to estimate soil losses

Help landowners and operators understand the cost and benefit of the various soil and water quality management practices on their farm operation

Help landowners and operators understand the principles of good soil conservation

4.3.4.3 Program Components

Letters to producers about the RCWP project

Meetings with potential participants about the RCWP project

Field demonstrations of BMPs

Tours of demonstration farms

Field spot checks related to RCWP contracts

4.3.5 Producer Participation

4.3.5.1 Level of Participation

Participation was good to excellent.

4.3.5.2 Incentives to Participation

Cost share rate of 75%

Payment limit of $50,000 per landowner

Extension I&E and SCS technical assistance

Encouragement from other farmers and demonstrations of recommended BMPs

4.3.5.3 Barriers to Participation

The dislike for government programs and economic conditions were leading barriers to participation.

Farmers also did not like to be told how to farm, felt current farming systems worked well enough, and thought changing practices was too much trouble.

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Chances are greater than 80% that most critical area BMPs will be maintained, according to a survey of project personnel conducted by the National Water Quality Evaluation Project at North Carolina State University.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The land treatment strategy was to increase ground cover, decrease velocity of surface runoff, and improve management of livestock waste.

4.3.6.2 Objectives and Goals

Reduce the amount of animal waste entering the water by applying waste management systems on 10 swine, five beef, and five dairy operations

Reduce the amount of sediment and sediment related pollutants entering the lake by applying BMPs on 10,500 acres through 85 RCWP contracts

Reduce sediment delivered to the lake by 60%

4.3.6.3 Critical Area Criteria and Application

Criteria:

Crop and pasture lands composed of natric soils with fine particle size and high erodibility and slopes greater than 2%

Crop and pasture lands of non-natric soils with slopes greater than 5% with high erodibility and close proximity to water courses

Animal operations were prioritized according to the number of animal units and distance to stream.

4.3.6.3 Critical Area Criteria and Application (continued)

These criteria were found to be a fairly accurate assessment of high pollutant source areas according to the AGNPS modeling results.

Application of Criteria: The criteria were followed carefully in selection of farm fields for contract.

4.3.6.4 Best Management Practices Used

The project used practices designed to increase ground cover, decrease the velocity of surface runoff, and improve the management of livestock waste.

BMPs Utilized in the Project*:

Permanent vegetative cover (BMP 1)

Animal waste management system (BMP 2)

Terrace system (BMP 4)

Diversion system (BMP 5)

Waterway system (BMP 7)

Cropland protection system (BMP 8)

Conservation tillage systems (BMP 9)

Stream protection system (BMP 10)

Permanent vegetative cover on critical areas (BMP 11)

Sediment retention, erosion, or water control structures (BMP 12)

Tree planting (BMP 14)

Fertilizer management (BMP 15)

*Please refer to Appendix I for description/purpose of BMPs.

Quantified Project Achievements:

Pollutant Source	Units	Critical Area		Treatment Goals	
		Total	% Contracted	Total	% Implemented
Acres	#	6,525	82%	4,894	83%
Cattle farms	#	695	119%	521	143%
Dairy farms	#	727	80%	545	84%
Hog farms	#	1,116	23%	837	138%
Contracts	#	125	89%	94	118%

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

BMP implementation was reported by units applied (acres, systems, feet). Data on animal units, tons of manure, and tons of phosphorus and nitrogen from manure treated by BMPs were recorded. Conservation Reserve Program (CRP) enrollment within the project area was also reported.

4.3.6.5.2 Data Management

Land use monitoring data were collected at the field, subwatershed, and watershed levels for analysis with water quality data.

The project had two detailed land use / land treatment surveys early in the project. Illinois State Water Survey had a GIS system and some watershed data was used in the system.

4.3.6.5.3 Data Analysis and Results

Not available

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

Conducted by the Illinois Environmental Protection Agency and Illinois State Water Survey.

The monitoring approach was designed to consider event and non-event sediment loadings and to measure BMP effectiveness at the field, stream, and lake levels.

4.3.7.2 Objectives and Goals

Determine if BMP application reduces sediment and nutrient loads sufficiently to achieve the following four goals:

Improve recreational potential by increasing aesthetic appeal
Improve sport fishing and aquatic habitat
Increase "useful life" of the reservoir
Minimize water treatment costs and taste and odor problems

4.3.7.3 Time Frame

Intensive monitoring supported by CM&E funding from December 1981-October 1985

Ambient lake monitoring continued from 1986 through 1990

Lake stations: May 1981 - 1990

Stream stations: January 1982 - October 1984

Field sites: spring 1982 - October 1984

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

9 lake sites and 1 lake outflow site
3 stream sites
8 field sites (7 cropland sites from 29 to 332 acres; 1 livestock waste management system)

4.3.7.4.2 Sample Type

Lake sites: grab (automatic at spillway)
Stream sites: automatic
Field sites: automatic

4.3.7.4.3 Sampling Frequency

See sections 4.3.7.4.4 and 4.3.7.4.7 below

4.3.7.4.4 Variables Analyzed

Lake: Total suspended solids (TSS), total volatile solids (TVS), turbidity, total phosphorus (TP), dissolved phosphorus (DP), nitrate and nitrite nitrogen (NO_2-N+ NO_3-N), ammonia nitrogen (NH_3-N), total kjeldahl nitrogen (TKN), temperature, dissolved oxygen (DO), pH, conductivity, total alkalinity, chlorophyll *a*, and metals (monthly)

Stream and lake spillway: TSS, TVS, turbidity, temperature, DO, pH, and conductivity (three times per week)

TP, DP, TKN, NO_2+ NO_3-N, NH_3-N (twice a month)

Total alkalinity, chlorophyll *a*, and metals (monthly)

Field: TSS, TVS, turbidity, TKN, TP, chemical oxygen demand (COD) (event-based)

4.3.7.4.5 Flow Measurement

Spillway: daily
Streams: continuous
Field Sites: H-flumes for continuous stage records during runoff events

4.3.7.4.6 Meteorologic Measurements

Precipitation: 3 sites in watershed

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

Biomonitoring: macroinvertebrates monitored near stream sampling sites twice per year
Channel & streambed surveys: December 1981 & November 1984
Sedimentation surveys: lake and bay - July 1981 / lake - September 1984

4.3.7.5 Data Management

Data from lake stations are in STORET. Other data are managed locally and by the Illinois State Water Survey.

STORET AGENCY CODE	STORET STATION NO.	PROFILE / STATION MAP / NO.
21ILLAKE	RO-A04ZA-1	IL-1 / 1
	RO-A04ZA-2	IL-1 / 2
	RO-A04ZA-3	IL-1 / 3
	RO-A04ZA-4	IL-1 / 4
	RO-A04ZA-5	IL-1 / 5
	RO-A04ZA-6	IL-1 / 6
	RO-A04ZA- 7	IL-1 / 7
	RO-A04ZA-9	IL-1 / 9
	RO-A04ZA-10	IL-1 / 10

4.3.7.6 Data Analysis and Results

Analysis:

For field sites, pollutant runoff data was summarized by event into an event mean concentration (EMC). Trends in EMCs for total suspended solids, total volatile solids, and turbidity were analyzed. Multivariate analysis was used to determine variables that would effect loading rates.

Trend analysis of EMCs and multivariate analysis of loads were both inconclusive. Each type of analysis suffered from lack of good experimental design and control of important factors such as land use. The length of the study was also a major factor, because only a few events were measured.

To assess temporal and spatial trends of tributary sites, the data were stratified by periods conforming to typical agricultural patterns in the watershed (Kelly and Davenport, 1986). Periods were defined as follows:
Period 1 (P1): fertilizer, seedbed and establishment (April-June)
Period 2 (P2): reproduction and maturation (July-November)
Period 3 (P3): residue (December-March)

Data were routinely analyzed by site, sampling year, period, and by period-sampling year. Multiple comparison of means was accomplished using Tukey's studentized multiple range test. Pearson's product moment correlation coefficients were routinely calculated for various stratifications of data (temporal and spatial) and resultant matrices examined for significant correlations. If significant correlations were found, they were examined by scattergrams to insure that a significant relationship did exist. When appropriate, multiple linear regression analysis was used. Cluster analysis followed by canonical discriminant analysis was also used on field site event data to determine which variables were most important in accounting for variance in runoff water quality.

Lake water quality data were analyzed graphically and using regression analysis.

Results:

Lake data from 1980-1990 showed limited improvements. Average annual Secchi transparency increased from 10 inches in early project years to 12 inches from 1985-1990. The project goal was to increase Secchi transparency to 24 inches. Total suspended solids also improved with an early project mean of 40 milligrams per liter (mg/l) and a reduction to an average of 33 mg/l in latter years. The project goal was 25 mg/l (Hite and Bickers, 1991).

Annual weighted lake means for turbidity, volatile suspended solids, and total ammonia showed limited reductions in later project years. Chlorophyll *a* concentrations increased significantly when regressed with BMP implementation (Hite and Bickers, 1991).

Analysis of changes in lake quality due to BMP implementation was confounded by resuspension of fine natric soil particles from the sediment, low particle settling velocity, lake turnover, and wind action. These factors are difficult to distinguish from the effects of reduced watershed loadings.

A sedimentation survey indicated an average annual capacity decrease by 0.67 %. This rate does not pose a threat to use of the lake for municipal water supply.

Generally dry conditions with few rainfall events resulted in a small, sporadic, stratified data set from the field monitoring sites (Makowski et al., 1986). The data were used to calibrate the CREAMS model. CREAMS results indicated that no-till is effective in reducing sediment yield. Results also indicated that contouring, grassed waterways, and grade stabilization structures are effective in reducing sediment yield (Davenport, 1984).

4.3.8 Linkage of Land Treatment and Water Quality

The project was unable to link land treatment and water quality.

4.3.9 Impact of Other Federal and State Programs on the Project

None

4.3.10 Other Pertinent Information

None

4.3.11 References

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

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Makowski, P.B., M.T. Lee, and M. Grinter. 1986. Hydrologic Investigation of the Highland Silver Lake Watershed: 1985 Progress Report. SWS Contract Report 380. Illinois Dept. of Energy and Natural Resources, State Water Survey Div., Surface Water Section at the University of Illinois, Champaign, IL.

4.3.12 Project Contacts

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Information and Education

None

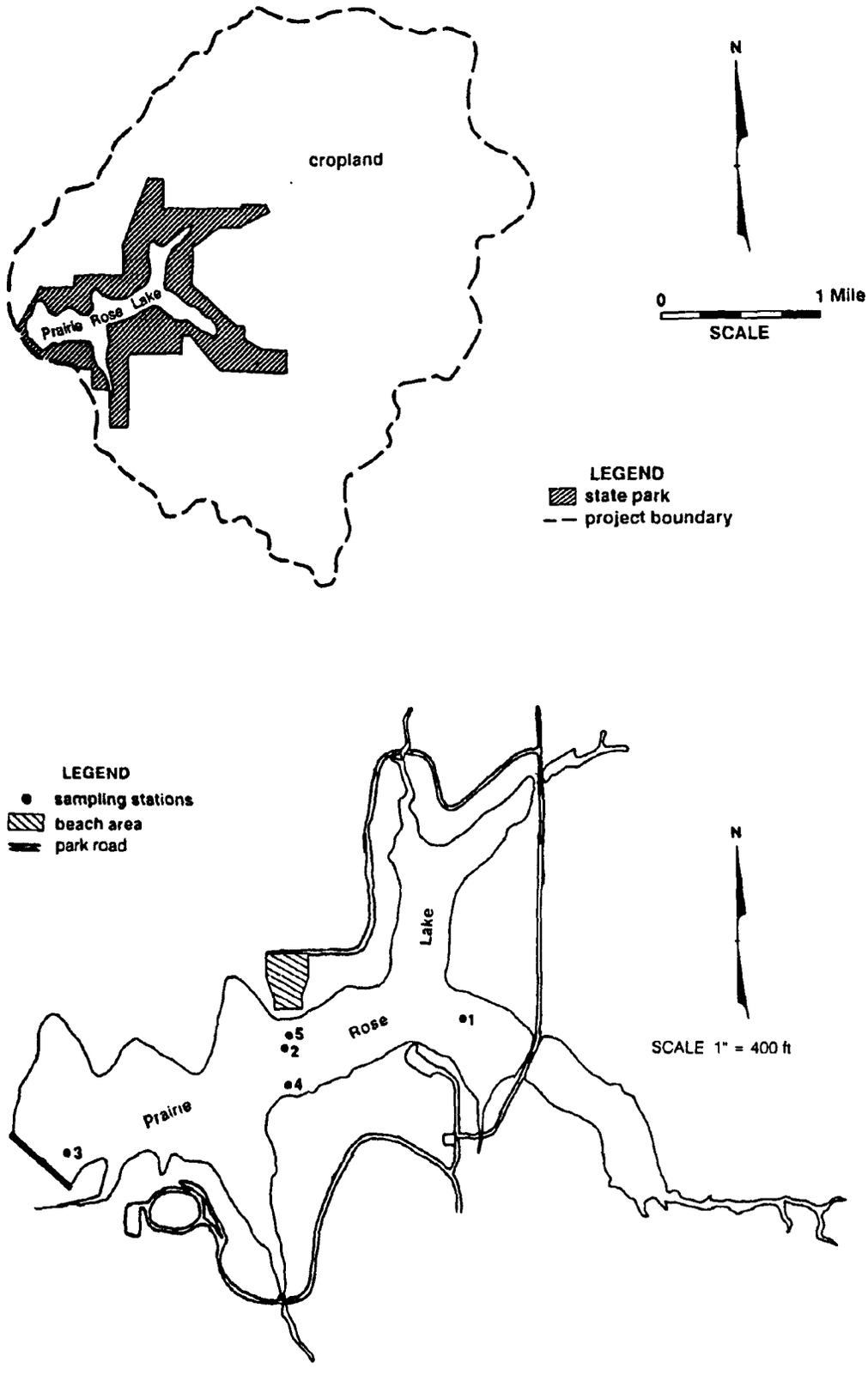
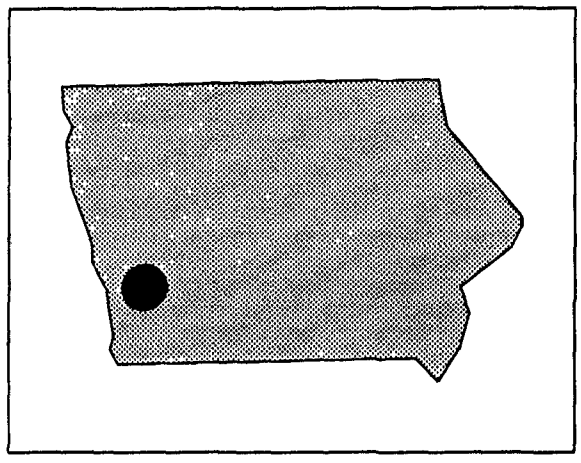


Figure 4.7: Prairie Rose Lake (Iowa) RCWP project map, IA-1.

Iowa
Prairie Rose Lake

(RCWP 5)



Shelby County
MLRA: M-107
HUC: 102400-020

4.1 Project Synopsis

Prairie Rose Lake is a 215-acre impoundment located within a state park in west central Iowa about 75 miles west of Des Moines. The Prairie Rose Lake RCWP project encompassed the surrounding 4,610-acre bowl-shaped watershed, of which almost 80% (3,648 acres) is cropland. The lake and adjacent state park comprise 648 acres within the watershed, which drains into the lake.

All of the area except the state park was identified as critical area. Soils in the watershed are subject to severe erosion.

The lake and adjacent state park comprise an important local recreational resource for fishing, boating, swimming, camping, and other activities. Sediment in runoff from the surrounding cropland was causing turbidity and loss of lake volume and surface area. Approximately 19% of the lake volume and 10% of the lake area was lost between 1971 and 1980. Sediment damage to spawning areas of desirable game fish resulted in decreased populations. Nutrients and pesticides entering the lake were also of concern due to the fact that the lake is a source of drinking water for the state park and a major fishing resource for that part of the state. Algae blooms were occurring.

The major goal of the project was to reduce sediment yield from excessively eroding cropland.

Best management practices (BMPs) implemented through the project consisted of management and structural sediment control practices, animal waste controls, and fertilizer and pesticide management practices.

The project was well received by landowners in the watershed, who were already aware of the water quality problems in the lake. Thirty-four producers (92%) in the project area participated in the RCWP project. Ninety percent of the critical area was treated (83% through RCWP and 7% through other programs). Fertilizer management and Integrated Pest Management were implemented on 27 farms totaling 2,379 acres.

A water quality monitoring program was conducted in the lake by the Iowa Department of Natural Resources. A confounding factor in the water quality data analysis was the effect of the draining and restocking of the lake in the fall of 1981.

Water clarity was highest in 1982-83, following draining of the lake. Since then, water clarity has deteriorated to pre-RCWP levels. Reduction in sediment delivery due to adoption of conservation practices may have improved water clarity, but algal density has increased, apparently because of greater light penetration. Recreational lake use has increased. Users perceive water quality improvement, although monitoring data cannot document this.

The Prairie Rose Lake RCWP project demonstrates that a very high rate of implementation is possible in a voluntary nonpoint source (NPS) control project. Inter-agency cooperation was exemplary at both the local and state levels. Producer participation was excellent due to a number of factors, including 1) a highly visible water quality problem in a valued recreational lake, 2) strong leadership within the farm community, 3) a strong positive relationship between the park ranger and landowners in the watershed, 4) a previously existing conservation ethic within the community, and 5) pre-project work by the participating agencies encouraging community involvement in and support for the project. Other factors that contributed to the success of the project were: substantial amounts of money available for cost sharing, preferred BMPs (terracing in this case), a strong technical assistance program, active publicity programs, services to assist farmers in fertilizer management and integrated pest management, and good economic years during the beginning of the RCWP project.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

The cause of the water quality impairment was clearly understood and there was consensus within the community about the source of the problem. As a result, the water quality and land treatment goals were well defined, realistic, and adequate to guide project development and evaluate progress.

4.2.1.2 Recommendations

None

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

Interagency cooperation at both the local and state levels was exemplary and contributed significantly to the success of the project. The physical proximity of the participating agencies facilitated frequent and effective communication about the project. The annual report served as a method for keeping all participants informed about all aspects of the project.

The Agricultural Stabilization and Conservation (ASC) County Committee chairperson headed the Local Coordinating Committee (LCC) and was responsible for developing and administering the RCWP program. The LCC coordinated the implementation by participating agencies of the RCWP work plan.

4.2.2.2 Recommendations

Up front payment (versus three smaller payments) to producers for implementation of conservation tillage practices would allow the cooperators to purchase equipment and would reduce administrative expense and problems (Lawyer et al., 1991)

In projects where considerable state or other publicly-owned land is included in the drainage area, a commitment to implement needed practices by the public landowner should be obtained. This could be accomplished by inventorying public land and signing an agreement at the initiation of the project. (Lawyer et al., 1991)

Purchase of expensive conservation tillage equipment by the soil and water conservation district for demonstration and loan purposes at the initial stages of a project can facilitate adoption of practices that require a large initial outlay of capital.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

The Cooperative Extension Service (CES) coordinated a strong information and education program, assisted by the Soil Conservation Service (SCS) and the Agricultural Stabilization and Conservation Service (ASCS). Cooperation among the agencies was excellent and essential for the success of the project.

Three public meetings were held to inform the community about the RCWP project before the application was submitted were effective in helping to get the project off on a fast start once funded.

4.2.3.2 Recommendations

Involvement of the affected community in project planning prior to submission of an application for funding contributes to community ownership and involvement in the project.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

Landowner participation was high, with 34 landowners signing contracts for over 83% (3,239 acres) of the critical area (Lawyer et al., 1991).

A high rate of BMP implementation was possible because the water quality problem as well as the project objectives and goals were clear.

The practices recommended for improving the water quality of the lake were considered desirable by the landowners. Farmers recognized the need for terracing to prevent soil erosion, and they believed this practice would improve the quality of the recreational lake.

Assistance in the form of cost sharing, soil testing, and pest scouting helped promote this project.

The water quality problem was highly visible to producers. After heavy rains the lake was filled with cornstalks, indicating extensive surface runoff directly into the lake. Residents could see the reduction in lake area and notice the decrease in desirable fish species. These factors helped motivate farmers to become involved in the project.

There was a strong sense of community in the project area and strong leadership by community leaders who were also producers. These factors, as well as the high cost share rate, contributed to the high rate of producer participation.

4.2.4.2 Recommendations

Producers should be involved in project selection and development so that they will feel committed to the project once it is funded.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

Ninety percent of the critical area was treated (83% through RCWP and 7% through other programs), exceeding the project goal of treating 75% of the critical area.

Through the cooperative efforts of private landowners and a number of federal, state, and local agencies, the Prairie Rose Lake RCWP project made substantial progress in reducing sediment and nutrient delivery to the lake (Link, 1991).

Soil losses in the watershed were reduced from a pre-project level of 80,800 tons per year to a current level of 19,000 tons per year. Assuming a sediment delivery ratio of 32%, the annual sediment delivery to the lake has been reduced by 76%, from a pre-project level of 26,300 tons to a current level of 6,200 tons (Link, 1991). This reduction has slowed the rate of lake volume change compared to the pre-project period.

Data from participating farmers indicates that the nutrient management program influenced their use of fertilizers, with average application rates of phosphorus declining from 44 to 20 pounds per acre for corn and from 55 to 6 pounds per acre for soybeans (Link, 1991).

Two-foot contour maps were helpful in selling a terrace- contour program because they enabled the producer to readily visualize what the implemented BMP would look like.

One-to-one contact was important in gaining the participation of producers.

4.2.5.2 Recommendations

If pesticide and nutrient management are included as BMPs in a project, the Cooperative Extension Service (CES) should hire a management specialist locally to get the program started.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

Water clarity has increased during most seasons of the year, and lake turbidity no longer routinely increases following runoff events.

Water quality monitoring indicates that sediment has become secondary to algae as the cause of turbidity following implementation of erosion control practices. Algal growth during late summer periods appears to be increasing, due to a combination of high in-lake nutrient levels and decreased sediment related turbidity levels.

Water clarity was highest in 1982-83, following draining of the lake and restocking of fish in the fall of 1981 in an attempt to improve the fishery. Since then water clarity has deteriorated to pre-RCWP levels. Analysis of biweekly data shows that year-to-year variability is greater than within-year variability.

Although it may appear that the RCWP project has simply changed the lake's water quality problem from one of excessive sedimentation to one of problematic algal growth, it is important to recognize that sedimentation was threatening the very existence of the lake. The problems associated with algal growth are minor as compared to the previous sedimentation problem. (Link, 1991)

Recreational lake use has increased. Users perceive water quality improvement, although monitoring data do not confirm this.

Clarity improvement from reduced sediment loading may be masked by turbidity due to algal growth increase. Monitoring data are highly variable. After correcting for both precipitation and chlorophyll *a*, there is no significant trend over time.

Monitoring sediment concentrations (weight/water volume), as was done with chlorophyll *a* concentrations, would have been useful for interpretation of changes in turbidity and estimation of sediment and algal contributions to turbidity levels in the lake. A physical separation, characterization, and quantification of sediment particulates would have made possible a direct determination of whether sediment concentrations were decreasing, increasing, or remaining stable with respect to base period measurements. This, in turn, would have helped the project team to relate sediment to turbidity. (Lawyer et al., 1991)

Draining of the lake and direct manipulation of the fish population may have obscured some water quality results.

4.2.6.2 Recommendations

Draining of a lake located in an experimental study should not be conducted unless all project participants have been informed and plans have been made to account for changes in water quality due to the draining as opposed to land treatment or other experimental activities.

A sedimentation survey of a lake may be used to determine the current rate of sedimentation if baseline survey results are available for comparison.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

The Prairie Rose Lake RCWP project appears to have been successful in meeting its primary water quality goal of reducing sediment loads entering the lake from the watershed. Evidence of the effectiveness of the project BMPs was a slowed rate of lake volume change (measured using lake contour map information) during the project period. Water quality data indicate that sediment became secondary to algae as a cause of turbidity, thus lending support to the thesis that land treatment implemented through the project was effective in reducing sediment delivery to the lake. (Lawyer et al., 1991)

4.2.7.1 Findings and Successes (continued)

Lack of a longer-term pre-BMP implementation data base and the mid-project draining of the lake hindered the project team's ability to document a clear land treatment - water quality link.

Recreational use of the lake increased during the project period. This may be at least partially attributable to the attention it has received as an RCWP project as well as user perceptions that the water quality of the lake has improved.

Reduction of the sedimentation problem by extensive adoption of conservation practices (primarily terracing) may have improved water clarity, but this appears to have allowed algal density to increase. Evidence suggests that BMPs have not reversed eutrophication.

The loss of lake volume to sedimentation has been significantly slowed.

4.2.7.2 Recommendations

Pre-BMP implementation water quality monitoring (and funding to support such monitoring) is essential if a project is to document land treatment - water quality links.

The water quality changes observed in relation to the RCWP project indicate that implementing BMPs in the watershed surrounding a lake will not necessarily correct all of the lake's water quality problems. Other measures may be needed. (Link, 1991)

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1980 - 1991

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Prairie Rose Lake

215-acre impoundment

4.3.2.1.2 Water Uses and Impairments

Prairie Rose Lake is a man-made lake located in one of the largest parks in west central Iowa. The lake is used for swimming, boating, and fishing by about one-quarter of a million park visitors each year. The lake also provides a source of drinking water for a state park.

Use of the lake is impaired by sediment, turbidity and agricultural chemicals. The lake is eutrophic.

4.3.2.1.3 Water Quality Problem Statement

Swimming, boating, fishing, and related recreational activities were impaired by eutrophic conditions and by accumulations of sediment. Lake turbidity increased after significant runoff events.

Lake water quality has been impaired by loadings of agricultural nutrients and pesticides, often attached to eroded soil particles.

Between 1971 and 1980, 10% of usable boating and fishing areas and 19% of lake volume were lost due to sedimentation.

Total recreational use of the lake increased from 1981 to 1985 before declining in 1986 to the lowest level since 1981. Fishing use decreased from 1981 to 1983, following a total fishery renovation, but increased from 1983 to 1985. Use of the swimming beach also increased annually from 1981 to 1985. (Increased swimming use may have been a reflection of improved public perception of lake aesthetics. Construction on the park access road in the latter part of 1985 may have depressed the annual increase of park visitors and contributed to decreased user totals in 1986. The sudden decline in lake use in 1986 may be attributable to the institution of a state park user fee, predominantly wet weather, and additional roadway construction.)

There has been no documented decrease in turbidity since the RCWP began. Water quality monitoring data indicate high variability with no consistent trend in surface turbidity and water clarity. Chlorophyll *a* concentration may explain a large portion of this variability, and improved clarity may be masked by increasing algal growth.

Draw down and fish toxicant applications in the Prairie Rose Lake in 1981 may have resulted in the relatively high water clarity observed in 1982 and 1983.

4.3.2.1.4 Water Quality Objectives and Goals

Water quality objectives:

Reduce the impacts of sediment from the watershed on in-lake turbidity levels and the lake's fisheries

Reduce the rate at which sedimentation was reducing the lake's depth, area, and volume

Reduce the impacts of other NPS pollutants (nutrients, pesticides, and animal wastes) on the lake's water quality; and designated uses.

Reduce resuspension of lake bottom sediments and renovate the lake fishery by eliminating carp and other rough fish and restocking with desirable game fish.

Specific goals:

Control excessive soil erosion on at least 80% of the agricultural land area

Reduce sediment delivery rate by 60%

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 4,568 acres
Project Area: 4,568 acres
Critical Area: 3,920 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 29.15 inches

USLE 'R' Factor: 175

Geologic Factors: Upland soils are generally well-drained, silty clay loams that developed in loess. Soils in the drainage ways are alluvial. Slopes in the watershed range from 0-18%.

4.3.2.2.3 Project Area Agriculture

Approximately 80% of the project area is cropland. Principal crops are corn, soybeans, small grains, and hay.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	80	93
Pasture/range	3	4
Woodland	3	3
Urban/roads	0	0
Other		
Lake/park land	14	0

4.3.2.2.5 Animal Operations

Operation	Total # Animals	Total Animal Units
Beef	120	120
Hogs	2,700	1,080

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	331,229	0	148,748	0	479,977
Info. & Ed.	18,750	0	0	0	18,750
Tech. Asst.	131,140	0	0	0	131,140
Water Quality Monitoring	NA	NA	0	0	NA
SUM	481,119	0	148,748	0	$629,8670*

* Total does not include water quality monitoring costs

Sources: Prairie Rose Lake RCWP Project, 1989; Lawyer et al., 1991

4.3.4 Information and Education

4.3.4.1 Strategy

The information and education (I&E) program was focused on involving the farming community in the RCWP project beginning even before funding was granted.

4.3.4.2 Objectives and Goals

Provide information that will lead to the incorporation of pesticide and nutrient management techniques, principally by farmers in the project area, but also by producers outside the watershed

Inform the public about the RCWP and supply basic information to farmers about BMPs

4.3.4.3 Program Components

One-to-one contact with producers by SCS and CES personnel

Public meetings prior to submission of the RCWP project application

Technical assistance for cost shared BMPs

Technical assistance for nutrient and pesticide management (not cost shared)

Free soil tests conducted the first and fourth years, with individual follow-up by extension agronomist

Integrated Pest Management (IPM) scout visited fields every three days

Group meetings of producers with agronomist for presentations and discussions

Newsletter for producers during early stages of RCWP (1981- 1987)

Weekly IPM newsletter for participants

Publicity in local newspapers, magazines in Iowa and other states

Tours of participating farms by farmers from within and outside the project area

Opening and closing ceremonies

RCWP project annual reports

Survey of producers outside the project area toward the end of the project

4.3.5 Producer Participation

4.3.5.1 Level of Participation

Excellent: 92% of the producers whose farms were located in the critical area participated in the RCWP project.

4.3.5.2 Incentives to Participation

Cost share rates of 75%, except for nutrient and pesticide management

Payment limit of $50,000 per farm

Number and type of practices available for cost share attractive to the producers

Ability to cost share a complete program, including waterways, tile, and other materials not paid for through any other federal or state cost share programs

Extensive information and education technical assistance in nutrient and pesticide management.

Recreational resource valued by producers was at risk

Strong leadership by producers within the project area

Sense of community

Individual visits by SCS with key producers helped encourage the first few producers to sign up

Demonstration of BMP implementation on community leaders' farms convinced others to try them

4.3.5.2 Incentives to Participation (continued)

Water quality problem was easily visible: the farmers could see what was happening to the lake. Just before the opening RCWP ceremony there was a heavy rain and the lake was filled with corn stalks and debris.

Existing conservation ethic within the farming community, particularly among community leaders

The state park manager was a good neighbor and well-liked; producers listened to him

Free soil testing for RCWP participants

4.3.5.3 Barriers to Participation

Absentee landowners not interested

Inability of producers to carry their share of the cost of implementing BMPs

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Good; the 579 acres of conservation tillage implemented through the RCWP project have now increased to every row crop acre in the watershed except one farm where the producer is still plowing.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The land treatment strategy was to implement BMPs designed to reduce soil erosion and sedimentation.

4.3.6.2 Objectives and Goals

Control excessive soil erosion on at least 80% of the agricultural area

Treat 83% of the critical area with BMPs by RCWP contract

Install one sediment basin with 60 acre-feet of capacity at the east end of the lake

Install one sediment basin with 5 acre-feet of capacity on state park property

Treat 300 acres with other programs to a level equal to that obtained with RCWP contracts

4.3.6.3 Critical Area Criteria and Application

Criteria: all land draining into the lake except the state park. This definition was chosen because of the bowl-shaped watershed which drains into Prairie Rose Lake. The critical area is all close to the lake, with the farthest point slightly more than two miles from the lake. All cropland was intensively farmed, very erosive, and not protected by needed conservation measures.

Application of Criteria: consistently applied

4.3.6.4 Best Management Practices Used

General Scheme: Sediment control practices used included conservation tillage, contour farming, terraces, grassed waterways, grade stabilization structures, and pasture management.

RCWP funds were used to pay for up to 75% of the installation costs of structural practices such as terraces and grade stabilization structures, while a per-acre payment was made for management practices such as conservation tillage. Technical assistance for fertilizer and IPM were provided through the information and education program.

The original RCWP project application identified a need for up to eight animal waste control systems and set as a project goal the installation of six systems. However, further evaluation determined that only one cattle feedlot posed a problem and required additional waste controls. This cattle feedlot was closed in 1986. At present, four small cow-calf operations (averaging 30 stock cows per operation) and nine small swine feeding operations (averaging 300 pigs per operation) are located in the project area. None of these operations is considered to require additional waste controls at this time.

BMPs Utilized in the Project*	Units	Project Accomplishments
Permanent vegetative cover (BMP 1)	acres	32
Animal waste management system (BMP 2)	#	
Terrace system (BMP 4)	miles	55
Diversion system (BMP 5)		
Waterway system (BMP 7)	acres	12
Conservation tillage system (BMP 9)	acres	579
Permanent vegetative cover on critical areas (BMP 11)	acres	
Sediment, retention, erosion, or water control structures (BMP 12)	#	13
Fertilizer management (BMP 15) (not cost shared)	acres	2,379
Pesticide management (BMP 16) (not cost shared)	acres	2,379

* Please refer to Appendix I for description/purpose of each BMP
Source: Link, 1991

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

Follow-up and status reviews were used by SCS to track maintenance of BMPs. CES used soil tests in years 1 and 4 of contract period to evaluate status of nutrient management and field monitoring to evaluate the IPM practice.

4.3.6.5.2 Data Management

Regular record keeping is conducted by project personnel and reported in RCWP annual reports.

4.3.6.5.3 Data Analysis and Results

Ninety-two percent of the producers in the project area participated in the RCWP. Ninety percent of the critical area was treated (83% through RCWP and 7% through other programs)

By the end of the RCWP project, conservation tillage was being used on all but about 300 acres of cropland (3,648 acres) in the project area.

Quantified Project Achievements:

Pollutant Source	Units	Critical Area Total	Critical Area % Implemented	Treatment Goals Total	Treatment Goals % Implemented
Cropland	acres	3,648	80%	2,926	99%
Pasture	acres	148	34%	111	45%
Feedlots	#	8	0%	6	0%
Farmsteads	#	120	54%	95	68%
Contracts	#	47	72%	37	92%

Source: Prairie Rose RCWP Project, 1989 (form RCWP 3)

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

Water quality monitoring was designed to determine trends in water quality using 1981 as a basis for comparison with following years. It was necessary for 1981 to serve as the base year because insufficient pre-1981 water quality data were available. BMP implementation commenced in 1981 as well. (Lawyer et al., 1991)

The monitoring was conducted by the Iowa Department of Natural Resources in cooperation with the University of Iowa Hygienic Laboratory and the U.S. Environmental Protection Agency.

4.3.7.2 Objectives and Goals

Determine whether there is a statistically significant correlation between watershed BMP implementation (erosion reduction) and water quality improvement, mainly related to water clarity (Secchi depth, turbidity, and chlorophyll *a* levels)

Measure the rate of sediment accumulation in the lake

4.3.7.3 Time Frame

1981 - 1989

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

3 mid-lake stations (upper, middle, and lower reaches) sampled at surface and bottom
1 station at drinking water intake
1 station at the swimming beach

4.3.7.4.2 Sample Type

Grab

4.3.7.4.3 Sampling Frequency

Mid-lake stations: every other week May - September
Water intake and beach: after rainfall events that exceed 1 inch of precipitation

4.3.7.4.4 Variables Analyzed

Miscellaneous: turbidity, chlorophyll *a*, dissolved oxygen (DO), pH, temperature, Secchi depth, wind direction and speed, cloud cover, precipitation, lake depth
Nutrients: total phosphorus (TP), orthophosphate (OP), nitrite-nitrogen (NO_2-N) and nitrate-nitrogen (NO_3-N) , total ammonia-nitrogen (NH_3-N)
Microorganisms: coliform bacteria
Other: heavy metals, selected pesticides (once only, at water intake)

4.3.7.4.5 Flow Measurement

None

4.3.7.4.6 Meteorologic Measurements

Iowa Department of Natural Resources rain gauge at Harlan, Iowa, six miles west of Prairie Rose Lake (records kept at lake)

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

Prairie Rose Lake was partially drained in the fall of 1981, after which rotenone was added to kill the lake's existing fish population. Lake refilling, stabilization, and restocking with desirable game fish took place over the next several years; thus water quality data for 1982-83 are not representative of the filled lake.

One purpose of the intentional fish kill in 1981 was the removal of carp. Bottom feeding and spawning activity by carp result in resuspension of bottom sediments and aggravate turbidity. Either fishery renovation was not completely successful in eliminating carp from the lake or carp were introduced. In any case, carp reappeared in significant numbers in 1987 and 1990 surveys. In addition, the activities of the large population of bullheads (bottom feeders) that developed from a 1982 stocking may have contributed significantly to resuspended sediments (turbidity) (Lawyer et al., 1991).

4.3.7.5 Data Management

The data are in STORET.

STORET AGENCY CODE:	STORET STATION NO.	PROFILE / STATION MAP / NO. (depths of sampling)
21IOWA	L00580	IA-1 / 1 (0, 8 ft)
"	L00589	IA-1 / 2 (0, 11 ft)
"	L00578	IA-1 / 3 (0, 24 ft)
"	L00581	IA-1 / 4 (0, 15 ft)
"	L00579	IA-1 / 5 (0, 11 ft)

4.3.7.6 Data Analysis and Results

Analysis:

Annual mean values of Secchi depth, turbidity, chlorophyll *a*, TP, and OP were compared for evidence of overall trends. Linear association of water clarity with land treatment was tested by covariate analysis.

Results:

Water clarity has increased during most seasons of the year, and lake turbidity no longer routinely increases following runoff events.

Water quality monitoring indicates that sediment has become secondary to algae as the cause of turbidity following implementation of erosion control practices. Algal growth during late summer periods appears to be increasing, due to a combination of high in-lake nutrient levels and decreased sediment related turbidity levels.

Water clarity was highest in 1982-83, following draining of the lake and restocking of fish in the fall of 1981 in an attempt to improve the fishery. Since then water clarity has deteriorated to pre-RCWP levels. Analysis of biweekly data shows that year-to-year variability is greater than within-year variability.

Clarity improvement from reduced sediment loading may be masked by turbidity due to algal growth increase. Monitoring data are highly variable. After correcting for both precipitation and chlorophyll *a*, there is no significant trend over time.

Although it may appear that the RCWP project has simply changed the lake's water quality problem from one of excessive sedimentation to one of problematic algal growth, it is important to recognize that sedimentation was threatening the very existence of the lake. The problems associated with algal growth are minor as compared to the previous sedimentation problem. (Link, 1991)

Monitoring sediment concentrations (weight/water volume), as was done with chlorophyll *a* concentrations, would have been useful for interpretation of changes in turbidity and estimation of sediment and algal contributions to turbidity levels in the lake. A physical separation, characterization, and quantification of sediment particulates would have made possible a direct determination of whether sediment concentrations were decreasing, increasing, or remaining stable with respect to base period measurements. This, in turn, would have helped the project team to relate sediment to turbidity. (Lawyer et al., 1991)

Draining of the lake and direct manipulation of the fish population may have obscured some water quality results.

4.3.8 Linkage of Land Treatment and Water Quality

The Prairie Rose Lake RCWP project appears to have been successful in meeting its primary water quality goal of reducing sediment loads entering the lake from the watershed. Evidence of the effectiveness of the project BMPs was a slowed rate of lake volume change (measured using lake contour map information) during the project period. Water quality data indicate that sediment became secondary to algae as a cause of turbidity, thus lending support to the thesis that land treatment implemented through the project was effective in reducing sediment delivery to the lake. (Lawyer et al., 1991)

Lack of a longer-term pre-BMP implementation data base and the mid-project draining of the lake hindered the project team's ability to document a clear land treatment - water quality link.

4.3.9 Impact of Other Federal Programs on the Project

BMPs installed in the project area prior to RCWP included contour farming on 1,000 acres, grassed backslope terraces protecting 528 acres and two sediment control structures and 14 conservation plans covering 2,270 acres. Approximately 150 more acres have been treated through other programs (Agricultural Conservation Program, state, county, private).

4.3.10 Other Pertinent Information

None

4.3.11 References

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

Lawyer, M., D. Feltz, U. Agena, B. Bryant. 1991. Ten Year Report: Prairie Rose Rural Clean Water Project, Shelby County, Iowa. March 1991. Cooperators: USDA-SCS, USDA-CES, and the Iowa Department of Natural Resources.

Link, R.V., T. Oswald, and B. Bryant. 1991. The Prairie Rose Lake Rural Clean Water Program Project. Presented at the Regional Lake Management Conference, June 11, 1991, Des Moines, Iowa, 15p.

Prairie Rose Lake RCWP Project. 1987. Annual Report.

Prairie Rose Lake RCWP Project. 1989. Annual Report.

4.3.12 Project Contacts

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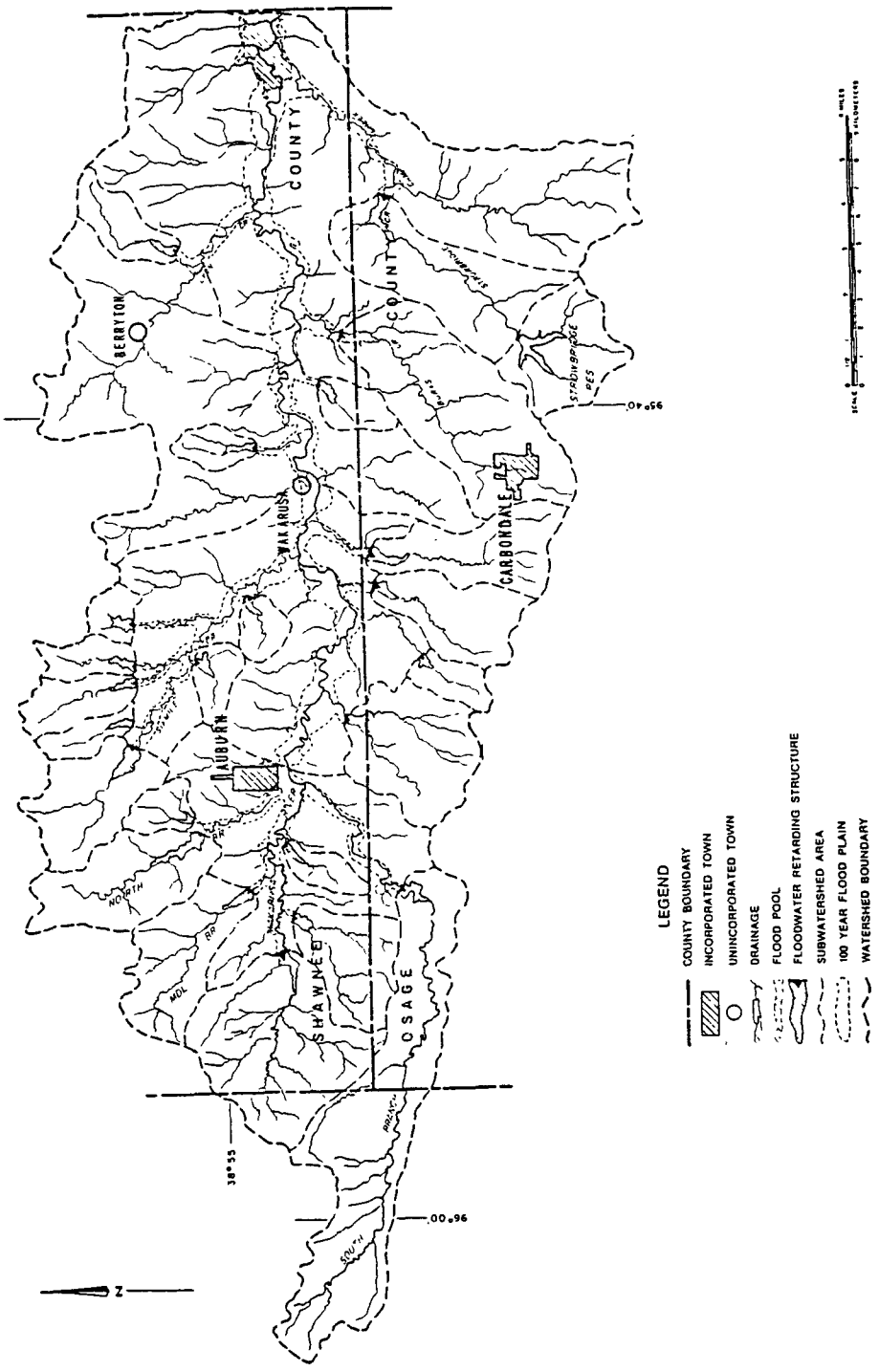
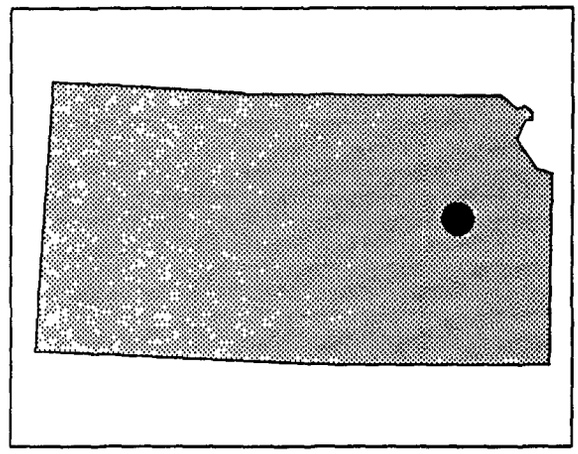


Figure 4.8: Upper Wakarusa (Kansas) RCWP project map, KS-1.

Kansas
Upper Wakarusa

(RCWP 6)



Osage, Shawnee & Wabaunsee Counties
MLRA: M-106
HUC 102701

4.1 Project Synopsis

The Upper Wakarusa RCWP project, located in the true prairie region of northeast Kansas, was initiated to control sediment and nutrient pollutant transport to water supply reservoirs. The alleged water quality problem was sediment delivery and nutrient loading causing taste and odor problems attributed to algal growth and sediment. Sediment deposition had already caused fish habitat degradation and was a potential problem for the Clinton reservoir, an important water supply for the City of Lawrence. The total project area was 154,011 acres of which 43,252 acres were considered critical. The drainage area of two public water supplies was targeted as the number one priority for land treatment. Drainage areas of 14 constructed and eight planned PL-566 structures were given second and third priority.

Critical area land use was 83 % cropland, 9% rangeland, with the remainder being primarily pasture and forest. Crops grown in the area include corn, wheat, grain sorghum, soybeans, and alfalfa. At the time the RCWP project was initiated, there were seven hog farms with total of 2,100 animals and 10 dairies with a total of 375 cows in the project area.

Best management practices (BMPs) were focused on conservation tillage, vegetative cover, and water control structures. The land treatment goal was to implement BMPs on 100% of the critical area. Actual implementation was 10,506 acres or 24% of the goal. There were 485 potential participants; of these, 123 (25%) completed or nearly completed their contracts.

The water quality monitoring design was a single downstream station sampled to assess overall ambient conditions. The monitoring program detected no trends in water quality.

The Upper Wakarusa RCWP project played an important role in the beginning of coordination of state nonpoint source (NPS) programs in Kansas. Overall management and administration during the short project was exemplary. However, the project lacked essential technical assistance to document a water quality problem linked to a use impairment, target well-defined critical areas, or establish a meaningful water quality monitoring program. The project team interacted well with the State Coordinating Committee (SCC), but needed more assistance on water quality problem and critical area identification. The project was terminated in September of 1983, for failure to meet basic program requirements.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

Overall project objectives were very general and provided little direction for project activities. The water quality objective did not mention any water resource by name or designated use. Goals were set using rule-of-thumb estimates of what was thought to be achievable.

4.2.1.2 Recommendations

Project objectives are very important because they help keep activities on track. Inadequate attention to developing objectives results in fragmented, non-targeted activities. The total set of project objectives should be comprehensive, making sure all important concerns are addressed. Individual objectives should be clearly focused, and should not overlap. An achievable, measurable goal should be established to support each objective. Setting goals is based on knowledge of the system and can be enhanced by using a model to simulate change in a variable that is meaningful for progress toward the objective.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

The project was well organized and had a very active Local Coordinating Committee (LCC). The chairman of the LCC was effective in promoting the project and facilitating teamwork. The LCC met monthly and members were required to report on their progress at each meeting. Administrative, information and education (I&E), and technical advisory committees were formed and were active in project planning and implementation. Initial advisory committee task assignments resulted in some overlap of duties and some committees had too many members. These problems were addressed so that individual committee tasks did not overlap and committee membership was reduced to an optimal size. The project benefited from the extensive committee participation of concerned individuals in the community.

The project had a manager; the position was held alternately by the Soil Conservation Service (SCS) and the Extension Service (ES). The quarter-time manager position was rated as somewhat to very effective by project staff.

Members of the State Coordinating Committee (SCC) felt the National Coordinating Committee (NCC) could have provided more guidance on developing project direction and setting goals. The SCC members also felt they did not receive a clear definition of what was expected of them and that adequate guidance was not available. Technical guidance (such as critical area definition and establishment of practice standards for nutrient and pesticide management) was not available; as a result, the project team had to develop methods based on expertise in the state or to rely on other sources.

The SCC supported the project. A representative of the SCC attended the LCC meetings on a regular basis. SCC members saw their role as providing information to the project and answering questions. There was good interaction and cooperation between the LCC and the SCC.

The project area was located in three counties, making the project somewhat difficult to administer. The project failed to use the standard RCWP reporting forms, making the tracking of contracts and critical area treatment difficult. Although the project had 17 critical area feedlots it is difficult to determine if any of the animal waste from 1,365 animal units was treated. Also, the project was difficult to manage due to its large size (154,011 acres).

An inter-agency appraisal of the project was conducted by representatives of ASCS, SCS, USEPA, and ES of the project in June, 1983. The conclusions of the appraisal team were that: a) there was no documentable water quality problem resulting in impaired uses of the waters of the project area, b) there was some overlap of RCWP and PL-566 activities (RCWP activities were being used in a preventative mode to protect PL-566 structures), c) there was no definitive delineation of critical areas and that such delineation was not feasible in the absence of impaired uses of water. Based on the findings of the inter-agency review team, the NCC canceled the project in September, 1983. Authority to approve additional contracts after that date was terminated, with contracts approved before that date honored and serviced in the regular manner.

4.2.2.1 Findings and Successes (continued)

Available information indicates high pollutant levels in streams, especially during the runoff season. Other problems regarding taste, odor, and fishery degradation are important findings. However, the project needed outside technical assistance from USEPA or the NCC to document a use impairment. Greater coordination between the NCC and the SCC may have resulted in technical support to the project. The water quality baseline data known to the NCC at the time of the application was similar to the data available in June 1983 when the interagency team made their appraisal. It is unclear whether the NCC expected the project to document a problem at some point or it is possible that the lack of a water quality problem was overlooked when the project was funded.

4.2.2.2 Recommendations

This project serves as a model for overall project management and administration. The highly organized LCC met monthly, was well attended, and had advisory committees to help ensure progress. The SCC regularly attended the LCC meetings, which served to foster team work by state and local level project personnel. The project had an active and effective LCC chair who promoted the project and gained farm operator participation. We recommend projects choose a management and administration style similar to this project. The project needed a manager with water quality expertise as well as knowledge of USDA agencies.

While project administrators must rely on the technical expertise of the water quality agency proposing a project, they must demand clear documentation of the problem. The technical merit of the entire project is based on the problem definition. Critical area definition and BMP selection are also determined based on the definition. of the water quality problem.

The NCC should develop detailed project selection criteria to improve the chances that projects will contribute to the objectives of the program.

Projects should follow the annual reporting format established at the national level (such as by the NCC in the RCWP). Standardized data collection facilitates tracking of BMP implementation, meaningful data analysis, and program evaluation.

Realization of lack of problem documentation at the start of the project by the NCC could have resulted in more technical assistance, changing the project area, or not funding the project. Any of these choices would have been preferable, since the project has contributed little toward the objectives of RCWP. National program staff must provide a minimum standard and methodology for water quality problem definition to guide project personnel. Local project staff should study the problem statement provided by the water quality agency to ensure adequacy and should seek outside help if needed.

The overall goal of the state was to protect Clinton Reservoir from sedimentation and nutrient impacts. The objectives of both the RCWP and federal PL-566 program included reduction of sedimentation of the reservoir. The implementation of the PL-566 program at the same time as the RCWP project made it difficult to differentiate the effects of one program from the effects of the other. A higher level of planning and coordination is needed when large federal programs with overlapping goals are implemented in the same area.

This project illustrates the need to include in NPS programs projects intended to protect a water supply or other water resource. In the Upper Wakarusa project area, ground water is not a viable water supply, so surface impoundments must be used for domestic sources. If sedimentation is the primary problem, then protection is the preferred management approach because restoration involves dredging, which can be prohibitively expensive.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

The information and education (I&E) program relied on several methods to encourage participation and adoption of BMPs. Farmers did not receive as much one-to-one contact as was needed to explain the program. Farm operators also needed information on the differences between BMPs to conserve soil and those needed to improve water quality.

As a result of the RCWP project, area farm operators developed some awareness of the water quality problem and an awareness of the potential impact of agricultural NPS pollution. Overall, the I&E program was somewhat effective in developing farm operator knowledge of management and structural BMPs. However the I&E program was not very effective in developing an attitude change that would have resulted in implementation of both management and structural BMPs. In general, farmers did not develop the skills to implement management BMPs nor did they maintain BMPs for the long term. Farmers implemented traditional practices rather than practices specifically designed to protect water quality. Also, farm operators were also not very interested in tracking project success for the long term. These shortcomings resulted in part due to the cancellation of the project at the end of the third year.

Field demonstrations on chemical applications and minimum tillage were thought to be less effective I&E tools than one-to-one contact. Agrichemical companies helped to promote the proper use of chemicals with demonstrations.

A larger staff was needed to make one-to-one contact with 485 potential participants. Farm operators had difficulty understanding the difference between the state project in the watershed and the RCWP. Due to this confusion, more individual contact with the producers by project staff were required to make one-to-one contacts to explain the unique features of the RCWP program.

4.2.3.2 Recommendations

Keeping farm operators informed is a major key to success in a project. Farmers need to know the overall plan of work and what they can expect from the project staff. Lack of a clearly defined water quality problem reduced the effectiveness of the project. Farm operators need specific information on pollutants and impacts so they can better understand how the operation of their farm is important to the goals of the project.

Farmers needed more education on the differences between BMPs to protect water quality and those needed to save soil.

Greater emphasis on I&E was needed to change farmers' attitudes and develop their skills to implement and maintain management BMPs. Development of these attributes in on-going and future programs is important because management practices are less expensive than structural practices and can be very effective. Because future maximum payment levels are likely to be less than the $50,000 level used for RCWP, less expensive practices will be increasingly important and desirable.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

The project completed or nearly completed a total of 123 contracts (25%) out of a potential 485 during the three-year contracting period. This rate of contracting is quite good considering the length of time available for contracting. The project was successful in attracting the innovative farmers, but not as successful in gaining participation from the farmers who could have had the greatest impact on water quality .

The primary reason that farm operators decided to participate in the RCWP project was the availability of cost share funds. Other important incentives were the concern for water pollution, concern about future pollution regulations, conservation ethic, and assistance and encouragement from the government. Reasons why farm operators did not participate included poor economic conditions, insufficient cost share rates, the perception that the project would involve too much red tape, resistance to changing practices, lack of interest in investing in rented land, not wanting to be told how to farm, and the opinion that the current system was working well enough.

4.2.4.2 Recommendations

Projects should use monitoring data to help explain the nature of the water quality problem to farmers, thereby encouraging participation.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

The project area was identified as the state's number one priority agricultural NPS water quality management area based on criteria established by the State Water Quality Management Plan adopted in 1979 (Upper Wakarusa River RCWP Project, 1980). The state criteria emphasized the protection of water resources and not restoration. Problem definition for projects emphasizing protection is a particularly difficult task. The RCWP project team was unable to adequately identify the problem; as a consequence, they had trouble defining the critical area and selecting BMPs. The project also needed more assistance on the best use of management versus structural BMPs.

SCS allotted a full time staff position to the project; this person was responsible for writing farm plans and allocating funds to treat critical area pollutant sources. The assignment of this staff person to the RCWP project helped the project move forward on farm plan development much faster than if regular field office staff had been responsible for the task.

The project also had a full-time ES agent responsible for I&E and technical assistance on nutrient and pesticide management. The ES agent also helped farm operators keep implementation of farm plans on schedule. However, the project received very little guidance on and few practice standards for nutrient and pesticide management. The project also needed guidance on agricultural waste management as applied to nutrient management.

BMP maintenance occurred on 50% of the practices installed. This was in part due to farmers' lack of water quality knowledge and lack of skills needed to continue the practices installed.

The soil testing program was effective due to participation from the farmers' cooperative and the ES.

Program administrators felt that conservation tillage should have been dropped from the list of cost shared BMPs. Although the practice was useful for increasing participation, many farm operators in the watershed were already using minimum tillage and conservation tillage. Also many farm operators getting cost share for conservation tillage were reluctant to install structural practices such as waterways, terraces, and sediment ponds. However, one land treatment person felt that lack of cost share for management practices hurt the project because many of the farm operators would not implement a new practice without cost share.

4.2.5.1 Findings and Successes (continued)

The cost-effectiveness of practices was an issue raised by some project staff. Filter strips and contour grass strips were thought to be an effective means of reducing sediment yield. However, these BMPs were not cost-effective from the farm operators' viewpoint because they require that acreage be taken out of production.

The project should have emphasized management BMPs as an alternative to structural BMPs to reduce sediment delivery.

4.2.5.2 Recommendations

The SCC should spend more time at the beginning of a project to discuss the general purpose, help with the identification of critical areas, and assist with the selection of BMPs.

The NCC should provide technical assistance for critical area selection incorporating the use of a spatially distributed pollutant runoff model (such as AGNPS).

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

The water quality monitoring program provided very little information to the project or toward achieving the objectives of the RCWP.

The water quality problem was not clearly identified and minimal monitoring data were available for use by the project team in defining the problem. If the problem was a potential for the loss of storage capacity in Clinton Reservoir by sedimentation, surveys to measure the rate of sedimentation should have been performed.

The water quality agency indicated that the following analyses would be completed in the Strowbridge and Shawnee County Rural Water Supply District No. 6 public water supplies: taste and odor, filtration and chemical use, algae control chemical use, sedimentation rate, trophic state index, and organic chemicals (Upper Wakarusa River RCWP Project, 1980). These analyses, if completed, would have supported either the need for or the termination of the project.

High concentrations of suspended sediment and high turbidity during runoff conditions were measured, but these concentrations are not documented as causing a specific impairment or threat to designated use.

4.2.6.2 Recommendations

All projects should have adequate problem identification monitoring and assessment. Problem identification is the key to all projects, since the specific pollutant(s) and conditions must be treated if there is to be any hope of protection or improvement of water quality.

When the objective of the project is to protect a lake or reservoir from degradation, the monitoring design should have two major elements: a) monitoring of the subwatershed stream directly below the critical area before, during, and after implementation to evaluate trends in a water quality variable in response to BMP implementation and b) monitoring of the lake or reservoir for trends in variables associated with the threat to loss of use.

Projects with potential sedimentation problems should complete pre-, during, and post-sedimentation surveys to determine sedimentation rate. Sedimentation survey protocols are well documented and the technique is a basic tool for water supply lake management.

Because the relative treatment strength or impact of BMPs is greater for smaller areas, projects should monitor small subwatersheds rather than trying to monitor near the outlet to the entire watershed.

Water quality agencies should be held more accountable on commitments to monitor according to the plan of work submitted to the NCC.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

The project did not track land treatment data for linkage with water quality data.

4.2.7.2 Recommendations

None

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1980 - 1994 (Although the project was terminated in 1983, RCWP contracts executed prior to project termination were carried out and water quality monitoring was conducted through 1991.)

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Wakarusa River and its tributaries, water district reservoirs, Clinton Reservoir, watershed flood- retarding reservoirs

4.3.2.1.2 Water Uses and Impairments

Water resource uses include public and domestic water supplies, recreation, agriculture, and fish and wildlife habitat. Water supplies and reservoirs were reported to have periodic taste and odor problems attributed to algal growth and sediment. Sedimentation posed potential threats to wildlife and fish habitat along project streams as well as excess sediment loads to Clinton Reservoir. Potential threat of impairments of drinking water supplies from phosphorus, bacteria and pesticides was also a concern.

4.3.2.1.3 Water Quality Problem Statement

Sediment deposition in ponds and stream channels is a problem below sloping untreated croplands. Excess sediment loads of the Wakarusa River are deposited in the upper end of Clinton Reservoir. Sediment in agricultural runoff is a limiting factor for fish populations in the Wakarusa River. High inorganic turbidity in runoff is linked to a change in the distribution of several species of fish in the Wakarusa River and tributaries.

4.3.2.1.4 Water Quality Objectives and Goals

The objective of the project was to improve and maintain water quality in the water impoundments and streams within the 154,011-acre project area by applying BMPs to control agricultural NPS pollution (Upper Wakarusa River RCWP Project, 1980).

Specific Goals:

Reduce pollutant loading from livestock operations by 75%
Reduce nitrogen loading by 41%
Reduce phosphorus loading by 43%
Reduce organic matter entering waters by 45%
Reduce soil loss from 5.2 to 2.8 tons/acre/year

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 154,011 acres
Project Area: 154,011 acres
Critical Area: 43,252 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 34.46 inches (most during April- October)

Geologic Factors: Topography of the region varies from nearly level flood plains to bluffs and slopes up to 30%. The upland soils are deep to moderately deep silt loams to silty clay loams, bottom soils are deep and friable silty clay loams.

4.3.2.2.3 Project Area Agriculture

Most of the farms are diversified and the primary crops are corn, wheat, grain sorghum, soybeans, and alfalfa. Corn, wheat, and soybeans are the major cash crops with most of the other grains and hay being fed to livestock.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	40	83
Rangeland	41	9
Pasture	7	2
Forest	7	3
Other	5	3

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Hogs	7	2100	840
Dairy	10	375	525

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	2,229,000	0	2,928,000	0	5,157,000
Info. & Ed.	87,000	0	0	5,000	92,000
Tech. Asst.	466,344	0	0	72,540	538,884
Water Quality Monitoring	78,000	2,328,800	0	1,500	2, 408,300
SUM	2,860,344	2,328,800	2,928,000	79,040	$8,196,184

Source: Upper Wakarusa River RCWP Project, 1987

4.3.4 Information and Education

4.3.4.1 Strategy

To develop a special educational program to help landowners and farm operators understand the importance of clean water for a community even if clean water in itself does not benefit them directly.

4.3.4.2 Objectives and Goals

The objective was to effect changes in attitudes and behaviors by producers as evidenced by acceptance and implementation of BMPs that improve water quality.

Goals were to:

Use the I&E delivery system to achieve project objectives using existing programs as a base

Coordinate information among federal, state, and local agencies involved in the project

Conduct educational programs for landowners toward the adoption of BMPs that will reduce siltation and minimize the presence of fertilizer, pesticides, and animal waste in the main streams and tributaries

Assist in the project monitoring and evaluation, as appropriate, in cooperation with agencies involved in the monitoring phase of the project

Provide current information to both Kansas and national audiences on the positive impacts resulting from the adoption of BMPs by landowners in the project area to improve water quality

Evaluate farmers' attitudes toward the project

4.3.4.3 Program Components

A variety of printed materials including newsletters, brochures, form letters, and facts sheets

Mass media including radio, newspapers, and television

Public meetings

One-to-one contacts with producers

Tours of participating farms

Demonstrations of tillage, proper fertilizer use, range and pasture management, proper pesticide usage, and BMP maintenance

4.3.5 Producer Participation

4.3.5.1 Level of Participation

The contracting period was three years because the project was canceled in 1983. The project was able to write 123 contracts out of a possible 485 potential participants, resulting in 25% of the participation goal of 485 participants being achieved.

4.3.5.2 Incentives to Participation

Cost share rate of 75%, except for grazing land protection (60%)

Payment limit of $50,000 per farm

4.3.5.3 Barriers to Participation

Economic conditions

Secondarily, farmer preference not to participate in government programs, nor to change their farming methods

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

The chances of maintaining BMPs was rated 50 to 90% by project personnel surveyed in 1992. These findings seem consistent with the conservation status prior to the project.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The project had a general strategy to apply BMPs to control NPS pollution from agricultural land.

4.3.6.2 Objectives and Goals

The objective was to improve and maintain water quality in water impoundments and streams within the 154,011-acre project area. The goal was to treat all of the 43,252-acre critical area.

4.3.6.3 Critical Area Criteria and Application

The drainage area of two public water supplies was targeted as the number one priority. Drainage areas of 14 constructed and eight planned PL-566 watershed retarding structures were targeted as second and third priorities. The remainder of the critical area was fourth priority.

4.3.6.4 Best Management Practices Used

Emphasis of the project was placed on sediment reduction. Land treatment was achieved through conservation tillage, vegetative cover, and control structures.

BMPs Utilized in the Project*

Permanent vegetative cover (BMP 1)

Terrace system (BMP 4)

Diversion system (BMP 5)

Grazing land protection (BMP 6)

Waterway system (BMP 7)

Conservation tillage systems (BMP 9)

Permanent vegetative cover on critical areas (BMP 11)

Sediment retention, erosion, or water control structures (BMP 12)

* Please refer to Appendix I for BMP descriptions/purpose.

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

Land treatment was not tracked.

4.3.6.5.2 Data Management

No data management system was in place during the project.

4.3.6.5.3 Data Analysis and Results

Quantified Project Achievements:

Pollutant Source	Units	Critical Area Total	Critical Area % Implemented	Treatment Goals Total	Treatment Goals % Implemented
Cropland/ rangeland/other	acres	43,252	24%	43,532	24%
Feedlots	#	21	0%	17	0%
Contracts	#	485	25%	262	49%

Source: Upper Wakarusa River RCWP Project, 1990

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The monitoring strategy included two overall designs. The first design was an intensive before and after study. Baseline conditions were monitored at the start of the project and then after 95% land treatment implementation. A post-project evaluation was planned to determine overall treatment effect. The second design employed sampling at a single station near the watershed outlet to integrate all treatment effects.

Monitoring was conducted by the Kansas Department of Health and Environment.

4.3.7.2 Objectives and Goals

Objectives were to:

Evaluate the water quality effectiveness of applying BMPs to agricultural land

Evaluate the public water supply impacts of BMP applications

valuate the fisheries impacts on BMP applications

valuate the recreation impacts of BMP applications

Evaluate the impact of the project on Clinton Reservoir

ater quality monitoring goals were established.

/.3 Time Frame

981 - 1990

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

Single sampling station at the Wakarusa River near Richland

36 stations were monitored throughout the project area to gather baseline data in 1982

4.3.7.4.2 Sample Type

Grab

4.3.7.4.3 Sampling Frequency

Monthly and for selected runoff events

4.3.7.4.4 Variables Analyzed

Sediment, turbidity, nutrients, biochemical oxygen demand (BOD), pesticides, total suspended solids (TSS), nitrate (NO_2), ammonia (NH_3), phosphorus (P)

Periodic analysis of macroinvertebrates, fish, and fish tissues

4.3.7.4.5 Flow Measurement

None

4.3.7.4.6 Meteorologic Measurements

None

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

Macroinvertebrate samples were collected and analyzed using a biotic index.

4.3.7.5 Data Management

All chemical data was entered into STORET.

4.3.7.6 Data Analysis and Results

None

4.3.8 Linkage of Land Treatment and Water Quality

None

4.3.9 Impact of Other Federal Programs on the Project

Federal PL-566 funding in the watershed was used to construct up to 22 structures for flood cont. Some highly erodible land was seeded with funds from the Conservation Reserve Program. The impact of these programs has not been quantified.

4.3.10 Other Pertinent Information

None

4.3.11 References

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

Upper Wakarusa River RCWP Project. 1980. RCWP Plan of Work.

Upper Wakarusa River RCWP Project. 1987. Annual Progress Report.

Upper Wakarusa River RCWP Project. 1990. Annual Progress Report.

4.3.12 Project Contacts

Administration

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Land Treatment

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(913) 296 5567

Information and Education

None

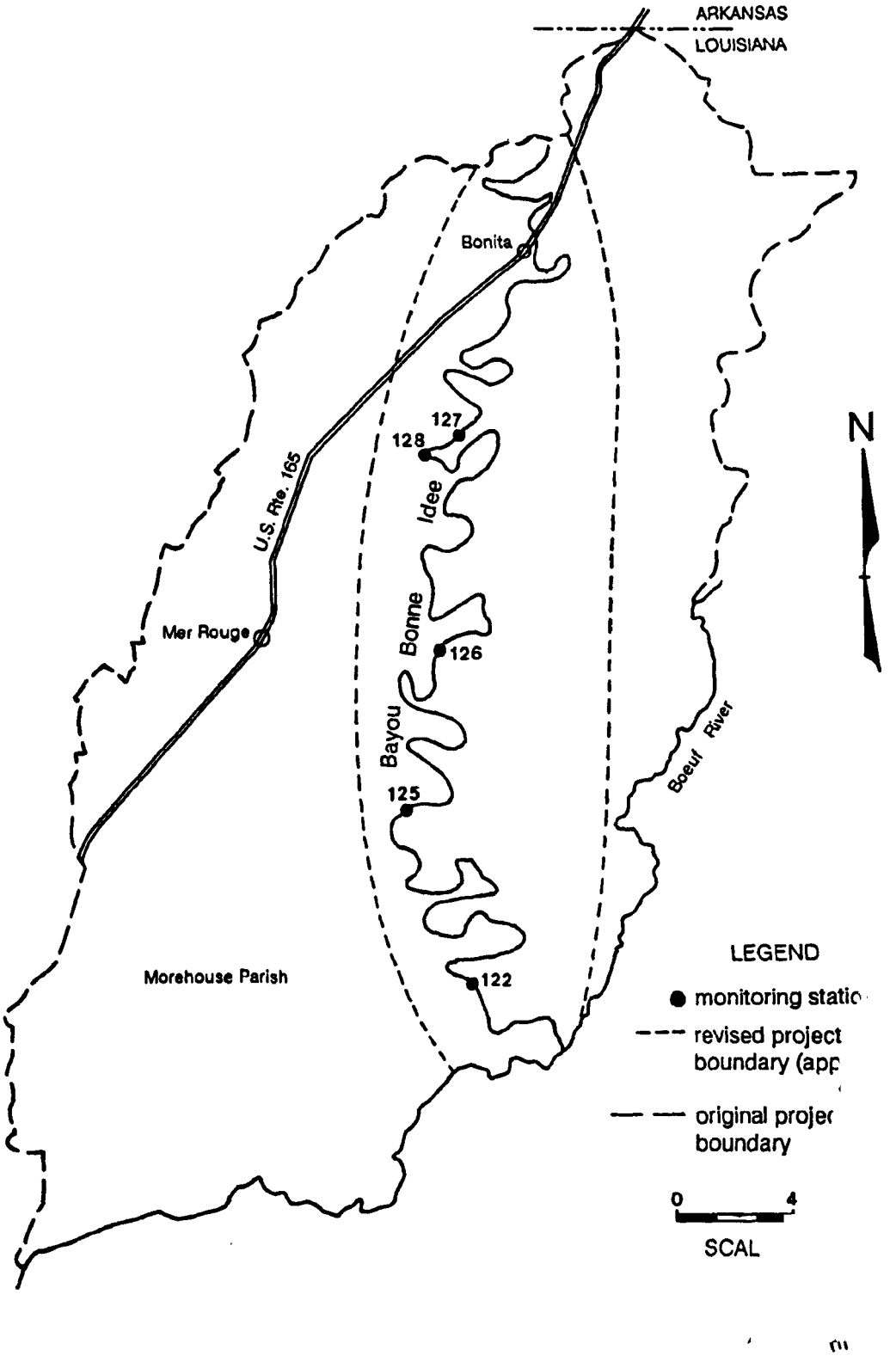
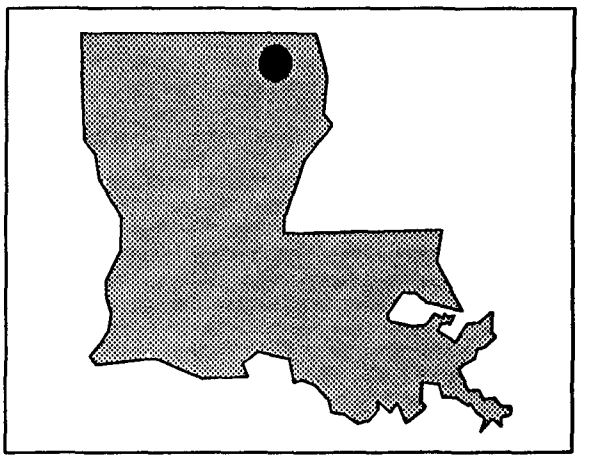


Figure 4.9: Bayou Bonne Idee (Louisiana) RCWP project map, LA-1.

Louisiana
Bayou Bonne Idee

(RCWP 7)

Morehouse Parish
MLRA: 0-134
HUC: 080500-01



4.1 Project Synopsis

The project area, located in the Mississippi delta region of northeastern Louisiana, consisted primarily of large, relatively flat cotton fields. Sediment and pesticides from these fields were polluting the Bayou Bonne Idee, impairing its uses for primary contact recreation and sport and commercial fishing.

The purpose of the project was to reduce the influx of sediment and pesticides to the bayou by implementing best management practices (BMPs) on 75% of the cotton land within 0.75 miles of the bayou (critical area). The most common BMPs used were permanent vegetative cover on critical areas (BMP 11), conservation tillage systems (BMP 9), and improving an irrigation and/or water management system (BMP 13). Because the last two of these BMPs were expensive and labor intensive to implement, the project critical area was decreased from 166,452 to 44,880 acres, after the project team realized that the original critical area was too large to achieve adequate BMP coverage with available resources. This downsizing caused a drain on project resources because the many contracts developed for land (about 20,000 acres) outside the revised critical area still required cost share and technical assistance. Even with this drain, the project succeeded in contracting nearly 60% (27,103 acres) of the revised critical area representing about 81% of the land treatment goal.

'he water quality monitoring program consisted of ambient monthly grab sampling at four sites along the 75-mile 'ou. Trend analysis indicated slight decreases in turbidity, total suspended solids, and total phosphorus over the ct period; however, these decreases were not statistically significant or specifically linked to land treatment.

)ject Findings, Recommendations, and Successes

2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

Project personnel realized during the sign-up period that the goal of treating 75% of the original 166,452 acre critical area was too ambitious considering available resources, so the project area was decreased to include only land draining directly to Bayou Bonne Idee. This downsizing may have been necessary, at least partially, due to an unfulfilled promise of additional funding made by the National Coordinating Committee (NCC).

ıe formation of objectives and goals depends on an accurate assessment of the water resource impairment, without which it is difficult to identify critical areas and choose appropriate water quality BMPs.

commendations

4.2.1.2 R

The BM

s that best address the pollution problem should be emphasized in the implementation statements, thereby maximizing the chances of realizing the water quality objective.

)bjectives and goals must be established with respect to the amount of resources available to accomplish them.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

Cooperative ties between USDA agencies, U.S. Environmental Protection Agency, and state agencies involved in nonpoint source (NPS) pollution control established during the RCWP have helped subsequent water quality projects.

The voluntary and multi-agency nature of the project made it difficult to manage because personnel involved placed less priority on cooperative efforts than on projects totally under their agency's control.

The project's overall effectiveness suffered from a lack of cooperation between agencies due to conflicts between key individuals and a lack of funds for water quality monitoring.

Project personnel attempted to manage and direct the RCWP effort in nearly the same manner and using the same decision groups as they had utilized for previously established programs, such as the Agricultural Conservation Program, (ACP): establishing strong local and state coordinating committees or a project advisory group might have been more effective.

4.2.2.2 Recommendations

Project personnel indicated that because this type of project was new, more guidance from the NCC early in the project should have been given. Future projects would benefit from the same early guidance.

For multi-agency projects to be successful, each agency should recognize its responsibility and have a method of making its employees accountable to the project.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

Although the project designated only limited resources ($6,000) toward information and education (I&E) efforts, overall producer interest and participation was relatively high. However, perhaps more resources designated for I&E, especially pesticide management, would have been appropriate since the emphasis of the project was on reducing pesticide levels in Bayou Bonne Idee.

One-to-one visits to producers by Cooperative Extension Service (CES) staff after initial correspondence had been sent were most successful in convincing producers to reduce nutrient pesticide inputs. On-farm demonstrations of proven research technology were also effec in persuading producers to use less pesticides in their integrated pest management scher

The efforts of both the Soil Conservation Service (SCS) and the CES were essential, initial helping producers become aware of and understand the project. Regular newsletters the Agricultural Stabilization Conservation Service (ASCS) kept farmers aware of P changes and progress.

Letters, newsletters, and news articles in themselves were not effective methods of pr project; however, they did serve as continual reminders of the program.

4.2.3.2 Recommendations

On-farm visits by project staff who can communicate water quality objectives are r cially to ensure proper implementation of management intensive BMPs.

Close cooperation among participating agencies should be maintained. All agenc age producers to adopt BMPs best suited to address the water quality pro just those BMPs the agency is primarily responsible for implementing.

Additional resources should be made available for the I&E efforts of agenc plementing BMPs that best address the water quality problem, espec a significant management component.

responsible for im- those BMPs have

lem, rather than should encour-

spe-

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

High implementation levels can be achieved for practices that are perceived to significantly increase farm production or decrease labor needs.

Project personnel reported fair to excellent participation in the project, as well as adoption of some BMPs by non-participants.

Participation was limited by a lack of cost share funds near the end of the sign-up period.

BMPs, such as irrigation improvements, that benefit the producer were instrumental in getting farmers to participate in the RCWP and to agree to implement other, often less desirable BMPs.

The poor agricultural economy during the sign-up period limited participation.

4.2.4.2 Recommendations

A low interest loan program, perhaps sponsored by the United States Department of Agriculture (USDA), should be offered to help producers finance their portion of BMP installation costs, especially when interest rates are high. Such a program might significantly increase producer participation in programs like the RCWP.

Linking commodity price supports to water quality improvements might be a method of increasing participation in future projects.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

Practices having primarily off-site benefits can be added to contracts that include practices with high on-site benefits such as irrigation improvements.

Nearly 60% (27,103 acres) of the revised critical area was treated with BMPs. This represented about 81% of the land treatment goal.

The high turnover rate (about one per year) of soil conservationists used to develop farm plans and provide technical assistance for the project made BMP tracking and evaluation difficult.

Project personnel report that land leveling and smoothing has reduced the amount of sheet erosion occurring on cropland draining to Bayou Bonne Idee, although there are no monitoring data to substantiate this claim.

Tracking of BMPs included standard farm-by-farm review of implementation.

4.2.5.2 Recommendations

The implementation of BMPs that best mitigate the water quality problem should be emphasized even though they may not be popular with producers. As an experimental program, the RCWP was designed to initiate and encourage the use of innovative, sometimes unpopular, practices to abate agricultural pollution.

BMPs which are very effective at reducing pollution, but not popular with producers, should be cost shared at higher rates to encourage their adoption.

People hired for project term positions should be encouraged to remain in the position for several years with the understanding that they will be offered the next available permanent position after this period.

Critical area criteria should be based on more than simply proximity to the water resource, but should also include factors such as critical sources of pollutants and probability of pollutant transport to the impaired water resource.

4.2.5.2 Recommendations (continued)

Land treatment tracking should include where and when BMPs are implemented and how well they are being maintained, not just the total number implemented. Management factors such as maintenance and timing of tillage and pesticide application often determine BMP effectiveness and, therefore, should be included in the BMP and also tracked for producer compliance.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

No significant reductions in sediment or turbidity levels have been documented with the water quality monitoring data collected during this project. Trend analysis of monitoring data indicated slight improvements in dissolved oxygen (DO), turbidity, total suspended solids, and total phosphorus; however, these improvements may have been due to climatic variability.

Part of the objective of the project was to reduce the influx of pesticides to the Bayou, but very little pesticide monitoring data were reported. Monitoring was limited by the high cost of sample analysis and the limited availability of funding for monitoring.

Annual fish tissue analysis conducted during the first half of the project (prior to 1986) showed significant decreases in the residue levels of organochlorine insecticides. This decrease is attributable primarily to the banning of several pesticides by USEPA in the late 1970s.

4.2.6.2 Recommendations

Monitoring is required at the field level, or at least subwatershed level, to assess the effectiveness of BMPs, especially if BMPs are not implemented on a very high percentage of the critical area.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.1.1 Findings and Successes

Neither the water quality monitoring nor the land treatment tracking/monitoring were designed to meet the goal of relating changes in water quality to land treatment.

4.2.1.2 Recommendations

In order to establish linkages between water quality changes and land treatment, projects should include field or stream level water quality monitoring in which a high portion of the land draining to the monitoring station is treated with BMPs.

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1980 - 1991

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

A meandering, approximately 75-mile long bayou

4.3.2.1.2 Water Uses and Impairments

Bayou Bonne Idee is used mainly for water sports and fishing. It is popular for recreation that contributes significantly to the local economy. An estimated 10,000 recreational fisherman use the project area water resources each year. Use of project area water resources is impaired by turbidity, sedimentation, and toxic agricultural chemicals in cropland runoff.

4.3.2.1.3 Water Quality Problem Statement & Status

High turbidity levels impair recreational uses (water sports and fishing) of Bayou Bonne Idee. Pesticide residues in fish tissue have also been a concern.

4.3.2.1.4 Water Quality Objectives and Goals

Abate NPS pollution (sediment and toxic agricultural chemicals) to a level compatible with state water quality standards

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 66,000 acres
Project Area: 66,000 acres (originally 220,000)
Critical Area: 44,880 acres (originally 166,452)

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 48 inches

Geologic Factors: The project area is in the Arkansas River Alluvial Plain within the Southern Mississippi Valley Alluvium Major Land Resource Area. Topography is nearly level to gently sloping. Soils are highly erodible.

4.3.2.2.3 Project Area Agriculture

Cotton is the primary crop grown in the watershed critical area. Some soybeans and rice are also grown in the watershed.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	75	100
Pasture/range	4	-
Woodland	11	-
Urban/roads	10	-
Other	-	-

4.3.2.2.5 Animal Operations

None of significance

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	2,300,000	0	2,320,000	0	4,620,000
Info. & Ed.	6,000	NA	0	15,000	21,000
Tech. Asst.	765,921	NA	0	64,440	830,361
Water Quality Monitoring	300,000	72,000	0	0	372,000
SUM	3,371,921	72,000	2,320,000	79,440	$5,843,361

Source: Smolen et al., 1989; Bayou Bonne Idee RCWP Project, 1992.

4.3.4 Information and Education

4.3.4.1 Strategy

Responsibility for the information and education (I&E) effort was divided, with the Cooperative Extension Service (CES) agents concentrating on fertilizer and pesticide management (BMPs 15 and 16), the SCS handling all other BMPs, and the ASCS overseeing the overall project.

4.3.4.2 Objectives and Goals

Objectives and goals were not clearly stated, but generally focused on publicizing the RCWP and educating producers.

4.3.4.3 Program Components

Farm demonstrations of proven practices such as fertilizer placement, biological pest control, and cover crops

Personal contacts to train and assist producers in BMPs related to nutrient and pesticide management

Several articles in the local newspaper explaining the project and announcing the first contract signing

One public meeting sponsored by the SCS to announce the RCWP project and answer questions

Local ASCS newsletters to publicize RCWP changes and announcements

4.3.5 Producer Participation

4.3.5.1 Level of Participation

Although the project did not reach its BMP implementation goal, producer participation was good, limited mainly by the cut-off of cost share funds.

4.3.5.2 Incentives to Participation

Cost share rates of 75% for soil conservation practices, 50% for irrigation improvements, and 90% for farmers located adjacent to the Bayou Bonne Idee

The perception that recommended BMPs would reduce labor requirement or increase productivity

4.3.5.3 Barriers to Participation

Total cost share limit of $50,000

Economically difficult situation during sign-up period

Perception that implementing certain BMPs would decrease soil productivity

Unwillingness to change from traditional farming practices

Relatively low regard for water quality problems, in a few cases

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

The chances of continued adherence to many BMPs is not good. The chances of the adoption of BMPs on additional land without cost share assistance are slim to none.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The basic strategy was to treat all land within the revised critical area.

4.3.6.2 Objectives and Goals

Implement BMPs on 75% of the revised critical area to reduce sediment and toxic chemical yield from cropland along Bayou Bonne Idee.

4.3.6.3 Critical Area Criteria and Application

The revised critical area was all land within 3/4 mile of the bayou. More than 20,000 acres of land outside the critical area was treated because it was contracted before the downsizing of the project.

4.3.6.4 Best Management Practices Used

BMP Utilized in the Project*	Units	Planned	Installed
Permanent vegetative cover (BMP 1)	feet	4,972	4,800
Terrace system (BMP 4)	feet	20,400	8,334
Waterway system (BMP 7)	ac. served	120	60
Cropland protection system (BMP 8)	acres	7,721	7,916
Conservation tillage system (BMP 9)	acres	48,817	61,491
Permanent vegetative cover on critical areas (BMP 11)	acres	194	133
- Field border	feet	1,257,851	1,035,260
Sediment retention, erosion, or water control structures (BMP 12)	number	134	31
Improving an irrigation and/or water management system (BMP 13)	acres	11,177	9,104
- Irrigation water conveyance	feet	78,295	81,909
Fertilizer management (BMP 15)	acres	10,071	4,380
Pesticide management (BMP 16)	acres	15,820	11,764

*Please refer to Appendix I for description/purpose of BMPs.

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

An annual table of BMP implementation showed amount planned, cost share earned, and amount applied. Accomplishments under other programs were also reported. ASCS and SCS maintain the land treatment and land use records.

4.3.6.5.2 Data Management

The data were managed locally by the project.

4.3.6.5.3 Data Analysis and Results

Quantified Project Achievements:

		Critical Area		Treatment Goals	
Pollutant Source	Units	Total	% Implemented	Total [1]	% Implemented
Cropland	acres	44,800	35%	33,600	47%[2]

[1] Usually 75% of the project critical area.
[2] Project has contracted 27,103 acres or 60% of the critical area.

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The original monitoring program design called for more extensive data collection, including automatic stormwater sampling, an area-wide stormwater monitoring program, and fish tissue analysis for pesticide residues. These activities would have contributed to a better understanding of pollutant loading to Bayou Bonne Idee. However, due to budgetary constraints and weather, only ambient monitoring at five stations on Bayou Bonne Idee has taken place since the project began.

Conducted by the Louisiana Department of Environmental Quality

4.3.7.2 *Objectives and Goals*

Assess the initial water quality of project area water resources and determine the effects of BMP implementation on water quality as the project progressed

Reduce sediment and toxics levels to comply with state water quality standards

4.3.7.3 Time Frame

1980-1990

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

5 sites along Bayou Bonne Idee

4.3.7.4.2 Sample Type

Grab

4.3.7.4.3 Sampling Frequency

Monthly

4.3.7.4.4 Variables Analyzed

Total suspended solids (TSS), nitrite plus nitrate nitrogen (NO_2+ NO_3-N), turbidity, periodic pesticide scans

4.3.7.4.5 Flow Measurement

Instantaneous measurement with each grab sample

4.3.7.4.6 Meteorologic Measurements

None reported

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

Automatic stormwater monitoring sampling was unsuccessful due to weather and equipment problems. No sampling has been done under the area-wide stormwater monitoring project.

4.3.7.5 Data Management

The data are in STORET.

STORET AGENCY CODE	STORET STATION NO.	PROFILE / STATION MAP / NO.
21LA10RS	58010121	LA-1 / 121 (1981-86)
"	58010122	LA-1 / 122 (11/81-12/89)
"	58010125	LA-1 / 126 (switched w/ STORET126) (7/82-12/89)
"	58010126	LA-1 / 125 (switched w/ STORET125) (7/82-12/89)
"	58010127	LA-1 / 127 (7/82-12/89)
"	58010128	LA-1 / 128 (southwest of Oak Ridge)
"	58010123	LA-1 / 123 (2/82-12/86 Cypress Bayou west of Oak Grove)

4.3.7.6 Data Analysis and Results

Trend analysis was performed by grouping all observations at each station and comparing mean values between stations for total suspended solids, nitrate-nitrogen, and turbidity.

The data analysis technique employed to determine water quality trends is insufficient to detect a real change. The technique does not account for precipitation influences, which may have a significant impact on the annual water quality parameter values.

4.3.8 Linkage of Land Treatment and Water Quality

No attempt was made to link land treatment and water quality because neither the land treatment/use nor the water quality monitoring systems were geared to this task.

4.3.9 Impact of Other Federal and State Programs on the Project

The federal Payment-In-Kind (PIK) program significantly reduced (30,000 acres) cotton acreage in 1983. Since that time, acreage has varied, to a lesser extent, with changes in government commodity programs.

An SCS watershed project to clean out Bayou Bonne Idee was sometimes confused with the RCWP project, but it helped improve the public's perception of the effect of the RCWP project by improving the drainage of the Bayou.

4.3.10 Other Pertinent Information

None

4.3.11 References

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

Bayou Bonne Idee RCWP Project. 1992. Bayou Bonne Idee Rural Clean Water Program Ten-Year Report. 26p.

Smolen, M.D., S.L. Brichford, J. Spooner, A. Lanier, T.B. Bennett, S.W. Coffey, and K.J. Adler. 1989. NWQEP 1988 Annual Report: Status of Agricultural Nonpoint Source Projects. EPA 506/9-89/002. p69-73.

4.3.12 Project Contacts

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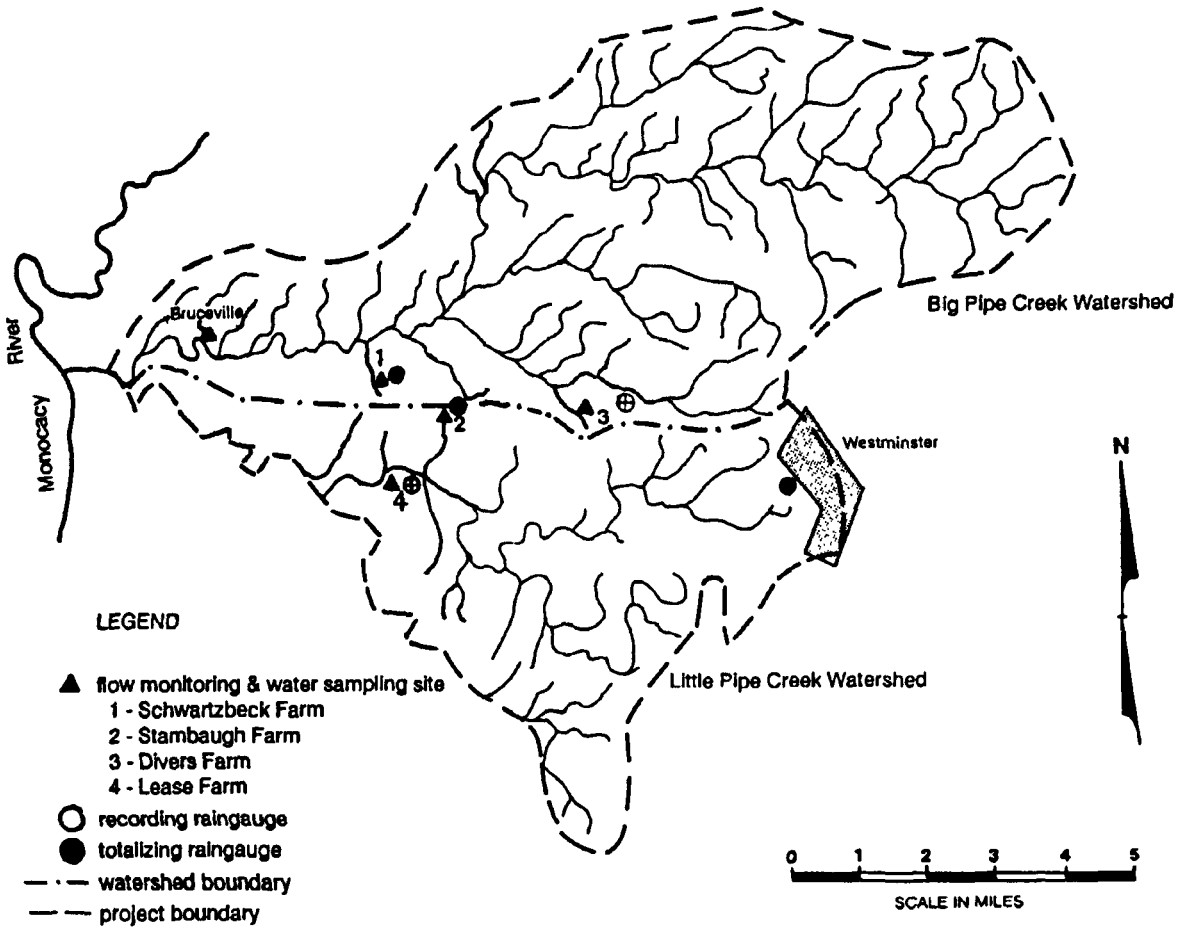
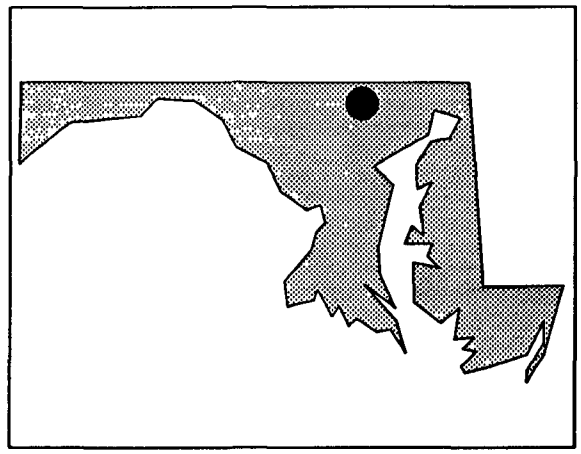


Figure 4.10: Double Pipe Creek (Maryland) RCWP project map, MD-1.

Maryland
Double Pipe Creek

(RCWP 8)



Carroll County
MLRA: S-148
HUC: 020700-09

4.1 Project Synopsis

The Double Pipe Creek drainage basin is part of the multi-county Monocacy River basin which runs from within Pennsylvania southeast to the Potomac River. The watershed consists of two subbasins, Big Pipe Creek (58% of the Double Pipe Creek watershed) and Little Pipe Creek (42% of the watershed) (McCoy and Summers, 1992).

Carroll County, located in the north central part of the state, is one of the leading dairy counties in Maryland. In 1980, there were approximately 18,000 dairy cattle in the county; by 1990, the number of dairy cattle had dropped to 12,900 (Sanders et al., 1991). Geographically, the area is characterized by rolling hills and lush valleys. Land use in the watershed/RCWP project area (112,200 acres) consists of 65% cropland, 15% woodland, 12% pasture, and 8% urban/roads. High fecal coliform counts, an indicator of pathogenic bacteria, in Little Pipe and Big Pipe Creeks threaten domestic water supplies, aquatic life, and contact recreation. Sediment, nutrients, pesticides, and herbicides are other water quality concerns. Sources of pollutants besides agricultural operations include two wastewater treatment plants and two quarries, all located on Little Pipe Creek.

The primary goal of the RCWP project was to improve water quality in the Double Pipe Creek basin through the application of best management practices (BMPs), particularly animal waste management. Emphasis was placed on treating cropland with conservation tillage and installing grassed waterways, building waste storage structures for critical animal operations, and spreading manure based on soil tests.

The project critical area included 18,180 acres. The first priority critical area included farms where livestock and the waste management situation presented a water quality problem and where severe gully erosion existed. Farms with erosion control problems due primarily to sheet and rill erosion were the second priority critical area.

Analysis of baseline monitoring data showed the project area to be a substantial source of nonpoint source (NPS) pollutants entering the Monocacy River. During the baseline monitoring period, a problem was encountered with BMP installation at three farm sites chosen as monitoring stations. Two landowners did not implement BMPs and the other landowner installed practices during the pre-treatment monitoring period. Monitoring at these sites was discontinued shortly thereafter. A new site (Lease farm) was established with the objective of estimating the effectiveness of BMPs for animal waste runoff control. These disruptions in the water quality monitoring program, as well as funding limitations, made it difficult for the project team to demonstrate definitive links between land treatment initiated through the project and water quality changes.

Water quality monitoring results through 1990 suggest that BMPs implemented under the RCWP in the project area improved water quality in Big Pipe Creek. Concentrations of ammonia and total organic carbon decreased in Big Pipe Creek. Total nitrogen and nitrate-nitrite nitrogen concentrations increased during the project period. The specific water quality goals of meeting the state standards for turbidity and fecal coliform were not met. (Sanders et al., 1991; McCoy and Summers, 1992)

4.1 Project Synopsis (continued)

Inter-agency coordination, communication, and cooperation in this project were outstanding. The Local Coordinating Committee (LCC) functioned effectively and smoothly, with support, but without interference, from the state level. The agencies' existing relationships with the producers were strong and positive and thus set the stage for a successful project in terms of producer participation. The timing of the project, which coincided with increasing regional concern and activity related to improving the water quality of the Chesapeake Bay, served to enhance the success of the RCWP project. Technical assistance was effective and embodied the experimental nature of the RCWP with the result that much was learned about the best designs for animal waste storage BMPs in the area. RCWP funds were used to hire a nutrient management specialist. This approach was so successful that when RCWP funds for the position ran out, the Maryland Department of Agriculture allotted funds to the Cooperative Extension Service to continue the position.

The one weak link in the project was the water quality monitoring program, which was handled sequentially by two different agencies and for which funding was insufficient. The loss of the original monitoring sites resulted in a lack of baseline data on which to base a water quality analysis. Although improvements in water quality appear to have occurred in Big Pipe Creek, the project has not been able to clearly link these changes to land treatment.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

The goals of the project must be clearly understood by all parties involved.

Water quality goals were not set at attainable levels. The goals of meeting the state standards for fecal coliform and turbidity during the project period were unrealistically high.

The land treatment goal of having 50% of the critical area under contract by the end of the third year was realistic. However, the goal might have been more meaningful if it had been set to measure BMPs implemented versus contracted.

More time should have been provided during the application period for needs assessment and establishment of goals.

4.2.1.2 Recommendations

Water quality goals should be defined clearly and early and should be set at achievable levels.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

The roles of the agencies must be clearly defined and accepted by agency personnel. The Double Pipe Creek RCWP project responsibilities and work were well balanced among the three agencies. All felt important and no agency overshadowed any other agency.

Inter-agency coordination, communication, and cooperation were major keys to the success of the project.

The team building that resulted from RCWP activities strengthened the cooperative working relationships among the agencies on the local level and now makes their work together even more effective than pre-RCWP.

4.2.2.1 Findings and Successes (continued)

The State Coordinating Committee (SCC) recognized that the LCC was doing its job well and did not try to control the project from the state level. The SCC tried to support the LCC as requested. For example, the SCC requested and obtained additional funding to enable the Cooperative Extension Service (CES) to hire an agent to work on nutrient and pesticide management within the RCWP project.

The structure of the LCC and SCC provided a coordinated approach to solving water quality problems. This team approach was highly successful.

Giving administrative decision making responsibilities to the local personnel actually implementing the project was important. The structure of the RCWP worked well in that both responsibility and credit for good work done lay at the local level. Top-down administration would have been a severe deterrent to effective working relationships at the local level and to the success of the Maryland RCWP project.

A city official in charge of the Westminster Wastewater Treatment Plant was an active member of the LCC. This was very important, since the plant had a big impact on the water quality of Little Pipe Creek. The official's involvement in the project also made the farmers feel that they were not being singled out as the sole source of pollution, but that other contributors were also playing a part in the project.

Having the Agricultural Stabilization and Conservation Service (ASCS) administer the project was a tremendous advantage, since the agency already had experience administering cost sharing programs.

Excellent cooperation existed among all the agencies involved in the Double Pipe Creek Project. The LCC and information and education subcommittee had good participation from local farm organizations and public officials.

The Carroll County ASCS set up its own system for tracking cost share and BMP implementation. Clearer direction from the National Coordinating Committee (NCC) and/or more communication among projects on approaches to program administration would have been helpful.

BMPs already being practiced in the project area, especially conservation tillage, were not cost shared under RCWP. In this way, the LCC ensured that the funds were used to implement new practices that would probably not have been installed without RCWP cost share funds.

Although agency roles and personnel changed throughout the project, these changes seemed to have minimal impact on the successful reaching of project goals and objectives, probably as a result of the strong on-going working relationships among the agencies.

4.2.2.2 Recommendations

It is important to invite all potential players with an interest in the project to participate in the initial LCC meetings. In this way, the whole community has been tied into the project at the initial stages and all parties feel that they are part of the project (such as mayors, other local agencies).

For water quality demonstration projects of this type, management staff at the national, state, and local levels need to insure that adequate staffing is available to carry out the special project without negatively affecting the ongoing local program.

A separate budget line should be added to provide for the printing of the annual and 10-year reports.

The initial guidelines for the project should clearly outline the expected contents of the yearly, 10-year, and end-of-project reports.

4.2.2.2 Recommendations (continued)

Eligibility rules should be clearly thought through and established, perhaps on the national level, in order to avoid conflicts. Lack of clearly stated rules sometimes led to conflicts and unfair treatment of producers. For example, a father and son, each owning a farm but working them together in a partnership, were considered one farm (and thus limited to $50,000 cost share), whereas non-related partners, each owning a farm and working them together, were considered two farms (and were limited to $100,000 cost share).

More (funded) opportunities for interaction among project staff nationwide would be helpful in order to facilitate inter-project information exchange.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

A wide variety of information and education (I&E) activities were conducted to promote the Double Pipe Creek Project. The result was that the objectives and activities of the RCWP project were effectively communicated to both the farm community and the general public.

The Double Pipe Creek RCWP project increased awareness in the project area and throughout the state of NPS pollution and the connection between land use and practices within the project area and the quality of Chesapeake Bay. The RCWP project activity was closely followed by increasing efforts to protect the Bay; the two programs enhanced each other and together increased citizen awareness of the need to protect water quality.

Project personnel consciously directed recruitment efforts to the large producers. The level of treatment indicates that this was an effective strategy.

At the end of the sign-up period, much effort revolved around one-to-one contact with producers. More personnel efforts during this time might have resulted in a higher number of contracts.

The Cooperative Extension Service (CES) had an opportunity to refine its techniques for preparing fact sheets and bulletins that targeted specific information to specific client groups.

Techniques developed during the RCWP are now being used in the daily work of the local and state agencies. For example, the concept of nutrient management was introduced to the project area during the Double Pipe Creek RCWP project. Additional RCWP funds were obtained to employ an agent specifically to work with RCWP farmers on nutrient management. When these funds ran out, the success of this phase of the project was so evident that the Maryland Department of Agriculture allotted funds to the CES to continue the position.

4.2.3.2 Recommendations

More interchanges between local level project personnel and personnel working on other RCWP projects would be helpful, especially in I&E, in order to provide training and support to project staff.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

The voluntary nature of the program was one reason for the success of the RCWP project. This is particularly striking because the sign-up and implementation years of the RCWP (decade of the 1980s) were among the worst years for agriculture in decades and there were four droughts during the RCWP project period.

Leadership provided by Soil Conservation District Board of Supervisors was important to the success of the project. One member of the Board was the first dairy farmer to sign a RCWP contract and complete a practice. The on-the-ground demonstration of the practices by a few farmers helped encourage other farmers to sign up under the RCWP. Seeing the practices implemented helped farmers understand the practices, their functions, and the benefits to be gained from them.

4.2.4.1 Findings and Successes (continued)

The willingness of project area farmers to implement practices that would help improve water quality was a critical factor in the success of the project. Animal waste storage was increased by 30% in the project area.

4.2.4.2 Recommendations

Agricultural cost share programs aimed at water quality improvement through voluntary BMP implementation should be continued because they have been shown to be an effective way of reducing agricultural nonpoint source pollution.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

The project goal of BMP implementation on at least 50% of the farms in the critical area (primarily animal waste management, grassed waterways, and stripcropping) was met. These practices are generally being maintained. Water Quality Plans covering 20,273 acres had been written and approved for 149 contracts by the end of the contracting period (1986).

Implementation is correlated to farm income and farm income is difficult to project over a 10-15 year program period. Weather cycles affect farm income. During the project, the area experienced several serious droughts.

The flexibility to modify and experiment with BMPs and the $50,000 payment limitation were great assets to the project. Many different and innovative waste storage facility designs were tried and RCWP cost share funds were used to modify the designs that didn't work as well as others (unless the farmer had already reached the $50,000 limit). The end result was that Soil Conservation Service (SCS), ASCS, and CES learned a lot about what designs do work best under local conditions.

The tracking and record system could have been better developed at the beginning of the project to facilitate more pertinent data collection in the form later requested.

Availability of contractors with the required experience, equipment, and ability was not a problem.

More personnel were needed to work with landowners and operators on management and maintenance of installed BMPs.

4.2.5.2 Recommendations

It is important to address all problems on a farm that are affecting water quality. This is feasible when the project area acreage is small and when the local agencies have adequate staffing to get the job done.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

Results through 1990 suggest that BMPs implemented under the RCWP in the project area improved water quality in Big Pipe Creek, where concentrations of ammonia and total organic carbon decreased by 44% and 51%, respectively. Total nitrogen increased by 25% and nitrate-nitrogen increased by 34% in Big Pipe Creek during the project period.

The results of the monitoring program indicate that the state's turbidity and fecal coliform standards are exceeded regularly in Big Pipe Creek.

4.2.6.1 Findings and Successes (continued)

An adequate pre-implementation water quality characterization was difficult to obtain. Once monitoring sites were picked, both producer and project team were anxious to begin implementing BMPs. The original project guidelines indicated that BMPs had to be implemented within one year of the producer signing a contract. Because of this rule, monitoring sites were chosen on three farms not under contract in order to get two years of pre- project water quality data. These producers either never signed a contract or never implemented the practices and it became impossible to collect post- implementation data.

Water quality data were affected by four major droughts in the project area during the RCWP decade. It is thus possible that some of the perceived water quality improvements were due to lower volumes of runoff rather than the effects of land treatment implemented through the project.

4.2.6.2 Recommendations

Several years and much money were spent monitoring three specific farm sites; however, two farmers decided not to implement BMPs. This illustrates the importance of developing a binding contract with landowners whose participation is essential to the monitoring program, even if implementation of such a contract requires providing special incentives to the landowner.

It would be helpful for project teams to have more guidance on establishing effective water quality monitoring programs within existing/realistic budgets.

Projects should plan an approach to water quality data analysis from the very beginning of the project and then stick to the plan. The Maryland project's monitoring design went through several changes, making it difficult to link the earlier and later phases of the monitoring data and diminishing the ability of the project to document water quality improvements linked with BMP implementation.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

None of the BMPs used in the RCWP project appear to have been effective in reducing fecal coliform densities in Big Pipe Creek. Additional work is required to determine what practices are effective in reducing fecal coliform densities. (McCoy and Summers, 1992)

To demonstrate a relationship between land treatment and water quality, the project would have had to work with a smaller sub-basin, comparing data collected under normal agricultural practices with post-BMP implementation data.

4.2.7.2 Recommendations

Careful planning of a water quality monitoring and data analysis strategy at the beginning of the project is critical. The monitoring design went through several changes, with the result that it was difficult to link water quality with land treatment.

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1980 - 1994

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Streams: Big Pipe Creek, Little Pipe Creek, and Double Pipe Creek (formed by the confluence of Little and Big Pipe Creeks)

4.3.2.1.2 Water Uses and Impairments

Project area streams and ponds provide public water supply for the city of Westminster and surrounding areas, serving approximately 18,000 people and several businesses. Secondary uses of water resources are contact recreation and fishing.

4.3.2.1.3 Water Quality Problem Statement

High levels of suspended sediment and coliform bacteria impair multiple uses of project area streams. Nutrient export to Chesapeake Bay is a concern.

4.3.2.1.4 Water Quality Objectives and Goals

Objectives:

Apply BMPs to address the most critical water quality problems in the project, specifically high fecal coliform bacteria and potential sediment loads

Show a measurable improvement in the degree of water quality

Goals:

Reduce the level of fecal coliform bacteria to below 200MPN/100ml (state standard)

Meet the state standard for turbidity (150 NTU, JTU, or FTU units or a monthly average of 50 units) at all times

Reduce the sediment delivery to the streams by approximately 36,000 tons per year

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 112,200 acres
Project Area: 112,200 acres
Critical Area: 18,180 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 45 inches

Geologic Factors: The project area lies within the north central Piedmont Region and is characterized by gently rolling to steep uplands with streams of average to steep gradient feeding into the bottom lands. Predominant soils are moderately erodible. Ground water within the project area occurs primarily in fractures and bedding-plane partings of rocks. It may also occur in solutional cavities in limestone and marble.

4.3.2.2.3 Project Area Agriculture

Agriculture in the project area consists primarily of dairy and cash grain. Corn, soybeans, small grain, and hay are the principal crops grown. (Schaeffer, 1992)

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	65	NA
Pasture/range	12	NA
Woodland	15	NA
Urban/roads	8	NA
Other	-	NA

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	75	19,774	27,684
Beef	NA	6,958	6,958
Poultry	6	700,000	23,100
Hogs	NA	6,222	2,489
Horses	NA	7,747	15,494

These data are as of 1980. Dairy cow numbers decreased by approximately 5,000 animals between 1980 and 1990 (Sanders et al., 1991) and poultry numbers decreased to 330,000 during the same period (D. Greene, Carroll County Cooperative Extension Service, personal communication).

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					**SUM**
Cost Share	3,576,137	0	1,227,613	0	4,803,750
Info. & Ed.	58,939	0	0	0	58,939
Tech. Asst.	1,232,569	0	0	0	1,232,569
Water Quality Monitoring	0	0	0	0	0
SUM	4,867,645	0	1,227,613	0	$6,095,258

4.3.4 Information and Education

4.3.4.1 Strategy

The Information and Education program was designed to utilize a wide diversity of communication methods to promote the Double Pipe Creek RCWP project among the farm community and general public.

4.3.4.2 Objectives and Goals

Inform the public and the farming community about the RCWP project and how the project would be funded and administered (Sanders et al., 1991)

Help farmers realize that they were part of the problem and help the rest of the community realize that they were also part of the solution

Encourage farmer and landowner participation in the RCWP (Sanders et al., 1991)

4.3.4.3 Program Components

Media coverage (press conferences, television/radio, news releases, farm newsletters)

RCWP Newsletter; flyers about the RCWP, Double Pipe Creek RCWP project, soil conservation, tours, and demonstrations

Fact sheet on grassed waterway maintenance

Informational displays

Slide tape show

Picture album of sample BMPs

Tours of participating farms for county officials, the general public, and producers

Manure spreader calibration demonstrations during field days and farm tours

Signs for "RCWP Cooperating Farms" and plaques for cooperators completing all of their planned BMPs

Communication with Vocational Agriculture teachers and classes

Individual farm visits

Meetings with contractors who build soil conservation BMPs

Demonstrations for schools, service clubs, and farm meetings of a mechanical ground water model to show the interaction of ground and surface water and how it is affected by human activities

4.3.5 Producer Participation

4.3.5.1 Level of Participation

Producer participation in the RCWP project was very good. The land treatment goal of having an acreage equal to 50% of the critical area under contract by the third year of the project met.

4.3.5.2 Incentives to Participation

Cost share rate of 75% for most practices

$50,000 payment limit per producer

Environmental concern during the 1980s related to the necessity of cleaning up the Chesapeake Bay created an awareness in the farm community that there was a problem with NPS pollution from farms and that farm operators would be expected to help solve the problem (Greene, 1992)

Strong leadership within the farm community

Peer pressure

Option for SCS to be flexible in adjusting designs to deal with problems and individual sites

4.3.5.2 Incentives to Participation (continued)

Fear of regulation of farming operations by federal and/or state agencies motivated some farmers to participate in voluntary programs

Success of the initial RCWP contracts

Effectiveness of SCS in properly designing practices and working with farmers

Perception that BMPs installed would benefit the farmer economically and contribute to sustainability of the farm

Interest in manure management as a labor- and cost-saving technique

4.3.5.3 Barriers to Participation

Economics of the dairy situation during the 1980s had a negative impact on farmer participation

Inability of some farmers to afford their share of the cost of implementing BMPs

$50,000 payment limit (for farmers owning more than one farm)

Unwillingness of some producers to participate in any government program

Fear on the part of some producers of being cited for water quality violations if they allowed federal and state agencies on their farms

Lack of interest by absentee landowners in investing in their land

Economic hardship due to three droughts during the project period (Sanders et al., 1991)

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Excellent because of 1) awareness by producers of the connection between their practices and the water quality of the Chesapeake Bay and 2) the personal investment made by farmers in the BMPs.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

Major emphasis was placed on preventative measures and management of the soil resource which directly affected water quality in order to make the project more cost- effective. For example, the concept of diverting fresh water around a livestock area as well as the proper handling of animal wastes inside the facility was considered in all applicable plans. Preventing the displacement of soil particles in a water course was emphasized over collecting it downstream.

4.3.6.2 Objectives and Goals

Objective:

Reduce the agriculturally generated pollutant load in the watershed

Goals:

Have an acreage equal to 50% of the critical area under contract by the end of the third year of the project

Treat cropland with conservation tillage and grassed waterways, and improve procedures for animal waste storage and field application

4.3.6.3 Critical Area Criteria and Application

Criteria:
Distance from major streams
Size of farm operation (especially size of livestock herd)
Present conservation status

4.3.6.4 Best Management Practices Used in the Project

The general scheme was to treat cropland with conservation tillage and install grassed waterways; build waste storage structures for critical animal operations; and spread manure based on soil tests.

There has been a significant shift in BMP emphasis to conservation tillage without RCWP funding in the project area.

BMPs Utilized in the Project *	Project Accomplishments
Permanent vegetative cover (BMP 1)	252 acres
Animal waste management system (BMP 2)	100 systems
Stripcropping system (BMP 3)	2,031 acres
Diversion system (BMP 5)	12,287 feet
Grazing land protection system (BMP 6)	84 systems
Waterway system (BMP 7)	213,148 feet
Stream protection system (BMP 10)	22 systems
Permanent vegetative cover on critical areas (BMP 11)	14 acres
Fertilizer management (BMP 15)	26 contracts
Pesticide management (BMP 16)	28 contracts

*Please refer to Appendix I for description/purpose of BMPs.
Source: Sanders et al., 1991

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

ASCS reported BMP implementation by units and cost share earned. Animal waste production, major crops, average yields, and fertilizer and pesticide use were also reported. Maintenance was tracked by SCS through annual status reviews of farms.

Land use was not tracked. There were few major land use changes in the project area during the RCWP project period (for example, cropland to residential or woodland); however, significant changes in rotation, contouring, and strip cropping did occur.

4.3.6.5.2 Data Management

Data were maintained by ASCS and SCS.

No geographic information system or other mapping was used.

4.3.6.5.3 Data Analysis and Results

Quantified Project Achievements:

Pollutant Source	Units	Project Area * Total	Project Area * Implemented
Cropland	acres	72,930	19,847
Pasture	acres	13,464	6,466
Dairies	#	NA	102
Feedlots	#	NA	37
Poultry Farms	#	NA	5
Contracts	#	235	140

* Data not available for critical area only

Sources: Double Pipe Creek RCWP Project, 1990 (form RCWP 3), Sanders et al., 1991, and personal communication from E. Schaeffer, County Executive Director, Carroll County ASCS.

Treatment has exceeded goals for cropland and livestock operations.

The installation of BMPs in the basin resulted in an estimated reduction of in-field soil erosion from cropland of 25,646 tons per year and the storage of 99,919 tons of manure per year by 1989. Based on a calculated average erosion rate of 9.6 tons of soil per acre of cropland for the basin, the net reduction of in-field soil erosion from cropland is approximately 4%. Based on the livestock population numbers for 1989, the net quantity of manure stored increased by 28%. The reduction in soil erosion and the increase in manure stored can be converted into pounds of N and P using the conversion factors of 1.1 pounds of P/ton and 5.4 pounds of N per ton for soil and 1.3 pounds of P per ton and 7.0 pounds of N per ton for manure. The net reduction of nutrients available from eroded soil and manure as a result of the implementation of BMPs was 13% for both N and P. (McCoy and Summers, 1992)

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The water quality monitoring program had two elements. The first element was designed to detect long-term changes in water quality. The second element was a before/after study to measure the effectiveness of a specific set of BMPs. (McCoy and Summers, 1992)

Conducted in two phases by Versar, Inc. (1982 - 1985) and by the Maryland Department of the Environment (1987 - 1992)

4.3.7.2 Objectives and Goals

Establish a baseline water quality data base for evaluating BMP effectiveness at the watershed and field levels by comparing storm event water quality data from a pre-treatment period with data from a post-treatment period

Determine the project's impacts on turbidity levels and fecal coliform levels in Big Pipe Creek

Provide sufficient data to design a long-term monitoring program in the area

4.3.7.3 Time Frame

Phase I - Baseline Monitoring: 1982-1985

Phase II - Final Monitoring: 1987-1992

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

Baseline:
Big Pipe Creek at the Bruceville U.S. Geological Survey (USGS) gauge no. 01639500 (50% of project area drainage above this site)
3 sites (Schwartzbeck, Stambaugh, Divers farms) monitoring effects of BMPs to treat animal waste, animal waste and erosion, and erosion

Final Monitoring:
Big Pipe Creek at Bruceville
1 site (Lease farm) monitoring effect of BMPs to treat animal waste runoff

4.3.7.4.2 Sample Type

Automated, flow-proportional composite over the duration of each storm event (all sites)

4.3.7.4.3 Sampling Frequency

2 - 3 storm events per season (8 - 12 per year) plus some base flow (all sites)
Baseflow samples collected monthly at the Lease farm and Bruceville site

4.3.7.4.4 Variables Analyzed

(all sites) total Kjeldahl nitrogen (TKN), nitrite-nitrogen (NO_2-N), nitrate-nitrogen (NO_3-N), ammonia-nitrogen (NH_3-N), total phosphorus (TP), orthophosphate (OP), total suspended solids (TSS), total organic carbon (TOC), fecal coliform (FC) and total coliform (TC) bacteria

4.3.7.4.5 Flow Measurement

Continuous flow over the duration of each storm event sampled
Stream gauge at watershed outlet station
H-type flumes for runoff at three baseline farm sites
24" culvert at Lease farm site

4.3.7.4.6 Meteorologic Measurements

Precipitation gauge at one farm site

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

None

4.3.7.5 Data Management

All data have been compiled into a single data base and verified by the Maryland Department of the Environment as part of the state of Maryland's Trend Monitoring Network.

4.3.7.6 Data Analysis and Results

Analysis:

The strategy was originally planned as a collection and analysis of before and after water quality data using a step trend. This design was modified in 1987 due to inadequate pre-project data. A decision was made at that time to utilize parametric linear trend analysis.

The following statistical tests were performed on three data bases from the first phase (base flow concentrations, storm flow concentration, and storm flow loadings): 1) parametric: one-way ANOVA, two-way ANOVA, and Scheffe's Multiple Range Test to determine differences between sites, groups of sites, seasons, and storms classified by quantity of precipitation and 2) non-parametric: Kruskal-Wallis one-way ANOVA (test for skewed data sets), Median Test (test of medians for skewed data sets).

The whole data base was analyzed for trends by regressing the log (concentration) against time and time^2. A second analysis was performed which adjusted for the effects of flow and season. Specifically, this second analysis involved a two-step process where the residuals from the regression of the log (concentration) against flow (flow^2) and season (sin and cos) were generated and then these residuals were regressed against time and time^2.

Results:

Water quality monitoring data (1981 through 1990) indicate improved water quality in Big Pipe Creek. Concentrations of ammonia and total organic carbon decreased. Total nitrogen and nitrate-nitrite nitrogen concentrations increased during the project period.

The specific goals of meeting the state standards for turbidity and fecal coliform were not met (Sanders et al., 1991; McCoy and Summers, 1992). Monitoring data indicate that the standard for fecal coliform is regularly exceeded in the creek. The turbidity standard was exceeded several times between 1982 and 1990 (McCoy and Summers, 1992).

The project increased the storage of animal waste in the basin by approximately 99,919 tons per year, thus decreasing the quantity of nitrogen and phosphorus readily available from manure for transport to the stream system by 28%. Decreasing trends in NH_4 and TOC concentrations may indicate that less manure is being washed off the land surface, since NH_4 and TOC are major manure runoff constituents (McCoy and Summers, 1992).

It has been estimated that the project has reduced the quantity of nutrients available for export from soil erosion and manure application in the basin by approximately 13%. The 13% reduction has not shown up in the PO_4 and TP constituent trends because 13% change is too slight to be statistically detected given the large natural variability in PO_4 and TP concentrations with changes in river flow (McCoy and Summers, 1992).

Similarly, the project team estimated that soil erosion has been reduced by 25,646 tons/year (4% reduction). This reduction has not shown up in TSS constituent trends because the magnitude of the change is too small to be statistically detected given the variability of TSS concentrations with storm events (McCoy and Summers, 1992).

4.3.7.6 Data Analysis and Results (continued)

Results (continued):

The increasing trend in nitrate-nitrite nitrogen, which leads to a corresponding increase in total nitrogen, indicates that the soluble forms of nitrogen are leaching through the system. A variety of factors are probably contributing to the observed increase in nitrate-nitrite nitrogen. The increased use of conservation tillage in the region over the last 15 years may have increased infiltration and thus increased the leaching of soluble chemicals into the ground water. The increased storage of animal waste reduces nitrogen losses to the atmosphere and to streams through direct runoff. However, storage of animal waste does result in more manure being applied to the fields, which increases the potential for leaching. The proper timing of manure applications and the incorporation of applied manure also reduces atmospheric losses of nitrogen and increases the quantity of nitrogen being applied. Increased atmospheric deposition of nitrogen and increasing numbers of residences with septic systems also contribute to the nitrogen load increases (McCoy and Summers, 1992).

4.3.8 Linkage of Land Treatment and Water Quality

Changes in the water quality monitoring program in mid-project made it difficult for the project to document a link between land treatment and water quality changes. Meteorological conditions (several severe droughts) also made the establishment of such a linkage difficult.

None of the BMPs used in association with the RCWP project appear to have been effective in reducing fecal coliform densities in Big Pipe Creek. Additional work is required to determine what practices are effective in reducing fecal coliform densities. (McCoy and Summers, 1992)

4.3.9 Impact of Other Federal Programs on the Project

Approximately 75% of the land in Carroll County is highly erodible based on the 1985 Farm Bill criteria. The emphasis placed by the law on establishing conservation plans on farms whose owners wanted to participate in government programs had a positive effect on the willingness of farmers to participate in the RCWP and eventually on the water quality of the project area. (Sanders et al., 1991)

By helping farmers focus on the need for a farm conservation plan, the Wheat and Feed Grain Program helped encourage farmers to implement BMPs contracted for under the RCWP.

The Maryland Agriculture Land Preservation Program complemented the effects of the Double Pipe Creek RCWP project. In order for a farm to be accepted into the state program, a conservation plan must be developed when easement rights are sold to the state. Since 1980, 21,473 acres of farmland in the Double Pipe Creek project area have been accepted into the program. The program has thus enabled many farmers to remain in farming and at the same time, the Agriculture Land Preservation Program has contributed to improved water quality (Sanders et al., 1991).

4.3.10 Other Pertinent Information

None

4.3.11 References

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

Greene, D.L. 1992. Diversity of I&E Efforts Help Obtain Goals for Double Pipe Creek RCWP, In The National Rural Clean Water Program Symposium, Ten Years of Controlling Agricultural Nonpoint Source Pollution: The RCWP Experience, September 13 - 17, 1992, Orlando, Florida, EPA/625/R-92/006, p. 313-319.

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Sanders, J.H., D. Valentine, E. Schaeffer, D. Greene, J. McCoy. 1991. Double Pipe Creek Rural Clean Water Program Ten Year Report. Cooperators: USDA-SCS, USDA-ASCS, University of Maryland Cooperative Extension Service, Maryland Department of the Environment, and the Carroll Soil Conservation District. 122p.

Schaeffer, E.A. 1992. Farmer Participation in the Double Pipe Creek Rural Clean Water Program, In The National Rural Clean Water Program Symposium, Ten Years of Controlling Agricultural Nonpoint Source Pollution: The RCWP Experience, September 13 - 17, 1992, Orlando, Florida, EPA/625/R- 92/006, p. 269-272.

4.3.12 Project Contacts

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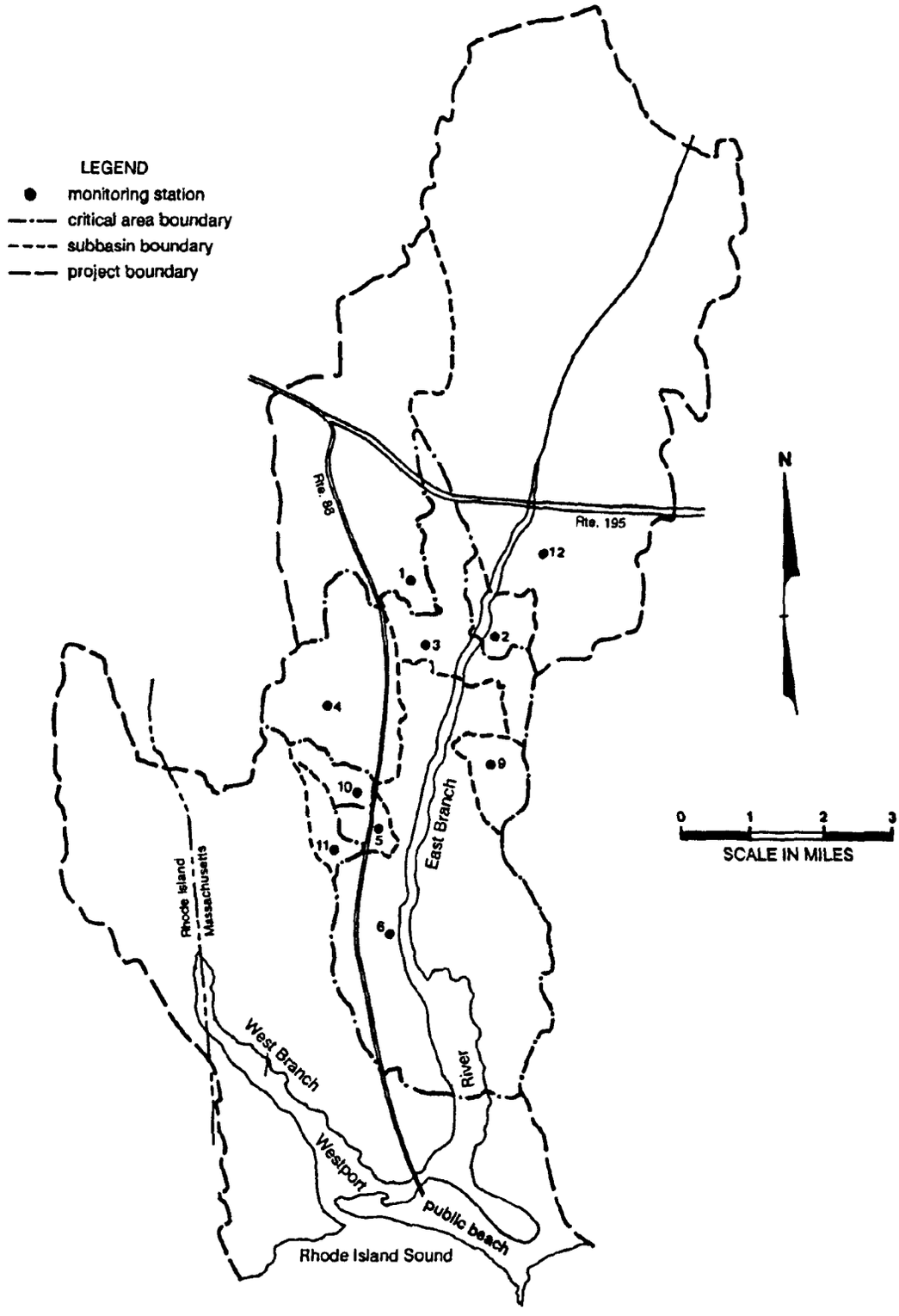
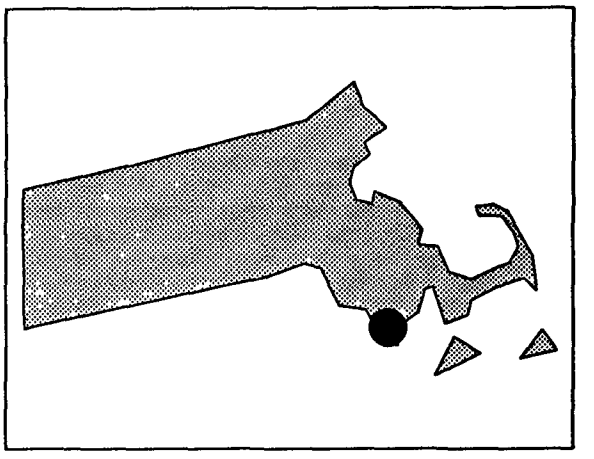


Figure 4.11: Westport River (Massachusetts) RCWP project map, MA-1.

Massachusetts
Westport River

(RCWP 15)



Bristol County
MLRA: R-145
HUC: 010900-04

4.1 Project Synopsis

The Westport River project is located in southeastern Massachusetts. The Westport River is an estuary containing shellfish resources of significant commercial value (bay scallops, oysters, hard and soft shell clams). The watershed/project area (47,000 acres) contained 15 dairy farms on which large numbers of cows were kept on extremely small acreages immediately adjacent to the estuary. Although a number of farms have gone out of business since the beginning of the RCWP project, the number of dairy cows in the critical area has actually increased.

The primary water quality problem was identified as bacterial contamination from animal sources. Additional sources of coliform bacteria entering the estuary include urban stormwater runoff, poorly maintained and leaking septic tanks located in the rapidly-growing residential developments also located in the watershed, and some small point sources. The lack of data demonstrating the proportion of the water quality problem being caused by each of these sources was problematic for the project.

The Westport River estuary has been completely or conditionally closed to shellfishing since 1980. The river was closed to shellfishing in its entirety during parts of the summer of 1991. The permanently closed shellfishing area has decreased in size during the project period. A larger rain event is now required before shellfish beds are closed, and the time period between a storm and the re-opening of the beds has been shortened from eight to five rain-free days.

The objective of the project was to implement agricultural BMPs on dairy farms in order to decrease coliform bacteria counts in the Westport River so that shellfish areas in the estuarine portions of the river could be reopened for commercial and recreational harvesting. This objective was not met.

The critical area (473 acres) was defined as all agricultural land within the project area. In 1986, the critical area was redefined to include additional dairy farms adjacent to the East Branch of the Westport River and tributaries. Eight dairies were thus ultimately included in the critical area. The best management practice (BMP) emphasis was placed on animal waste management systems for dairy farms in the critical area.

Few BMPs were actually implemented. Acres treated included 24 acres of pasture planting and 100 acres of crop and hayland on which contractual agreements were signed requiring avoidance of manure spreading on areas which would contribute significant unfiltered runoff to the river. Of eight dairy farms located in the critical area, one contracted for RCWP cost share funds. Two other farms outside the critical area were contracted.

A water quality and shellfish monitoring program was conducted with sample collection handled by the U.S. Department of Agriculture (USDA) - Soil Conservation Service (SCS); analysis was conducted by the U.S. Food and Drug Administration's (FDA) Shellfish Sanitation Branch. The water quality monitoring program was unable to demonstrate any improvements in water quality as a result of BMP implementation through the RCWP project. The data collected in this project contributed to the demonstration of the importance of rainfall events on the bacterial loadings in the Westport River. This information allowed the state to establish conditional openings and closings of the shellfish growing areas based on the amount of rainfall.

4.1 Project Synopsis (continued)

Although several valuable lessons were learned from this project, a variety of factors limited its success in addressing the water quality problem and documenting a link between land treatment and water quality improvements. These factors included: 1) the severity of the water quality/land use situation, with huge numbers of dairy cows on extremely small acreages immediately adjacent to an estuary; 2) poor inter-agency cooperation and communication; 3) lack of strong leadership within the farm community, within the local inter-agency team, and at the state level; 4) the dismal economic situation of dairy farmers in the northeastern United States during the project period; 5) the effects of a state (Purchase of Development Rights) program which, though positive in assisting farmers to stay in farming, failed to require adoption of BMPs aimed at water quality protection; 6) high SCS staff turnover at the local level; 7) failure to involve the community in the choice and designing of the RCWP project, and the consequent lack of community support for the project; 8) lack of community consensus that the dairy farms were the major source of the bacteria entering the estuary; 9) a possible lack of flexibility in the designing of BMPs suitable to address the problem and affordable for producers; 10) difficulties with the water quality monitoring program and in linking land treatment with water quality changes (both because of significant land use changes during the project and because of lack of funds and involvement in the monitoring program by the state water quality agency); and 11) a weak information and education program.

This project illustrates the important lesson that projects must be initiated and supported by the local community if they are to have any chance of succeeding.

A major result and success of this project is a new approach to farm visits developed by the local USDA agencies in which staff of both the Agricultural Stabilization and Conservation Service (ASCS) and SCS now routinely visit farms together to work on a variety of programs and projects. In this way, inter-agency cooperation and communication has been strengthened and messages received by farmers from the local agencies are now uniform. (The Cooperative Extension Service (CES) no longer has an extension agent in the county due to severe statewide funding cutbacks.) The RCWP project also served as the first step in a process to forge a spirit of cooperation between the fishing and farming portions of the Westport area community.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

The community was not involved in the definition of the RCWP project and its objectives and goals. As a result, consensus about both the need for the project and the source of the problem were lacking among the general community, the dairy farming community, and the local agencies involved in the project. This lack of consensus resulted in poor participation by producers.

Inadequate documentation of the source of the water quality problem contributed to the project's inability to meet the stated objectives and goals.

This project involved a complex nonpoint source problem in that the dairy farming operations were almost exclusively feedlot operations. The small size of the farms meant that most farmers were using their land only to house dairy cows and were buying feed as opposed to growing it. For this reason, farmers were not highly concerned about utilizing the manure productively. The waste generated presented a disposal problem rather than a resource for on-farm utilization. In cases where on-farm nutrients exceed crop needs, mechanisms for marketing and exporting manure should be considered as part of an experimental water quality project.

Projects in areas with high animal densities should consider means for encouraging reductions in animal densities, exporting manure out of watersheds, and land use changes to reduce water pollution.

4.2.1.1 Findings and Successes (continued)

This project might have been more successful if funds had been available to address all of the pollutant sources affecting the estuary rather than just the agricultural sources. As the project was structured and handled, the farming community felt unfairly singled out as polluters of the estuary.

4.2.1.2 Recommendations

Funds should be available for pre-proposal assessment and planning: identifying the problem, its causes, alternatives, educating the community about the water quality problem, and developing a broad base of support for the project.

There must be agreement on what the problem is and the approach to be taken to reduce or eliminate the problem. Ideally, this consensus would be reached prior to submission of the proposal. If this is not possible, the time necessary to reach consensus should be invested prior to beginning the project.

The source of the water quality problem must be clearly defined and documented, and all relevant agencies and the public must be in agreement about the principal source of the problem. When the source of the water quality problem is not clearly defined, different sectors of the community may tend to blame the pollution on other sectors, detracting from the goal of reducing the problem.

There appears to have been a particularly strong emphasis at the state level (which affected the local project) on keeping on schedule and demonstrating progress. This translated into extreme pressure on agency personnel to get as many contracts signed as possible. The result was an emphasis on getting any BMPs the farmer was willing to contract for installed, without requiring that the plan address the total needs of the farm for water quality- related BMPs or be cost-effective. In addition, this pressure resulted in a broadening of eligibility criteria for the project in order to present the appearance of success. Instead of addressing the core problems of the project, this progress-oriented approach and pressure seems to have been counter-productive. There is a strong need for the clear establishment of interim objectives accompanied by sufficient time to allow for proper evaluation to take place.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

Cooperation and coordination among all agencies (federal, state, local) is critical. The definition of each agency's role within the project must be acceptable to all the agencies.

This project might have benefited from the presence of an effective project coordinator accepted by all the agencies.

Stronger leadership on the state level might have helped this project get off to a stronger start or to carry out mid-course corrections.

Joint visits to farms by the local USDA agencies help provide a united presentation and approach to any project or program and a way to improve inter-agency cooperation. In Massachusetts, local ASCS and SCS personnel now routinely visit farms together to work on a variety of programs or projects.

4.2.2.2 Recommendations

Community involvement in the choice and design of a watershed project prior to submission of a proposal is key. Also, all relevant agencies need to be involved in the choice of project and submission of proposal. In this way, the chances that the entire professional and public community will support the project and be ready to participate once it is funded are enhanced.

Development of a comprehensive approach integrating all programs and issues related to the problem is important. Everybody should have a role. Such plans take time to develop (one to two years pre-proposal funding).

4.2.3 Information and Education

4.2.3.1 Findings and Successes

There was a significant lack of consensus among the three local agencies (SCS, ASCS, CES) involved in the RCWP project about the importance of the project, the major source of the coliform problem, and the value of the BMPs being recommended to producers. Mixed messages sent to producers by different agencies presented a major barrier to the success of the project.

Information and education was not a strong component of this project, at least partly because of the weak position of the CES in the state. There is, for example, no longer an extension agent assigned to the county or area due to budget cuts. In addition, project team members reported that there was a CES policy that extension agents were to visit farms only upon invitation by the producer. Thus, one-to-one contact initiated by the extension agent apparently did not occur.

4.2.3.2 Recommendations

Resolution of differences of opinion about the approach being taken in a water quality project must occur prior to initiation of the project. State-level agency staff should take the lead in ensuring that objectives, goals, roles, and approaches are clear and that there is no disagreement about them at the local level. This clarification should take place as the project is developed and prior to implementation. Cooperation and coordination among all agencies in implementing the project is critical to success.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

Participation in this project was poor. The success of experimental water quality projects like the RCWP depends heavily on the producers' attitudes and willingness to implement BMPs. Factors contributing to limited participation included: 1) the precarious economic situation of dairy farmers during the project period; 2) the effects of other federal and state programs (see section 4.3.9); 3) the effects of the residential development in the area during the project period, which tended to make farmers think they could sell their farms at a huge profit, decreasing their motivation to invest in them); 4) conflicting messages received from the three local agencies relating to the importance of the project, the major source of the bacteria problem (residential versus agricultural), and the value of the recommended BMPs; and 5) lack of trust in the local SCS staff due primarily to extremely high staff turnover and possibly to cultural differences.

4.2.4.2 Recommendations

The messages sent to producers by the local agencies implementing a water quality project must be consistent and uniform.

Economic factors must be considered when choosing and designing a water quality project. BMP installation must be perceived by the farmer as either economically profitable or economically sustainable. When these conditions are not met, farmers will not be motivated to adopt practices.

The farm community must be involved in the choice of the project, definition of the water quality problem, and definition of project objectives and goals.

Incentives for farmers to participate in a project must be designed so as to outweigh other factors tending to motivate farmers not to participate, such as incentives to sell their land to the highest bidder in areas where rapid residential development is occurring.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

Technical solutions to water quality problems must be perceived by the producer as practical, workable, economically supportable, and advantageous.

The RCWP was designed as an experimental program; however, in several projects the BMPs implemented were primarily traditional soil conservation practices. There needs to be more flexibility in the selection and modification of practices and the use of the funds to respond to local conditions. In the case of the Massachusetts RCWP project, more innovation and experimentation in the approach to land treatment as well as an effort to look beyond on-farm BMPs to the development of a community initiated and supported area-wide solution to the manure disposal problem might have been a more productive approach to reducing the NPS problem.

Joint visits to farms by the local USDA agencies help provide a united presentation and approach to any project or program and one way to work toward better inter-agency cooperation. In Massachusetts, local ASCS and SCS personnel now routinely visit farms together to work on a variety of programs or projects.

The unique characteristics of the Massachusetts project area (large dairy herds on extremely small acreages adjacent to a major shellfishing resource) might have required different use of the project funds than was allowable under the RCWP. For example, if the farms could have been documented through monitoring to be contributing a large proportion of the coliform count in the river, it might have been more effective to spend more funds on only a few high-impact farms, given the economically marginal situation of the dairy business and the reluctance of the producers to commit themselves to their portion of the cost of BMP implementation.

Success of the implementation program depends heavily on the producers' attitudes and willingness to implement BMPs.

During the early years of the project, construction costs in Massachusetts were extremely high as residential development was booming. This diminished the value of the $50,000 payments available to farmers and tended to increase the total cost of BMP installation at a time when milk prices were very low.

More emphasis on fencing and streamside buffers might have been helpful.

4.2.5.2 Recommendations

The choice of BMPs must be appropriate both to the land use/water quality situation and to the economic situation. BMP installation must be perceived by the farmer as either economically profitable or economically sustainable.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

The source of the water quality problem must be clearly defined and all relevant agencies and the public must be in agreement about the source of the problem.

This project would have benefited from technical oversight and planning by a water quality specialist specifically assigned responsibility for the project's water quality monitoring program.

Monitoring bacteria concentrations from multiple sources including point and nonpoint sources is extremely difficult. Meteorological events, slope, and soil type were especially critical variables within the Westport River watershed.

On several of the principal tributaries there exists sufficient distance between sources that it appears possible to isolate their respective effects. More discrete sampling couples with BMPs might have been sufficient to document reductions in loadings as a result of land treatment.

4.2.6.1 Findings and Successes (continued)

The sampling grid along the tributaries would have benefited by more discrete sampling along the tributary lengths to better isolate the sources and their relative significance. Establishment of hydrographs for each of the streams could have been useful in developing loading curves to convert the estimates from strictly measurements of concentration to mass loadings. The use of dyes to highlight sources would also help in focusing land treatment efforts on specific problem areas.

Newer technologies, such as gene probes, used to differentiate between human and animal bacteria in water might have helped resolve the lack of consensus about the source of the coliform bacteria problem.

4.2.6.2 Recommendations

Funds must be made available for water quality monitoring. Such funds can help encourage the active participation of state water quality agencies. Involvement of the state water quality agency in selection of the project and preparation of the proposal is also important as an effort to ensure state agency commitment to the project.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

Because of limited BMP implementation in this project, as well as significant land use changes during the project period, it was not possible to establish a link between land treatment and water quality.

4.2.7.2 Recommendations

None

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1981 - 1991

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Westport River, the lower portion of which is an estuary of commercial and recreational shellfishing importance. Wetlands and lakes in the upper section of the watershed drain into the West Branch of the Westport River.

4.3.2.1.2 Water Uses and Impairments

Ponds in the project area are used for recreation (limited to local residents) and for municipal water supply. The Westport River estuary supports commercial shellfishing (average of $425,000 annually from 1980-1984, $2,671,000 in 1985 due to extremely high scallop harvest), and public recreation.

The main use impairment is the closure of shellfishing beds in the estuary due to bacterial contamination. Other impaired uses include boating, contact recreation, and fishery.

4.3.2.1.3 Water Quality Problem Statement

Bacterial contamination is the major water quality problem in the Westport River. Dairy wastes are the major source of bacterial contamination. Other suspected sources are road runoff, septic systems, and waterfowl. Much of the Westport River East Branch is permanently closed or conditionally closed to shellfishing due to this contamination.

4.3.2.1.4 Water Quality Objectives and Goals

Decrease coliform bacteria counts in the Westport River through the implementation of agricultural BMPs on dairy farms so that shellfish areas in the estuarine portions of the river could be reopened for commercial and recreational harvesting

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 47,000 acres
Project Area: 47,000 acres
Critical Area: 473 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 39.8 inches

Geologic Factors: The project is located in the central lowland section of the New England Physiographic Province. Topography is gently rolling. Soils are loamy and moderately to well drained. Substrata are compact and permeability is slow. The surface drainage pattern is a series of wetland areas connected by a system of streams and the river.

4.3.2.2.3 Project Area Agriculture

The project area agriculture consists primarily of small- acreage dairy farms housing high numbers of cows on land located immediately adjacent to the Westport River. Some pasture and hayland is also located in the project area.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	3	62
Pasture/range	10	38
Woodland	75	-
Urban/roads	-	-
Other	12	-

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	15	1,250	1,750
Horses	1	5	10

The number of dairy farms in the project area decreased during the project period due primarily to the closure of farms as a result of both economically difficult times and by the federal Dairy Termination Program (DTP). Five out of 15 dairy farms in the project area went out of business during the project period due to buyout by the DTP. In addition, several other farmers went out of business or sold their herds during the project period. However, the number of animals in the critical area increased during the project period from approximately 1250 in 1986 to approximately 1295 cows in 1990.

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	205,523	0	152,661	0	358,184
Info. & Ed.	10,350	0	0	500	10,850
Tech. Asst.	203,590	500	0	0	204,090
Water Quality Monitoring	NA	NA	0	0	NA
SUM	419,463	500	152,661	500	$573,124

* Total does not include costs of water quality monitoring conducted by U.S. Food and Drug Administration, Shellfish Sanitation Branch and state water quality agency

Source: Westport River RCWP Project, 1992

4.3.4 Information and Education

4.3.4.1 Strategy

The information and education (I&E) program was designed to convince farmers that by participating in the RCWP program they would not be admitting to contributing to the water quality problem and that implementing BMPs would be economically feasible and advantageous to them.

4.3.4.2 Objectives and Goals

Objectives of the I & E program were to generate public awareness and support for the program, provide direct contact with all farmers in the project area, and provide educational programs related to alternative farm management practices. These objectives were to be accomplished through client counseling, fact sheets, field days, and demonstration tours. (Westport River RCWP Project Local Coordinating Committee, 1991)

There was a significant lack of consensus on the part of the local agencies as to the value of the project and the BMPs being recommended.

4.3.4.3 Program Components

Clientele counseling

BMP seminar

Fact sheets on the project

Field day

Demonstration plots

Updating of town officials on the progress of the project

4.3.5 Producer Participation

4.3.5.1 Level of Participation

Participation was poor due to a combination of factors outlined in 4.1 (Project Synopsis), 4.2 (Project Findings, Recommendations, and Successes), and 4.3.5.3 (Barriers to Participation).

4.3.5.2 Incentives to Participation

Cost share rates (75%) and $50,000 RCWP payment limit were much higher than other federal programs

Threat of state regulatory action

Threats by the town of Westport Board of Health to shut down farms adjacent to the estuary which were identified as the source of coliform bacteria

4.3.5.3 Barriers to Participation

There was a significant lack of agreement on the need for, purpose, and goals of the project within the inter-agency community, the farming community, and the community at large.

In many cases, because of the economic situation of dairies during the project and the cost of the recommended BMPs (especially roofed feedlots), the payment limitation of $50,000 per landowner served as a barrier to participation

High staff turnover in SCS technicians made it difficult for the agency to establish a good rapport with the producers.

Lack of cooperation and coordination among the local agencies resulted in farmers receiving conflicting messages about the value of the project and of the appropriateness of particular approaches to the water quality problem.

Lack of farm community leadership and the absence of an organization with financial leverage, such as the Tillamook Creamery Association in the Oregon RCWP project, to bring pressure on producers to participate in the RCWP project

Lack of an economic incentive to change management of animal waste

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Fair to poor given the minimal participation in the project. Also, maintenance appears unlikely because of large increases in herd numbers (on the same acreage) since the beginning of the project period. BMPs designed for 250 cows may not be continued on farms that have increased animal numbers up to 650, as occurred on one farm. Practices that benefit the operation economically will be maintained.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The strategy was to work with dairy farmers whose operations abutted the river in order to implement waste management BMPs that would reduce runoff of animal wastes into the river. Originally, soil erosion was also considered to be a problem and the project team planned to address sedimentation by implementing BMPs on 1,715 acres of agricultural land adjacent to the estuary.

4.3.6.2 Objectives and Goals

Implement animal waste management practices in order to decrease coliform bacteria levels in the Westport River estuary

Quantified implementation goal was to contract with all 8 dairies in critical area and to treat all agricultural land within the critical area (293 acres of cropland and 180 acres of pasture)

4.3.6.3 Critical Area Criteria and Application

Originally, the entire Westport River watershed was defined as the critical area. In 1986 the project redefined the critical area, focusing on eight dairy farms, a major source of bacterial contamination.

Application of Criteria: Participation within the critical area was poor. Practices were implemented and cost shared outside the critical area.

4.3.6.4 Best Management Practices Used

The main BMP emphasis was on animal waste management system (BMP 2).

BMPs Utilized in the Project *	Project Accomplishments
Permanent vegetative cover (BMP 1)	
Pasture and hayland planting	24 acres
Animal waste management system (BMP 2)	
Heavy use area protection	2 systems
Waste management system	3 systems
Waste storage structures	3 structures
Roofing for runoff control	2 (partially completed)
Diversion system (BMP 5)	1 system
Waterway system (BMP 7)	200 feet
Lined waterway	370 feet
Grassed waterway	100 feet

* Please refer to Appendix I for description/purpose of BMPs.
Source: Westport River RCWP Project Local Coordinating Committee, 1991.

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

Cost shared BMPs were reported in terms of acres treated by year in the critical area in RCWP annual progress reports.

4.3.6.5.2 Data Management

Land use was monitored by SCS personnel based on numbers of animals on each farm. BMP installation was reported in descriptive text and on a percent complete basis. Implementation was tracked via annual status reviews including a visit to each farm.

4.3.6.5.3 Data Analysis and Results

Quantified Project Achievements (as of 1990):

Pollutant Source	Units	Critical Area		Treatment Goals	
		Total	% Implemented	Total	% Implemented
Cropland	acres	293	34%	293	34%
Pasture	acres	180	13%	180	13%
Dairies	# farms	8	13%	8	13%
Feedlots	# farms	8	13%	8	13%
Horses	# farms	1	0%	1	0%
Contracts	#	8	13%	8	13%

Sources:
Westport River RCWP Project Local Coordinating Committee, 1988 (form RCWP 3)
Westport River RCWP Project Local Coordinating Committee, 1991 (form RCWP 3)

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The water quality monitoring program was aimed at sampling bacterial variables in the tributaries and the estuary. Sample collection was conducted by the USDA - Soil Conservation Service. Analysis of the samples was handled by the U.S. Food and Drug Administration Shellfish Sanitation Branch.

In 1986, a survey was conducted between September 20 and October 10, during which a total of seven samples were taken and analyzed for salinity, fecal strep, and fecal coliform. Temperature was measured and *E. coli* was included in this list for the fresh water runoff. After this survey, sampling returned to the original scheme.

4.3.7.2 Objectives and Goals

The objective of the water quality monitoring and evaluation program was to establish a data set of water quality variables sufficient to document water quality conditions before, during, and after implementation of BMPs in order to evaluate their effectiveness.

4.3.7.3 Time Frame

1982 - 1986

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

9 along the fresh water tributaries
1 in the tidal estuary

4.3.7.4.2 Sample Type

Grab

4.3.7.4.3 Sampling Frequency

6-10 times annually

4.3.7.4.4 Variables Analyzed

Temperature, pH, dissolved oxygen (DO), total carbon (TC), fecal coliform (FC), fecal streptococci (FS), chloride, total solids (TS), dissolved solids (DS), suspended solids (SS), nitrite-nitrogen (NO_2-N), nitrate-nitrogen (NO_3-N), total Kjeldahl nitrogen (TKN), ammonia-nitrogen (NH_3-N), total phosphorus (TP), dissolved phosphorus (DP) (all phosphorus present after passing through 0.45 micron filter), conductivity, total alkalinity

4.3.7.4.5 Flow Measurement

Discharge

4.3.7.4.6 Meteorologic Measurements

Precipitation: 2 gauges

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

None

4.3.7.5 Data Management

The data are managed locally.

4.3.7.6 Data Analysis and Results

Trend Analysis: Comparison of annual log means and medians of total coliform, fecal coliform, and fecal strep at each station for 1985 vs. 1988. Number of samples varies with station, averaging 6 in 1985 and 8 in 1988.

Geometric means were generated on the bacteria data along with fecal coliform to fecal strep ratios to aid in determining source dominance (i.e., animal versus human) (L. Gil interview, 1991)

4.3.8 Linkage of Land Treatment and Water Quality

The project was unable to demonstrate water quality improvements due to BMP implementation.

4.3.9 Impact of Other Federal and State Programs on the Project

The federal Dairy Termination Program (DTP) had an impact on the project area, with five dairy farms in the watershed closing from 1986-87 through this program. Although this program may have appeared to have had a positive effect on the problem of too many animals on too little acreage, the reality was that the total animal numbers in the project area did not decrease as a result of the DTP.

Although the Massachusetts Department of Agriculture's Purchase of Development Rights Program (PDR) had a positive effect in assisting farmers to stay in farming, it worked against RCWP goals because it enabled the state to purchase development rights from farmers without requiring implementation of practices to reduce NPS pollution. In 1986, the PDR acquired development rights to five farms in the project area; some of these farms were major violators of water quality standards.

4.3.10 Other Pertinent Information

The impact of the residential development boom in Massachusetts in the early 1980's was significant. Land prices were very high and the idea that they could always sell their farm at a high price may have caused farmers to be reluctant to make long-term financial investments in their dairies.

4.3.11 References

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

Westport River RCWP Project Local Coordinating Committee. 1988. Plan of Work and Annual Progress Report. Westport, MA.

Westport River RCWP Project. 1992. Revised 10-Year Report - Westport. 7p.

Westport River RCWP Project Local Coordinating Committee. 1991. 10-Year Report. Westport, MA. 28p. plus appendixes.

4.3.12 Project Contacts

Administration

David Rose, Bristol County ASCS
84 Center Street
Dighton, MA 02715
(508) 669-6621

Water Quality

Larry Gil, Water Pollution Control
Department of Environmental Protection
1 Winter Street
Boston, MA 02108
(617) 292-5884

Land Treatment

Leonard Reno, District Conservationist
SCS
21 Spring St.
Taunton, MA 02780
(508) 824-6668

Information and Education (None)

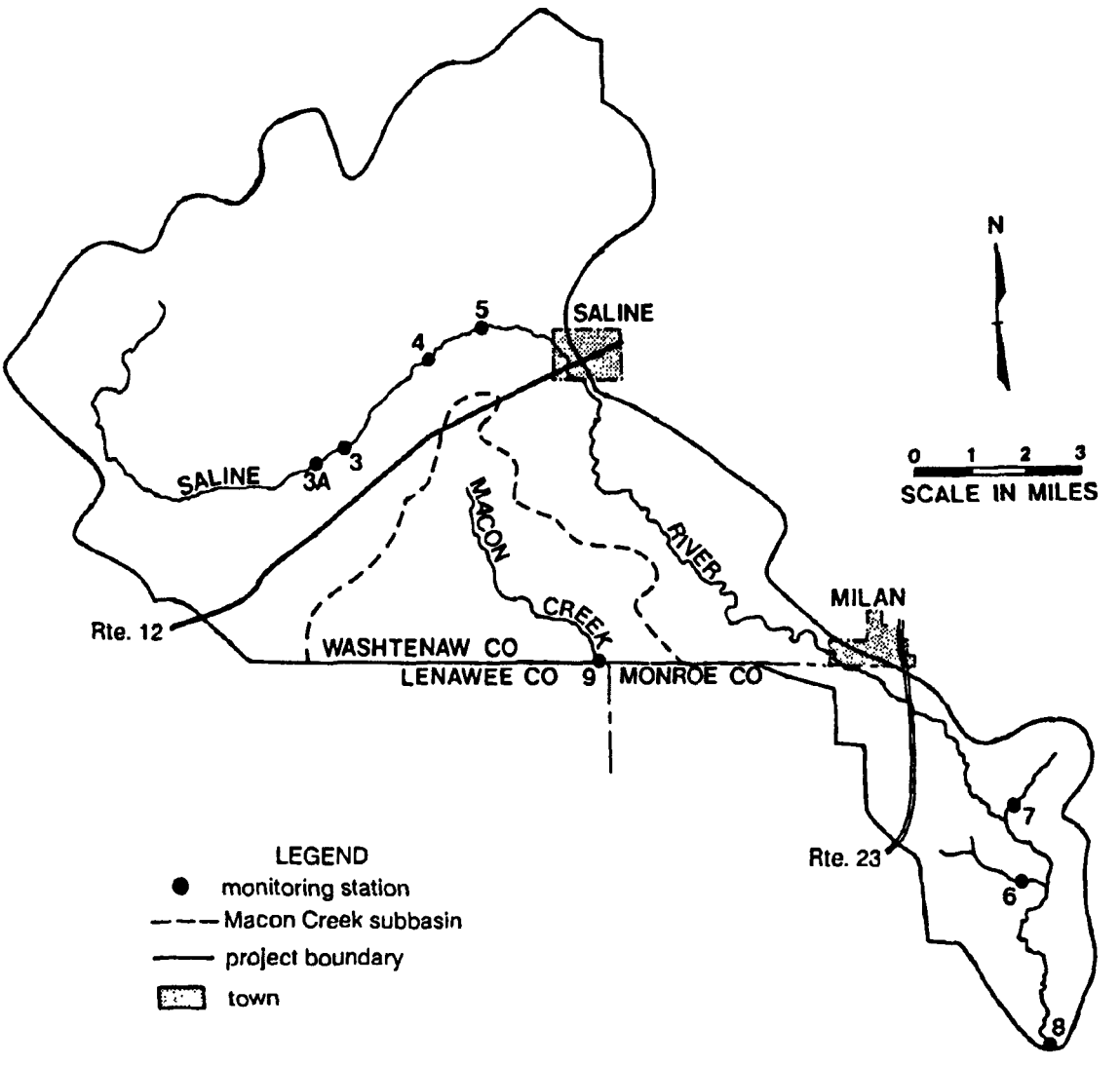
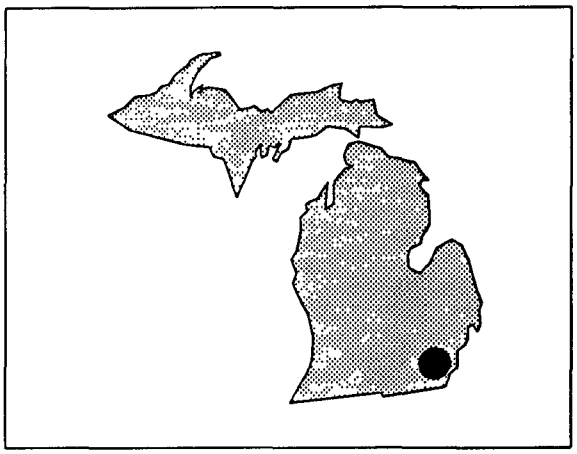


Figure 4.12: Saline Valley (Michigan) RCWP project map, MI-1.

Michigan
Saline Valley

(RCWP 9)



Washtenaw & Monroe Counties
MLRA: M-111 and L- 99
HUC: 041000-01

4.1 Project Synopsis

The Saline Valley is located in rural southeastern Michigan, an area of intensive agricultural production. Farms average 210 acres in size and crops grown include corn, small grains, and soybeans. Small livestock operations are present with a total of 9,600 livestock in the 76,600- acre project area. The project lies in Washtenaw and Monroe counties and includes portions of the Saline River and Macon Creek watersheds. The terrain varies from flat to small hills; flatter areas are poorly drained and have high water tables.

Excessive phosphorus (P) is the major water quality problem. The Saline Valley has been identified as having one of the highest phosphorus loadings in southeast Michigan and as a contributor of excessive phosphorus to Lake Erie. Soil erosion, sediment delivery, improper fertilizer management, and animal waste contribute to the problem.

The project objective was to reduce the amount of phosphorus entering the aquatic environment. The critical area was defined as those areas where phosphorus easily enters the riverine system (42,428 acres), primarily cropland but also containing 27 animal operations. Land treatment consisted mainly of conservation tillage, animal waste management, and fertilizer management with goals of implementing best management practices (BMPs) on 32,241 acres and 25 animal operations using 225 contracts. About 45% of the critical area was eventually treated with BMPS. It is uncertain if the BMPs will be continued by the producers beyond the end of the RCWP project.

Water quality monitoring suffered due to lack of funding, very low density of BMP implementation in the overly large project area with poor coverage of any watershed or subbasin, and lack of pre-BMP implementation baseline water quality data from the watersheds.

It was not possible to document water quality changes resulting from agricultural land treatment. Declines in phosphorus were observed in the Saline River, but were attributed to improved treatment at two municipal sewage treatment plants and the elimination of one industrial discharge. Spot monitoring of ground water near an animal waste storage facility indicated the presence of elevated concentrations of pollutants in the underlying ground water, but such pollution has not posed a threat to water supplies.

The project lacked support, proper administration, cooperation, and coordination from the state level, especially in its early stages. Water quality problems were never clearly defined, and the overall project lacked a comprehensive, coordinated strategy of selecting a subbasin with the potential to document water quality improvements resulting from land treatment.

Water quality monitoring was thorough and well-performed; however, meaningful results were not obtained due to poor communication between state and local agencies and a failure to link efforts between the project's land treatment and water quality monitoring teams.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

Program objectives were not clear, in part because the water quality problems were not clear and impairment of uses were not documented.

The project area was much too large and not defined on a hydrological basis. The large size and multiplicity of subbasins prevented the project team from conducting the intensive monitoring necessary to document water quality improvements. The large size of the project area also made it less likely that the high degree of BMP implementation necessary to measure water quality improvements could be achieved.

Project goals of phosphorus reduction were unrealistic given the size of the project area and the nature of agriculture in the area.

4.2.1.2 Recommendations

Project objectives of nonpoint source (NPS) control projects need to be well defined.

Water quality problems must be clearly defined and documented.

Project areas should be delineated on a hydrological basis. The preferred approach is to identify a small subbasin with very cooperative producers so that a high degree of BMP implementation can occur, thus enhancing the project team's ability to document measurable water quality improvements due to land treatment.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

The roles of the agencies involved were not clearly defined initially. This lack of clear role definition occurred partly because of the lack of cooperation and communication among agencies at the state level.

No personnel were assigned directly to the RCWP project (with the exception of an Extension information and education (I&E) agent); hence RCWP duties were added on to already full schedules. Few employees could afford the time to become familiar with the RCWP program and/or nonpoint source control principles.

Personnel turnover contributed to confusion and lack of direction in the project.

Innovation in procedures, methods, and land treatment practices was not supported. The lack of support at the state level left hampered the Local Coordinating Committee (LCC) and the local agency offices.

Some farmers encountered difficulties when participation in one program made them ineligible for another program. Agencies could provide direction and information to assist producers in choosing appropriate programs in which to participate. Concurrent programs need to be coordinated to avoid conflicts, ineligibility, and confusion.

4.2.2.2 Recommendations

Agency roles should be clearly defined and specific personnel should be assigned, with sufficient time, to carry out the program. All concurrent programs offered should be coordinated to avoid conflicts.

Agencies should make provision for continuity in project activities and administration in case of personnel turnover.

4.2.2.2 Recommendations (continued)

Innovative techniques that enhance the acceptance and function of the project should be supported and encouraged at the local and state levels. Such support has resulted in innovation and great gains in developing nonpoint source program participation in other RCWP projects (for example, see the project profile for the Conestoga Headwaters RCWP project, Pennsylvania).

To speed planning and administration, cost sharing for BMP implementation should be based on a set cost for each BMP rather than on a percentage of actual cost. The project staff could determine a reasonable cost for the implementation of a BMP in their project area and the amount of cost share funds required for the BMP. In this manner, the project could reasonably project the number of each BMPs it can support and the amount of activity for each year.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

The information and education (I&E) program was not established in advance of land treatment efforts, resulting in much confusion about the purpose of the project and low participation.

Individual contacts were the most effective means for achieving producer participation. Demonstration plots, especially of conservation tillage techniques, were very effective in gaining cooperation of producers.

4.2.3.2 Recommendations

I&E programs should be implemented well in advance of land treatment efforts. The I&E program should use personnel known and trusted by producers, and should incorporate individual contacts and on-site demonstrations of new techniques.

Group meetings where producers can communicate with each other and view BMPs in place should be planned.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

Producers were reluctant to participate due to economic pressures and lack of a documented water quality problem.

The high cost of animal waste management systems deterred many operators from participating.

4.2.4.2 Recommendations

Smaller watersheds with documented water quality problems and cooperative producers should be selected for nonpoint source control projects. High producer participation and thorough coverage of the watershed with BMPs are necessary if water quality improvements are to be documented.

Small watersheds with high participation can increase peer pressure on producers to participate in a NPS control project.

Agency personnel should be well informed about the relevant water pollution problem so they can help producers understand and recognize the problem.

Programs should appeal to producers' desires to conserve and protect soil and water and should relate local successes in water quality improvements to demonstrate the benefits to the environment.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

The original 200,000-acre project area was too large to achieve adequate BMP coverage with the available cost share funding and technical assistance personnel.

BMP effects are best observed if monitoring focuses on smaller subbasins with a high level of BMP implementation.

No priorities were set for implementing BMPs.

There were no methods to ensure that manure spreading plans were carried out or to ensure that BMPs were continued.

It was difficult to get farmers to believe the results of soil analysis were meaningful and to incorporate recommended fertilizer application rates in their farming decisions.

Participating producers were scattered throughout the watersheds; many were very far from the waterways. As a result, BMP implementation had little effect on the water quality.

4.2.5.2 Recommendations

NPS program managers should consider selecting smaller watersheds where a high degree of BMP implementation can be obtained, tracked, and more easily evaluated.

Land treatment teams must set priorities for BMP implementation and develop methods to ensure that plans are carried out by the cooperator. BMPs should be employed as systems to effect the greatest reduction in pollutants. For example, to maximize the reduction of phosphorus entering the water, both animal waste management and fertilizer management should be employed, in order to control both animal and crop sources of phosphorus.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

Water quality monitoring was thorough and well- performed; however, meaningful results were not obtained. This lack of documentable changes was due to a lack of severity of the water quality problem, insufficient numbers and improperly located BMPs, poor communication between state and local agencies and a failure to link efforts between the project's land treatment and water quality monitoring teams.

Monitoring was inconclusive as to the effect of land treatment on water quality.

Water quality monitoring was inadequately funded, poorly coordinated, and suffered from lack of support from the state and federal levels. At the local level, the lack of funding and the inability to obtain a solid experimental design hampered the monitoring effort.

4.2.6.2 Recommendations

Water quality problems need to be well defined at the commencement of the project.

Water quality monitoring should be administered/directed by technically trained staff in order to develop a monitoring plan that can show results and is technically sound.

Selection of projects located in small watersheds can facilitate intensive monitoring. Possibilities for monitoring designs and analytical techniques include paired watersheds, the before/after approach on a single watershed, and time-trend analysis on a single watershed.

The national level program should develop guidance on water quality monitoring and evaluation including details on monitoring and sampling protocols, location of stations, and statistical analysis and provide adequate funding to carry out meaningful monitoring efforts.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

There was no planned effort to implement those BMPs which improved water quality in locations where the water quality effects could be seen. Thus, the land treatment efforts were not driven by the water quality results.

Records on BMP implementation had little information on locations of land treatment and there was little follow-up on continuance of practices.

Participating producers were scattered throughout the watersheds; many were very far from the waterways. As a result, BMP implementation had little effect on the water quality.

No real BMP effects on water quality have been documented. The project encountered confounding factors such as low level of BMP implementation, difficulty in assessing the effects of the subbasin areas in which BMPs were not implemented, large variations in sources and transport of sediment and nutrients over time, and large variations in accuracy or meaningfulness of estimates of the area in which BMPs were implemented.

4.2.7.2 Recommendations

Effective communication between the water quality monitoring and land treatment teams to guide and direct land treatment based on monitoring results.

Projects should consider tying cost share funding to water quality monitoring results. Subbasins in which producer participation is high and in which water quality improvements can be documented could become eligible for a second tier of cost share funding that would increase the portion of costs borne by the project, reducing producer costs. This scheme could be used to fund other items of interest to producers such as more advanced BMPs or technical training in various aspects of agriculture and water pollution control.

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1980 - 1990

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Streams and Saline River draining to Lake Erie

4.3.2.1.2 Water Uses and Impairments

Water resources in the project area are used for recreation and public water supply. Water quality impairments are not clearly defined.

4.3.2.1.3 Water Quality Problem Statement

Excess phosphorus in project area streams impairs recreation and public water supplies. Phosphorus loads from the project area contribute to the eutrophication of Lake Erie. Cropland runoff and animal waste runoff are the primary nonpoint sources of phosphorus.

4.3.2.1.4 Water Quality Objectives and Goals

Objective:

Reduce phosphorus loading to project area water bodies and Lake Erie. Reduction of P loading to Lake Erie will contribute to meeting the objectives of the Great Lakes Water Quality Agreement (International Joint Commission, United States and Canada, 1978). The agreement calls for a goal of reducing P input to the Great Lakes by 30%.

Goals:

Reduce phosphorus entering project water bodies from agricultural fertilizer losses by 50% or 22,600 pounds (lbs)

Reduce phosphorus entering project water bodies from animal wastes by 30% or 9,600 lbs

Reduce phosphorus entering project water bodies from soil loss and sedimentation by 30% or 430 lbs

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 76,600 acres
Project Area: 76,600 acres
Critical Area: 42,428 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 32 inches

Geologic Factors: Project area soils vary from clay loam to organic deposits to sand. Glacial moraines run through the center of the project area. Steep slopes and highly erodible soils occur on about 20% of the farmland.

4.3.2.2.3 Project Area Agriculture

The area is intensively farmed, with major crops being corn, small grains, and soybeans. About 13% of the land is pasture and there are 27 animal operations with total animal population of 9,600 in the project area.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	67	100
Pasture/range	10	-
Woodland	21	-
Urban/roads	2	-
Other	-	-

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	NA	5,590	7,826
Beef	NA	960	960
Hogs	NA	860	344
Horses	NA	141	282
Sheep	NA	1,925	192

Source: Saline Valley Rural Clean Water Project, 1987

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other*	
ACTIVITY					SUM
Cost Share	1,888,106	0	629,386	0	2,517,492
Info. & Ed.	90,112	0	0	0	90,112
Tech. Asst.	758,887	0	0	10,000	768,887
Water Quality Monitoring	0	0	0	186,761	186,761
SUM	2,737,105	0	629,386	196,761	$3,563,252

* Other = Great Lakes Environmental Research Laboratories (SEA GRANT), Southeast Michigan Council of Governments (SEMCOG), Washtenaw Soil Conservation District, Washtenaw and Monroe County Boards of Commissioners, Michigan Department of Agriculture and grants

Source: Smolen et al., 1989; Bob Payne, USDA-ASCS, East Lansing, MI, September 29, 1992, personal communication.

4.3.4 Information and Education

4.3.4.1 Strategy

Primary efforts were individual contacts supported by group presentations, mass media coverage, and field demonstrations by Cooperative Extension Service (CES) personnel.

4.3.4.2 Objectives and Goals

Create awareness of rural nonpoint water pollution among farmers and let them know about technical and financial assistance available

Promote BMP implementation as a practical and effective solution to nonpoint source pollution

Inform the general public of problems and solutions of NPS pollution and how farmers are contributing to the general public well-being

4.3.4.3 Program Components

I&E efforts were carried out by CES with cooperation from Monroe and Washtenaw County Soil and Water Conservation Districts. The I&E program consisted primarily of one-to-one contacts with producers. Field demonstrations and group meetings were also held.

4.3.5 Producer Participation

4.3.5.1 Level of Participation

Participation was moderate. Many producers were not eager to change farming methods (such as would be needed for conservation tillage) and others felt that animal waste management facilities were too expensive or were not designed to fit their needs.

4.3.5.2 Incentives to Participation

Cost share rate of 75% for most practices

Payment limit of $50,000

4.3.5.3 Barriers to Participation

The project experienced low acceptance due to poor definition of the water quality problem, an oversized project area, and lack of adequate project staff. Animal waste management systems were considered by producers to be prohibitively expensive.

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Chances of adoption and maintenance of practices are moderate. Those producers who have invested in animal waste management facilities will continue to use them (mainly because of added convenience and flexibility). Conservation tillage is now being practiced more widely; however, many of the other practices were not seen as particularly beneficial and were less likely to be practiced.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

Land treatment strategy was not clearly defined, with the result that BMPs were implemented over a wide area in order to demonstrate to other producers the benefits of the practices. The strategy was thus to spread the money and technical assistance around as much as possible, rather than to concentrate on implementing a significant amount of BMPs in a selected subbasin.

4.3.6.2 Objectives and Goals

Reduce nonpoint source phosphorus loads by 40% by reducing surface water runoff

Improve application of phosphorus fertilizers

Improve animal waste handling and disposal

Reduce soil erosion and sediment delivery to the aquatic system

Implement BMPs on 32,241 acres and install 25 animal waste management systems

4.3.6.3 Critical Area Criteria and Application

Criteria:

Animal waste (animal waste critical areas vary by season):

May - Nov., within 300 ft. of streams

Dec. - April, within 1,000 ft. of streams

Cropland: all cropland within 1/4 mile of streams

4.3.6.4 Best Management Practices Used

General Scheme: phosphorus loading reduction through the use of various BMPs

BMPs Utilized in the Project*	Project Accomplishments
Permanent vegetative cover (BMP 1)	1909 acres
Animal waste management system (BMP 2)	23 systems
Diversion system (BMP 5)	4770 feet
Waterway system (BMP 7)	86 acres
Cropland protection system (BMP 8)	7522 acres
Conservation tillage system (BMP 9)	31 411 acres
Stream protection system (BMP 10)	0 feet
Permanent vegetative cover on critical areas (BMP 11)	36 acres
Sediment retention, erosion, or water control structures (BMP 12)	44 structures
Fertilizer management (BMP 15)	32,320 acres
Pesticide management (BMP 16)	22,301 acres

* Please refer to Appendix I for description/purpose of BMPs.
Source: Saline Valley Rural Clean Water Project, 1989

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

The project tracks RCWP and non-RCWP BMP implementation in units applied (acres, systems, feet). Reporting is done by SCS, Washtenaw County Soil Conservation District, ASCS, and CES.

4.3.6.5.2 Data Management

Data are reviewed annually by SCS.

4.3.6.5.3 Data Analysis and Results

Quantified Project Achievements:

Pollutant Source	Units	Critical Area Total	Critical Area % Implemented	Treatment Goal Total	Treatment Goal % Implemented
Cropland	acres	42,428	41%	26,400	66%
Dairies	#	27	89%	24	96%
Contracts	#	263	45%	165	72%

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The water quality monitoring program was intended as a before/after analysis of phosphorus loading in the aquatic environment; however, there were insufficient pre-BMP implementation data to make the before/after comparison possible. Therefore, a time-trend analysis was attempted.

Water quality monitoring was conducted by the Washtenaw County Soil Conservation District, the Great Lakes Environmental Research Laboratory, and The University of Michigan Department of Atmospheric, Oceanic, and Space Science .

4.3.7.2 Objectives and Goals

Determine if there were any significant differences in pollutant loads between years or between stations and relate these changes to land use or implemented BMPs

4.3.7.3 Time Frame

1980 - 1990

4.3.7.4 Sampling Scheme

The sampling scheme consisted of taking grab samples and instantaneous discharge measurements at eight stations on a fixed weekly schedule. Initially, the sampling scheme was to be adjusted to include additional sampling during storms and snow melt. Constraints of time, funding, and personnel limited the number of sampling periods to 35 to 40 per year after the first year. Sampling was performed on a fixed day of the week, but a two-week interval sometimes occurred between sampling.

Program design was based on a subbasin approach allowing for monitoring and tracking of BMP implementation close to water quality monitoring sites.

Discharge was not monitored continuously at any station; therefore, the accuracy of loading estimates is low.

Conducted by Dennis Rice, Washtenaw County Soil Conservation District
Water quality analysis was performed by T. Johengen, University of Michigan Center for Great Lakes and Aquatic Sciences Laboratory.

4.3.7.4.1 Monitoring Stations

8 stream stations associated with subbasins
9 ground water monitoring wells around 3 animal waste holding structures

4.3.7.4.2 Sample Type

Streams: grab

Ground water: bailer (two bailer volumes rinsed before sample taken)

4.3.7.4.3 Sampling Frequency

Streams: weekly (some adjustments were made for storm events and snow melt)

Ground water: 2-4 times per year

4.3.7.4.4 Variables Analyzed

Streams: suspended solids (SS), total phosphorus (TP), soluble reactive phosphorus (SRP), ammonia-nitrogen (NH_3- N), nitrate-nitrogen (NO_3-N), silica, pH, conductivity

Ground water: ground water chemistry included NH_3-N, SRP, NO_3-N, and chloride (Cl)

4.3.7.4.5 Flow Measurement

With each grab sample

4.3.7.4.6 Meteorologic Measurements

None

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

None

4.3.7.5 Data Management

The data are managed locally by the project.

4.3.7.6 Data Analysis and Results

Analysis:

The project has performed annual linear regressions of log- transformed concentration versus discharge for SS, TP, SRP, and NO_3-N.

Regression analysis was used to test whether BMP implementation changed the concentration/discharge relationship in each monitored parameter over time. This approach was chosen because BMP implementation has occurred throughout the project and there is no clear break between pre- and post- treatment data sets. (Johengen et al., 1989)

Annual loadings at each monitoring station were calculated using the sum of weekly estimates. Weekly estimates assumed a constant load over the interval between the midpoints of consecutive sampling periods.

Predicted concentrations at discharges of 0.1 and 0.5 cubic meter per second (m^3/sec) were plotted against yearly estimates of the percentage of subbasin area treated by BMPs.

Results:

Final analysis shows that no documentation of water quality changes resulting from BMP implementation is possible (Johengen, 1991).

Monitoring results showed that the strength of all pollutant sources must be identified before attempting to assess the effectiveness of a nonpoint source control program (Johengen et al., 1991).

The project's ability to reduce phosphorus input to the aquatic system was hampered by the lack of documented water quality impairment and that nonpoint source loading was lower than expected (Johengen et al., 1991).

Monitoring established seasonal trends in chemical parameters; however, no trends in water quality at the watershed level were documented probably due to the fact that overall BMP installation was generally low.

A reduction in phosphorus at station 8 (project outlet) coincided with implementation of a new sewage treatment facility for the city of Milan. (Holland et al., 1987) Other phosphorus reductions occurred due to upgrading the City of Saline sewage treatment plant, and the elimination of a high phosphate industrial waste discharge.

Notable increases in all forms of phosphorus were observed at half or more of the monitoring stations during the three-year monitoring period between 1984 and 1986. This increase did not continue in 1987. These data suggest that increases in soluble reactive phosphorus (SRP) concentrations at stations 3, 4, 5, 7 and 9 (all upstream from urban areas) could be explained by increased mean discharge at these stations. (Holland et al., 1987)

4.3.8 Linkage of Land Treatment and Water Quality

No linkage of water quality and land treatment was possible due to inconclusive monitoring results. The project's ability to document basin level phosphorus reductions from cropland treatment was also hampered by low BMP implementation. The project has been very successful in implementing animal waste system (BMP 2) but was not able to measure phosphorus reductions related to improved management of dairy waste.

4.3.9 Impact of Other Federal and State Programs on the Project

Approximately 32,900 acres in the project area have been planned for conservation reserve system due to requirements of the Food Security Act. The impact of this land entering the conservation reserve system will be minimal on the RCWP project.

4.3.10 Other Pertinent Information

None

4.3.11 References

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

Holland, R.E., A.M. Beeton, and T. Johengen. 1987. Saline Valley Rural Clean Water Project Interim Report on Monitoring During 1986.

Johengen, T.H., A.M. Beeton, and R. Holland. 1991. A Final Water Quality Monitoring Report and Evaluation of the Saline Valley Rural Clean Water Project. 137p.

Saline Valley Rural Clean Water Project, Michigan. 1987. Annual Progress Report.

Saline Valley Rural Clean Water Project, Michigan. 1989. Annual Progress Report, 27 p.

Smolen, M.D., S.L. Brichford, J. Spooner, A. Lanier, T.B. Bennett, S.W. Coffey, and K.J. Adler. 1989. NWQEP 1988 Annual Report: Status of Agricultural Nonpoint Source Projects. EPA 506/9-89/002.

4.3.12 Project Contacts

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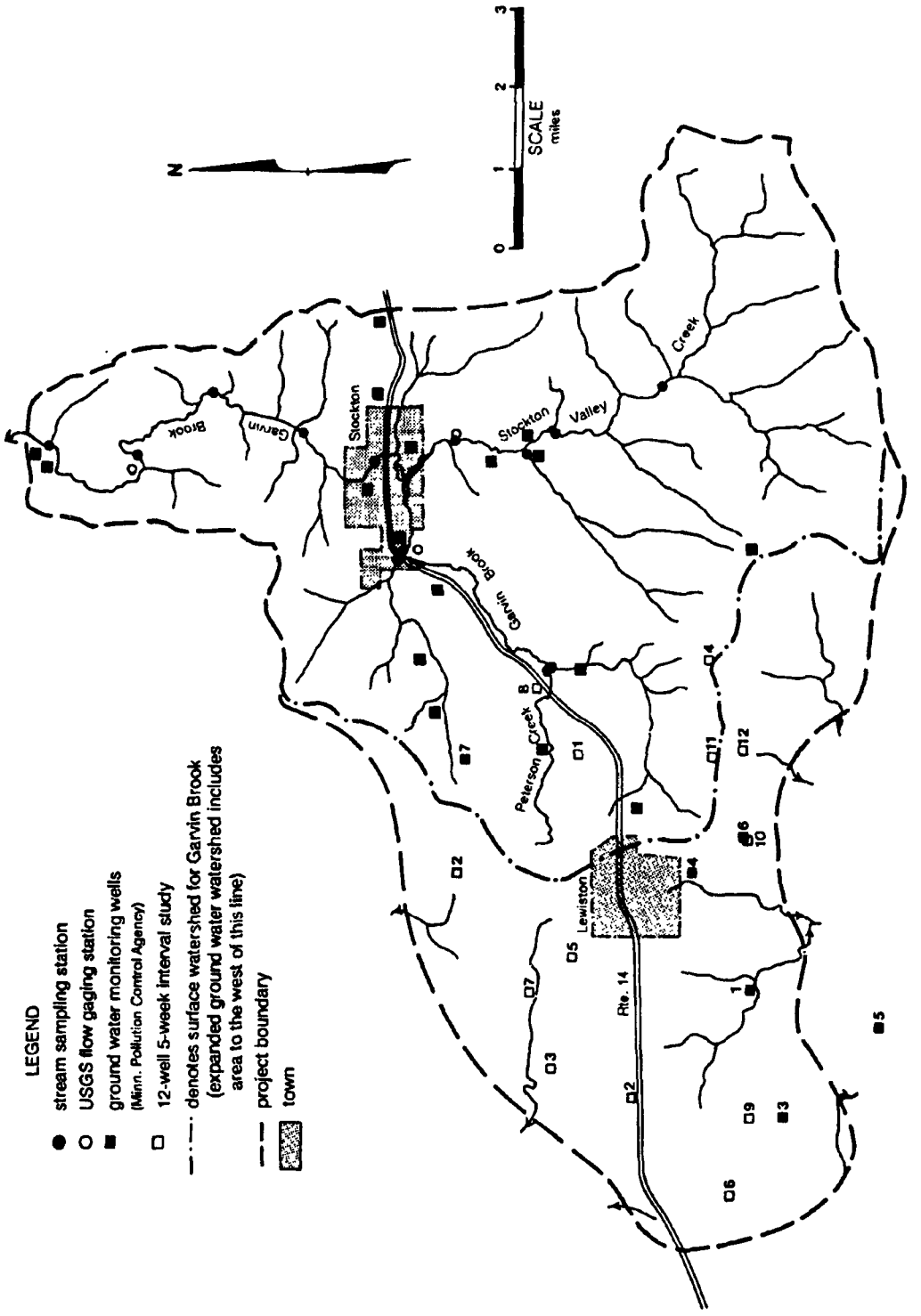
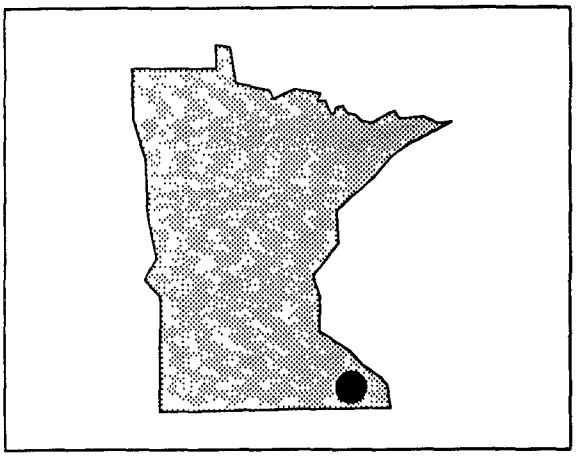


Figure 4.13: Garvin Brook (Minnesota) RCWP project map, MN-1.

Minnesota
Garvin Brook

(RCWP 16)

Winona County
MLRA: M-105
HUC: 070400-03



4.1 Project Synopsis

The Garvin Brook RCWP project encompasses two distinct projects. The original project targeted Garvin Brook, a 15.2-mile trout stream. Trout fishing was impaired due to sedimentation and habitat destruction. Any area that had high to moderate sediment losses or moderate nitrogen or phosphorus losses was designated as critical. In 1985, after determining that ground water pollution due to nitrate-nitrogen (NO_3-N) and pesticides was a problem (many domestic wells tested over the allowable drinking water standard of 10 milligrams per liter (mg/l) NO_3), the critical area was redefined to include the entire ground water recharge area for Garvin Brook.

The primary objectives of the project were to decrease bacteria and turbidity violations, improve stream aesthetics, and to increase trout in Garvin Brook; and to reduce NO_3 in ground water to acceptable drinking water standards.

The Garvin Brook watershed is located in Winona County, Minnesota. The watershed affecting surface water quality consists of narrow ridges and broad valleys. The watershed affecting ground water quality consists of broad ridges and narrow valleys. The underlying fractured, karst geology of the region allows preferential solute flow into the ground water. Together the Garvin Brook watershed (GBW) and the ground water recharge area (GWW) comprise 46,516 acres. Of these 46,516 acres, 20,255 acres are in the designated critical area. Sixty- seven percent of the total watershed, or 31,282 acres, is cropland. Corn is produced on approximately 15,000 acres. Many farmers in this area have mixed farming operations with dairy cows being the predominant livestock type.

Best management practices (BMPs) were implemented to decrease sediment and fecal coliform loads into streams and to reduce the amount of excess fertilizer and manurial nitrogen applied to soils. Two BMPs, fertilizer and pesticide management, were utilized extensively. One BMP, stream protection system, was so thoroughly disliked by area farmers that the insistence that it be implemented as a condition for other BMPs being contracted caused a refocusing of the project. This BMP was subsequently dropped and the focus of water quality shifted from surface to ground water. Eighty-one contracts were signed, representing 65% of the estimated 125 contracts that were needed to meet project objectives and goals.

Domestic wells, streams, and soil were monitored. Land treatment during the RCWP project did seem to make a difference for some of the variables measured. During the project period, the number of wells with greater than 10 mg/l of NO_3 decreased, although the number of wells with NO_3 levels between 3 and 9.9 mg/l increased. Trout numbers were increasing, although fingerling numbers decreased in 1989, probably as a result of high rainfall. Turbidity, total suspended solids (TSS), total phosphorus (TP), and median fecal coliform (FC) declined during mid-project years, but had increased by project's end (Garvin Brook RCWP Project, 1991).

The ground water project was very successful. The farmers understood the problem of ground water contamination and were willing to address the problem through the use of fertilizer and pesticide management BMPs. These BMPs were saving the farmers money and potentially reducing ground water contamination. Conversely, the surface water project almost failed. It never appeared that increasing trout populations in Garvin Brook was a compelling enough reason to entice farmers to spend money on BMPs. Additionally, some BMPs selected were either too expensive or the farmers were unconvinced that the practice would help the water quality of Garvin Brook. If a project is to succeed, farmers must be supportive of project objectives and goals; this was not the case for the surface water project.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

The ground water quality objectives were adequate. However, there were problems with the surface water quality objectives. The objectives weren't compelling enough to interest the farmers in solving the problem.

There was a problem with both the surface and ground water quality goals that were selected for this project. The surface water quality goals of reducing fecal coliform, sediment loading, and turbidity by such large and specific amounts were unrealistic, even if all BMPs had been applied. Since many of the BMPs aimed at solving the surface water quality problem were either not implemented or only partially implemented, there was no chance of reducing surface water pollutants. The ground water goal of reducing NO_3 levels to less than 10 mg/l was also unrealistic because there was not enough information about the residence time of the applied fertilizer in the soil or the effects of the nitrogen fertilizer management on ground water.

4.2.1.2 Recommendations

Water quality objectives must be supported by the farmers or they will not participate in the project.

Numerical goals should be set following initial monitoring and evaluation. These water quality goals should be reasonable if they are to be met during the project.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

In addition to the LCC, there was a Local Technical Committee (LTC) which established costs and guidelines for BMP installation. This committee appeared to be a neutral force in the project.

The National Coordinating Committee (NCC) assisted this project by raising questions and helping re-orient the focus of the project when it was floundering.

The Minnesota Pollution Control Agency was the lead monitoring agency (MPCA). Other agencies involved in monitoring included the Minnesota Department of Agriculture (MDA), the Minnesota Department of Health (MDH), the Minnesota Department of Natural Resources (MDNR), the Minnesota Geological Survey (MGS), the Winona County Extension Service, and the U.S. Geological Survey (USGS). These different agencies provided outstanding technical support to the project without any territorial disputes.

4.2.2.2 Recommendations

RCWP should include funds to hire a project coordinator at the start of the project to coordinate information and education (I&E) activities, BMP implementation, monitoring and evaluation. The coordinator should not have close ties but be familiar with all government agencies involved. This individual needs to be comfortable communicating one-to-one with project area landowners and participants.

The LCC needs to be representative of area farmers and the LCC must listen to their concerns and recommendations.

The SCC needs to have structured meetings just for RCWP business, otherwise RCWP affairs may not get the attention they deserve.

The NCC should actively assist project teams in refocusing or re-orienting a project, as needed.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

A respected local farmer was hired early in the project by the Cooperative Extension Service (CES) as a part-time program assistant. His duties included visiting landowners to sign-up participants and answer questions, preparing a quarterly newsletter, working with farmers on split nitrogen contracts, and testing wells. The well testing and subsequent identification of high NO_3 levels led to an interest in the project by area farmers and subsequent RCWP contracts.

Nitrogen plot studies conducted by the CES and the University of Minnesota led to a reduction in recommended nitrogen fertilizer rates.

The CES conducted demonstration plots for nitrogen application rates, rootworm insecticide rates, and weed control methods. Some of these practices, such as lowered nitrogen and insecticide rates, have been adopted by area farmers.

4.2.3.2 Recommendations

Projects should establish plot studies and use field demonstrations in the project area to convince and encourage producers to participate and give them confidence in the BMPs.

Specific services provided through Information and Education (I&E), such as well testing, can promote producer "ownership" of the project and increase participation.

One-to-one contact is essential to maintain communication links between farmers and project personnel. People with roots in the community can often promote BMPs more effectively than people who are perceived as outsiders.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

Initial producer participation was very limited due to the following reasons:

1983-1987 were difficult financial times for farmers and they did not have extra dollars to invest in cost share activities.

The first animal waste treatment system installed was extremely expensive. The system was expensive because it was the first but also because the farmer who installed it was relatively wealthy and has been described as wanting to have a "showcase farm". Other area farmers incorrectly believed they would have to install the same kind of system which most of them could not afford.

Originally, producers did not understand that they would have to address ALL water quality problems on their farms. Many producers in the area were pasturing streambanks and were unwilling to install fencing to keep the cows off the streambanks (which causes erosion into the streams) and out of the streams (which increases fecal coliform levels and trout habitat destruction).

The overriding participation problem appeared to be a lack of interest in the primary water quality problem: declining trout populations in Garvin Brook.

4.2.4.1 Findings and Successes (continued)

In 1985, the project underwent a major revision and change in emphasis from surface water remediation to ground water remediation. Project participation increased after this point for several reasons:

The stream protection system (fencing off streams) was dropped as a mandatory BMP.

An additional 12,681 critical acres were included due to the potential in this area for ground water contamination from pesticides and fertilizers.

Cost share rates increased temporarily to 90% due to the County Commissioners agreeing to cost share an additional 15% of any BMP.

Ground water deterioration caused by increased NO_3 levels from fertilizer and manure had a direct impact on the lives of the farmers and they could understand the value of changing farming practices to reduce ground water contamination.

Cost share for split nitrogen applications was allowed.

Although the number of contracts signed and the number of structural BMPs installed fell below expected goals, farmer participation for the fertilizer and pesticide management BMPs exceeded expectations. More contracts were signed by farmers in the ground water project area than the original surface water project area.

4.2.4.2 Recommendations

Expensive structural BMPs (such as BMP 2) are difficult to sell in times of depressed economic conditions, even with cost sharing as high as 90%. Lower cost manure structural alternatives should be promoted from the beginning of a project.

Pre-project surveys of farmers in order to assess their opinions about implementing certain BMPs (such as fencing cattle out of streams) can help project staff re-evaluate project implementation, cost share, and other considerations.

If a BMP is unacceptable to area farmers to the point that it is jeopardizing the entire project, consideration should be given to dropping or modifying that BMP if possible.

Identification of water quality projects that farmers are interested in solving is critical to project success.

Try to provide more than one BMP for each problem. This will allow farmers more flexibility in matching BMPs with their farm operations and prevailing economic conditions.

Increasing cost share rates may be necessary in periods of financial stress.

Implementation of BMPs by landowners may be enhanced by linkage of BMP implementation plans to ground water protection, since people are often more aware of the direct impact on their lives of well water protection than stream protection. Often the BMPs critical to protecting both surface and ground water resources are similar.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

Sixteen BMPs were originally selected; only twelve were utilized. Of the twelve BMPs, only four were used by 30% or more of the producers: conservation tillage system, permanent cover on critical areas, fertilizer management, and pesticide management.

The stream protection system (fencing) was unacceptable and therefore was discontinued. The animal waste system was too expensive and emphasis was shifted from large animal waste systems which were designed to hold all runoff from barnyard areas to systems which utilized grass filter strips and settling ponds to treat runoff.

4.2.5.1 Findings and Successes (continued)

Fertilizer management began as an educational practice to demonstrate to farmers the effectiveness of nutrient management based on a nitrogen budget. Before the project, the farmer's attitude was that manure was something to be disposed of on the nearest field. It was important to illustrate the value of animal waste as a nutrient resource to the farmers.

When NO_3 ground water contamination was discovered, the LCC made the fertilizer management BMP a cost share practice. Farmers made money on this practice twice: once through the cost share money and again through lower fertilizer rates which produced the same corn yields.

Sinkholes were filled and old abandoned wells were sealed to reduce their potential to contaminate ground water resources. Very late in the project, due to vadose zone monitoring, it was discovered that sink holes near commercial pesticide application facilities and those adjacent to corn fields were serving as a potential path for ground water contamination.

During the project there were frequent SCS staff changes. This lack of continuity made the implementation of structural BMPs more difficult and time consuming as it took the new SCS technician time to become acquainted with individual farm plans.

BMP maintenance was tracked by the agency responsible for technical assistance on the particular BMP. For example, the Soil Conservation Service (SCS) tracked the structural BMPs and the Cooperative Extension Service (CES) tracked the nitrogen and pesticide management BMPs.

The only direct evaluation for BMP effectiveness was vadose zone monitoring for nitrogen and pesticides, conducted on corn cropland, sinkholes, Crop Reserve Program (CRP) land, ponded run-off, and a research plot.

Modeling was conducted to evaluate the effectiveness of combined BMPs on stream water quality.

4.2.5.2 Recommendations

BMP identification and implementation decisions should be made with water quality goals and available resources in mind.

Management BMPs are more acceptable to absentee landowners since they do not cost the landowner any money and the operator receives the cost share payment.

Farm economics, along with the cost of damage to the environment, should be considered throughout the project, with changes being made in the program as necessitated by changing economic times.

The first structural BMPs installed should be representative for the area (average size and cost).

Prepare for personnel changeover in long-term projects by keeping detailed, accurate, up-to-date records; writing detailed semi-annual or annual reports; and allowing time for personnel training.

Development of nitrogen budgets for farmers' fields, which account for nitrogen from manure and legumes, not only keeps excess quantities of commercial fertilizer from being available for leaching, but also allows the farmer to optimize the use of N from manure and legumes.

Tailor land treatment to site specific problems and landowner needs within technical standards and specifications.

A computerized land tracking system is useful for monitoring land use changes.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

At the primary monitoring station near the mouth of Garvin Brook, surface water chemistry improvements were not evident during the project. During mid-project years, there were decreases in total suspended solids (TSS), turbidity, and fecal coliform (FC). However, during the last years of the project, all non-biological water quality indicators rose to pre- levels near those in 1982. Trout populations increased during the project. At the last sampling, fingerling numbers had dropped precipitously, which may indicate a change in this upward trend or just a temporary drop in trout numbers.

The objective for ground water was to reduce NO_3 below the acceptable drinking water standard. This objective was partially met. There was a 10% reduction in the number of wells in which concentrations exceeded the acceptable drinking water standard. Of the 51 wells with nitrate-N originally above 10 mg/l, there was a significantly decreasing trend in nitrate for 31% of the wells and no wells had a significant increasing trend. Since the ground water objective was added later in the project, and since there is a lag time between nitrogen fertilizer application and an increase in ground water NO_3, it is expected that water quality will continue to improve in the future.

Vadose zone monitoring was useful in determining sources of ground water contamination. Most pesticide contamination was determined to be a point source pollution problem caused by commercial pesticide application facilities. Improper handling of pesticides by commercial pesticide facilities were believed to be responsible for the high levels of pesticides found in some of the wells around Lewiston. Three of the five commercial pesticide application facilities located in Lewiston were found to have extremely high soil pesticide levels due to sloppy pesticide handling practices. These pesticides were leaching through the soil into the ground water or were being transported to nearby sinkholes. The majority of the nitrogen entering the ground water is from fertilized fields. High NO_3 concentrations were found in the soil solution even after fields had been under the fertilizer management BMP for two to four years. Great variability in nitrate and pesticide concentrations was found among various sinkholes.

Although there were some omissions in overall planning at the beginning of the project, inconsistent funding sources, and changes in project emphasis, water quality monitoring was relatively thorough and continuous. Ground water and vadose zone monitoring were especially thorough in the latter half of the project. Using the project assistant to test well water served a two- fold purpose of both collecting data and promoting the project to area farmers.

A comparison of nitrate concentrations in water collected at the same places and times, but analyzed at three different laboratories, showed significant and consistent differences in reported concentrations. Thus, there was a quality assurance/quality control (QA/QC) problem with certain analyses.

4.2.6.2 Recommendations

Nitrate testing of domestic wells in the project area can be a valuable service that promotes water quality awareness and provides another means for contacting landowners and tracking project progress.

Long-term monitoring strategies, including monitoring before, during, and after BMP implementation, should be developed at the beginning of the project.

Project money for long-term monitoring should be available from the outset of the project.

If long-term funding is not secured at the onset of a project, the monitoring strategy should be developed such that meaningful data can be obtained regardless of future funding levels.

Very strict field and laboratory QA/QC is needed in order to ensure reliable data for long-term trend monitoring.

A long-term project representative is needed to ensure coordination of all aspects of the project, including land use and water quality monitoring activities.

4.2.6.2 Recommendations (continued)

Quantitative water quality goals should be established prior to implementation of BMPs in order to establish a target. Monitoring results can be used to set aggressive but realistic goals.

Future projects should focus monitoring in critical subwatersheds and use biomonitoring to aid in assessing long-term trends.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

There was no established linkage between land treatment and surface water quality in this project because water quality and land treatment monitoring were insufficient.

Vadose zone sampling was useful in establishing linkage between ground water quality and land treatment. The vadose zone was monitored for nitrogen and pesticides on corn cropland, sinkholes, Conservation Reserve Program (CRP) land, ponded runoff, and a research plot. Results of the vadose zone monitoring were as follows:

Even after two to four years of using nitrogen management BMPs, residual soil nitrogen contents were still in the range of 20 - 50 mg/l. Either more stringent measures are needed to reduce nitrate leaching or more time is needed to observe the full benefits from the implemented BMPs.

Many sinkholes currently contribute very little nitrate to ground water.

Point sources of pollution (pesticide distribution and application facilities) contributed to ground water pesticides.

4.2.7.2 Recommendations

Since it is difficult to differentiate land treatment effects on water quality from climatic effects on water quality, the use of paired watersheds should be considered in future experimental studies.

Land management changes (such as types of crops grown, number of livestock produced, set aside programs, conservation programs) should be monitored throughout project duration.

Vadose zone sampling should be used to help determine the effectiveness of the implementation of particular BMPs.

Point sources of pollution should be targeted in pollution prevention efforts.

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1982 - 1994

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Garvin Brook, a designated trout stream

Prairie du Chien-Jordan aquifer, an impaired ground water resource

4.3.2.1.2 Water Uses and Impairments

Current project area population is estimated at 2,500, most of whom rely on domestic wells for water supply. The primary ground water impairment is decreased drinking water quality due to high nitrate concentration and pesticide contamination.

Approximately 25,000 people use Garvin Brook for recreation, primarily swimming and fishing. Use of Garvin Brook for trout fishing is reportedly impaired; however, fishing impairments are not well documented. The primary pollutants in Garvin Brook are bacteria, sediment, and turbidity. Pollutant sources include nitrogen fertilizers, animal operations (mostly dairy), and pesticides.

4.3.2.1.3 Water Quality Problem Statement

Reductions in trout productivity in Upper and Lower Garvin Brook and in Stockton Valley Creek are the major surface water quality impairments. (Lower Garvin Brook and Stockton Valley Creek join near Stockton, Minnesota, to form Upper Garvin Brook). Sediment from farming activities and bacteria from barnyards have been identified as major causes of impairment.

Nitrate and fecal coliform bacteria contamination of well water exceeding health standards and pesticides in some domestic wells are the major ground water concerns.

4.3.2.1.4 Water Quality Objectives and Goals

Final objectives and goals for surface and ground water were:

Surface water objectives: Increase the recreation potential of Garvin Brook

Surface water goals: Decrease sediment loading by 50%, decrease turbidity violations from 100% to less than 15%, and decrease fecal coliform bacteria violations from 79% to less than 40%

Ground water objectives: Decrease levels of biological and chemical health-related pollutants entering local aquifers

Ground water goals: Reduce nitrate levels to less than the 10 mg/l drinking water standard in the karst area and reduce health related pollutants

Initial goals and objectives for surface water only were:

Surface water objectives: Water quality improvement will focus on the improving trout fisheries and on enhancing contact recreation activities

Surface water goals: Decrease sediment load by 50%, decrease turbidity violations from 100% to below 15%, and decrease fecal coliform from 79% to 40%

43.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 46,516 acres:
Project Area: 46,516 acres
Surface watershed: 30,720 acre
Ground water recharge area: 15,796 acres
Critical Area: Total - 20,255 acres
Surface Watershed - 7,574 acres
Ground Water Recharge Area- 12,681 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 33 inches (75% occurs April- Sept.)

Geologic Factors: The watershed is characterized by karst topography. The bedrock is near-surface fractured and cavernous Dolomitic limestone and Paleozoic sandstone with sinkhole development. Sinkholes and rock fissures can be direct channels for contaminated agricultural runoff into the Prairie du Chien aquifer.

4.3.2.2.3 Project Area Agriculture

There are 218 farms in the project area, of which approximately 40% are livestock and grain operations. The remaining 60% are cash grain farms. Of the farmers who produce livestock, 64% are dairy farmers. Only 16% of the farmers own more than 500 acres. Of the 31,282 total cropped acres, 15,401, or 33% of the acreage, is in corn. Approximately 80% of all watershed farmers use some form of conservation tillage in their corn production.

Nitrogen fertilizer usage on contracted acres has dropped approximately 38 pounds per acre (lb/ac) since nitrogen has been applied as a split. This has reduced total applied nitrogen by 926,202 lbs since split nitrogen application started in 1985 (Wall, D.B., 1989; Garvin Brook RCWP, 1991).

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Surface Water Area		
Cropland:	58	NA
Pasture/range	12	NA
Woodland	25	NA
Urban/roads	5	NA
Other	-	NA
Ground Water Area		
Cropland	85	NA
Pasture/range	5	NA
Woodland	5	NA
Urban/roads	5	NA
Other	-	NA
Surface and Ground Water Areas Combined		
Cropland	67	NA
Pasture/range	9	NA
Woodland	17	NA
Urban/roads	7	NA
Other	-	NA

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	54	5,100	7,140
Beef	9	1,530	1,530
Hogs	13	4,355	1,742
Other	8	NA	85

Animal numbers appear to have been stable over the life of this project.

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	1,747,000	0	582,333	180,000	2,509,333
Info. & Ed.	112,220	7,500	0	0	119,720
Tech. Asst.	599,478	0	1,000	23,376	623,854
Water Quality Monitoring	40,000	227,000	500	14,500	282,000
SUM	2,498,698	234,500	583,833	217,876	$3,534,907

Source: Garvin Brook RCWP Project, 1992; Smolen, et al., 1989

4.3.4 Information and Education

4.3.4.1 Strategy

The information and education (I&E) strategy was to increase the awareness among local producers of water quality problems. It was then expected that landowners' increased awareness of water quality problems would translate into a change in management practices. CES provided the lead role in I&E with additional education support through the SCS as they worked with area farmers.

4.3.4.2 Objectives and Goals

Inform the landowners in the project area of the RCWP

Keep landowners up-to-date on current activities concerning the RCWP program through newsletters, public meetings, and tours

Keep RCWP participants informed of the project status

Inform the public of the project and keep them abreast of its status through radio programs and printed news media

Meet with elected officials, civic organizations, and other interested groups to inform them of the RCWP, its purpose, and the status of the Garvin Brook project

Evaluate the project each year with the project landowner cooperators through personal visits and a winter meeting

4.3.4.3 Program Components

Public meetings

Educational meetings

Farmer surveys

Tours

Quarterly newsletter

Individual contacts

Demonstrations

Tillage, nitrogen, and pesticide plots

Soil testing and analysis

Agricultural waste analysis

Surface and ground water studies

Media coverage (newspaper and radio)

Slide/tape show on sinkhole contamination

4.3.5 Producer Participation

4.3.5.1 Level of Participation

Project personnel estimated that 125 contracts were needed and set their goal at 94 signed contracts (75%). Only 81 contracts were signed (65% participation). The majority of the contracts were signed in the ground water watershed area.

4.3.5.2 Incentives to Participation

Cost share rates of 90% (75% from RCWP and 15% from the Winona County Board of Commissioners)

Payment limitations of $50,000 in RCWP funds plus $6,000 from Winona County per contract

Technical assistance programs: CES prepared nitrogen budgets for BMP 15 and included the use of legumes and manure; public meetings; newsletter; split nitrogen application demonstration farm; crop scouting; free soil testing; well testing.

4.3.5.3 Barriers to Participation

The requirement that all BMPs necessary to treat water quality problems be implemented and the universal dislike by the farmers of the stream protection system

A downturn in the farm economy during mid-project years

An initial overpriced waste management system which dissuaded many farmers from installing waste management systems

Lack of interest in the original water quality goals

Unwillingness to involve the government in individual farming decisions

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Chances of continuation of certain BMPs appear to be excellent. In a farmer survey conducted by CES and MPCA, 95% of the respondents indicated that they would continue BMPs after the project ended. This is not surprising since the most popular BMPs, fertilizer and pesticide management, were saving the farmers money.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The land treatment strategy was to keep soil and manure from reaching the trout stream through the use of waste management systems, stream fencing, terracing, diversion and waterway systems, erosion and water control systems, and conservation tillage.

4.3.6.2 Objectives and Goals

The original objective was to treat nonpoint sources of pollutants affecting surface water (Garvin Brook) and to protect ground water from sinkholes and abandoned wells. Project emphasis was expanded in 1985 to include a more comprehensive protection of ground water quality.

4.3.6.3 Critical Area Criteria and Application

Initial criteria was any area within 300 feet of flowing water, sinkholes, abandoned wells, or feedlots with a high rating.

Agricultural Non-Point Source Pollution Model I (AGNPS I) computer simulation model was used to evaluate the surface watershed and designate priority areas. Critical areas were substantially redefined in 1985 using new information about ground water problems both within and outside of the original surface watershed project area. The change was made after analysis of samples from 80 wells within the surface watershed showed that 21% of the wells had levels of NO_3 exceeding the 10 mg/l drinking water standard. During the summer of 1985, 64 additional wells in the expanded ground water watershed were tested for $N0_3$. Fifty-six percent of these wells had $N0_3$-N levels exceeding the 10 mg/l standard. Measurable amounts of alachlor and/or atrazine, which were below health advisory levels, were found in six of 10 wells tested. The project area was expanded to include all of the ground water watershed (approximately one-half is outside the surface watershed).

Redefinition of critical areas resulted in an expansion of critical acreage needing treatment. The critical area for ground water protection was defined as the areas classified as having very high or high sensitivity in the Winona County Geologic Atlas to ground water pollution.

4.3.6.4 Best Management Practices Used

General Scheme: Eight BMPs (BMP 2, 3, 4, 5, 9, 10, 15, 16) were considered important (see below). Four BMPs (6, 10, 17, 18) were never used. This project increased its emphasis on the fertilizer and pesticide BMPs (BMP 15, 16), including split nitrogen application, improved manure storage, and improved calibration of manure and fertilizer spreading equipment.

4.3.6.4 Best Management Practices Used (continued)

BMPs Utilized in the Project*:

Permanent vegetative cover (BMP 1)

Animal waste management system (BMP 2)

Stripcropping systems (BMP 3)

Terrace system (BMP 4)

Diversion system (BMP 5)

Grazing land protection system (BMP 6)

Waterway system (BMP 7)

Conservation tillage systems (BMP 9)

Stream protection system (BMP 10)

Permanent vegetative cover on critical areas (BMP 11)

Sediment retention, erosion, or water control structures (BMP 12)

Tree planting (BMP 14)

Fertilizer management (BMP 15)

Pesticide management (BMP 16)

Woodland access (BMP 17)

Water quality improvement through woodland improvement (BMP 18)

* Please refer to Appendix I for description/purpose of BMPs.

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

Land use and land treatment were monitored using several methodologies. Annual status reviews were used by the SCS to monitor land use and land treatment trends. Other U.S. Department of Agriculture (USDA) programs allowed monitoring of crop acreage, conservation programs, and other activities.

Land treatment and land use monitoring was reported by cumulative acres on which BMPs were implemented during any part of the RCWP project period. No land was summed more than once for any given BMP. However, land treatment/use was not quantified on an annual or subwatershed basis, making it difficult to track differences between years and/or by subwatershed.

The project has not reported the location of BMP activities with respect to critical areas.

4.3.6.5.2 Data Management

No data management system was in place during the project.

4.3.6.5.3 Data Analysis and Results

There was no data analysis.

Effectiveness of BMPs: During the 1985-1987 growing season total early (fall or early spring) applied nitrogen decreased 50% using split nitrogen applications. The total actual nitrogen applied decreased by 20%.

Effectiveness of BMPs for controlling sediment, phosphorus, nitrogen, and COD reduction in the project area was evaluated by the Agricultural Nonpoint Source Pollution Model (AGNPS). AGNPS was used to predict sediment and nutrient delivery to the mouth of Garvin Brook resulting from storm events for the periods before (1981) and after (1989) BMP implementation. AGNPS-predicted storm-event sediment delivery was found to be reasonably close to monitoring results following storms in 1984 and 1989. The computer model predicted a 17% reduction in total sediment and nutrients attached to sediment delivered to the Mississippi River from five- and one-year 24-hour storms as a result of practices implemented through the Garvin Brook RCWP. Total nitrogen and total phosphorus reductions of 12 and 15% were predicted for total nitrogen and total phosphorus, respectively, from the one year 24-hour storm (2.5-inch rainfall) (Wall et al., 1989).The model was also being used to illustrate how livestock producers, many of whom grow corn, would benefit by managing their manure as a fertilizer resource. It must be kept in mind, however, that this was a modeling exercise which is for predictive purposes only.

Quantified Project Achievements:

		Critical Area		Treatment Goals	
Pollutant Source	Units	Total	% Implemented	Total	% Implemented
Cropland	acres	10,793	66%	8,095	89%
Sinkholes	#	44	34%	33	46%
Split N	acres	10,714	295%	8,036	394%
Pesticides	acres	20,255	188%	15,169	251%
Contracts	#	125	65%	94	86%

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The original surface water quality monitoring strategy was to sample surface water and trout abundance in the Garvin Brook watershed. Sampling and analysis was to be conducted by the Minnesota Pollution Control Agency (MPCA) and Department of Natural Resources. Initially, ground water sampling consisted of quarterly sampling of 15 wells and 3 springs and was conducted by the MPCA. Later, the ground water monitoring network was expanded with the sampling and analysis being conducted by the MPCA, Winona CES, and Minnesota Department of Agriculture (MDA).

4.3.7.2 Objectives and Goals

Final Surface Water Monitoring Objectives:

Monitor baseflow water quality, stream runoff following storm events, and brown trout populations in order to evaluate stream water quality changes occurring throughout the BMP implementation period

4.3.7.2 Objectives and Goals (continued)

Final Surface Water Monitoring Goals:

Conduct continuous monthly sampling for 18 variables at a site near the mouth of Lower Garvin Brook in order to evaluate trends in baseflow water quality

Conduct brown trout surveys in the spring and fall each year at control sites on Upper Garvin Brook

Conduct storm monitoring to verify the AGNPS model and then use this model to estimate storm event sediment and nutrient loading reductions due to land treatment

Final Ground Water and Vadose Zone Goals:

Develop adequate baseline data regarding nitrate and pesticide concentrations and general chemistry of the Prairie du Chien-Jordan aquifer in Garvin Brook Watershed and Ground Water Recharge Area in order to assess long-term changes resulting from the RCWP and other programs

Determine nitrate and pesticide concentrations moving through the rooting zone in fields under RCWP contract for two to four years

Evaluate nitrate and pesticide contributions from agricultural fields, sinkholes, grassland, woodland, and ponds to better characterize the contamination

Evaluate well water nitrate concentrations between 1983 and 1990 from annual sampling of numerous domestic wells

Develop a greater understanding of ground water residence times in order to more appropriately evaluate ground water quality trends

Initial Surface Water Monitoring Objective:

Conduct intensive baseflow and runoff event monitoring for three consecutive years at three sites in order to adequately define baseline water quality

Initial Surface Water Monitoring Goals:

Evaluate which water quality variables were of greatest concern

Define the initial baseflow quality of streams at three sites in the watershed to allow for future documentation of changes resulting from implementation of BMPs

Characterize pollutant loadings during rainfall-runoff events

Continue trout population assessments each spring and fall to establish time trends

Initial Ground Water Monitoring Objectives:

Determine baseline ground water quality within Garvin Brook Watershed so that changes in quality due to human activities can be detected over time by sampling 15 wells and three springs

Heighten awareness of the farming community about ground water quality problems in the project area by sampling numerous wells for nitrate

4.3.7.3 Time Frame

1981 - 1990

Emphasis shifted to ground water in 1985

4.3.7.4 Sampling Scheme

In FY 1986, the emphasis of the monitoring program was shifted from surface water to ground water. Available funding was used for monitoring private farm wells, farm fields, and sinkholes; monthly sampling of one site on Garvin Brook; and limited storm event sampling of Garvin Brook. The expanded ground water monitoring effort conducted by the Minnesota Pollution Control Agency (MPCA) was intended to track long-term effects of BMPs 15 and 16 as well as further define sources and pathways of nitrate and pesticides in ground water.

Surface Water Monitoring: Garvin Brook is sampled for twelve variables and flow rate at one site on a monthly basis. During FY89, runoff event sampling was conducted at two sites on Garvin Brook.

Ground Water Monitoring: The ground water related monitoring was conducted primarily by the MPCA, Winona CES, and the MDA. A total of 160 wells were sampled at least once annually for nitrate. Twelve of these wells were sampled for nitrate every five weeks. These same 12 wells are sampled quarterly for pesticides and 15 other variables. An additional 10 wells were sampled quarterly only nitrates and pesticides only. Thirty-three sites for sampling soil moisture in farm fields and sinkholes were established and were sampled for nitrate, pesticides, and several other variables on a quarterly basis.

4.3.7.4.1 Monitoring Stations

Surface Water:

In 1981-1982, a total of 14 stream sampling stations located on Rollingstone Creek, Garvin Brook, Peterson Creek, and Stockton Valley Creek were monitored once per year. Four of these stations were sampled four to 12 times during 1982 and 1983. From 1981-1991 one site on Garvin Brook was monitored monthly for 18 variables.

Storm event monitoring was performed at two sites in 1984 and 1989. In 1988, one site on Garvin Brook and one on Stockton Valley Creek were monitored.

On upper Garvin Brook, two sites were monitored for trout every year from 1979 to 1991.

Ground Water:

Fifteen wells and three springs in Garvin Brook Watershed were monitored quarterly in 1982 and once in 1983, 1984, and 1987.

Eighty wells were sampled annually for nitrate in 1983. In 1985 an additional 83 wells were included in the sampling program. From 1986 to 1991, 161 wells were monitored annually.

Twelve wells in the ground water recharge area were sampled quarterly for general chemistry parameters and every five weeks for nitrate since 1958.

Thirty-three soil moisture sampling sites scattered around the watershed were sampled two to eight times during a two-year period.

Twenty-two wells were sampled quarterly for pesticides for a one to three year period between 1986 and 1989.

Residence time analysis was conducted on 31 wells between 1990 and 1991.

4.3.7.4.2 Sample Type

Surface Water: Grab and automatic / electroshocking for fish

Ground Water: Grab

Soil-moisture Sites: Instantaneous with lysimeters and BAT samplers

4.3.7.4.3 Sampling Frequency

Surface Water:

Monthly and selected storm events at Garvin Brook
Storm event only at Stockton Valley Creek
Spring adult trout and fall fingerlings sampled each year

Ground Water:

All 161 wells: annually for nitrate
Twelve wells out of the 161: quarterly for pesticides, 15 other variables and every five weeks for nitrate
Additional 10 wells: quarterly for nitrate and pesticides

Soil Water:

Thirty-three soil-moisture and sinkhole sites: 2 - 8 samples analyzed for nitrate, pesticides, and other variables during 1988 and 1989

4.3.7.4.4 Variables Analyzed

Surface Water: 1981-82: full spectrum of variables including pesticides

1986-88: temperature, pH, turbidity, conductivity, biological oxygen demand (BOD), chemical oxygen demand (COD), solids, nitrogen, phosphorus, organic carbon, chloride, sulfate, fecal coliform bacteria, trout abundance and weight

Ground Water: Nitrate-nitrogen, selected pesticides

Soil Water: Nitrate-nitrogen, selected pesticides, general water chemistry

4.3.7.4.5 Flow Measurement

Surface Water: Continuous stage measurements were obtained between 1984 and 1991 only at the Garvin Brook station near Minnesota City.

Ground Water: Potentiometric surface measurements were made at numerous wells during 1983 and 1990 and broad scale ground water flow directions were determined.

4.3.7.4.6 Meteorologic Measurements

Temperature and precipitation data were recorded by volunteer observers in and around the project area.

Precipitation (1982): 3 non-recording rain gauges in Garvin Brook watershed were read daily. Daily snowfall amounts were recorded in winter.

Data were computerized by the Minnesota Department of Natural Resources Climatology Department.

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

The 1989 farm survey indicated that 89 and 92 percent of survey respondents believed that the Garvin Brook RCWP was effectively improving stream and ground water quality respectively.

4.3.7.5 Data Management

The data are in STORET.

STORET AGENCY CODE	STORET STATION NO.	DESCRIPTION
Surface Water Stations:		
21MINN	GB-4.5	(6/81-1/90) ongoing Garvin Brook
"	GB-11.3	(6/81-3/83 data in STORET) ongoing Garvin Brook
"	SVC- 1	(6/81-present) ongoing Stockton Valley Creek
Additional stations with limited monitoring period:		
"	GB-2.5	(6/81-6/82)
"	GB-6.5	(6/81-5/89) selected variables
"	GB-8.3	(6/81- 6/82) 2 samples
"	GB-9.4	(6/81-6/82)
"	GBT-0.2	(6/81-6/82)
"	GB-13.8	(6/81- 6/82)
"	SCH-0.1	(6/81-6/82)
"	SVC-2.7	(6/81-6/82)
"	SVC-4.7	(6/81-6/82)
Ground Water Wells and Springs:		
21MINNG	GWQ0131	(1/76-6/87) domestic well
"	GWQ0282-291	(1/76-6/87) 10 domestic wells
4 "	GWQ0295	(1/76- 6/87) domestic well
"	GWQ0296	(1/76-6/87) domestic well
"	GWQ0298	(1/76-6/87) domestic well
"	GWQ0299	(1/76-6/87) domestic well
"	GWQ0318	(1/76-6/87) well spring
"	GWQ0319	(1/76-6/87) well spring
"	GWQ0320	(1/76-6/87) well spring
Domestic wells post-RCWP BMP implementation		
21MINNG	NPWLVD381- 393	(2/88-5/89) 12 samples @ 13 wells

4.3.7.6 Data Analysis and Results

Surface Water Analysis:

Median concentrations and loadings of 18 variables were calculated and plotted with median flow for three periods: the whole year, the spring months, and the summer-fall months for each year 1982-1990.

Ground Water Analysis:

Variations in time and space of nitrate, bacteria (total coliform), and pesticides (atrazine mostly) were compiled and plotted. Correlations of nitrate, bacteria, and pesticides with other water quality variables were also calculated.

4.3.7.6 Data Analysis and Results (continued)

Surface Water Results:

Adult trout and fingerling abundance and total weight have increased at two Garvin Brook stations. However fingerling numbers declined during the last sampling year, suggesting that adult numbers will also drop in the proceeding years.

AGNPS modeling of storm event delivery to the mouth of Garvin Brook predicted 17% reductions in TSS and 10 to 20% reductions in nutrient delivery resulting from implementation of BMPs.

Ground Water Results:

The number of wells with nitrate concentrations greater than 10 mg/l decreased for the third year in a row during 1990. Well nitrate concentrations may be linked to the geology of the area around the well and precipitation.

Monitoring of vadose zone soil and water indicated that nitrate contamination of ground water originates largely from leaching of nitrate from agricultural fields and very little nitrate appears to originate from grassland or woodland, with the exception of fertilized pasture land. Nitrate originating from septic tanks as a contributing factor to ground water contamination was not studied. Nitrate concentrations of 20 - 50 mg/l were still leaching below RCWP-contracted fields after three to four years of nutrient management.

While certain sinkholes are thought to contribute significantly to nitrate concentrations in localized areas, the number of sinkholes located in potential problem areas and the limited acreage draining into them suggests that sinkholes are not the major pathway for nitrate to enter ground water throughout the project area.

Of 21 wells in the project area sampled for pesticides in 1988 and 1989, 16 had at least one detection of the herbicide atrazine. Two wells nearly always had atrazine concentrations above the recommended allowable limit for drinking water (3 ppb). These two wells were also found to contain other pesticides (dicamba, alachlor, and metribuzin). Point sources from pesticide application and distribution facilities are thought to be the reason for the high pesticide concentrations in these wells.

20% of 143 wells in the project area sampled in June, 1989, for total coliform bacteria had detectable bacteria (at least 2.2 MPN/100 ml).

Denitrification is likely to be causing a reduction in nitrate in parts of the Prairie du Chien-Jordan aquifer. Due to the likelihood of denitrification in the deeper part of the Jordan Formation, and the relatively low residence time (37 years) of water in the Prairie du Chien and much of the upper Jordan, the nitrate situation should significantly improve in the Prairie du Chien-Jordan aquifer (Winona Co.) within one generation following reductions in nitrate loading into the aquifer.

4.3.8 Linkage of Land Treatment and Water Quality

The only monitoring activity that specifically tied land use to water quality was the vadose zone sampling. Thirty-three lysimeters of various types were installed in different ecological niches (grassland, woodland/pasture/, corn cropland, ponded runoff, and sinkholes) to determine the effects of RCWP BMPs.

4.3.9 Impact of Other Federal and State Programs on the Project

In some years, the federal Payment-In-Kind (PIK) program encouraged the production of more acres of corn. The Dairy Refund Program (DRP) and the Dairy Termination Program (DRP) affected RCWP participants more than the PIK program. Approximately one-third of the RCWP participants were involved in the DRP and three were accepted into the DTP. Those accepted into DTP found it difficult to keep enough hay in their rotation to satisfy their conservation plan for RCWP.

County tax dollars were used to increase the cost share rate from 75% to 90% for some of the more expensive BMPs for a limited period of time.

4.3.10 Other Pertinent Information

None

4.3.11 References

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

Garvin Brook RCWP Project. 1988. Annual Report.

Garvin Brook RCWP Project. 1991. Ten-Year Report.

Smolen, M.D., S.L. Brichford, J. Spooner, A. Lanier, K.J. Adler, S.W. Coffey, T.B. Bennett, and F.J. Humenik. 1989. NWQEP 1988 Annual Report: Status of Agricultural Nonpoint Source Projects. U.S. EPA Office of Water, Nonpoint Source Control Branch, Washington, DC. EPA 506/9-89/002. 167 p.

Wall, D.B., S.A. McGuire, and J.A. Magner. 1989. Water quality monitoring and assessment in the Garvin Brook Rural Clean Water Project area: Stream and Ground Water Monitoring and Best Management Practice Implementation Assessment (1981-1989). Minnesota Pollution Control Agency, Div. of Water Quality, St. Paul, Minnesota.

4.3.12 Project Contacts

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4.3.12 Project Contacts (continued)

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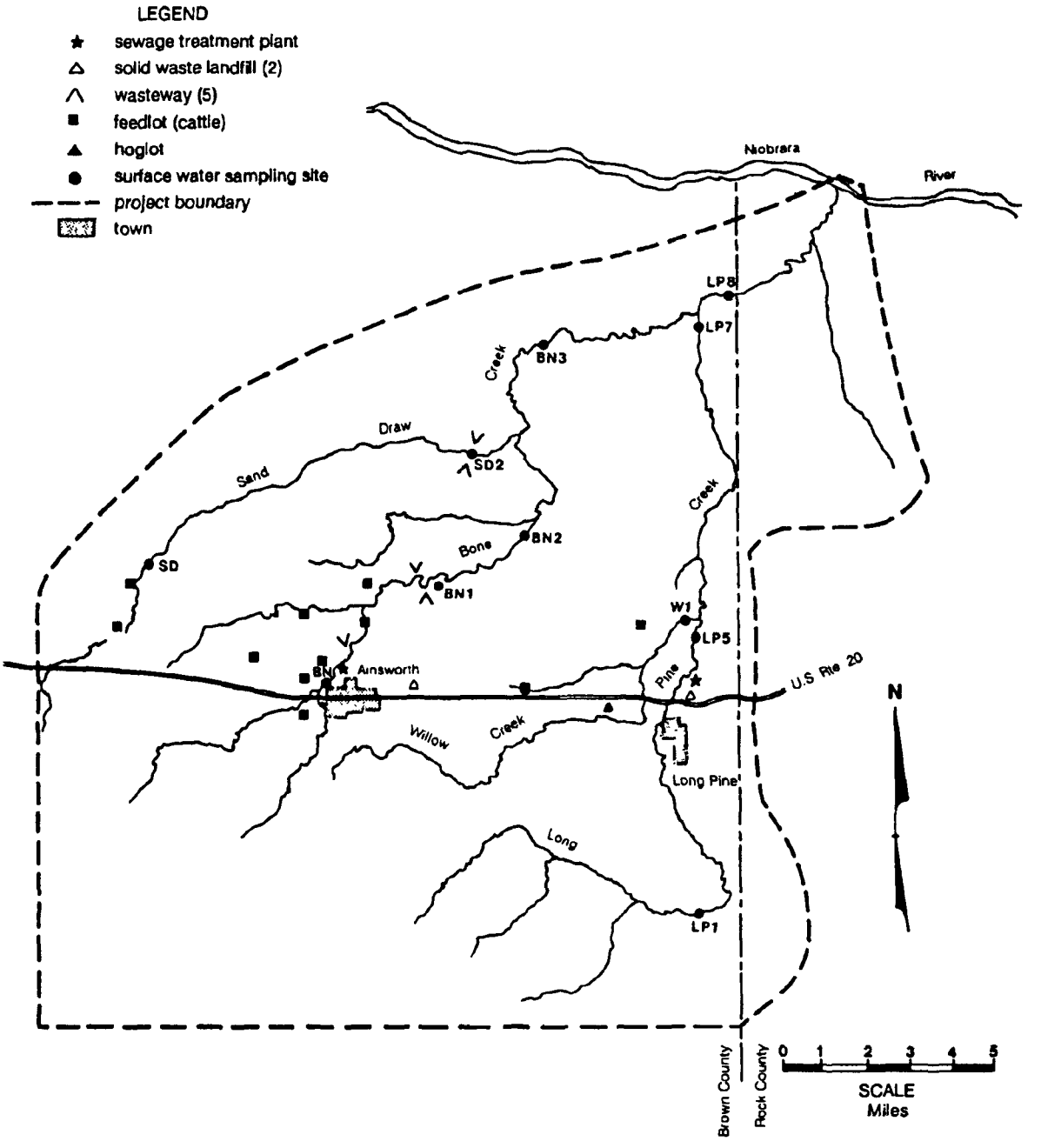
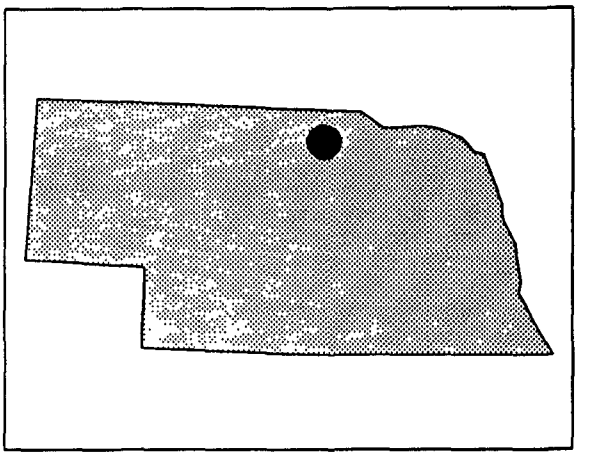


Figure 4.14: Long Pine Creek (Nebraska) RCWP project map, NE-1.

Nebraska
Long Pine Creek

(RCWP 17)



Brown & Rock Counties
MLRA: G-66
HUC: 101500-04

4.1 Project Synopsis

The Long Pine Creek RCWP project is located in north central Nebraska on the northeastern edge of the Nebraska Sandhills, the largest grass-covered sand dune area in the world. The Sandhills rest upon the Ogallala Aquifer, part of the High Plains Aquifer. The High Plains Aquifer is a 200- mile wide corridor of intermittently saturated sediment and rocks that extends south through Kansas and Oklahoma into Texas. This aquifer supplies water for irrigation, stock watering, and domestic and municipal water supply throughout the project area.

The watershed is drained by Long Pine Creek, the longest self-sustaining trout stream in Nebraska. Relic populations of three species of fish threatened in Nebraska can be found in Long Pine Creek and its tributaries. The Long Pine State Recreation Area, a state park within the project area, is used by over 8,500 people each season, primarily for contact recreation and fishing.

Sediment, bacteria, and nutrients are the primary surface water pollutants impairing contact recreation and fishing on Long Pine Creek. There is potential for degradation of ground water quality from nitrate and pesticide contamination from commercial fertilizers and pesticides.

The primary sources of sediment are from intensive grazing in riparian areas, streambank erosion, and irrigation return flows. Specifically, excessive erosion occurs in the headwaters of Long Pine Creek due to intensive grazing in riparian areas, streambank erosion, and head cutting at the stream's source. Sand Draw and Bone Creek deliver excessive sediment load, warmer water, high fecal coliform, and fluctuating flow to lower Long Pine Creek. The sediment from Sand Draw is primarily from irrigation wasteway discharges and return flows. Excessive erosion occurs along unprotected streambanks and adjacent gullies at the mid-reaches of Bone Creek. Point source feedlots and the Ainsworth sewage treatment plant contribute to high bacteria and nutrient loadings in these tributaries. The water quality monitoring identified the priority subwatersheds of Sand Draw and Bone Creek for best management practice (BMP) emphasis.

The primary water quality goal was to improve the beneficial use of ground and surface waters. Critical area (60,242 acres) criteria were based on high erosion rates and proximity to waterways. RCWP contracts were written on 71% of the critical area. Not all BMP implementation is complete.

The project, which will continue until 1995, is currently emphasizing a system of erosion control and stream protection BMPs. Irrigation water management is used to minimize the total water usage, thereby reducing pollutants entering the streams and ground water. The major components used for irrigation water management were the installation of irrigation tailwater recovery (re-use) systems and the construction of a secondary storage reservoir. This reservoir was completed in September of 1987 using pooled funds from 10 RCWP cooperators. The reservoir reduces the volume of irrigation water use by 2,000 acre-feet annually and, therefore, reduces the amount of irrigation waste water and associated sediment delivered to the creeks by as much as 28,000 tons of sediment per year.

4.1 Project Synopsis (continued)

Stream protection using cedar revetments was one of the most innovative and successful practices implemented under the RCWP. As of April, 1991, 19,000 feet of revetments had been constructed. Combined with grazing land protection and fencing, the revetments successfully decreased streambank erosion and provided habitat for trout and other wildlife.

The strong information and education (I&E) component of the project resulted in reduced fertilizer and pesticide use, addressing both ground and surface water pollution simultaneously.

Surface water quality of Long Pine Creek has visually improved. Biological, habitat, chemical, and physical monitoring are being used to monitor fish habitat in streams and demonstrate improvements in recreational fishing in Long Pine Creek. Installation of stream protection measures have improved the instream trout habitat. Nebraska Game and Parks Commission (NGPC) and Soil Conservation Service (SCS) staff estimate that the mean carrying capacity of Long Pine Creek has increased from about 75 pounds per acre to about 119 lb/acre, a 58% increase.

Ground water was monitored annually from 1982 and will continue until 1994. The presence of high nitrate concentrations in both irrigation and domestic wells has been documented. About 5-10% of the samples were above the drinking water standard of 10 mg/l. Low levels of atrazine were found in one to two wells per year.

Both surface and ground water were monitored before and after BMP implementation. Pre-BMP surface water quality monitoring was performed from 1979 through 1985 to provide baseline data. A three-year post-BMP monitoring phase began in the fall of 1992 for the surface water. Dedicated monitoring wells will be installed in 1993 to sample ground water. Data will be compared with the pre-implementation data in order to evaluate BMP effectiveness on subwatershed and project level scales.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

The water quality and land treatment objectives and goals were directed toward on-site erosion control and streambank stabilization.

The project suffered at the beginning because agreement on land treatment and water quality goals could not be reached at the local or the state levels. Some project-level personnel wanted to build large water retention structures, while others wanted to emphasize on-site erosion control BMPs. The latter was more in line with the objectives of the RCWP and was established as the primary project goal in the mid-1980's.

4.2.1.2 Recommendations

Water quality and land treatment objectives and goals should be established based on the water quality impairment and in conjunction with the national objectives of the nonpoint source (NPS) control program.

Pre-implementation water quality data should be utilized to establish critical areas contributing to the water quality problems.

Well-defined quantitative goals need to be established for water quality and land treatment.

Land treatment goals should be directly linked to the water quality goals. These goals should include the identification of priority areas for land treatment.

Water quality monitoring objectives should be quantitative and realistic. The amount of change expected to measure in each primary water quality variable should be stated as part of the monitoring objective. The monitored water quality variables should be directly related to the water quality use impairment. The project team should keep in mind that there may be a lag time between BMP implementation and observed water quality improvements, especially in ground water.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

The RCWP project encouraged inter-agency cooperation between Agricultural Stabilization and Conservation Service (ASCS), Soil Conservation Service (SCS), Cooperative Extension Service (CES), Nebraska Department of Environmental Control (NDEC), Nebraska Game and Parks Commission (NGPC), Middle Niobrara Natural Resource District (MNNRD), National Forest Service (NFS), Ainsworth Irrigation District (AID), and Long Pine Landowners Association.

The LCC formed three subcommittees which contributed to project success. The Executive committee provided administrative support and coordinated BMP development. The Technical Action Committee (TAC) developed the technical assistance, monitoring and evaluation, and project strategy portions of the Annual Plan of Work. The TAC also helped develop BMPs and a technical assistance priority system for treating water quality problem areas. The Information and Education (I&E) subcommittee developed the I&E portion of the Annual Work Plan and conducted I&E activities, including field tours and demonstration projects and media coverage.

This project suffered at times from inadequate communication between the Local Coordinating Committee (LCC) and the State Coordinating Committee (SCC). The goals of the RCWP were initially misinterpreted by some of the local project personnel.

The local project personnel finally established realistic land treatment goals and formulated and implemented a successful project.

The project would have been strengthened by early dedication of ASCS and SCS personnel to the RCWP project and by a designated full-time local project coordinator.

4.2.2.2 Recommendations

A project coordinator can be critical to project success. The coordinator should have excellent communication and organizational skills and the ability to cultivate an atmosphere of collaboration and teamwork within the LCC. The project coordinator must be able to take initiative, develop good public relations, write proposals, adjust priorities and goals as the project develops, and keep the LCC focused on the water quality and land treatment goals.

Clear, pre-project agreements must be established regarding agency roles, the water quality problem, critical area delineation, water quality and land treatment goals, and land treatment strategy in order for the LCC and the project participants to achieve project objectives and goals.

Priorities based on water quality objectives should be established for specific BMPs and Subbasins.

The SCC should create a Technical Committee who could evaluate the technical aspects of innovative and new practices recommended by the LCC.

To improve communication between the SCC and the LCC, at least one member of the SCC should attend the LCC meetings.

Funds should be available to encourage continued maintenance of BMPs.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

The strong I&E component of this project contributed to its high level of participation.

A strong I&E program resulted in reduced fertilizer and pesticide use, addressing both ground and surface water pollution simultaneously.

Fertilizer management, demonstrated through CES workshops and a 50-acre demonstration farm, was widely adopted as producers realized they could save $10 to $40 per acre by reducing application rates from 220 pounds/acre to 170-180 pounds/acre without sacrificing yields.

4.2.3.1 Findings and Successes (continued)

In Nebraska, an Integrated Pest Management (IPM) association was formed by farmers to provide weekly pest scouting for all members. The association published a newsletter through the CES and broadcast a radio program on insect activity. These efforts supported the pesticide management component of the project's I&E program.

The Cooperative Extension Service was a valuable resource for this project.

4.2.3.2 Recommendations

Emphasizing the economic advantages of the BMPs in discussions with producers can generally result in increased adoption of practices.

Field demonstrations can be a powerful tool for communicating the effectiveness of BMPs with producers.

Technical funds need to be allocated for I&E activities.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

Field demonstrations were very effective in communicating with producers.

Lack of a feeling of ownership of the off-site water quality problem by producers and lack of clear land treatment strategies hindered participation during the first four years of the project.

The most important reason farmers decided to participate was availability of cost share funds. Increased farm production was given as the second most important reason.

RCWP cost share improvements to feedlots were not approved because they are considered point sources under state regulation.

The most important reasons farmers decided not to participate were economic conditions and costs. Not wanting to be told how to farm was given as the second most important reason.

4.2.4.2 Recommendations

Potential participants should be encouraged to take an active role in defining the land treatment strategy. The strategy must be consistent with the project's water quality goals, not just the economic goals of individual farmer.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

The project achieved a high level of farmer participation in RCWP. Contracts were written on 71% of the critical area.

The ground and surface water monitoring program used in this project aided in prioritizing the critical area portions of the watershed.

Land treatment implementation was slow due to unclear water quality and land treatment goals, problem definition, critical area definition, and implementation strategies. Implementation was initiated in 1984.

Emphasis on fertilizer and pesticide management is a key factor in dealing with ground and surface water problems simultaneously.

Cedar revetments utilized for streambank stabilization were one of the most innovative and successful practices implemented under the RCWP. As of April, 1991, 19,000 feet of revetments had been constructed for streambank erosion. These revetments also provide a variety of habitat benefits for trout and other aquatic life. The trout carrying capacity of Long Pine Creek has increased as a result of the revetments and associated habitat improvements.

4.2.5.1 Findings and Successes (continued)

Approximately 68% of all cost share funds were spent on irrigation and water management. For example, almost 22% of the funds were used for the Ainsworth Irrigation District secondary storage structure. The rest centered on tailwater recovery and water control structures. By collecting irrigation runoff, sediment and chemicals were prevented from entering surface waters. The water collected was then reused. This recycling of runoff saved energy and dollars in addition to reducing the amount of sediment entering streams.

Grazing land protection received approximately 12% of the cost share funds. Fencing to exclude cattle from streambanks, in combination with providing alternative water supplies, became more acceptable to the farmers after they recognized that the fencing would limit, but not preclude, stream access and that the effective grazing acreage would increase because animals would be using the entire pasture, not just the riparian areas. To increase the atrractiveness of grazing land protection strategies, the windmills and pumps used to provide alternative water sources were cost shared.

Although streambank stabilization was addressed, the high priority areas of Sand Draw and Bone Creek did not receive sufficient revetments and other stabilization practices to completely address the major water quality problems.

Through the use of deep soil sampling to enhance fertilizer recommendations and irrigation scheduling, fertilizer use was greatly reduced throughout the watershed.

Fertilizer and pesticide management were widely adopted outside the critical area.

An Integrated Pest Management (IPM) Association was formed to provide field scouting, with the result that pesticide use was significantly reduced.

Improvements to both the Ainsworth and Long Pine sewage treatment plants have occurred so that the plants now comply with USEPA and state standards.

Feedlots continue to contribute pollutants to Long Pine Creek. Opportunities exist to reduce fertilizer use by transferring manure from large feedlots to RCWP-participating farms. RCWP cost share was not available for feedlot improvement due to the classification of feedlots with greater than 1,000 units as point sources under Nebraska law.

4.2.5.2 Recommendations

Water quality monitoring data should be used as fully as possible by resource managers to identify critical areas and select and prioritize BMPs.

Procedures for documenting land treatment / land use and cost share information need to be clearly defined at the beginning of the project. The data bases created should be on a subwatershed drainage scale such that they can be linked with the water quality data base. A data log with RCWP contract, subbasin number, BMP, practice code, critical acres served, units applied, date BMP effective, crop, soil loss savings, water saved, installation costs, and cost share should be recorded as cost-share payments are made. This will facilitate the annual summary of land treatment and land use.

The reporting of "acres served" and "units" applied need to be consistent over time.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

Surface water quality of Long Pine Creek has visually improved, especially below the confluence with Bone Creek. Recreational use in the project area has been steady since 1976. Fishing in the project area continues to be impaired by high sediment levels.

4.2.6.1 Findings and Successes (continued)

The surface and ground water samples reported for 1979 to 1985 were considered pre-implementation or baseline data. Analysis of baseline data identified impaired beneficial uses and helped in targeting location and type of needed BMPs. The pre-BMP water quality monitoring identified the priority subwatersheds of Sand Draw and Bone Creek for BMP emphasis. Based on the water quality results, it was recommended that emphasis be placed on installation of streambank protection and habitat improvement structures in the upper reaches of Long Pine Creek. Emphasis of BMPs which reduce the delivery of runoff into streams was also recommended.

This project has an extensive biological and habitat monitoring design which helped document use impairments.

Baseline data will serve as a comparison when the post- BMP implementation water quality analysis is performed.

The presence of high nitrate concentrations in both irrigation and domestic wells has been documented. About 5 to 10% of the samples were above the drinking water standard of 10 mg/l. A trend of increasing nitrate concentrations has been identified in some irrigation wells. No significant trend was observed in the domestic wells. The irrigation wells are a better source of regional aquifer water quality information compared to domestic wells; however, local contamination may still be a concern. Chemical accidents may have caused high levels of nitrate-N in some wells.

Low levels of atrazine (about 0.1-0.2 part per billion, ppb) were found in one to two wells per year. Trifluralin, alachlor, cyanide, and metolachlor have also been detected in a few samples.

Ground water trend analysis was difficult in most cases because different wells were sampled in different years. Most wells were sampled in two to five years. Only 5 wells were sampled 8 years. Attempts to sample each irrigation well annually were hampered by wells taken out of use by land enrolled in the CRP or set-aside programs, rainy weather, and irrigation rotation timing.

Surface water sampling was discontinued in 1985 at most stations, but was reinstated for 1992-1994. This break in the time series record decreases the potential to clearly demonstrate water quality improvements.

4.2.6.2 Recommendations

As used in the Nebraska RCWP project, direct measures of beneficial use support (e.g., fishery, macroinvertebrate, habitat assessment, aquatic biota occurrence, embryo survival, etc.) should be used whenever possible.

Weekly or biweekly sampling may be better than monthly sampling to increase the number of observations and account for a greater amount of natural variability, thereby increasing the ability to detect changes in water quality.

Use of dedicated monitoring wells is preferable to use of domestic and irrigation wells for monitoring ground water. Use of newly constructed dedicated wells minimizes the potential for local contamination and increases the chances that the wells will be available for monitoring throughout the project period. There is a need for sufficient information about the sampled wells and site-specific information to determine if the nitrate- or atrazine- contaminated wells are responding to local sources of contamination or represent general aquifer conditions.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.1.1 Findings and Successes

The project has estimated significant reductions in sediment delivery to Long Pine Creek. They estimate that streambank stabilization and tailwater recover systems have reduced sediment loadings. Six roadside Critical Area Treatments (CATs) are estimated to have reduced sediment loadings by 19,000 tons annually. The Ainsworth Irrigation District secondary storage reservoir has the potential to reduce sediment delivery by 28,000 tons per year. In addition, the MNNRD's drop structure addressing the headcutting in Long Pine Creek could prevent an additional 1,500 to 2,000 tons of sediment delivery.

Installation of stream protection measures has improved the instream trout habitat and may have increased the trout carrying capacity of Long Pine Creek. Using site-specific evaluations, the project NGPC and SCS staff estimate that the mean carrying capacity of Long Pine Creek has increased from about 75 lb/acre to about 119 lb/acre, a 58% increase (Hermsmeyer et al., 1991). Installing cedar revetments in combination with broadcasting or sodding reed canary grass decreased streambank erosion and flushing out of deposited sand. This resulted in re-exposure of the gravel bed, increased stream velocity, increased stream depth, decreased channel width, and increased spawning habitat.

The project has estimated significant reductions in pesticide and fertilizer use, but does not have an estimate on the corresponding impact on ground water quality. There may be a lag of several years before a measurable impact on ground water quality is observed.

The project has not completed its post-BMP monitoring. Analysis of the water quality and land treatment data will occur in 1995.

The project has a long pre-BMP monitoring record (five years) with both chemical and biological data. Three years of post-BMP monitoring data is planned. Some upstream-downstream site pairs are located in the tributaries. The length of the monitoring record and a high level of land treatment in the critical area provide the potential for documenting the effectiveness of irrigation water management, nutrient management, and streambank stabilization (cedar revetments and reduced riparian grazing) over a 10-year time frame. However, the influx of sediment from headcut erosion may reduce the ability to document BMP effectiveness.

The important explanatory variables of stream flow and rainfall were measured concurrently with water quality sampling. This should increase the project's ability to isolate water quality changes due to BMPs and climatic variability.

The project has documented annual land treatment and some of the land use changes on a subwatershed scale, which should facilitate the analysis. The Nebraska project took the initiative to revise their land treatment data base near the end of the project period in order to more effectively link their land treatment and water quality data bases (Hermsmeyer et al., 1991).

Creation of the land treatment data base after BMP implementation required a lot of effort and some useful information has been lost. Until 1992, there were no detailed procedures established for the collection of land treatment data on a subbasin basis. Delineation of subbasins, as defined by the land drained to the water quality monitoring stations at the tributary outlets, were not utilized to identify land treatment subbasins during the implementation period. In addition, consistent reporting procedures were not utilized for identifying critical acres and acres served. Reconstruction of the ASCS and SCS files that quantified BMP implementation in the critical acres on a subbasin and annual basis was required by the project.

4.2.1.2 Recommendations

Monitoring programs should be holistic. Monitoring should include chemical and physical variables, habitat quality, biotic integrity, land treatment, and land use.

Variations due to seasons and changes in flow need to be measured and incorporated into analyses to allow for valid interpretations on water quality trends. Additional hydrologic and meteorologic variables such as precipitation, storm intensity and frequency, stream flow, and ground water table depth should be measured if related to water quality in the project.

Land treatment and land use information should be tracked by hydrologic (drainage) units to facilitate evaluation of BMP effectiveness. Procedures for documenting critical areas, subbasin delineations, land use, and land treatment data must be established at the projects' beginning. Consistent reporting and a data base should be maintained seasonally or at least annually.

Land use and land treatment within the project area for both participants and non-participants should be tracked in the land treatment data base. Land treatment data tracking should not end with contract expiration if the practice is still being maintained.

Significant changes in annual land use should be incorporated into the analysis to allow valid interpretations to be made regarding water quality changes due to the BMPs and other land use changes. Land use activities that are important to track include cropping patterns, tillage methods, irrigation frequencies, rate and timing of chemical applications, and acres in set-aside programs.

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1981 - 1995

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Surface streams and ground water.

Surface water: Long Pine Creek (drainage = 293,100 acres, average aggregate flow = 150 cubic feet per second (cfs) at mouth); major tributaries are Bone Creek, Sand Draw, and Willow Creek.

The project area rests upon the High Plains Aquifer that extends south through Kansas and Oklahoma into Texas.

4.3.2.1.2 Water Uses and Impairments

Surface water: The watershed is drained by Long Pine Creek, the longest self-sustaining trout stream in Nebraska. Relic populations of three species of fish threatened in Nebraska can be found in Long Pine Creek and its tributaries. The Long Pine State Recreation Area, a state park within the project area, is used by over 8,500 people each season, primarily for contact recreation and fishing. The primary water use impairments are to recreation and fishing.

Ground water: Ground water is used for irrigation, stock watering, and domestic and municipal water supply throughout the project area. The source of ground water is the Great Plains Aquifer. There is potential for degradation of the drinking water supply from nitrate and pesticide contamination.

4.3.2.1.3 Water Quality Problem Statement

Surface Water:

Sediment, bacteria, and nutrients are the primary surface water pollutants impairing contact recreation and fishing on Long Pine Creek. The primary sources of sediment are from intensive grazing in riparian areas, streambank erosion and irrigation return flows. Specifically, excessive erosion occurs in the headwaters of Long Pine Creek due to intensive grazing in riparian areas, streambank erosion, and head cutting at the stream's source. Sand Draw and Bone Creek deliver excessive sediment load, warmer water, high fecal coliform, and fluctuating flow to lower Long Pine Creek. The sediment from Sand Draw is primarily from irrigation wasteway discharges and return flows. Excessive erosion occurs along unprotected streambanks and adjacent gullies at the mid-reaches of Bone Creek. Point source feedlots and the Ainsworth sewage treatment plant on Bone Creek contribute to high bacteria and nutrient loadings in these tributaries.

Ground water:

There is potential for degradation of the drinking water supply from high nitrate and pesticide contamination from commercial fertilizers and pesticides.

4.3.2.1.4 Water Quality Objectives and Goals

Develop new and innovative solutions to water quality problems

Improve the beneficial uses of ground and surface waters in the project area, including domestic, agricultural, industrial, recreational, and cold-water fisheries

Plan, implement, and evaluate BMPs that have been selected to improve water quality and beneficial uses of water in the project area

Demonstrate the water quality effects of nutrient and pesticide management, irrigation water management, and streambank stabilization as BMPs for surface and ground water protection

Educate the general public about the importance of water quality

Develop positive community attitudes toward the importance of water quality

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 325,100 acres
Project Area: 197,000 acres
Critical Area: 60,242 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 21.5 inches; about 14.5 inches of irrigation water is needed to grow corn.

Geologic Factors: The watershed is underlain by shale and sand stone. Topography is diverse, ranging from nearly level to steep. Most of the watershed is covered by a blanket of eolian sand material. Soils are predominantly silts and sands.

4.3.2.2.3 Project Area Agriculture

The primary agricultural activities are ranching and irrigated corn production, with some production of popcorn, soybeans, and alfalfa.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland (corn and alfalfa):	NA	18
Pasture/range:	NA	81
Woodland:	NA	-
Urban/roads:	NA	1

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	3	140	196
Beef	12	25,500	25,500
Hogs	5	1800	720

4.3.3 Total Project Budget (as of 4/91)

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	857,540	0	265,069	0	1,122,609
Info. and Ed.	230,605	0	0	0	230,605
Tech. Asst.	422,659	0	0	0	422,659
Water Quality Monitoring	300,000	297,850	0	0	597,850
SUM	1,810,804	297,850	265,069	0	2,373,723

Source: Hermsmeyer et al., 1991

4.3.4 Information and Education

4.3.4.1 Strategy

The I&E program was directed at informing the eligible landowners of the available RCWP BMPs and the landowners' responsibilities under their RCWP contracts. Particular emphasis was given to irrigation scheduling, fertilizer management involving deep soil testing, and pesticide management using Integrated Pesticide Management (IPM) techniques. The I&E efforts were directed towards landowners and farm operators in the critical area, fertilizer and chemical dealers, the general public, and schools and youth groups.

The CES took the lead role in developing and implementing the I&E components of this project. SCS assisted with the development water quality plans and by providing technical assistance.

4.3.4.2 Objectives and Goals

Increase public awareness of water quality concerns

Educate the general public about the importance of water quality

Coordinate project-related information flow between federal, state, and local agencies

Support and encourage implementation of appropriate BMPs outside the project area

Promote a good working relationship between the local agricultural community and state and federal agencies involved in the RCWP

4.3.4.3 Program Components

Workshops

RCWP quarterly newsletter entitled "Long Pine Rural Clean Water Program Newsletter"

Field tours and demonstrations to study the effectiveness of fertilizer, pesticide, liming, and water management. The CES used a 50-acre demonstration farm to display and test and demonstrate these BMPs.

Survey of land users' attitudes about the effectiveness of the I&E program and the RCWP

Secure adequate media coverage, including the production and viewing of three videotapes, two of which appeared on Nebraska Public Television.

An Integrated Pest Management (IPM) Association was formed in 1983 and provided field scouting, a IPM newsletter, IPM training sessions in identification of pests, weather and soil temperature reports, alerts to potential insect problems, and recommended application methods and rates of herbicides and pesticides.

4.3.5 Producer Participation

4.3.5.1 Level of Participation

4.3.5.2 Incentives to Participation

Cost Share Rates: 75%

Payment Limitations: $50,000 per farmer

Availability of cost share funds

Perception that increased farm production would result from implementation of RCWP BMPs

Fertilizer management, demonstrated through CES workshops and demonstrations, was widely adopted as producers realized they could save $10 to $40 per acre without sacrificing yields.

4.3.5.3 Barriers to Participation

The most important reasons farmers decided not to participate were economic conditions and costs. Not wanting to be told how to farm was given as the second most important reason.

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

About 70 to 100% of the critical area BMPs were maintained after the RCWP contracts expired. Maintenance could have been improved if additional funds were available for this purpose. The BMPs most often not maintained were fertilizer and pesticide management, cedar revetments, rotational grazing, and streamside fencing. Fertilizer and pesticide management had the widest adoption rate for non-RCWP participants.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The project emphasized a system of erosion control and stream protection BMPs. Land treatment emphasis was placed on irrigation water management, grazing land protection, diversion systems, streambank stabilization, and fertilizer and pesticide management. Irrigation water management was used to minimize the total water usage, thereby reducing pollutants entering the streams and ground water. The major components used for irrigation water management were the installation of irrigation tailwater recovery (re-use) systems and the construction of a secondary storage reservoir. Cedar revetments were constructed to stabilize streambanks. The revetments consisted of dried cedar trees that were secured by cable and steel fence posts to the streambanks. Reed canarygrass seed on top of sediment trapped by the revetments was used to further stabilize the streambank. Fencing, in combination with providing alternative water supplies, was used to exclude cattle from the riparian areas. Emphasis on fertilizer and pesticide management is a key factor in dealing with ground and surface water problems simultaneously.

The project had applied to have a one million dollar sediment structure built on Sand Draw. The structure was never funded because the project could not demonstrate the on-farm water quality benefits and justify expenditure of RCWP funds. After denial of the structure was final, the project concentrated on irrigation water management and streambank stabilization.

Roadside Critical Area Treatments (CAT) were installed to reduce roadside erosion in the project area. These were not funded under RCWP, but by the North Central Nebraska Resource Conservation and Development USDA program through SCS, MNNRD, and Brown County.

4.3.6.2 Objectives and Goals

Reduce streambank erosion

Reduce the delivery of sediment from agricultural lands

Reduce the deep percolation of irrigation water contaminated with fertilizers and pesticides

Reduce excess irrigation water runoff

Reduce agricultural NPS pollution from feedlots

Quantified Implementation Goals: 75% of the critical areas

4.3.6.3 Critical Area Criteria and Application

Criteria: High erosion rates and proximity to waterways, specifically:

Streambanks or gullies with active erosion

Center pivot irrigated cropland with greater than 5T/acre/year soil loss

Rangeland in poor or fair condition

Application of Criteria: Contracts were primarily being applied to the critical areas; however, little priority was given to the order or selection of BMPs.

4.3.6.4 Best Management Practices Used

BMPs Utilized in the Project*:

Permanent vegetative cover (BMP 1)

Animal waste management system (BMP 2)

Diversion system (BMP 5)

Grazing Land Protection (BMP 6)

Waterway system (BMP 7)

Cropland protection system (BMP 8)

Conservation tillage system (BMP 9)

Stream protection system (BMP 10)

Permanent vegetative cover on critical areas (BMP 11)

Sediment retention, erosion, or water control structures (BMP 12)

Improving irrigation system and / or water management system (BMP 13)

Tree Planting (BMP 14)

Fertilizer Management (BMP 15)

Pesticide Management (BMP 16)

*Please refer to Appendix I for description/purpose of BMPs

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

Cost shared and non-cost shared land BMPs were compiled to reflect units installed and acres served on a subwatershed and annual basis (Hermsmeyer et al., 1991).

4.3.6.5.2 Data Management

Data are collected by SCS, CES, and ASCS. ASCS maintains the land treatment records and prepares reports.

Procedures for consistent documentation of land treatment / land use and cost share information were not clearly defined at the project beginning. These data bases should be maintained on a subwatershed drainage scale so that they can be linked with the water quality data base. Consistent definitions for critical acres and acres served were not established at the project initiation, making compilation of acres served in each subbasin by year difficult.

4.3.6.5.3 Data Analysis and Results

The ground and surface water monitoring program used in this project aided in prioritizing portions of the watershed for critical area definition. Originally, the streambank erosion in the headwaters of Long Pine Creek was the primary source of sediment. Monitoring and geologic investigations revealed that streambank erosion in both Sand Draw and Bone Creeks was the major contributor.

4.3.6.5.3 Data Analysis and Results (continued)

The Ainsworth irrigation district secondary storage reservoir, upstream of 33,000 acres of irrigated cropland, was completed in September of 1987 using pooled funds from 10 RCWP cooperators. The reservoir reduces the volume of irrigation water applied by an estimated 2,000 acre-feet annually for gravity-irrigated cropland in the critical area, and therefore, reduces the amount of irrigation waste water and associated sediment delivered to the creeks by as much as 28,000 tons of sediment per year.

Stream protection using cedar revetments was one of the most innovative and successful practices implemented under the RCWP. As of April, 1991, 19,000 feet of revetments had been constructed. Combined with grazing land protection and fencing, the revetments successfully decreased streambank erosion and provided habitat for trout and other wildlife. Project personnel developed several innovations to overcome difficulties in implementing cedar revetments. To prevent beaver damage, the cedar trees had to be cut and dried up to a year before use. Reed canarygrass seed was broadcast or placed as sod on top of sediments trapped by the revetments to prevent damage by heavy rains and runoff.

Over half of all cost share funds were spent on irrigation and water management; 21.8% was for the Ainsworth Irrigation District secondary storage structure. The rest centered on tailwater recovery. Sediment and chemicals were prevented from entering surface waters when the irrigation runoff was collected and then reused. This recycling of runoff saved energy and dollars in addition to reducing the amount of sediment entering streams.

The small sediment control dams constructed under BMPs were more cost-effective than the cost of the large structure that was not approved for Sand Draw.

The MNNRD's drop structure is attempting to address the headcutting in Long Pine Creek.

Fertilizer and pesticide management were widely adopted outside the critical area. As a result of deep soil sampling and irrigation scheduling, fertilizer use was greatly reduced throughout the watershed.

An Integrated Pest Management (IPM) Association involving field scouting resulted in a large reduction in pesticide use.

Improvements to both the Ainsworth and Long Pine sewage treatment plants have occurred so that the plants now comply with USEPA and state standards.

Feedlots continue to contribute pollutants to Long Pine Creek. Opportunities exist to reduce fertilizer use by transferring manure from large feedlots (defined by the state as point sources) to RCWP-participating farms. RCWP cost share was not available for feed lot improvement due to the classification of feedlots with greater than 1,000 units as point sources under Nebraska law.

Streambank erosion continues to be a problem in Sand Draw and Bone Creek.

Quantified Project Achievements:

		Critical Area	
Pollutant Source	Units	Total	% Implemented
Cropland	acres	11,000	71%*
Pasture	acres	49,242	71%
Dairies	#farms	2	100%
Feedlots	#	2	100%
Contracts	#	86	98%

* Contracts were written on 71% of critical area.

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The basic strategy is to monitor surface and ground water before and after BMP implementation. Upstream - downstream monitoring stations were utilized in the tributaries and on Long Pine Creek to account for changes upstream of BMP implementation. The Nebraska Department of Environmental Control (NDEC) performed pre-BMP water quality monitoring from 1979 through 1985 to provide the baseline data and identify priority tributaries for BMP emphasis. A three-year post-implementation phase began in the fall of 1992. These data will be compared with the pre-implementation data in order to evaluate BMP effectiveness on subwatershed and project level scales. Biological, habitat, chemical, and physical monitoring are being used to directly monitor fish habitat in streams and demonstrate improvements in recreational fishing in Long Pine Creek.

Water quality monitoring was performed by the NDEC with the assistance of SCS, NGPC, CES, MNNRD.

4.3.7.2 Objectives and Goals

Objectives:

Document the magnitude of surface and ground water quality problems

Demonstrate the water quality effects of nutrient and pesticide management, irrigation water management, and streambank stabilization as BMPs for surface and ground water protection

Pre-BMP Implementation Monitoring Goals:

Document pre-BMP water quality conditions

Identify existing water quality problems, including any areas where surface-water-quality-dependent beneficial uses are impaired by land use activities

Identify and prioritize areas where BMP installation will have the greatest effect

Provide baseline data for evaluation of site-specific BMPs and changes in water quality

Post-BMP Implementation Monitoring Goals:

Determine if there is any change in ambient surface water quality from pre-implementation conditions in Long Pine Creek, Bone Creek, Sand Draw, and Willow Creek

Determine if a primary contact recreation use is attainable on the lower reaches of Bone Creek based on the physical conditions and current public utilization of the stream

Determine the frequency of water quality criteria violations and the level at which the appropriate beneficial uses are supported in streams within the project area

Determine at what level salmonid spawning is currently supported in Long Pine and lower Bone Creeks based on embryo survival in artificial redds

Determine if the macroinvertebrate population (i.e., taxa present, frequency of occurrence, number of individuals, diversity, and pollution tolerance) in Long Pine and Bone Creeks has significantly changed from pre-implementation conditions due to the implementation of BMPs

Determine if the fishery population (i.e., taxa present, frequency of occurrence, diversity, and pollution tolerance) in Long Pine Creek, Bone Creek, and Sand Draw has significantly changed from pre- implementation conditions due to the implementation of BMPs

Determine if the salmonid population (i.e., standing crop, size class composition, and condition factors) in Long Pine Creek has improved from pre-implementation levels due to the implementation of BMPs

4.3.7.2 Objectives and Goals (continued)

Determine if the project implemented by the MNNRD to control headcutting in the upper reaches of Long Pine Creek is effective in reducing sediment delivery from this source

Determine the combined effect of implementing BMPs (cedar revetments, other streambank stabilization measures, and control of headcutting) on fishery habitat and sediment delivery in upper Long Pine Creek

Determine the change in trends in the suspended solids, substrate composition, and bacterial levels in Long Pine Creek due to the implementation of BMPs and feedlot controls

Determine if summer water temperature and instream habitat still restrict the potential for cold water fisheries in the lower reaches of Long Pine Creek

Determine the change in trends in suspended solids, substrate composition, bacteria, nutrients, organic waste, and water temperature in Bone Creek due to the implementation of BMPs and feedlot controls

Determine the change in trends in suspended solids, substrate composition, and water temperature in Sand Draw due to the implementation of BMPs

4.3.7.3 Time Frame

Surface Water:
All sites (except LP8): July 1979 - 1985 and 1992 - 1994
United States Geological Survey (USGS) gauge site near project outlet on Long Pine Creek (LP8): July 1979 - October 1989 and January 1991 - 1994

Ground Water: 1982 - 1994

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

Surface Water: 11 sites on Long Pine Creek, Bone Creek, Willow Creek, and Sand Draw (see project map) / runoff event data are collected at 6 surface sites (LP1, LP7,, LP8, BN1, BN3, SD2)

Ground Water: Varying numbers and locations of irrigation and domestic wells were sampled each year (approximately 4-20 of each well type) from a total of 67 different wells.

Streambank erosion: 4 sites to evaluate the magnitude of erosion reduction effectiveness of cedar revetments and upstream movement of the headcut

4.3.7.4.2 Sample Type

Grab

Flow actuated automatic samplers for runoff sampling

4.3.7.4.3 Sampling Frequency

Surface Water: monthly (bimonthly during winter) for baseline samples, composite samples during runoff events, fish and macroinvertebrate samples were collected 2-3 times/year

Ground Water: annually in July or August when the aquifer is used for irrigation / Each well was sampled 1 to 8 times over the project period.

Streambank erosion sites: annually

4.3.7.4.4 Variables Analyzed

Surface Water:

Total suspended solids (TSS), fecal coliform (FC) bacteria, fecal Streptococcus bacteria, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), suspended solids (SS), total dissolved solids (TDS), total organic carbon (TOC), conductivity, nitrate-nitrite- nitrogen (NO_3+ NO_2-N), ammonia-N (NH_3- N), total phosphorus (TP), chloride,, dissolved calcium, dissolved sodium, magnesium, total organic carbon, pH, and water temperature

Biological monitoring (fish, macroinvertebrate, and periphyton, and bacteria) sampling, aquatic habitat (flow, substrate composition, cover), and riparian conditions along stream at 7 sites

Addition Surface Water Variables During Post-BMP Monitoring:

Artificial redds to assess spawning success in Long Pine and Bone Creeks. A site on the Snake River will be used as a reference cite.

Stream morphology characteristics of width, depth, velocity, and gradient measured annually

Ground Water:

NO_3-N, 14 pesticides including atrazine, conductivity, pH, TP, total organic carbon, sodium, chloride, calcium, magnesium

4.3.7.4.5 Flow Measurement

Stream discharge is recorded with all grab samples / runoff event data are collected at 6 surface sites (LP1, LP7,, LP8, BN1, BN3, SD2)

4.3.7.4.6 Meteorologic Measurements

Precipitation is measured at 4 sites (LP1, LP8, SD1, and Ainsworth Airport).

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

There is interest in assessing the contact recreational potential at Keller Park State Recreation Area on Bone Creek. Bacterial levels and ambient water quality in Bone Creek was investigated in a special interim project study. Monthly samples were collected from November, 1989 through March, 1990; weekly samples were collected from April through October, 1990. The objective was to evaluate the impact of feedlots near the stream. Several feedlots upgraded their livestock waste systems in the 1980's, which is hoped to have reduced pollution from these sources. However, the City of Ainsworth is not currently required to disinfect their effluent which discharges into Bone Creek.

During the post-BMP monitoring period, a recreational use attainability study on lower Bone Creek near the State Recreational Area will be conducted.

4.3.7.5 Data Management

All surface and ground water chemical and biological data are stored locally at the Nebraska Department of Environmental Control, Lincoln, NE. All data collected prior to 1986 were reported by Maret (1985). Ground water data for all years and wells are tabulated in the 10-Year Report (Hermsmeyer et al., 1991)

Both surface and ground water monitoring data are stored in STORET. The biological data have been entered into BIOS, a companion data base to STORET. The BIOS agency and station codes are the same as those used for STORET. For a description of the biological variables measured at each station, see Maret (1985).

STORET AGENCY CODE	STORET STATION NO.	PROFILE / STATION MAP / NO.
Surface Water Monitoring Stations		
21NEB001	LP0001	NE-1 / LP1
"	LP0005	NE-1 / LP5
"	LP0007	NE-1 / LP7
"	LP0008	NE-1 / LP8
"	BN0000	NE-1 / BN
"	BN0001	NE-1 / BN1
"	BN0002	NE-1 / BN2
"	BN0003	NE-1 / BN3
"	SD0001	NE-1 / SD1
"	SD0002	NE-1 / SD2
21NEB001	W0001	NE-1 / W1
"	LPR001	NE-1 / Rainfall collected near LP1
"	LPR007	NE-1 / Rainfall collected near LP7
"	LPR008	NE-1 / Rainfall collected near LP8
"	BNR001	NE-1 / Rainfall collected near BN1
"	BNR003	NE-1 / Rainfall collected near BN3
"	SDR02B	NE-1 / Rainfall collected near SD2

The STORET agency code is 21NEAGO1. The STORET station code is of the form "LPGWnn" where 'nn' is the well number. The RCWP project has wells 1 through 64 with this naming convention. There are 3 Health Department wells that are used in the RCWP reports, but these wells are not in STORET.

4.3.7.6 Data Analysis and Results

Analysis:

Exploratory data analysis includes tabular presentation of the data, time plots, and calculation of minimum, means, medians, maximums, and standard deviations for water quality concentrations at each site over the pre- implementation period.

Water quality index values are calculated using weighted values of DO, pH, NO_3-N, NH_3-N, suspended solids, and conductivity. Species diversity and biotic indices were calculated with macroinvertebrate data.

Surface water quality data are compared to the Nebraska Surface Water Quality Standards.

4.3.7.6 Data Analysis and Results (continued)

After the post-BMP monitoring is complete, the project plans additional analyses including:

Comparing mean values, frequency distributions, and probability of standard violations between the pre- and post-BMP periods

Analyzing for significant linear and monotonic trends

Evaluating changes in flow/water quality relationships following BMP implementation

Comparing the pre- and post-BMP values after correcting for flow and rainfall using the analysis of covariance technique

Examining the relationship among several quantitative variables using principal component analysis

Trend analysis for changes in NO_3-N in ground water was performed using data from a selected group of ground water wells that had at least 3 years of data and where monitoring started prior to 1984. Trend analysis was difficult in most cases because different wells were sampled in different years.

Results:

Surface water quality of Long Pine Creek has visually improved, especially below the confluence with Bone Creek.

The surface and ground water samples reported for 1979 to 1985 were considered pre-implementation or baseline data. Analysis of baseline data identified impaired beneficial uses and helped in targeting the locations and types of needed BMPs.

The pre-BMP water quality monitoring identified the priority subwatersheds of Sand Draw and Bone Creek for BMP emphasis. Based on the water quality results, it was recommended that emphasize be placed on installation of streambank protection and habitat improvement structures in the upper reaches of Long Pine Creek. Emphasis of BMPs which reduce the delivery of runoff into streams was also recommended.

Baseline water quality data will serve as a comparison when the post-BMP implementation water quality analysis is performed (Maret, 1985).

Recreational use in the project area has been steady since 1976. Fishing in the project area continues to be impaired by high sediment levels.

The presence of high nitrate concentrations in both irrigation and domestic wells has been documented. About 10% of the samples were above the drinking water standard of 10 mg/l. A trend of increasing nitrate concentrations has been identified in some irrigation wells. No significant trend was observed in the domestic wells. The irrigation wells are a better source of regional water quality information compared to domestic wells; however, local contamination may still be a concern. Chemical accidents may have caused high levels of nitrate-N in some wells.

Low levels of atrazine (about 0.1-0.2 ppb) were found in one to two wells per year. Trifluralin, alachlor, cyanide, and metolachlor have also been detected in a few samples.

4.3.8 Linkage of Land Treatment and Water Quality

The project has estimated significant reductions in sediment delivery to Long Pine Creek. They estimate that streambank stabilization and tailwater recover systems have reduced sediment load. Six roadside Critical Area Treatments (CATs) are estimated to have reduced sediment loadings by 19,000 tons annually. The Ainsworth Irrigation District secondary storage reservoir has the potential to reduce sediment delivery by 28,000 tons per year. In addition, the MNNRD's drop structure addressing the headcutting in Long Pine Creek could prevent an additional 1,500 to 2,000 tons of sediment delivery.

Installation of stream protection measures has improved the instream trout habitat and may have increased the trout carrying capacity of Long Pine Creek. Using site-specific evaluations, the project NGPC and SCS staff estimate that the mean carrying capacity of Long Pine Creek has increased from about 75 lb/acre to about 119 lb/acre, a 58% increase (Hermsmeyer et al., 1991).

The project has estimated significant reductions in pesticide and fertilizer use, but does not have an estimate on the corresponding impact on ground water quality. The lag time for a measurable response in the ground water may be years.

The project has not completed its post-BMP monitoring. Analysis of the water quality and land treatment data will occur in 1995.

Changes in annual land use were significant and need to be incorporated into the final analysis to allow valid interpretations to be made.

The project has documented land treatment changes on a subwatershed scale which should facilitate the analysis. The Nebraska project took the initiative to revise their land treatment data base near the end of the projects in order to more effectively link their land treatment and water quality data bases. This after-the-fact data base creation required a lot of effort and some useful information was lost. The project had no consistent procedure established for the collection of land treatment data on a subbasin basis that would allow the land treatment information to be directly linked to the water quality monitoring. Delineation of subbasins, as defined by the land drained to the water quality monitoring stations at the tributary outlets, were not utilized during the implementation period for recording land treatment progress. In addition, consistent reporting procedures were not utilized for identifying critical acres and acres served. Reconstruction of the ASCS and SCS files that quantified BMP implementation in the critical acres on a subbasin and annual basis was required.

Documentation of non-RCWP land use changes and activities is sketchy.

4.3.9 Impact of Other Federal and State Programs on the Project

The project felt that the 1985 Farm Bill had a positive effect on the implementation of conservation practices by alleviating economic stress using subsidy payments with the constraint of having a conservation plan.

However, the 1985 Farm Bill competed with the SCS personnel time available to implement the RCWP. The CRP program, Highly Erodible Land (HEL) identifications for each cropland field, conservation plan preparation, and the RCWP all competed with a limited amount of SCS staff time available.

Federal farm programs had a large effect on changes in annual land use. These federal programs are adjusted annually, based on grain stocks on hand. These programs changed annual acres in grain, the amount of chemicals applied to land, and the amount of water needed to irrigate cropland.

Nebraska law defines feedlots with over 1000 animal units as permitted point sources. Feedlots were not eligible for RCWP cost share.

4.3.10 Other Pertinent Information

None

4.3.11 References

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

Hermsmeyer, B., D. Jensen, and M. Link. 1991. Nebraska Long Pine Creek Rural Clean Water Program Ten Year Report 1981-1991. Brown County Agricultural Stabilization and Conservation Service (ASCS), Ainsworth, NE. 275p.

Maret, T. 1985. Water Quality in the Long Pine Rural Clean Water Project 1979-1985. Nebraska Department of Environmental Control, P.O. Box 94877 - Statehouse Station, Lincoln, NE. 194p.

4.3.12 Project Contacts

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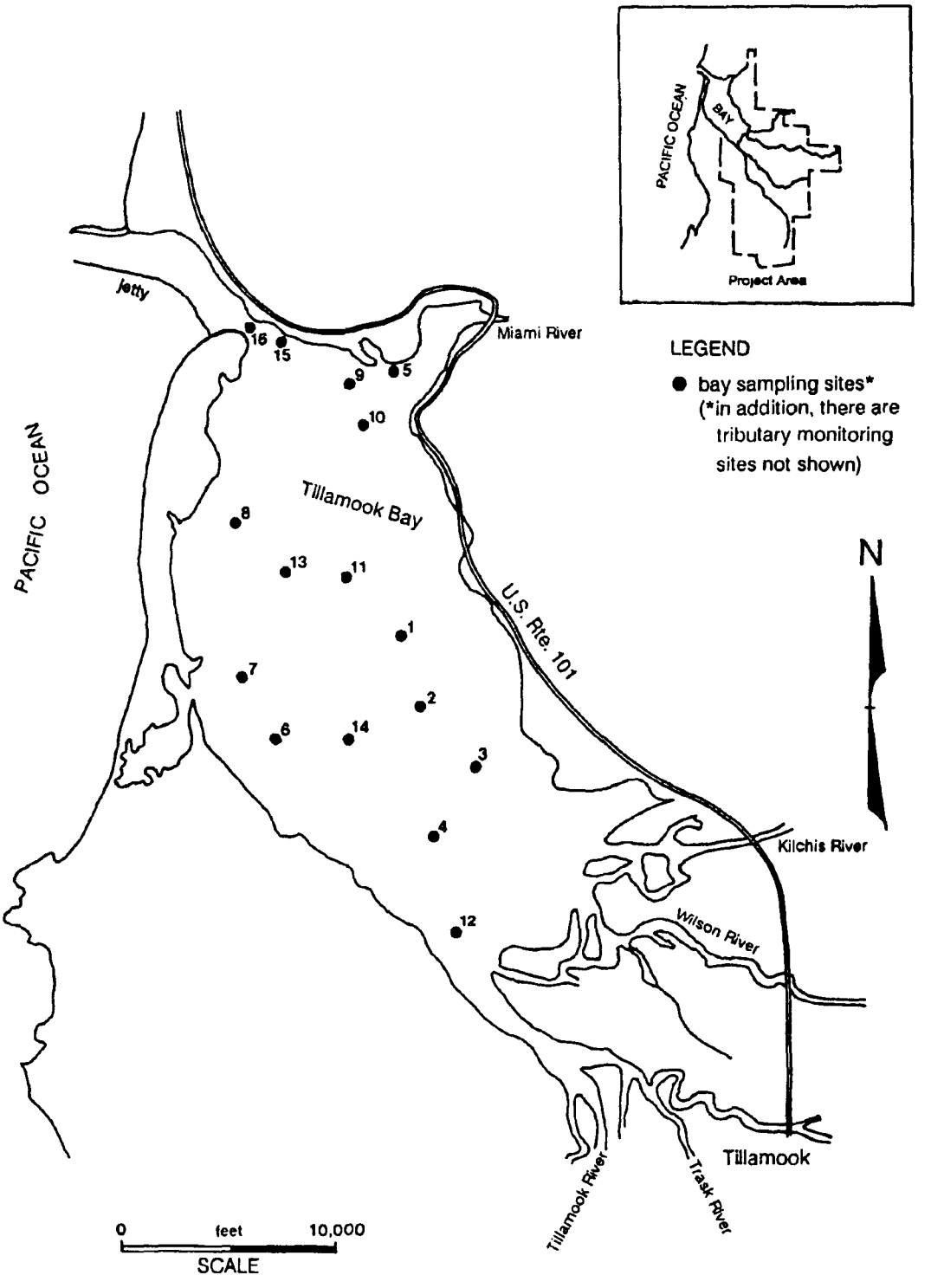
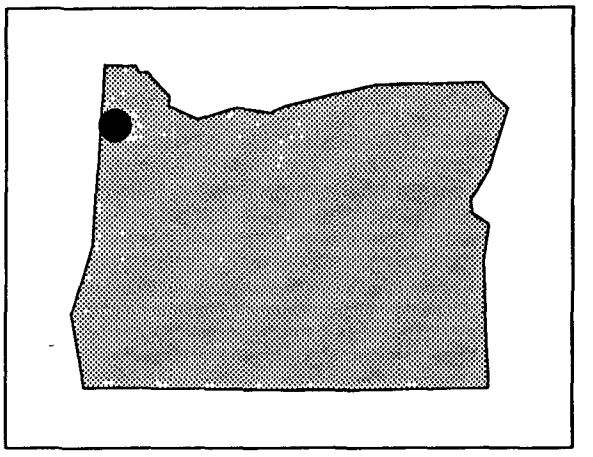


Figure 4.15: Tillamook Bay (Oregon) RCWP project map, OR-1.

Oregon
Tillamook Bay

(RCWP 18)



Tillamook County
MLRA: A-1
HUC: 171002-03

4.1 Project Synopsis

Located in northwest Oregon, Tillamook Bay is bounded on the east by the Coast Mountain Range and on the west by the Pacific Ocean. Five watersheds consisting of 363,520 acres drain to Tillamook Bay. This high rainfall area receives 90 to 150 inches of rain per year. Agricultural lands comprise 23,540 acres of the watershed. The land is used for pasture, hay, and silage production for the dairy herds that occupy the lowlands adjacent to the bay and its tributaries.

Water quality impairment is due to high fecal coliform levels caused primarily by manure in runoff from the dairy farms, which occupy 7% of the drainage basin and produce about 322,500 tons of manure annually. High fecal coliform levels were causing potential health hazards, and negatively affecting the commercial oyster industry, recreational clam digging, fishing, boating, and other tourist activities. Many of the oyster beds were closed periodically due to excessive coliform levels. The primary objective of the project was to reduce fecal coliform levels by 70% in order to reduce the deleterious effects being caused to the oyster and tourism industries.

Of the 122 dairy farms, implementation of best management practices (BMPs) on 109 farms was considered critical for the project's success. This included 8,723 acres (37%) of agricultural lands. Throughout the project period, there was a continued upward revision in the number of dairies needing treatment until 102 dairies were contracted. As a consequence, land treatment installation will continue to the end of the project, 1996. As of December 31, 1990, BMPs had been implemented on only 48% of the contracted critical acres.

All installed BMPs were targeted toward manure storage and management. Many of the practices utilized by this project were added to address the specific manure management needs imposed by the unusual climatic conditions and are unique to this project.

The general water quality monitoring strategy was to gather data that would describe the condition of Tillamook Bay and its tributaries relevant to water quality standards and beneficial use. The number of tributaries sampled and the sampling frequency changed over the course of the project from quarterly sampling to monthly sampling. These changes hindered the project team's ability to detect trends in the measured parameters.

Although the number of oyster bed sites restricted under Food and Drug Administration (FDA) classification criteria has been cut in half, from 12 to 6, it is still too early to make a final assessment of Rural Clean Water Program (RCWP) project results. Continued water quality improvements are expected to occur for a number of years as all BMPS are installed and as operators develop management techniques to utilize implemented and installed BMPs.

The strategy of this project was very clear to everyone: keep the water off the manure and keep the manure from entering the waterways. However, agency officials were unaware at the beginning of the project that this would mean treating the majority of the farms in the project area. There was excellent coordination among governmental and private agencies as evidenced by the high rate of participation. At the beginning of the project, farmers were aware that if they did not solve the problem, they could very well be regulated by the state. Since all BMPs are not yet installed and because water quality sampling frequency changed during the course of the project, water quality monitoring will have to continue for many more years in order to determine how successful the project has been.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

The overall goal of reducing fecal coliform by 70% during the original project period (1980-1990) was too optimistic because neither the magnitude or the complexity of the problem was understood at the beginning of the project.

The overall goal of measuring changes in water quality was appropriate. However, the water quality monitoring frequency changed during the course of the project. It was not possible to demonstrate long-term trends in the bacteria data. This may be due, in part, to the reduced sampling frequency.

Objectives and goals in the information and education (I&E) as well as land treatment aspects of the project were appropriate and attainable.

4.2.1.2 Recommendations

Before project initiation, critical areas must be defined accurately, even if this means visiting all farms during the wet season.

Statistical or modeling tools should be used to help establish realistic and achievable goals.

Water quality monitoring should be extended past the life of the project in order to document water quality changes.

Monitoring goals and objectives should be clearly defined prior to the project start-up and should be consistent with available, stable, funding levels.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

Organizationally, the Local Coordinating Committee (LCC) was comprised of 13 diverse agencies or groups. The LCC developed criteria for prioritizing producer water quality plans and assisted in monitoring project plans (Tillamook Bay RCWP Project, 1991). Local program administration was exemplary.

Computerization of project activities was found to be extremely useful in planning, implementation, administration and workload analysis functions.

The State Coordinating Committee (SCC) provided assistance to the LCC when needed. The SCC was instrumental in obtaining support from the NCC for both modifying particular BMPs and adding new BMPs. Cooperation among the federal, state, and local agencies was excellent and was critical to successful project implementation.

National RCWP project application guidelines were not well defined when the program was first announced.

4.2.2.2 Recommendations

Future programs should be announced in advance with clear project application guidelines so that agencies preparing applications will know exactly what information is required.

At the national level, a procedure for transferring project funds to cooperating agencies is needed in order to insure smooth and efficient program administration at the state level.

For future projects, agencies responsible for administration, planning, implementation, and water quality data should have computer networking capabilities. This would enhance overall project management, reports, program redirection, and project evaluation.

Local leadership and cooperation is critical to any project's success.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

A continuous and coordinated information and education (I&E) effort was difficult to conduct because of budgetary problems within the Cooperative Extension Service (CES) at the county level. Many of the I & E activities were assumed by the other agencies including the CES at Oregon State University. Once the county budget was restored, the county CES again took responsibility for I & E activities.

Manure management practices required more I & E than did structural changes or additions; manure management education is still continuing.

The Tillamook County Creamery Association (TCCA), a private creamery, supported the project from the beginning and made major contributions. Information about the RCWP project frequently appeared in TCCA newsletters sent to all farmers. The TCCA field representative explained the program to many of the farmers in an attempt to involve them in the project. In addition, the TCCA had the ability to discount milk prices paid to producers who did not correct pollution problems.

Other I&E activities for farmers included newsletters, brochures, TV and radio spots, and newspaper and other publications. The newsletter was not as effective an I&E tool as personal contacts, but it appeared to be more effective than radio and TV spots. Tours were conducted for financial lending agencies in order to educate them about the project and help participants obtain their share of the BMP installation expense. Slide shows and displays were effective in informing the general public about the project. A workshop was held to discuss RCWP with potential BMP contractors.

In this area, where farmers live within a twenty-mile radius of each other, peer pressure worked as an incentive.

Structures implemented during the initial phases of the project have served as important educational tools for other area farmers, enabling them to see implemented and functioning BMPs.

One of the most effective I&E approaches was for farmers to show the manure runoff problem during wet weather to other farmers.

4.2.3.2 Recommendations

Regional financial institutions must be educated about RCWP and similar programs.

Private business, in this case the Tillamook County Creamery Association, can play a pivotal role in farmer education and compliance.

State and county governments must be required to continue funding for each project element (such as I&E) if it is still needed and the project is worthwhile.

I&E for many management practices should be extended past the end of the project if full benefits of the BMPs are to be derived.

There is no substitute for one-to-one contacts to gain participation and complete contracts.

Agricultural and water quality agency personnel should work together closely on designing, publicizing, and implementing the nonpoint source (NPS) pollution control program to ensure a high level of farmer participation.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

Producer participation was greater than expected. At the end of the project, of the 109 dairy farms designated as needing BMPs, 102 (94%) of the farms were under contract with RCWP and an additional three farms were under Agricultural Conservation Program (ACP) contracts, thus bringing the contracted farm total to 96%. Because contracting has been ongoing, only 43% of the critical dairy operations, representing 48% of the critical acres, have been treated to date. This represents 193,595 tons (60%) of the manure produced within the Tillamook Bay Drainage Basin (Tillamook RCWP 10 Year Report, 1991).

Implementation of some BMPs were delayed because of high interest rates during the 1980's and the 1982 Omnibus Budget Reconciliation Act, both which limited cash flow and participants' ability to pay for their portion of the BMPs.

4.2.4.2 Recommendations

A U.S. Department of Agriculture (USDA) program is needed to assist participants in financing their portion of the BMP installation costs. A low interest loan program would reduce the contracting time frame for BMP installation and maintain agricultural producers' cash flow requirements.

The combination of financial incentive and environmental regulation can used effectively to achieve high rates of participation.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

Although eight BMPs were utilized on area farms, the majority of money and most of the project efforts were directed toward animal waste management systems (BMP 2). Traditional BMPs were not adequate to solve manure runoff problems. The project and state technical staff developed special methods for manure storage. Additional practices that diverted water from the manure (such as curbing, conduits, down spouts, roofs, etc.) were added to the list of BMPs approved for cost share and used by area farmers.

For dry storage, a roofed area with paving was built onto the barn. Paving allowed for daily scraping which was essential. Wet storage systems consisted of a below-ground storage tank in the barn. The effluent was pumped to above-ground storage areas located outside. Because of the high water table in the area, a special design was needed for these storage tanks. The SCS, the farmers, and the Agricultural Stabilization and Conservation Service (ASCS) had to work closely together to design a system that fit farm operations, that was structurally sound, and that was affordable.

Diverting the water from accumulation areas was found to be more cost-effective than collecting and storing contaminated rainwater. Implementation of some components of BMP 2 were delayed while SCS designed large-volume liquid and solid manure storage facilities.

A manure management system that included both storage and utilization of manure was found to be necessary. Each component of the manure management system was based on site specific requirements and participants' preferences.

The high rate of land treatment implementation is credited to the SCS technicians' willingness to communicate with farmers.

Although critical land area remained the same during the project, the number of farm units considered critical almost doubled. Prioritizing of RCWP applications was facilitated by the use of a rating system based on twelve different factors. This increase in the number of farms considered critical has caused a lag in implementation.

A computer shared by the various agencies, originally purchased to accelerate project activities, tended to hinder activities because there were too many users. The problem was resolved with the installation of computers by all agencies during the last few years of the project.

4.2.5.1 Findings and Successes (continued)

Changes in local and/or state regulations during project implementation affected the implementation process. Tillamook County began requiring agricultural building permits eight years after the project started. The State of Oregon also required confined animal feeding permits starting in 1990. These changes resulted in additional reviews prior to BMP implementation.

Annual status reviews by the SCS were the primary method for BMP tracking. During the first five years of the project, some reviews were not completed due to the heavy workload. ASCS spot checked BMPs to ensure adequate maintenance and management.

4.2.5.2 Recommendations

BMP systems must be modified at the local level. The agricultural industry and potential participants must be involved in BMP selection.

Local decision makers must have flexibility in choosing BMPs for cost share. Traditional practices may not be technically adequate to solve all water quality problems.

Rather than pricing the whole BMP, components of the BMP should be priced. This allows for better accounting and identification of inflated pricing.

An adequate technical staff must be available. The Tillamook Project, with 102 farms under contract, could not be efficient with less than a soil conservationist, a soil conservation technician, and a civil engineer in addition to the district conservationist. Agency personnel must be trusted by the farmers and must be viewed as "advocates" rather than "enforcers".

Local decisions about handling contract violations must be supported at the state and national levels for consistency of enforcement. Otherwise, area farmers who are in compliance can become resentful toward those farmers who have not complied with contractual guidelines.

As individual farmers increase herd sizes, BMPs may become obsolete. For this reason, BMPs must be regularly re-evaluated and updated.

For future projects, it is recommended that agencies responsible for administration, planning, implementation, and water quality data have computer networking capabilities. This would enhance project management, reporting, program redirection, and project evaluation.

For future projects requiring a large planning workload, consideration should be given to allowing annual status reviews for ten-year contracts to start three years following plan development, except where substantial contract completion has occurred. This would allow for a more efficient use of project personnel.

Lessons learned from the RCWP projects need to be transmitted to the local Agricultural Conservation Programs (ACP).

Once animal manure systems are installed, different management is required. BMP installation can be accomplished within a short period of time, but proper management and maintenance of the systems are long-term commitments. Education is a continual process.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

Bacteria concentrations continue to exceed water quality standards at both bay and tributary sites. Concentrations remain significantly higher downstream of farm operations than upstream. Water quality improvements have likely occurred in Tillamook Bay and its tributaries, although statistically valid trends have not yet been successfully established using the current data sets. Comparison of worst case (wet weather) events indicate that maximum bacteria concentrations may have been reduced, although this observation is limited by the project's ability to compare only two events. Since over 50% of the BMPs contracted for have yet to be completed, the possibility exists that water quality improvements will be documented in the future.

4.2.6.1 Findings and Successes (continued)

It was difficult to demonstrate trends in this data because sampling frequencies changed during the course of the project and since bacteria data is inherently variable.

The minimum parameter set for which monitoring is needed includes fecal coliform bacteria, bay salinity, river flow, and rainfall. This allows for covariate analysis which is important in identifying other factors affecting bacteria concentrations.

The water quality monitoring program would have been strengthened by additional data on river levels and flood stage conditions in the basin which play an important role in determining fecal coliform levels.

4.2.6.2 Recommendations

Some measurable indicator of hydrologic state such as precipitation, stream flow, or salinity should be included in water quality monitoring programs attempting to identify water quality trends.

A pre-BMP water quality data base of at least two years duration greatly facilitates documenting water quality effects of BMPs.

Water quality monitoring activities must be adequately funded throughout the project period.

In order to be completely successful, the monitoring effort must receive adequate and stable staffing throughout the life of the project.

For trend detection, a minimum monitoring strategy should be established early in project planning and should then be adhered to throughout the project.

A monitoring strategy should include regularly spaced sampling on a predetermined schedule, at least a sub-set of trend detection sampling sites (i.e. monthly or even more frequent sampling).

Methods of data analysis should be chosen early in project planning in order to ensure that data sufficient for the anticipated analysis are collected.

Other sampling should be done in addition to, not instead of, the predetermined and scheduled trend sampling. Additional sampling might include intensive wet weather sampling, effectiveness monitoring, or up-stream/down-stream sampling.

Additional intensive monitoring studies, particularly during summer/fall runoff events, would be useful both for evaluating the effectiveness of installed practices and for identifying "hot spots" that need further monitoring.

Regular monthly sampling should continue beyond the contracting and BMP implementation phase of the project to allow for more complete long-term evaluation of the effects of the project. Improvements resulting from installation of manure management practices would be expected to continue for some period of time.

For the Oregon RCWP project, funding should be secured to perform additional data analysis (both of existing data and future data) after three to five more years of data are collected.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

The influence of BMPs on the water quality of Tillamook Bay is still inconclusive even though water quality improvements have likely occurred.

4.2.7.2 Recommendations

Increase sample frequency and regularity to improve the project's ability to correlate water quality changes with BMPs.

Thorough records of land treatment accomplishments are essential if water quality trends are to be linked to BMP implementation.

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1981 - 1996

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Tillamook Bay, estuaries, streams, and tributaries

4.3.2.1.2 Water Uses and Impairments

Water resources in the project area are used primarily for domestic consumption, recreation, and commercial shellfishing. Sport fishing throughout the watershed is a popular activity. Recreational clamming and angling in Tillamook Bay account for approximately 70,000 user-days per year. Commercial shellfishing in the bay is a $1.5 million industry (annual gross sales).

The shellfish industry is impaired by excessive fecal coliform (FC) levels in the bay. Shellfish harvesting has been closed down frequently during periods of high FC contamination and health hazards exist in tributaries where water contact recreation is popular.

4.3.2.1.3 Water Quality Problem Statement

Excessive FC bacteria in storm runoff from agricultural operations combined with sewage treatment plant discharges were contaminating shellfish and impairing contact recreation in Tillamook Bay. Site factors include very high rainfall and abundant dairy herds very close to a large commercial shellfishing area. Identified point sources of pollution, including a waste treatment plant and septic systems, were remedied during the project period.

4.3.2.1.4 Water Quality Objectives and Goals

Original Project Goals (Tillamook Bay RCWP Project, 1982):

30% reduction in sediment delivery from agricultural land in the critical area
70% reduction in fecal coliform bacteria entering the water courses

Revision of Goals (Tillamook Bay RCWP Project, 1983):

A national inter-agency team reviewed the project in 1983 and reported that 87% of the sediment reaching the bay originated from forest land. Since the vast majority of sediment was originating from non-agricultural land, the project goal of a 30% reduction goal in sediment delivery from agricultural land was dropped.

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 363,520 acres
Project Area: 23,540 acres
Critical Area: 8,723 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 90 - 150 inches

Geologic Factors: The watershed topography is extremely diverse. Moving west from the Coast Range, there are gently to steeply sloping rocky uplands, deeply incised canyons to flat and gently rolling flood plains. The coastline is largely sand dunes, beaches and sedimentary rock outcrops alternating with occasional rugged headlands of volcanic rock. Slopes range from 0 to 90%. Soils are varied, ranging from deep, well-drained coarse-textured bottomland soils with high permeability and slow runoff to well-drained, fine-textured upland soils with moderate permeability and medium to rapid runoff.

4.3.2.2.3 Project Area Agriculture

All agriculture in the project area consists of dairies. There are 122 dairy farms on 23,540 acres with approximately 22,000 head of cattle. Cropland production consists of pastures, and hay and silage fields. Feed grains are trucked in from outside the area. All milk is sold for cheese production to the locally-owned creamery cooperative, Tillamook County Creamery Association (TCCA).

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	-	-
Pasture/range	100	100
Woodland	-	-
Urban/roads	-	-
Other		

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	122	22,000	30,800

The number of animals rose from approximately 19,000 dairy cows in 1982 to 22,000 dairy cows by the end of the project.

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	5,262,292	0	2,484,304	0	7,746,596
Info. & Ed.	41,158	0	0	2,806	43,964
Tech. Asst.	812,415	0	0	122,375	934,790
Water Quality Monitoring	9,821	83,090	0	51,625	144,536
SUM	6,125,686	83,090	2,484,304	176,806	$8,869,886

Source: Tillamook Bay RCWP Project, 1990

4.3.4 Information and Education

4.3.4.1 Strategy

There were two specific information and education (I&E) strategies: 1) to create an awareness and understanding of the RCWP among participants and 2) to inform the general public about RCWP by stressing positive aspects of the project, including financial investments required of participants.

4.3.4.2 Objectives and Goals

Initial objectives were aimed at increasing public and producers' understanding of the RCWP program.

Final project objectives:

Focus producers' attention on the importance of proper management and maintenance of BMPs so water quality improvement will continue

Provide localized crop nutrient uptake data to producers so they will know when and how much manure to apply to their fields

Work to improve waste utilization by producers

Monitor reduction of agricultural pollution of Tillamook Bay and keep the public informed of progress

In order for the final I & E objectives to be met, there will have to be as much committed one-to-one contact between farmers and project personnel as there was during the project.

4.3.4.2 Objectives and Goals (continued)

Project I&E activities, goals, and achievements are listed in the table below.

I & E Activity	Project Goal	Achievements	% Completed
Major tours of project for news media, agency heads, political leaders, etc.	40	39	98
Project slide series	9	8	89
Project display booth	15	13	87
Meetings with participants	3	1	33
Talks to civic groups	48	37	77
Inter-agency meetings to evaluate progress and coordinate BMP implementation with water quality monitoring	20	19	95

4.3.4.3 Program Components

One-to-one contacts with producers

Newsletters

News media spots (radio, news articles and TV spots)

Slide series

Display booth

Tours

Talks to civic groups

Some of the I & E components were aimed specifically at the participants, whereas other I & E components were aimed at the general public.

4.3.5 Producer Participation

4.3.5.1 Level of Participation

Producer participation was extremely high. One hundred and five dairy farms out of 109 designated critical farms (96% of all dairy farms) were participating in manure abatement programs either through the RCWP or the ACP.

4.3.5.2 Incentives to Participation

Cost share rate of 75% on BMP-2

Payment limitation of $50,000 per landowner. Although many animal waste management systems cost more than $66,670 (which made the farmers' share exceed 33%), this did not seem to be a barrier to participation.

ACP cost sharing has also been used to treat some problems. ACP has a limit of $3,500/yr for animal waste management systems.

Oregon allows a 50% tax credit for conservation measures which can be spread over 10 years. Oregon also has regulations allowing the state to fine agricultural operations that are obvious pollution sources.

There was initial local support for this project from the government and business community.

The field representative of the TCCA was pivotal in marketing the project to the farmers.

SCS field representatives were advocates of the farmers rather than adversaries.

Farmers understood that if the NPS pollution problems weren't solved through voluntary measures, remedial measures could be legislated.

Tillamook is a close knit community where the participants either know each other or are related; thus a lot of peer pressure to comply with the RCWP goals was brought to bear on farmers.

4.3.5.3 Barriers to Participation

High interest rates during the 1980's and the 1982 Omnibus Budget Reconciliation Act caused a reduction in the farmers' cash flow. Some participants could not afford their share of the cost of installing BMPs.

The number of farms considered critical for project success was continuously revised upward, extending the contracting period and delaying project completion.

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Chances of continued maintenance and adoption of BMPs in this area are excellent. The I&E component changed farmers' attitudes dramatically. The farmers now see themselves as part of both the problem and the solution. Additionally, several other vested interests (the TCCA and the shellfish industry) whose goals converge, as well as the threat of regulation, will continue pressuring the dairy farmers to implement and manage BMPs.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The strategy was simple: keep rainwater off manure and manure storage areas. When this was not possible, the strategy was to keep contaminated surface waters from reaching the streams and Tillamook Bay.

4.3.6.2 Objectives and Goals

Objective: Reduce fecal coliform bacteria entering project area water courses by 70%

Goal: Establish appropriate BMPs on 106 dairy farms

4.3.6.3 Critical Area Criteria and Application

Criteria: Distance to watercourse, poorly drained soils on which manure is spread, animals per acre, location in flood plain or tidewater-influenced area, Department of Environmental Quality (DEQ) water quality complaint, DEQ-designated polluted stream, designated sub-basins

Application of Criteria: If the rating of several dairy farms was similar then a team consisting of a Tillamook County ASC Committee member (COC), a SWCD (Soil and Water Conservation District) member, and a TCCA member would prioritize farms for cost sharing.

4.3.6.4 Best Management Practices Used

General Scheme: The vast majority of cost share funds were focused on BMP 2, Animal Waste Management. The BMP was subdivided into five systems with from one to five components per system. Many components used were added by this project to address specific manure management needs imposed by extremely high rainfall and are unique to the project: roofing and guttering of manure storage areas, and pasture drainage systems to prevent water from standing in pastures where manure is applied.

BMPs Utilized in the Project*	Units	Goals	Achievements	
			Total	%
Permanent vegetative cover (BMP 1)				
Pasture and hayland management	acres	388	284	73
Pasture and hayland planting	acres	30	30	100
Animal waste management systems (BMP 2)				
Waste storage structure	ft^3	1,417,697	1,214,365	75
Guttering	ft	51,411	39,103	76
Roofing	ft^2	479,309	405,824	85
Buried mainline	ft	32,615	27,715	85
Waste treatment lagoon	acre-ft	21	21	100
Conduit	ft	60	20	33
Curbing	ft	7,969	5,569	70
Dike	ft	45	0	0
Grassed waterway or outlet	ft	6,049	3,440	57
Subsurface drain	ft	96,300	84,420	88
Surface drain, main, or lateral	ft	8,090	8,050	99
Waste management systems	#	98	45	46
Grazing land protection system (BMP 6)				
Pipeline	ft	4,650	2,150	46
Trough or tank	#	11	2	27
Stock trails or walkways	ft	259	104	40
Stream protection system (BMP 10)				
Streambank protection (not used)				
Fencing	ft	7,693	5,873	76
Permanent vegetative cover on critical areas (BMP 11)				
Critical Area Planting (not used)				
Sediment retention, erosion or water control structure (BMP 12)				
Structure for water control	#	4	2	50
Pumping plant for water control (not used)				
Improving an irrigation and or water management system (BMP 13)				
Irrigation water management (not used)				
Fertilizer management (BMP 15)				
Waste utilization	acres	8,700	5,849	67

* Please refer to Appendix I for description/purpose of BMPs.

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

Units of planned and applied BMPs per subwatershed were reported annually by SCS and ASCS. Land treatment was tracked by the SCS using contracts. By late 1986, the BMP tracking system was in place. All RCWP BMPs were entered in a computer. Annual status reviews were part of the tracking program. However, during the first five years, when planning activities were greatest, some annual status reviews were not performed due to inadequate staffing.

4.3.6.5.2 Data Management

No data management system was in place during the project.

4.3.6.5.3 Data Analysis and Results

Quantified Project Achievements (as of 12/31/90):

Pollutant Source	Units	Critical Area Total	Critical Area % Implemented	Treatment Goals Total	Treatment Goals % Implemented
Pasture	acres	8,723	47%	8,582	48%
Dairies	#	109	41%	105	43%
Contracts	#	109	41%	105	43%

Source: Tillamook Bay RCWP Project, 1991

Approximately half of the critical area has been treated with permanent vegetative cover and animal waste and grazing land management. Animal waste storage facilities are about 80% complete and roofing is approximately 85% installed. Manure control and conveyance devices are over 70% installed and fencing is 76% complete.

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The general strategy was to sample ambient water quality in the tributaries and Tillamook Bay. Sampling in the bay was conducted at low tide to ensure the highest fecal coliform readings. The monitoring program was conducted by DEQ and the SCS/SWCD.

4.3.7.2 Objectives and Goals

Objective: Classify and/or monitor commercial shellfish growing areas

Goal: Measure changes in water quality

4.3.7.3 Time Frame

1975-1990

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

14 bay stations (1979-1987)
16 bay stations (1988- 1990)
71 tributary stations (1979-1980)
9 tributary stations (1981-1982)
12 tributary stations (1983-1990)

4.3.7.4.2 Sample Type

Grab samples taken 40 inches below the surface in the bay
Grab samples taken from the shoreline or bridge over tributaries

4.3.7.4.3 Sampling Frequency

The bay stations have been monitored regularly from 1979 to the present for fecal coliform counts. The number of samples taken per year varies per station and per sampling year. Implementation started in 1981. Intensive wet weather sampling occurred during December of 1979, March and October of 1980, and March of 1985. From 1981 through September 1986, samples were collected once per calendar quarter. Starting in October of 1987, sampling was conducted on a regular monthly basis.

4.3.7.4.4 Variables Analyzed

Fecal coliform, salinity, water temperature, rainfall

Discharge at a major tributary has been monitored from 1979 to the present.

A dye study of bay circulation was conducted in 1980.

4.3.7.4.5 Flow Measurement

Wilson River discharge was measured using the recording gauge operated by the U.S. Geological Survey. Trask River stage was observed using a staff gauge located in tidewater. Tillamook, Kilchis, and Miami River stages were measured using Oregon Water Resources Department staff gauges located just above tide water. Gauges were installed in 1983.

4.3.7.4.6 Meteorologic Measurements

Precipitation data were obtained from the official weather service reporting station, radio station KTIL, located near the southern tip of the bay.

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

None

4.3.7.5 Data Management

The data are in STORET. STORET agency codes for water quality monitoring stations are 21ORMISC & 21ORECST

STORET STATION NO.	PROFILE / STATION MAP / NO.
Tillamook Bay Sites	
412006	OR-1 / 1 (North Dolphin)
412007	OR-1 / 2 (Middle Dolphin)
412008	OR-1 / 3 (South Dolphin)
412009	OR-1 / 4 (North end of dike)
412178	OR-1 / 5a (Garibaldi)
412011	OR-1 / 6 (Southern Middle Bay)
412012	OR-1 / 7 (Southwest Bay)
412013	OR-1 / 8 (Northwest Bay)
412014	OR-1 / 9 (marker #9)
412015	OR-1 / 10 (Hobsonville Pt.)
412016	OR-1 / 11 (Northeast Bay)
412153	OR-1 / 12 (break in dike)
412234	OR-1 / 13 (northern mid bay)
412176	OR-1 / 14 (southeast bay)
412520	OR-1 / 15 (west entrance)
412521	OR-1 / 16 (east entrance)
Tributary Sites (not shown on profile map, OR-1)	
412120	MM4 (Miami River)
412125	K4 (Kilchis River)
412250	K3A (Murphy Creek)
412130	W13 (Wilson River)
412142	Tr8 (Trask River)
412149	T4a (Tillamook River)
TIL-B2	B2 (Bewley Creek)
TIL-B1A	B1A (Bewley Creek)
TI- Mil	MI1 (Mills Creek culvert)
TI-Mi2	MI2 (Mills Creek)
412214	S2 (Simmons Creek)
New Stations (STORET status not known) (not shown on profile map, OR-1)	
	I1 (Illingsworth Creek)
	I2 (Illingsworth Creek)
	H1 (Hughey Creek)

4.3.7.6 Data Analysis and Results

Data analysis was conducted by project personnel using spreadsheet software and a statistical software package for non-parametric trend analysis. Trend analysis of geometric mean fecal coliform bacteria counts by water year has been conducted. Preliminary analysis of the bay water quality samples conducted by NWQEP used covariance analysis to identify linear time trends and before and after change. This analysis used salinity as a covariate (Smolen et al., 1985).

There were some oyster bed sites that re-opened which may indicate an improvement in the commercial shell fishing beneficial use. The number of oyster bed sites classified as approved increased and then decreased over the life of the project.

4.3.7.6 Data Analysis and Results (continued)

Throughout the project period, there was a continued upward revision of the number of dairy farms that would need BMPs installed if project goals were to be met. Many BMPs were not complete by project end. Water quality may continue to improve as the BMPs are installed and manure management practices become fully integrated in farm routines.

A dye study of bay circulation completed in 1980 showed that bacteria laden freshwater can, and does, influence bacteria concentrations at the shellfish growing areas. Most freshwater, however, probably travels down the eastern side of the channel.

4.3.8 Linkage of Land Treatment and Water Quality

This project was unable to show any trends in water quality improvement, probably due to changes in water quality monitoring as well as the fact that many BMPs remain to be installed. If a linkage between land treatment and water quality is to be demonstrated, water quality monitoring and analysis will have to continue for some time after the formal end of the project.

4.3.9 Impact of Other Federal and State Programs on the Project

Other ASCS cost share programs are being utilized to install tile drains, gutters, and outlets. Also three long-term ACP agreements have been signed for farms not approved for RCWP contracts.

4.3.10 Other Pertinent Information

None

4.3.11 References

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

Smolen, M.D., R.P. Maas, J. Spooner, C.A. Jamieson, S.A. Dressing, and F.J. Humenik. 1985. NWQEP 1985 Annual Report, Appendix: Technical Analysis of Four Agricultural Water Quality Projects. Biological and Agricultural Engineering Dept., North Carolina State University. 90p.

Tillamook Bay RCWP Project. 1982. Plan of Work.

Tillamook Bay RCWP Project. 1983. Annual Report.

Tillamook Bay RCWP Project. 1991. Ten-Year Report.

4.3.12 Project Contacts

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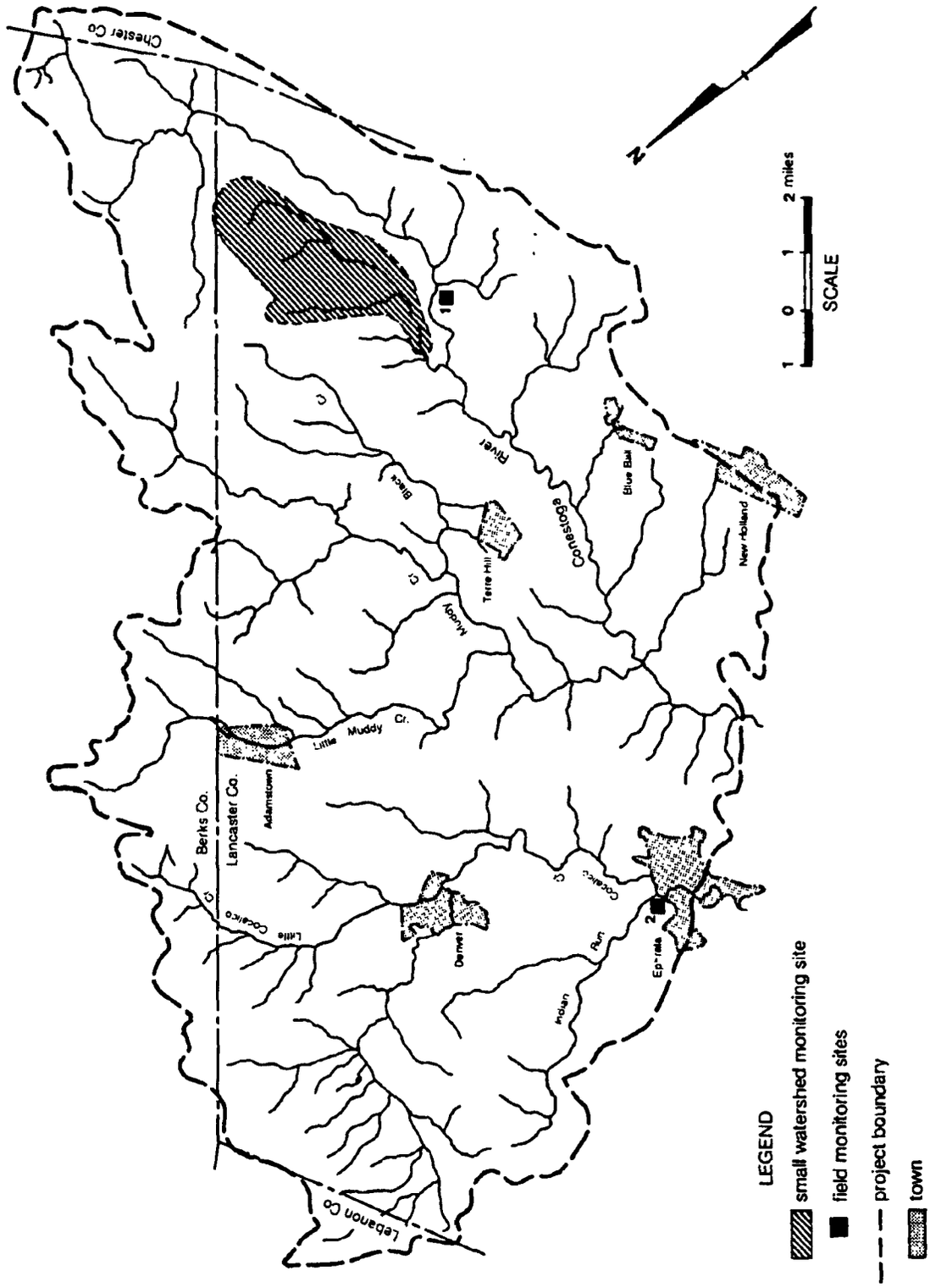
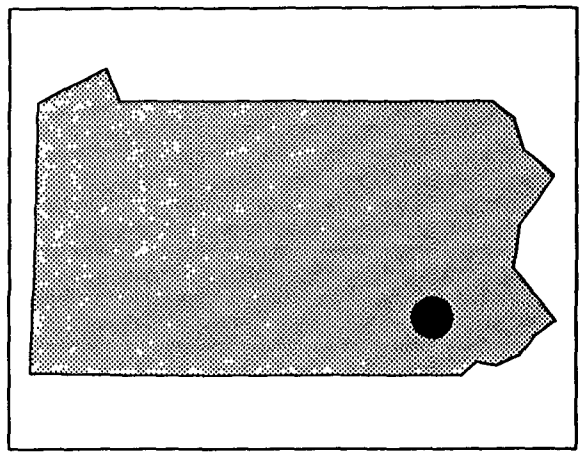


Figure 4.16: Conestoga Headwaters (Pennsylvania) RCWP project map, PA-1.

Pennsylvania
Conestoga Headwaters

(RCWP 19)



Lancaster County
MLRA: S-148
HUC: 020503-06

4.1 Project Synopsis

The Conestoga Headwaters area, located in southeastern Pennsylvania, is one of the most intensively farmed and productive areas in the world. The project area covers 110,000 acres of piedmont terrain characterized by small hills and valleys cut by streams. There are 1,250 small (52 acres average) farms in the area, including 1,009 beef and 445 dairy operations.

The surface and ground waters of the area provide water supplies for 175,000 people. Serious impairment of these water supplies has occurred due to excessive levels of agricultural sediment, nitrates, and phosphorus. The project goal was to reduce pollutants in surface and ground water to meet state water quality standards.

The project critical area, covering 16,000 acres, was defined as those farms adjacent to major or small streams with high animal densities, high fertilizer usage, or excessive erosion. Early monitoring showed excessive nitrate concentrations in areas with carbonate soils; therefore, those areas in the original critical area with carbonate soils received major attention and funding. Revised land treatment goals of 90 contracts and estimated reductions of 750,000 pounds of nitrogen and 375,000 pounds of phosphorus were met or exceeded.

Best management practices (BMPs) used were fertilizer management, animal waste management, terraces, and stabilized waterways. The project assisted in implementing a large number of BMPs that were not cost shared (a large number of producers would not accept cost share funds) and performed nutrient management planning for farms on a voluntary basis without RCWP contracts.

Water quality monitoring was performed at three levels: on a regional scale of the entire RCWP project area, on a small watershed contained within the project area, and on a field scale at two test fields. Regional monitoring was terminated early in the project due to low BMP implementation. The small watershed and field sites were intensively monitored for the duration of the project.

Monitoring results were mixed. Implementation of the BMPs appeared to alter the levels of some nitrogen and phosphorus compounds, but failed to show overall reductions in surface water and stream base flows. The use of terraces at one field site resulted in a reduction in suspended sediment in runoff with no change in the total nitrogen or phosphorus concentrations, and a significant increase in the nitrate concentrations in both surface runoff and ground water. Fertilizer management at the previously terraced ground water monitoring field site resulted in a significant reduction in nitrates in ground water.

The Pennsylvania project was characterized by excellent project management, strong lines of communication, and excellent inter-agency cooperation. Strong leadership at the state level was a key element in the success of the project. Significant involvement by Pennsylvania State University personnel enabled the development of deep-soil nutrient analysis and the "quick" nitrogen test. The project faced difficult social (the refusal of very conservative farmers to accept cost share funding) and logistical (large numbers of small farms) barriers to BMP implementation, but developed alternate methods to meet project goals. Consistent and intense monitoring, sampling, and analysis were major strengths of this project. The educational gains associated with nutrient practices have enhanced the work of the Chesapeake Bay and other regional water quality programs and this may, in the long run, be the greatest benefit of this project.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

Project objectives and goals were initially unrealistic because of a lack of clearly defined water quality problems, the large size of the watershed, and the large number of farms located in the project area, which made project logistics and administration difficult.

Initial contracting goals were unrealistic given the social and economic factors at work in this project area. The Local Coordinating Committee (LCC) and project personnel, in the early phases of the project, overestimated the acceptance by farmers of RCWP contracting and the success of cost sharing as a means to encourage implementation of nonpoint source (NPS) controls.

4.2.1.2 Recommendations

Water quality goals and objectives should be based on: analytical data on surface and ground water, restoration of beneficial uses of the water, the cause of the water quality problem, the social structure of the community, the willingness of farmers to accept needed land use or management changes, and the economic factors involved in implementing NPS control practices. Additional factors to be considered include changes in land use, public cost sharing, improved commodity income, and a combination of economic factors.

Detailed assessments of water quality problems, causes, and solutions should be made prior to setting program objectives and goals. Social and economic factors must be considered, and the target population (farmers) must be involved in the project selection and planning process.

Program authority at the national and state levels should permit changes in objectives and goals by the local project to better fit local conditions and improve the chances of project success.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

The National Coordinating Committee (NCC) provided adequate guidelines for agencies (including U.S. Department of Agriculture (USDA) agencies, U.S. Environmental Protection Agency (USEPA), and state agencies) to organize a functional RCWP project. Agency missions and expertise, when properly coordinated, met the program needs.

The RCWP administrative structure provided adequate project guidance, technical expertise, funding, and control to successfully implement a project.

Local level authority and flexibility fostered initiative and enabled innovation to tailor the project to fit local needs. The LCC was encouraged and supported by the State Coordinating Committee (SCC) to take initiative to surmount the lack of acceptance of RCWP contracts by farmers in the project area. The SCC acted as an advocate for the LCC in obtaining approval from the NCC for several innovative programs that were found to function better in this project.

4.2.2.2 Recommendations

Pre-project planning and assessment should include identification of water quality problems, the root causes of the problems, and their projected impacts in the future. Factors such as social and economic conditions as well as agricultural practices may need to be considered in project selection and planning.

Land treatment teams should coordinate with water quality monitoring and regulatory agencies to best meet the environmental, social, and economic goals of the project.

4.2.2.2 Recommendations (continued)

Project teams should consider the impacts of institutional arrangements involving agri-businesses, banking, feed producers, equipment producers, and marketing when planning approaches to control NPS source pollution. Current institutional production and marketing practices result in intense cropping and high densities of animals which can seriously degrade water quality.

Project administration must be sensitive to difficulties encountered in attaining project goals and permit flexibility in technical, social, and economic approaches to implementing NPS controls. In this project, lack of participation by farmers motivated the LCC to try different approaches to reach project goals. These ideas were brought to the SCC and NCC and approved. Through this process, the nutrient management program was established.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

Information and education (I&E) efforts, including technical assistance, appeared to produce higher BMP implementation than cost sharing. The combination of cost sharing, educational activities, and technical assistance offers choices that may satisfy social as well as economic needs.

Individual contact and good inter-agency cooperation worked well to influence farmers to implement BMPs.

4.2.3.2 Recommendations

Individual contacts are necessary, especially where the local population (such as Mennonite farmers) have little contact with mass media.

Educational programs should be implemented by people and organizations that are known and trusted by producers.

Educators must understand and respect the cultural, religious, and social customs of their clientele. For instance, in hiring nutrient management specialists, familiarity and experience with the local culture were important criteria in selecting applicants. These qualities enhanced the specialist's credibility with the Lancaster County farmers.

Programs should make use of all information delivery systems available. Mass media, workshops, demonstrations, individual contacts, educational meetings, and evening programs are all effective means of promoting water quality improvement programs.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

Long-term contracts associated with cost sharing were not well accepted by producers.

Technical assistance and educational efforts were well accepted by producers and the public.

Design of BMPs and implementation schedules hindered acceptance by producers due to conflicts with the producers' finances, equipment constraints, and social attitudes. RCWP contracts were viewed by producers as restrictive and interfering with their finances. Modified designs of BMPs gained the participation of some farmers where the new design was a better fit to the farmer's needs. One example was an animal waste storage facility that functioned by gravity designed for a local farmer who did not want to use electrical devices but was very interested in protecting water quality through better animal waste management.

Cost sharing was not effective in gaining farmer participation when manure nutrients exceeded crop needs and manure had no value to the farmer.

Targeting of critical areas was not effective in this project where farmer participation and interest were low.

4.2.4.2 Recommendations

Recognition should be extended to all who participate in a project, including those farmers who implement BMPs with technical assistance but do not use cost share money.

Technical assistance should be available to all operators to optimize water quality improvements. Agencies should cooperatively deliver technical assistance by sharing personnel who have the needed technical expertise.

Projects should make provision for BMP design and implementation schedule changes to accommodate the unique needs of the producers in the area. Modified designs and implementation schedules can better fit producer's finances and needs which can increase participation.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

There may be trade-offs between BMPs designed to improve surface water and those designed to address ground water quality, complicating treatment if both surface water and ground water are impaired. For example, water quality monitoring indicates that terraces may result in ponding of water and increased nitrate infiltration. Thus, although terraces may reduce sediment loadings to surface water, in permeable soils with excess manure, terraces may increase nitrate transport to ground water.

Conservation tillage systems, fertilizer management, and contour stripcropping systems were found to be the lowest cost alternatives for this project area. Extensive implementation of these BMPs over other practices is expected to produce the greatest water quality improvement at the lowest cost.

Implementation goals were met through personal, individual contacts with producers by agency personnel. These meetings provided project personnel a means to discuss water quality problems and the importance of implementing management practices to improve water quality. Such contacts enabled the project team to reach implementation goals with non-contracted BMP (no cost sharing) implementation. In this project, non-cost shared BMP implementation exceeded contracted (cost shared) land treatment.

The main project results come from two intensively monitored field sites and one stream site. Results are summarized below:

In this project, the amount of nitrogen from animal wastes sometimes exceeds crop needs (about 10-15% of the farms). Water quality benefits from animal waste storage BMPs are partially offset because nitrogen that could have been volatilized during immediate spreading was conserved in the storage facility and applied as a solid to the soil.

Nutrient management BMPs (soil and manure testing, proper matching of application rates, and timing to match plant needs) can reduce both ground and surface water nitrogen loading.

Nutrient management is readily accepted by producers who see benefits in reduced water pollution, labor, and costs.

Manure applications must be considered when determining the total amount of nutrients applied to farmland.

Although stream protection systems (BMP 10) were not widely utilized in the project, fencing might have had a significant and rapid impact on overall water quality had it been employed more widely.

4.2.5.2 Recommendations

The most effective means of obtaining land treatment implementation is through personal, individual contacts with producers by known, knowledgeable, and credible agency personnel.

Where manure nutrients exceed crop requirements, waste management systems must be designed to reduce the burden on surface and ground waters. Volatilization of nitrogen may be desirable.

When on-farm manure nutrients exceed crop needs, manure is a waste product, not a resource. High cost share rates, regulations, and export markets for manure should be considered.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

Excessive agricultural nutrients applied to farmland were found to be the major pollutants of project area surface and ground water.

Delivery of pollutants to surface and ground water is affected by erosion, which, in turn, is due to intense crop production, land topography, soil characteristics, and climatic conditions.

In areas underlain with carbonate rock (karst geology), ground water can play a major role in the overall volume of water (base flow and storm flows) discharged from a site and its quality.

Only one BMP should be evaluated at a site. Combinations of BMPs reduce the possibility of evaluating effectiveness of a specific BMP, rendering the information less widely applicable.

Observing similar water quality responses to a specific BMP at different sites helps determine effectiveness of the practice.

To properly study the effectiveness of a specific BMP, the area should be no more than a single farm to avoid problems with monitoring and accounting for changes in agricultural practice.

Controlled study designs facilitate the evaluation of data. Controlled design studies of BMPs include upstream and downstream monitoring and paired or nested watersheds for surface water, and up-gradient and down- gradient monitoring for ground water. Paired watersheds are a preferred design for surface water monitoring, but site selection is difficult because geology, hydrology, land use, and agricultural practices must be very similar. This project had marginal success with a paired subbasin design to study the effects of nutrient management.

Extreme hydrological events confound data interpretation because many transport processes are controlled by precipitation events and many BMPs may have widely varying effectiveness under extreme conditions.

Process studies lead to improved understanding of transport mechanisms and to the development of more effective BMPs.

The regional study produced no results because the level of BMP implementation in the project area was too low and there were too many other uncontrolled variables to result in any measurable water quality effect. For instance, fertilizer rates were reduced about 50% throughout the watershed between 1980 and 1987. However, land development and other activities overwhelmed the impact of the nutrient reduction. Monitoring was discontinued to conserve resources.

Results of the small watershed study indicate a possible decline in base flow nitrate-nitrogen concentrations that may be attributable to nutrient management in a portion of the watershed. Monitoring has not continued long enough to confirm this.

The field monitoring sites have shown that ground water levels respond rapidly to rainfall and ground water quality responds to watershed management. At Field Site 1, nitrate concentrations in ground water at four wells increased after terraces were installed. Monitoring at Field Site 2 showed a substantial decline in ground water nitrate-nitrogen concentration as the result of reductions in manure applications recommended by a nutrient management plan and by manure export from the farm.

4.2.6.2 Recommendations

Projects should invest heavily in the planning and design of the water quality monitoring and evaluation program. Consultation with experienced personnel will greatly help project staff to avoid collecting useless data. The plan should include adequate baseline monitoring, before implementation, and enough monitoring after implementation to thoroughly document the effects of the NPS controls.

Controlled design studies; implementation of only one BMP at a site; use of small, homogeneous sites; and the use of multiple sites with similar land treatment will aid in water quality monitoring and evaluation.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

Ground water and, consequently, base flow of streams are highly susceptible to agricultural pollution in areas with karst geology.

Suspended sediment and phosphorus were predominately transported in surface runoff.

Surface runoff quality is seriously degraded when nutrients are applied to frozen ground.

Terracing reduced sediment losses to surface runoff, but had little effect in reducing nutrient losses to surface and ground water.

Water quality improvements due to fertilizer management were not able to be clearly documented. At the small watershed level, analysis of pre- and post-BMP implementation monitoring data shows no statistically significant reduction in nitrate, total Kjeldahl nitrogen, or phosphorus in base flow. Nitrate concentrations in wells at Field Site 2 showed some decrease due to an overall 30% reduction in applied nitrogen as a result of improved fertilizer management.

4.2.7.2 Recommendations

BMPs chosen for use in areas with karst geology should address the transport of contaminants to ground water as well as to surface water.

BMPs available for use in a NPS pollution control program should include a reduction of application rates or a reformulation of triazine herbicides to reduce leaching to ground water.

Project teams should consider the effects on both surface and ground water when selecting NPS controls.

Practices to control surface runoff should be selected if sediment and phosphorus are significant pollutants.

Fertilizer management practices must eliminate application of manure on frozen ground.

Practices to control erosion and sediment-borne pollutants must be implemented as complete systems, which should include secondary sediment removal to control fine sediments in surface runoff and fertilizer management to reduce ground water contamination.

Fertilizer management has the potential to be the most effective approach to improve ground water quality where nutrients are causing impairment of waters. If crop nutrient requirements can be met, substantial reductions in manure and commercial fertilizer application should be implemented.

Projects in areas with high animal densities should consider means for encouraging reductions in animal densities, exporting manure out of the watershed, and changing land use to activities which reduce water pollution.

4.3 Project Description

4.3.1 Project Type and Time Frame

Comprehensive Monitoring and Evaluation (CM&E) RCWP Project

1981 - 1991

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Streams, ground water

4.3.2.1.2 Water Uses and Impairments

Public water supplies for approximately 175,000 people plus 2,000 commercial industries originate within and downstream from the Conestoga Headwaters (Conestoga Headwaters RCWP, 1981). Water resources also support private water supplies, livestock watering, fisheries and contact recreation. Streams used for these activities are impaired by bacteria, nutrients, pesticides and sediment. Nitrates and pesticides impair potable ground water supplies.

4.3.2.1.3 Water Quality Problem Statement

Water resources in the area are designated to support use as public water supply, industrial water supply, fishery, and contact recreation. Bacteria, nutrients, pesticides and sediment impair streams. Nitrates and pesticides impair sources of potable ground water.

In one summer sampling period during the initial phase of the project, 67% (22 of 33) of wells in carbonate geology and 20% (2 of 10) of wells in non-carbonate geology had nitrate concentrations above the drinking water standard (10 mg/L as nitrogen).

4.3.2.1.4 Water Quality Objectives and Goals

Objective:

Reduce pollutants to levels consistent with the water quality standards of the Commonwealth of Pennsylvania (Conestoga Headwaters RCWP Project, 1982).

Specific goals:

Reduce the amount of animal waste entering receiving streams and lakes by applying waste management systems on 80 livestock operations

Reduce amounts of nitrates, phosphates,and pesticides entering receiving streams and lakes by applying fertilizer management and integrated pest management on 3600 acres

Reduce the amount of sediment and sediment-related pollutants entering receiving streams by applying BMPs on 12,000 acres (300 RCWP contracts) to bring the annual erosion rate to an acceptable rate. (This goal has been revised twice by the project as follows: 1984 --- 80 contracts on 6,000 acres; 1989 --- 90 contracts on 7,000 acres (Conestoga Headwaters RCWP Project, 1989))

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 110,000 acres
Project Area: 110,000 acres
Critical Area: 16,000 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean annual precipitation: 42 inches

Geologic Factors: The northeastern two-thirds of the project area lie in the Triassic Lowlands underlain by conglomerate, shale, sandstone, and diabase. Average depth to the water table is 15 to 35 feet. The southwestern one-third of the project area is in the Conestoga Valley underlain by carbonate and shale rocks, where average depth to the water table is 20 to 50 feet. Throughout the project area, soils are mainly well drained, deep, or moderately deep silty loams that provide ample infiltration of precipitation to ground water.

4.3.2.2.3 Project Area Agriculture

Agriculture in the project area is characterized by intense use of the land for crops and animal operations. The farms are small (52 acres average) and numerous (1,250 in the project area). Cropland covers 57% of the land and crops grown are: corn, hay, wheat, tobacco, and vegetables. Animal operations include dairies, beef cattle, hogs, and poultry. Animals generate 1.2 million tons of waste per year, and cropland receives in excess of 24 tons per acre per year of animal waste.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	57	NA
Pasture/range	6	NA
Woodland	20	NA
Urban/roads	-	NA
Other	15	NA

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	445	39,542	30,820
Beef	1,009	53,945	45,853
Hogs	NA	33,914	7,461
Poultry	NA	3,462,425	15,314

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	1,100,542	0	NA*	0	1,100,542
Info. & Ed.	10,000	0	0	78,468**	88,468
Tech. Asst.	1,268,417	0	0	0	1,268,417
Water Quality onitoring	1,123,686	1,183,865	0	0	2,307,551
SUM	3,502,645	1,183,865	NA	78,468	$4,764,978***

* Farmer participation is difficult to estimate because many farmers implemented BMPs with no contracts and no cost share funding.
** Pennsylvania State University Cooperative Extension Service (for nutrient management planning)
*** Total does not include producer portion of BMP implementation costs

Source: Conestoga Headwaters RCWP Project, 1991

4.3.4 Information and Education

4.3.4.1 Strategy

The primary information and education strategy was to provide producers with individual nutrient management plans. Technical assistance provided an analysis of current farm management, a nutrient plan to fit crop needs, and soil and manure testing. Two nutrient management agents were hired by the Penn State Cooperative Extension Service to carry out the nutrient management efforts.

4.3.4.2 Objectives and Goals

Reduce nitrogen applications by 750,000 lbs. on 20,000 acres through nutrient management plans

Reduce phosphorus applications by 375,000 lbs. on 20,000 acres through nutrient management plans

Encourage the adoption of other BMPs

Encourage the development of a crop management association to continue nutrient management and integrated pest management after the project is completed

4.3.4.3 Program Components

Individual contacts by nutrient management agents and other project personnel, and individual nutrient management plans for each farm to encourage the voluntary adoption of BMPs, many without cost sharing

Test plots established on working farms to demonstrate to producers that nutrients from the manure may meet crop needs

Soil testing and computer modeling conducted to determine long-term nitrogen release from manure and crop needs

A quick soil nitrogen test developed so producers could determine crop needs in a 24-hour time period

Meetings for area fertilizer dealers and tours of test plots and farms implementing BMPs to educate the community about nutrient management

4.3.4.3 Program Components (continued)

A newsletter linking producers willing to sell/give manure with those wishing to obtain manure to more effectively use fertilizer in the area

Numerous educational meetings, published articles in newspapers, local radio spots, and educational materials to inform producers and the public about nutrient management

4.3.5 Producer Participation

4.3.5.1 Level of Participation

The level of participation is a low percentage of the number of farmers, but given the very conservative nature of the local residents participation is good. Also, there were more BMPs installed without cost sharing than were installed with cost share.

4.3.5.2 Incentives to Participation

Cost share rate of 50% on animal waste management; free soil and manure testing; free fertilizer recommendations

Payment limit of $50,000

Technical assistance from two nutrient management specialists and other project personnel

4.3.5.3 Barriers to Participation

The large number of small farms simply made project logistics difficult.

The majority of the area producers are of the plain religious sects (Mennonite and Amish) or are simply very conservative, in general, by nature. These factors limited the number of farmers who would accept government aid; thus, cost sharing did not function well as an incentive.

Many producers with manure in excess of that needed for crops had little incentive to invest heavily in storage facilities or manure application reduction strategies.

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

The nutrient management plans and pest scouting have been well received and will be continued in the future. The soil conservation BMPs installed will be maintained, as will modified conservation tillage practices.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The original land treatment strategy was to put structural controls on about 75% of the critical area so that the effects of the BMPs on the water quality could be determined. The strategy was revised when the reluctance of farmers to enter into government contracts became apparent and BMP implementation was low. The new strategy shifted to education and providing technical assistance for all farmers in the area. The land treatment team wrote quality plans and helped design BMPs to fit specific farms.

4.3.6.2 Objectives and Goals

Reduce the amount of animal waste entering water resources by implementing waste management systems on 80 livestock operations

Reduce amounts of crop nutrients entering water resources by applying fertilizer management and Integrated Pest Management on 3,600 acres

Reduce amounts of sediment and sediment-related pollutants entering water resources by applying appropriate BMPs on 12,000 acres (in 300 contracts) to lower the annual erosion rate to an acceptable level (revised: 1984 - 80 contracts on 6,000 ac.; 1988 - 90 contracts on 7,000 ac.).

4.3.6.3 Critical Area Criteria and Application

Criteria: Originally, the critical area included all farms bordering a stream that had high animal densities (1.5 animal units /acre), high application of fertilizers, or high erosion rates. Early monitoring showed excessive nitrates in areas underlain by carbonate soils; therefore, the LCC defined priority one and two areas as areas with carbonate soils located in the original critical area. The priority one area contained a small watershed to be used in a controlled monitoring experiment. Priority three areas were areas with non-carbonate soil located in the original critical area.

Application of Criteria: Adherence to the criteria has been undermined by the lack of farmer participation; however, I&E efforts have focused on the identified critical areas.

4.3.6.4 Best Management Practices Used

General Scheme: Revised implementation goals included securing 90 contracts to treat about 7,000 acres. Emphasis was redirected to educational programs and nutrient management plans to encourage better nutrient management instead of contracts with cost sharing.

BMPs Utilized in the Project*	Project Accomplishments
Permanent vegetative cover (BMP 1)	178 acres
Animal waste management system (BMP 2)	69 systems
Stripcropping systems (BMP 3)	2,913 acres
Terrace system (BMP 4)	62 miles
Diversion system (BMP 5)	8 miles
Grazing land protection system (BMP 6)	4 systems
Waterway system (BMP 7)	27 miles
Cropland protection system (BMP 8)	3,346 acres
Conservation tillage system (BMP 9)	12515 acres
Stream protection system (BMP 10)	5 systems
Permanent vegetative cover on critical areas (BMP 11)	1 acre
Sediment retention, erosion, or water control structures (BMP 12)	3 units
Tree planting (BMP 14)	3 acres
Fertilizer management (BMP 15)	24,500 acres
Pesticide management (BMP 16)	6,900 acres

*Please refer to Appendix I for descriptions/purpose of BMPs

4.3.6.5 Land Treatment and Use Monitoring and Tracking Program

4.3.6.5.1 Description

Participating farmers in monitored subbasins and field sites were asked to submit quarterly reports, giving information on plowing, planting, harvesting, field conditions, fertilizing, manure spreading, and pesticide application.

4.3.6.5.2 Data Management

Land treatment and use monitoring and tracking were done manually by the ASCS and SCS through periodic reviews of visitation records and contracts.

4.3.6.5.3 Data Analysis and Results

Ninety farmers participated in RCWP contracts with complete water quality plans.

In total, 365 farms implemented nutrient management plans, most with no RCWP contract. Follow-up surveys found that farmers implemented about 75% and 50% of the recommended reductions in nitrogen and phosphorus, respectively, in the plans.

Quantified Project Achievements:

Pollutant		Critical Area		Treatment Goals	
Source	Units	Total	% Implemented	Total	% Implemented
Cropland	Acres	16,000	23%	7,000	68%[a]
Dairies	#	110	38%	45	93%
Feedlots	#	100	10%	20	50%
Poultry	#	130	15%	8	240%
Hog	#	60	23%	7	200%
Contracts	#	400	21%	80	106%

[a]Estimated as conservation tillage practices applied

Source:Conestoga Headwaters RCWP Project, 1989

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

Monitoring was conducted by the U.S.Geological Survey and the Pennsylvania Department of Environmental Resources

The original monitoring strategy had the following three components with specific goals:

Regional network of wells and surface water sites designed to determine the effects of the RCWP on a regional scale by comparing concentrations and discharges of suspended sediment, nutrients, and pesticides before and after implementation of BMPs (The network as such was discontinued after baseline sampling due to lack of farmer participation in the program. Some sampling sites were maintained, however, for possible future use.)

Small watershed site designed to determine the effects of nutrient management on surface water quality by comparing concentrations and discharges of suspended sediment, nutrients, and pesticides before and after implementation of nutrient management using paired-watersheds and upstream- downstream approaches.

4.3.7.1 Strategy and Design (continued)

Field sites designed to determine the effects of animal waste storage, terracing, and nutrient management on surface and ground water quality with the parameters of concern being suspended sediment, nutrients, and pesticides (Field Site 1) and compare the concentrations and discharges of nutrients before and after the implementation of nutrient management (Field Site 2).

4.3.7.2 Objectives and Goals

Overall Initial CM&E Objective:

Determine the effects of agricultural BMPs on surface and ground water quality

Final Goals:

Quantify the transport of sediments, nutrients, and pesticides in surface waters

Quantify the movement of nitrate to ground water aquifers

Investigate the transport of water-soluble pesticides to ground water

Measure the effectiveness of BMPs in reducing nutrient pollution to surface water and ground water

4.3.7.3 Time Frame

Regional network: 1982 - 1983 (discontinued)

Small watershed site: 1984 - 1991 (with continuation as part of the Chesapeake Bay Program)

Field site 1: 1983 - 1989

Field site 2: 1984 - 1990 (with continuation as part of the Chesapeake Bay Program)

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

Regional network: 4 surface water sites and 43 wells (discontinued)

Small watershed (5.8 mi^2): 2 stream gauged sites, 3 additional base flow surface sites, 6 wells, and 2 springs / includes fertilizer management subwatershed and control subwatershed

Field site 1 (23.1 ac): 1 surface outlet gauged site, 5 wells, and 1 spring / area treated with terraces and nutrient management

Field site 2 (47.5 ac): 1 surface outlet gauged site, 7 wells, and 1 spring / previously terraced area treated with nutrient management

4.3.7.4.2 Sample Type

Grab and automatic

4.3.7.4.3 Sampling Frequency

Gauged sites: Automatic sampling of all major storms

Base flow sites: Every 4 weeks

Ground water sites: Monthly (field sites)

4.3.7.4.4 Variables Analyzed

Total and dissolved nutrients: ammonia-nitrogen (NH_3-N), nitrite-nitrogen (NO_2-N) and nitrate-nitrogen (NO_3-N), total Kjeldahl nitrogen (TKN), phosphorus (P)
Pesticides: atrazine, propazine, simazine, cyanazine, metolachlor, toxaphene, alachlor

Other variables: suspended solids (SS), specific conductance, temperature

4.3.7.4.5 Flow Measurement

At all gauged sites (streams, terrace drains, and intermittent runoff sites)

4.3.7.4.6 Meteorologic Measurements

Precipitation: 1 recording precipitation gauge at small watershed and each field site

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

Monitoring and sampling, laboratory analysis, and statistical analysis have been consistent and thorough.

Soil profiles were analyzed for nutrient content.

Resources were concentrated on the periods of interest for each variable, such as growing season for pesticides, spring and fall for soil tests, and surface flows keyed to major storm events.

The monitoring program had built-in flexibility to accommodate unplanned changes in the project work plan. When contract sign-ups failed to meet expectations, the monitoring program was scaled back to conserve resources.

The study area is underlain by both carbonate and non-carbonate rocks. The project documented differences in runoff, subsurface drainage, and pollutant transport between the two rock types. Sink holes are present in Field Site 1.

Subbasins within the small watershed site were paired and calibrated to provide real-time data on nutrient management. Farmers were asked to submit regular land use reports with information on field conditions and agricultural operations.

Farmer participation and BMP implementation have not been sufficient to demonstrate basin-wide water quality changes on the scale of the original plans.

4.3.7.5 Data Management

All water data are in STORET.

STORET AGENCY CODE	STORET STATION NO.	PROFILE / STATION MAP / NO.
Small Watershed		
112WRD	015760831	PA-2 / Station 1
	0157608325	Station 2
	0157608335	Station 3
	015760839	Station 4
	01576085	Station 5
Field Site 1 (Ground Water)		
112WRD	400741075584301	PA-3 / LN 1643
	400746075584301	LN 1645
	400744075584701	LN 1646
	400741075585101	LN 1650
	400739075585101	LN 1651
	400744075583901	LN SP58
	GWNS07J047*	LN SP58
Field Site 1 (Surface Runoff)		
112WRD	01576083	PA-3
Field Site 2 (Ground Water)		
112WRD	401152076105501	PA-3 / LN 1667
	401149076105501	LN 1669
	401156076105701	LN 1670
	401148076110301	LN 1673
	401152076110101	LN 1676
	401156076110501	LN 1677
	401152076105701	LN 1679
	401152076105301	LN SP61
	GWNS07J008*	LN 1667
Field Site 2 (Surface Runoff)		
112WRD	1576335	PA-3

* Part of PA Department. of Environmental Resource's Ground water Fixed Station Monitoring Network

4.3.7.6 Data Analysis and Results

Analysis:

The modified Wilcoxon (Mann-Whitney) seasonal rank-sum test (95% confidence level) was applied to determine the presence of statistically significant trends in flow data and pollutant concentrations and loads at the small watershed and field sites.

Regression and covariate analyses were applied using data from the nutrient management and control sub-basins to determine the efficacy of nutrient management techniques and the presence of long-term trends in nutrient levels.

Trend analyses were supported by tables and plots of means, medians, maximums, and minimums of pollutant concentrations and loadings, flow measurements, and other data.

Results:

Some project personnel believe the period of record in this project was too short to achieve a strong indication of long-term water quality effects of BMP implementation.

The regional study produced no results because BMP implementation level in the project area was too low to expect any measurable water quality effect. Monitoring was discontinued to conserve resources.

Results of the small watershed study indicate a possible decline in base flow nitrate-nitrogen concentrations that may be attributable to nutrient management in a portion of the watershed. Monitoring has not continued long enough to confirm this.

The field monitoring sites have shown that ground water levels respond rapidly to rainfall and ground water quality responded to watershed management. At Field Site 1, nitrate concentrations in ground water increased after terracing. Monitoring at Field Site 2 showed a substantial decline in ground water nitrate-nitrogen concentration in 4 wells as the result of reductions on manure applications which were part of the implementation of nutrient management plans.

4.3.8 Linkage of Land Treatment and Water Quality

Nutrient management plans which reduce the application of manure and commercial fertilizer to cropped land have the potential to be the most cost-effective BMP in reducing nutrients in ground water. Substantial reductions in manure and/or fertilizer application should improve ground water quality.

Animal waste management, as practiced in the RCWP, could not be documented as resulting in reductions in nutrient levels and was relatively expensive to producers (the reduction of *manure application* to Field Site 2 resulted in reduced ground water concentrations of nitrates). However, eliminating manure spreading on frozen ground will significantly reduce nutrients in surface runoff and manure storage facilities may allow reductions in commercial fertilizer application which will reduce surface and ground water contamination. Animal waste management and fertilizer management must be coupled to provide a complete management plan for each individual farm.

Results of the field site study (Field Site 1) indicated that terracing reduced sediment losses to surface runoff, but had little effect in reducing nutrient losses to surface and ground water. This BMP was viewed as possibly being effective in reducing nutrients in waters when it is coupled with secondary sediment retention, erosion, or water control structures (BMP 12), to retain fine soil particles that bind to phosphorus.

Erosion control and surface runoff control practices reduced sediment and phosphorus in surface runoff.

Only minor changes in water quality are anticipated since the number of BMPs installed is small relative to the large area affected by NPS pollution. Localized improvements in individual drinking water wells may occur; however, these improvements will be isolated. Significant improvement in water quality may require the export of manure out of the watershed.

4.3.9 Impact of Other Federal and State Programs on the Project

The state Wetlands Protection Act affected the project in that two springs could not be developed under grazing land protection systems (BMP 6) due to provisions in the law.

4.3.10 Other Pertinent Information

The educational gains associated with nutrient practices have enhanced the work of the USEPA Chesapeake Bay and other regional water quality programs. In the long run, this may be the greatest benefit of the RCWP project. Modest on- and off- site water quality improvements were associated with practices that reduce runoff and conserve nutrients.

4.3.11 References

A complete list of all project documents an other relevant publications may be found in Appendix IV.

Conestoga Headwaters RCWP Project. 1981. Project Application. Lancaster County, Pennsylvania.

Conestoga Headwaters RCWP Project. 1989. Progress Report. USDA-ASCS, PA State ASCS Office, Harrisburg, PA. 169p.

Conestoga Headwaters RCWP Project, 1991. Draft Ten-Year Report.

4.3.12 Project Contacts

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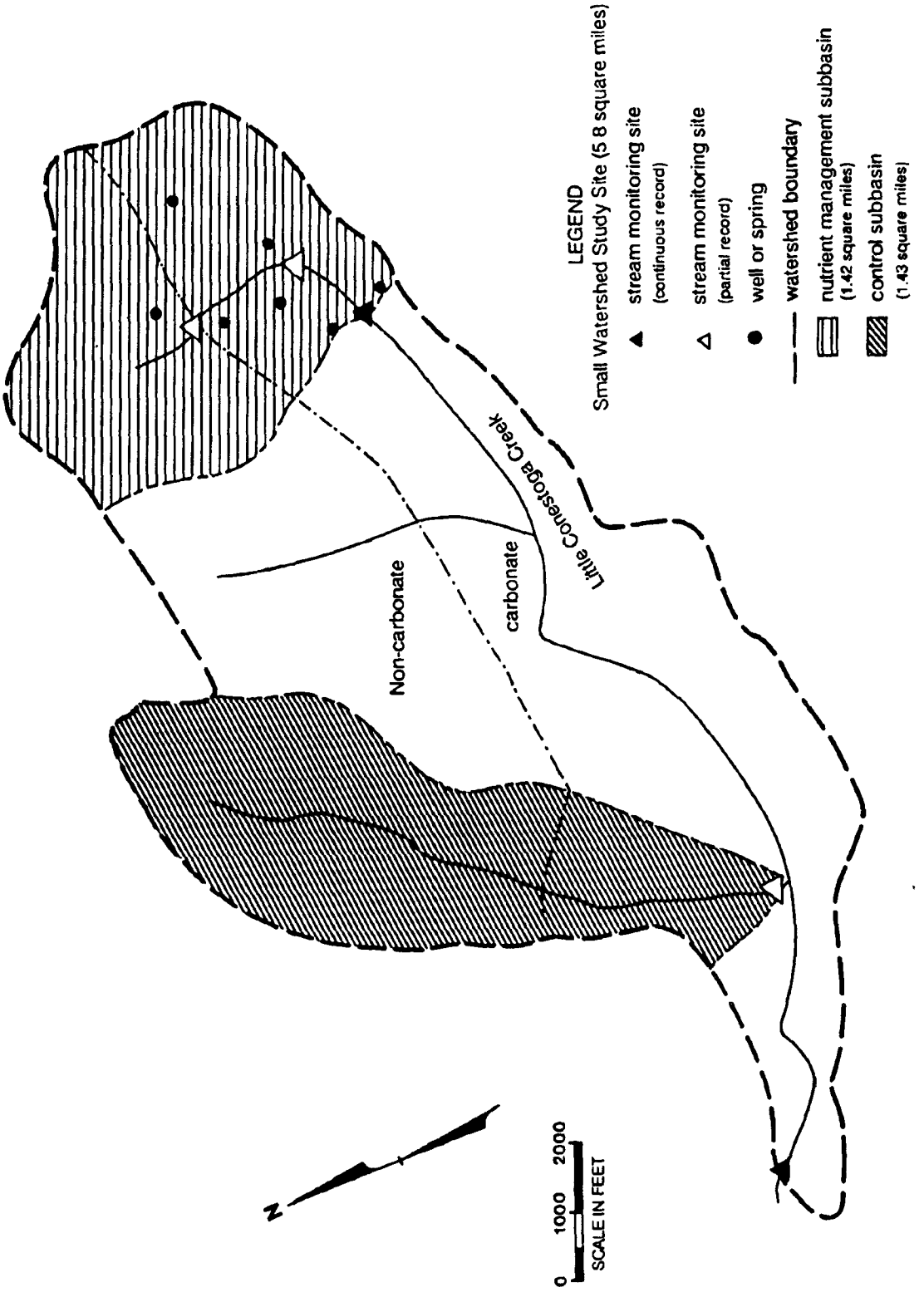


Figure 4.17: Conestoga Headwaters (Pennsylvania) RCWP project map, PA-2.

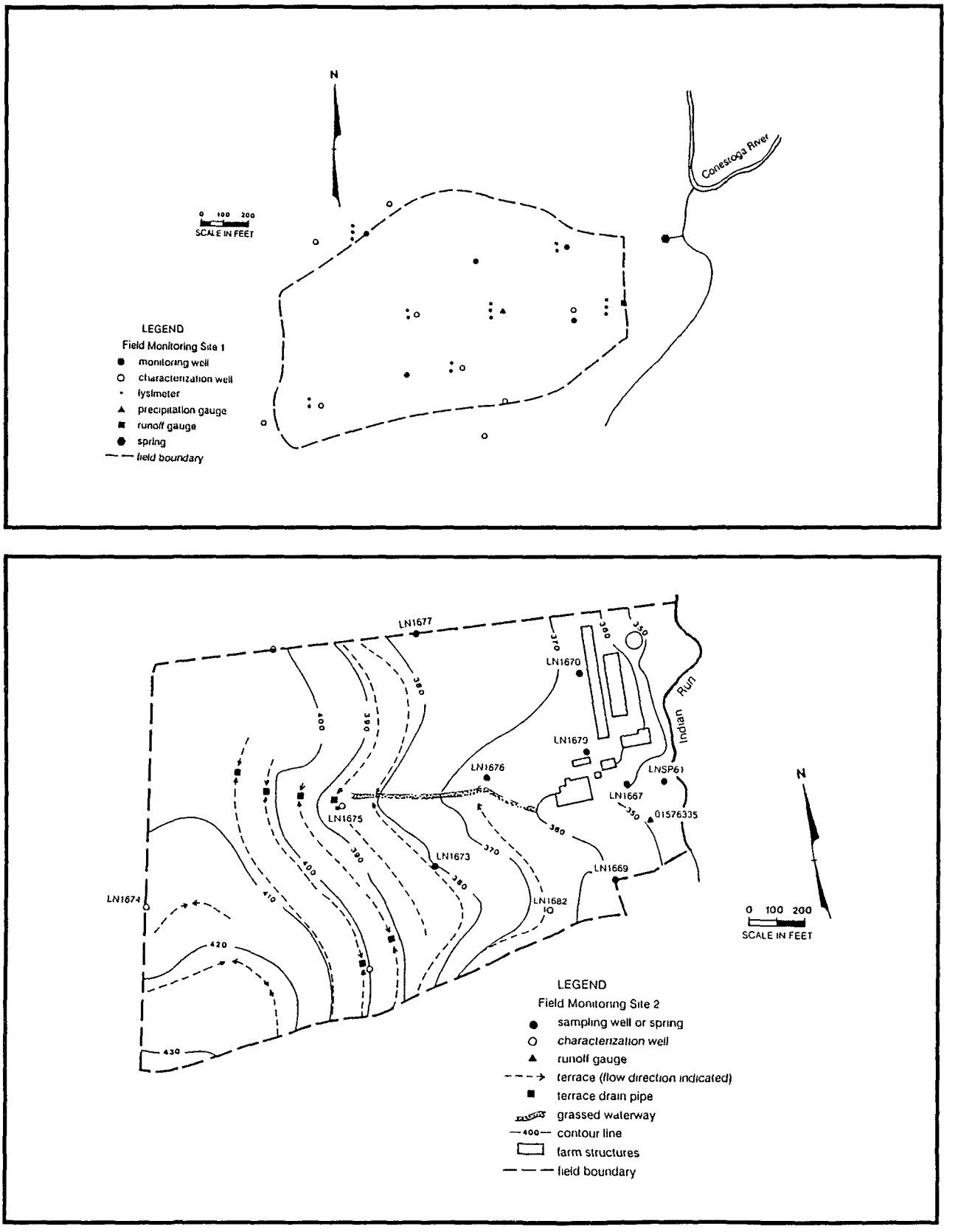


Figure 4.18: Conestoga Headwaters (Pennsylvania) RCWP project map, PA-3.

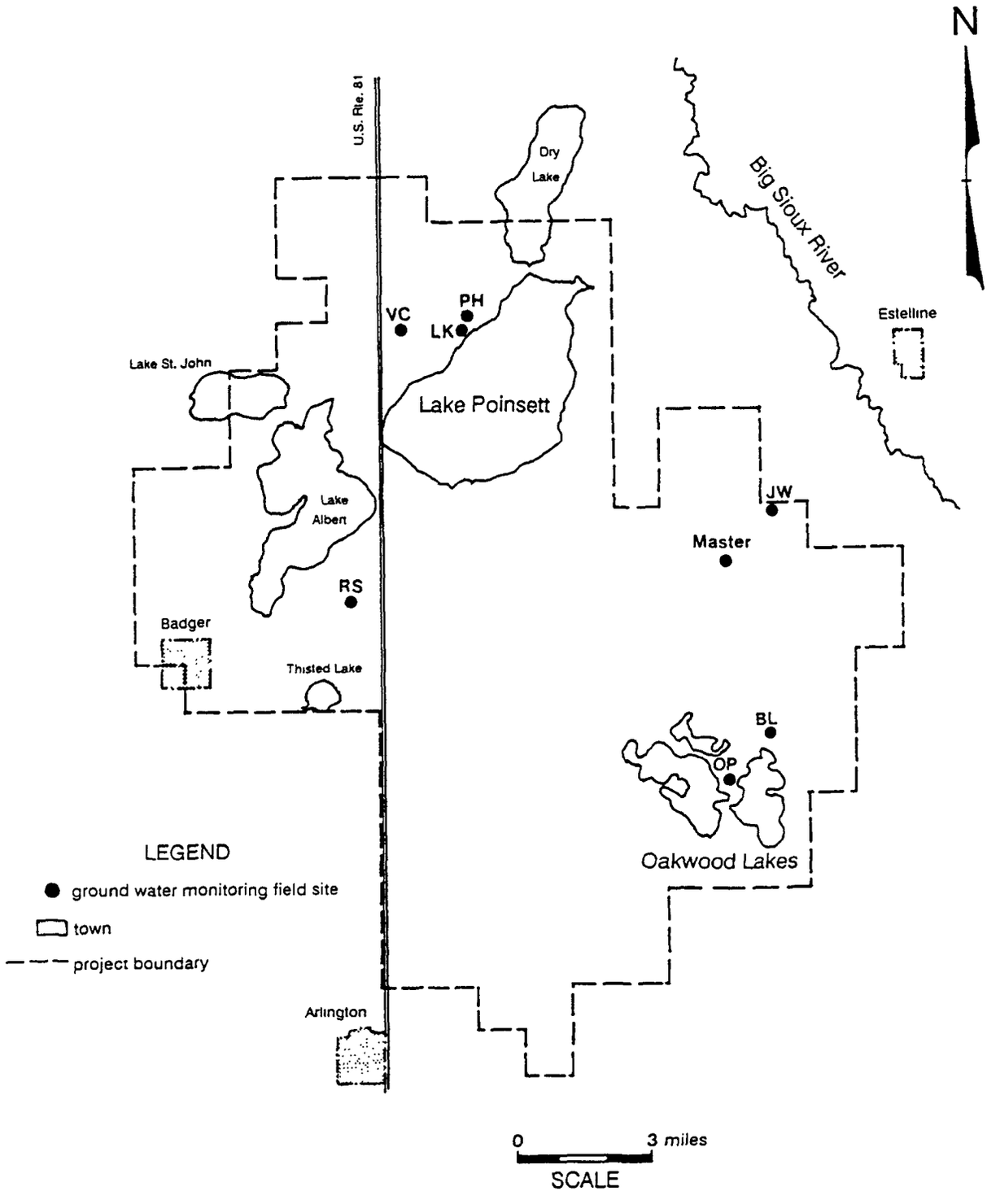
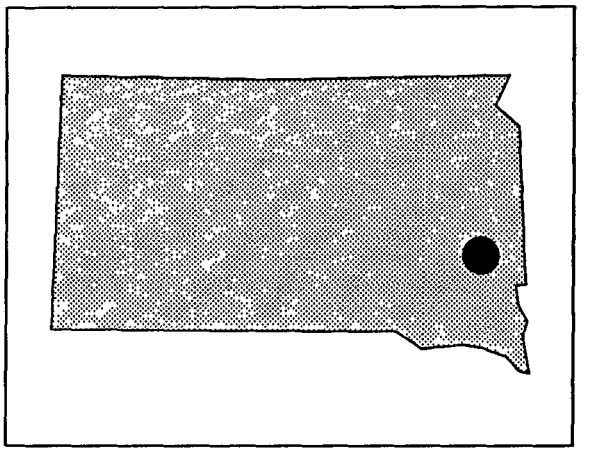


Figure 4.19: Oakwood Lakes - Poinsett (South Dakota) RCWP project map, SD-1.

South Dakota
Oakwood Lakes - Poinsett

(RCWP 20)



Brookings, Kingsbury, & Hamlin Counties
MLRA: 102-A
HUC: 101702-01,02

4.1 Project Synopsis

The Oakwood Lakes-Poinsett area is located in east-central South Dakota. This area is characterized by a rolling topography with deep, rich soils and a continental climate with an average rainfall of 22 inches per year. Agriculture forms the economic basis for the area; major crops include corn, soybeans, and small grains. Small livestock feeding units are scattered throughout the region. The project area is underlain by the shallow Big Sioux water table aquifer which provides drinking water for small towns and farms.

Oakwood Lakes, Dry Lake, Lake Albert, and Lake Poinsett provide a major recreational resource for the residents in the eastern part of the state. The lakes, of glacial origin, are shallow, hyper-eutrophic, and hydraulically connected to the underlying aquifer. Fish kills, algae blooms, and excessive algae growth greatly restricted the recreational use of the lakes and excessive nitrate levels violated drinking water standards in water from the Big Sioux aquifer. Monitoring showed elevated levels of nutrients being transported into the lakes via intermittent tributaries. All pollutants were believed to be related to the agriculture in the area.

The water quality objectives of the project were to reduce nonpoint sources of nutrients, pesticides, water- and sediment-borne pollutants, and animal wastes. To meet the water quality objectives, project land treatment goals were to implement conservation tillage and pesticide management on 52,000 acres and fertilizer management on 56,000 acres, and to install eight animal waste management systems. Originally, the project designated 79,450 acres as critical. Later 59,500 acres (of the original 79,540) draining directly to the lakes and having a shallow water table were designated as "Priority Area 1," the highest priority for best management practice (BMP) implementation.

Final tallies indicate that the project obtained contracts on 81% of the Priority Area 1 (60% of the original critical area) with most farmers maintaining the best management practices (BMPs) after the project ended. Implementation of the BMPs reduced the sediment entering the lake system but had little effect on the quality of the surface and ground water.

The monitoring efforts in this project added greatly to our understanding of nonpoint source (NPS) pollution. This Comprehensive Monitoring and Evaluation project instituted three major monitoring efforts: ground water monitoring of field sites to determine inputs to ground water from fields, the Oakwood Lakes System Study to evaluate inputs of nutrients to the lakes from surface and ground water, and the Agricultural Chemical Leaching Study to evaluate the transient movement of agricultural leachates in the vadose zone. Innovative techniques to monitor in the vadose zone and in the lakes were developed as part of these intensive studies.

The project has been an outstanding success in developing monitoring techniques for NPS controls. It received excellent interagency cooperation throughout its duration. Comprehensive planning and an intensive monitoring program resulted in gathering valuable information concerning NPS control. The hiring of a temporary full-time technical planner greatly increased producer participation and contributed significantly to the overall success of the project.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

Overall project goals did not change during the project. Reductions in nutrients, pesticides, water and sediment-borne pollutants, and animal wastes entering the surface and ground water systems remained the overall goals throughout.

Emphasis on BMPs did change in response to water quality monitoring data, which indicated that certain BMPs would be more effective in achieving project goals. Monitoring data showed that animal waste management could significantly reduce nutrient inputs to the surface water.

As the project progressed, information and education goals changed to include information transfer of project findings and accomplishments to audiences outside the project area.

Water quality monitoring goals and objectives did not change throughout the project but strategies and methods were refined. Additional emphasis was placed on surface water and vadose zone monitoring.

4.2.1.2 Recommendations

Water quality problems should be accurately defined and clearly stated to enable the development of achievable goals and objectives. Water quality problem statements should be based on pre-implementation data collected from the project area.

Sources of water quality problems and their respective significance should be determined to allow effective targeting of BMP implementation, cost share funds, and Information and Education efforts.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

Two positions created to assist the project were vital to its success. A part-time coordinator at the local level enhanced program administration and interagency cooperation. The second position, a temporary full-time technical planner hired by the Conservation District, greatly aided the acceptance of the program by producers and implementation of the BMPs. Since both positions were fully devoted to Rural Clean Water Program (RCWP), they were able to make much better progress for the program than if program duties had been simply added to already full schedules of permanent employees.

Delays on National Coordinating Committee (NCC) decisions, report reviews, and program changes impaired the ability of the project to respond and make appropriate adjustments to project-level conditions. This was evident in joint participation teams where the Cooperative Extension Service (CES) and the Economic Research Service (ERS), who received their directions from the national level offices rather than the state or local offices, had problems coordinating with the other agencies.

Interagency cooperation and adequate resources at all levels are necessary for a successful project. The State Coordinating Committee (SCC) was very successful in ensuring that adequate resources were dedicated to meet project objectives.

State-level mechanisms, such as contracts, memoranda of understanding (MOUs), and memoranda of agreement (MOAs), can provide formal and legal arrangements that keep duties and tasks clear and allow for proper planning and funding of each agency's project activities.

Coordination of land treatment efforts between the SCC and the Local Coordinating Committee (LCC) was very smooth and a major reason for the success of the project.

4.2.2.1 Findings and Successes (continued)

Active participation of the USEPA Region VIII nonpoint source coordinator (as a member of the SCC) was very important. This participation made travel funding available for project participants to attend RCWP workshops and brought national attention to the local project.

The availability of technical experts, such as geologists and hydrogeologists from the federal agencies involved, was very important in the development of the program.

Contracting with the state water quality agency to perform the water quality monitoring was very effective.

At the local level, the LCC was active during implementation of land treatment but not as active as it could have been during the monitoring and evaluation phases of the project.

Informal contacts and exchange of annual reports among RWCP projects provided new ideas for the project and stimulated self evaluation.

4.2.2.2 Recommendations

Project work plans should specify responsibilities for a project coordinator and a technical planner at the local level and an active SCC and LCC.

A data base should be established early to provide a cumulative summary of project accomplishments for the project's duration. This is essential for reporting purposes and for information exchange between the project's land treatment and water quality teams.

Responsibility for key project activities should be shared by several team members to ensure continuity despite staff turnovers.

Regional workshops for two to four projects addressing similar water quality or other regional problems should be planned at the national level to facilitate exchange of ideas among projects.

Economic analysis should be incorporated into the state and local work plans at the beginning of the project to allow for use of economic data and possible adjustments to the project strategy. Economic analysts should work in close coordination with the other project participants to provide a meaningful analysis of project impacts.

4.2.3 Infomation and Education

4.2.3.1 Findings and Successes

Direct one-to-one contact with producers resulted in good producer participation. Public meetings and mass media were used to create an awareness of the project goals.

Other audiences besides the producers, mainly recreational interests, were concerned primarily with water quality improvements and had little interest in practices adopted by the farmers.

Project findings, as well as national and regional information programs, were immediately incorporated into the information and education (I&E) program.

Fertilizer and pesticide management programs were well received by producers. The acceptance of these efforts may be due to positive effects of these programs on both profitability and water quality.

4.2.3.2 Recommendations

An active I&E program is essential for a successful NPS control project.

An I&E committee consisting of representatives of cooperating agencies should develop a strategy, provide guidance, and prepare a program to last throughout the project. The I&E program should be approved by the project management team.

An annual I&E plan should be developed to identify specific activities, needed materials, responsible agencies and individuals, and timetables for completion of activities. Such a plan would allow the I&E activities to evolve with the program.

The I&E program should be evaluated annually to ensure that needed activities are being carried out. All I&E materials developed should be recorded and maintained in an appropriate file.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

The project was well received. Participation by landowners was 81% for the Priority 1 Area (Priority 1 Area is equivalent to critical area).

Producers were influenced primarily by the effect of the pollution control practices on profits, although many were concerned about water pollution.

The main incentive for producers was cost sharing. Some farmers used cost share money to purchase new equipment and try alternative farming methods.

One-to-one contacts with producers and follow-up contacts ensured the success of the project.

4.2.4.2 Recommendations

Future projects should include monetary incentives and personal contacts to obtain participation.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

Conservation tillage was the BMP most used by the participants. This BMP was effective in reducing sedimentation of the Oakwood Lakes-Poinsett waters and transport of sediment-bound phosphorus to the lakes. Reducing sedimentation is important because these shallow lakes are very susceptible to being filled in with sediment. Reducing phosphorus inputs will limit the rate of eutrophication because phosphorus is the limiting nutrient in the lakes.

Most producers have continued to use conservation tillage after expiration of their contracts.

Animal waste management systems were not well received due to the high cost of such systems and the economic stresses of the early '80s.

Scouting for pests was well received and continues to be used by producers.

Critical area mapping was hampered until sufficient hydrogeological data were collected to outline the Big Sioux aquifer and identify those areas where the ground water was most susceptible to agricultural or other activities on the land surface.

Designation of the "Priority Area 1" (equivalent to critical area in other projects) allowed more effective use of cost share funds to attain desired goals.

Economic modeling results indicated that fertilizer management was the most cost-effective strategy to reduce nutrient loading.

The federal Payment-in-Kind (PIK) Program reduced the number of acres which qualified for the conservation tillage systems under the RCWP due to the one year set-aside for PIK.

The federal Conservation Reserve Program (CRP) positively affected water quality in the project area by converting 7,000 acres of cropland to permanent vegetative cover for ten years.

4.2.5.2 Recommendations

Land use and agricultural management data should be obtained before BMP implementation.

To control sediment and nutrient loading (especially sediment-bound nutrients), contracts should include conservation tillage, fertilizer management, pesticide management, and animal waste management as minimum requirements.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

Monitoring results showed that measurable water quality improvements may not occur through the use of land treatment as practiced in the RCWP. Sediment reduction may extend the life of the lakes, but phosphorus from surface and ground water is efficiently trapped and stored in lake sediments, providing a large reservoir to promote hyper-eutrophic conditions.

Site-specific monitoring was chosen to assess the impacts of actual farming practices on water quality and evaluate the effectiveness of the project. This approach was taken for several reasons: 1) land treatment had already been implemented before monitoring commenced, allowing only trend analysis to be used to determine water quality improvements; 2) the BMPs set up for RCWP had been designed to reduce surface water pollution and little was known of their effect on ground water; and 3) although the hydrology of the area was not fully understood, ground water inputs to the lakes were thought to be very important. However, the site-specific approach encountered difficulties because variations in farming techniques introduced by individual operators tended to compromise portions of the monitoring design.

In situ geologic monitoring allowed the development of "geozone" classifications which aggregate hydrogeologic environments, thereby reducing the numbers of samples needed for statistical analysis. The project characterized each monitoring well by the site-specific geologic stratum, or geozone, in which it was screened and the depth of the well screen. This method of characterization is transferable to other ground water monitoring projects.

Monitoring site selection and easements for egress/ingress were limited by the willingness of landowners to cooperate. This affected the monitoring design and the ability of the project team to adjust the monitoring strategy to better compare practices and impacts.

Nested wells allowed sampling of stratification, vertical gradients, and water quality differences in varying geologic strata. Horizontal sampling of the vadose zone, tracer studies, and electronic tensiometers were used to monitor infiltration and ground water flow pathways. Automatic sampling of the vadose zone allowed collection of macropore water from storm events.

Seepage meters defined ground water movement through lake beds, but on-land wells and in-lake wells provided better data to estimate water quality and nutrients entering the lake system.

Individual storm events and seasonal pollutant loadings could be described using event-based automatic sampling data from the master (research) site.

The Oakwood Lakes System Study is a good example of development of a materials (nutrient, sediment, water) budget to understand the processes that affect NPS pollution of shallow prairie lakes.

Given the difficulties of monitoring land use impacts on ground water quality on a watershed scale, the project's field studies offer a good approach to documenting the effect of conservation tillage. However, the ground water field sites experiment had only one site with conventional tillage to serve as a comparison with the conservation tillage field sites; thus there were no replications.

Monitoring of the field sites was hampered by the cooperators who modified or implemented the BMPs in their own unique styles which affected the monitoring results and introduced much variability and uncertainty.

Constraints affecting access to private land to conduct monitoring activities can sometimes limit the application of the monitoring program; therefore, the need to work closely with landowners while developing the monitoring network is very important.

4.2.6.2 Recommendations

Monitoring methods and strategies should be designed to meet the monitoring objectives.

Funds for purchase of easements should be provided to enable optimal monitoring system design and capability for changes in the design. Also, funds should be available to enable farmers to radically change land use practices to obtain comparisons of different practices on the same site.

Event-based monitoring is necessary to determine ground water transport mechanisms and frequent sampling is necessary to follow pesticide and nutrient movement.

Pesticides used previously on field sites should be included in pesticide scans because of pesticide persistence in the unsaturated soil horizon.

A thorough understanding of project area geology is essential for accurate interpretation of ground water monitoring results. Future projects should perform geologic investigations, especially in a project with complex hydrogeology, even though such studies can be time-consuming and expensive.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

Correlation of BMP implementation with tributary water quality was not possible because record keeping of BMP implementation was by farm unit rather than by watershed.

There is no observable difference in water quality in the lakes attributable to BMP implementation. BMPs used may extend the life of the lakes by reducing sedimentation but may not result in measurable water quality improvements. The lakes trap nutrients in inflowing waters very effectively and the lake sediments act as a reservoir of nutrients; hence, it is likely that eutrophic conditions will continue in the lakes.

No significant differences in ground water quality were found as a result of different tillage practices.

Water movement through the vadose zone was more rapid with no-till than with conventional moldboard plowing. Water from the no-till plots delivered higher quantities of nitrates to the 6-foot depth; however, overall nitrate concentrations in the deeper ground water were lower under no-till plots. This is perhaps due to enhanced denitrification that could occur as a result of enhanced transport of carbon substrates to deeper soil depths under no-till tillage.

The ground water monitoring program showed that under the site conditions in the project area agricultural pesticides had a negligible impact on ground water quality.

4.2.7.2 Recommendations

A record of BMP implementation should be kept by watershed unit in order to make possible a proper evaluation of program effectiveness.

Water quality and land treatment teams should work together to identify appropriate BMPs to protect the water resource.

Agricultural waste management should be considered in watershed protection plans where agricultural wastes have been identified as a problem. Agricultural waste management designs should include ground water protection.

Protection strategies for vulnerable groundwater aquifers should employ fertilizer and pesticide management, crop rotations requiring little or no nitrogen, and conservation tillage practices.

4.3 Project Description

4.3.1 Project Type and Time Frame

Comprehensive Monitoring and Evaluation RCWP Project (CM&E)

1981 - 1991

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Lake Poinsett, Lake Albert, Oakwood Lakes, ground water (portions of the Big Sioux aquifer)

4.3.2.1.2 Water Uses and Impairments

The project area has several lakes, sloughs, and shallow ground water aquifers. The lakes are heavily used for recreation (fishing, boating, swimming, water-skiing) and stock watering. Recreational visitations to the lakes number about 300,000 annually. Ground water is relied upon for drinking water and stock watering. Approximately 174,000 people live within fifty miles of the lakes.

Recreational activities are impaired by hyper-eutrophic conditions in the lakes. Algal blooms, excessive aquatic weed growth, and dissolved oxygen (DO) depletion are common. Pesticides and excessive nitrates in ground water are also of primary concern.

4.3.2.1.3 Water Quality Problem Statement

The quality of shallow ground water used for drinking water and watering livestock is threatened by high levels of nitrate-nitrogen associated with commercial fertilizers applied to cropland. Recreational activities at several shallow prairie lakes in the project area are threatened and impaired by hyper-eutrophic conditions aggravated by sediment and excessive nutrients in runoff from agricultural activities.

4.3.2.1.4 Water Quality Objectives and Goals

Objective: Improve and protect surface and ground water quality of the area

Goals: Reduce the amount of total nitrogen, pesticides, animal waste, and other pollutants entering ground and surface waters

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: NA
Project Area: 106,163 acres
Critical Area: 79,450 acres
Priority 1 Area: 59,500 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 22 inches

Geologic Factors: The project area has typical glacial Pleistocene morphology with many glacial outwash deposits, lakes, potholes, and shallow ground water resources. Soils are deep, silty, loamy and well- drained on rolling slopes. Generally, the water table is about 10 feet below ground level. Ground water flow is active and a large aquifer, the Big Sioux, underlies a portion of the project area and is hydraulically connected to the lake system.

The lakes serve as either discharge or recharge areas for the aquifer.

4.3.2.2.3 Project Area Agriculture

The area's economic base is production agriculture characterized by family farms averaging 600-700 acres in size. Major crops include corn, oats, soybeans, and wheat while barley, sunflowers, flax, rye, and alfalfa-brome also are grown. Small livestock operations raising cattle and hogs are scattered throughout the area.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	61	61
Pasture/range	13	40
Water	11	-
Other	15	-

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	8	830	1,162
Beef	20	2,550	2,550
Hogs	8	4,500	1,800
Sheep	3	375	38

Source: Oakwood Lakes-Poinsett RCWP Project Annual Report, 1986

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	744,729	0	271,613	0	1,016,342
Info. & Ed.	109,268	0	0	54,634	163,902
Tech. Asst.	939,258	0	0	40,000	979,258
Water Quality Monitoring	1,666,927	200,000	0	350,000	2,216,92
SUM	3,460,182	200,000	271,613	444,634	$4,376,429

Source: Goodman et al., 1991

4.3.4 Information and Education

4.3.4.1 Strategy

The information and education strategy was to utilize the strengths of the various agencies involved and have them concentrate on their specialty areas (see section 4.3.4.3 below)

4.3.4.2 Objectives and Goals

Objectives:

Inform and instruct the general public and producers about the RCWP and how to participate in it

Report the accomplishments of the program

Goals:

Obtain 75% participation in RCWP

Use the information learned from RCWP to maintain or improve agricultural productivity while minimizing impacts on the environment

4.3.4.3 Program Components

Each agency involved concentrated on a specialty area to provide information or instruction for the general public or producers.

The CES provided general information to the public and participants about the program. During the middle years of the program, CES provided detailed support and individual contact for producers in fertilizer and pesticide management and general BMP implementation. During the latter half of the project, the emphasis changed to providing information about accomplishments of the project.

The SCS concentrated on one-to-one contact with producers about project participation and BMP implementation.

The ASCS provided producers with information on project information and cost sharing.

The South Dakota Department of Environment and Natural Resources and the Water Resources Institute of South Dakota State University prepared reports and disseminated information as quickly as possible to project personnel and the public.

4.3.5 Producer Participation

4.3.5.1 Level of Participation

Producer participation was high. Contracts were implemented in 80% of the Priority 1 Area (equivalent to critical area), obtaining the participation of 157 producers.

4.3.5.2 Incentives to Participation

Cost share rate of 75%

Payment limit of $50,000 per farm

Cost sharing was the most important incentive. The cost share funds enabled some producers to try alternatives with which they would not otherwise have experimented.

I & E program to support fertilizer and pesticide management BMPs offered assistance with interpreting soil test results and pest scouting service.

Conservation tillage was well received by the producers and continues to be utilized.

4.3.5.2 Incentives to Participation (continued)

Pest scouting was well received and is continuing.

Individual contacts and continuous follow-up ensured the project's success.

4.3.5.3 Barriers to Participation

Animal waste management systems were not well accepted due to their high costs and general economic stresses which occurred during the project period.

Some producers were not eligible for RCWP cost sharing because they were already using conservation tillage systems.

Economic conditions and changes in land ownership prevented some BMPs from being implemented.

Other federal programs hampered the RCWP by removing land from eligibility. The Payment-in-Kind (PIK) Program reduced the number of acres which qualified for the conservation tillage systems under the RCWP due to the one year set-aside for PIK. The Conservation Reserve Program (CRP) positively affected water quality in the project area by converting 7,000 acres of cropland to permanent vegetative cover for ten years.

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

BMPs such as conservation tillage systems, fertilizer and pesticide management, and pest scouting have been well received and are expected to be continued.

Animal waste management systems were not well received and have lower chances for further adoption, although those installed will be maintained.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The program emphasized four BMPs: conservation tillage systems, fertilizer management, pesticide management, and animal waste systems. These BMPs were viewed as having the greatest potential impact and the best chances for acceptance.

4.3.6.2 Objectives and Goals

Implement fertilizer and pesticide management, conservation tillage, and animal waste management to improve and protect surface and ground water

Quantified Implementation Goals:

Fertilizer management on 56,000 acres (66% of project area)
Pesticide management on 52,000 acres (61% of project area)
Conservation tillage for erosion control on 56,000 acres
Waste management systems on 8 livestock operations

4.3.6.3 Critical Area Criteria and Application

Criteria: All cropland and grassland (79,450 acres). The project area was divided into three priority areas based on sediment delivery and the impact on ground water (regional ground water movement, distance from lakes or streams, drainage characteristics, and thickness of overburden). First priority (59,500 acres) included most of the livestock operations and encircled the lakes.

4.3.6.4 Best Management Practices Used

General Scheme:

Reduce nutrients and pesticides entering ground water using fertilizer and pesticide management (BMP 15 & 16)

Reduce sediment related pollutants entering waterways and lakes using conservation tillage (BMP 9)

Reduce amount of animal waste entering waterways, lakes and ground water by applying animal waste management systems (BMP 2)

BMPs Utilized in the Project*	Project Accomplishments
Permanent vegetative cover (BMP 1)	1365 acres
Animal waste system (BMP 2)	3 systems
Stripcropping systems (BMP 3)	132 acres
Terrace system (BMP 4)	10,101 feet
Grazing land protection system (BMP 6)	6 systems
Waterway system (BMP 7)	4.2 acres
Cropland protection system (BMP 8)	2321 rod rows
Conservation tillage system (BMP 9)	81,820 acres
Fertilizer management (BMP 15)	45,571 acres
Pesticide management (BMP 16)	16,011 acres

* Please refer to Appendix I for description/purpose of BMPs.

Source: Goodman et al., 1991

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

The project tracks land use, cropping patterns, and yields on an annual basis. These data include acreage enrolled in programs such as Payment-in-Kind (PIK) and Conservation Reserve (CRP). BMP implementation data are reported in units applied (acres, systems, feet), cost share earned (dollars), and calculated soil loss prevented (tons). Records are maintained by SCS, ASCS, and CES.

4.3.6.5.2 Data Management

Land use records were updated yearly through personal interviews with landowners. Crops, fertilizer application, pesticide application, and tillage methods were obtained for each field for each year.

4.3.6.5.3 Data Analysis and Results

Land treatment data were managed by the SCS, CES, and ASCS to target landowners in the Priority Area 1, and to direct the monitoring efforts.

Quantified Project Achievements:

		Critical Area		Treatment Goals	
Pollutant Source	Units	Total	% Implemented	Total	% Implemented
Cropland	acres	79,450	54%	59,590	81%
Dairies	units	0	0%	0	0%
Feedlots	units	16	57%	8	37%
Contracts	#	157	100%	186	84%

Source: Goodman et al., 1991

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The approach was to study the soil profile and ground water in small field areas and the surface water in one lake system. The knowledge gained would then be used to extrapolate to other areas using hydrologic models.

4.3.7.2 Objectives and Goals

The overall CM&E Objective: Describe the cause and effect relationship between the application of agricultural BMPs and changes in the quality of the ground and surface water. Interpretation of site-specific data will provide the basis for estimating BMP effectiveness on a project-wide level.

Ground Water: Study the effects of conservation tillage, fertilizer management, and pesticide management on the quality of shallow ground water

Vadose Zone and Agricultural Chemical Leaching Study: Differentiate the effects of tillage systems and crops on soil water fluxes and ground water quality.

Since 1986, specific goals for extended monitoring at the master site have been:

Determine the differences in vertical fluxes of nitrates, organics, tracers, and water to specific depths between moldboard plow and no- till tillage systems for a corn-oats rotation

Develop an event-actuated monitoring/control system for collecting low tension unsaturated soil water (characteristic of soil water held in macropores), during or after precipitation/leaching events

Determine the differences in response time to a given precipitation event for changes in matric potential at specific depths between no-till and moldboard plow tillage systems on oats and corn.

Oakwood Lakes System: Determine if BMP application in an agricultural watershed will affect the water quality of shallow, hyper-eutrophic prairie lakes. The strategy incorporates monitoring of water quality and quantity, biological surveys, land use modeling, and lake modeling.

4.3.7.3 Time Frame

Ground Water: 1984-1990

Vadose Zone: Originally 1982-1986; extended 1987-1989

Oakwood Lakes System Study: 1987-1989

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

Ground Water:
7 field sites (10 - 80 acres)
6 farmed (5 with BMP treatment - conservation tillage)
1 control site (not farmed)
114 monitoring wells at 60 locations

Vadose Zone Monitoring:
1 field site (the master site) with 15 test plots: (approx. 105' by 55')

Test plots: corn-oats rotation on 2 tillage systems (moldboard & no-till) with 3 replications of each crop/tillage management system (12 plots); and 3 replications of an alfalfa treatment (3 plots)

Fertilizer and pesticide application on test plots: 200 lbs. of actual N for corn; 100 lbs. of actual N for oats; no fertilizer for alfalfa; pesticides applied at label rates for each tillage system (alachlor, dicamba, metolachlor, terbufos, 2-4 D ester, MCPA, carbofuran, glyphosate)

Oakwood Lakes System Study

Surface Water:
7 stations at all tributaries to the lakes system
7 in-lake stations
3 inter-lake stations

Ground Water: 29 terrestrial wells
nested wells at some sites
37 seepage meters
20 in-lake wells

4.3.7.4.2 Sample Type

Oakwood Lakes System Study:
Tributary and Interlake:

Grab samples for base flow and snowmelt

Automatic samplers at all tributaries to collect runoff when it occurs

In-lake:

Integrated sampler at lake surface and within 1 foot of lake bottom

4.3.7.4.3 Sampling Frequency

Ground Water: All wells sampled quarterly from 1984 through August 1989; All wells sampled every 2 weeks from August 1989 through December 1990; Pesticide wells sampled monthly from 1984 through December 1990; Pesticide wells sampled every 2 weeks during June/July of 1989 and June/July of 1990.

Vadose Zone: Hourly automatic soil matric potential monitoring which triggers soil water sampling during leaching events (a significant increase in soil water content sensed at 2 ft. below the surface)

Oakwood Lakes System Study

Tributary and Interlake: Determined by hydrologic activity

Base flow: Weekly for all inlet tributaries; 3 times per week for interlake sites and outlet

Snow melt: Once to twice daily;

In-lake stations: Every two weeks from May - October; monthly from November - April

Terrestrial wells: Every 2 months; water levels recorded weekly through 1988;

Seepage meters: Determined by seepage rate;

In-lake wells: All months except winter

4.3.7.4.4 Variables Analyzed

Ground Water:

Nitrite-nitrogen (NO_2-N) and nitrate-nitrogen (NO_3-N), ammonia nitrogen (NH_3- N), organic nitrogen, total dissolved phosphorus (TDP), chloride, sulfate, total dissolved iron, potassium, total hardness (occasionally), total alkalinity (occasionally), pesticide scan (21 compounds), pH, conductivity, and dissolved oxygen (DO)

Vadose Zone: NO_3-N, pesticide scan (11 compounds)

Oakwood Lakes System Study:

Tributary and interlake stations: Total phosphorus (TP), orthophosphorus (OP), NO_2-N, NO_3-N, NH_3-N, total Kjeldahl nitrogen (TKN), suspended solids (SS)
In-lake Stations: TP, OP, NO_2-N, NO_3-N, NH_3-N, TKN, pH, chlorophyll *a*, algal density, suspended solids (SS), total solids (TS), alkalinity, Secchi transparency
Terrestrial and In- lake wells: TDP, OP, NO_2-N, NO_3-N, NH_3-N, TKN, total dissolved solids (TDS), chloride, sulfate, water levels

4.3.7.4.5 Flow Measurement

None

4.3.7.4.6 Meteorologic Measurements

Agricultural Chemical Leaching Study

Amount and intensity of precipitation, solar radiation, soil and air temperature, wind speed and direction, and chemical quality of precipitation

Ground Water Study

Atmospheric Deposition: 2 rain gauges / combined wetfall and dryfall samples collected following rainfall events to measure bulk deposition and rain water (supplemental rain data collected by volunteers) / atmospheric samples analyzed for TP, NO_2+ NO_3-N, NH_3-N, TKN, pH, TDS

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

The Ground Water Study included collection of land use, soil profile, surface runoff, and climatic data.

Oakwood Lakes System Study also included phytoplankton and zooplankton dynamics, a fisheries study, land use histories for ground water field monitoring sites, and a denitrification study of soil cores collected from the field.

4.3.7.5 Data Management

The data are managed locally and by the South Dakota Department of Environment and Natural Resources and the Water Resources Institute.

4.3.7.6 Data Analysis and Results

Analysis:

Ground Water Field Site Monitoring: Well data were tested for normality using the Shapiro-Wilk or Kolmogorov-Smirnov test as appropriate. Non-normal distributions typical of ground water data required the use of nonparametric statistics such as the Mann Whitney U or equivalent Wilcoxan 2 Sample Test. Median values were selected for analysis since these are less responsive to outliers. Plots were made of NO_3- N medians versus time and depth below water table, and for each hydrogeologic setting, or geozone. Pesticide detections were plotted by year, month, and geozone.

Vadose Zone Monitoring: Preliminary analysis has been performed to determine if there is a relationship between the amount of nitrogen applied at the soil surface and the amount detected in water from the saturated zone. Linear regression was used for all tillage treatments, no-till treatments alone, and moldboard plow treatments alone. Pesticide detections were plotted by depth and cropping treatment. Concentrations of the most often detected compound, Banvel, were plotted versus cropping treatment.

Oakwood Lakes System Study: The project is developing nutrient, sediment, and hydrologic budgets for comparison with reductions in loadings estimated by watershed models following verification of the AGNPS model.

Please refer to the Oakwood Lakes- Poinsett, South Dakota Rural Clean Water Program Comprehensive Monitoring and Evaluation Technical Report, 1988, May, 1989, and the Oakwood Lakes-Poinsett Rural Clean Water Program Ten-year Report, December 1991 (Goodman, et al., 1991), for a comprehensive description of data analysis and results.

Results:

Ground Water Monitoring

Nitrate was the predominate form of nitrogen and was found at all sites. All sites had at least one well with nitrates exceeding 10 mg/l; however, nitrate concentrations rarely exceeded 5 mg/l at depths of more than 20 feet below the water table. Certain geologic profiles showed higher concentrations of nitrates than other profiles in similar conditions.

Monitoring confirmed that nitrate concentrations are controlled by the amount of nitrogen applied to the land surface (dependent on crop), the amount and rate of infiltration (nitrate concentrations declined during and after rainfall due to dilution), and the amount and rate of denitrification occurring in the soil zones.

Pesticides were detected in 11.3% of the ground water samples. Evidence indicates that pesticide residues bind to the soil particles remaining in the soil profile for long periods until being released to the ground water during infiltration events.

4.3.7.6 Data Analysis and Results (continued)

Vadose Zone Monitoring

Rainwater movement to the water table is faster for no-till tillage than for the conventional moldboard plow tillage. Tillage was not important in pesticide detections but no-till plots showed a higher flux of nitrate into the ground water than moldboard plowing plots.

The most significant flow path in the vadose zone is macropores, or pores with diameters greater than 0.04 inches.

Oakwood Lakes Monitoring

The lakes system is hyper-eutrophic and will remain so due to the following factors: all tributaries carry excessive nutrients; the lakes efficiently trap the majority of phosphorus entering the lakes; and even if the nutrients in surface runoff were reduced, the lakes' sediments will contribute an amount of phosphorus equal to the amount brought in by tributaries. BMP implementation may extend the lifetime of the lakes through reductions in sedimentation, but will not reduce the hyper-eutrophic conditions.

Concentrated animal feeding operations contribute significantly to degradation of water quality as compared to allowing the animals to graze on pastures.

Correlation of water quality with BMP implementation was not possible because BMP implementation was recorded by farm unit rather than by watersheds.

4.3.8 Linkage of Land Treatment and Water Quality

This project utilized a comprehensive multi-pronged effort to study the effects of land treatment on surface and ground water quality. Monitoring was done on farms, research sites, and in the lakes with the idea that site-specific results could be used to estimate, by modeling, the effectiveness of BMP implementation on the overall project area. The site-specific monitoring yielded much information on transport processes and pathways by which pollutants enter surface or ground water and on techniques for measuring pollutants in surface and ground water and lakes.

However, the lack of measurements of the actual tributary surface and ground water resources before BMP implementation, and the dispersed locations of the BMPs in the critical area (Priority Area 1) prevented the project team from reaching a definitive conclusion as to the effect of land treatment on the water quality. Future projects should concentrate efforts on obtaining actual water quality improvements through paired watershed or pre/post BMP implementation studies where a high percentage of BMP implementation can be obtained in the selected project area.

Several additional studies that became part of the overall monitoring for this project were conducted. Those studies included the Land Surface Nutrient Budget Study (to contribute data on mineralization and denitrification of nitrates), the Agricultural Chemical Leaching Study (to provide information to enable more precise predictions of water quality and movement in the soil zone), and the Oakwood Lakes System Study (to evaluate the water quality impacts of BMP implementation by determining hydrologic and nutrient budgets for the Oakwood Lakes).

Much analysis was done to determine the effects of alternate tillage systems, crops, and BMPs on surface and ground water. Records were kept of the crops planted and fertilizer and pesticides used and were correlated to water quality measurements. Mathematical modeling was used to predict nutrient loading and help in making a nutrient budget for the lakes system.

4.3.9 Impact of Other Federal and State Programs on the Project

Programs that affected the RCWP were the Payment in Kind (PIK) Program and the Conservation Reserve Program (CRP). These programs took significant amounts of land out of production and changed cropping patterns. These changes affected the modeling of the water quality improvements because the erosion rates and fertilizer inputs were changed from the usual crop uses.

The Dairy Termination Program eliminated only three operators in the area during the project period.

No programs affected water resources management during the RCWP project.

4.3.10 Other Pertinent Information

The Oakwood Lakes study is a good example of development of a materials (nutrient, sediment, water) budget to understand the processes that affect NPS pollution of shallow prairie lakes.

Given the difficulties of monitoring land use impacts on ground water quality on a watershed scale, the project's field studies offer a good approach to documenting the effect of conservation tillage. However, the ground water field sites experiment had only one site with conventional tillage to serve as a comparison with the conservation tillage field sites; thus there were no replications.

Constraints affecting access to private land to conduct monitoring activities can sometimes limit the application of the monitoring program; therefore, the need to work closely with landowners while developing the monitoring network is very important.

4.3.11 References

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

Goodman, J., M. Kuck, R. Larson, D. Clayton, K. Cameron-Howell, A. Bender, L. Holtsclaw, D. German, J. Bischoff, J. Davis, C.G. Kimball, T. Lemme, C. Berry, C. Ullery, G. Carlson. 1991. Ten-Year Report: Oakwood Lakes-Poinsett Rural Clean Water Program 1981-1991. South Dakota Department of Environment and Natural Resources, South Dakota State University, Water Resources Institute, Pierre, SD.

Oakwood Lakes - Poinsett, South Dakota. 1986. Annual RCWP Progress Report - Project 20.

4.3.12 Project Contacts

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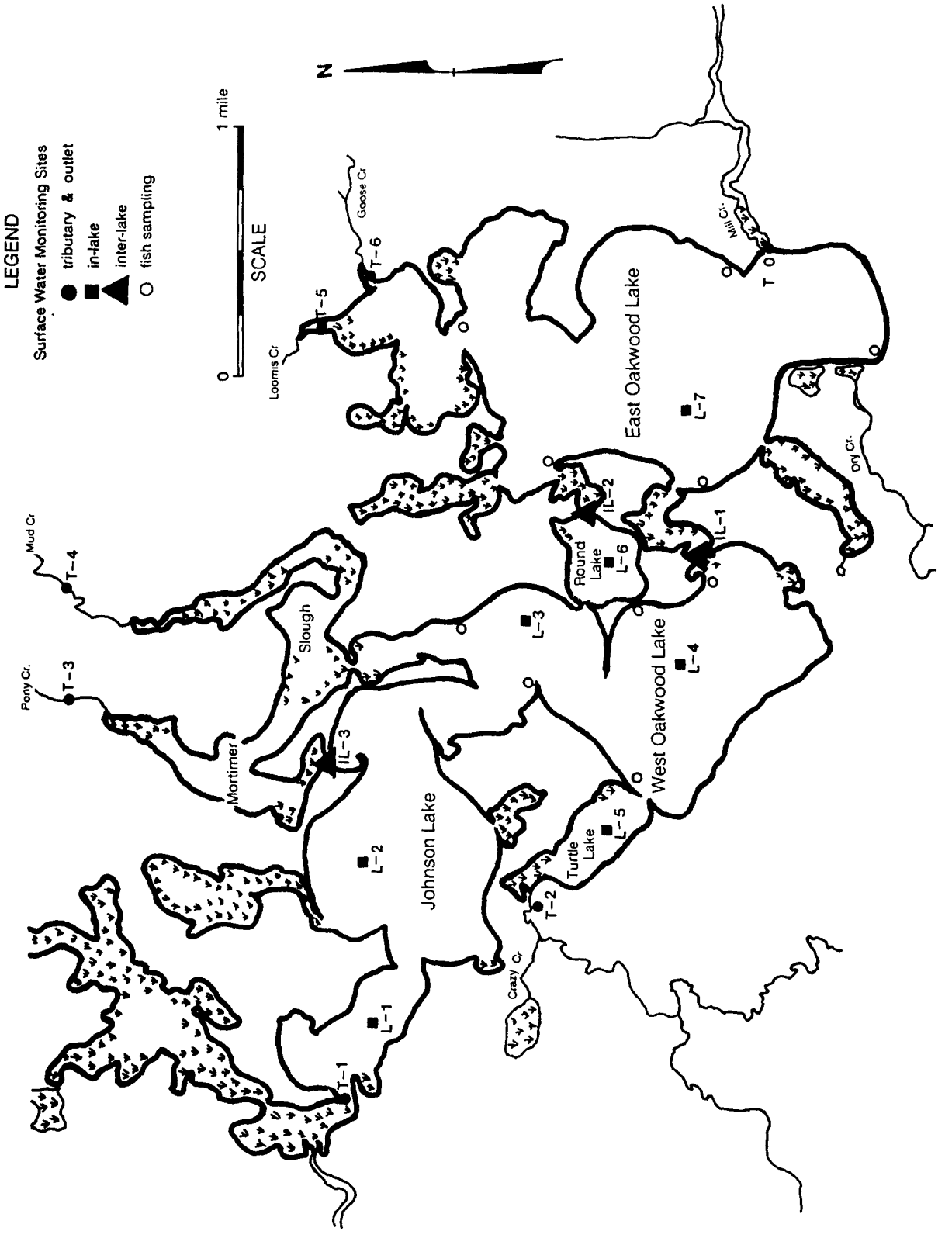


Figure 4.20: Oakwood Lakes - Poinsett (South Dakota) RCWP project map, SD-2.

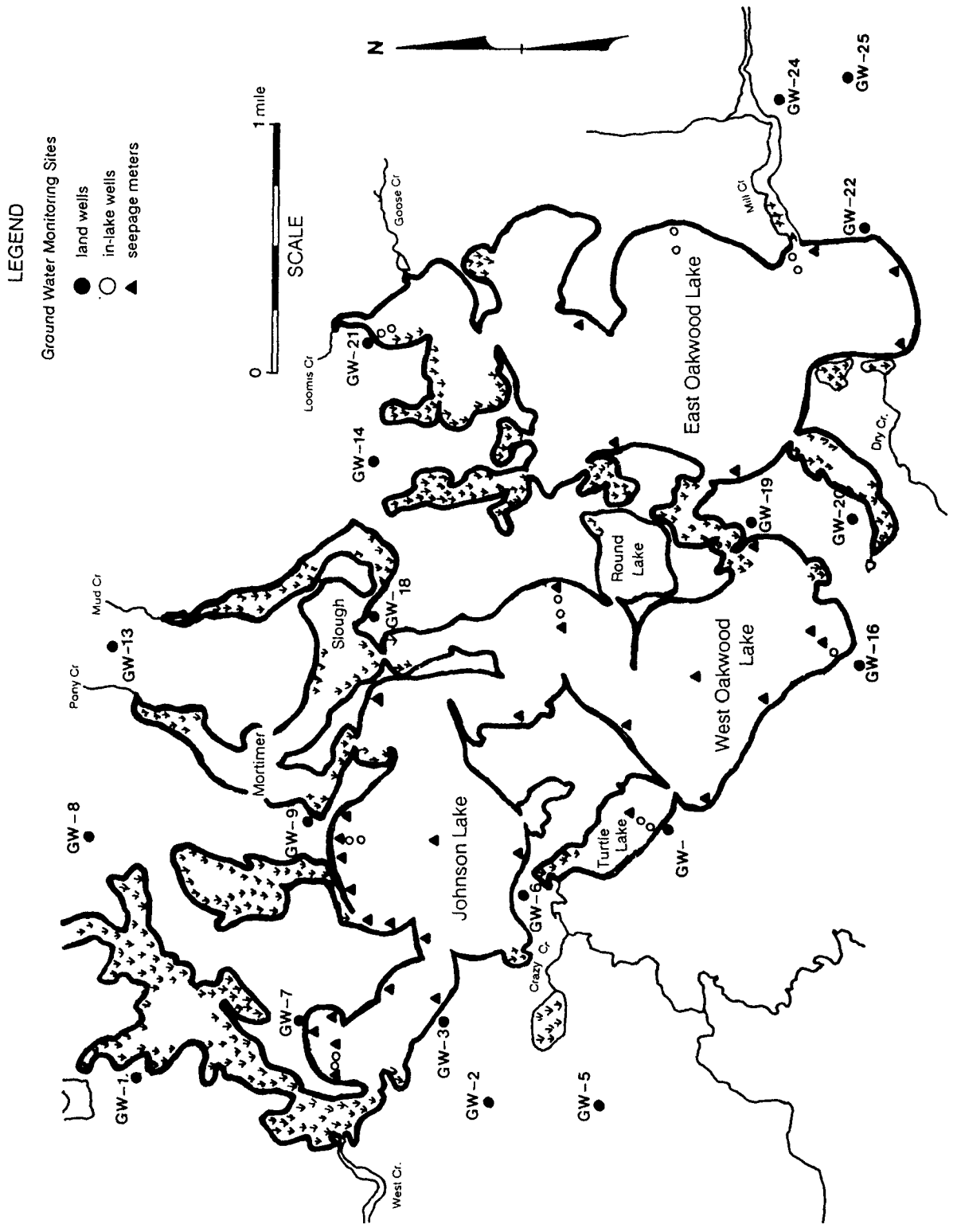


Figure 4.21: Oakwood Lakes - Poinsett (South Dakota) RCWP project map, SD-3.

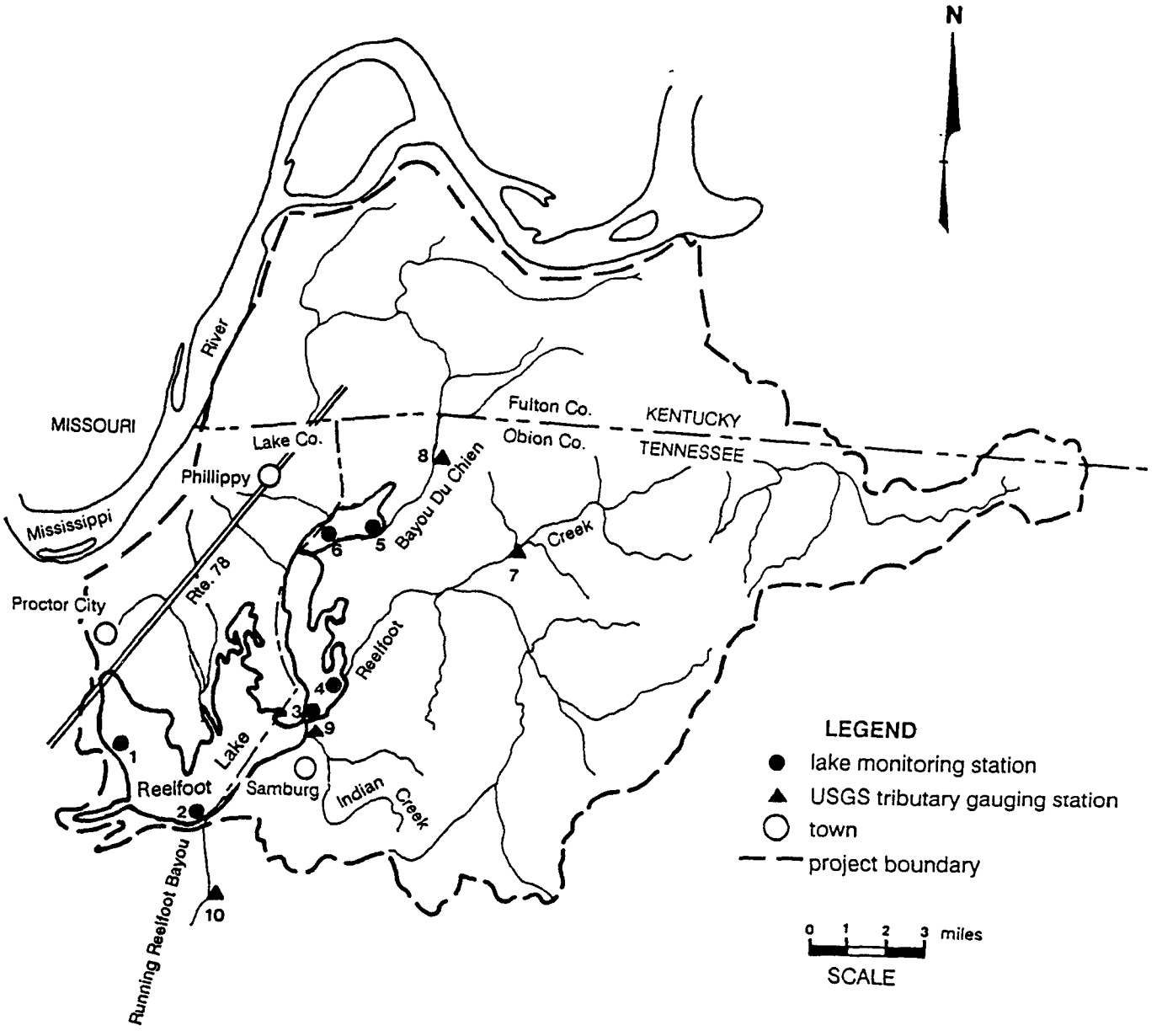
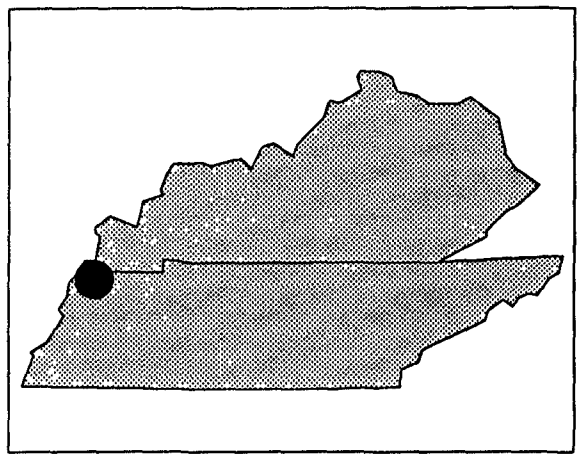


Figure 4.22: Reelfoot Lake (Tennessee/Kentucky) RCWP project map, TN/KY-1.

Tennessee/Kentucky Reelfoot Lake

(RCWP 10)



Obion & Lake Cos. (TN) & Fulton Co. (KY)
MLRA: 0-131 and P-134
HUC: 080102-02

4.1 Project Synopsis

Reelfoot Lake, the only natural lake in Tennessee, was formed from the Mississippi River through earthquake activity. Its drainage area encompasses land in Kentucky and Tennessee and covers a total of 153,600 acres. The lake attracts large, migratory waterfowl and wintering bald eagles. The lake is famous for its sport and commercial fisheries.

The land bordering the western side of the lake is characterized by steeply rising, loess-covered hills, 300 to 450 feet high. These hills are cropped with corn, wheat, and soybeans planted in rotation. Because of the topography, the land cannot be terraced and erosion from cropland is significant.

The water quality problem in Reelfoot Lake is caused by excess sediment and nutrients. If sedimentation is not reduced, Reelfoot Lake will fill in within the next 60 to 200 years. Cropland and gullies are the major sources of sediment. Large gullies are found on the eastern shore where runoff erodes the steep hillsides. These gullies, which form not only in cropped areas but also in forested and grassland areas, deposit a significant amount of sediment into Reelfoot Lake. The rate of sedimentation is amplified by man-made stream channelization (Denton, 1986). Lake eutrophication from nutrient runoff and alleged contamination of aquatic life by pesticides is also occurring.

Based on topography, erodibility, and closeness to Reelfoot Lake and streams, about one-third of the watershed (45,118 acres) was deemed critical. Approximately 60% (26,431 acres) of all critical acres were treated as part of the RCWP project.

The emphasis of the land treatment program was to retard erosion and to limit nutrient and pesticide influx into Reelfoot Lake. Six best management practices (BMPs) were used extensively to address water quality problems: permanent vegetative cover, conservation tillage, stream protection, permanent vegetative cover on critical areas, fertilizer management, and pesticide management.

Project coordination and cooperation between the two states was good. There was also an excellent cooperative effort among several agencies (local, state, and federal), providing a good model for how multiple agencies can coordinate to address a common water quality goal.

Four separate monitoring studies were conducted during the project. The monitoring design did not allow trend or statistical analysis. There has been no documented change in water quality during the project. Lack of water quality improvement was due to: 1) the lack of local ownership in the project and only fair farmer participation; 2) the need for the majority of the cropland on the eastern portion of the lake to be converted to pasture or hay crops or needing winter cover crops on all cropland; 3) the need for gully stabilization; and 4) the need for dechannelization of channels.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

One of the land treatment objectives, reducing erosion, was met. However, the other land treatment objective of improving water quality was not met.

Land treatment goals were overly ambitious and none of the six goals were met. Some of the goals were never even attempted, such as treating gullies.

The water quality objectives were diverse but the underlying theme of the objectives was to understand the entire lake as a system. Several of the objectives and their goals were met through appropriate water quality studies. The objective of determining short- and long-term benefits from implemented BMPs was not met due to the lack of a long-term water quality monitoring effort and an inadequate number of samples for trend detection. Additionally, if the information from some of the water quality studies conducted as part of the RCWP project had been available at the beginning of the project, it is possible that the water quality problem would have been addressed with different BMPs and different critical areas would have been defined.

4.2.1.2 Recommendations

The magnitude of the pollution problem must be adequately documented. Otherwise, realistic and attainable goals cannot be established.

Set realistic land treatment and water quality goals in order to ensure project success.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

Some members of the LCC believed that the local farmers should have had more of a role in project planning and that agency responsibility should have been primarily project administration. According to some individuals, the SCS was sometimes asked by the LCC to make decisions that should have been made by the LCC. The LCC stopped meeting quarterly in 1986, which decreased project communication.

The communication between the LCC and the SCC was quite good. These groups met on a regularly scheduled basis during the first two years of the contracting period. The SCC also gave assistance to the LCC upon request, but generally allowed the LCC to make the majority of the decisions.

Because this project encompassed two states and three counties, the logistics of project administration were often complicated. Simple procedures, such as permission for travel, often delayed inter-agency communication. Also, personnel in the same agency, but working in different states, often advocated different solutions to the same problem. In spite of these problems, there was excellent coordination and cooperation among the many different groups.

The project could have been strengthened by improved communication between land treatment and water quality personnel. BMP installation and water quality monitoring results were not effectively shared between the two groups.

4.2.2.2 Recommendations

The LCC needs to meet throughout the life of the project.

It is essential that water quality and land treatment personnel inform each other about the status of project activities and monitoring results.

An effective water quality project can span two states if both states and the agencies involved are willing to cooperate and communicate.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

Initially, the local CESs had the lead role in information and education (I&E) activities with help from all other agencies. The CES made mostly group presentations while the SCS and ASCS made the one-to-one contacts with producers. Later, the University of Tennessee Extension Service took the I&E leadership role. Extension specialists provided help with fertilizer and pesticide management BMPs, offering soil testing and technical assistance with Integrated Pest Management (IPM). Responsibility for the conservation tillage BMP was shared by CES and SCS.

Through the I&E effort, every farmer was contacted individually, one to three times, early in the project. Fewer contacts were made later in the project.

The I&E activities were well coordinated and extensive and involved all agencies. I&E was effective. Moderate producer participation was not a reflection of I&E effectiveness but was rather a reflection of the farmers' attitudes toward changing their farming practices and government programs.

4.2.3.2 Recommendations

Increase the use of public meetings to encourage participation, to explain contracting procedures, and to make implementation of BMPS more understandable for land users.

There should be continued enhancement of education and technical services offered in the watershed in order to foster continued adoption and maintenance of BMPs.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

Producer participation was fair. Only 59% of the critical acres was contracted. Some of the reasons cited by project personnel for the lack of participation were cost, the trouble involved in changing practices, and farmers not wanting to be told how to farm. There was also a problem in changing farmers' attitudes and awareness of the sources of the water quality problems. Even with all the I&E, many farmers still did not believe that they were contributing to the water quality problem.

There were problems contacting absentee landlords. It was difficult to convince absentee landlords as well as area farmers to seed cropland to pasture because they would experience a loss of income. When the project started paying 75% of the cost share for seeding, as well as an additional one-time $70 payment for converting cropland to pasture for ten years, participation increased.

Another way participation was increased was by allowing portions of a farm to be treated rather than requiring that all water quality problems on a farm be addressed.

4.2.4.2 Recommendations

Special monetary incentives should be made available in projects where large areas need to be converted from cropland to pasture.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

The project made all 16 approved RCWP BMPs available, although the implementation of only six BMPS met or exceeded project estimated needs. The six BMPs were stripcropping, conservation tillage, stream protection system, vegetation of critically eroding areas, fertilizer management, and pesticide management.

Only two BMPs (permanent vegetative cover and permanent vegetative cover on critical area) could reduce soil losses to acceptable levels on the more erosive soils. In spite of being the most cost effective BMP, permanent vegetative cover was not the most attractive BMP option to the farmers. This switch from row crops to pasture or hayland systems was too costly for many farmers and many farmers were not skillful grass managers.

Using the Universal Soil Loss Equation (USLE), calculated reduction in soil erosion was 800,000 tons from the RCWP project and another 325,000 tons from non-RCWP area projects.

Although area technicians estimated that 50% of the sediment was from the cropland and 50% from the gullies or "bully holes" (as they are called locally), the problem with the large gullies was never addressed. No accounting was kept of how much sediment the gullies were contributing to Reelfoot Lake. Despite the fact that large sums of money were spent on pilot projects to stabilize these structures, all stabilization techniques failed.

Land treatment was tracked manually by SCS technicians while the contracts were being carried out. Annual follow-up spot checks were made by SCS.

4.2.5.2 Recommendations

All sources contributing sediment must be identified. If there is more than one sediment source, a sediment budget should be completed prior to project implementation.

The amount and timing of sediment loaded into the water body must be documented in order to identify the correct BMPs.

If cropland is to be converted to pasture, a one-time payment should be made in conjunction with the installation cost share in order to subsidize farmers for loss of income during the period of pasture establishment.

Higher cost share incentives should be available for much needed streambank protection or riparian zone stabilization as a part of water quality projects.

Higher cost share incentives should be made available to encourage long-term cover crop implementation and maintenance.

Each Conservation Reserve Program (CRP) Plan or RCWP-like project in this area should include a sizable portion of wetland habitat since wetlands were so effective in trapping sediment from Reelfoot Lake (Reelfoot Lake RCWP Project, 1991).

Because the majority of the erosion occurs during the winter, a measure should be developed and implemented that would require winter cover crops.

Streams should be dechannelized to reduce their velocity and decrease their sediment loads.

Small watersheds that were not originally included under the Reelfoot Lake RCWP project, but which have been found to contribute significant amounts of localized sediment, should be targeted for BMP implementation.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

Water quality in the streams and lake was monitored for status only. No change in water quality chemistry was documented during the life of the project.

4.2.6.1 Findings and Successes (continued)

The RCWP assessment omitted over a dozen small watersheds on the eastern side of the lake, because they were considered insignificant contributors of sediment. However, a Cesium sedimentation study indicated that these watersheds may have very significant effects in localized areas of the lake where it is forming a stable soil structure (Denton, 1986).

Although 85% of all sediment deposited into Reelfoot Lake comes from Reelfoot Creek, much of this sediment is being deposited in Grassy Island Wetland (Denton, 1986). This clearly demonstrates the effectiveness of wetlands in filtering sediment. However, the large amount of sediment that has been trapped is beginning to affect the wetland system and some of the trees are starting to die.

The rapid increase in the rate of sediment deposition in Lake Reelfoot corresponds to the man-made channelization of streams that flow into the lake (Denton, 1987).

The following findings are from a two-year USGS study (Lewis et al., 1992) of three Reelfoot Lake tributaries. A summarization of the study can be found in the project's Ten-Year Report (Reelfoot Lake RCWP Project, 1991).

Storm runoff contributed 87% of the total sediment loadings to the lake and ranged from 82% to 95% for various streams.

Significantly different seasonal loadings were observed for many variables surveyed and these differences were associated with row-crop agriculture.

Approximately 80% of the annual stream flow, 75% of the total nitrogen load, and 80% of the total phosphorus load occur during the months of October through March, when cropland is exposed.

Sedimentation of the lake continues at an alarming rate. Approximately 80% of the sediment loading occurred during the October to March time period.

Although pesticide sampling during many previous studies resulted in no detectable concentrations (with the exception of sediment samples), 32% of the samples collected showed high levels of atrazine or alachlor. Alachlor was present in 90% of the samples collected during the growing season.

Water quality continues to decline within the associated lake subbasins.

4.2.6.2 Recommendations

Water quality monitoring for trend detection must be properly designed and executed if project achievements are to be documented.

Studies that document water quality problems associated with sedimentation, sediment sources, rates of sedimentation, and seasonal sediment loading trends should be conducted prior to project selection, planning, and implementation.

Water quality investigations throughout the watershed and especially in the lake should be continued in order to document water quality changes (Lake Reelfoot RCWP Project, 1991).

Water quality sampling should be conducted at regular, pre-defined intervals in order to make possible detection of trends possible.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

Since water quality monitoring and land treatment tracking were not designed to determine the relationship between the two, there is no way to document the water quality effects of land treatment implemented through this RCWP project. However, water quality studies conducted during the middle and later part of the project suggest that 1) the critical area was not defined correctly, 2) the emphasis in BMP strategy should have been changed, 3) artificial wetlands should have been developed, and 4) an attempt to dechannelize the streams should have been made (Denton, 1986; Reelfoot Lake RCWP Project, 1991).

4.2.7.2 Recommendations

Water quality monitoring and land treatment monitoring must be designed correctly if linkage between the two are to be documented.

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1980 - 1990

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Reelfoot Lake (18,400 acres) and tributary streams

4.3.2.1.2 Water Uses and Impairments

Reelfoot Lake is located in a popular state park in Tennessee. The lake is used primarily for fishing, boating, and waterfowl hunting. Other water uses within the project area are irrigation and livestock watering.

Impairments of Reelfoot Lake are: decreased lake volume, degraded fishery and wildlife habitat, and impaired recreational use caused mainly by sediment loading and high nutrient concentrations. The lake is severely eutrophic. Pesticides are reported to be a cause of impairment to aquatic life, but data, from a project study, do not support this claim (Reelfoot Lake RCWP Project, 1986).

4.3.2.1.3 Water Quality Problem Statement

Sedimentation decreases lake storage capacity and, along with excessive nutrients from agricultural fertilizers, promotes excessive aquatic weed growth in the lake. The eutrophication of Reelfoot Lake has also damaged wildlife habitat, fisheries, and impaired contact and non-contact recreational uses. There is also concern about pesticide contamination of aquatic life.

4.3.2.1.4 Water Quality Objectives and Goals

Reduce sediment delivery to the lake and attain a desirable level of water quality

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 153,600 acres
Project Area: 153,600 acres
Critical Area: 45,118 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: ~ 48 inches

Geologic Factors: The project area lies within the Mississippi embayment section of the Gulf Coastal Plain. Uplands and bottomlands are divided by a distinct bluff running north-south through the area. Substrate consists primarily of compact silt and clay mixtures. Bottomlands are covered by deep alluvial deposits of silt, clay, sand and gravel. Uplands are covered by fluvial gravels topped with silty loess. Predominant soils are moderately well-drained to somewhat poorly-drained loams. All soils in the area are highly susceptible to gully and sheet erosion. The calculated annual soil loss is 1.4 million tons. Topography is nearly level on uplands to steeply sloped along bluffs adjacent to the lake.

4.3.2.2.3 Project Area Agriculture

There are 562 farms in the project area, of which 95% are owner-operated. The average size of a farm is 225 acres. The primary commodities grown in this area are corn, soybeans, and wheat. There is some hog and cattle production.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	41	NA
Pasture/range	19	NA
Woodland	20	NA
Urban/roads	1	NA
Other		NA
Water and wetlands	12	
Park/wildlife refuge	7	

4.3.2.2.5 Animal Operations

Operation	Total # Animals	Total Animal Units
Beef cattle	6,325	6,325
Hogs	35,800	14,320

There was no indication that animal numbers changed significantly during the project.

4.3.3 Total Project Budget

The total project budget was approximately $ 4,500,000, of which $ 900,000 was expended for technical services and $ 3,394,485 was spent on cost share (Reelfoot Lake RCWP Project, 1991).

4.3.4 Information and Education

4.3.4.1 Strategy

There was a three-pronged information and education (I&E) strategy: broad spectrum education of the general public, education of landowners and operators, and information to educational groups.

4.3.4.2 Objectives and Goals

The I&E objective was to provide information that would promote participation in the project.

The I&E goals were to inform producers about RCWP, the need for progress in water quality, and how and where to obtain project information about the project.

4.3.4.3 Program Components

Newsletters

News media (radio, TV, and news articles)

Educational meetings

Demonstrations (alfalfa production, herbicides and insecticides)

Alfalfa exhibit

One-to-one contacts

4.3.5 Producer Participation

4.3.5.1 Level of Participation

Two hundred and sixty-five contracts were signed on 26,431 acres or 59% of the critical area.

4.3.5.2 Incentives to Participation

Cost share rate of 75%

Payment limitation of $50,000 per landowner

The state of Tennessee paid 25% of the cost share to establish alfalfa on designated steep, erodible lands within the project area. When this 25% payment was combined with the 75% RCWP cost share, the cost share rate for establishing alfalfa was 100%.

A one-time $70 payment for converting cropland to pasture for 10 years

Additional incentives provided by the Conservation Reserve Program (CRP) to farmers to convert highly erodible lands to more permanent vegetation

Perception that practices, such as fertilizer and pesticide management, would increase profits

4.3.5.3 Barriers to Participation

Lack of acceptance by farmers that they were contributing to the water quality problem

Reluctance to deal with government programs

Unwillingness to be told how to farm by the government

Poor farm economic conditions

Unwillingness by farmers to place their entire farm under RCWP contract (before a decision was made not to require that all land on a farm had to be contracted and treated if necessary)

Unwillingness of absentee landlords and renters to invest in the land

Lack of technical solutions/cost shared BMPs to address the problem of gullies

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

The prospects for continued maintenance appear to be mixed. Fertilizer and pesticide management, stripcropping, and some conservation tillage are being discontinued. Pastures which had to be maintained for ten years are, for the most part, being maintained as pastures. It is too early to know whether the farmers will keep this land in pasture or return it to cropland when the ten years are over. Since BMPs are being discontinued, it seems unlikely that any BMPs would be adopted.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

Keep the soil on the land.

4.3.6.2 Objectives and Goals

The objectives were to:

Reduce erosion

Improve water quality

The goals were to:

Meet soil loss tolerance on at least 80% of the drainage area

Reduce sediment delivered to the lake by 75% (equivalent to sediment reduction of 638,019 tons/year)

Meet state water quality criteria for the designated uses of Reelfoot Lake

Convert land use on soils classified as land capability class VIe and VIIe from cropland to permanent cover of grass, trees, or wildlife plantings

Treat all gully areas and other critical areas

Increase long-term farm income potential through improved conservation management systems

4.3.6.3 Critical Area Criteria and Application

83% of the cropland in the project area was designated as critical and was prioritized into three classifications based on cropping intensity, erosion rate, and proximity to the lake and streams:

Area I: Close proximity of lake or streams, Class IV, VI or VII land (Soil Management Support System, 1990), soil loss of 50 tons/acre/year (T/A/yr), and continuous row crops

Area II: Class II & III land, continuous row crops, and soil erosion rates of 5 T/A/yr

Area III: Mississippi River Flood plain, and erosion rates of 10 T/A/yr

The critical area in Lake County was reduced in 1985 from 12,000 acres to 6,900 acres because many of the farmers were already applying BMPs.

4.3.6.4 Best Management Practices Used

Land treatment emphasized by this project includes erosion controls (such as conservation tillage), stream protection, and fertilizer and pesticide management.

BMPs terrace systems, diversion system, grazing land protection system, and waterway system were discontinued because the undulating topography was not compatible with their use.

BMPs Utilized in the Project*	Units	Goals	Achievements	
			Total	%
Permanent vegetative cover (BMP 1)	acres	8,840	9,526	108
Animal waste management system (BMP 2)	#	50	30	60
Stripcropping systems (BMP 3)	acres	100	359	359
Terrace systems (BMP 4)	acres	2,000	111	6
Diversion system (BMP 5)	feet	11,925	57	5
Grazing land protection system (BMP 6)	#	26	92	354
Waterway system (BMP 7)	acres	200	59	30
Cropland protection system (BMP 8)	acres	9,000	44	--
Conservation tillage systems (BMP 9)	acres	15,758	4,051	26
Stream protection system (BMP 10)	feet	--	39,202	--
Permanent vegetative cover on critical areas (BMP 11)	acres	160	332	201
Sediment retention, erosion, or water control structures (BMP 12)	#	349	152	44
Improving an irrigation and or water management system (BMP 13)	(available but not utilized)			
Tree planting (BMP 14)	acres	1,539	17	1
Fertilizer management (BMP 15)	acres	7,760	14,064	181
Pesticide management (BMP 16)	acres	7,760	13,230	170

*Please refer to Appendix I for description/purpose of BMPs.

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

Regular record keeping was conducted by project personnel and reported in RCWP annual reports. Contracts were tracked by the SCS by hand using a list of RCWP practices that had been installed on each farm. It was a very cumbersome tracking procedure. ASCS conducted random checks.

4.3.6.5.2 Data Management

No data management system was in place during the project.

4.3.6.5.3 Data Analysis and Results

Quantified Project Achievements:

Pollutant Source	Units	Critical Area Total	Critical Area % Implemented	Treatment Goals Total	Treatment Goals % Implemented
Cropland	acres	45,118	59%	33,839	79%
Contracts	#	425	56%	240	75%

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The majority of the water quality studies conducted during the RCWP project were studies intended to delineate the sedimentation problems of Reelfoot Lake. These studies were not designed to track changes in the lake associated with BMP implementation.

There were four distinct water quality monitoring studies. They are listed below:

1980-1982 Reelfoot Lake Summary Report
1982-1983 EPA Clean Lakes Study
1984-1986 Sedimentation Study with expanded water quality monitoring
1987-1989 USGS storm event monitoring through the 1988 Clean Water Act.

Since no funds were available for in-lake monitoring during the project, it was determined that monitoring would continue during the RCWP project as it had before: water, sediment and fish tissue analysis in the spring and fall.

The monitoring and analysis were conducted by the Tennessee Department of Health and Environment (Tenn. DHE), University of Tennessee at Martin, U.S. Geological Survey (USGS), and U.S. Department of Agriculture's Water Quality and Watershed Research Laboratory (USDA-ARS).

4.3.7.2 Objectives and Goals

Objectives were to:

1) Describe the historical relationship of lake environment problems to causative factors, such as land use patterns, in order to predict the potential for alleviating existing and future problems

2) Determine the levels of toxic substances present in tissue of Reelfoot Lake fish, thus protecting public health and the use of the lake for fish and wildlife

3) Define the impact of tributary inflows on the lake by quantifying the current pollutant load from sediment and by determining the lake's trophic status

4) Determine the short- and long-term benefits of the Rural Clean Water Program to the impaired uses of the lake for fish, wildlife, and recreation

Goals corresponding to the objectives were to:

1a) Document the changes in the physical and ecological aspects of the lake environment from 1930-1980

1b) Summarize the influence of human activities in developing the watershed and lake shore

1c) Establish the relationship between significant changes in the lake environment through the past 50 year period to human uses of the lake and watershed

2a) Determine the extent to which the fisheries resource was used by the general public and by commercial fishermen

2b) Document levels and types of toxic substances in the lake

3c) Establish severity of toxics contamination of the lake

3a) Determine current sediment loading based on development of sediment rating curves

3b) Determine current nutrient loading and lake retention rate

3c) Define a water budget for the lake

4a) Define the fishery community structure which has adapted to current conditions

4b) Relate current pollutant loadings to land use in the watershed with specific location of row crops

4c) Quantify short-term project benefits in terms of reduced sediment loading

4d) Relate project activities to long-term changes in nutrient loading and basic productivity

4e) Relate project activities to long-term changes in sediment loading

4.3.7.3 Time Frame

1977 - 1986, 1987 - 1989

4.3.7.4 Sampling Scheme

Storm runoff, sedimentation, and ambient monitoring was conducted. None of these sampling schemes were in effect during the entire project.

4.3.7.4.1 Monitoring Stations

6 in-lake
4 in tributaries (Tenn. DHE)
7 in Buck Basin segment of lake (Clean Lakes study)
5 in tributaries (USGS)

4.3.7.4.2 Sample Type

Grab and flow-activated automatic, depending on the study

4.3.7.4.3 Sampling Frequency

Tenn. DHE in-lake stations: once yearly 1977 - 1979, twice yearly 1980 - 1983, monthly 1984 - 1986.
Clean Lakes stations: monthly 1982 - 1983.
Tributary stations: twice yearly 1980 - 1984, quarterly 1984 - 1986, storm event 1987 - 1989.

4.3.7.4.4 Variables Analyzed

Dissolved oxygen (DO), biochemical oxygen demand (BOD), temperature, pH, suspended solids (SS), dissolved solids (DS), total solids (TS), Secchi disk transparency (in-lake only), nitrite-nitrogen (NO_2-N), nitrate-nitrogen (NO_3-N), ammonia-nitrogen (NH_3-N), total Kjeldahl nitrogen (TKN), fecal coliform (FC) bacteria, phosphates, selected heavy metals, selected pesticides

4.3.7.4.5 Flow Measurement

Tributary stations: continuous at gauged sites and instantaneous at ungaged sites

4.3.7.4.6 Meteorologic Measurements

Daily precipitation was collected during the runoff study at a field station located at the Reelfoot National Wildlife Refuge.

4.3.7.4.7 Other Important Quality Monitoring and Evaluation Information

Funding for and coordination of the project's monitoring activities expired early in the project. The Tennessee Office of Water Management of the Department of Health and Environment and the USGS conducted extensive lake and tributary monitoring through 1986.

Fish tissue samples were analyzed for "toxic materials" at unreported intervals.

Since there was never any long-term plan or long-term study, trend analysis is impossible.

4.3.7.5 Data Management

The data are in STORET.

STORET AGENCY CODE	STORET STATION NO.	PROFILE / STATION MAP / NO.
21TNWQ	REELFOOTLKIS01	TKY-1 / 1 (Reelfoot Lake)
"	REELFOOTLKIS02	TKY-1 / 2 (Reelfoot Lake)
"	REELFOOTLKIS03	TKY-1 / 3 (Reelfoot Lake)
"	REELFOOTLKIS04	TKY-1 / 4 (Reelfoot Lake)
"	REELFOOTLKIS05	TKY-1 / 5 (Reelfoot Lake)
"	REELFOOTLKIS06	TKY-1 / 6 (Reelfoot Lake)
"	REELFOOTLKIS07	TKY-1 / 7 (tributary)
"	REELFOOTLKIS08	TKY-1 / 8 (tributary)
"	REELFOOTLKIS09	TKY-1 / 9 (tributary)
"	REELFOOTLKIS10	TKY-1 / 10 (tributary)

4.3.7.6 Data Analysis and Results

Water quality data were plotted and least square regression lines were drawn. In-lake trend analysis was attempted, but was hampered by the lack of consistent and long-term data.

Fish tissue samples indicated no toxicity from pesticides. A later study detected alachlor and atrazine in the water, although these two herbicides would not directly affect the fish.

Sediment analysis of the lake, using Cesium-137 as an indicator, demonstrated that sediment deposition began in the 1940's when pasture land was converted to cropland (McIntyre and Naney, 1990). Excessive deposition is due to both cropland erosion and stream channelization. Average deposition ranged from 0.35 in/yr in the Blue Basin to 0.67 in/yr in the Upper Blue Basin. Subwatersheds that had been deemed unimportant during critical area determination were in some cases significant sources of localized sediment deposition. Some subbasins in Reelfoot Lake will become too shallow for most recreational purposes in 60 to 200 years.

Sediment analysis of a forest wetland adjacent to Reelfoot Lake showed that although it can filter some sediment, the wetland is losing its ability to trap sediment (McIntyre and Naney, 1991). Average deposition rates ranged from 0.4 to 0.2 in/yr; this constitutes about 21% of the sediment eroding from cropland. Tree mortality occurs+ due to these high rates of sedimentation.

A storm event study conducted by USGS revealed that most of the sediment, nitrogen, and phosphorus is deposited during winter months (October - March) and water quality is declining.

4.3.8 Linkage of Land Treatment and Water Quality

No long-term monitoring objectives have been established for collecting data to relate land treatment to water quality improvements. Thus there was no linkage between land treatment and water quality in this project.

4.3.9 Impact of Other Federal and State Programs on the Project

Farmers used the Conservation Reserve Program (CRP) extensively during the project. A total of almost 9,000 acres were enrolled in this program.

There was a PL-566 program to control flooding which may have also influenced project results. Six flood water structures were completed with six more planned. An additional 2,130 acres of gullied land and six miles of road were to be treated with PL-566 and private funds.

The state of Tennessee provided additional money for alfalfa establishment cost share ($60,000) and the establishment of an alfalfa cooperative ($140,000). Used pelleting machinery was purchased with the $140,000. Another $440,000 was appropriated by the Tennessee legislature for the alfalfa cooperative. The cooperative received a $36,000 grant from the Tennessee Valley Authority (TVA) to purchase haying machines.

4.3.10 Other Pertinent Information

During the project time frame there was a decrease in total acres cropped due to the project, CRP, and low commodity prices. There was also a switch to more corn and less soybeans. These changes should, in theory, have reduced erosion; however, the data were not good enough to document this. Many of the older pesticides that are bioaccumulators were replaced during the project period with newer, less persistent chemicals. Although phosphorus and potassium use were probably reduced over the life of the project, nitrogen use probably increased due to an increase in corn acreage. No data to support these assumptions exist.

4.3.11 References

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

Denton, G.M. 1986. Summary of the Sedimentation Studies of Reelfoot Lake, 1982 - 1986. Tennessee Department of Health and Environment, Office of Water Management.

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Lewis, M.E., J.W. Garrett, and A.B. Hoos. 1992. Nonpoint-Source Pollutant Discharges of the Three Major Tributaries to Reelfoot Lake, West Tennessee, October 1987 through September 1989. U.S. Geological Survey, Water-Resources Investigations Report 91-4031.

McIntyre, S.C. and J.W. Naney. 1990. Reelfoot Lake Sedimentation Rates and Sources. Water Res. Bull. 26(2):22-232.

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Reelfoot Lake RCWP Project. 1986. Annual Progress Report.

Reelfoot Lake RCWP Project. 1991. Ten-Year Report.

Soil Management Support System. 1990. Soil Taxonomy, 4th Ed. VA Polytechnic Inst,Blacksburg, VA.

4.3.12 Project Contacts

Administration

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Nashville, TN 37203
(615) 736-7112

Information and Education (none)

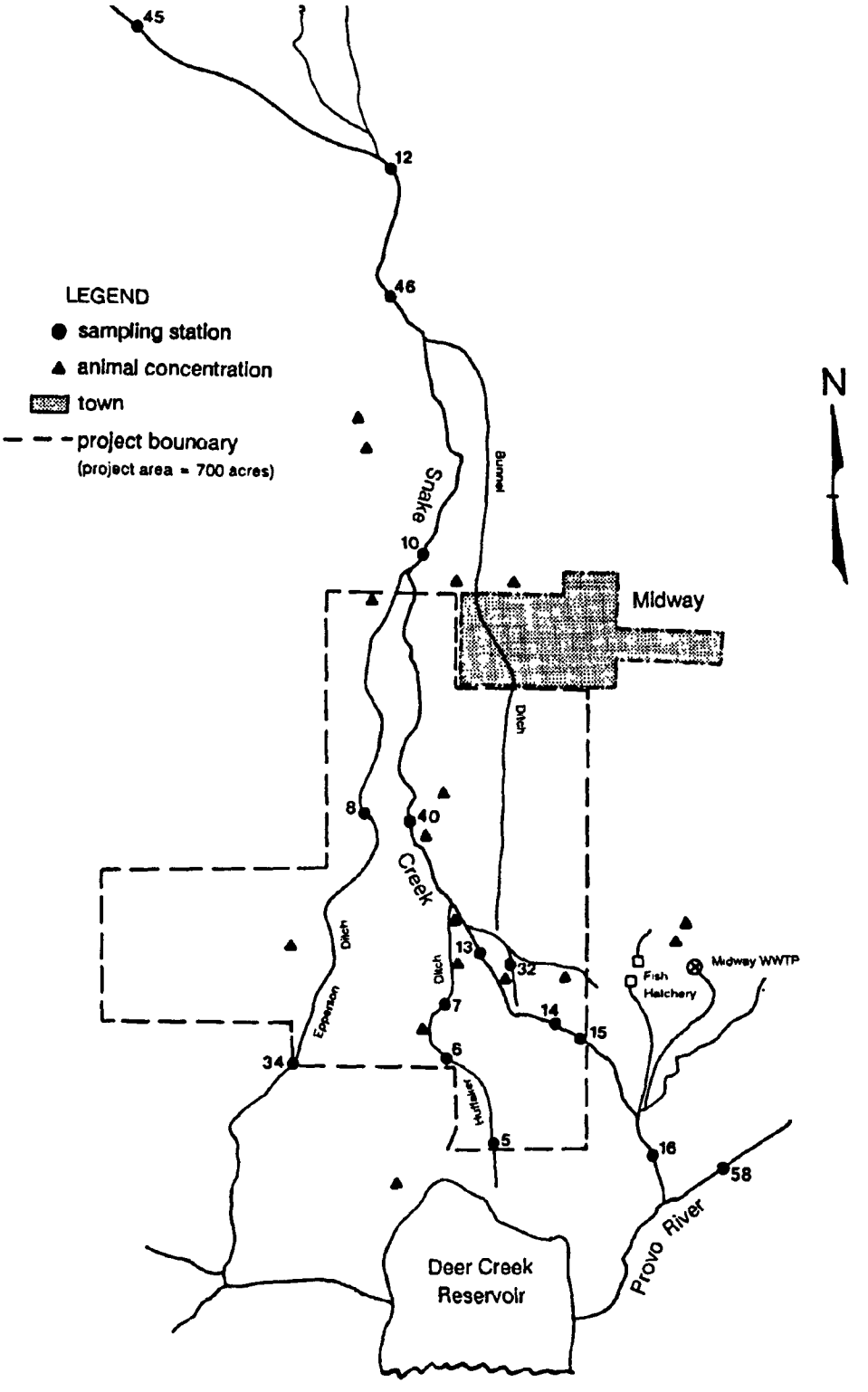
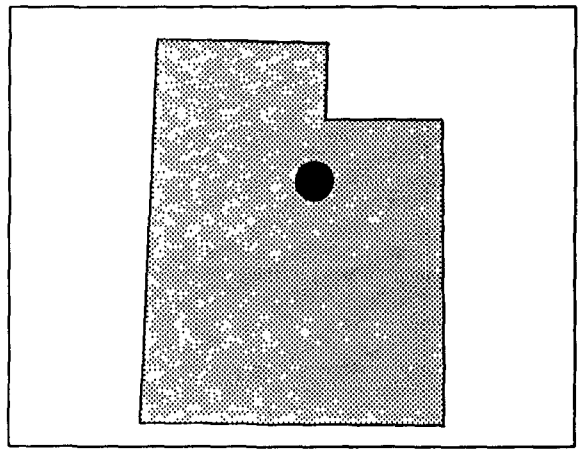


Figure 4.23: Snake Creek (Utah) RCWP project map, UT-1.

Utah
Snake Creek

(RCWP 11)



Wasatch County
MLRA: E-47
HUC: 160202-03

4.1 Project Synopsis

Snake Creek lies in Wasatch County, Utah in a high valley surrounded by mountains. Water from the creek flows into the Provo River which empties into Deer Creek Reservoir. The reservoir is used for municipal and industrial supplies and irrigation in Utah and Salt Lake Valleys, and is an important recreational resource for the region.

Studies indicated that Deer Creek Reservoir was eutrophic due to excessive amounts of nutrients, primarily phosphorus. The lower Snake Creek drainage basin covers 1.4% of the Deer Creek drainage basin, but was contributing almost 13% of the phosphorus to the reservoir.

Agriculture in the valley consists mainly of livestock operations with crops of alfalfa, small grains (barley, wheat, and oats), and pasture to support the livestock. Eight animal operations along Snake Creek were identified as contributing phosphorus and high levels of coliform bacteria to the creek. The RCWP project assisted farmers in implementing best management practices (BMPs) to control animal wastes entering the stream and reduce streambank erosion. Eight water quality plans were written, six of which were funded through the RCWP, providing 100% producer participation and 95% coverage of the 700-acre project area and the 489-acre critical area.

The water quality goal was to reduce phosphorus loading from the project area by 1000 kilograms/year through the use of animal waste management systems, grazing land protection systems, stream protection systems, and improvements to water management systems. Because all producers participated, the water quality goal was achieved by 1987. Monitoring was begun in 1979 to collect pre-implementation data, and was continued through 1989. Samples were collected monthly, and more frequently during periods of higher precipitation, at as many as 20 stations. Monitoring data showed unmistakable declines in phosphorus and coliform levels in Snake Creek.

The project was successful in meeting or exceeding its goals and establishing a model for other pollution reduction programs now in progress in the area. Cooperation among participants, a dramatic reduction of pollution in Snake Creek, a reduction in eutrophic conditions in Deer Creek Reservoir, and increased public awareness of water quality issues highlighted the project.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

The main goals of the project were to reduce nonpoint source phosphorus by 1000 kilograms/year in Snake Creek and to determine the effectiveness of selected BMPs in achieving water quality improvement. The small area and small number of producers involved made the project work quite well.

4.2.1.2 Recommendations

The size of the project, in both area and number of farmers, greatly affects the logistics involved in administration, management, tracking of practice implementation, and linking water quality improvements to land treatment. Smaller project areas and smaller numbers of farmers are two important factors that can contribute to a successful project in terms of tracking BMP implementation, obtaining measurable water quality improvements, and establishing links between land treatment and water quality monitoring.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

One-to-one contact between producers and project personnel made the project and implementation of management systems run smoothly. Without this individual contact, the project would not have been as successful.

Intense peer pressure at the initiation of the project resulted in 100% participation, a key factor in the project's success.

Inter-agency cooperation and public support were high for the RCWP project due to larger regional management plans being instituted to protect Deer Creek Reservoir and the proposed Jordanelle Reservoir during the RCWP project duration. The regional plans incorporated the RCWP project as part of the regional effort.

Although there was continuing support for RCWP, the State Coordinating Committee (SCC), Local Coordinating Committee (LCC), and participating agencies had little contact after the initial phase. The LCC met only three or four times and the SCC was even less active.

4.2.2.2 Recommendations

The Agricultural Stabilization and Conservation Service (ASCS), Soil Conservation Service (SCS), and Cooperative Extension Service, at both the state and local level, should participate fully throughout the duration of the project.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

The small number of producers in the project area made personal visits the best method of getting information to the project participants.

More information and education activities throughout the project and especially at the beginning would have been useful. Participation of all producers in the project area (and critical area) was obtained in early meetings held to plan the project. Little effort was put into public awareness programs or to inform and educate other farmers.

4.2.3.2 Recommendations

Some form of weekly newsletter or other information and education (I&E) program should be used to keep the public and area farmers informed, even when producer participation is very high.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

Intense peer pressure from neighboring producers in a small watershed resulted in 100% participation, which was key to the project's success.

4.2.4.2 Recommendations

One of the criteria that should be used in selecting nonpoint source projects is high probability of good producer participation in the project. Obtaining information from prominent local producers can help nonpoint source program managers locate areas where cooperative farmers and peer pressure can ensure high farmer participation.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

The small area of the project made it easy for nearly complete implementation and ease of tracking. Since there were only eight farms, tracking of the animal waste management systems was not difficult. Regular site visits were easy and provided a means to educate and encourage proper application of wastes to minimize water quality impairments.

4.2.5.2 Recommendations

Smaller watersheds and smaller numbers of participants can ease the problems of tracking BMP implementation, ensuring proper management of the BMPs, and obtaining practice information from producers.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

Monitoring along Snake Creek and its tributaries occurred at as many as 20 stations, both upstream and downstream of the project, and before, during, and after BMP implementation over a period of 10 years. Analysis of the samples show a pronounced decline in phosphorus and bacteria in Snake Creek downstream of the project area.

The impact of the project alone on Deer Creek Reservoir would have been minimal because the project area contributes only 12% of the phosphorus entering the reservoir. However, the RCWP project and several regional nonpoint source (NPS) control efforts, in combination, have contributed significantly to documented improvements in the water quality of Deer Creek Reservoir.

The reservoir is used as a primary water supply for several nearby towns, including Salt Lake City, and is considered to be of good quality.

Data on the effectiveness of a single best management practice (BMP) implementation could have been gathered if installation of BMPs had been done in stages. This strategy would involve installation of only one BMP throughout the project at each stage in order to allow enough time to adequately monitor the water quality impact of the BMP before another practice is introduced.

4.2.6.2 Recommendations

A small watershed with participation of all producers can show marked and rapid water quality improvements, thus simplifying water quality monitoring and evaluation.

If a project can obtain a small watershed with total participation, i.e., highly controlled, then the project should consider staging specific BMP implementation to determine the effects of each practice. This could provide much information about the cost-effectiveness of a BMP. Other variations on BMP implementation and monitoring should also be considered.

Funding of water quality monitoring, from the national level, would enhance monitoring efforts.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

Results of the monitoring show definite water quality improvements linked to BMP implementation. Reported monitoring results from Snake Creek indicate a 90% reduction in average phosphorus concentration and a 99% decrease in fecal coliform numbers after BMP installation. Results from Huffaker Ditch indicate about 83% reduction in average phosphorus concentrations and fecal coliform numbers have decreased by 94%. Other non-RCWP BMP implementation in the watershed is due to the success of this project.

This project has not only been successful in reducing nutrient and bacterial concentrations, but is also exemplary for its region. Other dairies in the area are installing similar practices after seeing the success of the Snake Creek RCWP.

The small area of this project made it ideal for nearly complete implementation and ease of tracking.

Water quality data analyses conducted by the National Water Quality Evaluation Project identified two critical areas: one small reach of the Snake Creek and Huffaker Ditch. These analyses indicated that it may not have been necessary to install practices outside of these two critical areas.

4.2.7.2 Recommendations

Projects can benefit from thorough analysis, including modeling, to identify critical areas and appropriate BMPs to attain water quality improvements. Although this project showed pronounced improvements in water quality, similar improvements may have been possible at lower cost through identification of smaller critical areas for BMP implementation.

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1980 - 1990

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Irrigation canals draining into Snake Creek which flows into the Provo River slightly upstream from the river's discharge into Deer Creek Reservoir.

4.3.2.1.2 Water Uses and Impairments

Water is stored in Deer Creek Reservoir, located just outside the project area, primarily for municipal, industrial, and irrigation use in neighboring valleys. About 500,000 people in the Salt Lake Valley received potable water from the reservoir when the project began in 1980. Recreational use of the reservoir is also important.

The reservoir is eutrophic which impairs its use for water supply and recreation. High concentrations of fecal coliform bacteria and phosphorus occur frequently in Snake Creek; however, Snake Creek is a relatively minor source of the total pollutants entering Deer Creek Reservoir (Snake Creek Local Coordinating Committee, 1987).

4.3.2.1.3 Water Quality Problem Statement

Deer Creek Reservoir is eutrophic, impairing the use of the reservoir for water supply and recreation. High concentrations of fecal coliform bacteria and phosphorus occur frequently in Snake Creek; however, from a basin-wide perspective Snake Creek is a minor source of the total pollutants entering Deer Creek Reservoir.

4.3.2.1.4 Water Quality Objectives and Goals

Reduce the total phosphorus in Snake Creek by 50%, in Huffaker Ditch by 75%, and in Bunnel Ditch by 75%, which will reduce phosphorus entering Deer Creek Reservoir by 1000kg each year.

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 523,403 acres
Project Area: 700 acres
Critical Area: 489 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 16.4 inches

Geologic Factors: The project area is in a valley which has a floor underlain by beds of unconsolidated material from 40 to over 1,000 feet deep. Soils range from well drained deep soils formed in alluvium and residuum from sedimentary rocks on foothills and alluvial fans to moderately well drained and poorly drained deep soils formed in mixed alluvium on flood plains, low stream terraces and valley bottoms. Surface drainage patterns indicate that all surface water entering the valley runs in a direct manner toward the reservoir adjacent to the project area.

Meteorologic Factors: The area has a short growing season, and very cold winter temperatures.

4.3.2.2.3 Project Area Agriculture

The main agricultural effort is livestock production, including dairies, beef feedlots, and horses. Crops grown include alfalfa, small grains (wheat, barley, and oats), and pastures to support the animals.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	90	91
Pasture/range	4	9
Urban/roads	6	0
Other	-	-

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	4	409	302
Beef	3	37	196
Horse	1	18	22

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	143,684	0	66,824	0	210,508
Info. & Ed.	3,000	0	0	0	3 ,000
Tech. Asst.	76,800	0	1,600	0	78,400
Water Quality onitoring	143,422	0	0	47,808	191,230
SUM	366,906	0	68,424	47,808	$483,138

Source: Smolen et al., 1989; Snake Creek Local Coordinating Committee, 1991

4.3.4 Information and Education

4.3.4.1 Strategy

Early meetings enlisted the cooperation of all producers in the critical area. Individual contacts with the participants were used after the initial meetings since the number of people was small.

Information to the public was provided through a number of newspaper and newsletter articles published during the project.

4.3.4.2 Objectives and Goals

The main effort was to assist participants in remaining with the program and in solving problems involved with the BMP implementation.

4.3.4.3 Program Components

Individual contact to assist producers in implementation of BMPs

Local publicity released in newspapers

Letters and newsletters sent to participants

State-wide publicity released after project was successfully completed

4.3.5 Producer Participation

4.3.5.1 Level of Participation

The participation level in this project was 100%. All farms within the project critical area were under RCWP contract.

4.3.5.2 Incentives to Participation

Cost share rate of 75%

Payment limit of $50,000 per landowner

4.3.5.3 Barriers to Participation

None

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Chances for continued maintenance and adoption appear to be good. Producers have seen the benefits associated with the use of BMPs and are likely to continue using them.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

General Scheme: The land treatment strategy emphasized installation of animal waste management systems (BMP 2) on all farms in the project area to prevent direct entry of waste into streams and to better utilize nutrients in waste through managed land application.

Another art of the strategy was to deny cattle access to Snake Creek and irrigation streams through the use of stream protection systems and grazing land protection systems. Irrigation systems were modified to prevent mixing of irrigation water with animal wastes and to reduce irrigation return water.

4.3.6.2 Objectives and Goals

Reduce the pollution entering Deer Creek Reservoir from agricultural NPS and determine the effectiveness of selected BMPs for achieving water quality improvement

Implement animal waste control and stream protection at all major animal operations in the project area

Quantified Implementation Goals: Contracts were planned for all four dairies and two of the beef operations in the project area; the other two beef operations agreed to use conservation methods without the aid of the RCWP project. The two horse operations were not considered critical and were not included in the contracting plans.

4.3.6.3 Critical Area Criteria and Application

Criteria: All major animal operations

Application of Treatment According to Criteria: Adequate

4.3.6.4 Best Management Practices Used

BMPs Utilized in the Project *

Animal waste management system (BMP 2)

Grazing land protection system (BMP 6)

Stream protection system (BMP 10)

Improving an irrigation and/or water management system (BMP 13)

* Please refer to Appendix I for description/purpose of BMPs.

Quantified Project Achievements:

Pollutant Source	Units	Critical Area		Treatment Goals	
		Total	% Implemented	Total	% Implemented
Cropland	acres	489	93%	456	93%
Dairies	#	4[a]	100%	4	100%
Feedlots	#	4[b]	50%	2	100%
Contracts	#	8	75%	6	100%[c]

[a] As of 1987, 1 dairy changed operation to beef feedlot. BMP management deemed sufficient for the new operation needs.
[b] Two feedlot owners decided to solve their water quality problems without cost share assistance.

4.3.6.5 Land Treatment and Use Monitoring and Tracking Program

4.3.6.5.1 Description

The small area of the project made it ideal for nearly complete implementation of land treatment in the project area and for ease of tracking. Since the project proposed to install animal waste management systems on all farms in the project area, and since there were only eight animal farms, tracking implementation and land use was done manually. Frequent visits by project staff were enough to keep the project team well informed about activities on the eight farms in the critical area. There was no recorded or automated system of tracking land use and land treatment.

4.3.6.5.2 Data Management

No data management system was in place during the project.

4.3.6.5.3 Data Analysis and Results

Analysis:

No statistical or otherwise formal data analysis was done. The small size of the project made it possible for the project staff to be informed of the producers' activities through regular visits.

Results:

Eight water quality plans were written, six of which were funded through the RCWP, providing 100% producer participation and 100% coverage of the 700-acre project area and the 489-acre critical area.

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

Water quality analysis was conducted by the Mountainland Association of Governments. The basic design was to perform pre-implementation / post-implementation and upstream / downstream analysis to observe improvements in the water quality as the project progressed.

4.3.7.2 Objectives and Goals

Objectives:

Reduce the pollution entering Deer Creek Reservoir from agricultural nonpoint sources
Determine the effectiveness of animal waste management systems in reducing phosphorus

Goal: Reduce the total phosphorus in Snake Creek by 50%, in Huffaker Ditch by 75%, and in Bunnel Ditch by 75%.

4.3.7.3 Time Frame

November 1979 - 1990

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

Initially, the project monitored water quality at 20 stations along Snake Creek, Provo River, and several irrigation ditches. In 1986, monitoring was reduced to sampling at seven stations.

4.3.7.4.2 Sample Type

Grab

4.3.7.4.3 Sampling Frequency

Monthly, with weekly samples taken during spring runoff

4.3.7.4.4 Variables Analyzed

Total phosphorus (TP), orthophosphorus (OP), total Kjeldahl nitrogen (TKN), nitrite-nitrogen (NO_2-N), nitrate-nitrogen (NO_3-N), ammonia- nitrogen (NH_3-N), biochemical oxygen demand (BOD), total suspended solids (TSS), total dissolved solids (TDS), fecal coliform (FC), conductivity, temperature, pH

4.3.7.4.5 Flow Measurement

Instantaneous at time of sampling

4.3.7.4.6 Meteorologic Measurements

None

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

Adjusting concentration data for meteorologic and hydrologic variability would have strengthened the comparison of pre- and post- BMP data.

4.3.7.5 Data Management

The data are in STORET.

STORET AGENCY CODE	STORET STATION NO.	PROFILE / STATION MAP / NO.
21UTAH	591005	UT-1 / 5
	591006	UT-1 / 6 (Huffaker Ditch below Vincent dairy)
	591007	UT-1 / 7 (Huffaker Ditch above Vincent dairy)
	591008	UT-1 / 8
	591010	UT-1 / 10 (below Epperson diversion)
	591012	UT-1 / 12
	591013	UT-1 / 13 (above Pride Lane dairy)
	591014	UT-1 / 14 (below Pride Lane dairy)
	591015	UT-1 / 15
	591016	UT-1 / 16
	591032	UT-1 / 32
	591034	UT-1 / 34
	591040	UT-1 / 40
	591045	UT-1 / 45 (Snake Creek above Wasatch Mt. state park)
	591046	UT-1 / 46
	591058	UT-1 / 58

Project data analysis focused on stations 6, 7, 10, 13, 14, and 45.

4.3.7.6 Data Analysis and Results

Analysis:

Annual average concentrations and loads were reported. The project compared average phosphorus concentrations above and below critical livestock operations. The project also looked at pre-implementation versus post-implementation results.

Results were manually compared and displayed, no statistical analysis was done.

Results:

Significant water quality improvements attributable to BMP implementation have been reported. On the main reach of Snake Creek, analysis showed 43 to 90% reduction in TP, OP, TKN and FC concentrations. Analysis of Huffaker Ditch showed a 48 to 66% reduction in TP, OP, TKN, and FC concentrations attributable to BMP implementation. No significant water quality impact on Deer Creek Reservoir is expected from this project, however, because the project area constitutes less than 1% of the reservoir drainage. (Sowby and Berg Consultants, 1984)

4.3.8 Linkage of Land Treatment and Water Quality

The project was able to reduce phosphorous and fecal coliform concentrations as a result of implementation of BMPs on the eight farms in the critical area. No statistical analysis was performed, but the water quality monitoring results showed obvious and pronounced reductions in phosphorus and bacteria.

4.3.9 Impact of Other Federal and State Programs on the Project

The federal Dairy Buy-Out Program conflicted with RCWP objectives in this project. Considerable time and money were spent to treat a problem dairy but this effort was nullified when the dairy entered the buy-out program. This single dairy was the only one to change its operations as a result of the buy-out program.

4.3.10 Other Pertinent Information

None

4.3.11 References

A complete list of project documents and relevant publications may be found in Appendix IV.

Smolen, M.D., S.L. Brichford, J. Spooner, A. Lanier, T.B. Bennett, S.W. Coffey, and K.J. Adler. 1989. NWQEP 1988 Annual Report: Status of Agricultural Nonpoint Source Projects. EPA 506/9-89/002.

Snake Creek Local Coordinating Committee. 1987. Annual Progress Report on the Snake Creek Rural Clean Water Program. Wasatch County, Utah.

Snake Creek Local Coordinating Committee, 1991. Ten-Year Report.

Sowby and Berg Consultants. 1984. Deer Creek Reservoir and Proposed Jordanelle Reservoir Water Quality Management Plan. Prepared for Wasatch and Summit Counties, Provo, Utah.

4.3.12 Project Contacts

Administration

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P.O. Box 6, Heber City, UT 84032
(801) 377-5296 or 654-0232

Water Quality

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(801) 377-2262

Land Treatment

Jack Young, Wasatch Soil Conservation District,
P.O. Box 87, Heber City, UT 84032
(801) 654-0242

Todd C. Nielson, USDA-SCS
88 West 100 North, Provo, UT 84032
(801) 377-5580

Information and Education

None

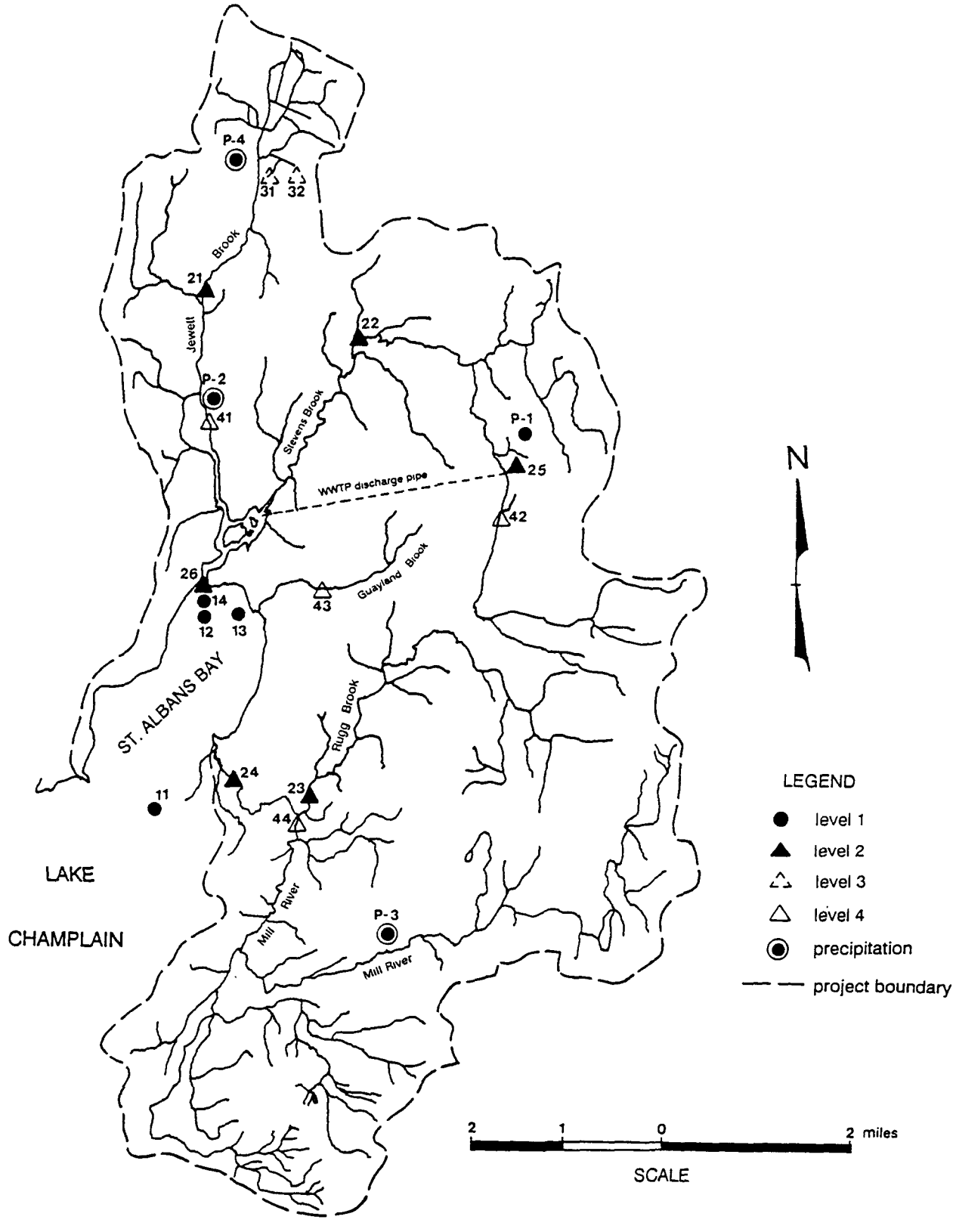
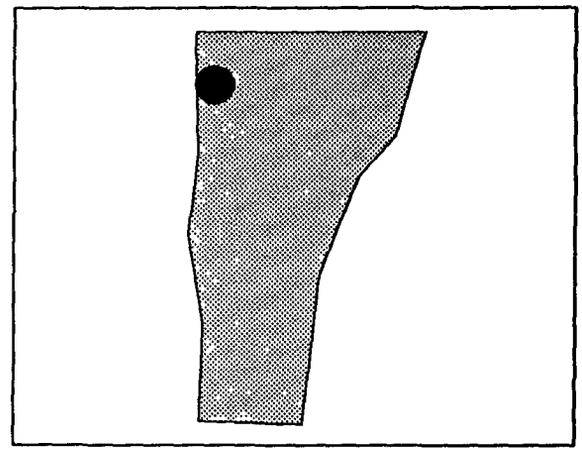


Figure 4.24: St. Albans Bay (Vermont) RCWP project map, VT-1.

Vermont
St. Albans Bay

(RCWP 12)



Franklin County
MLRA: R-142
HUC: 020100-05,07

4.1 Project Synopsis

St. Albans Bay of Lake Champlain is located in northwestern Vermont. The project area watershed encompasses 32,162 acres of mostly agricultural land used primarily for dairy production. Bacteria, sediment, and nutrients from dairy farms were enriching the bay causing high bacteria counts, large algal blooms, and prolific macrophyte growth. These impairments resulted in beach closings, decreased shoreline property values, and overall declining recreational use of the bay.

The objective of the project was to reduce excessive agricultural nonpoint source (NPS) pollution by implementing best management practices (BMPs) on the 15,431 critical acres. Critical acres were designated as those areas or sources of NPS pollutants having the most significant impact on the impaired use of receiving waters. The project succeeded in treating 74% of the critical acres and 76% of the mass of manure, primarily with animal waste management system (BMP 2) and cropland protection system (BMP 8) BMPs. BMP implementation and land use were tracked using land treatment data organized in a geographical information system (GIS).

An extensive effort was made to track pertinent farm data such as the quantity and timing of manure application and the number of cows under BMP manure management. These data were then used to correlate land treatment/use to water quality on a subwatershed scale. The strongest correlation was between an increasing proportion of animals under BMP manure management and decreasing bacteria counts in associated streams.

The project successfully employed a paired watershed study to document the pollutant export reduction associated with changing from the common practice of winter manure spreading to applying manure during the growing season.

The water quality monitoring program consisted of weekly and monthly grab sampling of the bay and continuous automated monitoring of major subbasin tributaries and the St. Albans wastewater treatment plant. Monitoring data showed that sediment export and indicator bacteria counts decreased in most of the monitored streams feeding the bay. Also, bacteria counts near the public beach along the northern shore of the bay decreased to below state standards for swimming during the last three years of the project.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

Accomplishing the objective of improving the water quality and restoring the beneficial uses of St. Albans Bay was complicated by internal sources of stored nutrients within the bay, unmonitored runoff from the town of St. Albans, and the lag time between the implementation of BMPs and water quality improvement.

4.2.1.1 Findings and Successes (continued)

The goal of documenting changes in water quality resulting from land treatment requires more detailed land treatment/use data than are normally collected for a Rural Clean Water Program (RCWP) project. Also, this goal probably cannot be attained without greater control over when and where land treatment occurs. In other words, land treatment should be implemented to change water quality as opposed to implementing land treatment and then monitoring to see if the water quality changes.

4.2.1.2 Recommendations

Projects should have quantitative water quality objectives and goals even if they are somewhat arbitrary, because they provide a clearly defined way to measure whether the objective was reached.

To obtain maximum benefit from available resources, goals should include targeting of land treatment based on estimated pollutant export and not simply on a given level of critical area treatment (Croft and Mahood, 1992).

Water quality objectives and goals should be set with the understanding that significant changes in water quality occur gradually, especially for waters that have a relatively long history of pollution. For this reason, some monitoring programs should continue for more than 10 years.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

The Project Advisory Council (PAC), which consisted of project-level representatives from all agencies involved in the project, was a highly effective vehicle for insuring good cooperation among agencies and for keeping the project activities on schedule.

Many factors contributed to the success of this project, including the close proximity of state and local agencies, good working relationships between agencies, and strong support from both farmers and the general public.

4.2.2.2 Recommendations

Each project should develop an advisory committee to coordinate activities and discuss problems. The committee should consist of selected members of the state coordinating committee (SCC) and the local coordinating committee (LCC) who are actually working on the project, or have close contact with the project.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

Information and education (I&E) efforts were essential in informing farmers about the RCWP and convincing them to become cooperators. These I&E efforts have also contributed to increased adoption of conservation practices in other areas of the state.

I&E efforts have also educated the general public so that many can now identify agricultural practices that cause excessive pollution.

4.2.3.2 Recommendations

The role of I&E should be expanded beyond the initial sign-up period to encourage long-term optimal management of installed BMPs even after contracts have expired.

On-farm one-to-one visits are the most effective I&E tools and, therefore, should be emphasized in future projects.

A continuing I&E effort on management-related issues of BMPs should be emphasized by all agencies.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

The benefits of reducing both equipment wear and labor needs associated with daily manure spreading were important incentives to implementation of animal waste management BMPs.

Providing producers with a variety of land treatment alternatives enhanced contract acceptance.

In most cases, cost share rates and limits did not hinder producer participation. Only three farms were affected by the $50,000 cost share payment limit.

4.2.4.2 Recommendations

An increased level of compliance monitoring should be maintained to verify adherence to contracted management practices both during and after the contract period.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

The project achieved 98% of its BMP implementation goal, with animal waste management, fertilizer management, and cropland protection being the most widely used BMPs. After implementation was complete, 79 % of watershed animal units were under BMPs representing 133 tons of manure phosphorus and 664 tons of manure nitrogen under waste management.

Constant contact between program participants and agency representatives helped avoid potential misunderstandings and contract disputes so that no contract maintenance violations occurred.

The combination of the Soil Conservation Service (SCS) computerized data base and the University of Vermont's GIS proved invaluable for tracking BMP implementation in the watershed.

Farm conservation programs in other parts of the state are benefiting from this project both because of the experience gained by the agencies and the positive publicity among farmers.

The voluntary land use monitoring program based on reporting by producers was more successful than anticipated, but the accuracy of some of the data was thought to be suspect because farmers didn't keep comprehensive records and, therefore, often had to rely on memory.

Water quality modeling results indicated that implementation of BMPs will cause total phosphorus (TP) loading to decline 47% overall (a 73% reduction in critical TP load) and sediment loading to decrease 12% (an 86% reduction in critical sediment load).

4.2.5.2 Recommendations

Many BMPs, the waste management system BMP in particular, should include more emphasis on management such as waste application timing, rate, location, and incorporation. Management and maintenance of certain BMPs should be included in the tracking and evaluation process to insure continued compliance.

Additional and/or modified BMPs should be implemented, where applicable, to address specific on-farm situations such as animal stream crossings and watering points.

A mechanism to track the continued adherence to BMPs after contracts expire is very important. This could be a separate longer-term operations and maintenance agreement.

The progress of BMP implementation should be tracked more closely with reporting not only of the number of systems constructed, but also where and when such systems are completed. This might be accomplished by aerial photography.

All participating agencies should make a commitment to adequately analyze and report project data.

The contracting process should include adequate time for review by all concerned and an explanation of the operator's role in the management and maintenance of BMPs.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

Long-term monitoring in a northern climate is demanding on personnel and equipment. Monitoring equipment requires frequent maintenance due to the effects of freezing temperatures.

Significant improvement in the water quality of a relatively large water body, such as a lake bay, may take more than 10 years to become evident due to the lag time between treatment and water quality improvement.

The start-up date of monitoring should coincide with the beginning of some reasonable annual period to avoid the collection of partial years of data which often cannot be used in later analysis. However, trial monitoring to establish sampling procedures, quality control, and sample management can occur during this period.

4.2.6.2 Recommendations

Water quality monitoring should include a control watershed, in which no BMPs are implemented and the agricultural activity is relatively stable and similar to that of the project or treated watershed.

Monitoring in watersheds with a significant point source should be avoided because changes in the pollutant contribution of the point source often easily mask changes in NPS pollution.

Monitoring should include consideration of pollutant movement to and with ground water, because ground and surface water quality are often closely linked.

Considerable emphasis must be placed on data management and quality assurance at the beginning of the project to ensure that the data collected are worthwhile.

All participating agencies should allocate sufficient resources for analysis of, interpretation of, and access to project data.

Short-term intensive monitoring studies of individual BMPs should be included to provide information on physical processes and a basis for assessing the longer-term, overall effectiveness of the project.

Because it is often easy to focus on data collection and neglect analysis, frequent analysis of monitoring data should be included in the work plan. Such analyses can reveal problems early, improve monitoring efficiency, and, most importantly, regularly test the effectiveness of the project against monitoring results.

Long-term NPS monitoring should collect enough data to quantify variability in water quality and quantity variables, so that the effects of background noise can be removed from the data analysis.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

No significant relationships were observed between stream nutrient levels and either manure storage, manured area, manure quantity, or percentage of animals under waste management BMPs. However, increased manure storage did appear to significantly lower stream bacteria counts, possibly due to rapid mortality of bacteria in stored manure. Stream bacteria counts declined with the increasing proportion of watershed animals under waste management BMPs.

Manure management on land within 50 meters of Jewett Brook seemed to have a significant influence on stream water quality. Stream nitrogen levels were lower when more adjacent land was in pasture and higher when more was in corn. However, more corn acreage adjacent to the brook seemed to yield lower stream bacteria counts, perhaps due to greater use of stored manure, or because direct manure deposition by grazing cattle was less likely.

4.2.7.1 Findings and Successes (continued)

A paired watershed study confirmed that winter spreading of manure on corn land resulted in significantly higher nitrogen and phosphorus concentrations and loads in edge-of-field runoff compared to applying manure only during the growing season.

The confounding effects of weather and the relatively low precision of agricultural activity information (such as inability to determine exactly when and how much manure was spread) are two factors that must be addressed when investigating the effect of land treatment on water quality.

Linking water quality changes to land treatment often requires intensive monitoring of agricultural activities such as manure application and cropping practices of all producers (cooperators and non-cooperators) in the area corresponding to the water quality monitoring.

4.2.7.2 Recommendations

Information on management and changing land use patterns in addition to BMP implementation data should be collected in order to establish strong and valid linkages between land treatment and water quality.

Greater control of land treatment and management in the study area is needed to establish statistically significant relationships between land treatment and water quality.

Because agricultural activities, such as changes in the types and numbers of livestock and the distribution of animals between contract to non-contract farmers, may have a significant impact on the effective level of treatment within a watershed, they should be tracked throughout the monitoring period, not just during the active BMP implementation phase.

4.3 Project Description

4.3.1 Project Type and Time Frame

Comprehensive Monitoring and Evaluation (CM&E)

1980 - 1991

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

St. Albans Bay of Lake Champlain and project area streams

4.3.2.1.2 Water Uses and Impairments

St. Albans Bay has been used heavily for recreation in the past. Boating, swimming, and aesthetic enjoyment of the bay were impaired by eutrophic conditions, high bacteria counts, and excessive macrophyte and algal growth.

4.3.2.1.3 Water Quality Problem Statement

The water supply and recreational uses of St. Albans Bay are being impaired by excessive tributary and nonpoint source loadings of phosphorus and bacteria from animal waste and sediment from cropland. Two sewage treatment plants currently contribute 8-14% of the phosphorus load, but have discharged 38-42% during past decade.

4.3.2.1.4 Water Quality Objectives and Goals

Improve the water quality in St. Albans Bay and restore beneficial uses by reducing the amount of bacteria, sediment, phosphorus, and nitrogen entering the bay.

Document changes in the water quality of tributaries resulting from the implementation of agricultural BMPs within the watershed.

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 32,162 acres
Project Area: 32,162 acres
Critical Area: 15,257 acres (Revised to 15,355 ac)

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 34 inches

Geologic Factors: Topography ranges from steep slopes in the eastern region of the project area to fairly level terrain in the western region near Lake Champlain. Soils of the eastern region are largely glacial tills.

4.3.2.2.3 Project Area Agriculture

Dairy farming is the primary agricultural activity within the watershed. Farms average 330 acres with an average dairy herd of 110 animal units, up from 95 in 1980. Corn for silage, the principal cultivated crop, is grown on about 10-15% of the total land in the watershed. Cropland is generally fall-plowed due to the high clay content of the soil and lack of corn residue from silage harvesting.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland		
Corn	12	NA
Hayland	31	NA
Pasture	17	NA
Woodland	22	NA
Urban/roads	18	NA
Other		NA

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	98	6,500	9,100

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	1,686,349	0	562,116	0	2,248,465
Info. & Ed.	18,670	43,224	0	0	61,894
Tech. Asst.	1,011,052	0	0	0	1,011,052
Water Quality Monitoring	2,362,473	657,704	0	0	3,020,177
SUM	5,078,544	700,928	562,116	0	$6,341,588

Source: St. Albans Bay RCWP Project, 1991

4.3.4 Information and Education

4.3.4.1 Strategy

The information and education (I&E) effort, under the direction of the county extension agent, was concentrated into the first three years of the project to quickly publicize the project and garner farmer cooperation. To this end, a water quality advisor was hired early in the project and given the day-to-day responsibility of administering the I&E program.

4.3.4.2 Objectives and Goals

Create an appreciation and understanding of the RCWP project

Develop awareness among farmers of the importance of preventing excessive water pollution

Provide necessary technical assistance and education to producers so that they can make sound decisions concerning alternative waste management and pesticide and fertilizer use

4.3.4.3 Program Components

Mass media presentations such as a monthly newspaper feature, a television show, and a radio program to inform the general public

Slide shows, poster contests, and personal visits to inform and educate school children

Monthly newsletters on the project's progress and many informational meetings to update producers

Numerous farm visits to assist cooperators in their decision-making process

Demonstrations of applied research on reduced tillage techniques, pasture management, and reduced fertilizer and pesticide application

4.3.5 Producer Participation

4.3.5.1 Level of Participation

Producer participation was good with 61 of 102 watershed farms under contract. BMP implementation on contracted farms achieved 98% of the goals for critical area treatment.

4.3.5.2 Incentives to Participation

The 75% cost share rates for animal waste management systems and additional Agricultural Conservation Program (ACP) assistance funds

Peer pressure from neighboring participators and public pressure from concerned citizens

4.3.5.3 Barriers to Participation

Economic uncertainties related to their farming operations made a few producers unwilling to sign long-term RCWP contracts.

Distrust of federal programs/agencies

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Chances of continued maintenance of manure handling facilities appears to be good primarily because of the flexibility they provide to farmers.

Several project cooperators stated that the chances of continued adherence to implemented BMPs was pretty good, but the chances of adoption of new or additional BMPs was not very good.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

The project focused on implementing manure management and cropland protection BMPs on the areas and/or sources of agricultural nonpoint source (NPS) pollution identified as having the greatest impact on receiving waters. Only the portions of farms or pollution sources needing treatment were considered critical.

4.3.6.2 Objectives and Goals

Reduce nutrients, bacteria, and sediment entering tributary streams through use of animal waste management and cropland protection practices

Treat 11,443 acres (75% of critical area) of the watershed and 64 farms considered to be sources of NPS pollution

Manage at least 76% of the manure by weight

4.3.6.3 Critical Area Criteria and Application

The criteria were based on amount of manure, distance from watercourse, present manure management practices, and manure spreading rates.

The criteria were rigorously applied in order to prioritize cost share applications.

4.3.6.4 Best Management Practices Used

BMPs Utilized in the Project*	Units	Installed	% of Goal
Permanent vegetative cover (BMP 1)	acres	4,021	89
Animal waste management system (BMP 2)	number	66	94
Stripcropping system (BMP 3)	acres	9,397	100
Diversion system (BMP 5)	ac. served	25	100
Grazing land protection system (BMP 6)	number	6	100
Waterway system (BMP 7)	ac. served	132	88
Cropland protective system (BMP 8)	acres	7,074	110
Conservation tillage system (BMP 9)	acres	10	100
Stream protection system (BMP 10)	ac. served	483	97
Permanent vegetative cover on critical areas (BMP 11)	acres	63	84
Sediment retention, erosion, or water control structures (BMP 12)	number	55	110
Fertilizer management (BMP 15)	acres	7,610	109

* Please refer to Appendix I for description/purpose of BMPs.

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

A computerized data base was used to track BMP implementation in the watershed. The project developed a cooperative program of land use tracking which was designed to collect detailed agricultural activity data such as the amount, date, and location of manure and commercial fertilizer application, other cropping activities, and animal management changes. These data were kept by farmers in a checkbook style log and collected by project personnel on either an annual or biannual basis. Personal interviews with farmers were used to fill in missing or incomplete data.

4.3.6.5.2 Data Management

The land treatment/use data were managed in a GIS located at the University of Vermont. Farm data were combined to a subwatershed scale to correspond to water quality data.

4.3.6.5.3 Data Analysis and Results

Analysis of land treatment/use data consisted primarily of combining records from individual farms within a watershed to relate the treatment of the whole watershed to its water quality.

Quantified Project Achievements:

Pollutant Source	Units	Critical Area Total	Critical Area % Implemented	Treatment Goals Total	Treatment Goals % Implemented
Cropland	acres	15,355	74%	11,443	99%
Dairies	# farms	84	73%	63	97%
Truck Farms	# farms	1	100%	1	100%

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

Water quality monitoring was divided into four levels based on the resource, level of detail desired, and specific monitoring objectives.

Level 1 consisted of about 21 grab samples per year, at different depths and locations, from St. Albans Bay. The next level consisted of long-term continuous monitoring of the four major tributaries to the bay and the city wastewater treatment plant. Level 3 involved field monitoring to assess the effect of manure management practices on individual fields using a paired watershed approach. Level 4 monitoring, which was discontinued in 1985, was designed to supplement level 2 monitoring by collecting grab samples on additional bay tributaries and at upstream sites on the four major tributaries.

4.3.7.2 Objectives and Goals

Document changes in the water quality of specific tributaries within the watershed resulting from land treatment

Measure the changes in the amount of suspended sediment and nutrients entering St. Albans Bay as a result of the implementation of water quality management programs within the watershed

Document trends in the water quality of St. Albans Bay during the project period

4.3.7.3 Time Frame

1981-1990

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

Level 1:
Bay monitoring at four stations (at the beach, near the wetland, and an inner and outer bay station) to detect long-term trends in St. Albans Bay over the life of the project

Level 2:
Monitoring at five major subbasin tributaries and the St. Albans City wastewater treatment plant

4.3.7.4.1 Monitoring Stations (continued)

Level 3:
Monitoring at two field drainage ditches, one below conventional practices and the other below BMPs for manure management

Level 4:
Station 41: Jewett Brook station is the tributary station closest to the bay and furthest upstream location affected by the backwater from St. Albans Bay
Station 42: Stevens Brook is sampled to determine the effects of urban development on downstream agricultural use
Station 43: Guayland Brook is not monitored with the level 2 monitoring network. This subwatershed is about 8% of the total watershed area and land use is 50% agricultural, 25% urban and 25% forest
Station 44: Mill River is upstream from the confluence of Mill River and Rugg Brook and is being monitored to separate the impact of Rugg Brook from the level 2 station at Mill River

3.3.7.4.2 Sample Type

Level 1: Grab samples (1.5 meters above the bottom and 1.5 meters below the surface)

Level 2: Grab, in situ, composite, and continuous depending on variable

Level 3: Composite or grab

Level 4: Random grab sampling

3.3.7.4.3 Sampling Frequency

Level 1: October - April: monthly / May - July: biweekly / August - September: weekly

Level 2: Weekly, biweekly, and continuous depending on variable

Level 3: 4-hr. intervals during runoff events, or 1 sample per event

Level 4: Smaller subbasins average every 20 days May- February and weekly March-April

3.3.7.4.4 Variables Analyzed

Level 1:
Temperature, Secchi depth, dissolved oxygen (DO), acidity (pH), conductivity, total suspended solids (TSS), volatile suspended solids (VSS), total phosphorus (TP), orthophosphate (OP), turbidity, chlorophyll *a*, total Kjeldahl nitrogen (TKN), ammonia-nitrogen (NH_3-N), nitrite- and nitrate-nitrogen (NO_2+ NO_3-N), fecal coliform (FC), and fecal streptococci (FS)

Level 2:
FC and FS - weekly grab samples
Temperature, turbidity, pH, DO - biweekly in situ
TSS, VSS, all nutrients, composite samples - 2-48 hr. and 1-72 hr. and weekly based on subsamples every 8 hours

Level 3:
TSS, VSS, TP, all nutrients

Level 4:
Turbidity, TSS, VSS, nutrients, FC, FS, temperature, DO, pH, conductivity, and flow

3.3.7.4.5 Flow Measurement

Level 2: Continuous recording with a bubble-type flow meter

Level 3: Recording device tripped by event

3.3.7.4.6 Meteorologic Measurements

Precipitation data were collected at several (3-4) locations in the watershed throughout the monitoring period.

Continuous record of wind speed and direction was also made during the first three years of the project.

3.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

Monitoring of macrophyte species and extent of growth in the bay occurred annually during the peak of the growing season. Both visual and aerial surveys provided data to document impact and map trends in macrophytes.

Benthic macroinvertebrates, periphyton, and fish were monitored at Mill River near the discharge to the bay, at the confluence of Rugg Brook and Mill River, and on Jewett Brook during 1982-83, 1986, and 1989-90.

3.3.7.5 Data Management

The data are managed locally by project personnel.

3.3.7.6 Data Analysis and Results

For bay and tributary monitoring data other than temperature, DO, and pH, all values were log transformed to approximate a normal distribution and to calculate summary statistics. The standard deviation was calculated with antilog values.

Techniques for trend analysis included time regression, analysis of variance, flow/concentration regression, analysis of covariance, paired regression, and nonparametric techniques. For bay parameters, mean annual values for each station were compared and plotted. Bay data were also grouped into two periods: 1) before tertiary treatment upgrade at the city of St. Albans treatment plant (project years 1982-86) and 2) after treatment and complete BMP implementation (project years 1987-88).

No significant trends in Secchi depth, chlorophyll a, TKN, TSS, or VSS have been measured at bay sampling stations. Bacteria counts at the beach station have decreased since 1987.

TP and OP concentrations have decreased at the treatment plant and at the outlet of the wetland. Nitrogen constituent concentrations have not varied significantly except for the decline in TKN and NH_3 and an increase in NO_2+ NO_3-N resulting from the upgrade to tertiary sewage treatment. Fecal coliform bacteria counts have decreased in Jewett and Stevens Brooks and at the treatment plant. Turbidity has decreased in Stevens Brook, Mill River, and at the treatment plant discharge. At Stevens Brook and at the treatment plant, TSS and VSS concentrations have declined. Monthly TSS loads have significantly decreased at Stevens Brook, Rugg Brook, and Mill River; however, decreases have not been documented at Jewett Brook or at the outlet to the Stevens wetland. Annual mean bacteria were correlated with annual animal density in the Rugg Brook and Mill River watersheds.

3.3.8 Linkage of Land Treatment and Water Quality

The relationship between land use and water quality was assessed using annual data summaries. Correlation and regression were used to evaluate the relationships between annual tributary TSS, VSS, nutrients, and bacteria and farm data including annual animal units; animal units under BMPs; animal density; acres manured; quantity of manure stored, applied, and incorporated; acres in corn and in pasture; and acres with erosion control practices. The only consistent and significant relationship documented was that stream bacteria counts declined with an increasing proportion of watershed animals under waste management BMPs.

3.3.9 Impact of Other Federal Programs on the Project

A few potential participants felt the recommended practices were inexpensive enough to be handled by Agricultural Conservation Program (ACP) annual agreements and, therefore, chose to not participate in RCWP.

The Dairy Termination Program necessitated the elimination of several practices that were no longer needed on affected farms because they no longer had cows.

3.3.10 Other Pertinent Information

None

3.3.11 References

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

Croft, R. and J. Mahood. 1992. A method for tracking land treatment progress in the St. Albans Bay watershed RCWP project, Vermont. In:Proceedings of the National Rural Clean Water Program Symposium. (accepted for publication)

St. Albans Bay RCWP Project. 1991. St. Albans Bay Rural Clean Water Program: Final Report 1991.

3.3.12 Project Contacts

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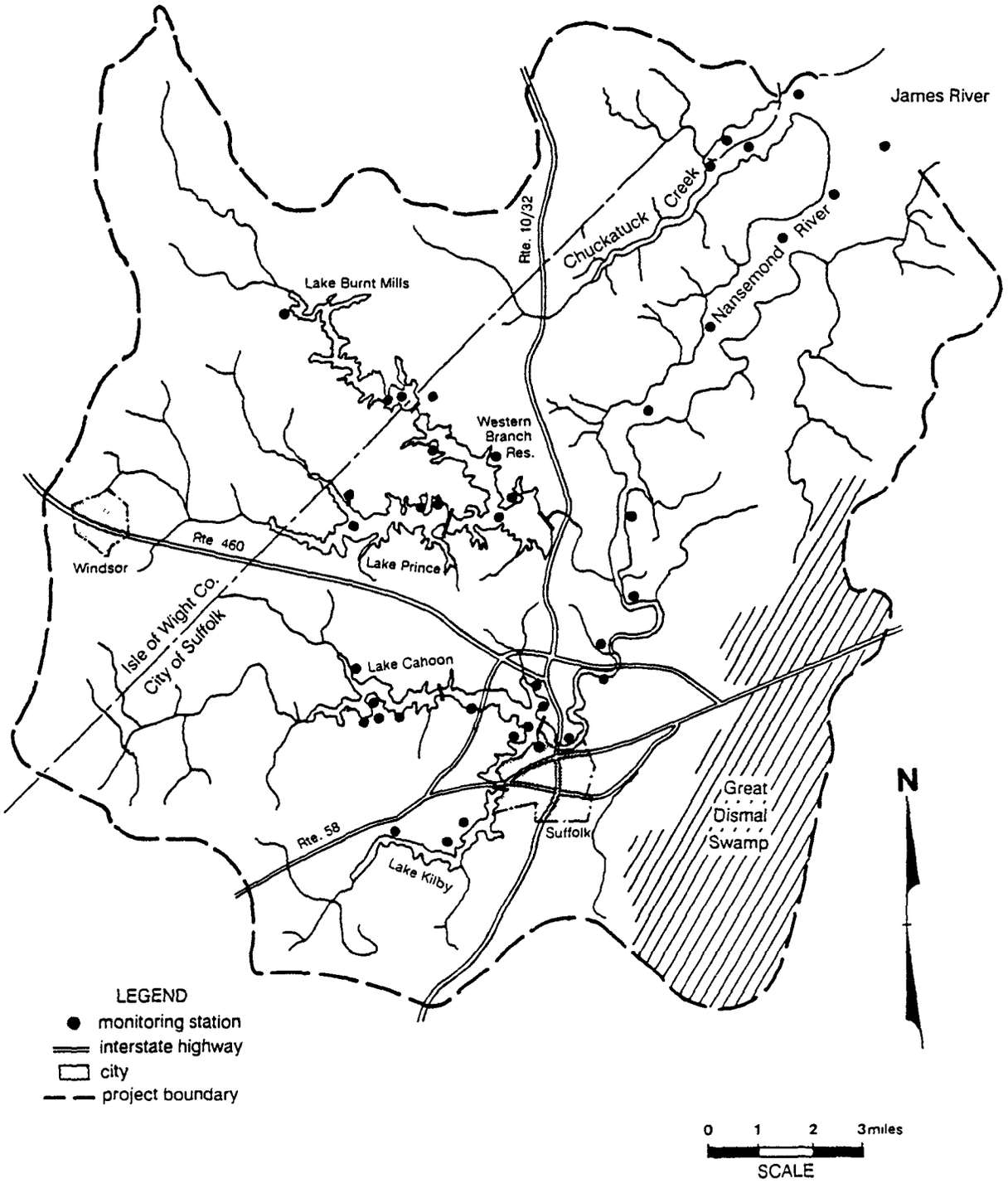
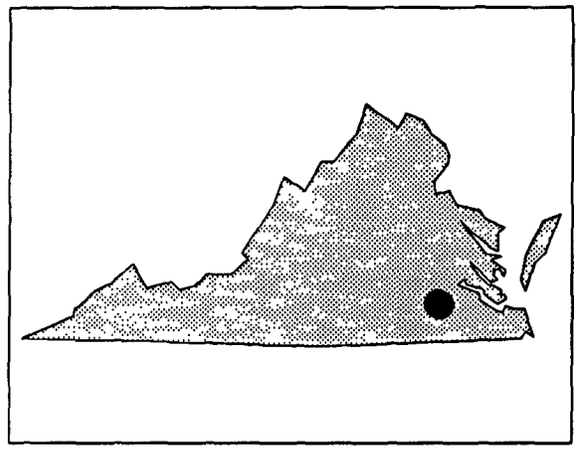


Figure 4.25: Nansemond - Chuckatuck (Virginia) RCWP project map, VA-1.

Virginia
Nansemond-Chuckatuck

(RCWP 21)



City of Suffolk & Isle of Wight County
MLRA: T-153A
HUC: 020802-08

4.1 Project Synopsis

Located in the coastal plain of southeastern Virginia, the project area watershed contains two estuaries, the Nansemond and Chuckatuck Rivers, which drain into the James River, and seven reservoirs used for water supplies to the cities of Norfolk, Chesapeake, Portsmouth, Suffolk, and Virginia Beach, Virginia. The water quality of the reservoirs is degraded due to excessive nutrients, phytoplankton, and fecal coliform as a result of storm water runoff. Extensive shellfish areas in the estuaries have been closed to direct market harvesting due to fecal coliform levels. The project goal was to reduce the level of nutrients, sediments, pesticides, and fecal coliform entering the reservoirs, streams, and estuaries in order to upgrade water quality.

This large watershed covers 161,365 acres. Originally, the critical area (about 66,000 acres) was defined as any farm within a one-mile radius of the tidal shellfish area, the reservoirs, or their principal tributaries. In 1985, the critical area was expanded to include 116,710 acres, of which 23,908 acres were cropped.

Participation by area farmers in the project was excellent. There was only enough money to fund 107 of the 132 applications filed. Farms were prioritized for contracting purposes. One hundred and ninety farms were represented by the 107 signed contracts. This represented approximately 78% of the 245 farms (15,034 acres) needing conservation treatments. An estimated 56,546 tons per year or 65% of the manure was treated.

Twelve categories of best management practices (BMPs) were utilized for control of sediment, nutrient, and pesticide losses or for manure storage and utilization. Pesticide and nitrogen management were two of the most widely used BMPs.

An initial baseline for water quality was established, followed by monthly and quarterly samples to detect water quality trends. Lack of funds caused the cancellation of the proposed final monitoring effort. There was no direct monitoring of land treatment to determine the effects of BMPs on water quality.

In spite of the high level of farmer participation and the number of acres treated, there was no improvement in water quality for the variables measured.

This project was characterized by an extremely high level of coordination and cooperation among the different agencies and a high level of participation among area farmers. The BMPs were selected properly. The inability of the project team to document water quality improvements attributable to land treatment is at least partially due to lack of funding for intense end-of-project monitoring. In addition, the size of the critical area was large and the number of applied BMPs was limited by funding which, most probably, decreased the overall effectiveness of BMPs on basin- wide water quality .

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

It was impossible to document achievement of some of the water quality goals because the variable involved was not measured, such as pesticide levels, soil loss, or sediment loads. Other water quality goals did not specify quantitative targets for reducing water contaminants.

Water quality monitoring goals outlined the steps necessary for a coherent water quality monitoring plan.

4.2.1.2 Recommendations

Water quality goals need to be based on quantitative guidelines so that monitoring can be used to document water quality changes.

Specific water quality variables utilized in goal setting must be monitored; otherwise, the goal is useless.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

This project was extremely well coordinated at all levels which is especially notable since the watershed spanned two counties. As a result, two Agricultural Stabilization and Conservation Service (ASCS) offices and six water quality monitoring groups were involved in the project. The Soil Conservation Service (SCS) was credited with serving as the bridge between all the various agencies.

The Local Coordinating Committee (LCC) formed a very cohesive working group with no turf battles. There were four subcommittees: Administration, Information and Education (I&E), Technical Assistance, and Monitoring. There was a high degree of coordination among several agencies concerned with water quality monitoring. These included the utilities departments of the cities of Portsmouth and Norfolk, the Virginia Institute of Marine Sciences, the State Water Control Board, the State Department of Health, and the Hampton Roads Water Quality Agency, which was responsible for coordinating the monitoring program from 1981 through 1989. Beginning in 1990, the monitoring was coordinated by the Hampton Roads Planning District Commission (formerly the Southeastern Virginia Planning District Commission) (Spooner, 1991).

Several years before the project ended a number of agency personnel retired. The LCC and the State Coordinating Committee (SCC) discontinued their meetings. As a consequence of personnel changes and lack of meetings, communication broke down toward the end of the project.

4.2.2.2 Recommendations

Due to the long-term nature of water quality projects, a good transference of project history and details to new staff members is essential.

Meetings must be continued through the life of the project in order to keep people informed, involved, and enthusiastic about the project.

Good coordination and communication among participating agencies is a necessary condition for a successful project. Other factors such as critical area or BMP selection are equally important in determining success.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

The Cooperative Extension Service (CES) had the lead role for I&E. Initially there was good coordination within the I&E committee, but meetings stopped, communication broke down, and the I&E effort became less effective.

The most effective tool the I&E committee had for communicating information to area farmers was one-to-one contact. The least effective tool was mailings.

CES was responsible for educating the farmers on fertilizer, animal waste, and pesticide management BMPs. Of the three, animal waste management was the most demanding because of the necessity for determining manure nutrient content, appropriate application rates, and type of application.

4.2.3.2 Recommendations

If project activities are to continue, it is essential that I&E Committee meetings continue over the life of the project.

There is no substitute for one-to-one contacts to transfer technical information to the farmers. Through such contacts, staff can communicate the projects' goals and objectives directly to the farmer.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

There was a high level of participation in this project. One hundred and thirty-two contracts were received; however, only 107 contracts were signed due to budgetary constraints. Prioritizing of farm attributes allowed the contracting of those farms most in need of BMPs. A combination of several factors led to the high number of participants: the threat of mandatory controls, a positive attitude by the SCS and ASCS, and the availability of cost share dollars.

4.2.4.2 Recommendations

The combination of financial incentive and threat of environmental regulation is effective in achieving farmer participation in water quality programs.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

Of the 13 BMPs tailored to address water quality problems, 12 were actually implemented. Both the fertilizer and pesticide management BMPs as well as the permanent vegetative cover and the sediment retention BMPs exceeded their contracting goals. All other BMPs were implemented at 50% of their target goals or higher. Within the expanded critical area, 15,084 acres were treated (63% of the acreage).

Some project personnel believed that in order for BMPs to have been effective in reducing nonpoint source (NPS) pollution, the entire watershed should have been designated as the critical area.

Several participants believed that Integrated Crop Management (ICM) would have been an extremely valuable BMP in that it would have dealt with the water quality problem within the context of a complete system rather than in separate parts.

Land treatment implementation practices were tracked through the use of color-coded SCS contracts. Annual status reviews were conducted by the SCS.

4.2.5.2 Recommendations

Flexibility in choosing and designing BMPs tailored to specific farm operators or sites was important in determining their successful implementation.

Farming practices that save the farmers money and are easily maintained will be continued beyond the formal end of the project.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

Monthly water quality monitoring efforts were conducted for trend analysis. Detailed data from water quality monitoring exist but the project lacked the funds for final data analysis and trend support.

Regression equations for the 1983-1988 water quality data were calculated using a program in STORET, but the equations have not been tested for significance. Improving trends in total suspended solids (TSS) and orthophosphorus (OP) was observed for Nansemond River as compared with reports from the 1960s. An improving trend in nitrate nitrogen (NO_3-N) was observed for Chuckatuck Creek. However, these trends may not be attributable to the Rural Clean Water Program (RCWP) project because they emerged in the late 1960s after point sources were removed from the project area. Thus an improving trend in water quality was already in effect in the estuaries when the RCWP project began.

Analysis of water supply lakes in the project area indicates high variability in water quality data and little evidence of trends. Manipulation of the water supply lakes for water withdrawal and storage of pumped ground water substantially confounds results. Ground water with high OP contents was pumped into the reservoirs when the reservoirs drop below a specified height. No allowance was made for climatological variation, for events outside the project area such as a lack of homogeneity and changes in land use such as urbanization and population growth at the expense of farms and wetlands. No pesticide monitoring, flow measurements, or storm sampling was conducted.

Intense end of project water quality monitoring and statistical analysis had been planned. However, due to a shortage of funds, this monitoring and analysis was not completed.

4.2.6.2 Recommendations

In order to ensure water quality monitoring over the life of the project, adequate funds must be made available.

Trend detection in reservoirs is difficult even under good conditions. When water quality measures are confounded by pumping ground water into a reservoir or drawing a reservoir down, trend detection is almost impossible. In order to determine the effectiveness of BMPs on water quality, tributaries should have been monitored using paired watershed or downstream/upstream monitoring.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

The project was unable to demonstrate any linkage between land treatment and water quality.

4.2.7.2 Recommendations

Water quality and land treatment monitoring must be designed correctly if linkage between the two are to be documented.

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1981 - 1991

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

7 water supply reservoirs: 4,850 acres

Streams: 195 miles

2 estuaries: size not reported

4.3.2.1.2 Water Uses and Impairments

Reservoirs in the project area are sources of public water supply for the cities of Norfolk, Chesapeake, Portsmouth, Suffolk, and Virginia Beach, Virginia. Chuckatuck Creek is a productive shellfish growing area and a tidal tributary to the James River. Commercial and recreational fishing and shellfishing are important water uses. The reservoirs are becoming eutrophic due to sediment and nutrients. Tidal waters are impaired by high fecal coliform levels.

4.3.2.1.3 Water Quality Problem Statement

Tidal waters are impaired by high fecal coliform levels that increase during and after run-off events. Reservoirs in the project area are becoming eutrophic due to excess nutrients and sediment.

4.3.2.1.4 Water Quality Objectives and Goals

Reduce the fecal coliform organisms in the water supply reservoirs, Nansemond River, and Chuckatuck Creek to within tolerable limits

Reduce the total soil loss by 87,000 tons per year

Reduce the turbidity and sediment loading of the 195 miles of streams and 4,850 acres of water supply reservoirs

Reduce the amount of plant nutrients and pesticides being discharged into local streams and reservoirs

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 161,365 acres
Project Area: 161,365 acres
Critical Area: 23,908 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

Mean Annual Precipitation: 48 inches

Geologic Factors: The project area is characterized by nearly level to gently rolling topography with steep slopes adjacent to small tributary streams. Most soils have moderately low erodibility factors. Depth to ground water is generally 25 feet or more.

4.3.2.2.3 Project Area Agriculture

In the project area there are 825 farms, averaging 177 acres, which produce peanuts, corn, soybeans, small grains, hogs, beef, poultry, and dairy livestock. There are 162 animal operations. The majority of the 65,000 tons (T) of manure produced annually in the critical area is either from hog or beef operations. Before the project started, many of the hog production facilities were located on dirt lots.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	27	32
Pasture-range	3	NA
Woodland	63	NA
Urban/roads	1	NA
Other		
Wetland	4	NA
Unspecified	2	NA

4.3.2.2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	1	125	175
Beef	24	2,724	2,724
Hog	40	24,000	9,600
Poultry	8	448,000	1,478

Animal numbers and annual production of manure decreased during the life of the project. From 1982 to 1984, dairy cow numbers declined by 275; hog numbers declined by 6,365. Poultry declined by 18,000 birds. This translates into a reduction of 13,381 tons or 13% of wet manure generated per year. Figures given above are for 1984.

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	1,721,000	0	4,242,000	0	5,963,000
Info. & Ed.	63,900	0	0	2,000	65,900
Tech. Asst.	448,595	0	0	48,000	496,595
Water Quality Monitoring	72,000	23,400	0	25,000*	120,400
SUM	2,305,495	23,400	4,242,000	75,000	$6,645,895**

* Additional funding for water quality monitoring (exact amounts unknown) was contributed by the following state and local agencies:

Commonwealth of Virginia Water Control Board
State Health Department
Cities of Norfolk and Portsmouth
Hampton Roads Water Quality Agency
Hampton Roads Planning District Commission

** Total does not include all water quality monitoring costs

Source: Smolen et al., 1989

4.3.4 Information and Education

4.3.4.1 Strategy

No information available

4.3.4.2 Objectives and Goals

Introduce farmers to the project

Teach farmers about nutrient management

4.3.4.3 Program Components

Newsletters

Personal visits

Media coverage (newspapers, radio spots)

Meetings

Tours

Education materials

Diagnostic clinic

Farm demonstrations on the use of swine and broiler waste as a source of nitrogen

Soil and animal waste testing

4.3.5 Producer Participation

4.3.5.1 Level of Participation

Between 50 and 70 producers were waiting to sign contracts when the contractual period started. More applications for contracts (132 contracts) were received than could be funded (107 contracts). Signed contracts covered 15,034 critical acres (84% of the critical area originally proposed). Although contracts were selected through a prioritization process based on location, type of animal operations, and other factors, the critical area ended up being defined based on funding availability.

4.3.5.2 Incentives to Participation

Cost share rate of 75% for most practices, except cover crops and some waste application equipment cost shared at 50%. Fertilizer and pesticide management were not cost shared.

Payment limit of $50,000 per contract (some contracts cover multiple tracts)

Excellent coordination among all the agencies involved, resulting in a well designed program that interested the farmers

Concern among area farmers that they would be regulated if they didn't participate

4.3.5.3 Barriers to Participation

Lack of availability of cost share funds

Lack of interest on the part of absentee landowners

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Chances for continued maintenance for most BMPs is considered excellent. Two of the four BMPs with the highest rate of implementation, fertilizer and pesticide management, were not cost shared, yet the farmers used them. The farmers are aware of the threat of regulation if they do not deal with the water quality problem through voluntary adoption of BMPs. Further, continued BMP maintenance will facilitate compliance with the Chesapeake Bay Preservation Act.

Most structural BMPs and stabilizing structures at field edges will probably be maintained. Waterways will be harder to maintain due to the sandy soils and the necessity for reseeding.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

Application and maintenance of BMPs on the part of the farm contributing to water quality problems.

4.3.6.2 Objectives and Goals

No information available

4.3.6.3 Critical Area Criteria and Application

Criteria: Originally - the area one mile from the Nansemond River or its impoundments and one mile from Chuckatuck Creek

Due to concerns about accelerated soil erosion in the in the Nansemond, an erosion and sediment evaluation was conducted in 1985. As a consequence of the evaluation findings, RCWP critical areas were expanded to include areas of high erosion (the new boundary included a one-mile radius from all tributaries).

In treating the expanded critical area, the project established a priority checklist for ranking. Weights were based primarily on distance to live streams and less than optimal soil or animal waste management. Animal waste operations were given twice the priority of croplands, and erosion problems were given the same priority as pesticide and fertilizer management problems. Farms with animal operations and no cropland treatment needs did not qualify.

Unfortunately, the project was not able to secure the additional funds necessary to treat all farms needing and wanting BMPs in the expanded critical areas.

4.3.6.4 Best Management Practices Used

General Scheme: The project has concentrated primarily on animal waste management, for hog and dairy operations, and conservation tillage with fertilizer and pesticide management.

BMPs Utilized in the Project*	Units	Goals	Achievements	
			Total	%
Permanent vegetative cover (BMP 1)	acres	200	282	141
Animal waste management system (BMP 2)	#	41	22	54
Diversion system (BMP 5)	feet	15,000	7,750	52
Grazing land protection system (BMP 6)	#	30	21	70
Waterway system (BMP 7)	acres	20	11	55
Cropland protection system (BMP 8)	acres	14,000	9,452	68
Conservation tillage system (BMP 9)	acres	9,500	7,870	83
Stream protection system (BMP 10)	feet	12,000	8,000	67
Permanent vegetative cover on critical areas (BMP 11)	acres	100	66	66
Sediment retention, erosion or water control structures (BMP 12)	#	100	109	109
Tree planting (BMP 14)	acres	100	0	0
Fertilizer management (BMP 15)	acres	14,000	14,536	104
Pesticide management (BMP 16)	acres	14,000	14,530	104

*Please refer to Appendix I for description/purpose of BMPs.

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

The land treatment program was implemented by the SCS, which kept records to identify each contract with respect to the water resource affected. The watershed was divided into four subwatersheds for ease of tracking.

4.3.6.5.2 Data Management

No data management system was in place during this project.

4.3.6.5.3 Data Analysis and Results

Quantified Project Achievements:

Pollutant Source	Units	Critical Area Total	Critical Area % Implemented	Goals Total	Goals % Implemented
Cropland	acres	23,908	63%	16,665	90%
Dairies	#	1	100%	1	100%
Feedlots	#	50	74%	38	97%
Poultry	#	8	38%	6	50%
Contracts	#	184	58%	107	81%

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

A monitoring program was developed by the Hampton Roads Water Quality Agency (HRWQA) based on ongoing monitoring efforts of public utilities in Portsmouth and Norfolk and the Virginia State Water Control Board and the Virginia Department of Health. HRWQA also funded and managed a major pre-project water quality assessment and evaluation conducted by the Virginia Institute of Marine Science. Beginning in 1990, monitoring was coordinated by the Southeastern Virginia Planning District Commission (now called the Hampton Roads Planning District Commission).

4.3.7.2 Objectives and Goals

The general objective was to determine whether or not large- scale implementation of agricultural BMPs would result in improved water quality in the principal project area water bodies.

Specific goals for each phase in the work plan included:

Setting pre-RCWP baseline as a basis for comparison

Collecting water quality data during the project so that annual changes could be observed

Conducting an intensive water quality survey at the end of the program

4.3.7.3 Time Frame

Reservoir Monitoring: 1982 - 1991

Estuarine Monitoring: 1983 - 1991

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

Reservoir Monitoring: 12 stations in Nansemond River water supply reservoirs

Estuarine Monitoring: 4 stations in Nansemond River estuary and 3 stations in Chuckatuck Creek estuary

4.3.7.4.2 Sample Type

Grab

4.3.7.4.3 Sampling Frequency

Monthly

4.3.7.4.4 Variables Analyzed

Reservoir Monitoring: Total solids (TS), total suspended solids (TSS), total phosphorus (TP), pH, temperature, fecal coliform (FC), dissolved oxygen (DO), biochemical oxygen demand (BOD), algal species

Estuarine Monitoring: DO, salinity, TSS, nitrate nitrogen (NO_3-N), dissolved orthophosphate (OP), FC, BOD

4.3.7.4.5 Flow Measurement

None

4.3.7.4.6 Meteorologic Measurements

Monthly rainfall: 1982-1988

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

None

4.3.7.5 Data Management

Monitoring data for Chuckatuck Creek and Nansemond River stations are in STORET. Reservoir data are maintained as follows:

Norfolk Utilities: 6 stations in Lake Prince, Lake Burnt Mills, and Western Branch

Portsmouth Utilities: 8 stations in Lake Meade, Lake Cahoon, Lake Kilby, and Lake Speights Run

4.3.7.5 Data Management (continued)

STORET AGENCY CODES	STORET STATION NO.
Chuckatuck Creek	
21VASWCB	2-CKT000.19
	2-CKT001.63
	2-CKT003.05
Nansemond River	
21VASWCB	2-NAN000.20
	2-NAN005.82
	2-NAN007.89
	2-NAN012.53
	2-NAN019.14

4.3.7.6 Data Analysis and Results

Visual comparison of monitoring data (tabular and graphic) with baseline information from a survey by Hampton Roads Water Quality Agency (1982) was done in order to detect trends. Regression analysis was also conducted. A more detailed statistical analysis was planned for the end of the project but was not completed due to funding limitations.

The project did not unequivocally meet its objectives for reducing fecal coliform, total soil loss, turbidity and sediment loading, plant nutrients, and pesticides. Some of the measurements needed for determination of goal achievement were never made, such as pesticide concentrations and total soil loss. Analysis of the water supply lakes in the project area indicated high variability in water quality data and little evidence of trends. For the other variables, initial trend analysis in the Nansemond River estuary indicated that TSS and NO_3-N appear to be declining, but OP is increasing. NO_3-N and OP are declining in the Chuckatuck Creek estuary. These trends may be attributable to changes in point source discharges on Nansemond River and closure of a large swine operation on Chuckatuck Creek rather than BMPs installed through the RCWP project.

4.3.8 Linkage of Land Treatment and Water Quality

The project was unable to demonstrate any linkage between land treatment and water quality.

4.3.9 Impact of Other Federal and State Programs on the Project

Under the Agricultural Conservation Program (ACP), 3,000 acres of cover crops and conservation have been implemented with $12,000 in cost share money, thus increasing the total number of acres under conservation practices.

4.3.10 Other Pertinent Information

None

4.3.11 References

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

Nansemond-Chuckatuck RCWP Project. 1992. Ten-Year Report.

Smolen, M.D., S.L. Brichford, J. Spooner, A. Lanier, T.B. Bennett, S.W. Coffey, and K.J. Adler. 1989. NWQEP 1988 Annual Report: Status of Agricultural Nonpoint Source Projects. EPA 506/9-89/002.

Spooner, J., J.A. Gale, S.L. Brichford, S.W. Coffey, A.L. Lanier, M.D. Smolen, and F.J. Humenik. 1991. NWQEP Report: Water Quality Monitoring Report for Agricultural Nonpoint Source Projects - Methods and Findings from the Rural Clean Water Program. National Water Quality Evaluation Project, NCSU Water Quality Group, Biological and Agricultural Engineering Department, North Carolina State University, Raleigh, NC.

4.3.12 Project Contacts

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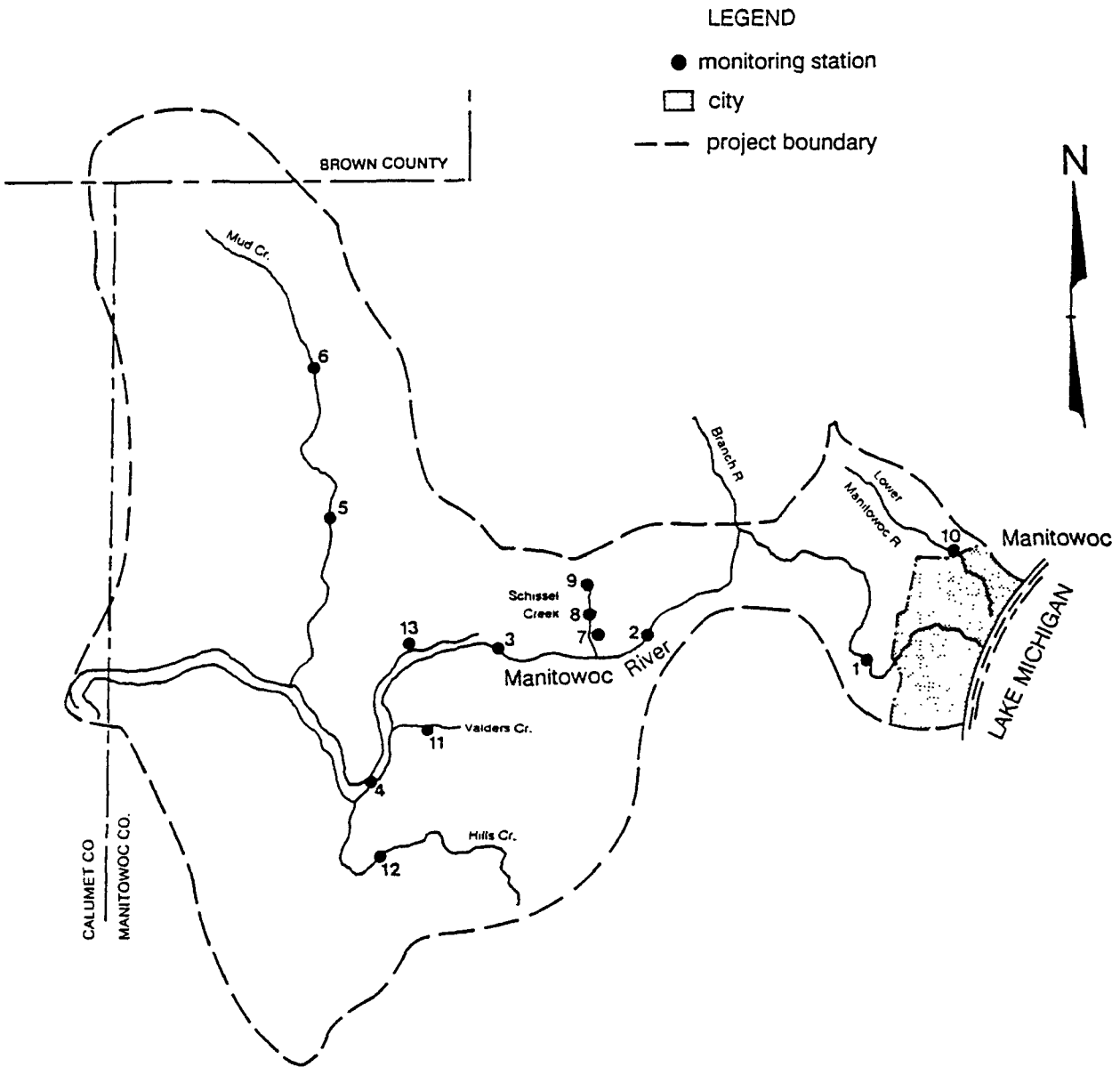
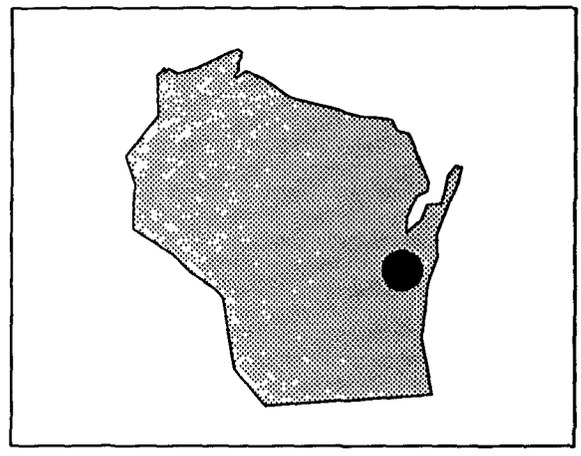


Figure 4.26: Lower Manitowoc River (Wisconsin) RCWP project map, WI-1.

Wisconsin
Lower Manitowoc River

(RCWP 13)



Manitowoc, Brown, & Calumet Counties
MLRA: L-95 A & B
HUC: 040301-01

4.1 Project Synopsis

The Manitowoc River, located in east central Wisconsin, discharges into Lake Michigan. The entire river basin covers 352,000 acres. The project area borders the lake and is 102,000 acres in size. Topography is rolling and eastern areas have some steep slopes. Rainfall averages 29 inches per year and snowfall averages 40 inches per year. Dairy farming is the primary agricultural activity and the project area contains approximately 13,000 dairy cows. Crops include corn, barley, wheat, alfalfa hay, and canning crops.

Recreation, shipping, and public water supply for the City of Manitowoc are the primary uses of the nearshore waters of Lake Michigan. Streams and lakes in the project area are used for recreation. Phosphorus, sediment, and coliform bacteria loadings from cropland and dairy waste runoff and point sources have impaired uses in the watershed and nearshore waters.

The objective of land treatment was the effective control of nutrients and sediment. Land treatment emphasized animal waste storage systems and best management practices (BMPs) to control erosion such as permanent vegetative cover, stripcropping, grassed waterways, and conservation tillage. The project critical area included all lands less than 1\8 mile from a water course and lands with slopes greater than 6%. Critical area livestock operations were determined by a rating system based on the need for barnyard runoff controls and manure storage.

The overall water quality objective was to restore the nearshore and watershed designated uses. Water quality monitoring consisted of macroinvertebrate sampling at 13 locations. Monitoring results were inconclusive.

The Lower Manitowoc RCWP project has demonstrated that a local project staff can work together effectively toward a common goal despite limited administrative and technical support from the State Coordinating Committee (SCC). The project achieved 92% of its contracting goal; slightly over half of the acres and dairies needing BMPs have been treated. Nutrient management was not approved by the SCC as a cost shared BMP. Because nutrient management was a fundamental practice for water quality in this project, the lack of cost share for the practice reduced the effectiveness of this project substantially. Due to the lack of cost share, farmers had little incentive to change the way they farmed to protect water quality. Monitoring was insufficient in design to clearly document a water quality problem or to show measurable change toward goals. The result was uncertainty about the impacts and location of pollutant source areas, making the selection of critical areas and BMPs less effective than if monitoring data had been available. Local staff, farmers, and citizens lacked feedback on water quality progress to reinforce or refine efforts.

4.2 Project Findings, Recommendations, and Successes

4.2.1 Definition of Project Objectives and Goals

4.2.1.1 Findings and Successes

From the onset, the project had numerous water quality problems to address in Bullhead Lake, tributaries, the Lower Manitowoc River, and nearshore areas. Limited biological and chemical data were available and the usefulness of the data was not clear. A large project area, several impaired resources, and poor problem definition made formulation of effective objectives and goals difficult.

The project would have benefited from outside help to calculate phosphorus loadings to the stream and priority water resources, to estimate the effectiveness of control measures, and to develop goals.

4.2.1.2 Recommendations

Goals must be specific, attainable, and measurable (Lower Manitowoc River RCWP, 1991). Goals not only determine what the project is striving to accomplish but also serve to identify the methods and BMPs to be used to accomplish the goals. The project would have benefited from more technical assistance to help with problem definition, definition of critical areas, selection of BMPs, and setting goals to achieve water quality improvement.

4.2.2 Project Management and Administration

4.2.2.1 Findings and Successes

Prior to its selection as a RCWP project, the Lower Manitowoc River watershed was designated as a nonpoint source (NPS) pollution control project in the state's Priority Watershed Program, administered by the Department of Natural Resources (WIDNR). During the transition from one program to the other, identification of the lead agency responsible for coordination of the project at the state level was not made. The Agricultural Stabilization and Conservation Service (ASCS) reluctantly took over the lead when the project was converted to RCWP. ASCS staff were not particularly interested in the project because they had not been involved in choosing the project. They felt the project had little chance of documenting a water quality improvement because of limited background monitoring data. Also the RCWP project area was in the lower third of a large 352,000-acre watershed. ASCS personnel felt it would be difficult to measure water quality improvement when there was little control of land use activities in the drainage area above the project and there was little chance of monitoring a change due to BMPs.

The local agency administering the cost share funds for the state's Priority Watershed program was the Land Conservation Committee and there were some minor changes to make the transition to administration under ASCS. The RCWP project staff needed guidance with local coordination and administration for running the federal program at the local level. Local administration and communication would have been facilitated if ASCS and Soil Conservation Service (SCS) had been located in the same building.

The SCC provided administrative support but very little leadership to the project. SCC members visited the project only during startup. The SCC did not meet after the initial project setup. Most of the remaining communication within the SCC and with the project was done through telephone or mail correspondence. The SCC should have met more often and on a regular basis to provide continuity, report on progress and project expenditures, and provide direction.

The SCC provided assistance to the local project by instituting cost control measures for expensive practices and setting priorities. The SCC also sought to make the RCWP project consistent with the state Nonpoint Source program and the Agricultural Conservation Program (ACP), thereby preventing the project from developing an independent approach using innovative BMPs.

4.2.2.1 Findings and Successes (continued)

The SCC was slow to review requests from the Local Coordinating Committee (LCC) and sometimes denied requests to approve cost share for very important practices (e.g. nutrient management). Lack of interest by the SCC provided negative feedback to the project. The lack of technical support for land treatment was acknowledged by both the SCC and the LCC.

The project staff seemed to be very capable and interested in the project. Cooperation and sharing of workload at the local level was excellent between the SCS, the Soil and Water Conservation District staff, and the ASCS. The project did a good job of setting priorities, installing practices, and following the project work plan. Many of the project activities were coordinated at annual meetings.

Understaffing due to a high rate of project staff turnover resulted in a delay in BMP installation.

The project team lacked the technical and administrative support they needed to adequately treat the water quality problem. The LCC made a request to the SCC for authorization of cost sharing for the following BMPs, which were not approved: 1) control of roadside erosion due to construction, 2) treatment of milkhouse waste water, 3) nutrient management, 4) soil and manure testing, 5) long-term rotations on hay to control erosion.

The local project personnel had very little knowledge about the management of phosphorus; they relied on the technical agencies to provide information, but received little support. The project would have benefited from technical assistance from other watershed programs. The SCC could have provided leadership and innovative techniques for NPS management, but the local project felt as though they were not being lead.

4.2.2.2 Recommendations

A shared commitment to the program objectives by the NCC, the SCC, and the LCC is a critical element in individual project success.

Because the SCC is so instrumental to project success, projects should be terminated if the local project does not receive adequate technical and administrative support from the SCC. Administrative and technical support and commitment for an experimental program beyond that required for established programs must be provided. Where this is not demonstrated, projects should be terminated after two years.

Projects that document water quality problems due to animal waste pollution sources must have nutrient management available as a cost shared BMP.

4.2.3 Information and Education

4.2.3.1 Findings and Successes

SCS and the conservation district played the lead role in encouraging farmer participation. Initially, the project had difficulty getting farmers to sign up for the program. It was unclear if the project had evidence of a water quality problem linked to individual pollutant sources. It was also unclear if farmers knew about the water quality problem. Agencies doing I&E work also did not agree on the nature of the water quality problem.

Most critical area dairy farms needed expensive manure storage facilities. In the early years of the project, economic conditions prevented farmers from making the financial investment in manure storage facilities necessary for participation in the RCWP project.

A retired district conservationist (DC) was hired to contact former clients and encourage participation in the project. Because of the former DC's good working relationship with farmers, participation increased.

The information and education (I&E) program was only somewhat effective in helping farmers become aware that each of them could be part of the water quality problem.

The I&E program was also only somewhat effective in helping farmers change their attitudes and develop knowledge and skills necessary to implement structural and management BMPs.

4.2.3.1 Findings and Successes (continued)

Animal waste management systems required the most I&E. An important consideration for installing animal waste systems was the payback potential of the system based on herd size.

Farmers' decisions to install practices were influenced by their perceptions about the potential for increased income or reduced labor.

Overall, farmers installed traditional practices that were perceived by some to improve water quality.

There was no clear indication whether farmers perceived changes in water quality over the life of the project.

4.2.3.2. Recommendations

Effective problem identification monitoring and trend monitoring on one or more tributaries is needed where farmers are reluctant to participate and where evidence of project effectiveness is needed to encourage farmers to adopt practices for an extended period.

For projects with water quality problems from dairy manure, I&E activities should receive intensive and long-term support from the Extension Service at the state and local levels. Developing a BMP system for animal waste requires several years of educational and technical assistance to help each farmer adopt not only new farm management but a new way of conducting daily farm operation.

Farmers must be shown what the water quality problem and its sources are. Recommended solutions must be practical and make sense for each farm.

4.2.4 Producer Participation

4.2.4.1 Findings and Successes

Overall producer participation was average to good.

Economic conditions and the stage of a farmer's career were big factors affecting participation. Older farmers often did not participate. Many of the older farmers rented their land and did not push hard for renters to participate.

Cross-compliance for cropland practices reduced participation in the RCWP project. If farmers wanted to stay in commodity programs, they were required to maintain a minimum or base acreage in corn. In order to comply with this requirement, if they did not have enough land to maintain the base acreage on land with low erodibility, they planted some corn on land with high erodibility. Although farmers wanted to convert corn acres to permanent vegetative cover on highly erodible land, they could not always do so without going below the base requirement for corn acreage.

One highly vocal producer was opposed to the project. The publicity of this producer's opinion was perceived by project staff to be a negative factor which may have reduced participation.

Cost share for manure transfer equipment was only 40%. Such equipment was instrumental for efficient transfer of manure from the barn to the storage facility. The low cost share for this important component of the total manure management system sent a negative message to farmers.

Lack of cost share for nutrient management reduced the credibility and effectiveness of the overall project. Spreading manure on frozen ground in the winter was a common practice; the RCWP project provided no financial incentive for cessation of this practice.

4.2.4.2 Recommendations

Projects must have a well-organized technical staff to assist leaders in the farm community in using animal waste storage and nutrient management as a system. In turn, when farmers show their colleagues the problem and demonstrate the use of the technology, participation grows. Farmers can have a positive influence on their peers, resulting in a high level of participation, especially if they perceive local project staff can provide technical and administrative leadership.

The SCC and NCC should be particularly careful to provide enough financial incentives and technical assistance to animal waste control projects because they require extra assistance, compared to cropland projects, to both farmers and project staff to be successful.

4.2.5 Land Treatment Implementation, Tracking, and Evaluation

4.2.5.1 Findings and Successes

The project team did a good job defining the critical area based on animal waste storage needs, but they would have benefited from the use of a computer model to identify critical cropland acres.

Proper management of manure and mineral fertilizers was a major problem. Many of the farmers viewed their waste storage facilities as a convenience and failed to practice farming to improve water quality. Many farmers did not credit the nitrogen stored in soil after a long rotation of alfalfa, nor did they credit manure nitrogen when they applied fertilizer to plant corn. It was difficult to get the farmers to apply manure to the correct field based on total farm nutrient management principles.

The project worked with 20 participants on nutrient management on a single field per farm. This demonstration was used for educational purposes with the goal of transferring the technology to more farms in the area.

Proper manure storage and nutrient management constitute a BMP system; both are needed for effective NPS pollution control. Project personnel suggested an alternative management plan using the same BMPs, but restricting the spread of manure to non-critical areas. However, this may not always be feasible; because of the volume of manure and farm size, there may not be enough non-critical land left on which to spread manure.

The physical setting of the project area makes effective control of manure difficult. Many barnyards are located on streams. The soils have a high clay content and a high runoff rate. Also a large amount of the total annual runoff occurs during snow melt, making the application of manure to snow-covered fields especially damaging to surface waters.

The project staff used a U.S. Geological Survey (USGS) topographic map to track the installation of BMPs in the project area. They did not develop a method for tracking land use.

Four farmer's cooperatives assisted the project by sampling manure and paying for lab nutrient analysis. Cooperatives have been providing this service to farmers to help them reduce fertilizer costs.

Implement dealers have been participating in conservation tillage field days. By providing the equipment free of charge for demonstrations, they are helping to promote erosion control as well as marketing their tillage equipment.

Innovative BMPs developed by the project include a filter wall at the end of the improved barnyard to trap solids while allowing liquid waste to flow through holes drilled in the wall. A gravel level spreader was then used to further trap solids and let the waste drain through the gravel before liquid manure was treated in a grassed filter.

Conservation tillage and manure management were the BMPs most often completely discontinued after contracts expired.

Avoidance of winter manure spreading, crop rotations, and filter strips below barnyards were the BMPs most often not adequately maintained after contracts ran out.

4.2.5.2 Recommendations

A distributed parameter computer model (such as AGNPS) should be used to determine critical cropland acres and dairies based on source type, magnitude and distance to streams.

Nutrient management should be used as a basic component for any water quality project with significant animal waste problems. Soil testing and use of spreadsheet software for nutrient management should be encouraged for every farm in the critical area.

Water quality and commodity programs should be better integrated so that base acreages can be reduced without penalty to facilitate application of BMPs to critical acres.

There is a high probability a good water quality monitoring program would have resulted in greater participation and the installation of more practices. Farmers need verification of a water quality problem and a method to track program success before investing in expensive structural BMPs.

A geographic information system (GIS) is needed to track land use and BMP installation at the field and farm level for RCWP and other programs. Suggested land treatment variables would be waste storage systems, complete waste management systems, nutrient management based on soil tests, acres treated with improved rotations, conservation tillage, or other erosion control measures.

Achievement of the water quality goals for this project through promotion of adoption, continuing use, and maintenance of BMPs will require on-going and intensive technical assistance to farmers.

4.2.6 Water Quality Monitoring and Evaluation

4.2.6.1 Findings and Successes

Water quality monitoring and evaluation suffered from the lack of a good experimental design. The project area does not include the headwaters of the river, which receives significant pollutant loadings. Tributaries and subwatersheds contain point sources of pollution or wetlands, which confound the detection of trends.

The LCC tried to meet monitoring goals, but with little success. The project would have benefited from greater cooperation from the state water quality agency (Lower Manitowoc River RCWP, 1991).

Macroinvertebrate monitoring was intermittent. The scale for the biotic index was changed twice during the project, making numerical comparisons among scales meaningless. Macroinvertebrate monitoring showed no clear trends in the biotic index for any station.

Chemical monitoring was intermittent and did not provide information on trends in phosphorus concentrations or loadings.

4.2.6.2 Recommendations

Water quality projects should not be funded without a firm commitment from the water quality agency to design and carry out an effective water quality monitoring program.

Water quality monitoring protocols and sampling frequency for trend detection should be consistent throughout the length of the project.

4.2.7 Linkage of Land Treatment and Water Quality

4.2.7.1 Findings and Successes

The project staff were unable to document linkage between land treatment and water quality due to the absence of meaningful water quality monitoring and land treatment tracking.

4.2.7.2 Recommendations

Nonpoint source pollution control programs will not produce meaningful results until land treatment and water quality data can be linked and analyzed.

4.3 Project Description

4.3.1 Project Type and Time Frame

General RCWP

1980 - 1990

4.3.2 Water Resource and Watershed Descriptions

4.3.2.1 Water Resource and Water Quality

4.3.2.1.1 Water Resource Type and Size

Bullhead Lake, Lower Manitowoc River, wetlands and streams, all draining through the City of Manitowoc to Lake Michigan

4.3.2.1.2 Water Uses and Impairments

The nearshore waters of Lake Michigan are used for recreation (swimming, fishing and boating), shipping, and public water supply for the city of Manitowoc. These waters are impaired by algal growth due to excessive quantities of phosphorus and by high bacteria levels. The harbor capacity is reduced by sedimentation which necessitates dredging to maintain shipping channels.

The river, streams, and lakes within the project area are used primarily for fishing and other recreational activities. Bullhead Lake is eutrophic as a result of excess phosphorus, impairing the fishery. The fishery in the river is impaired by high phosphorus levels and high fecal coliform levels. Sedimentation of the riverbed is also a problem.

Project area water resources are used by about 40,000 people in and near the watershed. This number does not include recreational visitors to the watershed.

4.3.2.1.3 Water Quality Problem Statement

Phosphorus, sediment, and coliform bacteria loadings from cropland and dairy waste runoff impair designated uses (swimming, fisheries, shipping channels, drinking water supplies) in the Lower Manitowoc River watershed and nearshore waters of Lake Michigan.

4.3.2.1.4 Water Quality Objectives and Goals

Reduce agricultural nonpoint source phosphorus loads by 48%

Minimize further degradation to Bullhead Lake by reducing phosphorus loads

Improve the overall water quality in the Lower Manitowoc and Little Manitowoc Rivers to a "good rating" as indicated by the Hilsenhoff Biotic Index (a measure of macroinvertebrate community)

Reduce fecal coliform counts to or below 200 per 100 milliliters (ml) in the watershed

4.3.2.2 Watershed Characteristics

4.3.2.2.1 Watershed Area: 352,000 acres
Project Area: 102,000 acres
Critical Area: 23,598 acres

4.3.2.2.2 Relevant Hydrologic, Geologic, and Meteorologic Factors

The climate is modified continental because the watershed borders Lake Michigan. Rainfall averages 29 inches and snowfall averages 40 inches. A large portion of the runoff during the year is due to snow melt.

Topography is rolling to moderately rolling to some steep slopes in the eastern part of the watershed.

Soils have a high runoff potential because they are generally predominantly fine-textured clay loams (Lower Manitowoc River RCWP, 1991).

4.3.2.2.3 Project Area Agriculture

Dairy farming is the primary agricultural activity. Crops (percent area in parentheses) include corn (34%), oats (15%), barley and wheat (7%), alfalfa hay (38%), other hay (2%), and canning crops (4%). Ninety-six percent of the cropland acreage is tilled conventionally with the remainder in conservation tillage. All cropland is fall tilled due to the high clay content of the soils.

4.3.2.2.4 Land Use

Use	% of Project Area	% of Critical Area
Cropland	67	NA
Pasture/range	-	NA
Woodland	28	NA
Urban/roads	5	NA
Other	-	NA

4.3.2 2.5 Animal Operations

Operation	# Farms	Total # Animals	Total Animal Units
Dairy	333	13,000	18,200

There are 333 operations with an average of 39 cows per operation: 83 small herds of less than 20 milk cows and 250 larger herds of more than 20 milk cows.

4.3.3 Total Project Budget

SOURCES	Federal	State	Farmer	Other	
ACTIVITY					SUM
Cost Share	817,100	0	591,900	0	1,409,000
Info. & Ed.	1,000	900	0	0	1,900
Tech. Asst.	104,479	0	0	20,557*	125,036
Water Quality Monitoring	0	5,000	0	0	5,00
SUM	922,579	5,900	591,900	20,557	$1,540,936

* Performed by Land Conservation Department staff and reimbursed with RCWP funds

Source: Lower Manitowoc River RCWP Project, 1991

4.3.4 Information and Education

4.3.4.1 Strategy

The strategy was to generate landowner and operator acceptance of BMPs.

4.3.4.2 Objectives and Goals

The overall objective was the same as the strategy. I&E goals were based on performance for the following 11 activities to promote the acceptance of BMPs.

Activity	Goal
Watershed demonstrations	Inform landowners and general public
Farm and watershed signs	Promote community spirit
Watershed meetings	Information and updates- 1/year
Newsletter	Information and progress - 4/year
BMP tours	Information - 1 or 2/yr
Workshops	1/year
Brochures	1 on RCWP, 1 on minimum tillage, 1 on BMPs
Contacts with owners/operators	130/year
Radio and news releases	12/year
Slide presentations	Unknown number of presentations
Awards and recognition programs	Conservation banquet/year

4.3.4.3 Program Components

Please refer to section 4.3.4.2 above

4.3.5 Producer Participation

4.3.5.1 Level of Participation

The project achieved 133 approved projects out of the goal of 144. Participation was average to good.

4.3.5.2 Incentives to Participation

The availability of cost share funds and the assistance and encouragement from the government were the most important incentives for participation. Demonstrations or meetings sponsored by RCWP and the assistance and encouragement from other farm operators were also important incentives. Least important incentives were the concern for the environment, conservation ethic and increased farm production.

The convenience of storing manure to avoid daily hauling was an incentive for many farmers. Providing a clean, paved barnyard reduced animal cleaning and was beneficial to animal health.

Peer pressure was somewhat effective in gaining project participation. Agency personnel were also successful in encouraging participation.

Cost Share Rates: Permanent vegetative cover was cost shared at 50% and stripcropping systems were cost shared at 70%; animal waste transfer components were cost shared at 40%; all other animal waste storage components had a 70% rate.

Payment limit of $50,000 per landowner

Within the project area a state cost share program was being used in conjunction with the RCWP project.

4.3.5.3 Barriers to Participation

Economic conditions presented a significant barrier to participation.

Farmers did not want to install BMPs on rented land.

Low cost share rates, the lack of a defined water quality problem, and the dislike for government programs were also barriers to participation.

Many older farmers often did not want to participate.

4.3.5.4 Chances of Continued Maintenance/Adoption of BMPs

Project personnel estimated that they expect about 90% of critical area BMPs are expected to be maintained or continued. Farmers are getting used to the idea of storing manure for the sake of convenience and water quality. Interest in animal waste management is growing along with technology transfer to other areas.

The extent of continued maintenance and adoption depends on the BMP. Conservation tillage and nutrient management are the practices most likely to be discontinued after contracts expire. Waste utilization to avoid winter spreading, nutrient management, crop rotations, and filter strips to treat barnyard runoff are all BMPs that may have a lower rate of maintenance.

4.3.6 Land Treatment

4.3.6.1 Strategy and Design

Land treatment practices focus on nutrient and animal waste management and erosion control.

4.3.6.2 Objectives and Goals

The goal of the land treatment was to treat 75% of the critical area, including dairies and erosion sources other than livestock farms.

4.3.6.3 Critical Area Criteria and Application

Criteria:

All lands within 1/8 mile of a water course

Lands with slopes 6% or greater that are 1/4 mile from a water course

Livestock operations categorized as: 1) in need of barnyard runoff controls and manure storage, 2) in need of manure storage, 3) small water quality impact, 4) no impact on water quality

Application of Criteria: Procedures well established and consistent

4.3.6.4 Best Management Practices Used

Land treatment practices that deal with animal waste management and erosion control have been emphasized by the project. BMPs approved for the project include RCWP

BMPs Utilized in the Project*:

Permanent vegetative cover (BMP 1)

Animal waste management (BMP 2)

- Semi-solid storage
- Solid storage
- Liquid storage
- Runoff measures

Stripcropping systems (BMP 3)

Terrace system (BMP 4)

Diversion system (BMP 5)

Waterway system (BMP 6)

Conservation tillage (BMP 9)

- Contour farming

Stream protection system (BMP 10)

Permanent vegetative cover on critical areas (BMP 11)

Sediment retention, erosion, or water control system (BMP 12)

*Please refer to Appendix I for description/purpose of BMPs.

4.3.6.4 Best Management Practices Used (continued)

Quantified Project Achievements (as of May 1991)

Pollutant Source	Units	Critical Area		Treatment Goals	
		Total	% Implemented	Total	% Implemented
Cropland	acres	23,598	35%	1,593	52%
Dairies	#	153	39%	115	51%
Contracts	#	192	70%	114	92%

Source: Lower Manitowoc River Watershed RCWP, 1990

4.3.6.5 Land Treatment and Use Monitoring & Tracking Program

4.3.6.5.1 Description

Phosphorus delivery was estimated based on manure spreading for animal operations, and barnyard runoff and slope for cropland. Reductions in phosphorus delivery for operations with fewer than 20 cows, more than 20 cows, and cropland source categories were provided (Lower Manitowoc RCWP, 1991).

4.3.6.5.2 Data Management

No data management system was in place during the project.

4.3.6.5.3 Data Analysis and Results

Analysis:

No data analysis plans have been implemented.

Results:

More than half of the goal for treating critical area cropland with waste management practices has been achieved.

Over half of the dairies have been treated with structural practices to control animal waste.

4.3.7 Water Quality Monitoring and Evaluation

4.3.7.1 Strategy and Design

The project used an impact assessment design (pre- and post- BMP implementation) with almost no sampling during implementation.

Conducted by the Wisconsin Department of Natural Resources

4.3.7.2 Objectives and Goals

The overall water quality objective was to restore the nearshore and watershed designated uses.

No specific water quality monitoring goals were identified.

4.3.7.3 Time Frame

1979 - 1991

4.3.7.4 Sampling Scheme

4.3.7.4.1 Monitoring Stations

13 stations on the Lower Manitowoc River and tributaries

4.3.7.4.2 Sample Type

Benthic Surber sample

4.3.7.4.3 Sampling Frequency

Spring and fall 1979, 1982, fall 1987, and fall 1990

4.3.7.4.4 Variables Analyzed

Macroinvertebrate taxa and habitat evaluation

4.3.7.4.5 Flow Measurement

None

4.3.7.4.6 Meteorologic Measurements

Mean Annual Precipitation: ~ 29 inches

4.3.7.4.7 Other Important Water Quality Monitoring and Evaluation Information

None

4.3.7.5 Data Management

Data from one station near the mouth of the Manitowoc River for 1980-82 are in STORET. Other data are managed locally.

STORET AGENCY CODE	STORET STATION NO.	PROFILE / STATION MAP / NO.	(COMMENTS)
21WIS	363219	WI-1 /	(short distance upstream from mouth of Manitowoc River)

4.3.7.6 Data Analysis and Results

Analysis:

Hilsenhoff Biotic Index values have been calculated and ratings determined for macroinvertebrate data sets. While other metrics and statistical tests are potentially applicable, no other data analysis has been conducted.

Site factors, experimental design deficiencies, and lack of funding and interest in monitoring have prevented the detection of water quality impacts. Substantial phosphorus loads originate from outside the project area.

Point sources, wetlands, and sources outside the project influence the main stem of the Lower Manitowoc River and reduce the chances of isolating the effect of agricultural NPS controls. As a result of limited funding and the low probability of detecting treatment effect, monitoring of chemical parameters and flow at the base of the watershed was abandoned early in the project.

Results:

Macroinvertebrate monitoring in selected tributaries may detect an impact if upstream land use and land treatment can be documented. The pre- implementation macroinvertebrate data set (1979 and 1982, spring and fall) may be an adequate baseline for comparison with post-implementation data. While macroinvertebrates may not respond to changes in nutrient loads it is expected they will respond to reductions in nutrient concentrations.

4.3.8 Linkage of Land Treatment and Water Quality

The project has not linked land treatment and water quality.

4.3.9 Impact of Other Federal and State Programs on the Project

The project had significant loss of manpower because technical staff were required to complete a conservation plan for every farm in the county in addition to completing other duties. This extra work was mandated by the Food Security Act, but the complete impact on the project has not been determined.

4.3.10 Other Pertinent Information

None

4.3.11 References

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

Lower Manitowoc River RCWP Project. 1990. Annual Report.

Lower Manitowoc River RCWP Project. 1991. Annual Report.

4.3.12 Project Contacts

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APPENDICES

Appendix I

RCWP BEST MANAGEMENT PRACTICES

This appendix lists the BMPs approved by the U.S. Department of Agriculture (USDA) and U.S. Environmental Protection Agency for cost sharing in Rural Clean Water Program projects. Information included for each BMP includes its official RCWP number and title, a brief description of the intended purpose of the BMP, the minimum life span, and a list of applicable BMP components. The number in parentheses following each BMP component indicates the respective USDA - Soil Conservation Service conservation practice specification code.

BMP 1 Permanent Vegetative Cover

Purpose: To improve water quality by establishing permanent vegetative cover on farms or ranch land to prevent excessive runoff of water or soil loss contributing to water pollution.

Lifespan: minimum of 5 years

Components:

- Fencing (382)
- Grasses and legumes in rotation (411)
- Pasture and hayland management (510)
- Pasture and hayland planting (512)
- Proper grazing use (528)
- Range seeding (550)
- Planned grazing systems (556)

BMP 2 Animal Waste Management System

Purpose: To improve water quality by providing facilities for the storage and handling of livestock and poultry waste to abate pollution that may otherwise result from livestock or poultry operations.

Lifespan: minimum of 10 years

Components:

- Waste management system (312)
- Waste storage structure (313)
- Critical area planting (342)
- Dike (356)
- Waste treatment lagoon (359)
- Diversion (362)
- Fencing (382)
- Filter Strips (393)
- Grassed waterway or outlet (412)
- Waste storage pond (425)
- Irrigation system, sprinkler (442)
- Irrigation system, surface, and subsurface (443)
- Subsurface drain (606)
- Subsurface drain, field ditch (607)
- Surface drain, main or lateral (608)
- Waste utilization (633)

BMP 3 Stripcropping Systems

Purpose: To improve water quality by providing enduring protection to cropland causing pollution by establishment of contour or field stripcropping systems.

Lifespan: minimum of 5 years

Components:

- Obstruction removal (500)
- Stripcropping, contour (585)
- Stripcropping, field (586)
- Stripcropping, wind (589)

BMP 4 Terrace System

Purpose: To improve water quality through the installation of terrace systems on farmland to prevent excessive runoff of water or soil loss contributing to water pollution.

Lifespan: minimum of 10 years

Components:

- Obstruction removal (500)
- Terrace (600)
- Subsurface drain (606)
- Underground outlet (620)

BMP 5 Diversion System

Purpose: To improve water quality by installing diversion on farm or ranchland where excess surface or subsurface water runoff contributes to a water pollution problem.

Lifespan: minimum of 10 years

Components:

- Dike (356)
- Diversion (362)
- Obstruction removal (500)
- Subsurface drain (606)
- Underground outlet (620)

BMP 6 Grazing Land Protection System

Purpose: To improve water quality through better grazing distribution and better grassland management by developing springs, seeps, wells, ponds, or dugouts and installing pipelines and storage facilities. This practice is applicable only when needed to correct an existing problem causing water pollution due to over concentration of livestock.

Lifespan: minimum of 10 years

Components:

- Pond (378)
- Fencing (382)
- Pipeline (516)
- Pond sealing or lining (521)
- Spring trails and waterways (574)
- Stock trails and waterways (575)
- Trough or tank (614)
- Well (642)

BMP 7 Waterway System

Purpose: To improve water quality by installing a waterway to safely convey excess surface runoff water across fields at non-erosion velocities into watercourses or impoundments. The waterway is protected from erosion and reduces pollution through filtering out silt with the establishment of sod cover of perennial grasses or legumes, or both.

Lifespan: minimum of 10 years

Components:

- Fencing (382)
- Grassed waterway or outlet (412)
- Lined waterway or outlet (468)
- Subsurface drain (606)

BMP 8 Cropland Protection System

Purpose: To improve water quality by providing needed protection from severe erosion on cropland between crops or pending establishment of enduring protective vegetative cover.

Lifespan: recommended by COC and STC and approved by Administrator, ASCS, if less than 5 years

Components:

- Conservation cropping system (328)
- Cover and green manure crop (340)
- Field windbreaks (392)

BMP 9 Conservation Tillage Systems

Purpose: Improving water quality by use of reduced tillage operations in producing a crop. The reduced tillage operations and crop residue management need to be performed annually.

Lifespan: recommended by COC and STC and approved by Administrator, ASCS, if less than 5 years

Components:

- Conservation cropping system (328)
- Conservation tillage system (329)
- Contour farming (330)
- Crop residue use (344)
- Land smoothing (466)
- Stubble mulching (588)

BMP 10 Stream Protection System

Purpose: To improve water quality by protecting streams from sediment or chemicals through the installation of vegetative filter strips, protective fencing, livestock crossings, livestock water facilities, or other similar measures.

Lifespan: minimum of 10 years

Components:

- Channel vegetation (322)
- Fencing (382)
- Filter strip (393)
- Streambank protection (580)
- Tree planting (612)

BMP 11 Permanent Vegetative Cover On Critical Areas

Purpose: To improve water quality by installing measures to stabilize source of sediment such as gullies, banks, privately owned roadsides, field borders, or similar problem areas contributing to water pollution.

Lifespan: minimum of 5 years

Components:

- Critical area planting (342)
- Fencing (382)
- Field borders (389)
- Filter strip (393)
- Livestock exclusion (472)
- Mulching (484)
- Sinkhole treatment (571)
- Spoilbank spreading (572)
- Tree planting (612)
- Well plugging (643)

BMP 12 Sediment Retention, Erosion, or Water Control Structures

Purpose: To improve water quality through the control or erosion, including sediment and chemical runoff from a specific problem area.

Lifespan: minimum of 10 years

Components:

- Sediment basin (350)
- Dike (356)
- Fencing (382)
- Grade stabilization structure (410)
- Structure for water control (587)
- Water and sediment control basin (638)

BMP 13 Improving An Irrigation And Or Water Management System

Purpose: To improve water quality on farmland that is currently under irrigation for which an adequate supply of suitable water is available, on which irrigation will be continued, and on farmland with a critical area or source that significantly contributes to the water quality problem by: a) installation of tailwater return systems, b) conversion to a different system to reduce pollutants, or c) reorganization of an existing system to reduce pollutants.

Lifespan: minimum of 10 years

Components:

- Irrigation water conveyance (428)
- Pipeline (430)
- Irrigation system, drip (441)
- Irrigation system, sprinkler (442)
- Irrigation system, surface and subsurface (443)
- Irrigation system, tailwater recovery (447)
- Irrigation water management (449)
- Irrigation land leveling (464)
- Structure for water control (587)

BMP 14 Tree Planting

Purpose: To improve water quality by planting trees to treat critical areas or sources contributing to water pollution.

Lifespan: minimum of 10 years

Components:

- Cover and green manure crop (340)
- Fencing (382)
- Proper woodland grazing (530)
- Tree planting (612)

BMP 15 Fertilizer Management

Purpose: To improve water quality through needed changes in the fertilizer rate, time, or method of application to achieve the desired degree of control of nutrient movement in critical areas contributing to water pollution.

Lifespan: recommended by COC and STC and approved by the Administrator, ASCS, if less than 5 years.

Components:

- Fertilizer management (384)
- Waste utilization (633)

BMP 16 Pesticide Management

Purpose: To improve water quality by reducing pesticides use to a minimum and manage pests in critical areas to achieve the desired level of chemicals contributing to water pollution.

Lifespan: recommended by COC and STC and approved by the Administrator, ASCS, if less than 5 years.

Components:

- Pesticide management (514)

Appendix II

ABBREVIATIONS

(Terms, Agencies, Programs)

ACP..... Agricultural Conservation Program (also USDA-ACP)

ACR ..... Acres Conservation Reserve (Federal Commodity Program)

AGNPS..... Agricultural Nonpoint Source Pollution Model

ANSWERS .... Areal Nonpoint Source Watershed Environment Response Simulation (Model)

ARS..... Agricultural Research Service, USDA

ASC ..... Agricultural Stabilization and Conservation

ASCS ..... Agricultural Stabilization and Conservation Service, USDA

A.U. (a.u.)..... Animal Unit

BMP(s) ..... Best Management Practice(s)

BOD ..... Biochemical Oxygen Demand

CAT..... Critical Area Treatment for Roadside Erosion

CES..... Cooperative Extension Service, USDA

Chl *a*..... Chlorophyll *a*

cfs ..... Cubic Feet Per Second

Cl..... Chloride

CLP..... Clean Lakes Program, Section 314 of PL92-500

CM&E..... Comprehensive Monitoring and Evaluation

COD ..... Chemical Oxygen Demand

CRP..... Conservation Reserve Program

CREAMS ..... Chemical Runoff and Erosion from Agricultural Management Systems (Model)

DEQ ..... Division of Environmental Quality

DO..... Dissolved Oxygen

DP ..... Dissolved Phosphorous

DS ..... Dissolved Solids

DTP ..... Dairy Termination Program, USDA

ERS..... Economic Research Service, USDA

ES..... Extension Service, USDA (see also CES)

FC ..... Fecal Coliform

FDER ..... Florida Department of Environmental Regulation

FmHA..... Farmers Home Administration, USDA

FS..... Fecal Streptococci

FS..... Forest Service, USDA

FSA..... Food Security Act (of 1985)

GIS..... Geographic Information System

HEP ..... Habitat Evaluation Procedures

HUC..... Hydrologic Unit Code (and Cataloging Unit)

I&E ..... Information and Education Programs

ICM..... Integrated Crop Management

IGDO..... Intragravel Dissolved Oxygen

IN ..... Inorganic Nitrogen

IPM..... Integrated Pest Management

JTU ..... Jackson Turbidity Unit

LCC ..... Local Coordinating Committee

LTA ..... Long-Term Agreement (under USDA-ASCS ACP)

Mg/l ..... Milligrams Per Liter

MLRA ..... Major Land Resource Areas

MP..... Moldboard Plow Treatment

MPN..... Most Probable Number/100 ml

N ..... Nitrogen

NA..... Not Available

NCC..... National Coordinating Committee

NCSU..... North Carolina State University

NDEC ..... Nebraska Department of Environmental Control

NH_3 ..... Ammonia-Nitrogen

NO_2 ..... Nitrite-Nitrogen

NO_3 ..... Nitrate-Nitrogen

NPDES ..... National Pollutant Discharge Elimination System

NPS ..... Nonpoint Source

NT..... No Tillage Treatment

NTU ..... Nephelometric Turbidity Unit

NWQEP..... National Water Quality Evaluation Project

OP..... Orthophosphate-Phosphorus

P ..... Phosphorus

PIK..... Payment-in-Kind

PL-566..... Watershed Protection and Flood Prevention Act (PL83-566)

PLUARG ..... Pollution of the Great Lakes from Land Use Activities, Reference Group

ppb ..... Parts Per Billion

ppm ..... Parts Per Million

QA/QC ..... Quality Assurance/Quality Control

RCWP ..... Rural Clean Water Program

SCC..... State Coordinating Committee

SCD..... Soil Conservation District

SCS ..... Soil Conservation Service, USDA

Section 108a... Section 108a PL92-500; USEPA Pollution Control Demonstration - Great Lakes Basin

Section 208 .... Section 208 PL92-500; Planning for Wastewater Management

Section 319 .... Section 319, Water Quality Act of 1987

SFWMD ..... South Florida Water Management District

SS ..... Suspended Sediment

STORET..... EPA STOrage and RETrieval Data Base for Water Quality

STP ..... Sewage Treatment Plant

SWIM ..... Surface Water Improvement and Management Plan, State of Florida

TC ..... Total Coliform

TCNS..... Taylor Creek - Nubbin Slough Basin, Florida

TDS..... Total Dissolved Solids

TKN ..... Total Kjeldahl Nitrogen

TN ..... Total Nitrogen

TP..... Total Phosphorus

TSS ..... Total Suspended Solids

TVS..... Total Volatile Solids

USLE..... Universal Soil Loss Equation

USDA ..... United States Department of Agriculture

USEPA..... United States Environmental Protection Agency

USGS..... United States Geologic Survey

USPHA ..... United States Public Health Association

VSS..... Volatile Suspended Solids

WATSTORE.. USGS Water Data Storage System

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 ungaged agricultural watersheds.

Animal unit - A unit of measurement for any animals in a feeding operation. Calculated in this report as follows:

Dairy cattle - number animals x 1.4
Beef cattle - number animals x 1.0
Hogs - number animals x 0.4
Horses - number animals x 2.0
Sheep - number animals x 0.1
Poultry - number animals x 0.033
Mink - number animals x 0.001

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

BASIN - Basin-scale Nutrient Delivery Model - a model that predicts the total annual nutrient load at the outlet of an agricultural basin, based on estimated delivery of average annual nutrient loads from individual fields or cells.

Bedload - Sediment or other material that slides, rolls, or bounces along a stream or channel bed of flowing water.

Before-after - A term referring to monitoring designs that require collection of data before and after BMP implementation.

BMPs - Practices or structures designed to reduce the quantities of pollutants -- such as sediment, nitrogen, phosphorus, and animal wastes -- 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), 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 accumulated.

Cost sharing - The practice of allocating project funds to pay part of the cost of constructing or implementing a BMP. The remainder of the costs are paid by the producer.

Conservation tillage - A tillage practice or system of practices that leaves plant residues on the soil surface for erosion control and moisture conservation.

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.

Covariates - 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.

CREAMS - Chemicals Runoff and Erosion from Agricultural Management Systems Model - a physically-based, field-scale watershed model developed for comparing pollutant loads from alternate management practices.

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 water quality standards for each water body or segment, whether or not they are being attained.

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.

Experimental NPS project - A scientific study designed primarily to document the effectiveness of specific and/or combinations of multiple NPS controls (BMPs) at reducing NPS pollution. The study may also include evaluating the policies and programs employed to implement the BMPs, effects of the implemented BMPs on an impaired water resource, or economic considerations related to the implementation of BMPs.

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. The term fertilizer includes both commercial fertilizers and manure.

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.

Land treatment - The whole range of BMPs implemented to control or reduce NPS pollution.

Loading - The influx of pollutants to a selected water body.

Management BMPs - BMPs that primarily involve a change in management practices such as changing the timing, method, and/or amount of the application of a potential pollutant in order to reduce the chance of its contaminating water resources.

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

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

Nutrient management - see *Fertilizer management*

Objective - a focus and overall framework or purpose for a project or other endeavor, which may be further defined by one or more goals (see definition above).

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 - Information used as input to a water quality model or estimated by a water quality model. Examples of parameters include: slope from a statistical relationship between two variables, mean annual value or standard deviation of a variable, and number of observations for a particular variable.

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.

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.

Revetment - Facing of stone or other material either permanent or temporary, placed along the edge of a body of water to stabilize the bank and/or protect it from erosion.

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.

Structural BMPs - BMPs that require the construction or use of a structure such as a terrace, lagoon, or waste storage facility.

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.

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.

Tracking - Documenting/recording the location and timing of BMP implementation.

USLE - Universal Soil Loss Equation - an empirical erosion model designed to compute long-term average soil losses from sheet and rill erosion under specified conditions.

Variable - A water quality constituent (for example, total phosphorus pollutant concentration) or other measured factors (such as streamflow, rainfall).

Water management - The practice of limiting the amount of water used in activities such as animal waste flushing systems or milking operations in order to reduce the amount of runoff and, therefore, decrease the probability of polluting nearby surface water.

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 references to publications addressing the Rural Clean Water Program as a whole, as well as a separate list of project documents and other relevant publications for each of the RCWP projects. Project document lists appear in alphabetical order by state. All lists are organized in chronological order.

General Rural Clean Water Program Publications

Anonymous. 1979. Rural Clean Water Program (RCWP). USEPA Water Planning Division, August 1979 (WH-554).

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Maas, R.P. 1985. Practical guidelines for selecting critical areas for controlling nonpoint source pesticide contamination of aquatic systems. p. 363-67. In: Proc. Natl. Conf. Perspectives on Nonpoint Source Pollution. EPA 440/5-85-001.

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Smolen, M.D., R.P. Maas, C.A. Jamieson, J. Spooner, S.A. Dressing, F.J. Humenik. 1985. Rural Clean Water Program, Cross Project Evaluation. National Water Quality Evaluation Project, Biological and Agricultural Engineering Dept., North Carolina State University. 17 p.

Smolen, M.D., R.P. Maas, J. Spooner, C.A. Jamieson, S.A. Dressing, and F.J. Humenik. 1985. Rural Clean Water Program, Status Report on the CM&E Projects. National Water Quality Evaluation Project, Biological and Agricultural Engineering Dept., North Carolina State University. 122 p.

Smolen, M.D., R.P. Maas, J. Spooner, C.A. Jamieson, S.A. Dressing, and F.J. Humenik. 1985. NWQEP 1985 Annual Report, Status of Agricultural NPS Projects. National Water Quality Evaluation Project, Biological and Agricultural Engineering Dept., North Carolina State University, Raleigh, North Carolina. 66 p.

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Appendix V

FARM OPERATOR SURVEY DESIGN

Sample Design and Implementation

The focus of the Farm Operator Survey was to determine whether there are differences between farmer operators who chose to participate in the RCWP and those who did not in terms of their personal characteristics, farm structure, attitudes, and behavior. The population included all farms in the RCWP critical areas regardless of the program enrollment status of the operator. A total sample of 1000 interviews was determined to be sufficient to provide a representative sample.

The USDA-ASCS provided lists of names, addresses, and telephone numbers for both participants and non-participants from each designated RCWP critical area. In almost all cases, fairly complete information was obtained for all project participants, as well as for all farm operators who were eligible, but did not participate. Lists specified which farm operators were participants and which were non-participants. Comparison of these two groups (i.e., participants and non-participants) forms the basis for much of the analysis.

The sampling design was based on advice from a statistical consultant and selected members of the advisory committee. Equal numbers of participants and non-participants for each project area were chosen to minimize the variance between the two groups. The sample size for each RCWP project area was chosen to be proportional to the cubic root of the total number of farmers in the group with the smaller number of cases (RCWP participants or non-participants). For example, of the 192 participants and 65 non-participants in the Alabama project, the selected sample size for both groups is proportional to the cube root of 65. This sampling technique represents a compromise between a proportional allocation technique which optimizes the differences between the groups and an equal allocation design which optimizes the estimation of the mean of the populations.

Since there are several project areas with only a few farmer operators in one or both groups, it was decided to make the sample size for each group in the project area equal to the number of cases in the smaller group if either or both groups had 20 or fewer cases. In order to produce a total sample size of 500 for each group, a proportionality constant (8.09) was used to compute the sample size for areas with groups containing more than 20 cases. To continue with the Alabama project example, the final sample size for each group was $8.09 \times (65)^{0.3} = 33$.

It is important to note that while this sampling scheme was used to make comparisons between the RCWP participants and non-participants, sampling weights (raising factors) would need to be applied to the data in order to make inferences about the entire population of farm operators in all 21 areas. Such weighting is used in this report.

Some rules were developed for counting farm operators in ambiguous situations. Farm operators whose phone numbers were not in the lists were not included in the population. If there was contradictory information about an operators' participation in the program, farmers who operated more than one farm in the RCWP area were considered to be participants. Also, if the data on one or more farms indicated that the operator was not a participant on any farms, he or she was considered to be a non-participant.

During the course of the survey, it was necessary to add additional phone numbers to the sample. This was necessary in some project areas because too few names and numbers of either participants or non-participants were available on the list. When adding new sample members, the approach was to maintain similar numbers of participants and non-participants across all project areas. For example, if we ran out of non-participants in a particular project area we had to decide whether to select more participants from the same project area or to select more non-participants from another project area. We chose to select more non-participants from another project that was as close as possible.

An important factor concerning respondents to this survey is whether respondents were RCWP participants (i.e., had contracts with ASCS for their specific RCWP project). In about ten percent of the cases discrepancies arose between reports from ASCS and farm operator responses on the survey. In some cases, ASCS reports indicated that certain farms were under contract, while the farm operators said that they were non-participants. In other cases, ASCS records showed that the farm was not under contract but the farm operator responded affirmatively to the question of RCWP participation.

To help resolve this situation, we first contacted all ASCS offices to verify their initial reports of RCWP contracts. Some corrections were made by this check. We learned also that, in several cases, farm management had changed since the contracts had been made. In some situations a son had assumed the father's farm management responsibilities; an owner had died leaving the farm to heirs to operate or lease; or other management shifts had taken place. In such cases, the person interviewed was unaware of previous contracts regarding RCWP.

Next, we called a sample of farmers whose status was uncertain because the ASCS maintained that the farm was not under contract while the farm operator had claimed to be a participant. In these cases, personal phone calls revealed one of two facts: the farm operator (1) reversed the earlier position and denied RCWP participation or (2) acknowledged that the reported RCWP participation was actually participation in a different ASCS program or a state conservation program instead of RCWP.

Through these follow-up calls we were able to clear up all but four of the previously inconsistent cases. Those operators who denied participation in RCWP (while ASCS showed contracts on their farms) were treated as participants. Those who said they were participants contrary to ASCS records were included as non-participants, because they were not formally RCWP participants.

The overall sampling plan and results for each RCWP project are shown in Table V.1. Target numbers of interviews from each specific RCWP project for both participants and non-participants are shown. The final sample sizes listed for each project reflect the resolution of the discrepant cases. Our approach was reasonably successful for nearly all the projects However, in some cases the target sampling was the same or very close to the population. This situation presented the greatest challenge. In a few instances (e.g., participants in Delaware RCWP or non-participants in Illinois) it was not possible to complete the target number of interviews. As mentioned above, in such cases replacements were drawn from the same group (i.e., participant or non-participant) from a nearby project.

Weighting for Proportionate Sample Representation

Because the sampling was intentionally designed to draw disproprotionately more of the farm operators from smaller project areas in order that they be better represented in the random sample, farm operators from smaller project areas are over represented in the responses to the survey. This over representation is slight and, in fact, causes no more than two or three percentage points difference on various questions. However, over representation biases the results toward the way farm operators from the smaller project areas answered the interview questions and gives slightly misleading results unless this bias is corrected.

Therefore, to adjust the responses so that all sizes of project areas are properly represented in the analysis, the item responses are statistically weighted. For farm operators participating in each RCWP area, the weighting technique multiplies each respondent's answer to a question by the ratio of the total number of participants in the project area to the total number of participants who were interviewed from that project area. An analogous weight was used to proportionately adjust the responses for those farming in each project area but who do not participate in RCWP. Using this statistical procedure, each of the 21 project areas is weighted for its sample of participants and separately for its sample of those who farm in the project area but who do not participate in RCWP.

For example, Alabama's project area--one which contains many farm operators--has a total population of 65 farm operators who participate in RCWP. Of these, a sample of 28 responded to the interviews. Therefore, the item responses for each of these 28 are weighted by the ratio of 65 divided by 28 which equals a factor of 2.31. In Utah, however, there were only two RCWP participants and, in order to ensure that they be represented in the random sample, both were interviewed. The ratio of their population size to their final sample size was 1.0. This means that, in the final results of the survey, the answers of Alabama's sample of 28 participants were increased by a weight of 2.31 as compared to a weight of 1.0 for those from Utah. In this manner, each state is proportionately represented in the final statistics of the study.

In order to achieve the proper balance of the project areas of varying sizes, these weights statistically increased the total sample from 1,107 to a weighted total of 3,083. To adjust this weighted total back to the actual sample size of 1,107, the weights for each project area were divided by the ratio of 3,083 to 1,107 which is equivalent to 2.785. By doing this, the total number of respondents for each weighted item again equals 1,107.

Table V.1. Summary of RCWP participants and nonparticipants in terms of population, target sample, and final sample.

	PARTICIPANTS			NON-PARTICIPANTS		
	Population	Target Sample	Final Sample	Population	Target Sample	Final Sample
Alabama (RCWP 1)	65	33	28	192	33	38
Delaware (RCWP 2)	29	26	8	28	26	19
Idaho (RCWP 3)	96	36	43	81	36	39
Illinois (RCWP 4)	57	13	16	13	13	6
Iowa (RCWP 5)	24	12	15	12	12	10
Kansas (RCWP 6)	24	24	19	87	24	30
Louisiana (RCWP 7)	79	32	28	55	32	30
Maryland (RCWP 8)	60	32	49	259	32	33
Michigan (RCWP 9)	70	34	29	246	34	38
Tennessee/Kentucky (RCWP 10)	174	41	41	127	41	47
Utah (RCWP 11)	2	2	2	2	2	2
Vermont (RCWP 12)	61	30	37	47	30	26
Wisconsin (RCWP 13)	94	37	39	189	37	40
Florida (RCWP 14)	45	20	20	20	20	15
Massachusetts (RCWP 15)	22	10	5	10	10	17
Minnesota (RCWP 16)	56	32	35	92	32	35
Nebraska (RCWP 17)	34	12	14	12	12	9
Oregon (RCWP 18)	97	26	31	29	26	17
Pennsylvania (RCWP 19)	30	26	23	125	26	32
South Dakota (RCWP 20)	97	37	46	110	37	34
Virginia (RCWP 21)	48	30	28	84	30	34
TOTALS	1208	513	556	1726	513	551

Appendix VI

FARM OPERATOR QUESTIONNAIRE

RURAL CLEAN WATER PROJECT
NATIONAL SURVEY - 1991

Eastern Standard Time

RESPONDENT NAME

STATE

Identification Number _____ (1-5)

Card 1 (6)

RCWP Project Number _____ (7-8)

Farm Number _____ (9-12)

RCWP Participant (Yes=1, No=2) ____ (13)

Telephone Number (____)____-_____

INTERVIEW START TIME: : - INTERVIEW END TIME: :

CONTACT STATUS												
TIME												
DATE												
STATUS												

STATUS CODES

AM	ANSWERING MACHINE	DL	DEAF/LANGUAGE	OS	OUT OF SERVICE
BG	BUSINESS / GOVERNMENT	HI	INELIGIBLE/NOT FARMING	PC	PARTIALLY COMPLETED
BS	BUSY SIGNAL	IN	INSTITUTIONALIZED	RF	REFUSAL
CB	CALL BACK / APPOINTMENT SET	NA	NO ANSWER	TI	TERMINATED INTERVIEW
CI	COMPLETED INTERVIEW	NL	NO LISTING	WN	WRONG NUMBER
CL	CAN'T LOCATE / UNAVAIL.				

INTRODUCTION

May I speak with (_RESPONDENT_)?

My name is _____ and I'm working on a project for the U.S. Department of Agriculture (USDA).

We are conducting a national study to help farm operators receive better information and assistance in the area of water quality protection. This survey is being done in areas across the country that received funding and technical assistance under the Rural Clean Water Program (RCWP).

You were randomly selected from a list of farm operators provided by the Agricultural Stabilization and Conservation Service (ASCS). All of the information you give us will be treated confidentially. The questions that I have will take about 15 minutes.

CONTINUE INTERVIEW

1. Is water pollution a serious problem, somewhat of a problem, or not a problem in <u>your area</u>?

SERIOUS PROBLEM	3	*(14)*
SOMEWHAT OF A PROBLEM	2	
NOT A PROBLEM	1	
DON'T KNOW	8	

2. Compared to ten years ago, do you think water quality in your area is better, about the same, or worse?

BETTER.	3	*(15)*
ABOUT THE SAME.	2	
WORSE	1	
DON'T KNOW	8	

3. What do you think are the major <u>causes</u> of water pollution in your area? **(DO NOT READ, BUT CIRCLE ALL MENTIONED)**

a.	RUNOFF FROM CROPLAND	1	*(16)*
b.	FERTILIZERS (NUTRIENTS)	1	*(17)*
c.	PESTICIDES/INSECTICIDES/HERBICIDES . .	1	*(18)*
d.	LIVESTOCK/ANIMAL WASTE (MANURE)	1	*(19)*
e.	LOGGING OR TIMBER HARVEST	1	*(20)*
f.	CITY OR TOWN SEWER SYSTEMS	1	*(21)*
g.	HOUSEHOLD SEPTIC SYSTEMS	1	*(22)*
h.	RUNOFF FROM URBAN OR PAVED AREAS . . .	1	*(23)*
i.	INDUSTRIAL WASTE/FACTORY DISCHARGE . .	1	*(24)*
j.	MINING	1	*(25)*
k.	LITTER OR GARBAGE	1	*(26)*
l.	HOME AND GARDEN CHEMICALS	1	*(27)*

(PROBE: Any others?)

m. YES (SPECIFY) _____ (__ __) *(28-29)*

n. YES (SPECIFY) _____ (__ __) *(30-31)*

4. Is water pollution a serious problem, somewhat of a problem, or not a problem on <u>your farm(s)</u>?

SERIOUS PROBLEM	3	*(32)*
SOMEWHAT OF A PROBLEM	2	
NOT A PROBLEM	1	
DON'T KNOW	8	

5. Are you very concerned, somewhat concerned, or not concerned about pollution of your own drinking water?

VERY CONCERNED	3	*(33)*
SOMEWHAT CONCERNED	2	
NOT CONCERNED	1	
DON'T KNOW	8	

6. How much have you heard or read about how agriculture might affect water quality. Would you say you have heard .... **(READ RESPONSES)**

A lot;	4	*(34)*
Some,	3	
A little, or	2	
Nothing?	1	

7. Farmers can do many things to protect water quality. How much information about protecting water quality have you received from....? **(START WITH HIGHLIGHTED ITEM)**

* Have you gotten a lot, some, a little or no information?

		ALOT	S	L	N	
a.	Newspapers*	4	3	2	1	*(35)*
b.	Farm magazines*	4	3	2	1	*(36)*
c.	Television*	4	3	2	1	*(37)*
d.	Radio*	4	3	2	1	*(38)*
e.	Meetings or workshops*	4	3	2	1	*(39)*
f.	Tours or demonstrations*	4	3	2	1	*(40)*
g.	Other farm operators*	4	3	2	1	*(41)*
h.	The Extension Service*	4	3	2	1	*(42)*
i.	The Soil Conservation Service*	4	3	2	1	*(43)*
j.	The ASCS*	4	3	2	1	*(44)*
k.	Pesticide or fertilizer dealers*	4	3	2	1	*(45)*
l.	Other farm organizations*	4	3	2	1	*(46)*

8. Overall, how much <u>more</u> information do you need about what you can do on your farm to help protect water quality? **(READ RESPONSES)**

A lot,	4	*(47)*
Some,	3	
A little, or	2	
Nothing.	1	

9. Some farming practices are available to help farm operators protect water quality. These are often called Best Management Practices or BMPs. Are you now using any of these BMPs? Are you using .... **(READ RESPONSES)**

		YES	NO	
a.	Conservation or reduced tillage . . .	1	0	*(48)*
b.	Contour strip-cropping	1	0	*(49)*
c.	Terraces	1	0	*(50)*
d.	Diversions	1	0	*(51)*
e.	Grass waterways	1	0	*(52)*
f.	Animal waste management or storage .	1	0	*(53)*
g.	Nutrient management or reduction . .	1	0	*(54)*
h.	Pesticide management or reduction . .	1	0	*(55)*
i.	Irrigation improvement	1	0	*(56)*
j.	Hayland or pasture planting and management	1	0	*(57)*
k.	Permanent vegetation cover	1	0	*(58)*
l.	Cover crops	1	0	*(59)*
m.	Grasses or legumes in rotation . . .	1	0	*(60)*
n.	Filter or buffer strips	1	0	*(61)*
o.	Stream protection or fencing	1	0	*(62)*
p.	Sediment traps	1	0	*(63)*
q.	Soil testing	1	0	*(64)*

(IF Q9 ALL ITEMS = NO, GO TO Q12)

10. Do you plan to continue using all of the practices you just mentioned?

YES (GO TO Q12)	1	*(65)*
NO	0	
DON'T KNOW	8	

(IF NO)

11. Which practices do you plan to stop using?
(WRITE LETTER OF PRACTICE)

_____(EDITOR CODE _____) *(66-67)*

_____(EDITOR CODE _____) *(68-69)*

12. How important would each of the following factors be in your decision about whether to use a new BMP to help protect water quality? **(START WITH HIGHLIGHTED ITEM)**

* Would _____ be very important, somewhat important, or not important in your decision to use a new practice?

		VI	SI	NI	
a.	Cost of the practice*	3	2	1	*(70)*
b.	How easy the practice is to use*	3	2	1	*(71)*
c.	Labor or time required*	3	2	1	*(72)*
d.	Availability of government cost-sharing* . . .	3	2	1	*(73)*
e.	Experience of other farm operators*	3	2	1	*(74)*
f.	Potential to improve water quality*	3	2	1	*(75)*
g.	Effects of the practice on profits*	3	2	1	*(76)*
h.	Information from government agencies*	3	2	1	*(77)*
i.	Information from farm businesses*	3	2	1	*(78)*

Now I want to ask you about the Rural Clean Water Program (or RCWP). This program was sponsored by the U.S. Department of Agriculture over the last ten years. It provided some farm operators in your area with technical assistance and cost-sharing to protect water quality.

13. Have you ever heard of the Rural Clean Water Program or RCWP?

YES (GO TO Q14) . . . . . 1 *(79)*
NO (GO TO Q23 WHITE PAGE) 0

14. During the past ten years did you participate in the RCWP?

YES (GO TO Q15 GREEN PAGE) . . . 1 *(80)*
NO (GO TO Q19 PINK PAGE) 0

DUP ID *(1-5)*
CARD 2 *(6)*

(ASK QUESTIONS 15-18 ONLY IF RESPONDENT DID PARTICIPATE)

15. What were the reasons you decided to participate in the RCWP? **(DO NOT READ, BUT CIRCLE ALL MENTIONED)**

a.	AVAILABILITY OF COST-SHARE FUNDS	1	*(7)*
b.	CONCERN FOR EFFECTS OF WATER POLLUTION	1	*(8)*
c.	CONSERVATION ETHIC/RIGHT THING TO DO	1	*(9)*
d.	INCREASED FARM PRODUCTION	1	*(10)*
e.	ASSISTANCE AND ENCOURAGEMENT FROM GOVERNMENT	1	*(11)*
f.	ASSISTANCE AND ENCOURAGEMENT FROM OTHER FARM OPERATORS	1	*(12)*
g.	DEMONSTRATIONS OR MEETINGS SPONSORED BY RCWP	1	*(13)*
h.	CONCERN ABOUT FUTURE POLLUTION REGULATIONS	1	*(14)*

(PROBE) Are there any other reasons you participated?

i. YES:_____(__ __) *(15-16)*

j. YES:_____(__ __) *(17-18)*

16. How satisfied were you with the technical assistance and information you received from the RCWP? Were you .... **(READ RESPONSES)**

Very satisfied 4	*(19)*
Satisfied 3	
Unsatisfied, or.....2	
Very unsatisfied? ...1	

17. How satisfied were you with the financial assistance you received from the RCWP? Were you .... **(READ RESPONSES)**

Very satisfied 4	*(20)*
Satisfied 3	
Unsatisfied, or.....2	
Very unsatisfied? ...1	

18. If the RCWP had not been available would you have been very likely, likely, unlikely, or very unlikely to have used all of the Best Management Practices you now are using?

VERY LIKELY 4	*(21)*
LIKELY 3	
UNLIKELY 2	
VERY UNLIKELY 1	
DON'T KNOW.....8	

(GO TO Q22--WHITE PAGE)

(ASK QUESTIONS 19-21) ONLY IF RESPONDENT DID NOT PARTICIPATE)

19. What were the reasons you decided not to participate in the RCWP? **(DO NOT READ, BUT CIRCLE ALL MENTIONED)**

a.	APPLIED/NO MONEY AVAILABLE	1	*(22)*
b.	APPLED BUT WAS NOT ELIGIBLE	1	*(23)*
c.	DID NOT KNOW ABOUT THE RCWP	1	*(24)*
d.	WAS NOT ASKED TO PARTICIPATE	1	*(25)*
e.	NOT HIGH ENOUGH COST-SHARE RATES	1	*(26)*
f.	ECONOMIC CONDITIONS, COSTS, MONEY	1	*(27)*
g.	WATER POLLUTION IS NOT A PROBLEM	1	*(28)*
h.	MY LAND DOES NOT REALLY AFFECT WATER QUALITY	1	*(29)*
i.	CHANGING PRACTICES IS OFTEN TOO MUCH TROUBLE	1	*(30)*
j.	CURRENT SYSTEM WORKS WELL ENOUGH	1	*(31)*
k.	DID NOT WANT TO BE TOLD HOW TO FARM	1	*(32)*
l.	LAND RENTED, LANDLORD	1	*(33)*
m.	TOO MUCH RED-TAPE OR COMPLICATED PROCEDURES	1	*(34)*
n.	DON'T LIKE ANY GOVERNMENT PROGRAMS	1	*(35)*

(PROBE) Are there any other reasons you did not participate?

m. YES:_____(__ __) *(36-37)*

n. YES:_____(__ __) *(38-39)*

20. Did any government agencies contact you about participating in the RCWP?

YES	1	*(40)*
NO	0	

21. If a new program, like the RCWP, were available to you today, how likely would you be to participate? **(READ RESPONSES)**

Very likely	4	*(41)*
Likely	3	
Unlikely, or	2	
Very unlikely . . .	1	

22. Would you say the RCWP had a positive effect, no effect or a negative effect on (READ ITEM)? (REPEAT FOR EACH ITEM)

		POS	NO	NEG	
a.	Surface water quality in your area	3	2	1	*(42)*
b.	Drinking water quality in your area . . .	3	2	1	*(43)*
c.	Operating costs for farm operators who participated in the RCWP	3	2	1	*(44)*
d.	Farm income for farm operators who participated	3	2	1	*(45)*
e.	Farm operators' knowledge about water quality	3	2	1	*(46)*

23. I'd like to read you a list of statements about water quality . For each statement, please tell me whether you Strongly Agree, Agree, Disagree or Strongly Disagree with the statement. The first statement is:

* Do you Strongly Agree, Agree, Disagree, or Strongly Disagree with this statement?

		SA	A	D	SD	DK	
a.	Agricultural water pollution is a serious threat to fish and wildlife.	4	3	2	1	8	*(47)*
b.	The farming practices I use now have no significant effect on water quality in my area.	4	3	2	1	8	*(48)*
c.	We need less expensive farming practices that will help protect water quality.	4	3	2	1	8	*(49)*
d.	Farm practices that protect water quality usually require more labor.	4	3	2	1	8	*(50)*
e.	Agriculture is being unfairly blamed as a cause of water quality problems.	4	3	2	1	8	*(51)*
f.	If farm operators don't do more to protect water quality on their own, the government will force them to through regulation.	4	3	2	1	8	*(52)*
g.	The government should help pay more for water pollution control on farms.	4	3	2	1	8	*(53)*
h.	Farm operators do not have the right to farm in ways that damage water quality.	4	3	2	1	8	*(54)*
i.	Land should be farmed in ways that protect water quality, even if this means lower profits.	4	3	2	1	8	*(55)*
j.	Water pollution can best be controlled through educational programs that encourage farm operators to use BMPs.	4	3	2	1	8	*(56)*

Now, I have a few questions about you and your farm operation. Most of these questions are the same as those used on the Farm Census. Remember all of the information you give will be treated confidentially.

24. How many total acres were in your farm operation in 1990, including all owned and rented land? Also include all locations and land uses (cropland, pasture, and idle).

_____ ACRES *(57-61)*

25. How many of these acres do you rent or lease from others?

_____ ACRES *(62-66)*

26. Which of the following best describes the legal organization of your farm? **(READ RESPONSES)**

Family or individual operation	1	*(67)*
Partnership (including family partners other than spouse or pre-adult children), or . . .	2	
Incorporated under state law	3	
DON'T KNOW	8	

27. What is the highest grade of school you have completed?

ONE	01	1 YEAR ASSOCIATE	13	*(68-69)*
TWO	02	2 YEAR ASSOCIATE	14	
THREE	03	1 YEAR COLLEGE, NO DEGREE	15	
FOUR	04	2 YEAR COLLEGE, NO DEGREE	16	
FIVE	05	3 YEAR COLLEGE, NO DEGREE	17	
SIX	06	BACHELOR'S (BA, BS, AB)	18	
SEVEN	07	SOME GRADUATE-NO DEGREE	19	
EIGHT	08	MASTER'S (MS, MA, MSW, MBA, MEd, MEng)	20	
NINE	09			
TEN	10	PROFESSIONAL (MD, DDS, DVM, LLB, JD)	21	
ELEVEN	11			
HIGH SCHOOL (Diploma/GED) . . .	12	DOCTORATE (Ph.D, EdD)	22	

28. In what year were you born?

_____ YEAR *(70-71)*

29. How many years have you been a farm operator?

_____ YEARS *(72-73)*

30. Do you live on your farm?

YES	1	*(74)*
NO	0	

BLANK (75-80)
DUP ID (1-5)
CARD 3 (6)

31. Which product or commodity would you say produced the most gross sales or income on your farm(s) in 1990?

_____ *(7-8)*

32. About what percentage of your total farm sales came from livestock, poultry, or animal products in 1990?

_____PERCENT *(9-11)*

33. What was the total gross value of the farm product sales--crops, animals and other products--from your farm for 1990? **(PROBE: "Would it be above or below $10,000?)**
(CIRCLE ONE RESPONSE ONLY)

Less than $10,000	1	*(12)*
Between $10,000 and $39,999	2	
Between $40,000 and $99,999	3	
Between $100,000 and $499,999	4	
Between $500,000 and $999,999	5	
$1 million or more	6	

34. In 1990, how many days did you work at least four hours per day in a job away from your farm(s)?

NONE	1	*(13)*
FEWER THAN 100 DAYS	2	
100 to 199 days	3	
200 days or more	4	

35. Did you <u>hire</u> any labor, other than contract labor, on your farm(s) in 1990?

YES	1	*(14)*
NO	0	

(IF YES)
36. Please estimate how much you paid for hired labor in 1990.

_____ DOLLARS *(15-20)*

37. Did you use any <u>contract labor</u> on your farm(s) in 1990?

YES	1	*(21)*
NO	0	

(IF YES)
38. Please estimate how much you paid for contract labor in 1990.

_____ DOLLARS *(22-27)*

39. Did you use any <u>custom work, machine hire or rental equipment</u> on your farm(s) in 1990?

YES . . . . . 1 *(28)*
NO 0

(IF YES)

40. Please estimate how much you paid for this labor in 1990.

_____ DOLLARS *(29-34)*

41. Thinking about all of the machinery, equipment, and implements kept and used on your farm(s) as of December 31, 1990 (including cars, trucks, tractors, plows, feeders, etc.), please give your best estimate of its total market value at that time. **(PROBE: "Would it be above or below $40,000?) (CIRCLE ONE RESPONSE ONLY)**

Less than $40,000 . . . . . 1 *(35)*
Between $40,000 and $99,999. 2
Between $100,000 and $499,999 3
Between $500,000 and $999,999 4
$1 million or more 5

42. Now thinking about all the land and buildings on your farm as of December 31, 1990, including rented or leased land, please give your best estimate of its total market value at that time. **(PROBE: "Would it be above or below $40,000?) (CIRCLE ONE RESPONSE ONLY)**

Less than $40,000 . . . . . 1 *(36)*
Between $40,000 and $99,999. 2
Between $100,000 and $499,999 3
Between $500,000 and $999,999 4
$1 million but less than $2 mil 5
$2 million or more 6

43. In 1990, about what percentage of your family's total net income (<u>after</u> taxes and <u>after</u> farm expenses) was from farming?

_____ PERCENT *(37-39)*

44. CODE RESPONDENT'S GENDER **(DO NOT ASK UNLESS UNSURE)**:

MALE . . . . . 1 *(40)*
FEMALE 2

This completes the interview. Thank you very much for your time and cooperation. Do you have any comments you would like to make?

BLANK (41-80)

Appendix VII

PROJECT PERSONNEL QUESTIONNAIRE AND DATA SUMMARY

The project personnel survey was designed by S.W. Coffey and T.J. Hoban of North Carolina State University (NCSU) as a supplement to the on-site evaluations of RCWP projects conducted by the National Water Quality Evaluation Project staff of the NCSU Water Quality Group in 1991 and 1992 ((see Chapter 1, section 1.3). The survey was administered by mail using the following questionnaire, which was sent to project personnel interviewed during the on-site project evaluations (see Chapter 3, section 3.3). Of 292 questionnaires mailed to project personnel, 62% were returned. All projects are represented in this survey, although the number of surveys sent to the projects and the percentage of returned questionnaires differed from project to project.

Presented here are the questions to which project staff responded and the responses tabulated using SAS. For most survey questions, respondents could answer only one category of the question. Responses were totalled for each category and are presented as a percent of the responses for that question (see, for example, Question 1).

For some questions, project personnel were asked to respond to more than one category and responses were totalled (for example, Question 3).

For two questions (Questions 25 and 26), project personnel had to prioritize their answers. In these cases, rather than present the actual responses, the three categories with the highest number of responses are noted.

For many questions, additional open-ended comments were encouraged. For this reason, Questions 30 and 31 have been restructured into a tabular format to make the data more accessible to the reader.

PROJECT COORDINATION

1 Did your RCWP project have a local project coordinator?
(Please check response)

51 %No (CONTINUE WITH QUESTION 2)
49 %Yes (CONTINUE WITH QUESTION 5)

2 Did you find that an overall project coordinator would have been helpful?

33 % No (SKIP TO QUESTION 7)
67 % Yes (CONTINUE WITH QUESTION 3)

3 What need(s) would a project coordinator have meet?
(Check all that apply)

39 project oversight and review
20 primary contact
43 monitor project progress
51 coordination of project reports
47 improved project efficiency

4 What level of effort would be needed for a project coordinator?

27 % Full Time
11 % 3/4 Time
42 % 1/2 Time
13 % 1/4 Time
7 % Less than 1/4 Time

5 What level of effort did your project coordinator have?

24 % Full Time
6 % 3/4 Time
26 % 1/2 Time
22 % 1/4 Time
22 % Less than 1/4 Time

6 Please rate the effectiveness of your project coordinator.

4 % Ineffective
37 % Somewhat Effective
59 % Very Effective

7 Please provide additional comments on coordinator position.

Many of the comments on the coordinator's position were specific to the individual project. Listed below are general comments that were cited by more than one individual:

Small project and very cooperative; agencies didn't require coordination.

Needs to be given adequate authority to make project decisions. Should be supervised by a higher level manager rather than the local district conservationist.

The coordinator position should be in place for the entire project period, not just the contracting phase.

Project coordination was adequately conducted by local staff, LCC, ASCS, or SCS.

The coordinator should remain in the project until all key activities are completed.

Some areas would have benefited from a coordinator. Those unchecked in question 3 were adequately covered.

I assume the coordinator was a Pa DER position; there were 4 people who held the position during the project. There was little consistency.

ASCS coordinator worked part-time. His efforts coordinated agency activities. Improved service to farmers and improved agency relationships.

Each agency had an established state and local lead person.

Coordinated the contacts of over 1200 landowners in the project. Collected land use data for minority program.

Only had part-time coordinator for latter part of the project. Had no decision-making authority.

ADVISORY COMMITTEES
(Not LCC or SCC)

8 Did your project have one or more committees?

34% No (SKIP TO QUESTION 10)
66% Yes (CONTINUE WITH QUESTION 9)

9 For each of the following committees please respond to both questions by circling either yes or no.

Committees	Did you have it?		Was it needed?	
	Yes	No	Yes	No
administrative	70%	30%	75%	25%
information and education	79%	21%	90%	10%
land treatment	60%	40%	76%	24%
water quality monitoring	69%	31%	82%	18%

additional committees established	Number of respondents
Technical	11
PAC	1
Farmer's Advisory	3
Report Writing	2
Cost-sharing	2
Point Source	1
Modeling	1
Interagency	2
Administrative	2

EFFECTIVENESS

10 Please rate each of the following project elements for their effectiveness in achieving project goals:

Elements	Not Effective	Somewhat Effective (%)	Very Effective
administration	7	49	44
information and education	9	46	45
critical area determination	9	40	51
achievement of sign-up goals	7	37	56
development of farm plans	3	26	71
development of cost-share rates	6	31	63
implementation of BMPs	4	41	55
land treatment monitoring	18	55	27
water quality monitoring	21	40	39
linkage of land treatment data and water quality data	36	50	14
project report writing	9	56	35

11 How satisfied were farmers with technical assistance and information they received from the RCWP?

34% Very Satisfied
59% Satisfied
5% Unsatisfied
2% Very Unsatisfied

12 Did your project suffer from insufficient technical support from experts or information?

72% No (SKIP TO QUESTION 14)
28% Yes (CONTINUE WITH QUESTION 13)

13 Mark the areas where your project could not meet goals because it was limited by technical support from experts or information.

20 information and education
19 technical assistance for developing farm plans
23 technical assistance for structural BMPs
23 technical assistance for management BMPs
27 land treatment monitoring
19 water quality monitoring
_____other _____

14 Did your project suffer from insufficient financial resources?

74% No
26% Yes

15 How satisfied were farmers with the financial assistance they received from the RCWP?

34% very satisfied
60% satisfied
5% unsatisfied
1% very unsatisfied

16 Did your project suffer because financial resources arrived too late?

93% No
7% Yes

If so, provide an example:

Money was cut from what we were told at the beginning and thus hurt the project.

Project ended in September 1991. Finally advised in 3/92 that water quality monitoring money was not available.

When the groundwater watershed was identified, funding was slow to provide cost-sharing monies for the expanded BMP/farm plans and installation.

State ASCS would not release monies when they received it from the federal government.

Large structures never received funding.

Funds for the Extension office were usually very late and the office was operated on loans.

We went ahead before it arrived but as soon as it was approved. It would have been a problem without it.

Monitoring of land treatment and water quality needed to continue but there was no funding for this.

Information-Education Specialists were not available until about one year after the start of the project.

17 Mark the areas where your project could not meet goals because it was limited by insufficient financial resources.

14 information and education
17 cost-share limit per participant
8 development of farm plans
13 cost-share assistance for structural BMPs
7 cost-share assistance for management BMPs
43 land treatment monitoring
60 water quality monitoring

other:

-More farms would have signed up.
-Final water quality effectiveness evaluation.
-Research to base BMP on.
-Washington took too long to approve BMP.
-All state and local money needed federal money to help for monitoring.
-Need more finances to have more technical assistance people.
-Ineligible participants (large feedlots).
-Cost-share rates and maximum limits.
-Water quality monitoring was very expensive for ten years with no financial assistance from the federal government.
-Link land use and water quality empirically.
-Dairy farmers uncertain about their future--reluctant to participate fully.

18 Would you say the RCWP had a positive effect (POS), no effect (NO), or a negative effect (NEG) for the following?

	POS	NO	NEG
a. Surface water quality in your area	86%	14%	0%
b. Drinking water quality in your area	46%	52%	2%
c. Operating costs for farm operators who participated	64%	23%	13%
d. Farm income for farm operators who participated	55%	31%	14%
e. Farm operators' knowledge about water quality	73%	7%	20%

INFORMATION AND EDUCATION

19 Please indicate the overall effectiveness of the I & E program in producing each of the following attributes among project area producers:

Attributes	Not Effective	Somewhat Effective	Very Effective
awareness of the water quality problem	3%	46%	51%
awareness of potential impact of agricultural activities on water quality	4%	48%	48%
knowledge that each producer may be part of the water quality problem	9%	57%	34%
knowledge of structural BMPs	9%	54%	37%
knowledge of management BMPs	7%	58%	35%
attitude change to enable implementation of structural BMPs	10%	62%	28%
attitude change to enable implementation of management BMPs	8%	60%	32%
skills change to enable implementation of management BMPs	12%	63%	25%
behavior change to maintain BMPs for the long term	12%	64%	24%
interest in tracking project success	32%	57%	11%
development of leaders within farm community	31%	48%	21%
education of youth on water quality issues	38%	45%	17%

20 To what extent was the I&E program important to the adoption and maintenance of the BMPs implemented in the project area?

BMPs	Not Important	Somewhat Important	Very Important
		(%)	
1 Permanent vegetative cover	24	59	17
2 Animal waste management systems	13	32	55
3 Stripcropping systems	45	42	13
4 Terrace systems	41	39	20
5 Diversion systems	29	53	18
6 Grazing land protection systems	39	48	13
7 Waterway systems	17	49	34
8 Cropland protective systems	19	51	30
9 Conservation tillage systems	10	38	52
10 Stream protection systems	24	44	32
11 Permanent vegetative cover on critical areas	18	45	37
12 Sediment retention, erosion, or water control structures	18	45	37
13 Improving an irrigation and or water management system	52	19	29
14 Tree planting	65	31	4
15 Fertilizer management	7	39	54
16 Pesticide management	13	41	46

FARM OPERATOR PARTICIPATION

21 Did the farmers who could have had the greatest impact on water quality implement BMPs on their farms due to RCWP?

11% No
89% Yes

22 Did the farmers who could have the greatest impact on water quality implement BMPs on their farms through non-RCWP programs?

55% No
45% Yes

23 Did the project attract the innovative producers?

12% No
88% Yes

24 Did the project get participation from the leaders of the local community?

15% No
85% Yes

25 In the space provided indicate (1) for the most important, (2) for the second-most important, and (3) for the third most-important reasons farmers decided to participate in the RCWP.

_1_ availability of cost-share funds
_3_ concern for effects of water pollution
__ conservation ethic/right thing to do
__ increased farm production
_2_ assistance and encouragement from government
__ assistance and encouragement from other farm operators
__ demonstrations or meetings sponsored by RCWP
__ concern about future pollution regulations

__ Other:
-better farm management
-to improve their irrigation delivery system
-state regulatory rules mandated implementation of BMPs to meet water quality regulations/
-threat of existing regulatory programs
-Florida DER Dairy Rule
-state regulatory requirement
-improve land use and erosion control
-they are farmers and want their children to farm
-improved farm efficiency

26 In the space provided indicate (1) for the most important, (2) for the second-most important, and (3) for the third-most important reasons farmers decided not to participate in the RCWP.

_3_ did not know about the RCWP
_3_ were not asked to participate
__ not high enough cost-share rates
_1_ economic conditions, costs, money
__ water pollution is not a problem
__ land use does not really affect water quality
__ changing practices is often too much trouble
__ current system works well enough
_2_ did not want to be told how to farm
__ land rented, landlords
__ too much red-tape or complicated procedures
__ don't like any government programs

__ other:

-age of operator
-retirement age
-not in critical area
-quite effective
-helped in evaluation, not implementation
-help understand what was needed in the way of implementation and documentation, even if we could not fully develop
-the farm operator was working too much ground and didn't have the time or want to have to do anything more
-did not feel they were a problem
-state offered "buy-out" program to dairy operators who did not want to comply with regulations. This alternative was chosen by some who could not economically or did not desire to continue.
-didn't come under Florida Der Dairy Rule
-took advantage of state buy-out program and closed dairies
-distrustful of government and strangers
-social structure of the area. Many farmers of the plain religious sects
-family grudge. The land taken from farm for the lake.
-small project, all were able to participate in the project
-uncertainty about staying in farming business
-elderly, about to retire

BMP IMPLEMENTATION

27 How important would each of the following factors be in a farmer's decision about whether to use a new BMP to help protect water quality? For each question, please circle Very Important (VI), Somewhat Important (SI), or Not important (NI).

	VI	SI	NI
	(%)		
Cost of the Practice	91	9	0
How easy the practice is to use	71	29	0
Labor or time required	61	36	3
Availability of government cost-sharing	68	28	4
Experience of other farm operators	39	57	4
Potential to improve water quality	18	69	13
Effects of the practice on profits	78	20	2
Information from government agencies	18	70	12
Information from farm businesses	26	63	11

28 What were the major reasons why a participant chose not to continue maintaining a BMP after the contract ran out?

73 poor farm economy
24 too trouble prone
48 got reduced contact by technical agencies (e.g. SCS, ES)
29 too time consuming
50 too expensive or costly
32 no pressure from peers to continue
50 change in crop eliminated the need for the BMP
___other:
-"If government isn't going to pay, I'm not going to do it."
-maintenance has been excellent due entirely to SCS working with producers
-failure to understand practice benefits
-dairy buy-out program
-rented land

29 What percent of critical area BMPs have been maintained or continued?

Critical area %	# Respondent
10	1
25	1
40	2
50	7
60	4
65	5
70	6
75	6
80	11
85	5
89	2
90	22
92	1
95	13
98	1
99	2
100	11

30 What BMPs were often discontinued after contracts expired?

PROJECT SITES BMPs	AL	DE	FL	ID	IL	IA	LA	MD	MA	MI	MN	NE	OR	PA	SD	TN/KY	UT	VT	VA	WI	KS
BMP 1 Perm. veg. cover	1						1			1					1				1		
BMP 2 Barnyard diversion																				1	
Manure storage and handling, all										1											
Animal waste util.	1									1	1									1	
Roofed feedlots									1												
BMP 3 Strip cropping									1					1		1		1			
BMP 4 Terraces	1										1										
BMP 5 Diversions			1																		
BMP 6 Rotation grazing												1									
Shade structures			3	3																	
Grazing land protection system																					
BMP 7 Water way system	1					1			1	1	1										
BMP 8 Cover crops		1																			
Cropland prot. sys.							1			2											
Crop rotation										1				1	1						
BMP 9 Cons. tillage	2	2		3	6	1	2			3				3	2	3			1	2	2
Chisel plowing																				1	
Contour farming strips														1						1	1
BMP 10 Fence			2	1																	
BMP 11 Field borders							1														
Turn rows							1														
Veg. filter strips				3																	

PROJECT SITES BMPs	AL	DE	FL	ID	IL	IA	LA	MD	MA	MI	MN	NE	OR	PA	SD	TN/KY	UT	VT	VA	WI	KS
BMP 12 Sediment basins	1			1																	
I-slots				2																	
Cleaning sediment ponds				3																	
BMP 13 Irrigation																					
BMP 14 Tree planting																					
BMP 15 Fertilizer mgt.						1	1		1	1		1		1	3	5					1
Manure mgt.						2												1			
BMP 16 Pesticide mgt.						1				1		1			1	3					1
IPM															2						
MISC. Maintenance practices on rented land		1																			

31 What BMPs were often not maintained after contracts expired?

PROJECT SITES BMPs	AL	DE	FL	ID	IL	IA	LA	MD	MA	MI	MN	NE	OR	PA	SD	TN/KY	UT	VT	VA	WI	KS
BMP 1 Grassed waterway		1							1	1											
BMP 2 Filter strips										1										1	
Gutters and downspouts													1								
Manure storage																				1	
BMP 3 Strip cropping														1							
BMP 4 Terraces						2								1							
BMP 5 Diversions			1							1				1							
Outlets										1								1			
BMP 6 Grazing land protection system																					
Cover crop	1													1							
Shade structures			2	2																	
BMP 7 Fencing			1	1					1	1											
Streamside fencing										1		1									
BMP 8 Crop rotation										1										1	
Cropland protection system										1					1						
BMP 9 Conservation tillage	1									1				1	1						1
BMP 10 Stream protection	1									1											
Cedar revetments										1		1									
BMP 11 Permanent vegetative cover									1	1											

PROJECT SITES BMPs	AL	DE	FL	ID	IL	IA	LA	MD	MA	MI	MN	NE	OR	PA	SD	TN/KY	UT	VT	VA	WI	KS
BMP 12 Control structures		1								1											
Cleaning sediment ponds				2						1											
BMP 13																					
BMP 14																					
BMP 15 Manure spreading										1			1							2	
Nutrient mgt.	1						1			1	1	1		2		1	1				
Waste										1							2				
BMP 16 Pesticide mgt.	1						1			1		1				1				1	
MISC. most																	1				

'ROJECT SITES 3MPs	AL	DE	FL	ID	IL	IA	LA	MD	MA	MI	MN	NE	OR	PA	SD	TN/KY	UT	VT	VA	WI	KS
3MP 12 Control structures		1								1											
Cleaning sediment onds				2						1											
MP 13																					
MP 14																					
MP 15 anure spreading										1			1							2	
utrient mgt.	1						1			1	1	1		2		1	1				
/aste										1							2				
MP 16 esticide mgt.	1						1			1		1				1				1	
ISC. ost																	1				

32 For each statement, please indicate Strongly Agree (SA), Agree (A), Disagree (D), or Strongly Disagree (SD) with each of the following statements:

	SA	A	D	SD
		(%)		
a. Agricultural water pollution is a serious threat to fish and wildlife.	43	45	11	1
b. We need less expensive farming practices that will help protect water quality.	33	64	1	2
c. Farm practices that protect water quality usually require more labor.	6	34	54	6
d. Agriculture is being unfairly blamed as a cause of water quality problems.	13	24	51	12
e. If farm operators don't do more to protect water quality on their own, the government will force them to, through regulations.	34	63	3	0
f. The government should help pay more for water pollution control on farms.	13	50	34	3
g. Farm operators do not have the right to farm in ways that damage water quality.	25	67	7	1
h. Land should be farmed in ways that protect water quality, even if this means lower profits.	9	64	25	2
i. Water pollution can best be controlled through educational programs that encourage farm operators to use BMPs.	22	48	26	4

RCWP WORKSHOPS

33 The following table is provided to gather data on attendance at RCWP workshops by agency. In the appropriate box please put the number of agency representatives that attended each workshop from your project.

	ASCS	SCS	ES	STATE WQ	USGS
1983 Arlington, VA	6	13	0	14	2
1984 Raleigh, NC	1	12	1	13	3
1984 Chicago, IL	0	4	0	5	1
1985 Kansas City, KS	1	11	2	14	1
1986 Chicago, IL	1	7	1	7	3
1988 St. Paul, MN	9	23	4	25	4
1989 Burlington, VT	5	9	5	13	2
1990 Brookings, SD	8	19	6	18	2

34 If you attended any of the workshops, what types of sessions were the most helpful?

14 institutional arrangements
30 information and education
15 definition of critical area
20 technical assistance with BMPs
23 water quality monitoring design
26 water quality data analysis
1 water quality and watershed modeling
20 land treatment monitoring
42 linking land treatment and water quality data
15 economic analysis

35 Overall did workshops help your project meet the objectives of the RCWP? Explain briefly.

24% No
76% Yes

It informed the people participating of the project and its purpose.

It helped meet the 10-year report. Staff in the field offices should attend all annual meetings.

Everyone needs more education concerning all aspects.

Would have if money for monitoring and evaluating had been available.

Good review on lessons learned and change objectives of BMPs.

Information obtained not easily transferable to project success.

Ideas for encouraging producers to implement practices were discussed. Results of other projects were shared with producers in our project.

Like to see positive aspects of other projects that could be integrated into our project.

It took two years to find out what was really supposed to be done.

By the time we were invited or allowed to attend, it was too late for any meaningful help.

Unfortunately, I only attended one due to financial constraints in SCS. I developed a much better understanding of the RCWP nationwide as well as gained from other project's experience.

A lot of up-to-date, useful information was obtained. They were also good motivational tools.

Helped provide guidance on what are expected products valuable to establish contacts with other projects.

Ideas on limiting land treatment with water quality improvements.

Should have developed user-friendly software for each project to use with a number of appropriate statistical applications.

Be aware of the importance of keeping track of BMPs for monitoring.

The information from other programs helped improve our program.

It provided an opportunity to learn about other projects.

They gave attendees insights into the problem.

Often USGS was looked to give the answers rather than as an agency seeking assistance from others.

Assisted agency in carrying out water quality monitoring duties.

Spend money on practices and projects.

Ideas shared were brought back to the project and shared with LCC and SCC. Good exchange of ideas.

Were able to gain information from other projects and specialists to improve our activities.

Participants expressed that the workshops were helpful.

We were not advised of the 1984-1989 workshops.

Periodic workshops help keep participating parties interested and on track for attainment of project goals.

Too much theory, not enough practical solutions to project problems (too many cooks in the kitchen).

Appendix VIII

METHODOLOGY FOR ON-SITE EVALUATION

Results of the Experimental Rural Clean Water Program:

Methodology for On-Site Evaluation

November 9, 1990

by
Steven W. Coffey
Michael D. Smolen
North Carolina State University

I. Introduction

The Rural Clean Water Program (RCWP) is a federally-sponsored agricultural nonpoint source (NPS) pollution control program begun in 1980 as an experimental effort to achieve improvement in the impaired water use and quality in 21 approved project areas across the US. The program is administered by the USDA-ASCS in cooperation with the EPA, SCS, ES, ERS, FS, ARS, FmHA, and others. Landowner participation is voluntary with cost-sharing and technical assistance offered as incentives for implementing best management practices (BMPs). The contracting period ended for most RCWP projects in 1986. The program will terminate in 1995, however most of the projects will end by 1992.

II. Objectives of the RCWP

The objectives of the RCWP (Federal Register 7 CFR Part 700) are: a) to achieve improved water quality in approved project areas in the most cost-effective manner possible in keeping with the provision of adequate supplies of food, fiber, and a quality environment, b) assist agricultural land owners and operators to reduce agricultural NPS water pollutants and to improve water quality in rural areas to meet water quality standards or water quality goals, c) develop and test programs, policies, and procedures for the control of agricultural NPS pollution.

III. Objectives of the Evaluation

Objectives of the evaluation are to assess: a) cooperation among project team members, committees and agencies, b) the agreement between the documented water quality problem and the choice of solutions, c) the achievements of the project and individuals in relation to RCWP objectives, d) monitoring and the assessment of project impacts, e) the effectiveness of the project and its progress toward improving water quality, and f) to compile lessons learned.

IV. The Model Project

We formulated a conceptual model RCWP project to serve as a benchmark for reviewing the activities of individual projects and for evaluating RCWP as a program. The RCWP regulations provide a basis for the model. The model emphasizes the coordination of project activities to achieve project goals and improve water quality. When the findings of the evaluation are compiled, the results will be compared to the present model and used to formulate a revised model.

The model project operates under the primary authority of USDA with consultation and concurrence from EPA. USDA approves BMPs with the concurrence of EPA. ASCS is the administrative lead agency. SCS provides technical supervision and assistance for the installation and maintenance of BMPs in cooperation with other USDA agencies, such as ES and FS. ES and other agencies (SCS, FS) provide informational and educational support. While agencies supervise project activities, committees are responsible for setting priorities and coordination. All agencies, committees, and program participants follow RCWP regulations. The model project will be revised and presented in the final report on the results of the experimental RCWP.

V. In-Person Interviews

An evaluation team will visit project sites, interview project team members, review project activities, and report results. The survey questions provided below are identical or nearly identical to the questions to be asked at the on-site in-person interviews. Some questions may be revised if they are difficult to interpret or if they fail to produce useful information.

Questions are designed to gather specific information on project elements including administrative oversight, local and state coordinating committees, information and education, land treatment, and water quality monitoring and evaluation. A separate companion telephone survey of producers will be used to determine factors that influence participation and BMP implementation and perceptions of program effectiveness.

1. Local Program Administration (County Executive Director, ASCS)

1.1 What are the objectives of the project?
1.2 What is the water quality problem?
1.3 How were project activities coordinated and how could they have been improved?
1.4 If needed, how could you improve local program administration?
1.5 How were cost-share rates determined?
1.6 Of the approved list of BMPs, were there any you would have added to improve the chances of achieving water quality goals? If yes, which ones and why?
1.7 Of the approved list of BMPs, were there any you would have dropped? If yes, which ones and why?
1.8 What methods were used to help assure that a contract on a farm would be continued from year to year?
1.9 If there were contracting problems with absentee landlords versus local owner/operators, how were they addressed?
1.10 If pooling agreements (i.e. two or more participants apply BMPs to a common area or source) were used, tell if they were effective, neutral, or ineffective and why?

2. Local Coordinating Committee - LCC (Persons who have participated in LCC meetings)

2.1 What agencies were involved in local coordination of project activities?
2.2 What were the roles and functions of the LCC?
2.3 How were project activities coordinated and how could they have been improved?
2.4 What are the objectives of the project?
2.5 What is the water quality problem?
2.6 How were critical areas identified?
2.7 If there were technical, social, and administrative problems of producer and/or land eligibility, how were they resolved?
2.8 How did the LCC decide which farms to treat?
2.9 How did the LCC decide which BMPs to install first and why?
2.10 How were water quality monitoring results used by the LCC?
2.11 If water quality monitoring results were used to modify BMPs or change the project critical area, what were the changes?
2.12 In what ways would you improve coordination with state programs and agencies in your project?
2.13 Suggest ways that the SCC could assist project efforts.

3. State Coordinating Committee - SCC (Persons who were members of the SCC)

3.1 What agencies were involved in state coordination of project activities and which agencies played the lead role?
3.2 What were the roles or functions of the SCC?
3.3 What are the objectives of the project?
3.4 What is the water quality problem?
3.5 How were local project activities coordinated and how could they have been improved?
3.6 How did the SCC help the LCC in obtaining funds or technical support for special project needs?
3.7 How did the SCC help in the determination of critical areas and in the selection of BMPs?
3.8 Was the National Coordinating Committee (NCC) helpful?
3.9 Was the NCC timely with their decisions and assistance?
3.10 How could the SCC be more effective?
3.11 How could the NCC be more effective?

4. Information and Education - I&E (Persons who contributed to the I&E effort)

4.1 What agencies were involved in I&E activities and which agency played the lead role?
4.2 What were the objectives and goals of I&E?
4.3 What is the water quality problem?
4.4 Was there a difference between producer perceptions and the stated water quality problem? Were these resolved? How?
4.5 How were project activities coordinated and how could they have been improved?
4.6 Were there targeted farmers in critical areas who were reluctant to participate?
4.7 What approaches were most effective for gaining producer participation from farmers in the critical area and why?
4.8 What approaches were the least effective and why?
4.9 Did agrichemical companies have a significant influence on agrichemical use?
4.10 If so, how were I&E activities targeted to achieve project goals?
4.11 Which BMPs require the most I&E (as opposed to technical assistance) and why?
4.12 Do farmers in the critical area implement BMPs designed specifically to improve water quality or do they implement traditional (soil conservation and waste management) practices?
4.13 What is your sense of the public perception regarding changes in water quality?
4.14 Describe how producers and the public in the project area were kept informed about project activities and accomplishments.
4.15 Were producers outside of the project area informed about the project?
4.16 If so, how were they informed and describe what the project meant to them.

5. Land Treatment (SCS District Conservationists)

5.1 What agencies or contractors were involved in implementing BMPs?
5.2 What were the objectives and goals of implementing BMPs?
5.3 What are the objectives of the project?
5.4 What is the water quality problem?
5.5 How were project activities coordinated and how could they have been improved?
5.6 Please suggest any improvements that should be made in defining the critical area.

5. Land Treatment (continued)

5.7 If quality of installation was a problem for any BMP, state the BMP, problem, and effect of the installation problem on water quality.

5.8 If maintenance was a problem for any BMP, state the BMP, problem, and effect of the maintenance problem on water quality.

5.9 Were enough BMPs installed to achieve the water quality objective for the project?

5.10 If not, what changes should have been made?

5.11 Were the most cost-effective BMPs targeted to critical areas?

5.12 Can you suggest alternate BMPs to do a similar job?

5.13 How did the project track land use and BMP installation and maintenance?

5.14 What were the most important land use and land treatment variables measured?

5.15 What were the sources of error in tracking land use and BMPs and what type of quality assurance/quality control was used?

5.16 Can you suggest some ways to improve the tracking of land use and BMPs?

5.17 What was learned from the water quality data analysis?

5.18 What is your sense of the public perception regarding changes in water quality?

5.19 Did agrichemical companies have a significant influence on agrichemical use?

5.20 If so, how were land treatment (installation and maintenance of BMPs) activities adjusted to achieve project goals?

5.21 Do farmers in the critical area implement BMPs designed specifically to improve water quality or do they implement traditional (soil conservation and waste management) practices?

5.22 Please state any innovations in BMPs or land treatment methods developed by the project.

6. Water Quality Monitoring and Evaluation (Persons involved in water quality problem identification, monitoring design, sampling, and data analysis)

6.1 What agencies or groups were involved with water quality monitoring and evaluation?

6.2 What are the objectives and goals of water quality monitoring and evaluation?

6.3 What were the objectives of the project?

6.4 What is the water quality problem?

6.5 How were project activities coordinated and how could they have been improved?

6.6 Do other pollutant sources in addition to agricultural NPSs (e.g. point sources, non-monitored NPSs, or non-project area loadings) contribute significantly to the water quality problem but were or were not directly evaluated?

6.7 If applicable, how did these other pollutant sources affect the ability of the monitoring program to detect water quality trends due to RCWP?

6.8 How did the design of the monitoring network reflect the specific goal of measuring land treatment effect on water quality?

6.9 Did the water quality monitoring program document improvement in designated use? How?

6.10 Did the water quality monitoring program document restoration of designated use? How?

6.11 Did the water quality monitoring program document compliance with water quality standards or health advisories?

6.12 What water quality variables were the most useful for detecting trends? Why?

6.13 If additional variables would have helped you document trends, state the variables and tell why you think so.

6.14 What water quality explanatory variables (e.g. covariates such as flow, water table depth, antecedent precipitation, animal numbers, cropping pattern) were meaningful for the analysis? Why?

6. Water Quality Monitoring and Evaluation (continued)

6.15 If you had to do the 10-year RCWP project monitoring again, how would you improve the water quality monitoring program?

6.16 Were water quality monitoring results used in modifying critical area BMPs? Was communication between the water quality monitoring and land treatment groups regular?

6.17 What data analysis plans were made at the beginning of the project and what were the statistical hypotheses that were formulated? How are these related to project objectives and goals?

6.18 What experimental features of the monitoring design (e.g. paired watersheds, post-BMP monitoring) helped in isolating water quality changes attributable to land treatment activities that were independent of climatic and meteorological factors?

6.19 Would more guidance on QA/QC for monitoring and analysis (e.g. field sampling, lab, data storage, and data analysis) have improved the water quality monitoring and evaluation component of your project? How?

6.20 How did the project track land use and BMP installation and maintenance for RCWP cooperators and non-cooperators?

6.21 What were the most important land use and land treatment variables measured?

6.22 What were the sources of error in tracking land use and BMPs and what type of QA/QC was used?

6.23 Can you suggest some ways to improve the tracking of land use and BMPs?

6.24 What was learned from the water quality data analysis?

6.25 What is your sense of the public perception regarding changes in water quality?

6.26 What changes in water quality can be related to land treatment accomplishment? Suggest improvements in either land treatment or the monitoring of land treatment or water quality to show a stronger relationship.

6.27 If it was not possible to measure change in water quality after BMP installation, state why and suggest techniques appropriate to detect a change in water quality.

7.0 Participation Questions (Respondents for participation questions are Local Program Administration, Land Treatment, and Information and Education)

7.1 Overall how would you rate producer participation in RCWP?

7.2 What barriers limited participation in RCWP?

7.3 What factors motivated the adoption of practices?

7.4 Overall how would you rate the chances of continued maintenance and adoption of practices after the program runs out?

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