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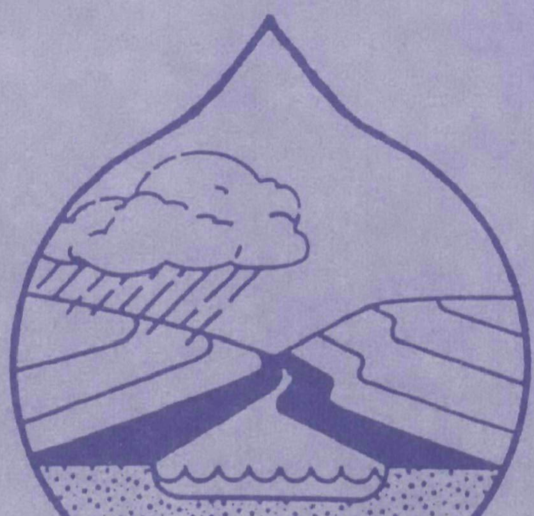
# NWQEP 1988 ANNUAL REPORT:

## Status of Agricultural Nonpoint Source Projects



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# NWQEP 1988 ANNUAL REPORT: Status of Agricultural Nonpoint Source Projects

BY

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## DISCLAIMER

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# EXECUTIVE SUMMARY

## FOREWORD

This report is one in a series of annual water quality reports published by the National Water Quality Evaluation Project (NWQEP) in cooperation with the United States Department of Agriculture and the United States Environmental Protection Agency. NWQEP performs technical evaluations of Rural Clean Water Program (RCWP) projects, analysis of nonpoint source (NPS) pollution abatement progress, and technical assistance on monitoring and data analysis systems.

RCWP is a federally-sponsored NPS control program begun in 1980 as an experimental effort to address agricultural NPS pollution problems in 20 watershed projects across the country. The program is administered by USDA- ASCS in cooperation with 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.

Results and lessons learned from RCWP projects are the primary source of information for other federal, state, and local NPS pollution control programs. RCWP provides detailed information on how to conduct a NPS control project. The program has also pointed up research needs in NPS pollution control and helped to promote NPS control objectives through increased public awareness.

Chapter one of this report is a complete, up-to-date listing of RCWP water quality results and lessons learned. RCWP projects have employed many of the recommendations of two previous NPS programs, the Model Implementation Program (MIP) and Great Lakes Demonstration Program (108a). These recommendations are listed in Appendix A. Chapter two focuses on reporting and information needs for linking land use with water quality monitoring data. Chapter three contains brief profiles of each RCWP project. The profiles include the most recent information about project results, major contributions to NPS control efforts, and lessons learned about NPS control.

# HIGHLIGHTS OF RCWP RESULTS AND LESSONS LEARNED

## Water Quality Results

- BMPs, when implemented properly, improve water quality.
- Fencing, water management, and animal waste management systems in the Florida Taylor Creek-Nubbin Slough RCWP have significantly reduced phosphorus concentration in water entering Lake Okeechobee.
- Animal waste management systems reduced phosphorus concentration in the Snake Creek RCWP. This reduces the impact of agricultural activity on Deer Creek Reservoir, an important water supply for Salt Lake City, Utah. This project is a model for other projects in the area.
- Water management and sediment control BMPs reduced sediment and phosphorus concentration in return flows from irrigated land in Rock Creek RCWP, Idaho.
- Animal waste management systems installed on dairies in the Tillamook Bay, Oregon RCWP reduced bacterial contamination of oyster beds in the Bay.
- Sediment and phosphorus loadings have been reduced by conservation tillage, animal waste management, vegetative cover on critical areas, and fertilizer management in the Appoquinimink River RCWP, Delaware.
- Terracing and other soil conservation practices have reduced sedimentation of an important Iowa recreational lake in the Prairie Rose Lake RCWP.

## Lessons Learned from RCWP

*Administration and Planning*

- A clear statement of specific goals and objectives is essential guidance for all aspects of NPS project implementation.
- Cooperation of local, state and federal agencies is necessary to achieve an effective NPS project.
- Economic benefits depend on reversing or preventing impairments to high valued public use water resources.
- Water quality models (AGNPS, CREAMS) have been demonstrated as useful tools for planning and evaluating NPS control projects and BMP- implementation sites.
- Pre-project assessment of impaired water uses, likely benefits of reduced or prevented impairments, and the costs and effectiveness of BMP options will contribute to greater economic efficiency of future programs.

*Farmer Participation / Information and Education*

- A high level of participation is needed in the critical area in a voluntary project to ensure that BMPs treat the most important sources.
- An intensive publicity campaign with one-on-one contact between project personnel and targeted landowners helps to achieve BMP contracting and implementation goals.
- Attractive cost sharing and technical assistance incentives can increase farmer participation, but these incentives may not be uniformly effective if there are recalcitrant farmers/landowners or uncertain economic conditions.

*Land Treatment*

- Target land treatment to critical areas where BMP implementation is most likely to yield water quality benefits.
- Practices should be selected to address pollutants of concern and water quality objectives.
- Practices must be acceptable to the landowners who will implement them.
- Monitor land treatment/use (RCWP and Non-RCWP) for correlation with water quality monitoring data.
- The highest cost share expenditures were earned by animal waste management systems (BMP-2), conservation tillage (BMP-9), permanent vegetative cover on critical areas (BMP-11), sediment retention, erosion or water control structures (BMP-12), water management systems (BMP-13) and nutrient and pesticide management (BMPs- 15 & 16).

*Water Quality Monitoring and Data Analysis*

- A data analysis strategy should be planned early in the project to address clearly stated water quality goals and objectives.
- The monitoring strategy must be appropriate for the water quality problem, water resource type, and project objectives.
- Consistency and uniformity in data collection, analysis and reporting over the project timeframe are essential for detecting water quality trends and relating them to implemented BMPs.
- Climatic variability can mask water quality effects in short-term monitoring or casual observation if there is no control site for comparison.

*Effectiveness of Best Management Practices*

- BMP effectiveness is very site specific.
- The effectiveness of BMP implementation is influenced by meteorology, hydrology, distance to waterbody, extent of implementation, and maintenance.
- A reduction in erosion rate may or may not result in improved water quality.
- The effectiveness of structural practices such as animal waste storage structures, sediment basins, terraces, and improved irrigation systems can be enhanced by water quality-oriented management practices such as nutrient management, pesticide management, waste management and conservation tillage.
- Practices that reduce surface runoff (e.g. level terraces and some forms of conservation tillage) generally increase the concentration of dissolved nutrients and pesticides in runoff and may increase leaching of nitrate and pesticides to ground water.

*Economic Efficiency*

- Recreation is generally the highest value public use and projects that reverse or prevent an impairment to recreational use can show high economic benefits.
- Elements other than water quality may produce economic benefits observed in NPS control projects (eg. park facilities, road improvements, population increase).
- Conservation tillage, nutrient and fertilizer management, and filter strips have been shown generally to be more cost-effective practices than structures (e.g. manure holding pits, sediment retention basins) for controlling sediment and nutrients.

*Problems and Pitfalls*

- Projects lacking a clear statement of goals and objectives are inefficient.
- Targeting is not effective in voluntary projects if participation is low in the critical area.
- There is no single accepted relationship to determine the amount of land treatment needed to restore impaired water uses. Generally, RCWP projects used 75% of the critical area as their treatment goal. This amount appears to be sufficient for some projects but not for others.
- Many projects lack the research expertise and reporting procedures to relate water quality changes to land treatment.
- Some RCWP projects were inappropriate for demonstration of NPS pollution control for the following reasons: a water use impairment was not documented, project areas were too large and contained varied pollution sources, local interest was inadequate, or monitoring capability was inadequate.

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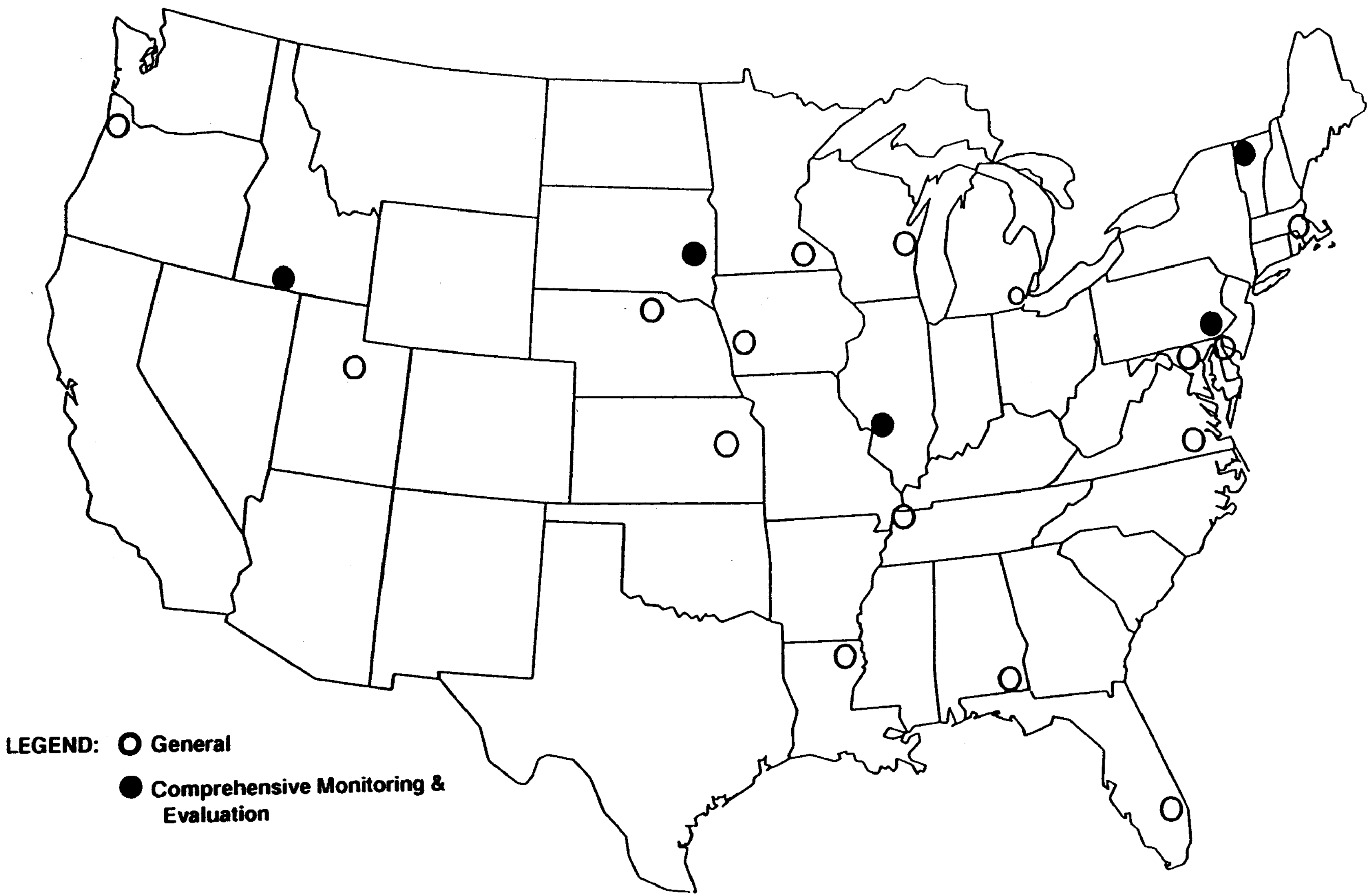
## Locations of RCWP Projects



# CHAPTER ONE

This report is the sixth in a series of annual water quality reports published by the National Water Quality Evaluation Project (NWQEP) in cooperation with the United States Department of Agriculture and the United States Environmental Protection Agency. NWQEP was begun in 1981 and is directed to play a supporting role to the Rural Clean Water Program (RCWP). The role of NWQEP has evolved into three basic functions: technical evaluation of RCWP projects, analysis of nonpoint source (NPS) pollution abatement progress, and technical assistance on NPS monitoring and data analysis systems. The overall objective of NWQEP is to measure the degree of success experienced by federal and state agencies in solving identified agricultural NPS problems through application of Best Management Practices (BMPs).

## RCWP OBJECTIVES

The federal Rural Clean Water Program[1] provides long-term financial and technical assistance to owners and operators having control of agricultural land for the purpose of installing and maintaining BMPs to control agricultural NPS pollution for improved water quality. Participation in RCWP is voluntary. Landowners are contracted to implement BMPs in designated critical areas. The length of a contract varies depending on the practice – typically three years minimum (conservation tillage) and up to ten years maximum (terraces, animal waste management systems). Appendix B contains a complete list of BMPs approved for RCWP projects.

There are 20 RCWP projects across the country. They were selected from state lists of NPS priority watersheds developed during the section 208 planning process under the 1972 Clean Water Act. RCWP projects began in 1980 – 1981 and will continue through 1990 – 1995. Each project is required to monitor water quality in addition to its land treatment activities. Five projects (Vermont, Illinois, South Dakota, Pennsylvania, Idaho) were selected to receive additional funds for Comprehensive Monitoring and Evaluation (CM&E) programs.

The lead agency for RCWP is the USDA's Agricultural Stabilization and Conservation Service. Other federal agencies involved in RCWP are the Soil Conservation Service, Environmental Protection Agency, Extension Service, Forest Service, Agricultural Research

1 Agriculture, Rural Development and Related Agencies Appropriations Act, FY80, PL 96-108

Service, Economic Research Service, Farmers Home Administration, and others. There are many state and local agencies involved in RCWP, principally the state water quality agency which is usually housed within the department of natural resources or environmental quality.

The program objectives of RCWP are:

1. Achieve improvement in impaired water use and quality in approved project areas in the most cost-effective manner possible in keeping with the provisions of adequate supplies of food, fiber and a quality environment.

2. Assist agricultural land owners and operators to reduce agricultural nonpoint source water pollutants and to improve water quality in rural areas to meet water quality standards or water quality goals.

3. Develop and test programs, policies, and procedures for the control of agricultural nonpoint source pollution.

## LESSONS LEARNED

RCWP has produced direct water quality benefits and provided a wealth of experience in agricultural NPS pollution control. Results and lessons learned from RCWP projects are a primary source of information for other federal and state NPS pollution control programs. The program has also helped to define research needs in NPS pollution control and promote increased public awareness and attention to this important water quality problem. This chapter focuses on lessons from the RCWP experience that can be applied to development, implementation and evaluation of a NPS control program or project.

### Project Administration and Planning

**Lesson:** NPS problems can be addressed successfully in any watershed given enough resources. The amount of technical, financial, and informational resources allocated to a project must be sufficient to address the water quality problems. Magnitude of effort should be based on the extent, diversity, and implementation needs of the critical area. Competing workloads must be anticipated over the long-term when project personnel are assigned responsibilities.

**Lesson:** Project size can effect attainment of water quality goals. Large projects with many farms may have difficulty gaining enough participation to achieve their land treatment goals. These projects are not generally suitable for demonstration projects. The magnitude of effort required to do the project properly could easily exceed available resources and the benefits accrued for demonstration purposes are likely minimal. A small watershed with well defined use impairment, pollutants, and pollutant sources makes a good demonstration project.

**Lesson:** Cooperation of local, state, and federal agencies is essential to the success of a water quality project. Federal programs like RCWP depend heavily on the long-term support and commitment of state agencies to achieve program objectives.

In developing their RCWP projects, many states have built strong working relationships between agricultural agencies, such as ASCS, SCS and Extension Service, and state water quality agencies. These relationships have been formalized through Memoranda of Understanding and other administrative mechanisms.

**Lesson:** Projects requiring interstate cooperation are difficult to conduct effectively if the states involved do not share the same priorities for the project.

Jurisdictional problems in the Massachusetts project are affecting the land treatment strategy. A subbasin in Rhode Island, outside the project area, may be contributing contaminants to shellfish beds in the project's designated water resource.

The Reelfoot Lake RCWP covering counties in Tennessee and Kentucky has obtained good cooperation between state agencies in defining, evaluating, and addressing common project objectives.

**Lesson:** Time and money can be saved by setting priorities for project selection and implementation.

Highest priority should be given to projects where there is high probability for reversing the water use impairment, i.e. clearly documented use impairment, substantial local support, adequate staff and expertise for technical assistance, and information and education support. Some regulatory authority is also helpful.

Projects addressing water resources with high public value, many users, high visibility, and clearly documented impairment of beneficial use generally have the highest probability of producing economic benefits.

**Lesson:** Causes of water pollution within a watershed may be diverse (e.g., animal waste, surface runoff, sewage treatment plants, residential septic systems). Therefore, water quality improvements from agricultural BMP implementation could be masked by non-agricultural sources of pollution.

**Lesson:** A project's timeframe should include a two to three year pre-implementation period for thorough assessment of water use impairments, economic and other benefits from water quality improvement, surficial and ground water flow regimes, identification and quantification of all pollutants and their sources, identification, quantification, and targeting of critical areas, and selection of BMPs. Pre-project assessment will contribute to the efficient use of water quality funding.

One-third or more of the RCWP projects have low likely economic benefits compared with costs. Many projects could have been more cost- effective in achieving water quality improvement by selecting different BMPs aimed at controlling the pollutants of concern.

Some RCWP projects lacked good assessment information and, as a result, had to redefine their original critical area two to three years after the program began. Reasons for these changes included better documentation of the water resource use impairment (Minnesota), and better documentation of pollutant sources (Massachusetts).

Two years into the project, the Kansas RCWP determined that there was no water use impairment and the project decided not to continue.

**Lesson:** Nutrient and water budgeting techniques and modeling are useful in quantifying pollutants and their sources and estimating the location and extent of land treatment needed to reverse the water use impairment.

Water quality models (AGNPS and CREAMS) have been demonstrated as useful for planning and evaluating activities such as critical area identification and land treatment strategy selection. (Minnesota, Illinois, Vermont)

The Vermont project used models in assessing sources of agricultural NPS phosphorus and sediment, critical and total pollutants loads, changes over time, and BMP selection. This type of modeling effort at the beginning of a project would be useful for ranking farms and setting treatment priorities.

Balance of nutrient mass at the farm level is required by law in the Florida RCWP. The project is directed to reduce phosphorus in effluent from dairies and beef cattle operations by a new State regulation that requires all available phosphorus beyond that assimilated by plants or adsorbed by the soil to be controlled. The intent of the regulation is to recycle all nutrients produced on livestock operations through nutrient budgeting.

The Vermont project monitored annual nutrient and water budgets to identify relative contributions of point and nonpoint sources to the impaired water resource. A wastewater treatment plant in the project area was identified as a significant and variable source of phosphorus loading to St. Albans Bay.

South Dakota is completing a water and nutrient budget study for a lake system to assess sources (origination areas) and sinks (storage areas) in this system. These data will be used to model the impact of changes in agricultural practices on water quality.

The nutrient budgeting technique is the basis of a computer template developed by the Pennsylvania RCWP to assist in making nutrient management decisions for farm and field application of manure. The template is a model for the country and has been demonstrated at several national water quality workshops and training sessions.

## Farmer Participation / Information and Education

**Lesson:** Obtaining a high level of participation is a major factor in project effectiveness. A high level of participation is needed to ensure that BMP implementation covers the critical area.

The Oregon, Utah, Florida, Iowa and Vermont projects achieved a high level of farmer participation through the cooperative effort of agricultural and water quality personnel on designing and publicizing the program.

**Lesson:** An intensive pre-project publicity campaign and one-on-one contact between project personnel and targeted landowners helps to achieve participation goals.

The Alabama RCWP showed that even in an economically depressed farming area voluntary participation is possible if the targeted BMPS are acceptable to the farmers and there is enthusiastic one-on-one contact between farmers and project personnel. Other projects (Iowa, Louisiana, Vermont, Virginia, Oregon) have shown that a high level of participation can be gained by cost-sharing practices that are acceptable to area farmers.

**Lesson:** Attractive cost-sharing and technical assistance incentives generally increase farmer participation. The RCWP cost-share maximum is $50,000 per farmer is an adequate incentive level for most projects, however, some projects found this limit too low.

The Florida project has several large livestock operations (dairies and beef cattle) that require animal waste management systems. The cost of treatment exceeds the $50,000 cost-share limit for the largest operations. Thus, instead of 75% cost share the operator receives about 25% from RCWP. The State is providing additional cost share funds.

In the early stages of the Minnesota project, supplementary local funding reduced the farmer's cost-share responsibility to 10%, however, this was still not enough incentive to get dairy farmers to participate. The farm economy was very depressed. A change in project priorities led to redefining critical areas and emphasis on nutrient and pesticide management for ground water protection. Participation was gained through intensive contact with a different target audience to explain the project's goals and objectives.

Pooling cost-share monies among several cooperators was used successfully by the Nebraska project to fund construction of a water control structure to prevent erosion and improve the timing of irrigation flows. The project benefitted many farmers and increased their interest in the RCWP.

**Lesson:** Regulatory authority boosted participation in the Florida and Oregon RCWP projects.

Florida's State law requires animal operations to maintain nutrient mass balance. This law compels operators to implement BMPs.

In the Oregon RCWP, the creamery that buys milk from project area dairy farmers penalizes those who don't participate in the RCWP.

**Lesson:** Media publicity stimulates public interest in the project, and newsletters, public meetings, and media exposure help keep participants informed.

In the Pennsylvania project a training session and workshop on nutrient management principles is provided for county extension agents who work one-on-one with participating area farmers. Water quality and project objectives are promoted through public meetings, mass media, experimental nutrient management, no-till and fertilizer management field plots and project newsletters. They issue special reports on experimental findings and public tours.

Demonstration field trials and other Extension education programs are offered through a fertilizer management program of the Vermont RCWP. Education programs provide newsletters, articles, mass media coverage and farmer-Extension meetings, as well as one-on-one contact, field tours, and summary reports on field test results and soil and manure analysis.

The information and education program in the Alabama RCWP established five pre-project objectives for improving farmer and general public awareness of the efforts, importance and benefits of the project. Training sessions, group meetings, letters, demonstrations, media coverage and personal contacts have been part of the educational program. These activities paid off in a high level of participation although the project area farm economy was very depressed.

I & E activities in the Idaho RCWP center on conservation tillage and project accomplishments. Two Soil Conservation Districts along with technical support from SCS have provided videotapes of RCWP activities, publications, media coverage, newsletters and tours of ARS field trials in the project area. The project has also placed signs designating conservation tillage activities and project accomplishments throughout the project area.

The South Dakota RCWP has found that public meetings, media releases, on-site demonstrations, and newsletter circulation are effective mechanisms for communicating information on project status to personnel, participating farmers, and the general public. Well defined educational procedures are aimed at making all the area landowners aware of the project benefits. Recent information and education efforts have focused on technical assistance in fertilizer and pesticide management, including one-on-one contact, soil sampling information, pest scouting, and presentation of project accomplishments.

Demonstration farms are utilized in Nebraska as information and education tools for RCWP activities. Integrated Pest Management (IPM) and RCWP information is presented in two separate monthly newsletters. Weekly field scouting and a radio broadcast report of insect activity support the IPM program. Extension programs are gathering yield data to show the benefits of fertilizer and pesticide management. A video tape of the activities and progress in this project is also being developed.

## Land Treatment

**Lesson:** Land treatment should be targeted to critical areas where BMPs are likely to provide the greatest improvement in the water resource. The primary factors in identifying critical areas are the pollutant(s) causing the water use impairment and the major pollutant sources. Appropriate criteria for prioritizing critical area treatment needs are: source magnitude, distance to water resource, type and severity of water resource impairment, type of pollutant, present conservation status, and on-site evaluation.

To control soil erosion and sediment yield problems, the Illinois project targeted critical areas as natric soils with 2% slope, fine particle size and high erodibility, and non-natric soils with 5% slope, high erodibility, and proximity to stream system.

The Louisiana RCWP, addresses turbidity and sedimentation problems by considering all cropland critical. Cotton on silty soils has highest priority because it is close to waterbodies, intensively cultivated, and has high pesticide and nutrient requirements. This project also offered high cost-share rates (90%) to farmers located adjacent to Bayou Bonne Idee to increase participation in the critical area.

The Maryland RCWP targeted farms with pollution sources close to streams based on their contribution to the documented water quality problems caused by sediment loads and high levels of fecal coliform bacteria.

In addressing eutrophication problems in St. Albans Bay, the Vermont RCWP targeted critical areas based on distance to streams and the Bay, presence of major NPS phosphorus source which reach the stream, and distance to major water courses. The project feels that evaluation of progress based solely on critical acres does not give an accurate indication of BMP effectiveness. As an alternative the project has used SCS computer models to estimate the total phosphorus and sediment loads. The portion of the total load that can be controlled by agricultural BMPs is designated as critical. Progress toward project goals is evaluated in terms of the amount of critical load treated with BMPs.

Water quality problems in the Oregon RCWP result from high fecal coliform levels and sediment loading to Tillamook Bay. Critical area in the project was identified as the acres on high priority dairies in the project area. Priority levels were based on a rating system that allocated points based on: distance to open water course, manure management practices, number of animals, and location of the operation within the project area.

The Utah project targeted dairies close to streams and ditches to control high levels of fecal coliform and phosphorus in streams draining the project area.

**Lesson:** Projects should be flexible in allowing partial BMP implementation on individual farms. BMP contracting rules that require *all or none* implementation involving expensive structures may deter project participation. Even with a 75% cost-share rate, the farmer's cost for BMP implementation can be a barrier to participation. It may be better to contract for management practices or BMP components that address the water quality problem and not hold up implementation because of minor needs for erosion control or one animal waste structure.

**Lesson:** In watersheds where cropland is the primary source of pollutants, implementation of BMPs must cover most of the critical cropland before water quality changes can be anticipated. Treating a smaller percentage of targeted area can produce positive results if animal waste is the primary source of water quality problems.

**Lesson:** Monitoring land treatment is necessary to assure effective implementation of a NPS project. Land treatment monitoring should include spatial and quantitative tracking of BMP implementation, including non-RCWP activities. See Chapter Two for further discussion.

Most projects, particularly Wisconsin, Pennsylvania, and Tennessee have a significant amount of non-RCWP, non-contract BMP implementation. Monitoring of this implementation is also necessary to document BMP effectiveness.

**Lesson:** Progress reports should distinguish between contracted BMPs and BMPs that have been implemented (i.e. installed, applied). Implementation is necessary for effectiveness and overall progress toward water quality objectives.

The monitoring procedures used by RCWP projects vary in their effectiveness. Most projects have found that manual tracking of BMP contracting and implementation using RCWP forms is tedious and have switched to computer spreadsheets. The Vermont project uses a GIS to track land use with good results. Reliance on the forms to tell the story leaves many questions unanswered, especially if the project has undergone changes in the project or critical area definition.

The Vermont project attempted a unique approach to tracking manure spreading in the project area. Each RCWP cooperator contract was given a "checkbook" and asked to write a check for the amount and location each time manure was spread on a field. The RCWP personnel collected the checkbooks on a regular basis and analyzed the data. Unfortunately, the contact of project personnel and farmers has decreased and check writing has declined.

**Lesson:** Depending on the water quality problem, the most popular BMPs for RCWP projects include animal waste management systems (BMP 2), conservation tillage (BMP 9), permanent vegetative cover on critical areas (BMP 11), sediment retention, erosion or water control structures (BMP 12), water management systems (BMP 13), nutrient management (BMP 15), and pesticide management (BMP 16). Waste management systems and erosion control structures are popular because they are desirable, expensive items that could be obtained for a fraction of the total cost by using RCWP cost share funds. Tillage, cover, and management practices have shown economic benefits to producers.

## Water Quality Monitoring and Data Analysis

**Lesson:** A data analysis strategy for linking water quality to the land use record should be planned early in the project. The strategy should address the stated water quality goals and objectives directly, rigorously, and specifically.

**Lesson:** Statistical tests that employ analysis of covariance techniques are preferable because they account for changes in meteorology and hydrology from year-to-year, season-to-season, and sample-to-sample.

**Lesson:** Selection of a monitoring strategy must be appropriate for the water quality problem, water resource type and project objectives. The most common monitoring strategy at the start of RCWP was to compare water quality data from pre- and post- BMP implementation periods. These strategies have largely been replaced with a trend-analysis approach in which improving trends in water quality over time could be associated with BMP implementation.

The Oregon, Florida, Idaho and Utah projects have shown that a pre-BMP water quality data base of at least 2-3 years duration facilitates documenting water quality effects of BMPs.

Most projects do not have sufficient water quality data from the pre-BMP implementation period. Trend analysis can still be attempted, however, the precision is significantly reduced such that a bigger change in water quality is needed if it is to be detected in the analysis.

Year-to-year variability in water quality data is very high and at least 2-3 years of post-BMP implementation are needed in all cases.

**Lesson:** The most effective monitoring design for documenting BMP impacts on water quality is the paired watershed design. In this design, two watersheds with similar physical characteristics, and ideally land use, are monitored for 1-2 years. Following this initial calibration period one of the watersheds receives treatment and monitoring continues in both watersheds for 1-2 years. This is a controlled experiment which accounts for all the factors that may effect the response to the treatment so that the treatment effect alone can be isolated.

The Vermont RCWP utilized a paired watershed study to demonstrate the detrimental effects of manure spreading in winter due to increased phosphorus losses in runoff.

**Lesson:** Consistency and uniformity in data collection, analysis and reporting over the project timeframe are essential for detecting water quality trends and associating them with implemented BMPs.

**Lesson:** Monitoring timeframes to assess water quality response to land treatment BMP implementation should account for type of water resource, location and climatic variability. Short-term monitoring is seldom effective because climatic and hydrologic variability can mask water quality changes.

Utah RCWP results indicate significant water quality response in drainage ditches and Snake Creek from animal waste management systems over a relatively short five-year data collection period. These results may be attributed to a small watershed (700 acres) with few pollutant sources that have been identified and treated.

Water quality response in large watersheds and lakes has been slower generally due to longer hydraulic residence times and recycling of pollutants. These factors constitute a buffering effect, essentially a time lag between initial impact and observed effect.

**Lesson:** Location of the water quality monitoring stations must complement BMP implementation if the objective is to associate BMPs with water quality changes.

The Wisconsin RCWP has found that the site selection for its monitoring station was inappropriate because the station is influenced by pollution sources outside the project area.

The Michigan, Vermont, Idaho, Utah, Virginia and Florida RCWPs have found that monitoring subbasins within the overall project area is a more effective strategy than monitoring only at the watershed outlet. Water quality changes are more likey to be observed at the subbasin level closer to land treatment areas where the confounding effects of external factors, other pollution sources, and scattered BMP implementation are minimized. It is still important to locate monitoring stations at the watershed outlet to document changes occurring at the watershed level.

**Lesson:** Monitoring of biological and habitat variables may be appropriate for NPS control projects.

Four projects (Idaho, Vermont, Wisconsin, Nebraska) have used extensive monitoring of biological and habitat variables as indices of water quality. Idaho has measured improvements in stream habitat and aquatic life. Nebraska and Wisconsin have pre-treatment data and will need a post-treatment data set for comparison. Preliminary analysis of biological data from the Vermont RCWP indicates a different interpretation of water quality changes compared to chemical data. Project personnel acknowledge that much work needs to be done to develop meaningful biological indices.

The Idaho project has measured increased trout numbers and size in Rock Creek since the RCWP began. These results have been used successfully to stimulate public interest in the project.

## Effectiveness of Best Management Practices

**Lesson:** BMP implementation and effectiveness are site specific depending on pollutants of concern, water resource, and use impairment. Approval of the BMPs or BMP modifications in voluntary programs should be based on their effectiveness for addressing the designated water quality problem and acceptability to farm operators.

**Lesson:** Projects that meet the following criteria are most likely to provide information on BMP effectiveness (see also Chapter Two):

BMPs were selected and implemented based on water quality problems and geographic location.

BMP implementation and land use are monitored closely such that this information can be paired with water quality monitoring data. Implementation data should include timing and location of all practice components.

An appropriate water quality monitoring design (e.g. sampling location, frequency, pollutants and other variables measured) is used. Design is dependent on water quality goals (e.g. documentation of BMP effectiveness, trend detection), variability in the water quality monitoring data, and selected statistical tests.

An appropriate data analysis method is employed that addresses water quality goals in the context of project conditions.

**Lesson:** Meteorologic conditions and other factors beyond control by human activities have an impact on BMP effectiveness.

Variability in annual rainfall can affect a project's effort to monitor BMP effectiveness. Because NPS pollution is generated mostly during storm events, the effectiveness of BMPs may appear to be deceptively large from monitoring in a year with few storms or low rainfall.

Irrigation canals and small streams with low hydraulic residence times have shown water quality improvements within a relatively short timeframe compared to lakes and rivers. While irrigation canals in the Idaho project may be "cleaner" than before RCWP, the impaired waterbody, Rock Creek, has been slower to show water quality improvement. Rock Creek is still prone to NPS pollution from runoff events, especially in spring.

**Lesson:** Soil characteristics can mask water quality improvements.

In the Illinois RCWP, fine colloidal sediment originating from natric soils on the watershed critical areas is remaining in suspension causing turbidity problems in a lake. Although BMP implementation controlled most of the large sediment particles reaching the lake, the fine particles still cause turbidity. The fine sediment fraction is difficult to control with BMPs and a significant amount of NPS pollutants may be associated with this fraction.

**Lesson:** Nutrients and agricultural chemicals in solution or attached to fine sediment particles can cause water quality problems independent of the volume of gross erosion. The amount of applied nutrients and chemicals that reach a water body may be more a function of runoff or fine sediment loss than total soil loss.

**Lesson:** Soil loss is not equivalent to sediment delivered to an impaired water body. Sediment delivery is a function of distance to water body, transport mechanisms, and relative percentages of sand, silt and clay fractions.

**Lesson:** If phosphorus and fecal coliform bacteria are the cause of water quality problems in an agricultural watershed, dairies and other livestock operations should be targeted as first-priority for land treatment.

Implementation of BMPs, fencing, water management, and animal waste management on dairies in the Florida Taylor Creek-Nubbin Slough RCWP has significantly reduced phosphorus concentration in water entering Lake Okeechobee.

The Oregon RCWP documented a 40-50% reduction in mean fecal coliform concentration attributed to treating 60% of the animal waste from dairies with BMPs.

The Utah RCWP documented significant reductions in phosphorus and nitrogen concentrations and fecal coliform bacteria levels as a result of improved animal waste management. This project has a small area (700 acres) with 4 dairies and 4 beef feedlots, all targeted for treatment with 100% of treatment goals obtained.

The Alabama project has learned that treatment of a few key animal operations is an effective strategy for reversing a water use impairment caused by fecal coliform bacteria.

**Lesson:** The effectiveness of structural practices such as animal waste storage structures, sediment basins, terraces, and improved irrigation systems can be enhanced by water quality-oriented management practices such as conservation tillage and nutrient management.

Sediment and phosphorus concentration in return flows from irrigated land in the Rock Creek RCWP, Idaho have been significantly reduced by water management and sediment control BMPs coupled with conservation tillage.

Sediment and phosphorus loadings have been reduced in Delaware by animal waste management systems (manure holding structures), conservation tillage, vegetative cover on critical areas, and fertilizer management in the Appoquinimink River RCWP.

Sedimentation of Prairie Rose Lake, an important Iowa recreational lake, has been reduced by implementing terraces and conservation tillage in the Prairie Rose Lake RCWP.

**Lesson:** Conservation tillage, and other forms of surface runoff reduction practices, generally increase the concentration of dissolved nutrients and pesticides in runoff and may increase leaching of nitrate and pesticides to ground water. Therefore, it is especially important to incorporate nutrient and pesticide management with surface runoff reduction practices to avoid over-application of nutrients and pesticides.

The Pennsylvania RCWP found that nutrient management can reduce transport of nitrate-nitrogen to both ground and surface water. Project results suggest that terraces, while effective in reducing sediment loading to surface water, may increase nitrate-nitrogen transport to ground water. A sesonal trend of increasing nitrate-nitrogen concentrations has been observed at a field site monitoring well located down-gradient of four terraces. The project feels that the pooling and controlled discharge of rainfall promoted by the terraces provides more time for leaching of nutrients. This along with variation in manure application rates is viewed as a possible cause of increasing nitrate-nitrogen concentrations.

The South Dakota RCWP has found that soil macropores are a significant pathway for nutrient and pesticide transport to ground water. Therefore, management practices that minimize the amount of excess nutrients and pesticides available for infiltration are essential.

**Lesson:** Nutrient management likely will not cause an immediate reduction in nutrient concentrations in ground and surface waters. The soil acts as a buffer, releasing nitrate-nitrogen to ground water on a continual basis. Also, a significant amount of nutrients can accumulate in stream and lake bottom sediments such that the effect of nutrient management is offset by existing high levels of nutrients.

## Economic Efficiency

**Lesson:** Economic efficiency requires that costs be kept in line with benefits and that the most cost-effective BMPs be utilized.

**Lesson:** From the viewpoint of public expenditure, management practices such as nutrient management, pesticide management, water management, and conservation tillage are more cost effective than structural practices in the long-term. These practices must offer an economic advantage to the farmer if they are to be maintained long-term.

**Lesson:** Conservation tillage and vegetative cover have been shown generally to be more cost effective practices than sediment retention structures for reducing sediment and nutrient losses.

The Idaho RCWP has documented reduction in sediment concentration in irrigation canals associated with structural practices (sediment basins, I-slots), but now the project is promoting conservation tillage as the preferred BMP because conservation tillage does not have the high maintenance costs associated with structural devices. Idaho found no-till practices reduce soil losses by 80% or more and minimum tillage reduce losses by 60 to 85% at the edge of field.

Illinois RCWP found conservation tillage to be the most cost effective method for reducing delivery of pollutants to Highland Silver Lake. Conservation tillage costs were $14-33 per ton of sediment controlled and $7-17 per pound of phosphorus controlled in lake (see project profile).

In the South Dakota RCWP, nutrient management including split application and injection of nutrients would be a very cost effective addition to soil testing and applying recommended amounts of fertilizer.

**Lesson:** Economic benefits depend on more than just water quality improvement or deterioration prevented. Economic benefits depend primarily on changes in water use and the number of users affected. Recreation is generally the highest value public use and projects successfully addressing impaired recreation can show high benefits.

The Vermont project can show economic benefits for many people in terms of recreational enhancement of St. Albans Bay. This makes the NPS project more cost effective in terms of public expenditure.

The Illinois RCWP found that the documented rate of sedimentation did not threaten use of Highland Silver Lake for domestic water supply. Potential benefits from reversal of recreational use impairments are diminished by limitations on contact recreation activities, boat motor size and access facilities. On-farm benefits have been positive, but these represent a majority of the total project benefits and are not expected to approach the costs of the project.

The South Dakota RCWP projected high potential benefits from reversal of recreational use impairments (swimming, boating, fishing), however, it may not realize these benefits because of insufficient surface water quality improvement.

The Utah project is a successful demonstration of NPS control at the project level. Benefits from this small project area include its use as a model that encourages farmer participation and public support in the watershed and across the state.

# Chapter Two

## Relating Water Quality Data to Land Treatment: Progress Reporting and Information Needs

Annually since 1982 NWQEP has reviewed the RCWP progress reports. In conducting our 1987 RCWP progress report reviews we have developed a series of reporting recommendations that may be useful to NPS control projects. Below are recommendations to other water quality projects on how to establish useful and readable progress reports. Part I is general reporting recommendations for land treatment and water quality monitoring results. Part II focuses on information needs, monitoring, and statistical approaches for relating water quality data to land treatment.

### PART I: NPS PROJECT PROGRESS REPORTING

### General Recommendations

Progress report writers should keep in mind that some readers have no knowledge of the project objectives, approach, or previous accomplishments, while others may be quite familiar with these topics. Primary documentation such as the Plan of Work or the first progress report should contain a thorough presentation of the project background and documentation of water quality problems. Later reports only require a concise description of the project area and the water quality problem if there are precise references to the earlier documents.

- Include a Table of Contents.
- Present annual project highlights and new information in an Executive Summary.
- Update existing background information to establish correct documentation on water quality problems.
- Provide interpretation of project results through reporting findings and observations.
- Include an abstract. The abstract can be located just after the cover page or just after the Table of Contents. It is a very concise summary of the report which can be used by abstracting services or others compiling literature references.
- Sections for acknowledgements and literature cited should always be included.
- The report should always have the author(s) listed. It is often very difficult to track reports without authors.

## Land Treatment and Land Use

As many RCWP projects have discovered during the BMP implementation phase, consistent and accurate reporting of location, type and maintenance of land treatment can be very difficult but is necessary. Standard report forms provide baseline information on program developments overall in a consistent manner; however, forms seldom tell the whole story. Therefore, they must be supplemented to describe the unique aspects of land treatment in each project.

The framework presented below is based on procedures for land treatment/use reporting used by RCWP projects. Some of the problems encountered in using land treatment/use data to assess water quality impacts of RCWP projects are addressed.

### Objectives

The water quality analyst seeks to answer these main questions:

- Do BMPs affect the magnitude of pollutant sources?
- How much reduction of pollutant loading to the water resource is possible from BMPs?
- Will BMPs improve the quality of the receiving water body?

To answer these questions, the analyst needs to know the location and extent of practices, and the timing of their installation and period of effect.

### Location of Treatment

Is the practice in the critical area – completely, partially or not at all? What subbasin is it in? Report the location of the practice, the sources treated, and the impaired resource[1] effected. Identify the water quality monitoring station(s) associated with the subbasin in which the practice was implemented. For example, an *annual* summary chart for each subbasin could look like the one shown in Table 1.

### Extent of Treatment

The extent of land treatment can be tracked as: acres treated, number or units of practice installed, portion of critical pollutant loads treated with BMPs, or complete or partial Resource Management Systems (RMSs). Basic reporting should specify the total number of acres treated in each project year, counting acres with more than one practice only once. Total acres treated provides a good approximation of the extent of land treatment that can be related to water quality data over time.

1 Information about the water resource of concern can be accessed using the U.S. EPA's Waterbody System (U.S.EPA, 1987). This system is a national computer database containing a geographically based framework for entering, tracking, and reporting information on the quality of individual waterbodies as defined by each state. The Waterbody System was developed to support reporting requirements as defined in Section 305(b) of the Clean Water Act (state biennial reports to U.S.EPA describing quality of navigable waters) and to fulfill new reporting requirements under the 1987 Water Quality Act.

TABLE 1. BMP Implementation Data: Year ___
Subbasin #___ Monitoring Station #___

Total Area of Subbasin ___acres
Critical Area of Subbasin ___acres
Critical Sources (animal operations) in Subbasin ___operations

| RCWP BMP No. | Total Units Treated | Units Treated in Critical Area | Primary Pollutants Treated | Critical Acres Treated |
|---|---|---|---|---|
| 2 Animal Waste Management | 5 systems | 5 systems | N, P, FC | 300 acres * |
| 12 Sediment Retention Structure | 3 sediment basins | 3 sediment basins | sediment, P | 250 acres ** |
| 16 Pesticide Management | 500 acres | 300 acres | pesticides | 300 acres *** |

*receiving better manure management
**reducing sediment load to stream
*** reduced pesticide application associated with IPM scouting

*Acres treated* means the number of source acres that are treated by best management practices. Note that acres treated does not mean acres benefited because those benefited may be off-site; acres treated also may not be actual acres implemented because the number of actual acres occupied by certain practices, like grass waterways, does not reveal the size of the field they protect.

*Annual BMPs implemented* on the same acres over time should not be counted multiple times for a cumulative implementation total. This is particularly troublesome where annual BMPs are implemented on the same acres. For instance, conservation tillage implemented on the same 10,000 acres over three years should be reported as 10,000 (not 30,000) acres treated each year.

*Practices installed* accounts for individual practices, acres treated or number, even if they overlap. Different BMPs may be selected to control different pollutants; therefore, it is helpful to track some practices separately and list the pollutants that each practice addresses.

*Estimation of pollutant load reduction* associated with each practice may be desirable. Pollutant load reduction should be calculated for both on- site and off-site locations if possible. A reduction in the magnitude of pollutant source is an on-site reduction. In addition, to calculate an off- site (e.g. subbasin outlet, project area outlet, watershed outlet, impaired water resource) reduction requires the estimated pollutant delivery ratio for the specified sampling points. An indication of error associated with these estimated values should be given. Inclusion in Table 1 is optional based on the availability of information.

Designating *systems of practices*, two or more practices implemented on the same acreage, is important because the effect of individual practices may be complementary, resulting in a greater water quality impact than any one practice for the targeted pollutant. Also, practices may have benefits for controlling other pollutants in addition to their targeted pollutant. Reporting should specify which pollutants the systems are believed to be controlling.

### Timing of BMP Implementation

Implementation data should be reported on an *annual* basis so they will be compatible with water quality monitoring data. Note that for practices expected to have a dramatic impact on water quality (e.g. construction of an animal waste lagoon, fencing) the specific dates of implementation should be reported.

Information on the timing of practice implementation and maintenance is needed to evaluate when the BMPs start *working* to protect water quality and when they stop working. Reporting should include information on the estimated time for a practice to stabilize, i.e. have a water quality benefit. The effective life of a practice should be documented. Table 1 is suggested reporting for annual information. Supporting discussion should be included in the text to cover situations when the effective life of a practice is less than one year (e.g. "T" slots for sediment control) or when implementation occurs within a year. If landowners choose to continue the practices after their initial contract expires, this should be indicated in a project's land treatment records.

### Changes in Land Use

All changes in land use need to be reported, not just BMP implementation. Land use changes such as conversion of row crops to pasture, changes in herd size or poultry flocks, closure of animal operations, implementation of the Conservation Reserve Program, non-contract soil and water conservation efforts, etc., may mask the changes in water quality due to land treatment. Specific dates for major changes, such as large changes in herd size, dairy closures, or acreage set aside should be reported.

### Other

Accuracy of the land use and BMP data should be evaluated and reported. Errors can be introduced by: lack of specific dates and location of land use changes (e.g. manure spreading) in relation to water quality monitoring dates and sites; lack of knowledge about maintenance of BMPs; lack of knowledge of efficiency of practices; lack of quantification of relative performance of the same practice in different physiographic settings.

Consider the accuracy and precision of both the land treatment/land use data and the water quality monitoring data when analyzing for cause-effect relationships. Consider the variability in the water quality data and the land treatment data and document the spatial and temporal orientation of land treatment and water quality observations. The record should indicate the time between runoff events and land use or land treatment activities.

It is understood that much of this information is difficult to obtain and the information needs are different for each project. The appropriate information should be gathered with this objective in mind: quantitative analysis to document the association between land treatment/use changes and water quality changes.

## Water Quality Monitoring

Changes in the water quality monitoring program should be avoided unless absolutely necessary. If changes are unavoidable describe them in detail in the progress report.

In each presentation of water quality data analysis include a recap of all previous years' results for comparison and consider the following aspects:

- Specify the water pollutants and use impairments associated with each monitoring site.
- Describe and quantify the sources of pollution affecting each monitoring site.
- Provide annual data on land use, land treatment, and topographic factors. The best presentation of this information is by subwatershed so that it can be associated with a monitoring station or specific hydrology-based unit.
- Provide pertinent hydrologic and meteorologic data for each water quality sample. For example, report precipitation data, groundwater level, or stream flow associated with each sampling observation. Other parameters might include salinity, depth, flow rate, etc.
- The primary flow and concentration data should be reported with loading estimates if they are based on grab sampling.
- Identify STORET station numbers if available or latitude- longitude.
- Specify what statistical techniques were used in data analysis.
- Include a detailed map of monitoring station locations and land treatment within the associated subwatershed.
- All water quality monitoring methods should be described in detail. Any new or innovative methods or techniques should be described and illustrated if appropriate.
- Quality assurance should be discussed in each report. Methods for accuracy and precision determination should be described in detail. Include discussion of the significance of the findings in appropriate Results and Discussion sections.
- Discuss the relationships between the BMPs implemented on the land and water quality monitoring results. Even if these relationships are not completely known or understood, it may give others useful ideas.

# PART II: RELATING WATER QUALITY DATA TO LAND TREATMENT: INFORMATION NEEDS

This part addresses questions concerning information needs in nonpoint source projects. This discussion was written with primary consideration given to chemical and physical surface water quality monitoring, however, most of the following concepts are also applicable to biological, habitat, and ground water monitoring. Special considerations for the latter are not addressed in this chapter. Two major themes are:

- How do you coordinate the acquisition of land treatment information and water quality monitoring data?
- How does one link land treatment information and water quality information?

## Monitoring Objectives and Methodologies, and Statistical Approaches to Monitoring

The *objectives* of the study dictate the type of water quality monitoring data and land treatment/use data one needs to obtain and, therefore, the required monitoring design. Most RCWP projects established their designs some time ago and now are completing their collection and analysis phases.

One of the RCWP objectives is to determine the role of monitoring water quality and land treatment simultaneously to determine if water quality changes can be documented and associated with changes in land treatment. More specifically, can the effectiveness of nonpoint source pollution control practices be documented at the project level, the watershed level or at the subwatershed level.

The next few years may be the most crucial period in the RCWP program to attain this objective because the post-BMP water quality and land treatment data are now just being collected. At least 2-3 years of post-BMP information is needed to analyze these data.

Quality control of water quality data and land treatment data is important when documenting changes in either, but especially if one is going to link them to examine their associations.

### Monitoring NonPoint Sources (Agricultural) vs. Point Sources

Monitoring NPS pollution may require a monitoring design with different characteristics compared to monitoring point sources.

The type and number of parameters measured with agricultural NPS monitoring are a function of the source and water use impairment. The parameters of concern may be sediment, phosphorus, nitrogen, fecal coliform, BOD, pesticides, or the degradation products of known pesticides. Good definition of the impairments and sources will allow monitoring for only a subset of these pollutants. Except for pesticides, most agricultural nonpoint source pollutants are naturally occurring and only harmful when found in excess. In fact, most are essential in some quantities to support biota in the water resources.

Point source pollutants are also a function of the source. If the source is well defined, e.g. a known chemical or processing plant, the number of measured parameters may be small. However, many point sources such as sewage treatment plants may contain many pollutants, some of which are unknown, and the required number of pollutants to monitor may be large. In addition, many of the pollutants from point sources may be toxic to the aquatic ecosystem.

For point sources, when stream flow increases, concentrations of pollutants usually decrease due to a dilution effect. However, with nonpoint source pollution, the relationship of pollutant concentrations and increasing stream flow or storm discharge is usually positive. When stream flow increases, pollutant concentrations increase.

Both point and nonpoint pollutant concentrations are affected by stream flow and in-stream processes, however, with nonpoint sources the concentration-hydrograph is further complicated by runoff and transport mechanisms. The flow vs. concentration pattern for nonpoint sources is not equivalent for each pollutant; the peak concentrations of the particulate and soluble pollutants occur during different parts of the hydrograph because concentration-hydrograph response is a function of both stream flow and the runoff and transport mechanisms. Usually, point source pollutant concentrations vary similarly because dilution is the primary determinant of concentrations.

The location of monitoring stations and the frequency and duration of sampling may be different for point and nonpoint sources. Point sources may be easier to monitor because location and sources can be identified more precisely than nonpoint sources. Nonpoint sources are more difficult to identify and quantify due to several spatial inputs, and more monitoring stations may be needed because sources are spatially diffuse instead of originating at a defined point.

Variability in water quality data can be a significant problem in evaluating both point and nonpoint sources. Point sources can vary with industrial processes, time of day, and day of week. Nonpoint sources usually exhibit high variability due to large fluctuations in hydrologic and meteorologic processes. For point sources, a short duration of monitoring above and below the source may be sufficient to determine the magnitude of a problem. Also, point source effluent is monitored directly for permit compliance. For nonpoint sources, longer periods of monitoring may be required to determine the magnitude of the problem. This is especially true at the watershed level where system variability is high. More than one year of monitoring may be required to assess the magnitude of a problem, and trend determination requires far longer timeframes.

The frequency of both nonpoint source and point source monitoring is a function of objective. Concentration measurements for trend analysis or assessment of standards violations require fewer samples than load calculation.

Due to the spatially diffuse nature of nonpoint sources, measuring NPS pollutants at the monitoring station is not constant and may involve a longer lag time compared to point sources. Lag time refers to the time elapsed during pollutant origination and pollutant detection at the monitoring station. Lag time at the monitoring station is a function of the distance to the monitoring point (e.g. tributary, lake), magnitude of the source, volume of drainage or runoff, and pre-existing soil and land use conditions before a runoff event.

In-stream processes affect the fate and transport of both point and nonpoint source pollutants. Water resources tend toward quasi-equilibriums maintained by these processes. For example, decreasing the delivery of sediment to a stream using NPS controls may not decrease the sediment concentration measured at a downstream monitoring station. Stream flow may pick up sediment that was deposited earlier on the stream bed or may scour the banks. The pollutants may be assimilated, adsorbed to soil, or degraded before reaching the monitoring station en route from the source. The influence of in-stream processes increases as distance from the source to the monitoring station increases.

### Study Planning

The study and monitoring objectives determine which pollutants to monitor, location of monitoring stations, frequency of sampling, length of monitoring, methods of monitoring, analytical methods, and the statistical methods that appropriately match these objectives. Study planning should also include selection and evaluation of statistical tests to determine if the design and sample number are sufficient to detect a water quality problem and/or trend. Water quality data for this preliminary evaluation can be obtained from prior studies at the same location or similar locations.

The level of funding for water quality monitoring in RCWP projects varied widely. Funding for monitoring is an important consideration when selecting objectives and appropriate monitoring strategies.

Possible *objectives* for monitoring nonpoint sources include:

- Baseline monitoring to establish current conditions (concentration, variance, etc) under base flow or storm flow on an event basis over seasonal or annual timeframes. This can be used to estimate the magnitude of a problem and/or as a baseline for trend analysis.
- Document a problem or identify major pollutant sources.
- Determine the fate and transport of pollutants.
- Define critical source areas.
- Monitor effectiveness of BMPs (e.g. RCWP water quality monitoring).
- Identify and quantify trends of pollutant concentrations or loads over time.
- Obtain input parameters for models, or obtain data for model calibration and/or verification.

To *detect trends over time* as influenced by BMP implementation to control nonpoint sources on a watershed scale, considerations include:

- What is the measured change in pollutant loads or concentration that will be needed to document a real change in the water resource? Watershed systems are highly variable and require as much as 40 to 60 percent reduction in concentrations over 6 to 10 years before statistical trend tests will indicate the change is real.
- What is the land treatment required?
- What is an appropriate monitoring scheme to detect such changes?

The *location* of monitoring depends on:

- *Type of study,* e.g. source documentation, loading estimates, trend detection, compliance.
- *Study objective,* e.g. measure only the impaired water resource and/or the inputs or tributaries to the resource. If pollutant source identification is an objective, field or subwatershed level monitoring is usually required.
- *System type,* e.g. fields, streams, rivers, lakes, ground water, etc.
- *Scale* of the water resource and watershed, e.g. field level vs. watershed level, stream vs. lake.
- *Monitoring station characteristics,* e.g. hydrology, flow gaging record.
- *Stratified system,* e.g. vertical strata in lake sampling, horizontal strata in stream sampling. Consider natural strata and the flow of water and associated pollutants from side streams into larger streams and lakes.

The *frequency* of monitoring is a function of:

- *Study objectives,* e.g. to examine frequency of standards violations, enough samples must be collected to determine probability of exceedence in the specified high or low runoff conditions. Trend detection in concentration, on the other hand, may require regular grab sampling over a long period of time. However, loading and transport mechanism studies generally require continuous sampling using automatic samplers.
- *System type,* e.g. monitor only during periods of the year when runoff occurs. A complex and changing system may require more frequent sampling to capture the true concentrations/loads over time.
- *System variability,* e.g. the greater the variability due to storms, season, runoff events, the more frequently sampling is required.

The *length of monitoring* is a function of the goals and objectives of the study:

- Short-term monitoring can be sufficient for: complaint investigations, source identification, standards violations, establishing guidelines.
- Long-term monitoring may be required for: planning and policy decisions, trend detection, BMP effectiveness or land use effects on water quality, quantification of the response time and mechanisms in the system. Watershed level monitoring may require a longer period of monitoring than field level. Land treatment effects demonstrated at a field level study may not be documented in a watershed level study in the same timeframe.

To compare monitoring data over time, a consistent sampling protocol should be followed. The *types of sampling methods* **include:**

- Grab samples. This is low cost and can be used to compare concentrations over time. They are usually not sufficient for loading calculations.
- Depth and/or cross section integrated samples may be necessary to account for stratification or other inhomogeneities.
- Flow weighted composite sampling.
- Time weighted composite sampling.

The *types of watershed monitoring designs* that can be effective for monitoring BMP effectiveness include:

- *Paired watershed.* This design consists of monitoring downstream from two or more agricultural drainages where at least one drainage has BMP implementation and at least one does not. The paired drainages must have similar precipitation patterns. Ideally, this design has the following characteristics: a) simultaneous monitoring below each drainage; b) monitoring at all sites prior to any land treatment (calibration period) to establish the relative responses of the drainages; and c) subsequent monitoring where at least one drainage area continues to serve as a control through the land treatment period, i.e. receives significantly less land treatment than the other drainage areas. The calibration period is generally 1-3 years depending on the consistency across basins of magnitude and direction of water quality monitoring data with respect to changes in hydrology and climate. An equally valid use of the paired watershed design could be the following: monitor treated and untreated basins for 2-3 years, then treat the untreated basin and continue monitoring for 2-3 years.
- Single watershed using a *before-after* monitoring scheme where monitoring is performed for 2-3 years Pre-BMP and 2-3 years Post-BMP implementation. Year-to-year variability in water quality parameter concentrations/loads is often greater than the BMP induced change in water quality in any given year or season; longer monitoring periods (pre- and post- BMP) are needed to account for year-to-year variability.

- Single watershed monitoring *above and below* the pollutant sources. Monitoring above a site can be used to correct for varying incoming pollutant sources not related to the changes in land treatment in the study area. Varying levels of consumptive use between monitoring points, however, may make interpretation difficult. This technique is applicable to point source monitoring and may also be useful in nonpoint source monitoring where a high correlation exists between concentrations of the pollutant over time measured at the monitoring sites above and below BMP implementation.

- Comparison of two watersheds with no control, i.e. both watersheds have BMP implementation over the same timeframe. This is usually not effective for relating water quality data to land treatment because there is no control and the relative response of each watershed over time is not known. Therefore, comparisons made may be due to the BMPs or due to other artifacts or variabilities in the two watersheds.

- Comparison of multiple watersheds. This may be more useful when comparing similar subwatersheds, especially when combined with the *before-after* and/or the *above-below* designs.

- Nested watersheds, i.e. subwatershed within watershed. The nested subwatershed can be treated and its outlet monitored for comparison with monitoring data from the outlet of the entire watershed. The control area is represented by water quality data monitored at the watershed outlet if the land use outside the nested subwatershed remains unchanged. The treated area is represented by the water quality data from the nested subwatershed outlet. Calibration (before) and treatment (after) periods are required.

## Specific Types of Data to Collect

Hydrologic systems are highly variable. To detect a real change in water quality, one must account for as much of the source of this variability as possible. This is essential not only for determining statistically significant trends, but also for determining the *magnitude* and *direction* of the trends. There may be unidentified or unmeasured variables in the system (e.g. flow, precipitation, ground water level) that distort the conclusion of the analyses, or yield highly variable data from which no conclusions can be drawn. Water quality measurements are a function of land use, hydrologic, meteorologic, and topographic factors. It is important to measure as much information about these factors as possible with every water quality sample. Accounting for some of the system variability by these factors will help detect real changes in water quality over time. These include the changes in land use, not just the ones related to the planned experiment or cost share programs.

At minimum, to detect changes in water quality over time and associate them with land treatment/use changes, the data required include:

- The concentration of identified water pollutants. These water pollutants should be associated with a use impairment in the water resource.

- Hydrologic/meteorologic and related chemical parameter variables, e.g. flow, precipitation, ground water depth, salinity, conductivity, DO, temperature, pH.

- Land treatment (cost shared and non-cost shared) and land use on a subwatershed-season basis relative to the water quality monitoring stations. Land use data includes set aside acreage, Conservation Reserve Program, changing herd size, closure of animal operations, or implementation of non-contracted soil and water conservation efforts. Contracting data alone do not reflect treatment actually installed, therefore, information on actual land use and any land use changes is needed. These data should reflect changes over time including adequate pre-BMP information.

The water quality analyst seeks to match up the water quality data, the land treatment data, the hydrologic data and other land use data. A paired relationship is best, but that may not be possible. You may have ten or more grab samples in a season, requiring assumptions to quantify the land use associated with the water quality monitoring data. The land use data is presented best on a *subwatershed* basis in terms of the monitoring station for the subwatershed.

## Some Considerations About Data Requirements and Statistical Tests

### Association vs. Cause and Effect

A trend in the water quality data that is associated with BMPs does NOT alone document a cause-effect link between BMPs and water quality.

A *controlled experiment* is the only way to confirm cause-effect relationships. Controlled refers to eliminating or accounting for all the factors that may affect the response to the treatment so the treatment effect alone can be isolated. Usually this control is obtained by subjecting the entire system to the same conditions, varying only the treatment variable and selecting replicates at random to assure that unmeasured sources of variability do not affect the interpretation. Ideally, in a watershed study, this includes an experiment with both treated and non- treated areas, repetitions, and each treatment being monitored for several years.

Except for projects that have *paired watershed design*, this is not generally being done in the RCWP. A controlled experiment can be performed at the plot level but is very difficult to obtain on a watershed level due to the limited resources and project goals calling for BMP implementation in all critical areas. However, the RCWP offers many watersheds where analyses of the land and water quality data can show strong *associations* between land use changes and water quality changes. These studies have important implications for demonstrating BMP effectiveness on a watershed scale.

Associations can be defined as a change in water quality that is correlated to a change in land use, specifically BMP implementation. Association is necessary but, by itself, is not sufficient to infer causal relationships. There may be other factors not related to the BMPs causing the changes in water quality such as changes in land use, rainfall patterns, etc. However, if the association is *consistent*, *responsive*, and has a *mechanistic* basis then causality may be supported (Mosteller and Tukey, 1977). *Consistency* means that the relationship between the variables holds in each data set in direction and amount. The data sets in RCWP include different subwatersheds, multiple years, and multiple stations. *Responsiveness* means that one variable will change accordingly if the other variable is changed in a known, experimental manner. *Mechanism* refers to the step-by-step path from cause to effect with the ability to make physical linkages at each step.

## Possible Statistical Tests to Link Water Quality and Land Use

*Regression:*

Regression is a statistical technique whereby a dependent variable (Y) is regressed against independent variables (Xs) to determine the extent of association that different Xs have with Y. This includes multiple regression, analysis of covariance, multivariate regression, and time series analyses. In agricultural NPS research, multiple regression can be used to determine the extent to which the value of a water quality parameter (dependent variable, Y) is influenced by land use or hydrologic factors (independent variables, Xs) such as crop type, soil type, percentage of BMP coverage, type of BMPs, amount of rainfall, or time. A regression model is used to test the significance of the correlation between land treatment/water quality variables.

Analysis-of-covariance combines the feature of analysis-of-variance with regression. Analysis of covariance is used to test the significance of the difference in mean values of a variable between levels of a group variable (e.g. years, seasons) after adjusting for the effect of other correlated variables (covariates). For RCWP water quality monitoring data, the mean values of the pollutant of concern can be compared over years after correcting for covariates such as precipitation, land use changes, and land treatment variables. If the land treatment variables explain a significant amount of the annual variation in the pollutant after correction for known changes in the system (e.g. precipitation, other land use changes), there is supporting evidence that land treatment may be associated with water quality change.

Another example of an analysis-of-covariance technique is the paired watershed analysis. The paired watershed approach is described under "Types of Watershed Monitoring Designs" (p. 23). Pollutant concentration pairs are plotted with the treatment basin values on the Y-axis and the control basin values on the X-axis. The concentration means for the calibration and treatment periods are compared for differences. In addition, the slopes of the pollutant concentrations plotted for both periods are tested for homogeneity. A change in slope and/or mean value indicates that pollutant concentrations for the treatment watershed exhibited different patterns, or magnitude, after BMPs were applied as compared to the pre-BMP (or calibration) period.

Multivariate regression models have several dependent variables (Ys). Multivariate analyses are used to examine the extent to which different data populations overlap or diverge. Also, these analyses are used to include the relationships between the dependent variables in simultaneous analyses. An application might be to examine the effect of different BMP implementation programs on several water quality parameters.

Time series is a sequence of values in order of occurrence that can be characterized by statistical distribution properties. Time series analyses can account for autocorrelation in the residuals in a regression analysis and may be required to remove autocorrelation in the observations. Autocorrelation is defined as the correlation of neighboring values in a time series. If autocorrelation exists and a correction factor is not added to the regression model, interpretations of the significance of the regression independent variables will be incorrect. Time series analysis can also remove seasonal fluctuations in the data. A time series which consists of a dependent variable (Y) can be regressed on a transfer function (a time series of the independent variable, X) to show the effect on a system parameter ($Y_t$) from an input series ($X_t$).

*Double-mass curves:*

A double-mass curve is a plot of accumulative distribution of one variable against the accumulative distribution of another quantity during the same period. The plot will be a straight line if the data are proportional; the slope of the line represents the constant of proportionality between the quantities. A break in the slope of a double-mass curve means that a change in the constant of proportionality between the two variables has occurred (Searcy and Hardison, 1960).

Historically, this technique has been used to validate long precipitation series and detect local inconsistencies between rain gages (Chow, 1964; Dunne and Leopold, 1978). The records from a rain gage may not be representative due to change in location or exposure. The double-mass curve is a plot of the accumulated annual totals over years of the suspect gage vs. accumulated average annual totals from a representative group of nearby gages. Chow (1964) recommends at least 10 stations be used in the representative group and that the record of each of the station in the group be tested for consistency with the other stations by the double-mass curve method to assure homogeneity in the data. If a break in the slope can be related to changes in location of the gage, or other changes, then the annual precipitation records before the change can be adjusted to make them more consistent with recent records by multiplying the precipitation values by the ratio of the slopes of the two lines.

Chow (1964) and Dunne and Leopold (1978) caution that factors other than a change in gage catch may have caused a real change in precipitation. Chow (1964) recommends that at least 5 years of data be collected before a correction in the slope can be made and states that the double-mass curve technique is not recommended for correction of storm or daily rainfall amounts when data are missing.

The double-mass curve technique is being used by the Florida RCWP to compare phosphorus concentrations and cow numbers in subwatersheds over years. This allows for a visual inspection of the possible effect of BMPs on phosphorus after accounting for changes in cow numbers. A break in the curve would indicate a change in phosphorus concentrations due to some factor other than changes in cow numbers.

*Intervention analysis:*

This is a complicated name for a simple concept. An intervention is an identifiable change in the observed system that occurs over a short time period which is thought will have an influence on measured variables (Ys). Intervention analyses can be used with linear regression or time series models with the addition of explanatory (indicator or dummy) variables (X) whose value are 0 or 1. An example could be a term in the regression model, X, which changes from 0 to 1 when a dairy shuts down. Several exploratory variables can be used in the same model (Brockleband and Dickey, 1986).

*Principle component analysis:*

Principal component analysis is a multivariate technique for examining relationships among several quantitative variables. It can be used to reduce the number of variables in regression, clustering, etc. (SAS Institute Inc. 1985). Given a data set with *p* numeric variables, *p* principal components can be computed. Each principal component is a linear combination of the original variables. The end result is that each of the principal component vectors are statistically independent and therefore can each be used independently each with 1 degree of freedom.

Factor analysis is a type of principle component analysis. BIPLOT is one method to visually plot the linear associations of the variables determined from principle component analyses.

Principle component analyses can be used to determine the relative importance of each independent variable and determine the relationship among several variables. This technique can be used in regression when there are too many X variables which are highly correlated to each other, for example, multiple BMPs treating the same acres, precipitation, or stream flow.

*Cluster and discriminant analyses:*

Cluster analyses group variable and/or observations into similar categories. Discriminant analysis is one example where observations are placed into defined groups based on a classification variable. Cluster analyses can be used to understand and adjust for spatial heterogeneity of water quality parameters. This may be necessary to study the transport of a pollutant in a system or to remove the spatial component in order to detect changes over time.

## Some Concepts to Remember When Linking Water Quality Data With Land Use

- Monitor land use changes relative to monitoring stations. For example, on a subwatershed basis. This will allow for a pairing of water quality data with land use data.
- Year-to-year variability is so large that at least 2 -3 years each of both pre- and post-BMP water quality data is required to give an indication that the improvement in water quality is related (i.e. associated) to land use changes in a consistent manner.

- Seasonal effects may also be very large. This is due to seasonal land uses, seasonal climatic changes, and field conditions that change during a year.

- In designing the monitoring system and subsequent statistical methods to detect changes over time or differences between treatments, one needs to increase the precision of the statistical analysis by removing as much as possible from the error term and eliminating bias. Spatial or temporal variability and autocorrelation should be accounted for because they can increase either the error or the bias of the estimated parameters. Also, correction for as much of the data variability due to meteorologic and hydrologic variables will reduce the residual errors and improve the power of the tests. For example, information such as rainfall, ground water levels, and stream flow need to be paired with water quality samples.

- All changes in land use need to be monitored, not just BMPs, to help identify the water quality changes associated with BMPs alone. Land use changes such as conversion of row crops to pasture, acreage set aside, Conservation Reserve Program, changing in herd size or poultry flocks, closure of animal operations or implementation of non-contracted soil and water conservation efforts are important because they also affect water quality.

- Quantify land use and BMPs with units that can be paired with water quality data. Examples include: acres treated by each BMP with consideration for relative efficiency from overlapping BMPs, acres treated by the BMPs *systems* to minimize double counting of land with multiple BMPs, tons of manure spread, miles of fencing, acres served by fencing, pounds fertilizer applied, etc.

- Determine what errors are associated with the land use and water quality data. It has been stated that "the data are only as good as the least reliable factor". For example, if you monitor water quality daily but only monitor the land use monthly, the information gained will only be as good as the monthly mean or median of the water quality. This is more than just sampling once per month. The mean is composed of more than just one grab sample in one month. It is a best estimate of central tendency and is derived from a distribution of samples.

## References:


Brockleband, J.C. and D. Dickey. 1986. SAS System for Forecasting Time Series, 1986 Edition. SAS Institute Inc, Cary, North Carolina. 240 p.

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# Chapter Three

## RCWP PROJECT PROFILES

This chapter contains profiles of all RCWP projects. Each profile provides a summary of project characteristics and results, contributions to NPS control, lessons learned, a bibliography of project documents, and project contacts. The information is based on 1987 annual progress reports from RCWP projects.

Projects

Alabama – Lake Tholocco (RCWP 1)
Delaware – Appoquinimink River (RCWP 2)
Idaho – Rock Creek (RCWP 3)
Illinois – Highland Silver Lake (RCWP 4)
Iowa – Prairie Rose Lake (RCWP 5)
Kansas – Upper Wakarusa (RCWP 6)
Louisiana – Bayou Bonne Idee (RCWP 7)
Maryland – Double Pipe Creek (RCWP 8)
Michigan – Saline Valley (RCWP 9)
Tennessee/Kentucky – Reelfoot Lake (RCWP 10)
Utah – Snake Creek (RCWP 11)
Vermont – St. Albans Bay (RCWP 12)
Wisconsin – Lower Manitowoc River (RCWP 13)
Florida – Taylor Creek/Nubbin Slough (RCWP 14)
Florida – Lower Kissimmee River (RCWP 14A)
Massachusetts – Westport River (RCWP 15)
Minnesota – Garvin Brook (RCWP 16)
Nebraska – Long Pine Creek (RCWP 17)
Oregon – Tillamook Bay (RCWP 18)
Pennsylvania – Conestoga Headwaters (RCWP 19)
South Dakota – Oakwood Lakes - Poinsett (RCWP 20)
Virginia – Nansemond - Chuckatuck (RCWP 21)

# Lake Tholocco – RCWP 1

**Dale and Coffee Counties, Alabama**
**MLRA: P-133A**
**H.U.C. 031402-01**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

Voluntary farmer participation is possible even in an economically depressed agricultural area if practices are acceptable and there is enthusiastic one-on-one contact by local agricultural agency representatives.

Water quality monitoring indicates that fecal coliform concentrations can be reduced significantly by treating a few key animal operations.

## II. Water Quality Goals and Objectives

The primary goal for Lake Tholocco is to reduce the fecal coliform bacteria count to a sustained level that will allow whole body contact recreation. (The lake is closed to whole-body, water-contact recreation when fecal coliform level exceeds 200/ml.) The second major goal is to reduce the sediment load to the lake by reducing the average cropland erosion rate of 11 tons per acre to an average of 5 tons per acre.

## III. Characteristics and Results

1. **Project Type:** RCWP

2. **Timeframe:** 1980-1991

3. **Total Project Budget (for timeframe):**

| SOURCES: / ACTIVITY: | Federal | State | Farmer | Other[a] | SUM: |
|---|---|---|---|---|---|
| Cost-share | 1,409,448 | 0 | 563,780 | 0 | 1,973,228 |
| 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: | 1,839,324 | 10,000 | 563,780 | 180,934 | $2,594,038 |

[a] Soil & Water Conservation District, U.S. Army, Alabama Dept. of Environmental Management & U.S. Army Preventive Medicine Branch

4. **Area (acres):**

| Watershed | Project | Critical |
|---|---|---|
| 51,400 | 51,400 | 9,270 |

## 5. Land Use:

| Use | % Project Area | % Critical Area |
|---|---|---|
| cropland | 15 | 90[a] |
| pasture/range | 7 | NA |
| woodland | 55 | NA |
| urban/roads | 4 | NA |
| military reserve | 19 | NA |

[a] estimated — 10% of critical area land use is shared by other categories (gully erosion, unpaved roads and road ditch erosion)

## 6. Animal Operations in Project Area:

| Operation | # Farms | Total # Animals | Total A.U |
|---|---|---|---|
| Hogs | 20 | 4,000 | 1,200 |

## 7. Water Resource Type:

Lake Tholocco (600 acre impoundment) and tributary streams.

## 8. Water Uses and Impairments:

Lake Tholocco's designated uses are swimming, fishing and wildlife. Watershed streams have a fish and wildlife classification. 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.

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. Capacity of the lake is impaired by sediment, which also impairs boating and water-skiing.

## 9. Water Quality at Start of Project:

Fecal coliform densities often exceeded 200/100ml in Lake Tholocco and 5000/100ml in tributaries.

## 10. Meteorologic and Hydrogeologic Factors:

a. Mean Annual Precipitation: 55 inches
b. USLE 'R' Factor: 400
c. 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.

## 11. Water Quality Monitoring Program:

a. Timeframe: 1980-1990
b. Sampling Scheme: conducted by the Alabama Dept. of Environmental Management and the U.S. Army
   1. Location and number of monitoring stations: 7 lake stations and 9 tributary stations
   2. Sampling Frequency: biweekly summer, monthly other times
   3. Sample Type: grab
c. Pollutants Analyzed: suspended solids, turbidity, fecal coliform, total coliform, nitrate
d. Flow Measurements: began in 1983

**12. Critical Areas:**

a. Criteria:

- all confined animal systems without waste treatment measures installed
- sloping cropland without adequate water disposal systems
- pastureland adjacent to creeks eroding above tolerance
- woodland with gullying problems
- eroding roadbanks
- abandoned or active soil mining pits

b. Application of Criteria: The project has adhered to the critical area criteria in committing cost share funds.

**13. Best Management Practices:**

a. General Scheme: Treat nearly all cropland; fix gullies; treat hog operations near streams

b. Quantified Implementation Goals: 6,953 acres, 8 swine operations

c. Quantified Contracting/Implementation Achievements:

| Pollutant Sources | Critical Area Treatment Needs | Project Treatment Goals | % Needs / Goals Contracted | % Needs / Goals Installed |
|---|---|---|---|---|
| Acres Needing Treatment | 9,270 | 6,953 | 80 / 107 | 64 / 85 |
| Hog Farms | 11 | 8 | 64 / 88 | 64 / 88 |
| # Contracts | 115 | 96 | 83 / 99 | NA / NA |

d. Cost of BMPs:

| BMP | Ave. Farmer Share ($) | Ave. RCWP Share ($) | Total Cost ($) |
|---|---|---|---|
| 1 perm. veg. cover | 69/ac. | 128/ac. | 197/ac. |
| 2 animal waste mgmt. | 675 ea. | 12,800 ea. | 13,475 ea. |
| 4 terraces | 44/ac. | 176/ac. | 220/ac. |
| 5 diversions | 20/ac. | 79/ac. | 99/ac. |
| 6 grazing land prot. | 1,630 ea. | 4,900 ea. | 6,530 ea. |
| 7 waterways | 215/ac. | 870/ac. | 1,085/ac. |
| 8 cropland prot. | 56/ac. | 84/ac. | 140/ac. |
| 9 conservation tillage | 33/ac. | 97/ac. | 130/ac. |
| 10 stream prot. | 22/ac. | 90/ac. | 112/ac. |
| 11 perm. veg. cover | 80/ac. | 450/ac. | 530/ac. |
| 12 sediment retention, erosion control struc. | 440 ea. | 3,960 ea. | 4,400 ea. |
| 14 tree planting | 11/ac. | 33/ac. | 44/ac. |
| 16 pesticide mgmt. | 2/ac. | 6/ac. | 8/ac. |

e. Effectiveness of BMPs: Project estimates that sediment control BMPs have reduced average soil loss on critical acreage to 6 tons/year.

**14. Water Quality Changes:**

Annual mean fecal coliform counts observed in Lake Tholocco have not exceeded 200/100ml (the State standard) since 1982. Exceedances of the standard still occur in spring during high intensity rainfall events.

**15. Changes in Water Resource Use:**

There is no documented change in water resource use since RCWP began. There have been no lake closures due to high bacteria levels since 1980 and lake use has remained steady at approximately 100,000 user-days per year. Reduced sedimentation is thought to have protected boating and fishing areas from degradation.

**16. Incentives:**

a. Cost Share Rates: 75% for most practices
b. $ Limitations: $50,000
c. Assistance Programs: I&E activities. This project uses radio programs and newsletters to inform the public about conservation programs.

**17. Potential Economic Benefits:**

a. On-farm: not evaluated
b. Off-farm:
1) Recreation: $65,000 - $195,000 per year
2) Water Supply: 0 - $5,000 per year
3) Commercial Fishing: 0
4) Wildlife Habitat: unknown
5) Aesthetics: unknown but positive
6) Downstream Impacts: 0

## IV. Lessons Learned

This is an extremely economically depressed farming area with an average net farm income of only $6,400 in 1974. The success of the project in obtaining farmer participation shows that aggressive marketing by the local agricultural agency personnel combined with water quality plans that integrate on-farm concerns can work even under very economically depressed conditions.

## V. Project Documents

1. Lake Tholocco Rural Clean Water Project Application. Dale and Coffee Counties, Alabama. July 15, 1979. Alabama Rural Clean Water Coordinating Committee.

2. Water Quality Monitoring Report Lake Tholocco RCWP Project, Fiscal Year 1981. November 1981. Alabama Water Improvement Commission.

3. 1982 Annual Progress Report, Lake Tholocco Rural Clean Water Program.

4. Water Quality Monitoring Report Lake Tholocco RCWP Project, Fiscal Year 1982. November 1982. Alabama Department of Environmental Management.

5. 1983 Annual Progress Report, Lake Tholocco Rural Clean Water Program.

6. Water Quality Monitoring Report Lake Tholocco RCWP Project, Fiscal Year 1984. October 1984. Alabama Department of Environmental Man agement.

7. 1984 Annual Progress Report, Lake Tholocco Rural Clean Water Program.

8. 1985 Annual Progress Report, Lake Tholocco Rural Clean Water Program.

9. 1986 Annual Progress Report, Lake Tholocco Rural Clean Water Program.

10. 1987 Annual Progress Report, Lake Tholocco Rural Clean Water Program.

## VI. NWQEP Project Contacts

**Water Quality Monitoring**
Mr. Victor Payne
USDA - Soil Conservation Service
P.O. Box 311
Auburn, AL 36830
tel. (205) 821-8070

**Land Treatment/Technical Assistance**
Mr. Bennie Moore
USDA - SCS
984C E. Andrews Ave.
Ozark, AL 36360
tel. (205) 774-4749

# Appoquinimink River — RCWP 2

**New Castle County, Delaware**
**MLRA: 149A**
**H.U.C. 020402-05**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

This project shows a declining trend in P concentration, attributable to BMPs. This appears to be due to a high level of BMP implementation early in the project timeframe and a consistent water quality monitoring effort at a stream station within the project area.

The project has also shown that farmers are willing to make adjustments in their practices to help improve water quality.

## II. Water Quality Goals and Objectives (ref. 7)

The project's stated goal is to improve water quality in the Appoquinimink River Basin and the surrounding region through control of nutrient loads, sediments, bacteria and chemical runoff from agricultural sources.

## III. Characteristics and Results

1. **Project Type:** RCWP

2. **Timeframe:** 1980-1991

3. **Total Project Budget (for timeframe):**

| ACTIVITY / SOURCE: | Federal | State | Farmer | Other | SUM: |
|---|---|---|---|---|---|
| Cost-share | 845,401 | 0 | 426,109 | 0 | 1,271,150 |
| Info. & Ed. | 0 | 0 | 0 | 0 | 0 |
| Tech.Asst. | 53,549 | 0 | 0 | 78,077 | 131,626 |
| Water Quality Monitoring | 225,000 | 0 | 0 | 90,000 | 315,000 |
| SUM: | 1,123,950 | 0 | 426,109 | 168,077 | $1,718,136 |

4. **Area (acres):**

| Watershed | Project | Critical |
|---|---|---|
| 30,762 | 30,762 | 13,000 |

5. **Land Use:**

| Use | % Project Area | % Critical Area |
|---|---|---|
| cropland | 63.7 | 61.4 |
| pasture/range | 4.1 | NA |
| wetlands/open water | 13.6 | NA |
| woodland | 13.1 | NA |
| urban/residential | 5.5 | NA |

There are about 160 farms in the project area, mostly grain and vegetable producers. Eighty-five percent of these farms are located in the critical area.

**6. Animal Operations in Project Area:**

| Operation | # Farms | Total # Animals | Total A.U. |
|---|---|---|---|
| Dairy | 7 | 945 | 1323 |
| Beef | 2 | 293 | 293 |
| Hog | 1 | NA | NA |
| Poultry | 1 | 70,000 | 350 |

Most dairy, beef and hog operations are located along or near streams. None of the operations had animal waste treatment facilities before the RCWP.

**7. Water Resource Type:**

lakes, streams, Appoquinimink River

**8. Water Uses and Impairments:**

The lakes and streams of the Appoquinimink River watershed are used for recreation by approximately 1/2 million people who live within 20 miles of the watershed. Water uses include passive recreation (sightseeing and birdwatching) 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.

Appoquinimink River water quality is fair. All lakes have eutrophic conditions with dense aquatic vegetation and algal growth due to excessive nutrient concentrations.

**9. Water Quality at Start of Project:** (ref. 4)

The Appoquinimink River had high nutrient levels. All three impoundments were eutrophic.
Water Quality Characterization for the Appoquinimink River (1977)

| | Wiggins Mill Rt. 446 | Silver Lake Pond | Noxontown Pond |
|---|---|---|---|
| Pollutant | | mg/l | |
| Total IN | 1.1 | 4.6 | 1.0 |
| TKN | 2.3 | 5.4 | 2.0 |
| TP | 0.4 | 0.2 | 0.2 |
| Chl a | --- | 27.0 | 38.0 |

Fecal coliform standards (200/100ml) were typically violated throughout the watershed during ambient conditions, even though point sources do not indicate violations of fecal coliform standards.

**10. Meteorologic and Hydrogeologic Factors:**

a. Mean Annual Precipitation: 45 inches
b. USLE 'R' Factor: 200
c. 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.

## 11. Water Quality Monitoring Program:

a. Timeframe: Monitoring began in 1980 at Wiggins Mill, in 1983 at Silver Lake and Noxontown Pond. Groundwater monitoring began in 1984. Monitoring at the river and pond stations ended in 1986. Groundwater monitoring ended in July 1987.

b. Sampling Scheme: Conducted by the University of Delaware, Agricultural Engineering Department

1. Location and Number of Monitoring Stations:
   - a) Wiggins Mill Pond - one station to monitor a 2,200-acre subwatershed, approximately 1,200 acres of this subwatershed are in the critical area
   - b) Noxontown Pond, Silver Lake and Shallcross Lake - 3 stations for each waterbody (2 within the lake and 1 at the outlet)
   - c) Groundwater - 2 row crop sites, 2 potato field sites
2. Sampling Frequency:
   - a) monthly for baseline data development of all physical/chemical parameters and generally bimonthly for biological indicators
   - b) three storm event samples collected seasonally
   - c) periodic water quality surveys taken at Silver and Shallcross Lakes
3. Sample Type: grab

c. Pollutants Analyzed: filtered and unfiltered N and P series, chl *a*, suspended and dissolved solids, COD, DO, FC, FS, BOD.

d. Flow Measurements: taken with each sample at Wiggins Mill

e. Other: temperature, alkalinity, acidity, pH also measured

## 12. Critical Areas:

a. Criteria:
- soil erosion exceeds T value
- gully erosion (including ephemeral) is present
- concentration of animal wastes are 1,500 feet or less from a stream
- need for better farm management with respect to application of fertilizer, pesticides and animal wastes

b. Application of Criteria: Critical area designation for individual contracts was determined by soil conservationists using the above criteria on a field by field basis.

## 13. Best Management Practices:

a. General Scheme: Primary BMPs are conservation tillage, fertilizer management and pesticide management. There is some implementation of animal waste management systems, primarily in the areas of manure - holding structures and calibration of manure application equipment.

b. Quantified Implementation Goals: The project goal was to treat 9,750 acres of the 13,000 acre critical area.

c. Quantified Contracting/Implementation Achievements: as of Sept. 30, FY87. (ref. 15)

| Pollutant Sources | Critical Area Treatment Goals | Project Needs | %Needs/Goals Contracted | %Needs/Goals Implemented |
|---|---|---|---|---|
| Acres Needing Treatment | 21,190 | NA | NA | NA |
| Cropland | 13,000 | 9,750 | 87.4/116[a] | 61.3/81.7[b] |
| Dairies | 7 | 5 | 42.9/60 | 42.9/60 |
| # Contracts | 160 | 80 | 48.1/96.3 | 46/92[c] |

[•] Not permitted to take further RCWP contracts in FY87.

[a] Based on total of 11,362 acres contracted for BMPs within critical area. This figure includes some acreage not contracted with cost share funds.

[b] Based on acreage covered under land treatment practices. The largest reported acreage (7,963; 1982) for BMP-9 was used for this purpose.

[c] Based on the amount of project funds utilized as of 9/29/87 (92%) for implementation of projects.

d. Cost of BMPs:

| BMP | Ave. Farmer Share ($) |
|---|---|
| 1 perm. veg. cover | 85/ac. |
| 2 animal waste mgmt. | 10,110 ea. |
| 5 diversions | 1/ft. |
| 7 waterways | 1,550/ac. |
| 8 cropland protection | 14/ac. |
| 9 conservation tillage | 13/ac. |
| 11 perm. veg. on crit. acres | 330/ac. |
| 12 sediment retention, erosion control structures | 2,000 ea. |

e. Effectiveness of BMPs:

1. Cost shared BMP installation for FY1986 saved 7,233 tons of soil on 977 acres (7 tons of soil per acre).
2. Improved fertilizer and pesticide management (BMPs 15 & 16) has reduced the rate of P application on cropland to one-half the amount needed if P were broadcast applied. Split N application for corn has minimized the opportunity for large amounts of N to wash away soon after application.
3. Installation of manure holding structures allows farmers to store animal waste for timely application to meet crop needs.
4. Meetings and printed fact sheets on how to calibrate fertilizer and pesticide application equipment are expected to improve the calculation of correct amounts and rates for application.
5. Changing tillage practices and implementation of BMPs which disturb less acreage has resulted in a decrease of more than 60 percent in the concentrations of suspended solids and total P reaching the stream. The BMPs credited with this effect include the following practices: permanent vegetative cover, waterway, cropland protection system, conservation tillage system, permanent vegetative cover for critical area, and erosion/water control structure.

f. Non-RCWP Activities:

USDA's PIK program resulted in the idling of 75 acres of cropland in the monitored watershed. An additional 200 acres of cropland has also been idled by PIK. Monitoring results, however, are believed to show minimal effects from these changes in practice. (ref. 15)

## 14. Water Quality Changes:

Suspended solids concentrations at Wiggins Mill have declined by 90% since 1980, for the three ponds, however, little change has been observed. Total phosphorus concentrations have declined by 65-70% since 1980. $NO_3$-N concentrations at Wiggins Mill have declined slightly the last three years. Chlorophyll *a* concentrations have increased sharply the last three years in Wiggins Mill and have increased through the sampling history for all three ponds (ref. 15).

## 15. Changes in Water Resource Use:

There are no documented changes in water use. However, swimming is not currently allowed in Silver Lake due to high bacteria, and algae in Noxontown Pond impairs boating. Assuming the area is used for recreation primarily by local residents and they would recreate at the state average, an additional 18,000 swimming user-days and 42,000 boating user-days could be possible if water quality improves in the future (ref. 14).

**16. Incentives:**

a. Cost Share Rates: up to 75%
b. Limitation: $50,000
c. Assistance Programs: fertilizer and pesticide management programs conducted by the Extension Service.

**17. Potential Economic Benefits:**

a. On-farm: not evaluated
b. Off-farm:
1) Recreation: $15,000 - $180,000 per year.
2) Water Supply: 0
3) Commercial Fishing: 0
4) Wildlife Habitat: unknown
5) Aesthetics: unknown but positive
6) Downstream Impacts: unknown

## IV. Lessons Learned

The project reports that implementation of BMPs existed prior to RCWP but no records are available that track those accomplishments, 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 BMP implementation under RCWP. The sampling program's ability to detect subtle changes in water quality may have been hampered by the timing of RCWP efforts in relation to what had already been accomplished.

The project has shown that voluntary programs for BMP implementation have resulted in conservation tillage becoming an acceptable practice for many farmers.

The water quality monitoring program results show that BMPs have decreased the total phosphorus and total suspended solids concentrations in the Appoquinimink watershed.

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# Rock Creek - RCWP 3

**Twin Falls County, Idaho**
**MLRA: B-11**
**H.U.C.: 170402-12**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

Information on the effectiveness of BMPs in an irrigated system has been gained from this project. After six years of water quality monitoring, significant sediment concentration reductions have been found in at least five subbasins, however, sediment concentrations have also increased in some basins. Biological monitoring has been succesfully used to evaluate water quality changes. Additional documentation of the relationship between land treatment and water quality is expected. Detailed analysis of this project is available in the NWQEP--CM&E Report, 1985.

## II. Water Quality Goals and Objectives

The project's stated objective is to significantly reduce the amount of sediment related pollutants and animal waste discharging into Rock Creek.

## III. Characteristics and Results

1. **Project Type:** RCWP, Comprehensive Monitoring and Evaluation Project

2. **Timeframe:** 1981 – 1990 for water quality monitoring; BMP implementation will continue until 1996.

3. **Total Project Budget:**

| SOURCE: / ACTIVITY: | Federal | State | Farmer | Other | SUM |
|---|---|---|---|---|---|
| Cost-share | 2,689,413 | 0 | 2,083,246 | 0 | 4,772,659 |
| Info. & Ed. | 187,417 | 10,000 | 0 | 12,000 | 209,417 |
| Tech. Asst. | 1,213,336 | 15,000 | 0 | 47,685 | 1,276,021 |
| Water Quality Monitoring | 110,000 | 70,000 | 0 | 0 | 180,000 |
| SUM: | 4,200,166 | 95,000 | 2,083,246 | 59,685 | $6,438,097 |

4. **Area:**

| Watershed | Project | Critical |
|---|---|---|
| 198,400 | 45,238 | 28,159 |

a. Subbasins

| Subbasin # | Priority | Total Acreage | Total Critical Acreage |
|---|---|---|---|
| 1 | 6 | 2,430 | 1,700 |
| 2 | 5 | 3,290 | 3,160 |
| 3 | 4 | 2,160 | 1,880 |
| 4 | 3 | 4,365 | 3,758 |
| 5 | 2 | 3,180 | 1,148 |
| 6 | 7 | 4,995 | 4,653 |
| 7 | 1 | 6,720 | 5,105 |
| 8 | 8 | 6,440 | 3,285 |
| 9 | 9 | 4,577 | 2,154 |
| 10 | 10 | 7,081 | 1,316 |
| | | | Total = 28,159 |

**5. Land Use:** (ref. 35 and 16)

| Use | % Project Area | % Critical Area |
|---|---|---|
| cropland(irrigated) (includes alfalfa) | 74.5 | 100 |
| pasture/range | NA | NA |
| woodland | NA | NA |
| urban/roads | NA | NA |

**6. Animal Operations in Project Area:** (personal communication, Bill Clark, Idaho DOE, Aug. 1986)

| Operation | # Farms | Total # Animals | Total A.U. |
|---|---|---|---|
| Dairy | 34 | 6,800 | 6,800 |
| Cattle | 21 | 6,300 | 5,355 |
| Mink* | 1 | 20,000 | ~200 |

*Not thought to be a critical farm by the project.

**7. Water Resource Type:**

Irrigation canals and Rock Creek (approx. 20 miles) flowing into the Snake River.

**8. Water Uses and Impairments:**

Rock Creek provides diverse habitat for wildlife and is a popular stream for swimming, tubing and fishing. Water-skiing and swimming are major recreational activities in the Snake River, 10-15 miles downstream from the confluence with Rock Creek. Rock Creek receives irrigation return flow from the RCWP project area.

The primary use impairments are to fishing and contact recreation in Rock Creek, and to irrigation ditches, canals and drains which become clogged with sediment. Fishing use of Rock Creek in 1981 was about 500 fishing days compared to an estimated 8,000 if it were a quality trout fishery.

High sediment loads in Rock Creek may 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 (personal communication, Bill Clark, Idaho DOE, 10/13/87). These costs are not formally documented and are subject to debate. The muddy color of Rock Creek is an aesthetic impairment which also effects the Snake River. The primary pollutants are sediment, phosphorus, nitrogen and bacteria coming mostly from irrigation return flow and feedlot runoff. Sediment loads entering the Snake River from Rock Creek do not appear to be significantly impairing downstream reservoir capacity and causing increased cost of power generation. The nearest power plant which relies on reservoir capacity is 120 miles downstream.

### 9. Water Quality at Start of Project:

1980 flow-weighted mean concentrations at the mouth of Rock Creek: (Monitoring site S-1)

| Pollutant | Concentration |
|---|---|
| TSS | 158.0 mg/l (irrigation season only) |
| TP | 0.123 mg/l (irrigation season only) |
| TN | 3.3 mg/l (water year) |
| FC | 1182.0 mpn (geometric mean) |

### 10. Meteorologic and Hydrogeologic Factors:

a. Mean Annual Precipitation: 8.5 inches
b. USLE 'R' Factor: ~ 20
c. 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 basalt. This formation yields large supplies of groundwater 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.

### 11. Water Quality Monitoring Program:

a. Timeframe: 1981 - 1990. Data collection scheduled to end at the end of the 1990 irrigation season.
b. Sampling Scheme: conducted by Idaho Dept. of Health and Welfare
1. Location and Number of Monitoring Stations: Monitoring stations have been established on Rock Creek since 1980, and at 6 of the 10 project subbasins since 1981. The subbasin stations are located on irrigation ditches. Some of the subbasin stations have been positioned in pairs at inlets from supply canals and at upstream and downstream points to Rock Creek. There are 21 monitoring stations on irrigation ditches and 6 stations on Rock Creek. There was a monitoring station on the Twin Falls Main Canal from 1980 - 1983. The project has initiated a study to determine if they should be assesing conservation tillage pesticide use on groundwater. The project has begun to monitor ground water.
2. Sampling Frequency: Biweekly to weekly at the Rock Creek and and subbasin stations during the irrigation period. Monthly monitoring is performed during the non-irrigation season on Rock Creek (the drains are dry during that time period).
3. Sample Type: grab samples

c. Pollutants Analyzed: TP, OP, TSS. FC, TKN, inorganic-N for the Rock Creek and the subbasin samples. Additional parameters are analyzed on Rock Creek including macroinvertebrates, fish population analysis, pesticides, metals and substrate sediment.
d. Flow Measurements: instantaneous flow taken with each grab sample. A USGS gauge records flows on Rock Creek at station S-2.

## 12. Critical Areas:

a. Criteria: All the irrigated cropland and animal production facilities are considered critical. The 10 subbasins within the project area were prioritized by project personnel. In addition, NWQEP examined the relative upstream- downstream water quality in subbasins 1,2,4,5, and 7. Subbasins 2 and 7 and the subbasin drained by sampling stations 4-4 and 4-3 have additional potential for sediment reduction. These subbasins and subbasin 5 also have potential for improvement in FC, phosphorus, and nitrogen levels.

b. Application of Criteria: 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.

## 13. Best Management Practices:

a. General Scheme: Focus during 1981-1984 was on sediment retention structures and irrigation management systems with some permanent vegetative cover on critical areas (BMPs 12, 13, and 11). Several other practices were approved, but few were implemented (i.e., BMPs 2, 9, 15, and 16). For the duration of the project, through 1991, emphasis has shifted to conservation tillage (BMP 9) and animal waste management (BMP 2).

b. Quantified Implementation Goals: The project goal is to install BMPs on 75 percent of the critical erosion acres within 10 years. The deadline for contracts was September 30, 1986. However, amendments to existing contracts will add conservation tillage beyond that date. It appears the implementation may fall short of the stated goal, especially in animal waste management.

c. Quantified Contracting/Implementation Achievements: as of 9/30/87 (Ref. 46)

| Pollutant Sources | Critical Area Treatment Needs | Project Goals | %Needs/Goals Contracted | %Needs/Goals Implemented |
|---|---|---|---|---|
| Acres Needing Treatment | 28,159 | 21,119 | 75.3/100 | 42/56 |
| Dairies | 8 | 8 | 25 | NA |
| Feedlots | 17 | 17 | 118 | NA |
| Conservation Tillage | 10,000 | 10,000 | 30 | 11 |
| # Contracts | 235 | 176 | 77.5/103 | 9.8/13.1[a] |

[a] In addition, a significant amount of partially completed contracts exist

Achievements for Individual Subbasins: (ref. 46)

| Subbasin | Needs | % Critical Area Contracted |
|---|---|---|
| 1 | 1,700 | 90 |
| 2 | 3,160 | 52 |
| 3 | 1,880 | 62 |
| 4 | 3,750 | 71 |
| 5 | 1,148 | 63 |
| 6 | 4,653 | 81 |
| 7 | 5,505 | 67 |
| 8 | 3,285 | 91 |
| 9 | 2,154 | 82 |
| 10 | 1,316 | 105 |

d. Cost of BMPs:
Costs of implementing principal BMPs were estimated in terms of the total change in variable and fixed costs per acre. Least costly were conservation tillage and irrigation water management (IWM), which actually reduced total costs:

| BMP | $/Acre change in cost/yr. |
|---|---|
| 9 Conservation tillage | $33 cost savings |
| 13 IWM | $4 cost savings |
| 11 Filter strips | $2 cost savings |
| 12 Sediment retention | $9-15 added cost |
| 13 Irrigation structures | $20-48 added cost |

e. Effectiveness of BMPs:
With 75% of the critical area under treatment, expected decreases in pollutant loads to Rock Creek from subbasins are estimated at 70 percent sediment, 70 percent TP and 65 percent toxics (mostly pesticides) (ref. 35, p.2). These estimated reductions appear to be feasible based on water quality data analysis already conducted (NWQEP, 1985).
Sediment reduction coefficients for the sediment retention BMPs have been developed by the USDA-ARS at Kimberly, ID. Mini-Basins, I-slots, sediment basins, and buried pipe runoff were effective with coefficients between 75 and 92 percent. Vegetative filter strips have a coefficient of 50 percent, irrigation improvements 5 to 40 percent, and conservation tillage 60 percent.
Management practices are by far the most cost-effective for reducing sediment loss on a per acre basis:

| BMP | $Change in cost/acre per one % reduction in sediment/acre |
|---|---|
| 9 Conservation tillage | $0.55 reduced cost |
| 13 IWM | 0.11 reduced cost |
| 11 Filter strips | 0.04 added cost |
| 12 Sediment retention | 0.09-0.17 added cost |
| 13 Irrigation structures | 0.48-5.20 added cost |

f. Non-RCWP Activities:
Some landowners have implemented BMPs on thier own without RCWP funding.

## 14. Water Quality Changes:

Suspended sediment has decreased significantly in five of six subbasins studied over the project timeframe: however, 1986 and 1987 data show an increase in sediment in some subbasins. Severe streambank erosion on the upper reaches of Rock Creek may be masking some of the effect on Rock Creek.

Efforts to monitor streambank erosion continued in 1987 showing that over 50% of Rock Creek has streambank erosion problems. Bulk density measurements of streambank soils were very low ranging from 1.05 to 1.22 $g/cm^3$ and were considered a major cause of high streambank erosion. Streambank erosion in 1987 was about two-thirds below 1986 conditions due to spring drought.

Between 1985 and 1987, the standing crop ($fish/m^2$) for rainbow and brown trout continued to increase at almost all stations. Fish in Rock Creek were sampled in 1987 for pesticides; however, concentrations appear to be below public health and ecological levels of concern and no changes from previous sampling were apparent.

Based on a model of the watershed, full implementation of the project as contracted would reduce sediment loadings to Rock Creek by 20 to 31 percent compared with pre-project conditions. Modification of contracts to implement 10,000 acres of conservation tillage is expected to reduce sediment loadings by 52 to 63 percent (ref. ERS, 1987).

## 15. Changes in Water Resource Use:

A 52-63 percent reduction in sediment loadings should help restore Rock Creek as a quality trout fishery, increasing fishing days per year from 500 prior to the project up to possibly 8,000. Other recreational uses of Rock Creek and the Snake River would be enhanced, but not so directly or dramatically as the fishery.

## 16. Incentives:

a. Cost Share Rates: 50 or 75 % depending on the practice
b. $ Limitations: $50,000 maximum on sediment retention and agricultural waste control systems, less for other BMPs
c. Assistance Programs: 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. There is a need for better technical assistance for animal waste management. A full-time SCS position for I & E activities was created in 1986 and will continue until the end of the project. The project publishes a newsletter, creates media contacts, and promotes publicity.
d. Other Incentives or Regulations: The General Permit for Confined Animal Feeding Operations in Idaho (EPA Region X) was passed into law in June 1987. Since the deadline for BMP contracts was September 1986, the new law will not have the significant incentive to implement animal waste management that was hoped. Fines for violating the permitting system may, however, speed implementation of animal waste management. Existing contracts can still be modified, to include BMP2.

## 17. Potential Economic Benefits:

a. On-farm: Farmers are gaining soil productivity (long term yield) maintenance benefits from conservation tillage and irrigation practices which keep soil in place in the fields. Conservation tillage also reduces short-term costs. Farmers also get depreciation on income tax deductions for the structural measures installed. Modification of contracts to add additional conservation tillage (CT) could substantially increase on-farm benefits over 50 years: (ref. 40)

| Benefits: | Project as contracted 9/86 | Project with 10,000 acres of CT |
|---|---|---|
| | (in million $ present value) | |
| Cost share payments received | 1.2 | 1.3 |
| Short & long term yield benefits | 1.0 | 1.9 |
| Tillage cost reduction | 0.3 | 1.2 |
| Tax savings on BMPs | 0.9-1.0 | 0.9-1.0 |
| Gross benefits | 3.4-3.5 | 5.3-5.4 |
| Less Cost of Benefits | 2.8-3.1 | 2.8-3.1 |
| Net on-farm Benefits | 0.60-0.4 | 2.5-2.3 |

b. Off-farm: Estimated beneftis over 50 years are:

| Benefits: | Project as contracted 9/86 | Project with 10,000 acres of CT |
|---|---|---|
| | (in million $ present value) | |
| Improved water recreation | 0.3-0.5 | 0.8-1.0 |
| Water supply and treatment | N/A | N/A |
| Commercial fishing | N/A | N/A |
| Improved hunting (habitat benefit of CT) | negligible | 0.2 |
| Reduced ditch cleaning costs | 0.1 | 0.3 |
| Aesthetic benefits not | measured | not measured |
| Reduced power generation costs | negligible | negligible |
| Total Off-Farm | 0.4-0.6 | 1.3-1.5 |

c. Benefits versus Costs: (over 50 years)

| | Project as contracted 9/86 | Project with 10,000 acres of CT |
|---|---|---|
| **Benefits:** | (In million $ present value) | |
| On-farm benefits total | 0.6-0.4 | 2.5-2.3 |
| Off-farm benefits total | 0.4-0.6 | 1.3-1.5 |
| Total benefits | 1.0 | 3.8 |
| **Costs:** | | |
| Government Costs | 1.9 | 2.1 |
| Total benefits minus cost | −0.9 | 1.7 |

## IV. Lessons Learned:

Project's such as this can succeed on a voluntary basis. Landowners who don't participate, however, can adversely impact the project. Also, landowner participation outside project contracts, while good, can complicate data analysis. (ref. 46)

Based on results from this project, irrigation canals appear to respond faster to land treatment than do streams and non-irrigated, humid areas. This is probably due to a relatively low variability in the hydrologic factors associated with the irrigated system, and to greater control of the water resource. Further comparisons with other projects will help to test this hypothesis. Although analyses showed less variability existed in the water quality and flow data of this project compared to projects in humid regions, a 40-60 percent decrease in mean concentrations over a period of 4 to 5 years is still necessary to have a statistically significant change in the water quality of irrigation canals. Data variability is likely to be greater in the Rock Creek and Snake River systems which are more strongly influenced by meteorologic factors. Adjusting for sources of variability (i.e., upstream concentration) has allowed more efficient monitoring to document the water quality changes.

Water quality monitoring was used successfully to quantify sediment loads to the impaired resource from subbasins and to indicate the subbasins that could most benefit from BMPs.

Results from the nearby LQ Drain project show that significant reductions in sediment loads may be lost if sediment retention devices are not properly maintained. It is possible that a similar situation could develop in the Rock Creek RCWP. Conservation tillage techniques to reduce in-field erosion are receiving increased emphasis as an effective, low-cost alternative to structural practices for improving water quality; however, the CT adoption rate, is still very low after four years of cost share availability. Many farmers reject CT because it is a non-traditional farming method. Custom operators who farm rented land do not have an economic incentive to practice CT. 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 are prone to contract with farmers who practice conventional methods. While there are several surface applied herbicides registered for use on soybeans, there are no such products registered for dry beans. This is a deterrent to adopting CT. (personal communication with Dr. David Carter, USDA-ARS, Kimberly, Idaho, Oct. 6, 1987).

Off-farm economic benefits from water quality improvement in Rock Creek are limited because no large scale recreational or municipal uses are impaired. Even though off-farm benefits may be small, additional implementation of conservation tillage could result in total benefits of the project exceeding costs, and would certainly have done so if the practice could have been implemented earlier in place of the less cost-effective irrigation structures.

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# Highland Silver Lake - RCWP 4

**Madison County, Illinois**
**MLRA: M-114**
**H.U.C. 071402-04**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

This project has shown that although BMPs may be successful in reducing sediment load to a lake, they may not improve the lake's water quality problem. A large part of the turbidity problem in Highland Silver Lake is caused by in-lake resuspension of fine sediment particles and the tendency for charged particles of natric soils to remain in suspension. RCWP efforts are unlikely to reverse this water quality impairment. The importance of controlling the fine particle sediment load to the lake has been demonstrated by this project.

The project has demonstrated that effective field site and stream water quality monitoring is heavily dependent on accurate identification of influential variables, careful documentation of land treatment activity, length of monitoring timeframe, and adequate collection of storm event data.

Water quality models (CREAMS and AGNPS) used by the project have proven to be effective tools for planning and evaluating activities such as critical area identification and land treatment strategy selection.

(For more information see the RCWP Status Report on the CM&E Projects, 1985, pp. 65-78.)

## II. Water Quality Goals and Objectives

1) Reduce sediment delivered to the lake by 60 % (with parallel reductions in P and organic N) – based on pre-project watershed gross erosion rate of 7.6 tons/acre/year and sediment delivery rate of 25% (ref. 2)

2) Increase transparency in lake to greater than 2 feet and reduce suspended soilds to less than an average of 25 mg/l. (ref. 33)

## III. Characteristics and Results

1. **Project Type:** RCWP, Comprehensive Monitoring & Evaluation Project

2. **Timeframe:** 1980 – 1990

3. **Total Project Budget (for timeframe):** (ref. 29, form RCWP 5)

| SOURCE: / ACTIVITY: | Federal | State | Farmer | Other | SUM: |
|---|---|---|---|---|---|
| Cost-share | 1,502,372 | 5,000 | 466,990 | 0 | 1,974,363 |
| 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 |

## 4. Area (acres):

| Watershed | Project | Critical |
|---|---|---|
| 30,946 | 30,348 | 6,525 |

## 5. Land Use:

| Use | % Project Area | % Critical Area |
|---|---|---|
| cropland | 82 | ~100 |
| pasture/range | 5 | |
| woodland | 4 | |
| other | 9 | |

## 6. Animal Operations in Project Area: (ref.29)

| Operation | # Farms | Total # Animals | Total A.U. |
|---|---|---|---|
| Beef | – | – | 944 |
| Dairy | – | – | 760 |
| Swine | – | – | 1,178 |

Project area has 35 animal operations and 21 are designated critical.

## 7. Water Resource Type:

Highland Silver Lake (600-acre impoundment) and tributaries

## 8. Water Uses and Impairments: (ref. 1)

Highland Silver Lake is 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. In 1979, the lake supported an estimated 42,600 angler-days.

Use of the lake is impaired by sediments, nutrients and toxics. High turbidity levels are caused by suspension and resuspension of fine natric soil particles. Lake volume is being lost to sedimentation. Excessive nutrient concentrations contribute to eutrophic conditions. Agricultural chemicals in surface runoff entering the lake are a public health concern.

## 9. Water Quality at Start of Project: (ref. 10, p. III-43)

Average water quality from Site 1, nearest the water intake at the base of the lake (May 1981 - April 1983).

| Parameter | Mean | N |
|---|---|---|
| TSS | 27.8 mg/l | 18 |
| Turbidity | 57.4 mg/l | 17 |
| Secchi | 11.4 inches | 17 |
| TP | 0.18 mg/l | 18 |
| TN | 2.0 mg/l | 18 |
| Chl a | 6.26 ug/l | 17 |

## 10. Meteorologic and Hydrogeologic Factors:

a. Mean Annual Precipitation: 40.5 inches

b. USLE 'R' Factor: ~200

c. Geologic Factors: Soils in the project area are almost entirely glacial in origin. Topography ranges from nearly level to very gently sloping.

**11. Water Quality Monitoring Program:**

a. Timeframe: conducted by Illinois Environmental Protection Agency and Illinois Dept. of Energy and Natural Resources - State Water Survey
   1) lake - May 1981 to 1990
   2) streams - Jan. 1982 to Oct. 1984
   3) field sites - spring 1982 to Oct. 1984

b. Sampling Scheme:
   9 lake sites (5 main lake & 4 bay sites) sampled monthly
   1 lake outflow site sampled daily (MWF) with automatic sampler
   3 stream sites sampled daily (MWF) with automatic samplers
   8 field sites sampled during events with automatic samplers

c. Pollutants Analyzed:
   Daily (MWF) -- TSS,TVS, Turb., Temp., DO, pH & Conductivity sampled at tributary & spillway sites
   Semimonthly -- TSS,TVS,Turb., TP, DP, TKN, $NO_3$, $NO_2$, Temp., DO, pH, Conductivity sampled at tributary & spillway
   Monthly -- ICAP metals sampled at tributary & spillway / TSS, TVS, Turb., TP, TKN, DP, $NO_3$, $NO_2$, $NH_3$, Temp., DO, pH, Conductivity, Total alkalinity, Chl *a*, ICAP sampled at lake sites
   Events -- TSS, TVS, Turbidity, TKN, TP were sampled at tributary & field sites

d. Flow measurements:
   1) spillway - daily
   2) streams - continuous
   3) field sites - event

e. Other:
   1) precipitation at 3 sites within watershed
   2) 3 stream sites biologically sampled twice a year
   3) 1 channel and streambed survey
   4) 1 lake sedimentation survey (1982)

**12. Critical Areas:**

a. Criteria: (1) crop and pasture lands composed of natric soils with fine particle size and high erodibility and slopes greater than 2%. (2) crop and pasture lands of non-natric soils with slopes greater than 5% with high erodibility and close proximity to water course. Feedlots are also prioritized according to the number of animal units and distance to stream. These criteria were found to be an accurate assessment of high pollutant source areas according to the AGNPS modeling results.
b. Application of Criteria: The criteria were followed carefully in selection of farm fields for contract.

**13. Best Management Practices:**

a. General Scheme:
   Project uses practices that increase ground cover, decrease the velocity of surface runoff, and improve the management of livestock waste (i.e., RCWP BMPs 1, 2, 4, 5, 7, 8, 9, 10, 11, 12, 14, and 15).

b. Quantified Implementation Goals:
   The project established a goal of treating 75% of the ritical areas, which is equal to 4,894 acres. Apply waste management systems on 10 swine, 5 beef, and 5 dairy operations. Implementation goals for each BMP were also established.

c. Quantified Contracting/Implementation Achievements: (through FY1987) (ref.30, Tables 1 & 2)

| Pollutant Sources | Critical Area Treatment Needs | Project Goals | % Needs / Goals Contracted | % Needs / Goals Installed |
|---|---|---|---|---|
| Acres Needing Treatment | 6,525 | 4,894 | 82 / 109 | 62 / 83 |
| Beef | 695 A.U. | 521 A.U. | 119 / 158 | 107 / 143 |
| Dairy | 727 A.U. | 545 A.U. | 80 / 107 | 63 / 84 |
| Swine [a] | 1,116 A.U. | 837 A.U. | 23 / 31 | 103 / 138 |
| # Contracts | 125 | 94 | 89 / 118 | 89 / 118 |

[a] includes animal units treated through RCWP and non-RCWP activities

d. Cost of BMPs:

| BMP | Expected Average Life (years) | Ave. Annual Gov't Cost/Acre Treated or Benefited ($) |
|---|---|---|
| 1 Permanent Veg. Cover | 5 | 24 |
| 4 Terraces | 10 | 24 |
| 5 Diversions | 10 | 22 |
| 7 Grassed Waterways | 10 | 5-6 |
| 9 Conservation Tillage | 4-20 | 22-4 |
| 11 Critical Area Cover | 5 | 8-9 |
| 12 Sediment Retention System | 10 | 24 |
| 15 Fertilizer Management | 3-10 | 4-1 |

(Based on CRES data and $17.60 per hour for technical assistance)

e. Effectiveness of BMPs:

BMPs have reduced erosion by approximately 42,000 tons per year (USLE) which corresponds to about 19,700 tons of sediment delivered to the lake.

Field site (CREAMS) modeling results: (ref. 29)
– non-structural BMPs on critical areas (conservation and no-till, permanent vegetative cover, etc.) can reduce sediment yield from the field sites by as much as 45%, to the streams by 8 to 18%, and to the lake by 17%. These BMPs were not effective in reducing soluble nitrogen and phosphorus loads from critical areas.
– no-till was most effective in reducing sediment yield from fields.
– contouring was effective in reducing overland flow erosion.

Watershed (AGNPS) modeling results under four BMP scenarios: (ref. 29)
– non-structural BMPs were effective in reducing sediment yield and sediment-associated nitrogen and phosphorus at field sites and gaging stations.
– waterways and impoundments were effective in reducing peak discharge, sediment yield and sediment-attached nitrogen and phosphorus at four field sites.
– animal waste systems were effective in reducing soluble nitrogen and phosphorus at field sites with feedlots in their drainage area.
– fertilizer management was effective in reducing soluble nitrogen and phosphorus at field sites and gaging stations.

d. Cost-effectiveness of BMPs: Estimates of project-wide cost-effectiveness based on the AGNPS and LP models for three categories of BMPs are:

| BMP | cost of sediment control (delivered to lake) $/ton | cost of P control (in lake) $/lb. | cost of 1% reduction (sed. in lake) $1,000 | cost of 1% reduction (N & P in lake) $1,000 |
|---|---|---|---|---|
| Conservation Tillage | 14–33 | 7–17 | 3–7 | 4–9 |
| Structural Practices (4,5,7,12) | 266 | 172 | 59 | 108 |
| Animal Waste Systems | NA | 43 | – | 70 |

## 14. Water Quality Changes:

Gage sites: Multiple linear regression analysis of normalized loading data indicates statistically significant reductions in TSS and TP over time.

Lake sites: In 1987, the mean Secchi transparency was 17 inches, the best yet recorded, and the mean TSS concentration was 21.7 mg/l, first time below the project goal of 25 mg/l. The project reports that 1987 was an exceptionally dry year and these data probably do not respresent a real change in water quality associated with RCWP activities. No statistically significant improving trends have been documented. High turbidity levels in the lake not directly related to sediment loading have masked the effect of reduced sediment load.

Lake sedimentation survey indicates an average annual capacity decrease by 0.67 percent. This rate does not pose a threat to use of the lake as a water supply for the city of Highland.

## 15. Changes in Water Resource Use:

Changes in use of Highland Silver Lake will likely be negligible. A survey of anglers conducted in 1982 indicated that most would increase trips to the lake by about 12 per year if water appearance (clarity) improved to the point of two-foot visibility. Such an improvement is unlikely as projected by models.

## 16. Incentives:

a. Cost Share Rates: 75%
b. $ Limitations: $50,000 per landowner
c. Assistance Programs: Extension I&E and SCS technical assistance.

## 17. Economic Benefits: (ref. 29)

a. On-farm:

| | Discounted Value Over 50 Years (@ 7-7/8% /Year) millions $ |
|---|---|
| **Benefits** | |
| Cost share payment | 1.2 |
| Tillage cost savings | 1.1 |
| Productivity benefits | negligible |
| Gross benefits | 2.3 |
| **Costs** | |
| Installation of BMPs | 1.6 |
| Maintenance of BMPs | 0.2 |
| Total costs | 1.8 |
| Net benefit before taxes | 2.3 - 1.8 = 0.5 |

Productivity benefits over 50 years were analyzed using the SOILEC model. The model indicated that benefits from BMP implementation are offset by a lack of productivity benefits, because most soils in the project area are deep.

b. Off-farm:

| Benefits | Discounted Value Over 50 Years (@ 7-7/8% /Year) |
|---|---|
| Boating | Negligible |
| Fishing | $24,000 |
| Swimming | Not Applicable |
| Property values | Negligible |
| Water treatment cost reduction | $225,000 |
| Reservoir capacity | Negligible |
| Total | $249,000 |

Fifty-six percent of the surveyed anglers indicted willingness to pay an additional fee to improve water clarity in the lake and that they would increase their visits per year by over one-half. Boating benefits apart from fishing are negligible because of limitations on boat and motor size. The lake's capacity is large relative to future water supply needs and sedimentation rate is low. Therefore, reducing the sedimentation rate has negligible benefits.

Several other possible benefits such as increased picnicking and aesthetics, improved upland game habitat and reduced maintenance of roadways were not estimated in this analysis due to lack of reliable data.

## IV. Lessons Learned (ref. 29)

The 75% cost-share rate for BMP installation was a very attractive incentive for project area landowners and a key motivation for participation in RCWP. Project acceptance was also gained through extensive one-on-one contacts at the beginning and, later, through visibility of installed BMPs seen on educational tours and discussed privately among landowners.

The definition of critical area was based on soil mapping units and many farm fields covered only a portion of the critical area. This presented problems in tracking land treatment because the smallest treatment unit was usually the farm field, which covered both critical and non-critical area. The reporting system was not sensitive to this problem and, as a result, total acres under contract were more than twice the number of critical acres targeted for contract. The project believes that a more practical approach would have been to identify the entire farm field as critical. Also, the land treatment reporting system was inadequate for tracking more than one BMP applied to the same acreage.

Automated tracking of BMP contracting and installation was a vast improvement over manual methods.

The project's CM & E water quality goal is to 1) reduce turbidity and increase visibility to greater than two feet, and 2) reduce total suspended solids concentrations to an average of less than 25 mg/l. It is unlikely that the project will meet these goals. The project believes that a more appropriate goal statement would have been in terms of percent reduction in fine particle size loading and to have included a particle size analysis in the monitoring strategy. Turbidity produced by natric soils, even when gross erosion rate is low, has been a persistent water quality problem. The BMPs applied may be effective in reducing sediment loading to the lake but ineffective in alleviating the lake's water quality problem.

The project reports that field site monitoring was unsuccessful due to "1) too many uncontrolled variables, 2) incomplete management records, and 3) too little event data collected." (ref. 29, p.50)

A modeling approach using CREAMS and AGNPS was demonstrated late in the project. The project found that use of these models in the planning stage of the project could have helped in identifying pollutant sources and critical areas, evaluating alternative treatment schemes, and developing an appropriate monitoring strategy.

The CREAMS and AGNPS models have been used to identify expected changes. According to the AGNPS modeling results, full implementation of RCWP contracts and the increasing adoption of conservation tillage should reduce sediment yield 33 percent and N and P yield 18 percent by 1991 compared to pre-project conditions. However, the net effectiveness of the RCWP project, taking out the conservation tillage trend, gives only about 12 percent reduction in loading of the three pollutants to the lake.

Conservation tillage and fertilizer management were shown to be the least costly BMPs to implement, assuming the practices will be continued well beyond the contract period. Grassed waterways were also shown to have low average annual costs per acre benefited compared with other structural measures and permanent cover.

Conservation tillage was the most cost-effective method of reducing the delivery of pollutants to the lake. Grass waterways and impoundments and animal waste management systems further reduced the generation of pollutants; however, these practices have a very high cost for the amount of additional pollution reduction achieved.

The modeling and economic evaluation show that the cost effectiveness of the project in achieving water quality could have been improved by promoting more extensive adoption of conservation tillage (reduced tillage or no-till) and certain crop rotations (e.g. soybean-wheat/double crop soybean) on all cropland in the watershed rather than using more costly structural measures to reduce erosion to tolerance levels on fewer acres.

The SOILEC model indicated that no significant long-term on-farm benefits are likely from BMPs primarily because of the deep soil over most of the project area.

## V. Project Documents


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## VI. NWQEP Project Contacts

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# Prairie Rose Lake - RCWP 5

**Shelby County, Iowa**
**MLRA M-107**
**H.U.C. 102400-020**

## I. Major Contribution Toward Understanding the Effectiveness of NPS Control Efforts

The project shows that a very high rate of implementation is possible in a voluntary NPS control project. Factors that may contribute to the high rate of participation include: water quality objectives that are visible, substantial amounts of money available for cost sharing (approx. $114 per acre), preferred BMPs (terracing in this case), a technical assistance program, active publicity programs, and services to assist farmers in fertility management and integrated pest management.

The institutional relationships in this project could provide a model for other NPS projects. In addition, completion of the implementation and monitoring programs will provide a definitive test of the effectiveness of terracing as a BMP for protection of water quality in a small midwestern lake. An in-depth analysis of this project can be found in the NWQEP 1987 Annual Report.

## II. Water Quality Goals and Objectives

The project's stated goals are to control excessive soil erosion on at least 80% of the agricultural land area and reduce sediment delivery rate by 60%. The project stated in their application (ref. 1) that they consider sediment delivery as a measure of water quality improvement because the lake water quality problems are all related to delivered sediment.

## III. Characteristics and Results

1. **Project Type:** RCWP

2. **Timeframe:** 1980 - 1991

3. **Total Project Budget(for timeframe):**

| ACTIVITY: / SOURCE: | Federal | State | Farmer | Other | SUM: |
|---|---|---|---|---|---|
| Cost-share | 446,182 | 0 | 148,748 | 0 | 594,930 |
| Info.& Ed. | 18,750 | 0 | 0 | 0 | 18,750 |
| Tech. Asst. | 131,140 | 0 | 0 | 0 | 131,140 |
| Water Quality Monitoring[a] | — | — | 0 | 0 | NA |
| SUM: | 596,072 | 0 | 148,748 | 0 | $744,820[b] |

[a] Combination of state and federal (EPA) funds - amount not reported.

[b] does not include water quality monitoring budget.

**4. Area(acres):** (ref. 9)

| Watershed | Project | Critical |
|---|---|---|
| 4,568 | 4,568 | 3,920 |

**5. Land Use:**

| Use | % Project Area | % Critical Area |
|---|---|---|
| Cropland | 79.9 | 93.0 |
| Pastureland | 3.2 | 3.8 |
| Lake & parkland | 14.2 | 0 |
| Farmsteads/roads/woodland | 2.7 | 3.2 |

**6. Animal Operations:**

The original RCWP project application identified a need for up to 8 animal waste control systems and set as a project goal the installation of 6 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, 4 small cow-calf operations (averaging 30 stock cows per operation) and 9 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.

**7. Water Resource Type:**

Prairie Rose Lake (215 acre impoundment)

**8 Water Uses and Impairments:**

Prairie Rose Lake is a 215-acre 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 million park visitors each year.

Use of the lake is impaired by sediment, turbidity and agricultural chemicals. Between 1971 and 1980, 19% of the lake volume was lost to sediment. The lake is eutrophic.

**9. Water Quality at Start of Project:**

Upper Mixed Zone and Bottom Sites-1981 (n = 10)

(Annual means were calculated from STORET values for this project. Observations reported with less than detection limit values were set to one half the detection limit.)

| | | (upper/bottom) | |
|---|---|---|---|
| Parameter | Site 1 | Site 2 | Site 3 |
| Turbidity(NTU) | 21 .0/ 31.0 | 11 .0/ 103.0 | 9.0 /84.1 |
| Secchi depth (in) | 16 .0/ -- | 21.0 /-- | 23.0 / -- |
| TP (mg/l-P)* | 0.12/0 .15 | 0.08 /0 .18 | 0.08 /0.16 |
| OP (mg/l-P)* | 0.04 /0.05 | 0.02 /0 .05 | 0.02 /0 .06 |
| Chl a (ug/l) | 33.7 /33.0 | 21.8 / 24.2 | 17.4 / 24.1 |

* TP & OP n = 5

**10. Meteorologic and Hydrogeologic Factors:**

a. Mean Annual Precipitation: 29.15 inches

b. USLE 'R' Factor: 150-175

c. Geologic Factors: Upland soils are generally well-drained, silty clay loams that developed in loess. Soils in the drainageways are alluvial. Slopes in the watershed range from 0-18%.

**11. Water Quality Monitoring Program:**

a. Timeframe: 1981 to completion of the project

b. Sampling Scheme: conducted by the Iowa Dept. of Natural Resources (1987 funding from EPA)

1. Location and number of monitoring stations: 3 lakes stations sampled at surface and bottom,

one station at the drinking water intake of the lake, and one station at the swimming beach
2. Sampling frequency: bi-weekly sampling summers only, sampling after rainfall events
3. Sample type: grab

c. Species Analyzed: $NO_3 + NO_2$, $NH_4$ and free $NH_3$, Dissolved P, TP, Sediment, DO, Chl *a*, FC, Secchi, Turbidity, E. Coli and enterococci

d. Other: Precipitation records are maintained at the lake.

## 12. Critical Areas:

a. Criteria: All croplands are critical acres.

b. Application of Criteria: consistently applied

## 13. Best Management Practices:

a. General Scheme: Most of the land treatment effort focused on controlling soil loss through practices such as terracing. Conservation tillage is encouraged, and there are I&E programs to introduce fertilizer management and integrated pest management.

b. Quantified Implementation Goals:

| BMP | Amount | BMP | Amount |
|---|---|---|---|
| 1 Perm. veg. cover | 111 ac. | 9 Conservation Tillage | 2,100 ac. |
| 11 Perm. Veg. on Crit. Acres | | 10 ac. | |
| 4 Terracing | 75 mi | 12 Sediment Control Struc. | 6 units |
| 5 Diversions | 2,000 ft. | 15 Nutrient Management | 3,170 ac. |
| 7 Waterway System | 20 ac. | 16 Pesticide Management | 3,170 ac. |

c. Quantified Contracting/Implementation Achievements: as of 9/30/87 (ref. 16)

| Pollutant Sources | Critical Area Treatment Needs | Project Goals | %Needs / Goals Contracted | %Needs / Goals Implemented |
|---|---|---|---|---|
| Acres Needing Treatment | 3,920 | 3,136 | 83/104 | 74/93 |
| Cropland | 3,648 | 2,926 | 77/96 | 65/81[a] |
| Pasture | 148 | 111 | 34/45 | 22/29 |
| Farmstead[b] | 120 | 95 | 54/68 | NA |
| Woodlands | 4 | 4 | 0 | 0 |
| # Contracts | 47 | 37 | 72/92 | 55/69[c] |

[a] Project claims that a large majority of cropland is farmed under some form of conservation tillage though only 579 acres are under RCWP contract. The major RCWP land practice is terracing (51 miles of terrace systems effecting 1,785 acres).

[b] No indication of what practices are involved with farmstead sources.

[c] Based on amount of project funds spent on intallation of practices as of 9/30/87.

[*] The project estimates that 87% of the work has been done on the contracts signed. Some contracts have been started but are not complete.

d. Cost of BMPs: (from RCWP Table 4, Ref. 14)

| BMP | Ave. Farmer Share ($) | Ave. RCWP Share ($) | Total Cost ($) |
|---|---|---|---|
| 1 perm. veg. cover | 7.50/ac. | 22.50/ac. | 30/ac. |
| 2 animal waste mgmt. | 1,000 ea. | 3,000 ea. | 4,000 ea. |
| 4 terraces | 0.15/ft. | 0.75/ft. | 0.90/ft. |
| 5 diversions | 0.33/ft. | 0.67/ft. | 1./ft. |
| 7 waterways | 845 ea. | 2,530 ea. | 3,375 ea. |
| 9 conservation tillage | 5/ac. | 15/ac. | 20/ac. |
| 11 perm. veg. on crit. ac. | 9/ac. | 21/ac. | 30/ac. |
| 12 sediment retention & erosion control | 2,500 ea. | 7,500 ea. | 10,000 ea. |

e. Effectiveness of BMPS: Soil loss has decreased from 80,800 tons/year (1980) to 36,900 tons/year (1985). Data from three bathymetric surveys indicate a reduction in sedimentation rate. Confirmation of this trend, however, depends on completing the fourth bathymetric survey planned at the conclusion of the RCWP project.

f. Non-RCWP Activities: BMPs installed prior to RCWP including 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 (ACP, state, county, private).

**14. Water Quality Changes:**

There has been no documented decrease in turbidity since the RCWP began. The project's 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.

Drawdown and fish toxicant applications in the Praire Rose Lake in 1981 may have resulted in the relatively high water clarity observed in 1982 and 1983.

**15. Changes in Water Resource Use:**

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. The project notes that 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.

**16. Incentives:**

a. Cost Share: Rates are generally 75%, except for nutrient and pesticide management, which are handled under the I&E program and are not cost shared.
b. $ Limitation: $50,000 per farm
c. Assistance Programs: Extensive I&E program handles all the nutrient and pesticide management in the project (program conducted by the Extension Service).

**17. Potential Economic Benefits:**

a. On-farm: not evaluated
b. Off-farm:
  1) Recreation: $30,000 - $85,000 per year
  2) Water supply: 0 - $45,000 per year
  3) Commercial fishing: 0
  4) Wildlife habitat: unknown
  5) Aesthetics: unknown but positive
  6) Downstream impacts: 0

## IV. Lessons Learned

A high rate of BMP implementation is possible when water quality objectives are clear and where the practices are considered desirable by the landowners. In this case, the farmers recognize the need for terracing to prevent soil erosion, and they believe this will improve the quality of the recreational lake. Assistance in the form of cost sharing, soil testing, and pest scouting provided enough incentive to promote this project.

Recreational use of the lake has increased during the project period. This may be at least partially attributable to the attention it has received as an RCWP project. Some water quality improvement has apparently been perceived by lake users, although water quality data do not yet confirm this.

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 to date suggests that BMPs have not reversed eutrophication.

The project has met its implementation goals, and the monitoring program has been consistent throughout the project period. Water quality effects attributable to erosion control should be documented by the end of the implementation period in 1991.

Positive net economic benefits are possible when treating sediment which adversely affects recreation.

## V. Project Documents


1. Prairie Rose Lake RCWP Application. July 1979.
2. Prairie Rose Lake RCWP Supplement to Application. Monitoring and Evaluation Plan. August 1979.
3. EPA Comments on Work Plan. June 2, 1980.
4. Experimental RCWP Plan of Work, Prairie Rose Lake Watershed. June 1980.
5. Prairie Rose Lake. Plan of Work-Amendment 2. September 5, 1980.
6. Prairie Rose Lake Monitoring RCWP Project-Year 1 (1981). March 23, 1982. 3,-4,-5, and SCS Report of Project Accomplishments.
7. Corrections and Additions to the Report Entitled "Prairie Rose Lake Monitoring RCWP-Project-Year 1 (1981), March 23, 1982".
8. Prairie Rose Lake Monitoring RCWP Project-Year 2 (1982). October 19, 1982.
9. 1982 Annual Report. November 30, 1982.
10. 1983 Annual Report. November 30, 1983.
11. 1984 Annual Report. November 30, 1984 (Includes Lake Monitoring Report).
12. 1985 Annual Report. November 30, 1985.
13. Prairie Rose Lake Monitoring RCWP Project-Year 5 (1985). April 9, 1986.
14. 1986 Annual Report. November 30, 1986.
15. Prairie Rose Lake Monitoring RCWP Project - Year 6 (1986).
16. 1987 Annual Report. November 30, 1987.
17. Prairie Rose Lake Monitoring RCWP Project - Year 7 (1987).

## VI. NWQEP PROJECT CONTACTS


**Water Quality Monitoring**
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Iowa Dept. of Natural Resources
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Des Moines, IA 50319
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**Land Treatment/Technical Assistance**
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# Upper Wakarusa – RCWP 6

**Osage, Shawnee & Wabaunsee Counties, Kansas**
**MLRA: M-106**
**H.U.C. 102701**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

This project will contribute little toward the objectives of RCWP due to the lack of a documented water quality impairment.

## II. Water Quality Goals and Objectives (ref. 1)

The project's objective is 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.

Specific Goals:
- Have 95% of the agricultural land area adequately protected.
- 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.

## III. Characteristics and Results

### Background:

The project area was identified as Kansas' number one priority agricultural NPS water quality management area through criteria set in the State Water Quality Management Plan adopted in 1979. Of the 154,011 acre project area, 2/3 was considered to be adequately protected prior to the RCWP project. The project targeted 85% of the remaining area for treatment. Pre-RCWP data showing high TSS and turbidity values targeted sediment as the project's major water quality problem. Runoff from agricultural lands was estimated to produce 2.1 tons/acre/year of sediment load to streams.

The project began to implement erosion control practices on unprotected acres. In 1983 an interagency appraisal of the project by ASCS, SCS, ES and EPA determined that there was no documented water quality problem causing use impairments of waters in the project area (ref 5). The NCC determined that as of September 30, 1983 the project was concluded under RCWP authority, but contracts already approved would be honored and serviced.

**1. Project Type:** RCWP

**2. Timeframe:** 1980-1994

**3. Total Project Budget (for timeframe):** (ref. 9)

| SOURCE / ACTIVITY | Federal | State | Farmer | Other | 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 | 2,328,880 | 0 | 1,500 | 2,408,300 |
| SUM: | 2,860,344 | 2,328,800 | 2,928,000 | 79,040 | $8,196,184 |

**4. Area** (acres):

| Watershed | Project | Critical |
|---|---|---|
| 154,011 | 154,011 | 43,252 |

**5. Project Land Use:**

| Use | %ProjectArea | % Critical Area |
|---|---|---|
| cropland | 40 | 83 |
| rangeland | 41 | 8.6 |
| pasture | 7 | 1.8 |
| forest | 7 | 3 |
| other | 5 | 3.6 |

**6. Animal Operation in Project Area:** 1982 data

| Operation | # Farms | Total # Animals | Total A.U. |
|---|---|---|---|
| hog | 7 | 2100 | 420 |
| dairies | 10 | 375 | 525 |

**7. Water Resource Type:**

Wakarusa River and its tributaries, water district reservoirs, Clinton reservoir, watershed flood-retarding reservoirs.

**8. Water Uses and Impairments:**

Water resources uses are identified for 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 algae growth and sediment (ref. 11). Sediment depositions posed potential threats to wildlife and fish habitats along project streams as well as excess sediment loads to Clinton Reservoir. Potential threat of impairments from phosphorus, bacteria and pesticides was also a concern.

**9. Water Quality at Start of Project:**(ref. 1)

| Condition | TSS mg/L | Turbidity JTU | F.C. #/100ml | $NO_3$ mg/L | TP mg/L |
|---|---|---|---|---|---|
| Runoff event | 1,170 | 519 | 53,400 | 1.0 | 0.73 |
| Low Flow | 106 | 91 | 770 | 0.7 | 0.24 |

No pesticides detected

## 10. Meteorologic and Hydrogeologic Factors:

a. Mean Annual Precipitation: 34.46 inches (most during April-Oct.)
b. USLE 'R' Factor: 200
c. 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.

## 11. Water Quality Monitoring Program:

a. Timeframe: 1981-1994
b. Sampling Scheme: conducted by the Kansas Dept. of Health and Environment
  1. Location and number of 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.)
  2. Sampling Frequency: monthly and for selected runoff events
  3. Sampling Type: grab samples
c. Pollutants Analyzed: sediment, turbidity, nutrients, BOD, pesticides, TSS, nitrate, ammonia, phosphorus (also have periodic analysis of macroinvertebrates, fish and fish tissues).

## 12. Critical Areas:

a. Criteria: The drainage area of two public water supplies was targeted as the number one priority. Drainage areas of 14 constructed and 8 planned PL- 566 watershed retarding structures were targeted as second and third priority. The remainder of the area is fourth priority.

b. Application of Land Treatment According to Criteria: No criteria for critical area identification is given other than the priority areas outlined above. No relationships are given between critical areas and priority areas.

## 13. Best Management Practices:

a. General Scheme: Emphasis of project focused on sediment reduction. Land treatment through conservation tillage, vegetative cover and control structures.
b. Quantified Implementation Goals: treat the unprotected critical area (43,252 acres)
c. Quantified Contracting/Implementation Achievements: The project reports that as of 1987, 71% of 150 contracts have been completed.
d. Cost of BMPs:

| BMP | Average cost share per unit applied | BMP | Average cost share per unit applied |
|---|---|---|---|
| 1 & 11 perm.veg cover | $45/ac | 7 waterways | $375/ac |
| 2 animal waste mgmt. | $9,000ea. | 9 cons. tillage | $11.25/ac |
| 4 terrace systems | $990/mi. | 12 sed. retention | $1,875ea. |
| 5 diversions | $1,584/mi. | 15 fert. mgmt. | 0 |
| 6 grazing land prot. | $3,600ea. | 16 pest. mgmt. | 0 |

e. Effectiveness of BMPs: The project estimates that at completion, the annual sediment delivery to the stream will be reduced by 24% (318,000 to 242,00 tons annually). Also estimate a 25% reduction in sediment load to Clinton Reservoir. (No indication of what these estimates are based on.)

f. Non-RCWP Activities: Twenty-two PL-566 watershed-retarding reservoirs.

## 14. Water Quality Changes:

No documented water quality changes have been seen.

## 15. Changes in Water Resource Use: None

### 16. Incentives:

a. Cost Share Rates: 75% except for grazing land protection (60%)
b. $ Limitations: $50,000 per farm

### 17. Potential Economic Benefits:

a. On-farm: 0
b. Off-farm:
   1. Recreation: little change, probably due to no apparent water quality changes
   2. Water Supply: no change
   3. Wildlife Habitat: may improve, but no real economic benefits
   4. Downstream Impacts: may prolong storage capacity of Clinton Reservoir, but sediment is not currently a problem.

## IV. Lessons Learned

Clear definition and documentation of water quality problems, critical areas and monitoring strategies is important in achieving NPS control objectives.

## V. Project Documents

1. Upper Wakarusa Rural Clean Water Project Plan of Work. 1980.

2. Upper Wakarusa Rural Clean Water Project Application. 1980.

3. Annual Progress Report: Upper Wakarusa RCWP, 1981.

4. Annual Progress Report: Upper Wakarusa RCWP, 1982.

5. Annual Progress Report: Upper Wakarusa RCWP, 1983.

6. Annual Progress Report: Upper Wakarusa RCWP, 1984.

7. Annual Progress Report: Upper Wakarusa RCWP, 1985.

8. Annual Progress Report: Upper Wakarusa RCWP, 1986.

9. Annual Progress Report: Upper Wakarusa RCWP, 1987.

10. Upper Wakarusa River RCWP Monitoring Plan, 1981.

11. Economic Evaluation Progress Report for FY87, Economic Research Service, USDA.

## VI. NWQEP Project Contact

**Land Treatment/ Technical Assistance**
Kansas State ASCS Office
2601 Anderson Avenue
P.O. Box 1448
Manhattan, Kansas 66502

# Bayou Bonne Idee – RCWP 7

**Morehouse Parish, Louisiana**
**MLRA: O-134**
**H.U.C. 080500-01**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

This project has demonstrated a high rate of landowner participation with cost-shared BMPs that have productivity benefits such as land leveling, land smoothing, and irrigation water conveyances. These practices may have been effective in reducing sediment loads to Bayou Bonne Idee, however, an improvement in water quality associated with land treatment has not been documented with the available water quality data.

Reducing sediment loads may reduce the total sedimentation rate, however, this effect may not have a measurable impact on bayou turbidity, pesticide residues in fish, and eutrophication rate. The reasons for this are: 1) field level management may not have the anticipated effect at the watershed level, 2) a large percentage of fine sediment particles may still be reaching the bayou from treated lands, 3) the ratio of phosphorus to sediment is highest for the fine sediment soil fraction, 4) dissolved nutrients in runoff may not be controlled as effectively as sediment loss with the practices (land leveling, land smoothing) used by this project.

## II. Water Quality Goals and Objectives

To abate non-point pollution (sediment and toxic agricultural chemicals) to a level compatible with State water quality standards.

## III. Characteristics and Results

1. **Project Type:** RCWP

2. **Timeframe:** 1980 – 1991

3. **Total Project Budget (for timeframe):**

| SOURCE: / ACTIVITY: | Federal | State | Farmer | Other | SUM: |
|---|---|---|---|---|---|
| Cost-share | 3,000,000 | 0 | 2,320,000 | 0 | 5,320,000 |
| Info. & Ed. | 6,000 | 0 | 0 | 15,000 | 21,000 |
| Tech. Asst. | 728,000 | 0 | 0 | 75,000 | 803,000 |
| Water Quality Monitoring | 650,000 | 72,000 | 0 | 0 | 722,000 |
| SUM: | 4,384,000 | 72,000 | 2,320,000 | 90,000 | $6,866,000 |

4. **Area (acres):**

| Watershed | Project | Critical |
|---|---|---|
| 66,000 | 66,000[a] | 44,880[b] |

[a] originally 220,000
[b] originally 166,452

## 5. Land Use:

| Use | % Project Area | % Critical Area |
|---|---|---|
| cropland | 75 | 100 |
| pasture/range | 4 | |
| woodland | 11 | |
| urban/roads | 10 | |

## 6. Animal Operations in Project Area: not applicable

## 7. Water Resource Type:

Bayou Bonne Idee (meandering - approximately 100 miles long)

## 8. 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. Use of project area water resources is impaired by turbidity, sedimentation, and toxic agricultural chemicals in cropland runoff.

## 9. Water Quality at Start of Project:

Means and Ranges for 6 grab samples taken from Nov. '81 through May '82

| Parameter | Station | Mean | Range |
|---|---|---|---|
| Turbidity | S - 121 | 109 | 10 - 260 |
| (JTU) | S - 122 | 28 | 3 - 120 |
| | S - 123 | 113 | 11 - 360 |
| | S - 124 | 146 | 15 - 330 |
| Total | S - 121 | 176 | 32 - 580 |
| Suspended | S - 122 | 391 | 6 - 140 |
| Solids | S - 123 | 184 | 24 - 440 |
| (ppm) | S - 124 | 83 | 32 - 240 |
| $NO_2 + NO_3$ | S - 121 | 0.39 | 0.02 - 0.74 |
| (ppm) | S - 122 | 0.07 | 0.01 - 0.24 |
| | S - 123 | 0.44 | 0.02 - 0.84 |
| | S - 124 | 0.62 | 0.2 - 0.96 |
| TKN | S - 121 | 1.7 | 0.79 - 2.58 |
| (ppm) | S - 122 | 1.37 | 0.95 - 2.43 |
| | S - 123 | 1.59 | 0.79 - 2.74 |
| | S - 124 | 1.65 | 1.13 - 2.14 |
| Total | S - 121 | 0.43 | 0.11 - 1.03 |
| Phosphorus | S - 122 | 0.29 | 0.06 - 0.83 |
| (ppm) | S - 123 | 0.38 | 0.07 - 0.80 |
| | S - 124 | 0.47 | 0.15 - 0.86 |

Pesiticides: organochlorine pesticide concentrations of about 0.5 ppm in fish tissue samples

## 10. Meteorologic and Hydrogeologic Factors:

a. Mean Annual Precipitation: 48 inches
b. USLE 'R' Factor: 350
c. 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.

**11. Water Quality Monitoring Program:**

a. Timeframe: 1980 - 1990

b. Sampling Scheme: conducted by Department of Natural Resources Water Pollution Control Division

1. Location and Number of Monitoring Stations: 5 bayou stations
2. Sampling Frequency: monthly - water; bi-annual-fish tissue (no fish samples were taken in 1986 and 1987)
3. Sample Type: grab

c. Pollutants Analyzed: 27 pesticides plus 26 conventional parameters

d. Flow Measurements: Instantaneous flow measurements are taken with each grab sample.

e. Other: Automatic stormwater monitoring sampling was unsuccessful due to weather and equipment problems. No sampling has been done under the areawide stormwater monitoring project.

**12. Critical Areas:**

a. Criteria: First priority: three-quarter mile proximity to Bayou Bonne Idee, all cotton land.

b. Application of Criteria: No information available on how strictly criteria have been applied.

**13. Best Management Practices:**

a. General Scheme: Treatment emphasis on furrow irrigation improvements and field borders.

b. Quantified Implementation Goals: Goal is to treat 33,660 acres of cropland. This is 75% of critical area.

c. Quantified Contracting/Implementation Achievements:

| Pollutant Sources | Critical Area Treatment Needs | Project Goals | % Needs / Goals Contracted | % Needs / Goals Implemented |
|---|---|---|---|---|
| Cropland | 44,880 | 33,660 | 60/80 | 62/80 |
| # Contracts | 180 | 135 | 120/160[a] | NA |

[a] Includes contracts developed for original critical area as well as revised critical area.

d. Cost of BMPs:

| BMP | Ave. RCWP Share ($) | BMP | Ave. RCWP Share ($) |
|---|---|---|---|
| 1 Fencing | 0.26/ft. | 11 Field Border | 17/ac. |
| 4 Terraces | 1.08/ft. | 11 ilter Strip | 55/ac. |
| 7 Grassed Waterways | 960/ac. | 12 Grade Stabilization Struc. | 440 ea. |
| 8 Green Manure Crop | 31/ac. | 12 Heavy Use Struc. | 1,430 ea. |
| 9 Land Smoothing | 350/ac. | 13 Irrig. Land Leveling | 170/ac. |
| 9 Crop Residue Use | 3/ac. | 13 Irrig. Water Conveyance | 2.50/ft. |
| 9 Conservation Tillage | 33/ac. | 15 Fert. Management | 2.50/ft. |
| 11 Critical Area Veg | 44/ac. | 16 Pest Management | 1.30/ac. |

e. Effectiveness of BMPs: The project reports that land leveling and smoothing has reduced the amount of sheet erosion taking place on cropland draining to Bayou Bonne Idee. The project has not reported quantification of this impact.

**14. Water Quality Changes:**

The project reports lower turbidity and TSS levels at the downstream monitoring station in comparison with three upstream stations. Problems in data gathering and analysis suggest that the lower parameter concentrations cannot be identified as a result of BMP installation and, in fact, may be due to manipulation of bayou water levels. Toxaphene concentrations in fish tissue have dropped dramatically since 1980. This appears to be due to the use of synthetic pyrethroids instead of toxaphene on cotton. The estimated half-life of toxaphene in fish tissue is about one year.

### 15. Changes in Water Resource Use:

An estimated 10,000 recreational fisherman use the project area water resources each year. Changes in recreational use associated with RCWP activities are unknown.

### 16. Incentives:

a. Cost Share Rates: 75% for soil conservation practices, 50% for irrigation improvements and 90% for farmers located adjacent to the Bayou Bonne Idee

b. $ Limitations: $50,000 maximum

### 17. Potential Economic Benefits:

a. On-farm: not evaluated

b. Off-farm:

1) Recreation: 0 - $40,000 per year.
2) Water supply: 0
3) Commercial fishing: 0
4) Wildlife habitat: unknown
5) Aesthetics: unknown but positive
6) Downstream impacts: 0

## IV. Lessons Learned

The original 220,000 acre project area was much too large to achieve adequate BMP coverage.

Formation of project goals depends on accurate assessment of water resource impairment and identification of critical pollutants. Without these elements it is difficult to identify critical areas and appropriate BMPs for water quality benefits.

High participation levels can be achieved at fairly low cost share rates (50%) for practices which are perceived to have significant productivity benefits.

Practices that have primarily off-site benefits can be tacked onto contracts that include practices with high on-site benefits such as irrigation improvements.

Treating a large project area will not result in high off-farm benefits unless impaired water uses are substantial.

## V. Project Documents


1. Bayou Bonne Idee RCWP Annual Progress Report, 1982.
2. Bayou Bonne Idee RCWP Annual Progress Report, 1983.
3. Bayou Bonne Idee RCWP Annual Progress Report, 1984.
4. Bayou Bonne Idee RCWP Annual Progress Report, 1985.
5. Bayou Bonne Idee RCWP Annual Progress Report, 1986.
6. Bayou Bonne Idee RCWP Annual Progress Report, 1987.

## VI. NWQEP Project Contacts

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**and**
Harry Hawthorne
(same address as above)

# Double Pipe Creek - RCWP 8

**Carroll County, Maryland**
**MLRA: S-148**
**H.U.C. 020700-09**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

The critical area is very small and clearly designated, allowing efficient information & education and technical assistance efforts. Also, there has been a significant shift in BMP emphasis to conservation tillage without RCWP funding in the project area.

The project is showing increased participation in pesticide management, however, no environmental effects are being evaluated. Increased participation is presumably due to significant cost savings to the farmer for reduced pesticide use.

## II. Water Quality Goals and Objectives

Water Quality Objectives:

1. To apply BMPs to address the most critical water quality problems in the project, specifically high fecal coliform bacteria and potential sediment loads.
2. To show a measurable improvement in the degree of water quality.

Specific Goals:

1. Reduce the level of fecal coliform bacteria to below 200MPN/100ml (state standard).
2. Meet the state standard for turbidity at all times for the streams as classified.

## III. Characteristics and Results

**1. Project Type:** RCWP

**2.Timeframe:** 1980-1994

**3. Total Project Budget (for timeframe):**

| SOURCE: ACTIVITY: | Federal | State | Farmer | Other | 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. Area (acres):**

| Watershed | Project | Critical |
| --- | --- | --- |
| 112,200 | 112,200 | 18,180 |

**5. Project Land Use:**

| Use | % Project Area | % Critical Area |
| --- | --- | --- |
| cropland | 65 | NA |
| pasture/range | 12 | NA |
| woodland | 15 | NA |
| urban/roads | 8 | NA |

**6. Animal Operations in Project Area:**

| Operation | # Sources | Total # Animals | Total A.U. |
| --- | --- | --- | --- |
| Dairy | 75 | 19,774 | 27,684 |
| Beef | NA | 6,958 | 6,958 |
| Poultry | 6 | 1,000,000 | 5,000 |
| Hog | NA | 6,222 | 1,244 |
| Horses | NA | 7,747 | 9,296 |

Many of the farmstead and barnyard areas are adjacent to streams.

**7. Water Resource Type:** streams

**8. Water Uses and Impairments:**

Project area streams and ponds provide public water supply for the city of Westminster and surrounding areas, approximately 18,000 people and several businesses. Secondary uses of water resources are contact recreation and fishing.

Water quality impairments are caused by suspended sediment and bacteria. There is also concern about nutrient export to the Chesapeake Bay.

**9.Water Quality at Start of Project:**

Maximum FC bacteria concentrations were 40,000/100 ml. Turbidity after runoff events was often greater than 100 ntu.

**10. Meteorologic and Hydrogeologic Factors:**

a. Mean Annual Precipitation: 45 inches
b. USLE 'R' Factor: 200
c. 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 bottomlands. 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.

**11. Water Quality Monitoring Program:**

a. Timeframe: 1980 - 1990
b. Sampling Scheme: conducted by Maryland Dept. of the Environment
Maryland Dept. of the Environment re-instrumented the Big Pipe Creek in May 1987. Monitoring conducted by Versar from 1982 – 1985. Water quality data have been collected but not analyzed.
1. Location and Number of Monitoring Stations: four on-farm sites; one station at downstream terminus of project area.
2. Sampling Frequency: storm event
3. Sample Type: automated composite sampler

c. Pollutants Analyzed: suspended sediment, fecal coliform, $NH_3$, $NO_3$, TKN, P-total, P-ortho
d. Flow Measurements: continuous

## 12. Critical Areas:

a. Criteria: distance from major streams, size of farm operation, present conservation status
b. Application of Criteria: no evidence that criteria have been rigorously applied

## 13. Best Management Practices:

a. General Scheme: Treat cropland with conservation tillage and install grassed waterways; build waste storage structures for critical animal operations and spread manure based on soil tests.
b. Quantified Implementation Goals: 13,635 acres (12% of project area)
c. Quantified Contracting/Implementation Achievements:

| Pollutant Sources | Critical Area Treatment Needs | Project Goals | %Needs/Goals Contracted | %Needs/Goals Implemented |
|---|---|---|---|---|
| Acres Needing Treatment | 18,180 | 13,635 | 159/212 | NA |
| Dairies | 75 | 60 | 149/187 | NA |
| Poultry | 6 | 4 | 67/100 | NA |
| Livestock | 34 | 26 | 147/192 | NA |
| Cash grains | 125 | 90 | 33/46 | NA |
| # Contracts | 240 | 180 | 86/115 | NA |

d. Cost of BMPs: (from RCWP Table 4, Ref. 8)

| BMP | Ave. Farmer Share ($) | Ave. RCWP Share ($) | Total Cost ($) |
|---|---|---|---|
| 1 perm. veg. cover | 48/ac. | 72/ac. | 120/ac. |
| 2 animal waste mgmt. | 6,500 ea. | 19,500 ea. | 26,000 ea. |
| 3 stripcropping | 5/ac. | 15/ac. | 20/ac. |
| 5 diversions | 0.55/ft. | 1.70/ft. | 2.25/ft. |
| 6 grazing land prot. | 625-5,850 ea. | 1,875-5,850 ea. | 2,500-11,700 ea. |
| 7 waterways | 1.50/ft. | 4.50/ft. | 6/ft. |
| 8 cropland prot. | 12.50/ac. | 12.50/ac. | 25/ac. |
| 9 conservation tillage | 18/ac. | 0/ac. | 18/ac. |
| 10 stream prot. | 860/ea. | 2,600 ea. | 3,460 ea. |
| 11 perm. veg. on crit. ac. | 165/ac. | 160/ac. | 325/ac. |
| 12 sediment retention, erosion control struc. | 875 ea. | 2,625 ea. | 3,500 ea. |
| 15 fertilizer mgmt. | 0.25/ac. | 0.75/ac. | 1/ac. |
| 16 pesticide mgmt. | 1.50/ac. | 4.50/ac. | 6/ac. |

e. Effectiveness of BMPs: 18,427 tons of soil saved per year / 3,267,357 cu.ft. of animal waste stored per year. In 1986, 80% of corn acreage was treated with pesticides. In 1987, pesticide management practices resulted in no pesticides being applied on corn.

f. Non-RCWP Activities: A significant amount of conservation tillage has been implemented without RCWP funding.

## 14. Water Quality Changes:

No water quality changes have been documented to date. Three farm sites that had intensive pre-BMP monitoring were discontinued because the farm operator withdrew his support.

### 15. Changes in Water Resource Use:

There are no documented changes in water resource use. There is very little recreational use and the cost of water treatment for the city of Westminster has not changed since RCWP began.

### 16. Incentives:

a. Cost Share Rates: 75% for most practices
b. $ Limitations: $50,000
c. Assistance Programs: Several landowners have been assisted through ACP.

### 17. Potential Economic Benefits: (ERS)

a. On-farm: (ref 9) Elimination of pesticide application on corn in 1987 is estimated to have saved participating farmers between $56,000 and $85,000.
b. Off- farm:
 1. Recreation: 0
 2. Water Supply (cost saved in treatment): 0
 3. Commercial Fishing: 0
 4. Wildlife Habitat: unknown
 5. Aesthetics: unknown
 6. Downstream Impacts: unknown but positive. As part of a larger effort to improve water quality in the Chesapeake Bay the project could generate off- site benefits.

## IV. Lessons Learned

Project may be a good test of whether an observable pollutant reduction can be achieved by treating specified critical areas that comprise only about 20% of the watershed.

Project personnel consciously directed recruitment efforts to the large producers. The level of treatment indicates that this was an effective strategy.

The project shows that implementation of pesticide management practices can have an economic impact.

Several years and much money were spent monitoring three specific 17-175 acre farm sites; however, all three farmers decided not to implement BMPs. This illustrates the importance of developing a binding contract with landowners whose participation is essential to the project even if it means providing crop insurance or inconvenience payments to the landowner.

## V. Project Documents


1. Rural Clean Water Project: Double Pipe Creek Water Quality Plan of Work 1980 - 1995, 1980.
2. Double Pipe Creek Project: Carroll County Maryland, Annual Progress Report, 1983.
3. Non-Point Source Water Quality Assessment Of Monocacy River Basin With Special Attention to the Double Pipe Creek Watershed. Versar Inc., 1983.
4. Rural Clean Water Project: Double Pipe Creek Water Quality Plan of Work 1980 - 1995 (Revised), 1983.
5. Rural Clean Water Project: Double Pipe Creek Project, 1984 Progress Report, 1984.
6. Rural Clean Water Project: Double Pipe Creek Project, 1985 Progress Report, 1985.
7. Results of the Nonpoint Source Water Quality Program Conducted in the Monocacy River Basin With Special Attention to the Double Pipe Creek Watershed. Versar Inc., February 1986.
8. Rural Clean Water Program: Double Pipe Creek Project, 1986 Plan of Work and Progress Report, 1986.
9. Rural Clean Water Project: Double Pipe Creek Project, 1987 Progress Report, 1987.

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# Saline Valley – RCWP 9

**Washtenaw County, Michigan**
**MLRA: M - 111 and L-99**
**H.U.C. 041000-01**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

The project's ability to document basin level phosphorus reductions from cropland treatment has been hampered by low BMP implementation. The project has been very successful in implementing animal waste systems (BMP 2) and may yet measure phosphorus reductions related to improved management of dairy waste.

## II. Water Quality Goals and Objectives

The objective is to reduce phosphorus loading to project area waterbodies 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%.

## III. Characteristics and Results

1. **Project Type:** RCWP

2. **Timeframe:** 1980-1990

3. **Total Project Budget (for timeframe):**

| ACTIVITY: / SOURCES: | Federal | State | Farmer | Other | 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 | * | 186,761 |
| SUM: | 2,737,105 | 0 | 629,386 | 196,761 | $3,563,252 |

[*] contributing to water quality monitoring budget

4. **Area (acres):**

| Watershed | Project | Critical |
|---|---|---|
| 76,660[a] | 76,660[b] | 42,428 |

[a] Saline River watershed 65,680
Macon Creek watershed 10,650

[b] Project area revised in 1983 - reduced from 200,000

| Subbasins | Acres | Critical Cropland |
|---|---|---|
| Saline-Bridgewater Drain | 3,969 | 2,080 |
| Upstream Saline-Bridgewater Drain | 14,010 | NA |
| Bauer Drain | 4,900 | 1,425 |
| Saline River at | | |
| Dell Road | 6,240 | 2,651 |
| Bear Creek | 2,470 | 1,741 |
| Wanty Drain | 1,920 | 947 |
| N. Macon Creek | 9,728 | 4,900 |

### 5. Land Use:

| Use | % Project Area | % Critical Area |
|---|---|---|
| cropland | 67 | 100 |
| grassland | 10 | |
| forest | 21 | |
| urban/roads | 2 | |

### 6. Animal Operations in Project Area: (ref. 7)

| Operation | # Farms | Total # Animals | Total A.U. |
|---|---|---|---|
| Dairy | NA | 2,795 | 3,913 |
| Young stock | NA | 2,795 | 2,376 |
| Beef | NA | 960 | 816 |
| Hogs | NA | 860 | 172 |
| Horses | NA | 141 | 169 |
| Sheep | NA | 1,925 | 192 |

### 7. Water Resource Type:

Streams and Saline River draining to Lake Erie.

### 8. Water Uses and Impairments:

Water resources in the project area are used for recreation and public water supply. Water quality impairments are caused by high nutrient concentrations and sedimentation.

### 9. Water Quality at Start of Project:

Eutrophic streams. Ortho-P concentrations about 0.1 mg/l. Highest per acre P loading to Lake Erie of any watershed in the area.

### 10. Meteorologic and Hydrogeologic Factors:

a. Mean Annual Precipitation: 32 inches

b. USLE 'R' Factor: 125

c. 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.

### 11. Water Quality Monitoring Program:

a. Timeframe: 1980 – 1990

b. Sampling Scheme: conducted by T. Johengen, University of Michigan Sea Grant Laboratory

1. Location and Number of Monitoring Stations: 8 stations on Saline River and its tributaries plus nine wells to monitor groundwater around three animal waste holding tanks

| Subbasin | Station # | Subbasin | Station # |
|---|---|---|---|
| Saline-Bridgewater Drain | 3 | Wanty Drain | 7 |
| Upstream Saline- Bridgewater Drain | 3A | Saline River at mouth | 8 |
| Bauer Drain | 4 | N. Macon Creek | 9 |
| Dell Road | 5 | | |
| Bear Creek | 6 | | |

2. Sampling Frequency: Surface: weekly - adjusted for dry periods, periods around storms and times of snowmelt. Ground water: 2-4 times per year
3. Sample Type: grab

c. Pollutants Analyzed: for each sampling date – suspended solids, Ortho-P, available P, Total P, $NO_3$, $NH_3$, silica, chloride / groundwater chemistry in wells near animal waste facilities

d. Flow Measurements: weekly

e. Other: biomonitoring using diatoms

### 12. Critical Areas:

a. Criteria: Defined as locations where phosphorus may easily enter waterbodies. Animal waste critical areas vary by season: May to November field spreading within 300 feet of water bodies, increased to 1,000 feet during winter months. Fertilizer and soil erosion critical areas: all cropland located within 1/4 mile of streams.

b. Application of Criteria: Strict adherence to criteria.

### 13. Best Management Practices:

a. General Scheme: nutrient loading reduction from animal waste management, conservation tillage, and fertilizer management

b. Quantified Implementation Goals: 26,400 acres, 27 animal operations (ref. 7, RCWP 3)

c. Quantified Contracting/Implementation Achievements:

| Pollutant Sources | Critical Area Treatment Needs | Project Goals | % Needs/Goals Contracted | % Needs/Goals Installed |
|---|---|---|---|---|
| Cropland | 42,428 | 26,400 | 32 / NA | 51 / NA |
| Dairies(no.) | 27 | 24 | 78 / 88 | 78 / 88 |
| # Contracts | 263 | 165 | 45 / 72 | NA |

| Subbasin | Critical Cropland(acres) | % Subbasin with BMPs (1985 data) ref. 8 |
|---|---|---|
| Saline-Bridgewater Drain | 2,080 | 2.5 |
| Upstream Saline-Bridgewater Drain | NA | 14 |
| Bauer Drain | 1,425 | 17 |
| Dell Road | 2,651 | 13 |
| Bear Creek | 1,741 | 23 |
| Wanty Drain | 947 | 20 |
| N. Macon Creek | 4,900 | 70 |

d. Cost of BMPs: (1981 annual report)

| BMP | Cost ($) |
|---|---|
| 1. Perm. veg. cover | 62.5/acre |
| 2. Animal waste mgmt. syst. | 22,500 each |
| 3. Strip cropping | 6/acre |
| 5. Diversions | 3.75/ft. |
| 7. Waterway systems | 150/acre |
| 8. Cropland protection systems | 4/acre |

| BMP | Cost ($) |
|---|---|
| 9. Conservation tillage | 6.75/acre |
| 10. Stream protection systems | 1.50/ft. |
| 11. Perm. veg. cover | 93.72/acre |
| 12. Sediment retention structures | 1,875 each |
| 15. Fertilizer mgmt. | 4.50/acre |
| 16. Pesticide mgmt. | 5.25/acre |

e. Non-RCWP Activities: 32,902 acres in the project area have been planned for conservation reserve systesm due to requirements of the Food Security Act.

### 14. Water Quality Changes:

Seasonal trends in chemical parameters have been established, however, no trends in water quality at the watershed level have been documented likely due to the fact that overall BMP installation is generally low.

A reduction in phosphorus at station 8 (project outlet) coincides with implementation of a new sewage treatment facility for the city of Milan. (ref. 8)

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. The project suggests 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. (ref. 8)

### 15. Changes in Water Resource Use:

There has been no documented change in recreational use and there is no documented water supply impairment. Recreational use of project area water resources continues to be low.

### 16. Incentives:

a. Cost Share Rates: 75% for most practices
b. $ Limitations: $50,000 maximum
c. Assistance Programs: conservation tillage demonstration fields

### 17. Potential Economic Benefits:

a. On-farm: not evaluated
b. Off-farm:
   1) Recreation: 0
   2) Water Supply: 0
   3) Commercial Fishing: 0
   4) Wildlife Habitat: unknown
   5) Aesthetics: unknown but positive
   6) Downstream Impacts: unknown but positive

## IV. Lessons Learned

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 in the project if monitoring focuses on smaller subbasins with a high level of BMP implementation.

## V. Project Documents

1. Saline Valley Rural Clean Water Project, Michigan. Revised Plan of Work, July 1983.

2. Saline Valley Rural Clean Water Project, Michigan. Annual Progress Report, 1984.

3. Saline Valley Rural Clean Water Project, Michigan. Annual Progress Report, 1985.

4. Holland, R. E., A.M. Beeton and D. Conley. Saline Valley Rural Clean Water Project Interim Report on Monitoring. Great Lakes and Marine Waters Center. October 1985.

5. Saline Valley Rural Clean Water Project, Michigan. Annual Progress Report, 1986.

6. Johengen, T. H., Documenting the Effectiveness of Best Management Practices to Reduce Agricultural Nonpoint Source Pollution. University of Michigan, Department of Atmospheric and Oceanic Sciences. Ann Arbor, MI. 1987.

7. Saline Valley Rural Clean Water Project, Michigan. Annual Progress Report, 1987.

8. Holland, R.E., A.M. Beeton, and T. Johengen. Saline Valley Rural Clean Water Project Interim Report on Monitoring During 1986. December 1987.

## VI. NWQEP Project Contacts

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# Reelfoot Lake - RCWP10

**Obion and Lake Counties, Tennessee**
**and Fulton County, Kentucky**
**MLRA: 0-131 and P-134**
**H.U.C. 080102-02**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

The project is an example of interagency and interstate cooperation in a NPS project.

With the implementation of a PL-566 project in the RCWP project area, it is not possible to monitor the effectiveness of the RCWP alone for erosion control.

## II. Water Quality Goals and Objectives

To reduce sediment delivery to the lake and attain a desirable level of water quality.

## III. Characteristics and Results

1. **Project Type:** RCWP

2. **Timeframe:** 1980 – 1990

3. **Total Project Budget (for timeframe):** $ 4,198,026 estimated / budget breakdown not available

4. **Area (acres):**

| Watershed | Project | Critical |
|---|---|---|
| 153,600 | 153,600 | 52,072 |

5. **Land Use:** (ref. 2, p. 7)

| Use | % Project Area | % Critical Area |
|---|---|---|
| cropland | 41 | NA |
| pasture/range (grassland) | 19 | NA |
| woodland | 20 | NA |
| urban/roads | 1 | NA |
| water and wetlands | 12 | NA |
| state park and wildlife refuges | 7 | NA |

6. **Animal Operations in Project Area:** not applicable

7. **Water Resource Type:**

Reelfoot Lake and tributary streams.

**8. Water Use Impairment:**

Reelfoot Lake is located in a popular state park in Tennessee used primarily for fishing, boating, and waterfowl hunting. The park had over 850,000 visitors during fiscal year 1974 (ref. 2). Other water uses within the project area are irrigation and livestock watering.

Impairments of Reelfoot Lake are: decreased lake volume, decreased fishery and wildlife habitat, and impaired recreational use caused mainly by sediment loading and high nutrient concentrations. The lake has a severe eutrophication problem. Pesticides are reported to be a cause of impairment, but data do not support this claim (ref. 11).

**9. Water Quality at Start of Project:** (ref. 7, pp.39-42A)

Concentrations (mg/l) at Lake Sites (1977-1982)

| Parameter | Station 1 (open water) | Station 2 (near outflow) | Station 4 (near creek confluence) |
|---|---|---|---|
| | x – n | x – n | x – n |
| Suspended solids | 33–8 | 27–7 | 26–7 |
| Phosphates[1] | 0.16–8 | 0.20–8 | 0.12–8 |
| TKN | 1.53–5 | 2.02–6 | 0.97–6 |
| $NO_3$ & $NO_2$ | 0.05–8 | 0.09–8 | 0.04 –8 |

[1] Species not noted.

**10. Meteorologic and Hydrogeologic Factors:**

a. Mean Annual Precipitation: ~48 inches

b. USLE 'R' Factor: ~260

c. 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. Topography is nearly level on uplands to steeply sloped along bluffs adjacent to the lake.

**11. Water Quality Monitoring Program:**

a. Timeframe: September 1987 to December 1989

b. Sampling Scheme: storm runoff and ambient monitoring / conducted by Tennessee Department of Health and Environment Nonpoint Source Program, and U.S.G.S.

1. Location and number of monitoring stations: 3 stations for tributary monitoring - North Reelfoot Creek, South Reelfoot Creek and Running Slough
2. Sampling Frequency: storm event, low and medium ambient flow
3. Sample Type: Flow activated automatic sampling and grab samples

c. Pollutants Analyzed: nutrients, pesticides

d. Flow Measurements:

1. Tributary monitoring: Continuous flow measurements
2. Ungaged stream sites: Instantaneous flow measurements at time of sampling

**12. Critical Areas:**

a. Criteria: 83% of the cropland is designated as critical and is prioritized in three classifications based on cropping intensity, erosion rate, and proximity to the lake and streams.

b. Application of Criteria: Contracts obtained for critical areas but prioritization unknown.

**13. Best Management Practices:**

a. General Scheme: Land treatment emphasized by this project includes erosion controls (e.g. conservation tillage), stream protection, fertilizer and pesticide management.

b. Quantified Implementation Goals:

1. Treat 80% of critical area (41,658 acres)
2. Reduce sediment delivered to the lake by 75%, which is equivalent to sediment reduction of 638,019 tons/year.

c. Quantified Contracting/Implementation Achievements: as of September, 1986 (ref. 11, p. 15)

The table below reflects only RCWP implementation. The project also has a significant amount of non-RCWP implementation under ACP and other programs.

| Location | % Under Contract | % Implemented |
|---|---|---|
| project area | 22 | NA |
| critical area | 64 | NA |

The project has exceeded contracting goals on BMPs 3 (strip cropping), 6 (grazing land protection systems), 11 (permanent vegetative cover on critical areas), 15 (nutrient management), and 16 (pesticide management). However, sediment control practices, the major emphasis of the project, have not achieved the same success.

d. Cost of BMPs: Not available by BMP.

e. Effectiveness of BMPs: positive effect - cumulative soil savings of 720,835 tons (reported for 1981-1987)

**14. Water Quality Changes:**

None have been reported to date. With the ACP and extensive PL-566 project in addition to the RCWP project area, the monitoring program will not document the water quality impacts of RCWP alone.

A preliminary open file report (#88-311) "Stream Flow and Water Quality Data for Three Major Tributaries to Reelfoot Lake, West Tennessee October 1987 - March 1988" is available (ref. 13). A final report is expected by December 1989.

**15. Changes in Water Resource Use:**

There are no documented changes in water use at Reelfoot Lake since RCWP began. However, if the installed BMPs reduce sediment, then the loss of lake capacity and severity of recreational impairments may be reduced.

**16. Incentives:**

a. Cost Share Rates: 75%

b. $ Limitations: $50,000 per landowner

c. Assistance Programs: TN will conditionally pay the other 25% cost share to establish alfalfa on designated steep, erodible lands within the project area.

d. Other Incentives or Regulations: The Conservation Reserve Program provides additional incentives to farmers to convert highly erodible lands to more permanent vegetation.

**17. Potential Economic Benefits:**

a. On-farm: not evaluated

b. Off-farm:

1) Recreation: 0 - $30,000 per year
2) Water Supply: 0 - $2,000 per year
3) Commercial fishing: 0
4) Wildlife Habitat: unknown
5) Aesthetics: unknown but positive
6) Downstream Impacts: 0

## IV. Lessons Learned

Project success requires a high quality advanced information and education program on project content, policies, and those agencies and organizations responsible for the program. Local people need to take part in decisions. A project will be successful if local people make the project their own. Local people need to form an agreement and achievements may have little to do with federal money.

Interstate cooperation is an essential element for the success of this project. Not only is the apparent cooperation between the two states good, but the cooperative efforts of several programs (local, state, and federal) also appear worthy of examination as a model of how multiple agencies can coordinate to address a common water quality goal.

## V. Project Documents


1. Tennessee Department of Public Health, Division of Water Quality Control, 1978. Reelfoot Lake Pesticide Survey, Lake and Obion Counties.

2. Application for RCWP Grant, Reelfoot Lake Drainage Area, 1979. 57pp.

3. USDA-Soil Conservation Service, 1979. Land Treatment Plan for Erosion Control and Water Quality Improvement, Reelfoot Lake Drainage Area. 34pp.

4. Reelfoot Lake RCWP Project Plan of Work, 1980.

5. Tennessee Department of Public Health, Division of Water Quality Control, 1981. Monitoring and Evaluation Plan Reelfoot-Indian Creek Watershed RCWP. 21pp.

6. Smith, W.L. and T.D. Pitts, 1982. Reelfoot Lake: Summary Report. University of Tennessee, Martin, TN. 128pp.

7. Local Coordinating Committee Reelfoot Lake RCWP, 1982. Reelfoot Lake RCWP Annual Progress Report. 151pp.

8. Local Coordinating Committee Reelfoot Lake RCWP, 1983. Reelfoot Lake RCWP Annual Progress Report.

9. Local Coordinating Committee Reelfoot Lake RCWP, 1984. Reelfoot Lake RCWP Annual Progress Report.

10. Local Coordinating Committee Reelfoot Lake RCWP, 1985. Reelfoot Lake RCWP Annual Progress Report.

11. Local Coordinating Committee Reelfoot Lake RCWP, 1986. Reelfoot Lake RCWP Annual Progress Report.

12. Local Coordinating Committee Reelfoot Lake RCWP, 1987. Reelfoot Lake RCWP Annual Progress Report.

13. "Stream Flow and Water-Quality for Three Major Tributaries to Reelfoot Lake, West Tennessee, October 1987 - March 1988," Tenn. Dept. of Health and Environment and US Geological Survey.


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# Snake Creek - RCWP 11

**Wasatch County, Utah**
**MLRA: E-47**
**H.U.C. 160202-03**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

Reported monitoring results from Snake Creek indicate a 90% reduction in average P concentration and a 99% decrease in fecal coliform numbers after BMP installation. Results from Huffaker Ditch indicate about 83% reduction in average P 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.

## II. Water Quality Goals and Objectives

Objectives are to reduce the pollution entering Deer Creek Reservoir from agricultural NPS and to determine effectiveness of selected BMPs achieving water quality improvement. The goal is to reduce the total phosphorus in Snake Creek by 50% (650 kg), in Huffaker Ditch by 75% (597 kg), and in Bunnel Ditch by 75% (120 kg).

## III. Characteristics and Results

1. **Project Type:** RCWP

2. **Timeframe:** 1980 – 1990

3. **Total Project Budget (for timeframe):**

| SOURCE: / ACTIVITY: | Federal | State | Farmer | Other | SUM: |
|---|---|---|---|---|---|
| Cost-share | 161,000 | 0 | 64,850 | 0 | 225,850 |
| Info. & Ed. | 3,000 | 0 | 0 | 0 | 3,000 |
| Tech. Asst. | 76,800 | 0 | 1,600 | 0 | 78,400 |
| Water Quality Monitoring | 143,422 | 0 | 0 | 47,808 | 191,230 |
| SUM: | 384,222 | 0 | 66,450 | 47,808 | $498,480 |

4. **Area (acres):**

| Watershed | Project | Critical |
|---|---|---|
| 523,403 | 700 | 489 |

5. **Project Land Use:** (ref. 4, p. 16-17, and ref.6, p.5)

| Use | % Project Area | % Critical Area |
|---|---|---|
| cropland (mostly alfalfa) | 90 | 91 |
| pasture/range | 4 | 9 |
| urban/roads | 6 | 0 |

**6. Animal Operations in Project Area:**

| Operation | # Operations | Total # Animals | Total A.U. |
|---|---|---|---|
| Dairy | 2 | 216 | 302 |
| Beef | 5 | 230 | 196 |
| Horse | 1 | 18 | 22 |

All considered critical sources.

**7. Water Resource Type:**

The water resources are irrigation canals draining into Snake Creek which flows into the Provo River slightly upstream from the river's discharge into Deer Creek Reservoir.

**8. Water Uses and Impairments:**

Water is stored in Deer Creek Reservoir, located just outside of the project area, primarily for municipal, industrial and irrigation use in neighboring valleys. Recreational use of the reservoir is also important (351,571 visitors during 1978 - ref. 1). About 500,000 people in the Salt Lake Valley received potable water from the reservoir when the project began in 1980.

The reservoir has a eutrophication problem 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 (ref. 10).

**9. Water Quality at Start of Project:** Nov. 1979 to Dec. 1981 (ref.4)

Station 14 (Snake Creek near base of project area)

| | min. | max. | mean | n |
|---|---|---|---|---|
| TP (mg/1) | 0.02 | 0.71 | 0.14 | 33 |
| TKN (mg/1) | 0.10 | 3.90 | 0.851 | 33 |
| FC (#/100ml)* | 30 | 7500 | 889 | 13 |

Station 6 (ditch downstream from dairy farm)

| | min. | max. | mean | n |
|---|---|---|---|---|
| TP (mg/1) | 0.04 | 0.56 | 0.19 | 31 |
| TKN (mg/1) | 0.10 | 4.60 | 1.08 | 31 |
| FC (#/100ml)* | 13 | 12,800 | 1,762 | 10 |

* Feb. 1981-Dec. 1981 only

**10. Meteorologic and Hydrogeologic Factors:**

a. Mean Annual Precipitation: 16.4 inches

b. USLE 'R' Factor: ~30

c. 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 residium 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.

**11. Water Quality Monitoring Program:**

a. Timeframe: Nov. 1979 – 1990

b. Sampling Scheme: conducted by the Mountainland Association of Governments

1. Location and Number of Monitoring Stations: Initially, the project monitored water quality at 20 stations along Snake Creek, Provo River and several irrigation ditches. As of 1986, monitoring has been reduced to seven stations.
2. Sampling Frequency: monthly, with weekly samples taken during spring runoff.
3. Sample Type : grab

c. Pollutants Analyzed: TP, OP, TKN, $NO_3$, $NO_2$, $NH_3$, BOD, TSS, TDS, conductivity, temperature, and pH
d. Flow Measurements: instantaneous at time of sampling

## 12. Critical Areas:

a. Criteria: Since this is a small project area, all major animal operations were considered critical.
b. Application of Treatment According to Criteria: adequate

## 13. Best Management Practices:

a. General Scheme: Project proposed to install animal waste management systems (BMP 2) on all farms in the project area.
b. 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 had 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.
c. Quantified Contracting/Implementation Achievements:

| Pollutant Sources | Critical Area Treatment Needs | Project Treatment Goals | % Needs / Goals Contracted | % Needs/Goals Implemented |
|---|---|---|---|---|
| Acres Needing Treatment | 489 | 456 | 93 / 100 | NA |
| Dairies | 4[a] | 4 | 100 / 100 | 100 / 100 |
| Feedlots | 4[b] | 2 | 50 / 100 | 50 / 100 |
| # Contracts | 8 | 6 | 75 / 100[c] | 75 / 100 |

[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.
[c] As of 1986.

d. Cost of BMPs: Cost shares not available by BMP.
e. Effectiveness of BMPs: Examination of recent data indicates continued water quality improvement.

## 14. Water Quality Changes:

Significant water quality improvements attributable to BMP implementation have been reported (ref. 9, p. 101). On the main reach of Snake Creek, analysis showed 43 to 90% reduction in TP, OP, TKN and FC concentrations. Recent data (1985 and 1986) from stations 10 and 14 indicate continued water quality improvement. Analysis of Huffaker Ditch (ref. 9, p. 101) shows 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. (For further discussion see appendix to NWQEP Annual Report, 1985.)

## 15. Changes in Water Resource Use:

Actual visitation appears to have increased as a result of opening the park for year-round use. The reservoir is still used as a primary water supply for several nearby towns and is considered to be of good quality.

## 16. Incentives:

a. Cost Share Rates: 75%
b. $ Limitations: $50,000 per landowner
c. Assistance Programs: none reported

**17. Potential Economic Benefits:**

a. On-farm: not evaluated

b. Off-farm:

1) Recreation: 0

2) Water Supply: $4,000 per year.

3) Commercial Fishing: 0

4) Wildlife Habitat: unknown

5) Aesthetics: unknown

6) Downstream impacts: 0

## IV. Lesson Learned

This project has not only been successful in reducing nutrient and bacterial concentrations, but is also exemplary for its region. Other dairies in the Heber Valley area now are considering installing similar practices after seeing the success of the Snake Creek RCWP.

The impact of the project alone on Deer Creek reservoir would have been negligible because the project area constitutes less than 1% of the reservoir drainage. However, the RCWP project, in combination with several county-wide NPS control efforts, has contributed significantly to documented improvements in the water quality of Deer Creek reservoir.

The small area of this project made it ideal for nearly complete implementation and ease of tracking. Water quality data analyses by NWQEP identified two critical areas: one small reach of the Snake Creek and Huffaker Ditch. These analyses also indicated that it may not have been necessary to install practices outside of these two critical areas.

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.

## V. Project Documents


1. Mountainland Association of Governments, 1979. Application for Rural Clean Water Program Funds, Snake Creek, Wasatch County, Utah. 34 pp.

2. Snake Creek Experimental Rural Clean Water Program, 1980. Plan of Work. 25pp.

3. Mountainland Association of Governments, 1980. Snake Creek RCWP Monitoring Study Progress Report. Provo, Utah. 53pp.

4. Snake Creek Local Coordinating Committee, 1982. Annual Progress Report on the Snake Creek Rural Clean Water Program. Wasatch County, Utah.

5. Snake Creek Local Coordinating Committee, 1983. Annual Progress Report on the Snake Creek Rural Clean Water Program. Wasatch County, Utah.

6. Snake Creek Local Coordinating Committee, 1984. Annual Progress Report on the Snake Creek Rural Clean Water Program. Wasatch County, Utah.

7. Snake Creek Local Coordinating Committee, 1985. Annual Progress Report on the Snake Creek Rural Clean Water Program. Wasatch County, Utah.

8. Snake Creek Local Coordinating Committee, 1986. Annual Progress Report on the Snake Creek Rural Clean Water Program. Wasatch County, Utah.

9. Sowby and Berg Consultants. Deer Creek Reservoir and Proposed Jordanelle Reservoir Water Quality Management Plan. Prepared for Wasatch and Summit Counties, Provo, Utah. (1984)

10. Snake Creek Local Coordinating Committee, 1987. Annual Progress Report on the Snake Creek Rural Clean Water Program. Wasatch County, Utah.

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# St. Albans Bay - RCWP 12

**Franklin County, Vermont**
**MLRA: R-142**
**H.U.C. 020100-05,07**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts:

This project has made substantial contributions in the following areas:

Water Quality Monitoring: The project has provided information on the level of monitoring needed to detect changes in watershed nutrient loadings and concentrations and design of watershed monitoring programs.

Land Use Monitoring: The project is using GIS to examine what level of land use tracking is needed to tie water quality changes to land use activities.

Effectiveness of BMPs: Modeling and monitoring by the project provide additional information about the nutrient reductions from various animal waste management practices.

Contributions in each of these areas are discussed in detail in the 1985 NWQEP RCWP-CM&E Report.

## II. Water Quality Goals and Objectives

The project's goal is to improve the water quality in St. Albans Bay and restore beneficial uses by reducing the amount of phosphorus, nitrogen and other nutrients entering the Bay.

## III. Characteristics and Results

1. **Project Type:** RCWP, Comprehensive Monitoring and Evaluation

2. **Timeframe:** 1980 – 1991

3. **Total Project Budget (for timeframe):**

| ACTIVITY: \ SOURCES: | Federal | State | Farmer | Other | SUM: |
|---|---|---|---|---|---|
| Cost-share | 1,682,144 | 0 | 560,714 | 0 | 2,242,858 |
| Info. & Ed. | 18,670 | 43,224 | 0 | 0 | 61,894 |
| Tech. Asst. | 961,552 | 0 | 0 | 0 | 961,552 |
| Water Quality Monitoring | 1,682,102 | 456,712 | 0 | 0 | 2,138,814 |
| SUM: | 4,198,668 | 499,936 | 560,714 | 0 | $5,405,118 |

4. **Area (acres):**

| Watershed | Project | Critical |
|---|---|---|
| 33,344 | 33,344 | 15,257 |

| Subwatershed | Total Acres | Critical Acres |
|---|---|---|
| Jewett Brook | 3,421 | 2,720 |
| Stevens Brook | 5,994 | 1,840 |
| Rugg Brook | 3,825 | 1,640 |
| Mill River | 14,358 | 5,980 |
| Stevens Wetland | 15,186 | 8,540 |
| Guayland Brook | 1,236 | 380 |
| Direct to Bay | 1,383 | 357 |

## 5. Land Use: (ref. 22 - 1986 data)

| Use | % Project Area | % Critical Area |
|---|---|---|
| corn | 11 | NA |
| hayland | 33 | NA |
| pasture | 19 | NA |
| woodland | 21 | NA |
| other | 16 | NA |

## 6. Animal Operations in Project Area:

| Operation | # Farms | Total # Animals | Total A.U. |
|---|---|---|---|
| Dairy | 98 | 6,500 est. | 9,100 |

## 7.Water Resource Type:

St. Albans Bay and project area streams.

## 8. Water Uses and Impairments:

St. Albans Bay has been used heavily for recreation in the past. From 1960 to 1978, annual day use of St. Albans State Park declined from 27,456 to 3,458 users due to worsening eutrophic conditions in the Bay (ref. 1). Boating, swimming and aesthetic enjoyment of the Bay are impaired by excessive macrophytes and algal growth.

## 9. Water Quality at Start of Project:

St. Albans Bay frequently had eutrophic conditions in summer.

## 10. Meteorologic and Hydrogeologic Factors:

a. Mean Annual Precipitation: 33 inches

b. USLE 'R' Factor: 100

c. 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.

## 11. Water Quality Monitoring Program:

a. Timeframe: 1980 - 1990

b. Sampling Scheme: conducted by the Water Resources Research Center at the University of Vermont

1. Location and Number of Monitoring Stations: 4 bay stations; 5 tributary stations.

| Subwatershed | Station # |
|---|---|
| Jewett Brook | 21 |
| Stevens Brook | 22 |
| Rugg Brook | 23 |
| Mill River | 24[a] |
| Stevens Wetland | 26[b] |
| Guayland Brook | 43 |

[a] includes Rugg Brook

[b] include Jewett Brook and Stevens Brook

2. Sampling Frequency: bi-weekly-bay; tributaries- storm and ambient
3. Sample Type (e.g. grab, automatic): bay-grab; tributaries- automatic

c. Pollutants Analyzed: TSS, VSS, TP, OP, Turbidity, FC, $NO_3$, $NH_3$, TKN

d. Flow Measurements: continuous

e. Other: biological monitoring

## 12. Critical Areas:

a. Criteria: Amount of manure, distance from watercourse, present manure management practices, manure spreading rates.

b. Application of criteria: The project has applied criteria rigorously to cost share applications.

## 13. Best Management Practices:

a. General Scheme: Install waste storage systems, control barnyard runoff, spread manure at proper rates

b. Quantified Implementation goals: treat 11,443 acres and 64 dairies

c. Quantified Contracting/Implementation Achievements: (ref. 22)

| Pollutant Sources[a] | Critical Area Treatment Needs | Project Goals | % Needs / Goals Contracted | % Needs / Goals Implemented |
|---|---|---|---|---|
| Acres Needing Treatment | 15,257 | 11,443 | NA / 101 | NA / 61 |
| Dairies | 98 | 64 | NA / 98 | NA / 59 |
| #Contracts | 98 | 64 | 64 / 98 | 63 |

[a] Total Animal Units in Watershed — 73% contracted / 66% under best management
Total Nitrogen and Total Phosphorus in Manure — 73% contracted / 66% under best management

| Subwatershed | % Critical Acres Contracted | % Manure Contracted | % Goal Installed |
|---|---|---|---|
| Jewett Brook | 78 | 81 | 75 |
| Stevens Brook | 55 | 55 | ~95[a] |
| Rugg Brook | 55 | 48 | ~100[a] |
| Mill River | 74 | 65 | ~100[a] |
| Stevens Wetland | 79 | 78 | 75 |

[a] only a few practices left to be installed in these subwatersheds

d. Cost of BMPs: Installation costs of the two major types of manure storage systems (180 day storage) for a 48 cow herd are:

| System | Total Cost ($) | Per cow Cost ($) |
|---|---|---|
| Earthen-pit | 15,230 | 263 |
| Above-ground | 43,844 | 756 |

Of these costs, RCWP pays about 75%.

e. Effectiveness of BMPs: Model results indicate that implementation of BMPs will cause total phosphorus to decline 47% overall (a 73% reduction in critical TP load) and sediment to decrease 12% (an 86% reduction in critical sediment load) (ref. 22).

f. Other: Animal waste management syatems (BMP 2) account for 77% of obligated cost-share funds. BMP 12, water control structures used to treat barnyard runoff, account for 19% of obligated cost-share funds (ref 22).

### 14. Water Quality Changes:

Bay stations trend analysis: The project reports that total phosphorus concentrations in 1986-87 were significantly greater than in 1982- 83, and this is presumed to be related to discharges during upgrading of a sewage treatment plant. No improving trend in phosphorus concentrations has been documented. (ref. 22)

Tributary mass export trends: Total phosphorus and ortho-phosphorus exports have significantly decreased in Stevens Brook. Mass exports of phosphorus at other tributary streams have been less since 1983-84. (ref. 22)

### 15. Changes in Water Resource Use:

Recreational use of the bay could more than double if significant improvements in water quality are perceived. Use of shoreline properties will also increase as water quality improves.

### 16. Incentives:

a. Cost Share Rates: 75% for animal waste management
b. $ Limitations:50,000 maximum
c. Assistance Programs: ACP funds are also being used

### 17. Economic Benefits:

a. On-farm: A farmer's net income is likely to improve with installation of manure management systems with RCWP cost-sharing of 75%. For the typical 48 cow herd and 180 day storage the increase in pre-tax income ranges from $900 for an above-ground system to $2,000 for an earthen-pit system. In total, farmers' net income over 50 years is projected to be $800,000 higher (discounted to present value) as a result of RCWP. This benefit comes primarily from labor, fertilizer and tax savings which exceed a farmer's share of costs.

b. Off-farm: Improving water quality in St. Albans Bay to that found in Lake Champlain would produce the following benefits (total over 50 years, discounted):

| Benefit | $ Million |
|---|---|
| Recreation enhancement (swimming and boating) | 5.2 |
| Property value increase around bay | 1.3 |
| Reduced bay weed treatment | minor |
| Total | 6.5 |

Part of these benefits would be due to improvements in municipal wastewater treatment.

## IV. Lessons Learned

Agricultural nonpoint source control projects can be designed so that benefits associated with water quality improvement exceed the costs of the project, even when the cost of treatment is relatively high.

1. Even in expensive dairy waste management projects, a high level of farmer participation can be obtained if there is:
– 75% cost share rates;
– a full-time coordinator who promotes participation;
– a high level of community and landowner awareness of the water quality problems; and
– substantial on-farm labor and fertilizer savings.

2. In project area with a history of over-application of nutrients, simply reducing nutrient application rate to meet crop uptake demand may not be sufficient to achieve nutrient loading reductions in the near term because of the large nutrient reservoir in the soil.

The project has identified critical TP and sediment loads as the percentage of total loads that can be controlled by BMPs. Evaluation based on critical loads provides a better understanding of actual pollutants being addressed through BMP implementation.

Models developed by the Vermont SCS have been used effectively to assess sources of agricultural NPS phosphorus and sediment, critical and total pollutant loads, changes over time, and BMP selection. This type of modeling effort at the beginning of a project would be useful for ranking farms and setting treatment priorities.

## V. Project Documents


1. An Application for Assistance for a Rural Clean Water Program - St. Albans Bay, Lake Carmi Watersheds, Vermont Agency of Environmental Conservation.

2. Rural Clean Water Program - St. Albans Bay Project Plan of Work. 1980.

3. Technical Manual for the SNR Water Resource Research Center (WRRC) - Computerized Data Management System (COMS)

4. Comprehensive Monitoring and Evaluation Plan for the St. Albans Bay, Vermont Rural Clean Water Program. February 1981. Vermont Rural Clean Water Coordinating Committee.

5. St. Albans Bay Watershed RCWP Project Comprehensive Monitoring & Evaluation. June - November 1981. Progress Report

6. Comprehensive Monitoring and Evaluation - Progress Report for 1981 - St. Albans Bay, Vermont, Rural Clean Water Program. January 1982. Vermont Rural Clean Water Coordinating Committee.

7. Socioeconomic Evaluation - St. Albans Bay, Vermont - Annual Report. 1982. C. Edwin Young.

8. St. Albans Bay Rural Clean Water Program - Annual Report. November 1982. U.S. Department of Agriculture, Vermont Water Resources Research Center.

9. St. Albans Bay Rural Clean Water Program - Annual Progress Report. 1983. U.S. Department of Agriculture, Vermont Water Resources Research Center.

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15. St. Albans Bay Watershed RCWP Project Comprehensive Monitoring and Evaluation - Progress Report. May 1986.

16. St. Albans Bay Rural Clean Water Program. Annual Progress Report. 1986.

17. Ribaudo, Mark O., C. E. Young and D. J. Epp. Recreation Benefits from Improvements in Water Quality at St. Albans Bay, Vermont. Staff Report no. AGES840127, Economic Research Services, U.S.D.A., March 1984.

18. Young, C. Edwin. "Perceived Water Quality and the Value of Seasonal Homes." Water Resources Bulletin, 20:153, April 1984.

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20. Frevert, Kathleen and Bradley Crowder. Analysis of Agricultural Nonpoint Pollution Control Options in the St. Albans Bay Watershed, Staff Report No. AGES870423. Economic Research Service, U.S.D.A., June 1987.

21. Ribaudo, Mark, C. Edwin Young, and James S. Shortle. Impacts of Water Quality Improvement on Site Visitation: A Probabilistic Modeling Approach. Water Resources Bulletin, Vol. 22. No. 4. August 1986. pp. 559-563.

22. St. Albans Bay Rural Clean Water Program 1987 Annual Progress Report. Vermont RCWP Coordinating Committee, December, 1987.

23. St. Albans Bay Watershed RCWP Project Comprehensive Monitorng and Evaluation Progress Report — Year 8, No. 1. September, 1987 - November, 1987.

## VI. NWQEP Project Contacts

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# Lower Manitowoc River Watershed - RCWP 13

**Manitowoc, Brown, and Calumet Counties, Wisconsin**
**MLRA: L-95 A & B**
**H.U.C. 040301-01**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

Little information on the water quality effectiveness of BMPs will be determined by this project. Although implemented practices may improve water quality, monitoring is not designed to detect it water quality changes as a result of RCWP implementation.

## II. Water Quality Goals and Objectives

The project's primary goal is to reduce phosphorus loads from agricultural nonpoint sources by 48%. Other goals are to minimize further degradation of Bullhead Lake by reducing P loads, improve macroinvertebrate community integrity in Lower and Little Manitowoc Rivers, and reduce fecal coliform counts to below 200/100 ml in the watershed.

## III. Characteristics and Results

1. **Project Type:** RCWP

2. **Timeframe:** 1980–1990

3. **Total Project Budget (for timeframe):** (ref. 8, p. 17)

| SOURCE: ACTIVITY: | Federal | State | Farmer | Other | 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 | 20,557 | 0 | 0 | 125,036 |
| Water Quality Monitoring | 0 | 5,000 | 0 | 0 | 5,000 |
| SUM: | 922,579 | 26,457 | 591,900 | 0 | $1,540,936 |

4. **Area (acres):**

| Watershed | Project | Critical |
|---|---|---|
| 352,000 | 102,000 | 23,598 |

5. **Project Land Use:**

| Use | % Project Area | % Critical Area |
|---|---|---|
| cropland | 67 | NA |
| woodland | 28 | NA |
| urban/roads | 5 | NA |

**6. Animal Operations in Project Area:** (reported – ref.4 pp. 8, 13, and 15)

| Operation | # Farms | Total # Animals | Total A.U. |
|---|---|---|---|
| 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.

**7. Water Resource Type:**

A small lake, Manitowoc River, wetlands and streams, all draining to Lake Michigan.

**8.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 the 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. The lake is eutrophic as a result of excess phosphorus which impairs the fishery. The fishery in the river is also 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 adjacent to the watershed. This number does not include recreational visitors to the watershed.

**9. Water Quality at Start of Project:** (ref. 4, p.5)

Phosphorus Loadings Measured at the Mouth of the Manitowoc River

| Year | Pounds of P Per Year[1] |
|---|---|
| 1973 | 211,000 |
| 1974 | 196,000 |
| 1975 | 106,000 |
| 1976 | 103,000 |
| 1977 | 39,000 |
| 1978 | 182,000 |
| Mean | 139,500 |

[1]P loads are from multiple point and nonpoint sources. The estimated P load from livestock waste and cropland erosion from the project area is 55,080 pounds of P per year (ref.7 p.20).

**10. Meteorologic and Hydrogeologic Factors:**

a. Mean Annual Precipitation: ~29 inches
b. USLE 'R' Factor: ~100
c. Geologic Factors: Topography varies from rolling to moderately steep. Soils are generally fine-textured with clay loams predominant. Precipitation does not readily infiltrate into these heavy soils and runoff is high.

**11. Water Quality Monitoring Program:**

a. Timeframe:
   1. Mouth of river: 1973 – 1990 and could continue
   2. Biological Monitoring: Mostly in the upper reaches and tributaries in the project area from 1979 to 1982. One site on a tributary will continue to be biologically monitored probably from 1985 to 1987.

b. Sampling Scheme: conducted by Wisconsin Dept. of Natural Resources

1. Location and Number of Monitoring Stations:
   Two water quality stations at the base of the project area are located above and within the city of Manitowoc. These stations are influenced, however, by the backwash of Lake Michigan, point sources, urban NPS, the RCWP project area, and areas upstream from the project. Thirteen sites were biologically monitored, 4 are located on the lower Manitowoc River and 9 are located on tributaries to the river.
2. Sampling Frequency: (ref.4, p.22)
   Mouth of river: In the zone of influence of urban sources and Lake Michigan)
   1973 – 1979--monthly and high flow 1979 – 1982--biweekly, 1982 – 1990--monthly
   Biological monitoring: Once in the fall and spring of 1979 and 1982. Fall and spring sampling of one site will continue from 1985 to 1987. The continuing site, however, was not selected to show impact of the project.
3. Sample Type:
   Mouth of river: not reported, probably grab sample
   Biological monitoring: sampling arthropods by grab samples with D-frame aquatic net

c. Pollutants Analyzed: Mouth of river: suspended solids, VSS, TP, soluble P, dissolved silica, total lead, chloride, total zinc, total solids, conductivity, copper, cadmium, and nickel

d. Flow Measurements: mouth of river with automatic, continuous equipment

e. Other: The project reports that the monitoring program has failed. The primary reasons are:
   1) The monitoring station at the mouth of the Manitowoc River is influenced by many pollution sources in addition to agricultural NPS from the RCWP project area; and
   2) Funds are not available to install monitoring stations in subbasins. In addition, subbasins contain point sources and large wetlands which would mask the effects of BMPs.

## 12. Critical Areas:

a. Criteria:
1. all lands within 1/8 mile of water course
2. lands with slopes 6% or greater that are 1/4 mile from water course
3. livestock operations have been categorized as follows:
   – need of barnyard runoff controls and manure storage--104 large operations
   – need of manure storage--88 large operations
   – small water quality impact--83 smaller operations
   – no impact on water quality--58 large operations

b. Application of Criteria: procedures well established and consistent

## 13. Best Management Practices:

a. General Scheme:
   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 1, 2, 3, 4, 5, 7, 9, 10, 11, and 12.

b. Quantified Implementation Goals:
   The project's treatment goals are to treat 75% of the critical areas, including dairies and erosion sources other than livestock farms.

c. Quantified Contracting/Implementation Achievements as of September 1987 (ref. 9)

| Pollutant Sources | Critical Area Treatment Needs | Project Treatment Goals | % Needs / Goals Contracted | % Needs / Goals Implemented |
|---|---|---|---|---|
| Acres Needing Treatemnt | 23,598 | 15,936 | 57 / 85 | 31 / 45 |
| Dairies | 153 | 115 | NA | 27 / 37 |
| Feedlots | 0 | 0 | 0 | 0 |
| Erosion | 39 | 29 | NA | 15 / 21 |
| **# Contracts:** | 192 | 144 | 69 / 92 | NA |

d. Cost of BMPs:

| BMP | Ave. Farmer Share ($) | Ave. RCWP Share ($) | Total Cost ($) |
|---|---|---|---|
| 1 Perm. veg. cover | 35/ac. | 35/ac. | 70/ac. |
| 2 Animal waste mgmt. | 890-9,000 ea. | 2,075-11,860 ea. | 2,965-16,940 ea. |
| 3 Stripcropping | 7/ac. | 16.40/ac. | 23.40/ac. |
| 4 Terracing | 3/ft. | 7/ft. | 10/ft. |
| 5 Diversions | 0.47/ft. | 1.10/ft. | 1.57/ft. |
| 7 Waterways | 865/ac. | 2,015/ac. | 2,880/ac. |
| 9 Contour Farming | 2.40/ac. | 5.60/ac. | 8/ac |
| 9 Conservation Till. | 8.25/ac. | 19.30/ac. | 27.55/ac. |
| 10 Stream Crossings | 300 ea. | 700 ea. | 1,000 ea. |
| 10 Fencing | 0.27/ft. | 0.62/ft. | 0.89/ft. |
| 11 Perm. veg. on crit. ac. | 46/ac. | 106/ac. | 152/ac. |
| 12 Sediment retention, erosion, water control | 128 ea. | 300 ea. | 428 ea. |

e. Effectiveness of BMPs:

The model CREAMS has been used to estimate relative differences in nutrient losses under different management practices. Results showed that storing manure for application just before fall plowing could reduce N and P losses (kg/ha/yr) by 8.3% and 54% compared to winter spreading.

The project estimates a cumulative soil savings of 22,357 tons/year.

Project estimates of P load reduction resulting from BMP implementation are: 51% from manure spreading, 23% from barnyard runoff, 60% from steep sloped cropland, and 13% from shallow sloped cropland.

## 14. Water Quality Changes:

The monitoring program is inadequate to document water quality changes related to RCWP efforts.

## 15. Changes in Water Resource Use:

The city of Manitowoc continues to pump water from the harbor for domestic use. About 10 days per year high bacteria levels due to heavy rains preclude use of the harbor as a water supply and secondary rain collector wells are used as a water supply. The secondary wells need to be maintained as long as periods of high bacteria levels occur. There is no information indicating any change in recreational use. The average amount of material dredged from the harbor since RCWP began has been 25,000 cubic yards per year, compared to 41,400 cubic yards per year prior to RCWP. However, there has been a large amount of variation in dredging rates due to varying rainfall levels.

## 16. Incentives:

a. Cost Share Rates: BMPs 1 and 3 are cost shared at 50%; BMP 2, animal waste transfer components, are cost shared at 40%; all other BMP 2 components have 70% rate; BMPs 4, 5, 7, 9, 10, 11, and 12 have 70% rate.

b. $ Limitations: $50,000 per landowner

c. Assistance Programs: Within the project area a state cost sharing program is being used in conjunction with the RCWP project.

d. Other Incentives or Regulations: none reported

**17. Potential Economic Benefits:**

a. On-farm: not evaluated

b. Off-farm:

1) Recreation: 0
2) Water Supply: $40,000 per year.
3) Commercial Fishing: 0
4) Wildlife Habitat: unknown
5) Aesthetics: unknown
6) Downstream Impacts: unknown but positive

## IV. Lessons Learned

If a majority of the practices under contract are installed, there could be an improvement in water quality from reducing agricultural NPS in the project area. The biological monitoring was performed prior to substantial BMP implementation and the two monitoring sites at the base of the watershed reflect the influence of the total watershed including urban areas. Thus, the water quality monitoring design cannot adequately document the sources of contamination (i.e., incoming waters from the upper portion of the watershed, backwash from Lake Michigan, point sources, and urban and agricultural NPS) nor the cause of any potential water quality improvement. Thus, any water quality benefit from this project will not be documented.

## V. Project Documents

1. Lower Manitowoc River Watershed Application for RCWP, 1979. Manitowoc, Brown, and Calumet Counties, Wisconsin, 17pp.

2. The Lower Manitowoc River Priority Watershed Plan, 1979. Wisconsin. 50pp.

3. Lower Manitowoc River Watershed RCWP, (no date). 44 pp.

4. 1982 Annual Report of the Lower Manitowoc River Watershed RCWP, 1982. Wisconsin. 68 pp.

5. 1983 Annual Report of the Lower Manitowoc River Watershed RCWP, 1983. Wisconsin.

6. 1984 Annual Report of the Lower Manitowoc River Watershed RCWP, 1984. Wisconsin.

7. 1985 Annual Report of the Lower Manitowoc River Watershed RCWP, 1985. Wisconsin.

8. 1986 Annual Report of the Lower Manitowoc River Watershed RCWP, 1986. Wisconsin.

9. 1987 Annual Report of the Lower Manitowoc River Watershed RCWP, 1987. Wisconsin.

## VI. NWQEP Project Contacts

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# Taylor Creek - Nubbin Slough Basin — RCWP 14

**Okeechobee and Martin Counties, Florida**
**MLRA: U-156A**
**H.U.C. 030901-02**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

The effectiveness of reducing phosphorus levels in Lake Okeechobee by preventing dairy cows from lounging in streams should be documented by this project. The combined effectiveness of stream protection, grazing land management, fertilizer management, and animal waste management to improve water quality on the subwatershed and watershed scales should be measured as well.

## II. Water Quality Goals and Objectives

The project seeks to reduce phosphorus and nitrogen loading to Lake Okeechobee by 50% measured at the watershed outlet. (ref. 15)

## III. Project Characteristics and Results

1. **Project Type:** RCWP

2. **Timeframe:** 1981 – 1991

3. **Total Project Budget (for timeframe):** (ref. 15)

| ACTIVITY: / SOURCE: | Federal | State | Farmer | Other | SUM: |
|---|---|---|---|---|---|
| Cost-share | 1,104,250 | 0 | 400,892 | 0 | 1,505,142 |
| Info. & Ed. | 13,000 | 0 | 0 | 0 | 13,000 |
| Tech. Asst. | 416,952 | 0 | 0 | 0 | 416,952 |
| Water Quality Monitoring | 0 | 400,000 | 0 | 0 | 400,000 |
| SUM: | 1,534,202 | 400,000 | 400,892 | 0 | $2,335,094 |

4. **Area (acres):**

| Watershed | Project | Critical |
|---|---|---|
| 110,000 | 110,000 | 63,109 |

| Sub-Watershed | Total | Critical |
|---|---|---|
| NW Taylor Creek | 12,203[a] | 11,865 |
| Little Bimini | 3,776[a] | 4,050 |
| Otter & E. Otter Creek | 10,753[a] | 10,753 |
| Main Taylor Creek | 11,031 | 6,464 |
| Williamson Ditch | 21,026 | 9,774 |
| Mosquito Creek | 12,836 | 4,101 |
| Nubbin Slough | 11,934[b] | 7,091 |
| Henry Creek | 10,049 | 4,255 |
| Lettuce Creek | 16,247 | 4,756 |

[a] Otter Creek, NW Taylor Creek, and Little Bimini are not perfectly defined hydrologically. There is an additional 8,077 acres in the Taylor Creek Headwaters defined by these 3 subwatersheds, but these are not critical.
[b] The total area my be larger by approximately 2800 acres with non-critical acreage east of Mosquito Creek.

## 5. Land Use:

| Use | % Project Area | % Critical Area |
|---|---|---|
| cropland | 2 | 0 |
| (mostly citrus groves) | | |
| pasture/range | | |
| a. dairy | 30 | 52 |
| b. beef | 45 | 48 |
| woodland and | | |
| wet prairies | 18 | 0 |
| urban/roads | 5 | 0 |

## 6. Animal Operations in Project Area:

| Operation | # FarmsTotal | # Animals | Total A.U. |
|---|---|---|---|
| Dairy | 24 | 28,000 | 39,200 |
| Beef | 56 | 25,000 | 21,250 |

## 7.Water Resource Type:

Streams, canals, Lake Okeechobee

## 8. Water Uses and Impairments: (ref. 3,12, 15)

Lake Okeechobee is the source of public drinking water for five towns around the lake. It is also the secondary source of water supply for the lower east coast from West Palm Beach to Miami. A commercial fishery worth $6.3 million annually is supported by the lake. The lake's sport fishing industry is worth $22 million annually (ref. 15). In addition, a diverse wildlife habitat draws many tourists to the lake area.

The Taylor Creek – Nubbin Slough Basin contributes a disproportionate amount of phosphorus to Lake Okeechobee (~30% of P load in only ~4% of inflow to the lake). Use of lake waters is impaired by eutrophic conditions.

## 9. Water Quality at Start of Project:

1980 mean annual concentrations at station S-191, the outlet of project area (ref.3, p.19).

| Pollutant | (mg/l) |
|---|---|
| TP | 0.99 |
| OP | 0.88 |
| TN | 3.33 |
| $NO_3$ $NH_3$ $NO_2$ | 1.01 |

## 10. Meteorologic and Hydrogeologic Factors:

a. Mean Annual Precipitation: 50.0 inches
b. USLE 'R' Factor: ~400
c. Geologic Factors: Topography is relatively flat. Soils are coarse textured, mostly poorly drained with rapid permeability and medium drainage. An organic hard pan underlies much of the area with loam or marl under the rest, all of a depth of less than 50 inches. The water table is very shallow. Seasonal groundwater fluctuations are closely related to the seasonality of rainfall.

**11. Water Quality Monitoring Program:**

a. Timeframe: RCWP monitoring is from 1981 to 1991; some stations have been monitored for water quality since 1978. Discharge at 5 reaches has been monitored since the early 1970's.

b. Sampling Scheme:

1. Location and Number of Monitoring Stations:
   There are 23 instream grab stations within the project area. These do not include Lake Okeechobee, which is monitored by other programs. Monitoring is performed by the South Florida Water Management District.
2. Sampling Frequency: biweekly
3. Sample Type: grab samples, with instantaneous flow measurements starting May, 1983 for those stations that had not been monitoring discharge. Continuous samplers were installed in 1987 and 1988 in some locations (personal communications).

c. Pollutants Analyzed: TP, OP, $NO_3$, $NO_2$, $NH_3$, TKN, pH, conductivity, turbidity, and color

d. Flow Measurements: Five stations have had flow monitored since the early 1970's. The other stations have had flow monitored since May, 1983.

e. Other: Precipitation and ground water levels have also been monitored within the project area.

**12. Critical Areas:**

a. Criteria: (1) all dairy farms in the project area, (2) beef cattle farms that have been extensively drained (especially improved and fertilized pastures), and (3) areas within 1/4 mile of streams, ditches, and channels that hold water year-round

b. Application: Application of criteria is exceptionally strict, with graphic reports of the critical areas and contracted areas of the project on a subwatershed scale. There appears to be little contracting of non-critical areas.

**13. Best Management Practices:**

a. General Scheme: The emphasis of BMP contracts is on grazing land management and protection, animal waste management, and stream protection (i.e., RCWP BMPs 1, 2, 6, and 10). Other BMPs include diversion systems, reduction of barn yard waste by improving water use efficiency, improved irrigation and/or water management and sediment retention (RCWP BMPs 5, 13, and 12). The Florida Department of Environmental Regulation (DER) has imposed a Dairy Rule. This requires the dairies to collect and dispose of runoff from high intensity areas on their farms, so that all of the phosphorus effluent would be assimilated by plants or absorbed by the soil.

b. Quantified Implementation Goals: The project has achieved its two implementation goals: (1) contracting 75% of the critical area and (2) contracting all 24 dairy farms in the project area. Two of these farmers elected not to participate after seeing their plans.

c. Quantified Contracting/Implementation Achievements: as of September 30, 1987. (ref.15)

| Pollutant Sources | Critical Area Treatment Needs | Project Treatment Goals | % Needs / Goals Contracted | % Needs / Goals Implemented |
|---|---|---|---|---|
| Acres Needing Treatment | 63,109 | 47,332 | 87 / 116 | 84 / 112 |
| Pasture/range | na | na | 80 / na | na |
| Dairies (# farms) | 24 | 24 | 92 / 92 | na |
| Cattle (# farms) | 35 | 26 | 86 / 116 | na |
| Hog (# farms) | 5 | 5 | 40 / 40 | na |
| Citrus (# farms) | 2 | 2 | 0 / 0 | 0 |
| # Contracts | 56 | 37 | 82 / 124 | na |

Critical Acres and Farms Contracted per Subwatershed:

| Subwatershed | %Critical acres contracted | % Farms contracted |
|---|---|---|
| N.W. Taylor Creek | 92 | 67 |
| Little Bimini | 100 | 100 |
| Otter Creek | 98 | 100 |
| Main Taylor Creek | 74 | 56 |
| Williamson Ditch | 99 | 83 |
| Mosquito Creek | 89 | 50 |
| Nubbin Slough | 98 | 100 |
| Henry Creek | 57 | 33 |
| Lettuce | 58 | 80 |

d. Cost of BMPs:

| BMP | Ave. Farmer Share ($) | Ave. RCWP Share ($) | State Share ($) | Total Cost ($) |
|---|---|---|---|---|
| 2 animal waste mgmt. | 51.35/ac. | 45.75/ac. | 13.60/ac. | 110.70/ac. |
| 5 diversions | 6.80/ac. | 1.40/ac. | 16.70/ac. | 24.90/ac. |
| 6 grazing land prot. | 2.65/ac. | 8.20/ac. | 1.70/ac. | 12.55/ac. |
| 10 stream prot. | 7.20/ac. | 28.50/ac. | 9.80/ac. | 45.50/ac. |
| 12 sediment retention & erosion control struc. | 9.80/ac. | 31/ac. | 8.20/ac. | 49/ac. |

e. Effectiveness of BMPs: The project has a study to document the effectiveness of removing cows from a stream. The preliminary results show that fencing cows away from the stream access, manure management, and fertilizer management are effective in decreasing the P concentrations exiting the project area.

## 14. Water Quality Changes:

This project has had a high rate of BMP implementation with most of the implementation occurring in 1985 and 1986. This allows for a very nice pre-BMP water quality data base which can be quantified more accurately in the next few years. There is strong evidence, however, that two dairy closures in the Otter Creek subwatershed (Sept. 1981 and 1985) had a possible impact on the phosphorus level in Otter Creek (Ref. 16). Mosquito Creek also shows a significant decrease in total phosphorus (Ref. 16).This subwatershed has an intensive BMP implementation program. In contrast, in northwest Taylor Creek subwatershed (in the upper part of the project area), increased animal densities have had a negative effect on water quality (Ref. 16).

There has been an overall decrease in total P concentration at station S191 (the main discharge to Lake Okeechobee from this watershed) (Ref. 16). 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 Mosquito Creek subwatershed. Fencing cows away from stream access, manure management, and fertilizer management are thought to be significant contributors to the decreased total P concentrations.

### 15. Changes in Water Resource Use:

Lake Okeechobee continues to be used for commercial fishing and as a primary water supply for approximately 27,000 people. Commercial fishing harvests have increased from 3.08 million pounds in 1981-1982 to 6.26 million pounds in 1984-1985. Water for domestic use continues to need treatment for algae related problems. No recreational fishing use data is available to indicate user trends. However, recreational fish harvests have increased from 660,300 fish in 1981-1982 to 1,248,100 fish in 1984-1985. Most of the variation in recreational fishing appears to be the result of low water levels in the early 1980's.

### 16. Incentives:

a. Cost Share Rates: (federal) 75% for structural BMPs
b. $ Limitations: (federal) $50,000 per landowner
c. Assistance Programs: include supplemental state funds for cost sharing BMPs in some parts of the basin to raise cost share to 100%.
d. Other Incentives or Regulations: The landowners have two incentives for implementing BMPs during this project period: cost- sharing is available for structural BMPs and technical assistance is available for all contracted BMPs. The 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 $450,000 per barn to comply with this rule.

### 17. Potential Economic Benefits:

a. On-farm: not evaluated
b. Off-farm:
   1) Recreation: 0 - $1,800,000 per year.
   2) Water Supply: $80,000 per year.
   3) Commercial Fishing: $250,000 - $1,000,000 per year.
   4) Wildlife Habitat: unknown
   5) Aesthetics: unknown but positive
   6) Downstream Impacts: 0

## IV. Lessons Learned

This project has used two tactics to attract farmer participation: the threat of regulation and the incentive of higher cost share rates in some subwatersheds (with supplemental state funds). These methods appear to have been successful in that the project has exceeded its contracting goal. This project is demonstrating that a large project can be successful. if it is well organized, tightly managed and sufficiently funded

In a large project area with several impaired water uses the off-farm benefits are potentially very high. When combined with low cost land treatment, positive benefits from nonpoint source control are being documented. Fencing cows away from stream access, manure management, and fertilizer management are thought to be significant contributors to the decreased total P concentrations. The project believes that the low cost RCWP BMPs when compared to the DER rule are a more cost effective method of treating nonpoint pollution (ref. 15).

The DER rule is very expensive (up to $200,000 per barn). The $50,000 per farm RCWP cost share funding limit has been a constraint to addressing the waste disposal problems of the high cattle intensive dairies.

The impact of the DER Dairy rule will make it difficult to monitor the long term water quality effects attributed to the RCWP BMPs. Fortunately, this project has one of the best pre-BMP data bases in the RCWP and will have at least 2 to 3 years of post-treatment water quality data collected prior to most of the DER effort. The monitoring should also be able to quantify the additional water quality effects of the DER program.

## V. Project Documents

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8. Taylor Creek-Nubbin Slough RCWP No. 14, November, 1983. Annual Progress Report. Okeechobee County, FL.

9. Taylor Creek-Nubbin Slough RCWP No. 14, November, 1984. Annual Progress Report. Okeechobee County, FL.

10. Kratzer, C.R. and P.L. Brezonik. 1984. Application of Nutrient Loading Models to the Analysis of Trophic Conditions in Lake Okeechobee, Florida. Environmental Management, 8(2):109-120.

11. Taylor Creek-Nubbin Slough RCWP No. 14, November, 1985. Annual Progress Report. Okeechobee County, FL.

12. Taylor Creek-Nubbin Slough RCWP No. 14, November, 1986. Annual Progress Report. Okeechobee County, FL.

13. Bowers, A.R. and W.F. Brandes. 1986. Evaluation of Treatment Alternatives for the Removal of Phosphorous From Taylor Creek / Nubbin Slough. Chemical and Environmental Services, Inc., 3200 West End Ave, Suite 405, Nashville, Tennessee 37203.

14. Bell, F.W. 1987. Economic Impact and Valuation of the Recreational and Commercial Fishing Industries of Lake Okeechobee, Florida. Department of Economics, Florida State University, Tallahassee, Florida.

15. Stanley, J., V. Hoge, L. Boggs, G. Ritter. November, 1987. Taylor Creek - Nubbin Slough Project, Rural Clean Water Program Annual Progress Report. Okeechobee County, FL.

16. Ritter, G.J. and E.G. Flaig. 1987. Taylor Creek-Nubbin Slough Project Rural Clean Water Program Annual Progress Report: 1986 Water Quality monitoring and Water Quality Trend Analysis. South Florida Water Management District, Department of Resource Planning - Water Quality Division.

17. Heatwole, C.D., A.B. Bottcher, and L.B. Baldwin. 1987. Modeling Cost-Effectiveness of Agricultural Nonpoint Pollution Abatement Programs on Two Florida Basins. Water Resources Bulletin, 23(1):127-131.

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# Lower Kissimmee River — RCWP 14 A

**Okeechobee, Highlands, and Glades Counties, Florida**
**MLRA: U-156A**
**H.U.C. 030901-02**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

The effectiveness of reducing phosphorus levels in Lake Okeechobee by intensive BMP implementation directed towards 'nutrient mass balance', (i.e. recycling all nutrients produced on large dairy farms) should be documented by this project. The combined effectiveness of stream protection from cows lounging in streams, grazing land management, fertilizer management, and animal waste management to improve water quality on the subwatershed and watershed scales should also be measured as well. Efficiency and long-term effectiveness of individual BMP practices should be demonstrated.

## II. Water Quality Goals and Objectives

The project seeks to reduce phosphorus loadings to Lake Okeechobee by 90% measured at the watershed outlet. (ref. 1)

## III. Characteristics and Results

1. **Project Type:** RCWP (expansion project of the Taylor Creek - Nubbin Slough Basin RCWP)

2. **Timeframe:** 1987–NA

3. **Total Project Budget (for timeframe):** (ref. 1)

| SOURCE: / 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. | 617,000 | 0 | 0 | 0 | 617,000 |
| Water Quality Monitoring | 0 | na | 0 | 0 | na |
| SUM: | 1,562,840[a] | 2,570,000 | 601,030 | 0 | $4,733,870 |

[a] $1,249,840 of this is RCWP funds.

4. **Area (acres):**

| Watershed | Project | Critical |
|---|---|---|
| 223,700 | 223,700 | 15,500 |

## 5. Land Use:

| Use | % Project Area | % Critical Area |
|---|---|---|
| cropland (citrus groves) | 0.1 | 0 |
| pasture/range | | |
| a. dairy (milk barns/pastures) | 7 | 100 |
| b. beef grazing | 91 | 0 |
| woodland and | | |
| urban/roads | 2 | 0 |

## 6. Animal Operations in Project Area:

| Operation | # FarmsTotal | # Animals | Total A.U. |
|---|---|---|---|
| Dairy | 15[a] | 18,000 | 25,450 |
| Beef | 155 | 68,500 | 58,225 |

[a] There are 19 milking barns.

## 7.Water Resource Type:

Streams, canals, Lake Okeechobee

## 8. Water Uses and Impairments:

Lake Okeechobee is the source of public drinking water for five towns around the lake. It is also the secondary source of water supply for the lower east coast from West Palm Beach to Miami. The lake is a source of irrigation water for 500,000 acres of cropland on the south side of the lake. A commercial fishery worth $6.3 million annually is supported by the lake. The lake's sport fishing industry is worth $22 million annually. In addition, a diverse wildlife habitat draws many tourists to the lake area.

The Lower Kissimmee River Basin delivers 20 percent of the total phosphorus and 25 percent of the total nitrogen to Lake Okeechobee with 31 percent of inflow to the lake. Use of lake waters is impaired by eutrophic conditions. The major sources of phosphorus are nutrient runoff from improved pastures that receive animal and fertilizer applications and direct deposits by cattle in the streams and ditches. Additionally, congregation of dairy cows in holding areas near the milking barns creates a diffuse point source of water pollution.

## 9. Water Quality at Start of Project:

Phosphorus concentrations in discharges at the outlet from this project area may exceed 1.0 mg/l. Baseline data is currently being evaluated.

## 10. Meteorologic and Hydrogeologic Factors:

a. Mean Annual Precipitation: 48.0 inches (primarily from June to October)
b. USLE 'R' Factor: ~400
c. Geologic Factors: Topography is relatively flat. Soils are coarse textured, mostly poorly drained with rapid permeability and medium drainage. An organic hard pan underlies much of the area with loam or marl under the rest, all of a depth of less than 50 inches. The water table is very shallow. Seasonal groundwater fluctuations are closely related to the seasonality of rainfall.

## 11. Water Quality Monitoring Program:

a. Timeframe: RCWP monitoring is from January, 1987 to unknown
b. Sampling Scheme:
1. Location and Number of Monitoring Stations:
There are several in-stream grab stations within the project area. In addition, individual dairy and beef pasture sites will be instrumented and monitored with automatic samplers. Lake Okeechobee is monitored by other programs. Monitoring is performed by the South Florida Water Management District.

2. Sampling Frequency: weekly and event sampling. In addition, automated samplers collecting time- or flow-proportional water samples will be conducted on major tributaries, at water control structures along major canals, and at each of the dairies.
3. Sample Type: grab samples, with instantaneous stream and ground water stage measurements and automated samplers at some sites. Baseline water quality data has been collected since January, 1986 at selected sites.

c. Pollutants Analyzed: TP, OP, $NO_3$, $N0_2$, $NH_4$, TKN, pH, conductivity, dissolved oxygen, temperature, turbidity, and color

d. Flow Measurements: Stream stage and flow conditions recorded with water quality samples.

e. Other: Precipitation and ground water levels have also been monitored within the project area. Flumes are being constructed for discharge measurements at selected dairies.

f. Water Quality Monitoring Objectives: (1) water quality assessment and provide baseline stream water quality data; (2) phosphorus assessment and forecasting of P-reductions at key dairies, specific beef cattle operations, tributaries, and structures. Selected stations will be used to determine the level of uncertainty associated with the monitoring network. Modeling will be used to forecast the P-reduction throughout the watershed. Investigations of P movement and retention in soil will be performed on one or more dairies by monitoring and modeling; (3) evaluation of specific BMPs, i.e. the efficiency and long-term effectiveness of individual practices on typical soils and land drainage patterns to reduce phosphorus loads to Lake Okeechobee; and (4) identify episodic high phosphorus loads and locate source areas.

**12. Critical Areas:**

a. Criteria: (1) all dairy farms in the project area, (2) high cow/acre density, (3) proximity to flowing water, (4) need for a lagoon system, (5) management potential, (6) farming practices, and (7) herd size

b. Application: The areas with high animal concentrations will be treated first and pastures will be treated second. Treatment will be only on critical areas.

**13. Best Management Practices:**

a. General Scheme: The BMPs are directed towards recycling all nutrients produced on the farm to comply with the Florida Department of Environmental Regulation (DER) Dairy Rule. This rule requires the dairies to collect and dispose of runoff from high intensity areas on their farms, so that all of the phosphorus effluent would be assimilated by plants or absorbed by the soil. This is known as the nutrient mass balance concept. Specific BMPs will include the capture and diversion of runoff from holding areas and milking barns, then apply it to a cropping system to meet plant needs (BMP-5). Cattle will be fenced from streams (BMP-10). Lagoons and waste disposal systems are installed on dairies (BMP-2). Portable shades and watering facilities will be used to keep animals away from streams and low areas. Other BMPs include: fertilizer management (BMP-15), water control structures to collect run-off from fields (BMP-12), grazing land protection (BMP-6), permanent vegetative cover for pasture and hayland management (BMP-1), pesticide management (BMP-16), and proper crop rotation to utilize waste effluent (BMP-8). The BMP emphasis is similar to the Taylor Creek-Nubbin Slough Project, with the addition of Waste Management Systems (BMP-2) that will be used to capture nutrients.

b. Quantified Implementation Goals: (1) contract 100% of the critical area and (2) contract all 15 dairy farms with their 19 milking barns in the project area. Implementation is planned to be over a three year period.

c. Quantified Contracting/Implementation Achievements: as of September 30, 1987. (ref.1)

| **Pollutant Sources** | **Critical Area Treatment Needs** | **Project Treatment Goals** | **% Needs / Goals Contracted** | **% Needs / Goals Implemented** |
|---|---|---|---|---|
| Acres Needing Treatment | 15,500 | 15,500 | 68 / 68 | NA[a] |
| Dairies (# farms) | 15 | 15 | NA | NA |
| Milking Barns (3) | 19 | 19 | NA | NA |
| # Contracts | 14 | 14 | NA | NA |

[a] Contracts on 10,500 acres are scheduled for implementation in FY 1988.

d. Cost of BMPs: It is estimated that it will cost an average of $238,000 per dairy barn in the Lower Kissimmee basin to comply with the implementation plan.

e. Effectiveness of BMPs: The project has 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 initiated in 1988 and baseline data only is available at this time.

### 14. Water Quality Changes:

Not documented due to recent starting date of project.

### 15. Changes in Water Resource Use:

The RCWP did not start implementation until 1988. Therefore, no changes in phosphorus loading to Lake Okeechobee from this watershed have been due to the RCWP to date. The Lake continues to be used for commercial fishing and as a primary water supply for approximately 27,000 people. Commercial fishing harvests have increased from 3.08 million pounds in 1981- 1982 to 6.26 million pounds in 1984-1985. Water for domestic use continues to need treatment for algae related problems. No recreational fishing use data is available to indicate user trends. However, recreational fish harvests have increased from 660,300 fish in 1981-1982 to 1,248,100 fish in 1984-1985. Most of the variation in recreational fishing appears to be the result of low water levels in the early 1980's.

### 16. Incentives:

a. Cost Share Rates: (federal) 75% for structural BMPs
b. $ Limitations: (federal) $50,000 of RCWP funds per landowner
c. Assistance Programs: Supplemental state funds for cost sharing BMPs.
d. Other Incentives or Regulations: The landowners have two incentives for implementing BMPs during this project period: cost-sharing is available for structural BMPs and technical assistance is available for all contracted BMPs. The 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 over $450,000 per barn to comply with this rule.

### 17. Potential Economic Benefits:

a. On-farm: not evaluated
b. Off-farm: not evaluated

## IV. Lessons Learned

This project has used two tactics to attract farmer participation: the threat of regulation and the incentive of higher cost share rates in some subwatersheds (with supplemental state funds). These methods appear to be successful in that the project has contracted two- thirds of its critical area in the first year.

Compliance with the State Dairy Rule requires determination of nutrient mass balance at the farm level. Use of this technique will result in better quantification of P loads associated with land use which in turn will lead to more efficient land treatment. The type and extent of land treatment required for compliance with the Dairy Rule will likely be more expensive than low cost BMPs for this watershed. The pollutant sources are large dairy operations and will need intensive waste management systems at milking barns costing over $200,000 per barn. The $50,000 per farm cost-share limit under RCWP has been a constraint to addressing the waste disposal problems of these dairies and beef cattle operations.

Monitoring should also be to quantify the combined water quality effects of intensive waste management systems and lower cost BMPs for stream protection.

## V. Project Documents

1. Stanley, J., V. Hoge, L. Boggs, G. Ritter, and E. Flaig. January 1988. Lower Kissimmee River Project Rural Clean Water Program Annual Progress Report. Okeechobee, Florida. (Addition to Taylor Creek-Nubbin Slough RCWP.)

## VI. NWQEP Project Contacts

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# Westport River Watershed - RCWP 15

**Bristol County, Massachusetts**
**MLRA: R-145**
**H.U.C. 010900-04**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

The project will make little contribution because it has a low level of implementation.

## II. Water Quality Goals and Objectives

The goal of the project is to improve water quality so that shellfish beds can be reopened.

## III. Characteristics and Results

1. **Project Type:** RCWP

2. **Timeframe:** 1981 – 1991

3. **Total Project Budget (for timeframe):** (1986 Project Progress Report, RCWP-5)

| ACTIVITY: / SOURCE: | Federal | State | Farmer | Other | SUM: |
|---|---|---|---|---|---|
| Cost-share | 518,401 | 0 | 172,799 | 0 | 691,200 |
| Info. & Ed. | 10,350 | 0 | 0 | 500 | 10,850 |
| Tech. Asst. | 214,640 | 500 | 0 | 0 | 215,140 |
| Water Quality Monitoring | 0 | 0 | 0 | 0 | |
| SUM: | 743,391 | 500 | 172,799 | 500 | $917,190 |

4. **Area (acres):**

| Watershed | Project | Critical |
|---|---|---|
| 47,000 | 47,000 | 473 |

Part of project area is in Rhode Island.

5. **Project Land Use:**

| Use | % Project Area | % Critical Area |
|---|---|---|
| cropland | 0.6 | 62 |
| pasture/range | 0.4 | 38 |
| other | 99 | |

6. **Animal Operations in Critical Area: (ref. 8, p. 5)**

| Operation | # Farms | Total # Animals | Total A.U. |
|---|---|---|---|
| Dairy | 7 | 1,440 | 2,016 |

**7. Water Resource Type:**

There are wetlands and lakes in the upper section of the watershed which drain into the West Branch of the Westport River. Both the East and West Branches of the river discharge into an estuary.

**8. 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 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 reported impaired uses include boating, contact recreation, and fishery.

**9. Water Quality at Start of Project:**

1979 Coliform Bacteria Data for Station 6 at Hix Bridge, the impaired tidal area: (ref. 4, p.36, ref. 6, pp. 34-36)

| | FC (*) | TC (**) | n |
|---|---|---|---|
| log mean (#/100ml) | 62 | 103 | 7 |
| median (#/100ml) | 36 | 91 | 7 |
| % exceedance 43/100 ml | 28 | --- | 7 |
| % exceedance 23/100 ml | --- | 43 | 7 |

* U.S.EPA recommendations for shellfishing waters include: a) median FC value should not exceed a MPN of 14 per 100 ml and b) not more than 10% of the samples should exceed an MPN of 43 (Quality Criteria for Water, 1976).
** MA Water Quality Standards for shellfishing waters include: a) median TC shall not exceed 70 MPN per 100 ml and b) not more than 10% of the samples shall exceed 230 MPN per 100 ml.

**10. Meteorologic and Hydrogeologic Factors:**

a. Mean Annual Precipitation: 39.8 inches
b. USLE 'R' Factor: ~ 150
c. 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.

**11. Water Quality Monitoring Program:**

a. Timeframe: 1982 – 1990
b. Sampling Scheme: conducted by SCS and Massachusetts Public Health Service
1. Location and Number of Monitoring Stations: 10 sampling stations, 9 of which are along the fresh water tributaries and streams and one is located in the tidal estuary.
2. Sampling Frequency: approximately 6 to 10 times per year
3. Sample Type: It appears that all stations except site 5 are monitored by grab samples. Site 5 has an automatic sampler but grab samples are taken for bacterial analysis.

c. Pollutants Analyzed: temperature, pH, DO, TC, FC, FS, Chloride, TSS, TDS, $NO_3$, $NO_2$, TKN, TP, DP, conductivity, and alkalinity.
d. Flow Measurements: For freshwater stream stations, the stage is to be measured and converted to flow after hydraulic analysis is completed. None of these values (stage or flow) has yet been reported by the project.
e. Other: In 1986 the sampling scheme changed to an intensive survey (Sept. 20 - Oct. 10, 1986) with a total of 7 samples taken and analyzed for salinity, fecal strep. and fecal coliform. Temperature was measured (growing area) and E coli was included in this list for the fresh water runoff. After this survey sampling returned to the scheme outlined above.

## 12. Critical Areas:

a. Criteria: The critical area was redefined to focus on dairy farms, which are the sources of bacterial contamination. 8 dairy farms are in the critical area.
b. Application of Criteria: Practices are being implemented outside the critical area. Participation within the critical area is poor. Cultural barriers between project personnel and most dairy farmers, the USDA Dairy Buy-Out program, and uncertainty in the dairy industry are factors in this project.

## 13. Best Management Practices:

a. General Scheme: RCWP BMPs approved for this project are 1-12, 15, and 16. The main focus, however, is on animal waste management.
b. Quantified Implementation Goals: To contract with all 8 dairies in critical area, and to treat all agricultural land within the critical area. Four farms in the critical area have contracts.
c. Quantified Contracting/Implementation Achievements: As of Sept. 30, 1986 (ref. 7, p. 6,13)

| Pollutant Sources | Critical Area Treatment Needs | Project Goals | % Needs / Goals % Contracted | % Needs / Goals % Implemented |
|---|---|---|---|---|
| Acres Needing Treatment | 473 | 473 | 110 | NA |
| Dairies | 8 | 8 | 5 | NA |
| Feedlots | 8 | 8 | 5 | NA |
| # Contracts | 8 | 8 | 14 | NA |

d. Cost of BMPs:

| BMP | Ave. Farmer Share ($) | Ave. RCWP Share ($) | Total Cost ($) |
|---|---|---|---|
| 1 perm. veg. cover | 124/ac. | 115/ac. | 239/ac. |
| 2 animal waste mgmt. | 18,200 ea. | 23,900 ea. | 42,100 ea. |
| 4 terraces | 2.87/ac. | 7.80/ac. | 10.67/ac. |
| 7 waterways | 0.56/ac. | 1.70/ac. | 2.26/ac. |

e. Effectiveness of BMPs: not reported to date

## 14. Water Quality Changes: no improvements have been reported

## 15. Changes in Water Resource Use:

Shellfish bed closures have continued in the Westport River area. The number of closed areas have increased due to continued high bacteria levels, with the greatest impact on oyster production. Commercial oyster harvests have decreased from 340 bushels in 1980 to 85 bushels in 1985. Harvests of other shellfish have generally increased during the same time period despite high bacteria levels. The amount of recreational shellfishing appears to be relatively steady, with 959 permits issued in 1985 compared to 814 permits in 1981.

## 16. Incentives:

a. Cost share rates: 75%
b. $ Limitations: $50,000 per landowner
c. Assistance Programs: None have been reported as part of the RCWP project other than I&E and technical assistance. ACP funds have been used to establish cover crops within the watershed.

**17. Potential Economic Benefits:**

a. On-farm: not evaluated

b. Off-farm:

1) Recreation: 0
2) Water Supply: 0
3) Commercial Fishing: 0
4) Wildlife Habitat: unknown
5) Aesthetics: unknown
6) Downstream Impacts: 0

## IV. Lessons Learned

Criteria for selecting critical areas were not well established at the beginning of the project and did not focus on the main cause of impairment. However, in 1986 the project redefined the critical area, focusing on dairy runoff. Although an adequate water quality monitoring design was employed, it will do little good if sufficient and appropriate BMP implementation is not achieved.

There has been a jurisdictional problem on the Rhode Island state boundary concerning who should address bacterial contamination which appeared downstream in the West Branch of the Westport River in Massachusetts. There has also been a communication problem concerning project activities because of cultural differences between project personnel and Portuguese dairy owners within the project area.

## V. Project Documents


1. Rose, D. and P. Fisher (ASCS), 1981. Westport River Watershed Application for USDA - RCWP Special Project. Bristol County, MA 47 pp.
2. Westport River RCWP Project Local Coordinating Committee, 1981. RCWP Westport River Watershed Project Plan of Work and Annual Progress Report. Westport, MA 50 pp.
3. Westport River RCWP Project Local Coordinating Committee, 1982. RCWP Westport River Watershed Project Plan of Work and Annual Progress Report. Westport, MA 26 pp.
4. Westport River RCWP Project Local Coordinating Committee, 1983. RCWP Westport River Watershed Project Plan of Work and Annual Progress Report. Westport, MA 108 pp.
5. Westport River RCWP Project Local Coordinating Committee, 1984. RCWP Westport River Watershed Project Plan of Work and Annual Progress Report. Westport, MA 42 pp.
6. Westport River RCWP Project Local Coordinating Committee, 1985. RCWP Westport River Watershed Project Plan of Work and Annual Progress Report. Westport, MA 51 pp.
7. Westport River RCWP Project Local Coordinating Committee, 1986. RCWP Westport River Watershed Project Plan of Work and Annual Progress Report. Westport, MA 15 pp.
8. Westport River RCWP Project Local Coordinating Committee, 1987. RCWP Westport River Watershed Project Plan of Work and Annual Progress Report. Westport, MA


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# Garvin Brook - RCWP 16

**Winona County, Minnesota**
**MLRA: M-105**
**H.U.C.: 070400-03**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

The project has demonstrated the use of a computer model to identify and evaluate critical areas for surface water problems. Critical areas for ground water problems were identified by extensive geologic mapping and locating sinkholes and abandoned wells through which pollutants can easily enter the ground water. Monitoring suggests that well contamination is due to poor construction of older wells and general contamination of the aquifer.

The project demonstrates the effectiveness of nutrient management based on a nitrogen budget utilizing data on crop yields, commercial fertilizer use, retention of N in soils, and animal waste application. This is important to illustrate to farmers the value of animal waste as a nutrient resource.

Continued project well tests and final analysis of these data may give important results in identifying and characterizing groundwater contamination problems.

## II. Goals and Objectives (ref. 13)

Surface Water:
*Goal*— Increase the recreation potential of Garvin Brook.

*Objectives:*
- Decrease sediment loading by 50%.
- Decrease turbidity violations from 100% to below 15%.
- Decrease fecal coliform bacteria violations from 79% to below 40%.

Groundwater
*Goal*— Decrease biological and chemical health related pollutants entering the groundwater aquifers.

*Objective*
- Reduce the nitrate-nitrogen load to the acceptable drinking water standard, which is below 10 mg/L.

## III. Characteristics and Results

### Background:

The project's original objective was to treat nonpoint sources of pollutants entering Garvin Brook, a trout stream. In 1985, after three years of work within the original surface watershed area, the project expanded its emphasis to include ground water quality. The change was made after analysis of samples from 80 wells within the surface watershed showed that 21% of the wells had levels of $NO_3$-N exceeding the 10 mg/l drinking water standard. In 1985, the Garvin Brook RCWP expanded its project area to include all of the ground water watershed (approximately one-half is outside the surface watershed). Critical areas were redefined and the total number needing treatment increased.

**1. Project Type:** RCWP

**2.Timeframe:** 1982 – 1994

**3. Total Project Budget:**

| SOURCES: ACTIVITY: | Federal | State | Farmer | Other | SUM: |
|---|---|---|---|---|---|
| Cost-share | 1,747,000 | 0 | 582,333 | 180,000 | 2,529,333 |
| 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 | 337,000 |
| SUM: | 2,498,698 | 234,500 | 583,833 | 217,876 | $3,609,907 |

**4. Area (acres):**

| Project Area | Watershed | Project | Critical | Acres Needing Treatment |
|---|---|---|---|---|
| Groundwater | 15,796 | NA | 12,681 | 7,609 |
| Surface Water | 30,720 | NA | 7,574 | 3,105 |
| Total | 46,516 | 46,516 | 20,255 | 10,714 |

**5. Land Use:**

| Use | % project area | % critical area |
|---|---|---|
| cropland | 67 | NA |
| woodland | 17 | NA |
| pasture | 9 | NA |
| urban | 2 | NA |
| other (roads) | 5 | NA |

There are 218 farms, mostly small dairies, in the project area. Dairy and cash grain are the primary farm operations.

Surface Water area:

| Use | % project area | % critical area |
|---|---|---|
| cropland | 58 | NA |
| woodland | 25 | NA |
| pasture | 12 | NA |
| urban | 2 | NA |
| other (roads) | 3 | NA |

Groundwater area:

| Use | % project area | % critical area |
|---|---|---|
| cropland | 85 | NA |
| pasture/woods/other | 10 | NA |
| urban | 5 | NA |

**6. Animal Operations in Project Area:**

| Operation | # Farms | Total # Animals | Total A.U. |
|---|---|---|---|
| Dairy | 54 | 5,100 | 5,100 |
| Beef | 9 | 1,530 | 1,3000 |
| Swine | 13 | 4,355 | 880 |
| Other | 8 | NA | 85 |

**7. Water Resource Type:**

Streams and ground water – Garvin Brook is designated a trout stream by the Minnesota Department of Natural Resources. The Prairie du Chien-Jordan aquifer is the impaired ground water resource.

**8. Water Use and Impairments:**

Current project area population is estimated at 2,500; most rely on domestic wells for water supply. Approximately 25,000 people use Garvin Brook for recreation, primarily swimming and fishing.

The primary ground water impairment is decreased drinking water quality from high nitrate concentration and pesticide contamination. 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.

**9.Water Quality at Start of Project:**

*Garvin Brook*: Turbidity levels exceeded standards (10 and 25 FTUs) 18-61 percent of the time. The FC standard (200 counts per 100 ml) was also violated 45-89 percent of the time.

*Ground water*: Of the 80 wells in the original project area tested in 1983 and 1984, about 21% had nitrate-N levels exceeding the drinking water standard of 10 mg/l. During the summer of 1985, 64 additional wells in the expanded ground water watershed were tested for $NO_3$-N. Fifty-six percent of these wells had $NO_3$-N levels exceeding the 10 mg/l standard. Measurable amounts of Alachlor and/or Atrazine were found in 6 of 10 wells tested. Levels were below health advisory level.

**10. Meteorologic and Hydrogeologic Factors:**

a. Mean Annual Precipitation: 33 inches (75% occurs April-Sept.)
b. USLE 'R' Factor: 160
c. 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 are direct channels for contaminated agricultural runoff to gain access to the Prairie du Chien aquifer.

**11. Water Quality Monitoring Program:**

a. Timeframe: surface water monitoring 1981-1990; ground water monitoring 1981-1990

b. Sampling Scheme: In FY1986, the monitoring program shifted its emphasis from surface water to focus on groundwater. Available funding is used for monitoring of private farm wells, farm fields, sinkholes, monthly sampling of one site on Garvin Brook, and limited storm event sampling of Garvin Brook. The expanded ground water monitoring efort by the Minnesota Pollution Control Agency (MPCA) is 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 on a monthly basis for twelve different parameters and flow rate at one site. During FY89 runoff event sampling is to take place at two sites on Garvin Brook.

Ground Water Monitoring: The ground water related monitoring is conducted primarily by the MPCA, Winona County Extension, and the Minnesota Department of Agriculture. A total of 160 wells are sampled at least once annually for nitrate. Twelve of these wells are sampled for nitrate every five weeks. These same twelve wells are sampled quarterly for pesticides and 15 other parameters. An additional ten wells are sampled quarterly only for nitrates and pesticides. Thirty-three sites for sampling soil moisture in farm fields and sinkholes have been established and are sampled for nitrate, pesticdes, and several other parameters on a quarterly basis.

**12. Critical Areas:**

a. Criteria: The Agricultural Non-point Source Pollution Model I (AGNPS I) computer simulation model, which predicts runoff rate and volume, eroded and delivered sediment, total nitrogen, total phosphorus, and chemical oxygen demand was used to evaluate the surface watershed and designate priority areas. Critical areas affecting ground water were determined by identifying excessive nitrogen and herbicide application areas and the location of sinkholes and abandoned wells.

b. Application of Criteria: Critical areas were substantially redefined in 1985 using new information about the ground water problems both within and outside of the original surface watershed project area.

Redefinition of critical areas has resulted in expansion of critical acreage needing treatment. These acres are now defined to be the cropland acres annually planted to row crops within the critical area and any sinkholes and abandoned wells. Only 1,423 acres reported as treated in the previously defined critical area meet the new definition of acres needing treatment. Animal units are known to be significant contributors to the pollution problem. However, animal waste systems were not accepted by farmers due to depressed economic conditions in the project area.

## 13. Best Management Practices:

a. General Scheme: BMPs 2,3,4,5,9,10,15,16 are considered important. This project has increased its emphasis on BMPs 15 and 16, including split nitrogen application, improved manure storage and improved calibration of manure and fertilizer spreading equipment.

b. Quantified Implementation Goals:

- -treat 8,095 of 10,793 critical acres (75%)
- -treat 33 of 44 dairies
- -fill 59 of 79 sinkholes
- -split N application on 8,036 of 10,714 acres
- -pesticide management on 15,169 of 20,255 acres
- -obtain 94 contracts

c. Quantified Contracting/Implementation Achievements:

The project has not reported the location of BMP activities with respect to critical areas. Quantified achievements are as follows:

| Pollutant Sources | Critical Area Treatment Needs | Projrct Goals | %Needs/Goals Contracted | %Needs/Goals Implemented |
|---|---|---|---|---|
| Acres Needing Treatment | 10,793 | 8,095 | 59/78 | NA |
| Dairies | 44 | 33 | 32/42 | NA |
| Sinkholes | 79 | 59 | 15/20 | NA |
| Split-N | 10,714 | 8036 | 116/155 | NA |
| Pesticide | 20,255 | 15,169 | 114/152 | NA |
| # Contracts | NA | NA | NA | NA |

d. Cost of BMPs: (RCWP-4 data)

| BMP | Ave. Farmer Share ($) | Ave. RCWP Share ($) | Total Cost ($) |
|---|---|---|---|
| 1 perm. veg. cover | 58/ac. | 175/ac. | 233/ac. |
| 2 animal waste mgmt | 15,000 ea. | 45,000 ea. | 60,000 ea. |
| 3 stripcropping | 3.69/ac. | 11.06/ac. | 14.75/ac. |
| 4. terraces | 0.56 /ft | 1.69 /ft | 2.25 /ft |
| 5 diversions | 0.36/ft. | 1.07/ft. | 1.43/ft. |
| 9 conservation tillage | 3.35/ac. | 10.05/ac. | 13.40/ac. |
| 10 stream protection | 10.50/ft. | 31.50 /ft | 42/ft. |
| 11 sinkhole protection | 1,882.25/ea | 5,646.75/ea | 7,529/ea |
| 12 sediment retention, erosion control struc. | 3,419/ea. | 10,257/ea. | 13,676/ea. |
| 14 tree planting | 50/ac | 150/ac. | 200/ac |
| 15 fertilizer mgmt. (split N) | 5/ac. | 15/ac. | 20/ac. |
| 15. fertilizer mgmt. (waste util.) | 1.33/ac | 3.99/ac | 5.32/ac |
| 16 pesticide mgmt. | N/C | N/C | N/C |

e. Effectiveness of BMPs: Under BMP 15 (split N application), during the 1985-1987 growing seasons the total early (fall or early spring) applied N decreased 50%. The total actual N applied also decreased by 20%.

Effectiveness of BMPs for controlling sediment, phosphorus, nitrogen, and COD reduction in the project area is being evaluated by AGNPS I. The model is also being used to illustrate how livestock producers, many of whom grow corn, would benefit by managing their manure as a fertilizer resource.

**14. Water Quality Changes:**

No trends in surface water quality are reported by the project. The project does not intend to evaluate surface water quality trends until 1990. The expected effects of land treatment on surface water quality are currently being modeled with AGNPS I. There is evidence of increasing $NO_3$-N levels over five years of ground water data collected from the 80 original wells in the surface water watershed from 1983 to 1987.

Testing of 64 wells showed that 56% had $NO_3$-N concentrations over standard levels. Ten of these wells were tested for pesticides and 60% were shown to have detectable levels, but not high enough to warrant a health advisory.

**15. Changes in Water Resource Use:**

Population growth in Winona County is slow, 2.1% from 1980 to 1984, therefore, ground water use has probably changed little since RCWP began. Garvin Brook outlets to Pool 5A of the Upper Mississippi River. Total recreational use of Pool 5A is about 159,000 users annually. However, the contribution of sediment to Pool 5A from Garvin Brook is very small. Fishing use of the project area does not appear to have changed since RCWP began.

**16. Incentives:**

a. Cost Share Rates: 90 percent (75 percent from RCWP and 15 percent from the Winona County Board of Commissions)
b. $ Limitations: $50,000 RCWP funds plus $6,000 from Winona County per contract
c. Assistance programs: Extension service did nitrogen budgets for BMP-15 and included the use of legumes and manure; public meetings; newsletter; split-N application demonstration farm; crop scouting; free soil testing.

**17. Potential Economic Benefits:**

a. On-farm: not evaluated
b. Off-farm:
   1) Recreation: 0
   2) Water supply: $35,000 - $130,000 per year
   3) Commercial fishing: 0
   4) Wildlife habitat: unknown
   5) Aesthetics: unknown but positive
   6) Downstream impacts: unknown but positive

## IV. Lessons Learned

Expensive structural BMPs (e.g. BMP-2) are difficult to sell in times of depressed economic conditions even with cost sharing as high as 90%. Lower cost manure management alternatives should have been promoted from the beginning of the project.

Critical area for treatment of surface water may differ from ground water critical area.

Development of nitrogen budgets for farmers' fields (accounting for N 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.

Off-farm benefits from improving or maintaining ground water quality are potentially large.

## V. Project Documents


1. Garvin Brook Rural Clean Water Project Application. 12 p.

2. Minnesota Soil and Water Conservation Board. March 1982. Minnesota's Soil and Water Conservation Program: A Process of Gaining Ground. Box 19, Centennial Office Building, St. Paul, Minnesota 55155. 56 p.

3. Balaban, N.H. and B.M. Olsen. 1984. Geologic Atlas Winona County, Minnesota. County Atlas Series Atlas C-2. Minnesota Geological Survey. University of Minnesota, St. Paul.

4. Annual Progress Report: Garvin Brook Rural Clean Water Project, Winona County, Minnesota. November 1982.

5. Payne, G.A.1983. Streamflow and Suspended-Sediment Transport in Garvin Brook, Winona County, Southeastern Minnesota--Hydrologic Data for 1982. U.S. Geological Survey. Open-File Report 83-212. St. Paul, Minnesota. 22p.

6. Annual Progress Report: Garvin Brook Rural Clean Water Project, Winona County, Minnesota. December, 1984. 20 p.
   Appendix A. Agreement Between the Agricultural Stabilization and Conservation Service and the MN Pollution Control Agency.
   Appendix B. Garvin Brook Watershed Water Quality: General Monitoring for the Rural Clean Water Program. 1984 Annual Report. Minnesota Pollution Control Agency.
   Appendix C. RCWP Garvin Brook Project Technical Report Update. September, 1984. 29 p.
   Appendix D. BMP - Fertilizer Management - Split Application.
   Appendix E. Forms: ACP-305, RCWP-3, RCWP-5, RCWP-7, Contract locations.
   Appendix F. Questionnaire
   Appendix G. Summary of Trout Stream Habitat Improvement. 2 p.
   Appendix H. Project Coordinator - Position Description. 1 p.

7. Annual Progress Report: Garvin Brook Rural Clean Water Project PN16, Winona County, Minnesota. November 1985.

8. Garvin Brook Watershed Detailed Action Plan. April 1985. 4 p.

9. Supplement to Plan of Work. April 1985. 3 p.

10. Method Used to Determine Nitrate Loading. April 1985. 2 p.

11. Annual Progress Report: Garvin Brook Rural Clean Water Project PN16, Winona County, Minnesota. November 1986.

12. Annual Progress Report. Garvin Brook Rural Clean Water Project PN16, Winona County, Minnesota. 1987.


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# Long Pine Creek – RCWP 17

**Brown and Rock Counties, Nebraska**
**MLRA: G-66**
**H.U.C. 101500-04**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

The Nebraska RCWP combines an approach to both ground water and surface water problems. This project has potential to demonstrate effects of nutrient and pesticide management, irrigation water management, and stream bank stabilization as BMPs for surface and ground water quality protection.

## II. Water Quality Goals and Objectives

General Water Quality Objectives:

1. Improve water quality in the project area in the most cost-effective manner possible taking into consideration the need for adequate supplies of food, fiber, and a quality environment.
2. Help agriculturalists reduce nonpoint agricultural pollution to improve water quality in rural areas and meet water quality standards or water quality goals.
3. Develop and test programs, policies, and procedures for controlling nonpoint water pollution from agricultural sources.
4. Improve the beneficial uses of ground and surface waters in the project area. These uses include domestic, agricultural, industrial, recreational, and cold-water fisheries.
5. Develop new and innovative solutions to problems.

Specific Objectives to Achieve these Water Quality Goals:

1. Reduce stream bank erosion.
2. Reduce the delivery of sediment from agricultural lands.
3. Reduce the deep percolation of irrigation water contaminated with fertilizers and pesticides.
4. Reduce excess irrigation water runoff.
5. Reduce nonpoint source agricultural pollution from feedlots.
6. Educate the general public about the importance of water quality.

## III. Characteristics and Results

**1. Project Type:** RCWP

**2.Timeframe:**1981 – 1995

**3. Total Project Budget:** (ref. 18, RCWP-5)

| ACTIVITY: / SOURCE: | Federal | State | Farmer | Other | SUM: |
|---|---|---|---|---|---|
| Cost-share | 1,101,143 | 1,500 | 302,542 | 33,106 | 1,438,291 |
| Info. and Ed. | 260,374 | 0 | 0 | 0 | 260,374 |
| Tech. Asst. | 562,416 | 0 | 0 | 30,777 | 593,193 |
| Water Quality Monitoring | 0 | 297,850 | 0 | 0 | 297,850 |
| SUM: | 1,923,933 | 299,350 | 302,543 | 63,883 | $2,589,708 |

**4. Area (acres):**

| Watershed | Project | Critical |
|---|---|---|
| 293,100 | 80,000 | 54,212 |

**5. Land Use:**

| Use | %Project Area | % Critical Area |
|---|---|---|
| cropland | NA | 23 |
| - irrigated corn | NA | (21) |
| - irrigated alfalfa | NA | (2) |
| pasture/range | NA | 72 |
| woodland | NA | 0 |
| urban/roads | NA | 1 |
| other | NA | 4 |

There are 130 farm or ranch units in the project area. Approximately 90 are thought to be critical.

**6. Animal Operations in Project Area:**

| Operation | # Farms | Total # Animals | Total A.U. |
|---|---|---|---|
| Dairy | 3 | 120 | 170 |
| Beef | 9 | 27,400 | 19,800 |
| Hog | 1 | 500 | 150 |

**7. Water Resource Type:**

Surface streams and ground water. Surface water: Long Pine Creek (drainage = 293,100 acres, average aggregate flow = 150 cfs at mouth); major tributaries are Bone Creek, Sand Draw, and Willow Creek.

**8. Water Uses and Impairments:**

Surface water:
The Long Pine Creek Recreation Area, a state park, is used by over 8,500 people each season. The primary water use impairments are to recreation and fishing. Long Pine Creek is the longest self-sustaining trout stream in the state. Relic populations of three species of fish, threatened in Nebraska, can be found in the streams in this area. The primary pollutants are: sediment, bacteria, and nutrients. Streambank erosion is the primary source of sediment. Excessive erosion occurs in the headwaters of Long Pine Creek due to intensive grazing in riparian areas, stream bank 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 the lower Long Pine Creek. The sediment from Sand Draw is primarily from irrigation wasteway discharges and irrigation return flows. Excessive erosion occurs along unprotected stream banks and adjacent gullies at the midreaches of Bone Creek. Point source feedlots and the Ainsworth sewage treatment plant contribute to high bacteria and nutrient loadings in these tributaries.

Ground water:
Ground water is used for irrigation, stock watering and domestic and municipal water supply throughout the project area. A stable population of about 3,200 people live within the project area. There is potential for degradation of the drinking water supply from high nitrate and pesticide contamination from commercial fertilizers and pesticides.

**9. Water Quality at Start of Project:**

See Reference #15 for a complete baseline documentation (1979-1985). Suspended solids data from 9 sample dates from July, 1979 to July, 1980 show that two tributaries, Bone Creek and Sand Draw, contributed greatly to the turbidity problems in Lower Pine Creek (LP8). Station LP7 is located upstream of the confluence of Sand Draw and Bone Creek with Long Pine Creek. Station LP8 is below this confluence. Total suspended solids (TSS) at LP8 were fairly high, but were less at up stream LP1, LP5, or LP7.

Surface monitoring, April, 1980 to September 23, 1981 (n = ~13):

| | Tot. Sus. Solids (mg/l) | | Fecal Coliform (#/100ml) |
|---|---|---|---|
| Station | Mean | Range | Geometric Mean |
| Long Pine (LP1) | 13 | 1-32 | 315 |
| Long Pine (LP5) | 11 | 1-40 | 35 |
| Long Pine (LP7) | 20 | 1-50 | 90 |
| Long Pine (LP8) | 70 | 9-220 | 400 |
| Bone Creek (BN) | 1 | 1-1 | 670 |
| Bone Creek (BN1) | 95 | 1-620 | 4550 |
| Bone Creek (BN2) | 330 | 1-3590 | 1680 |
| Bone Creek(BN3) | 640 | 1-4360 | 1180 |
| Sand Draw (SN1) | 10 | 1-30 | 410 |
| Sand Draw (SN2) | 130 | 1-1000 | 500 |

*LP1, LP5, and LP7 are above confluences with tributaries. LP8 is below confluences.

Ground water: 23 domestic wells monitored in 1977-1978 show that 17 percent exceeded 10 mg/l nitrate-N

**10. Meteorologic and Hydrogeologic Factors:**

a. Mean Annual Precipitation: 21.5 inches; about 14.5 inches of irrigation water are needed to supplement precipitation to grow corn

b. USLE 'R' Factor: 100

c. 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 in the range area are predominantly silts and sands.

**11. Water Quality Monitoring Program:**

a. Timeframe: Surface -- July 1979 - September 1984 - 1995; Groundwater -- 1979 - 1995

b. Sampling Scheme:

1. Location and Number of Monitoring Stations:
   Baseline surface monitoring at 11 sites was collected from July 1979 to September 1984 by the Nebraska Department of Environmental Control (ref. 15). This is considered the pre-implementation phase. Except for station LP8 (which will be sampled once per month after September 1984), surface water monitoring has been discontinued until the last two years of the project (1994-1995). Fish were collected between April 1981 and June 1984. Channel transects have been measured once per year since 1985 at the 11 water quality stations. Streambank erosion is monitored at 4 sites to evaluate the magnitude of erosion reduction effectiveness of cedar revetments. Upstream movement of the head cut is measured annually.
   Irrigation and domestic wells are sampled once per year in July or August when the aquifer is used for irrigation.

2. Sampling Frequency: Surface water: monthly for baseline samples, composite samples during runoff events, fish were collected 2-3 times per year. Ground water: Once per year in July or August (1982- 1985)

3. Sample Type: grab

c. Pollutants Analyzed: (1) Surface water: all 11 sites are sampled for TSS, FC, DO, and conductivity. Seven of the sites include macroinvertebrate and periphyton sampling. Diurnal water temperatures are also recorded. (2) Ground water: nitrite and nitrate as N, total phosphorus, chloride, calcium, magnesium, pesticides, and total organic carbon.

d. Flow Measurements: Runoff event data is collected at six surface sites. Stream discharge is recorded.

**12. Critical Areas:**

a. Criteria: high erosion rates and proximity to waterways

b. Application of Criteria: consistent -- Contracts are primarily being applied to the critical areas.

**13. Best Management Practices:**

a. General Scheme: The project is currently emphasizing on-site components such as irrigation water management (BMP-13). One major emphasis for this BMP is to install irrigation tailwater recovery (re-use) systems to minimize the total water usage, thereby reducing infiltration to ground water with ultimate release in the creek. A secondary storage reservoir (BMP-13) is being constructed using pooled funds from 10 RCWP cooperators within the Ainsworth irrigation district and was completed in September, 1987. The reservoir will save 2,000 acre feet of water annually for 8,000 acres of cropland and reduce the amount of irrigation waste water delivered to the creeks with an associated reduction in sediment delivered. Other BMPs include fertilizer and pesticide management (BMP-15, BMP-16), diversion systems (BMP- 5), grazing land protection systems (BMP-6), stream protection (e.g. cedar revetments and reduction of riparian grazing) (BMP-10), permanent vegetative cover on critical acres (BMP-11), Permanent vegetative cover (BMP-1), waterway system (BMP-7), Cropland protective system (BMP-8), conservation tillage (BMP-9), and tree planting (BMP-14).

b. Quantified Implementation Goals: 75 percent of the critical areas.

c. Quantified Contracting/Implementation Achievements as of Sept. 30 FY87: (ref. 18, RCWP-3)

| Pollutant Sources | Critical Area Treatment Needs | Project Goals | %Needs/Goals Contracted | %Needs/Goals Implemented |
|---|---|---|---|---|
| Acres Needing Treatment | 54,212 | 40,659 | 78/105 | NA |
| Dairies (# farms) | 2 | 0 | 0 | 0 |
| Feedlots (# farms) | 1 | 0 | 0 | 0 |
| # Contracts | 130 | 98 | 65/87 | NA |

d. Cost of BMPs: (from RCWP Table 4, Ref. 16)

| BMP | Ave. Farmer Share ($) | Ave. RCWP Share ($) | Total Cost ($) |
|---|---|---|---|
| 1 perm. veg. cover | 20/ac. | 60/ac. | 80/ac. |
| 2 animal waste mgmt. | 3,750 ea. | 11,250 ea. | 15,000 ea. |
| 5 diversions | 0.30/ft. | 1/ft. | 1.30/ft. |
| 6 grazing land prot. | 0.75/ac. | 2.25/ac. | 1.50/ft. |
| 7 waterways | 0.30/ft. | 1/ft. | 1.30/ft. |
| 8 cropland prot. | 5/ac. | 0 | 5/ac. |
| 9 conservation till. | 3.25/ac. | 9.75/ac. | 13/ac. |
| 10 stream protection | 0.40/ft. | 1.10/ft. | 1.50/ft. |
| 11 perm. veg. on crit. area | 125/ac. | 375/ac. | 500/ac. |
| 12 sediment retention | 300 ea. | 900 ea. | 1,200 ea. |
| 13 irrigation/water mgmt. | 2,500 ea. | 7,500 ea. | 10,000 ea. |
| 14 tree planting | 75/ac. | 225/ac. | 300/ac. |
| 15 fertilizer mgmt. | 0.33/ac. | 1/ac. | 1.33/ac. |
| 16 pesticide mgmt. | 0.33/ac. | 1/ac. | 1.33/ac. |

e. Effectiveness of BMPs: not documented

## 14. Water Quality Changes:

The surface and ground water samples reported for 1979 to 1984 are considered pre-implementation (ref. 15). However, an increasing trend in nitrate concentrations in some of the irrigation wells has been identified but no change has been observed in the domestic wells.

NWQEP analyzed a select group of 23 wells to further investigate any evidence of trends in the nitrate levels over time using the raw data from Appendix N (ref. 15). These wells were chosen because they had at least 3 years of data and monitoring started, on or before, 1984. Although still not perfect, the comparison of geometric means (anti log of the mean of the log values) over years form this subgroup of wells may be meaningful for a trend detection (Table 1).

**Table 1**. The geometric mean value of nitrate-N concentration for wells in which at least 3 years of nitrate data is available from 1982 to 1987 and monitoring started prior to 1985 (raw data from Appendix N). There were a total of 10 irrigation wells, 12 domestic wells, and 1 municipal well sampled, but not all wells were sampled in every year.

| | Irrigation Wells | | Domestic Wells | | Municipal Well | |
|---|---|---|---|---|---|---|
| Year | N | Ave. Nitrate* Conc. (mg/l) | N | Ave. Nitrate* Conc. (mg/l) | N | Ave. Nitrate* Conc. (mg/l) |
| 1982 | 4 | 0.8 | - | - | 1 | 5.4 |
| 1983 | 7 | 1.8 | 4 | 4.5 | - | - |
| 1984 | 6 | 2.2 | 8 | 3.6 | 1 | 0.2 |
| 1985 | 9 | 5.0 | 12 | 4.6 | - | - |
| 1986 | 6 | 5.1 | 11 | 3.6 | 1 | 1.8 |
| 1987 | 6 | 3.4 | 9 | 2.9 | - | - |

* Comparison of these means across years should be done with caution because the same wells are not sampled each year, and the variability of the data is large but can be used to document a problem.

Table 1 documents a problem with high nitrates, but visual inspection does not show a strong trend. There may be some indication of an increasing trend in the nitrate concentrations in the irrigation wells. It should be noted that the geometric mean values are lower than the mean values of the raw concentration data because they are more closely related to the median values.

Further analyses were performed by NWQEP to investigate if any trends were statistically significant for any well type or individual well. There was no statistical evidence of a change over time for the irrigation, domestic, or municipal wells. There was some evidence that not all the domestic wells exhibited the same trends over the years. The nitrate levels in two of the domestic wells appear to have increased over time, but the remainder have had no change or a decreasing trend. For the irrigation wells, the direction of change is increasing levels of nitrate over all the wells. This increase is not significant at the 10 percent level due to the large variability between years. There is good possibility that a trend may be statistically documented in the next few years if the monitoring continues for the irrigation wells.

### 15. Changes in Water Resource Use:

Domestic groundwater well samples in the project area showed 5-10% of the wells sampled in 1986 and 1987 have nitrate levels above federal standards. As a result of high nitrate levels, some well water is blended with lower nitrate level water to reduce health risks. Total domestic groundwater use has not changed since RCWP began. Recreational use of the project area has been steady since 1976 and fishing continues to be impaired in the project area by high sediment levels.

### 16. Incentives:

a. Cost Share Rates: 75% (90% cost share is being requested for a critical subarea of the Sand Draw (ref. 18)
b. $ Limitations: $50,000 per farmer
c. Assistance Programs: SCS develops water quality plans and provides technical assistance. The Extension Service has a 50 acre demonstration farm to display conservation tillage. There are IPM meetings and 4,519 acres were scouted in 1985.
d. Other Incentives or Regulations: RCWP cost share improvements to the feedlots have not been approved in the past because they are considered point sources under state regulation.

### 17. Potential Economic Benefits:

a. On-farm: not evaluated
b. Off-farm:
  1) Recreation: $5,000 - $50,000 per year.
  2) Water Supply: $15,000 - $50,000 per year.
  3) Commercial Fishing: 0
  4) Wildlife Habitat: unknown
  5) Aesthetics: unknown but positive
  6) Downstream Impacts: unknown

## IV. Lessons Learned

The ground and surface water monitoring program used in this project aids in prioritizing portions of the watershed for critical area definition. Emphasis on fertilizer and pesticide management is a key factor in dealing with ground and surface water problems simultaneously.

This project has the potential to document BMP effectiveness of irrigation water management and streambank stabilization by cedar revetments and reduced riparian grazing over a 10 year time frame.

Lack of surface water monitoring throughout the project greatly reduces the chance of showing water quality and water use improvements because of limited data for estimating within-site variance.

Opportunities exist to reduce fertilizer use by transferring manure from large feedlots (defined by the state as point sources) to RCWP participating farms. Cost-shared improvement of feedlots has not been approved, however, in the past because of their legal designation as point sources.

## V. Project Documents

1. Long Pine Creek Nebraska: A Rural Clean Water Program Application. 1981.

2. Plan of Work - Long Pine Creek RCWP Project. October 1981.

3. Monitoring and Evaluation Plan. 1981. 11 + p.

4. Report to Local Coordinating Committee Long Pine Creek Rural Clean Water Program. October 23, 1981. Program Planning Section, Nebraska Department of Environmental Control. 30 p.

5. NDEC Long Pine Intensive Survey Water Quality Update. January 22, 1982.

6. Jensen, D. January 1982. An Index for Assessing the Water Quality of Nebraska Streams. Program Plans Section, Water and Waste Management Division, Department of Environmental Control, State of Nebraska. 57 p.

7. Long Pine Creek Rural Clean Water Program Annual Report:FY 1982.

8. Long Pine Creek RCWP Plan of Work (FY 1983).

9. Long Pine Creek Rural Clean Water Program Annual Report:FY 1983.

10. Long Pine Creek RCWP Plan of Work (FY 1984).

11. Long Pine Creek Rural Clean Water Program Annual Report:FY 1984.

12. Long Pine Creek RCWP Plan of Work (FY 1985).

13. Long Pine Creek Rural Clean Water Program Annual Report: FY 1985.

14. Long Pine Creek Rural Clean Water Program: Plan of Work (FY 1986), revised November 1985. 32 p.

15. Maret, T. December 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 68509-4877. 194 p.

16. Long Pine Creek Rural Clean Water Program Annual Report: FY1986.

17. Long Pine Creek RCWP: Plan of Work (FY1987), revised November 1986. 30pp.

18. Long Pine Creed Rural Clean Water Program Annual Report: FY 1987.

19. Best Management Practices: Long Pine Creek Rural Clean Water Program. Revised November 1987.

20. Plan of Work (FY 1988). Long Pine Creek Rural Clean Water Program.

## VI. Project Contacts:

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# Tillamook Bay - RCWP 18

**Tillamook County, Oregon**
**MLRA: A-1**
**H.U.C. 171002-03**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

This project has made important contributions concerning the effectiveness of animal waste management for improving water quality at the watershed level. To date, the water quality monitoring shows a 40-50% reduction in mean fecal coliform concentration, attributed to bringing approximately 60% of the animal waste produced in the project area under best management. A more thorough knowledge of the marginal water quality benefits of increased manure management should be gained from this project as the total treatment approaches the expected 90% level. The project appears to be cost-effective on a water quality basis. Results from this project indicate that projects that address clearly defined impairments to high-valued recreational resources are most likely to be cost-effective.

## II. Water Quality Goals and Objectives

Original Project Goals (ref. 4)
- 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 (ref. 6)
A national interagency team reviewed the project in 1983 and reported that 87% of the sediment reaching the bay originated from forest land. This made the 30% reduction goal on agricultural land insignificant and it was dropped as a project goal.

## III. Characteristics and Results

1. **Project Type:** RCWP

2. **Timeframe:** 1981 – 1996

3. **Total Project Budget (for timeframe):**

| ACTIVITY: / SOURCES: | Federal | State | Farmer | Other | SUM: |
|---|---|---|---|---|---|
| Cost-share | 4,540,278 | 0 | 2,202,432 | 0 | 6,742,710 |
| 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: | 5,403,672 | 83,090 | 2,202,432 | 176,806 | $7,866,000 |

**4. Area (acres):**

| Watershed | Project | Critical |
|---|---|---|
| 363,520 | 23,540 | 8,723 |

**5. Land Use:** (ref. 3)

| Use | % Project Area | % Critical Area |
|---|---|---|
| pasture | 100 | NA |

Watershed Land Use:

| Use | % Watershed Area |
|---|---|
| forestland | 88.9 |
| agriculture | 6.5 |
| bay | 3.0 |
| urban | 1.6 |

**6. Animal Operations in Project Area:**

| Operation | # Farms | Total # Animals | Total A.U. |
|---|---|---|---|
| Dairy | 126 | 22,000 | 22,000 |

**7. Water Resource Type:**

streams, estuary, Tillamook Bay

**8. 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. Commercial shellfishing in the Bay is a $1.5 million industry (annual gross sales).

The shellfish industry is impaired by excessive fecal coliform 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.

**9. Water Quality at Start of Project:**

The FC concentration standard for commercial shellfishing waters is a log mean of 14/100ml with no more that 10% of samples allowed greater than 43/100ml. The standards were consistently violated in Tillamook Bay following moderate to large runoff periods.

**10. Meteorologic and Hydrogeologic Factors:**

a. Mean Annual Precipitation: 90 - 140 inches
b. USLE'R' Factor: 50
c. Geologic Factors: The watershed topography is extremely diverse, from the Coast Range in the east followed by gently to steeply sloping rocky uplands, deeply incised canyons to flat to gently rolling floodplains. 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.

**11. Water Quality Monitoring Program:**

a. Timeframe: 1975 - 1990

b. Sampling Scheme: conducted by Oregon Dept. of Environmental Quality

1. Location and Number of Monitoring Stations: five small tributary stations; five major river stations, fourteen bay stations.
2. Sampling Frequency: varies, usually monthly, some intensive wet weather samplings
3. Sample Type: grab

c. Pollutants Analyzed: fecal coliform bacteria

d. Flow Measurements: Flow measurements accompany all samples since 7/83. Before then only 2 stations have relatively complete flow records.

e. Other: salinity and turbidity measurements taken in Bay

**12. Critical Areas:**

a. Criteria: distance to watercourse, present manure management practices; designated subbasins

b. Application of Criteria: Criteria used to prioritize dairy farms for cost sharing.

**13. Best Management Practices:**

a. General Scheme: All RCWP cost share funds have been focused on BMP-2, Animal Waste Management. Unique BMP components are used in the animal waste systems such as: roofing and guttering of manure storage areas, tidal dikes to prevent high tides from spilling into pastures, and pasture drainage systems to prevent water from standing in pastures where manure is applied.

b. Quantified Implementation Goals: 109 dairies; 8,723 acres

c. Quantified Contracting/Implementation Achievements:

| Pollutant Sources | Critical Area Treatment Needs | Project Goals | %Needs/Goals Contracted | %Needs/Goals Implemented |
|---|---|---|---|---|
| Acres Needing Treatment | 8,723 | 8,582 | 98.4/100 | 69[a]/70 |
| Dairies | 109 | 109 | 94 | 20[b] |
| # Contracts | 109 | 109 | 94 | 20 (22 of 109) |

[a] Estimated as waste utilization and pasture vegetative cover treatments under BPMs 1& 15

[b] Completly installed/ balance has some components but not completed.

d. Cost of BMPs:

| BMP | Ave. Farmer Share ($) | Ave. RCWP Share ($) | Total Cost ($) |
|---|---|---|---|
| 2 Animal waste mgmt. | 5,450-6,300 ea. | 16,300-18,900 ea. | 21,750-25,200 ea. |
| 2 Subsurface drainage | 140/ac. | 420/ac. | 560/ac. |
| 2 curbing/guttering/ diversion | 0.50-2.00/ft. | 1.44-5.90/ft. | 1.94-7.90/ft. |
| 10 fencing | 0.13/ft. | 0.40/ft. | 0.53/ft. |

e. Non-RCWP Activities: Some treatment through ACP and individual farmer resources.

**14.Water Quality Changes:**

NWQEP analysis indicates that annual log-mean fecal coliform concentrations in both the streams and Bay have decreased significantly since BMP implementation, especially when variations in streamflow and Bay salinity are accounted for. See Tables 1 and 2 below.

Table 1. Tillamook Log Mean Fecal Coliform Concentrations 1975-1981 vs. 1982-1985.

| Sampling Sites | Log Mean 1975-1981 | Log Mean 1982-1985 | % Reduction |
|---|---|---|---|
| Bay 1 | 49.3 | 22.4 | 55 * |
| Bay 2 | 55.5 | 43.2 | 22 + |
| Bay 3 | 82.8 | 46.5 | 44 |
| Bay 4 | 111.0 | 53.3 | 52 + |
| Bay 5a | 131.0 | 31.8 | 76 * |
| Bay 6 | 36.7 | 20.6 | 44 |
| Bay 7 | 33.1 | 14.5 | 56 + |
| Bay 8 | 20.8 | 11.6 | 44 |
| Bay 9 | 33.3 | 12.7 | 62 * |
| Bay 10 | 19.8 | 16.1 | 19 |
| Bay 11 | 24.5 | 13.5 | 45 + |
| Bay 12 | 153.0 | 123.0 | 20 |
| Bay 13 | 23.5 | 11.7 | 50 + |
| Bay 14 | 49.3 | 20.0 | 59 + |
| Kilchis River | 87.0 | 61.0 | 30 |
| Miami River | 276.0 | 60.7 | 78 * |
| Track River | 168.0 | 63.4 | 62 * |
| Tillamook River | 387.0 | 162.0 | 58 * |
| Wilson River | 147.0 | 68.6 | 53 * |

* Statistically significant at $p = 0.05$
+ Statistically significant at $p = 0.10$

A 12 day sampling of the bay and lower tributaries by the FDA in December 1986 showed significant water quality improvements, but not yet up to an acceptable standard; howevere less than 50% of construction on BMPs was completed at this time (ref. 11).

### 15. Changes in Water Resource Use:

Due to the nonpoint source control project and associated changes in criteria for closing the bay to commercial shellfishing, permanent closure does not appear likely. Commercial oyster production has been steady after low production in 1979 and 1980. Recreational clamming is also likely to be affected by reduced bacteria levels. However, no recreational use figures are currently available to indicate changes attributable to RCWP.

### 16. Incentives:

a. Cost Share Rates: 75% on BMP-2

b. $ Limitations: $50,000 per landowner. Many animal waste management systems cost more than $66,670. Farmers' share may, therefore, exceed 33%.

c. Assistance Programs: ACP cost sharing has also been used to treat some problems. ACP has a limit of $3,500/yr. for animal waste management systems.

d. Other Incentives or Regulations: Oregon allows a 50% tax credit for conservation measures which can be spread over 10 years. Oregon also has regulations which allow the state to fine agricultural operations that are obvious pollution sources.

### 17. Potential Economic Benefits:

a. On-farm: (project lists the following on-farm benefits)

- water quality improvement
- more nutrients in manure preserved for use as fertilizer
- decreased commercial fertilizer needs
- improved manure handling
- decreased labor requirements
- cleaner facilities resulting in higher quality dairy products
- cleaner and healthier livestock
- reduced fuel or electricity consumption

b. Off-farm: (USDA-ERS quantification)

1) Recreation: $40,000 - $530,000 per year.

2) Water Supply: 0
3) Commercial Fishing: $20,000 - $50,000 per year.
4) Wildlife Habitat: unknown
5) Aesthetics: unknown
6) Downstream Impacts: 0

## IV. Lessons Learned

1. Animal waste management can improve water quality (reduced mean fecal coliform concentrations) when implemented for the critical sources in a 23,000 acre project area.

2. Some measurable indicator of hydrologic state such as precipitation, stream flow, or salinity should be included in water quality sampling programs to identify water quality trends.

3. Thorough records of land treatment accomplishments are essential to attribute water quality trends to BMP implementation.

4. A pre-BMP water quality data base of at least 2 years duration greatly facilitates documenting water quality effects of BMPs.

5. A high level of farmer participation can be achieved when agricultural and water quality agency personnel work together closely on designing and publicizing the program.

6. The combination of financial incentive and environmental regulation is effective in achieving high rates of participation.

7. Agricultural NPS control projects can be very cost-effective if they reduce an impairment to a water resource with high recreational value.

8. Recreational benefits from improved water quality are likely to outweigh commercial fishing benefits even in a region where impaired commercial fishing is the primary concern.

## V. Project Documents:

1. Jackson, J. E. and E. A. Glendening. Oregon Dept. of Environmental Quality. "Tillamook Bay Bacteria Study: Fecal Source Summary Report." January 1982.

2. Tillamook County SWCP and Tillamook Bay Water Quality Committee. January 1981. "Tillamook Bay Drainage Basin Agricultural Nonpoint Source Pollution Abatement Plan".

3. Tillamook Bay RCWP Application. Tillamook County, Oregon. January 1981.

4. Tillamook Bay RCWP. Plan of Work. Tillamook County, Oregon. 1982.

5. Tillamook Bay RCWP Annual Report 1982.

6. Tillamook Bay RCWP Annual Report 1983.

7. Tillamook Bay RCWP Annual Report 1984.

8. Tillamook Bay RCWP Annual Report 1985.

9. Tillamook Bay RCWP Annual Report 1986.

10. Maas, R.P., M.D. Smolen, J. Spooner and A. Patchek. 1987. Benefit/cost analysis of nonpoint source control in the Tillamook Bay, Oregon watershed. Lake and Reservoir Management J., Vol. III, pp. 157-162.

11. Tillamook Bay RCWP Annual Report 1987.

## VI. NWQEP Project Contacts

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# Conestoga Headwaters - RCWP 19

**Lancaster County, Pennsylvania**
**MLRA: S-148**
**H.U.C. 020503-06**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

Project results come from two, intensively monitored field sites and one stream site. Results are summarized below:

Terraces may reduce sediment loadings to surface water, but in permeable soils with excess manure, terraces may increase nitrate transport to ground water and dissolved nutrient concentrations in surface runoff.

In this project manurial nitrogen generally exceeds crop needs. Thus, water quality benefits from animal waste storage are partially offset because nitrogen that could have been volatilized in storage is conserved and applied as a sludge 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 losses.

## II. Water Quality Goals and Objectives

The stated goal of the project is to reduce pollutants to levels that are consistent with the water quality standards of the Commonwealth of Pennsylvania (ref. 1)

Specific Objectives:
– 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 the fertilizer management BMP and the integrated pest management BMP on 3600 acres.
– Reduce the amount of sediment and sediment-related pollutants entering receiving streams by applying BMPs on 12,000 acres in 300* RCWP contracts to bring the annual erosion rate to the alllowable rate ("T").

*this goal has been revised twice by the project as follows:(ref. 20)
1984 --- 80 contracts on 6,000 acres
1989 --- 90 contracts on 7,000 acres

## III. Characteristics and Results

1. **Project Type:** RCWP, Comprehensive Monitoring and Evaluation

2. **Timeframe:** 1981 – 1991

## 3. Total Project Budget (for timeframe):

| ACTIVITY: / SOURCES: | Federal | State | Farmer | Other | SUM: |
|---|---|---|---|---|---|
| Cost-share | 1,292,371 | 0 | 2,318,000 | 0 | 3,610,371 |
| Info. & Ed. | 35,000 | 20,000 | 0 | 50,000 | 105,000 |
| Tech. Asst. | 880,343 | 0 | 0 | 0 | 880,343 |
| Water Quality Monitoring | 979,200 | 1,000,000 | 0 | 10,000 | 1,989,200 |
| SUM: | 3,186,914 | 1,020,000 | 2,318,000 | 60,000 | $6,584,914 |

## 4. Area (acres):

| Watershed | Project | Critical |
|---|---|---|
| 110,000 | 110,000 | 16,000 |

| Monitoring: Small Watershed Site | Field Site 1 | Field Site 2 |
|---|---|---|
| 3,712 | 23.1 | 47.5 |

## 5. Land Use:

| Use | % Project Area |
|---|---|
| cropland | 44 |
| pasture/range | 16.4 |
| woodland | 25 |
| urban/roads | 14 |
| other | 14 |

## 6. Animal Operations in Project Area: (1981 data)

| Operation | # Farms | Total # Animals | Total A.U. |
|---|---|---|---|
| Dairy | 445 | 39,542 | 30,820 |
| Beef | 1,009 | 53,945 | 45,853 |
| Swine | NI | 33,914 | 7,461 |
| Poultry | NI | 3,462,425 | 15,314 |

## 7. Water Resource Type:

streams, groundwater

## 8. Water Use and Impairments:

Public water supplies originate in the project area for approximately 175,000 people plus 2,000 commercial industries within and downstream from the Conestoga Headwaters (ref. 8). Water resources also support fisheries and contact recreation. Streams used for these activities are impaired by bacteria and sediment. Nitrates and pesticides impair potable ground water supplies.

## 9. Water Quality at Start of Project:

Forty three monitoring sites (42 wells and 1 spring) were sampled 4 times. The sites were grouped two ways -- according to geology and land use. In one of the sampling periods, 56% (22 of 33) of the wells in carbonate geology and 20% (2 of 10) of the wells in noncarbonate geology had nitrate concentrations above 10 mg/L as nitrogen.

## 10. Meteorologic and Hydrogeologic Factors:

a. Mean annual precipitation: 42 inches
b. USLE 'R' factor: 175
c. Geologic Factors: The northeastern two-thirds of the project area lies in the Triassic Lowlands underlain by conglomerate, shale, sandstone and diabase. Average depth to the water table in this area 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 penetration of surface runoff to groundwater supplies.

## 11. Water Quality Monitoring Program:

a. Timeframe: 1981-1991
b. Sampling Scheme: conducted by: U.S.G.S. & PA Dept. of Environmental Resources
1. Monitoring Stations: One 3,700 acre watershed with 2 stream gauge sites and 3 additional baseflow sampling sites as well as 6 ground water sites and 2 springs. Two field sites: field site #1 with 1 surface outlet gauged site and 6 ground water sites (5 wells, 1 spring), and field site #2 with 1 surface outlet gauged site and 8 ground water sites (7 wells, 1 spring).
2. Sampling Frequency:
   - Gauged sites: all major storms
   - Baseflow sites: every 4 weeks
   - Ground water sites: quarterly (small watershed) monthly (field sites)
3. Sample Type: Grab and automatic

c. Pollutants Analyzed: TSS, nutrients, pesticides
d. Flow Measurements: continuously at gauged sites

## 12. Critical Areas:

a. Criteria: Small watershed experimental area, and land within carbonate area
b. Application of Criteria: Adherence to the criteria has been undermined by the lack of farmer participation; however, I&E efforts have been focused to the identified critical areas.

## 13. Best Management Practices:

a. General Scheme: Revised implementation goals include securing 90 contracts to treat about 7,000 acres. New emphasis is on educational programs and nutrient management plans to encourage better nutrient management instead of contracts with cost sharing.
b. Quantified Implementation Goals: emphasis on management of animal waste and reduction of commercial fertilizer use.
c. Quantified Contracting/Implementation Achievements (as of September 30, 1987):

| Pollutant Sources | Critical Areas Treatment Needs | Project Goals | %Needs / Goals Contracted | %Needs / Goals Implemented |
|---|---|---|---|---|
| Acres Needing Treatment | 16,000 | 6,000 | 36.4/97 | 23/61[a] |
| Dairies | 110 | 45 | 32/78 | –[b] |
| Feedlots | 100 | 20 | 9/45 | 8/38[b] |
| Poultry Farms | 90 | 10 | 4.4/40 | –[b] |
| Hog Operations | 60 | 5 | 20/240 | –[b] |
| Other | 10 | 0 | 130/NA | NA |
| No Livestock | 30 | 0 | 20/NA | NA |
| # Contracts | 400 | 80 | 20/99 | NA |

[a] Estimated as conservation tillage practices applied.

[b] Estimated as all animal waste management practices applied (dairies,feedlots,poultry and hogs)

d. Cost of BMPs: (for continuous corn silage with daily spread on a 5% slope - total 20 tons manure per acre) ref. 12

| BMP | Average Installation Cost of BMPs: |
|---|---|
| Earthen basin (6 month, manure storage structure) | $12,000 |
| Steel tank - slurry store (6-month manure storage structure) | $39,000 |
| | Estimated Annual Cost per Acre |
| Contour strip cropping | No Cost |
| Winter cover and residue mgmt. | $0 to $20/acre |
| Terrace systems | $56/acre |
| Diversion systems (with 20 ft. wide filter strip) | $10/acre |
| Sod waterway systems | $7/acre |

e. Effectiveness of BMPs: Results of CREAMS model on continuous corn silage daily spread on 5% slope, total 30 tons manure per acre (ref. 12):

| Condition | Soil erosion tons/acre | N loss Ground water | N loss Surface water | P loss |
|---|---|---|---|---|
| | | lbs/acre | | |
| No BMPs | 11 | 50 | 68 | 31 |
| Terraces | 3 | 52 | 29 | 12 |
| Reduced-till | 6 | 50 | 45 | 20 |
| No-till | 3 | 45 | 33 | 14 |
| Multiple BMPs | 1 | 54 | 14 | 5 |

In general, the project believes that nutrient loading reductions will be achieved by reducing nutrient application rates.

f. Cost-effectiveness of BMPs: Results of modeling continuous corn-grain on a 5 % slope (ref.12):

| | $/ton of soil saved | $/lb. of N saved | $/lb. of P saved |
|---|---|---|---|
| Terraces | 4.87 | 1.10 | 2.12 |
| Animal waste systems | NA | 0.67 | 1.50 |
| Diversions | 2.06 | 0.41 | 0.78 |
| Contouring | 1.66 | 0.33 | 0.76 |
| Grass waterways | 0.99 | 0.24 | 0.45 |
| Conservation tillage | .76 | 0.17 | 0.34 |

g. Non-RCWP Activities: Annual implementation of BMPs (primarily nutrient management) on non-RCWP farms is exceeding RCWP contracts. SCS reported 213 contacts in 1987 with 166 of these having at least one BMP implemented. Results of the overall nutrient management program (1986 - 1988) are as follows: 19,000 acres planned, 49% reduction in excess nitrogen applied, 42% reduction in excess phosphorus applied.

## 14. Water Quality Changes:

At the small watershed level, analysis of monitoring data pre- and post- BMP implementation shows a small but statistically significant reducton in kjeldahl-nitrogen in base flow. Field site 1 has shown an increase in nitrates at 4 wells, and no change in the other 2 wells. This may be due to water ponding on terraces. Nitrate concentrations in wells at field site 2 are decreasing in 1 well, increasing in 2 wells and 1 spring, and showing no change in 2 other wells.

## 15.Changes in Water Resource Use:

Only minor changes in water resource use are anticipated since the number of BMPs installed is small relative to the large area affected by the nonpoint source pollution. Localized improvements in individual drinking water wells may occur, however, these improvements will be isolated and may require the export of manure out of the watershed to be realized.

### 16. Incentives:

a. Cost Share Rates: 50% on animal waste management and soil/manure testing
b. $ Limitations: $ 50,000 maximum
c. Assistance Programs: Project has two nutrient management specialists.

### 17. Potential Economic Benefits:

The educational gains associated with nutrient management practices have enhanced the work of the Chesapeake Bay and other regional water quality programs. In the long run this may be the greatest benefit from this project. Some on-site benefits are possible from practices that reduce runoff and conserve nutrients for crop production. Off-site benefits associated with expected minor water quality improvement include (discounted 50 year):
Surface water improvements -- $65,000 to $200,000
Groundwater improvements -- $0 to $85,000
Total improvements -- $65,000 to $285,000

## IV. Lessons Learned:

High cost share rates are needed to gain farmer participation when manure nutrients exceed crop needs and manure has no value to the farmer.

There may be trade-offs between BMPs designed to improve surface and groundwater, complicating treatment of impaired uses if both surface water and groundwater are impaired. Water quality monitoring indicates that terraces may be ponding water and increasing nitrate infiltration.

Conservation tillage, nutrient management, and contour stripcropping are the lowest cost alternatives. Extensive implementation of these over other practices is expected to produce the most water quality results for a given expenditure.

1. Where manure nutrients exceed crop requirements, waste management systems must be designed to reduce the burden on surface and ground waters. Volatilization may be desirable.

2. 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.

3. Targeting is not effective in projects where farmer participation and interest are low.

4. Credit should be extended to all who participate in a project including those farmers who establish BMPs with technical assistance but do not use cost share money.

## V. Project Documents

1. Conestoga Headwaters RCWP. 1982 Plan of Work. Lancaster County, Pennsylvania.

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22. Fishel, D.K., and P.L. Lietman, 1986. Occurrence of Nitrate and Herbicides in Ground Water in the Upper Conestoga River Basin, Pennsylvania: Water-Quality Study of the Conestoga River Headwaters, Pennsylvania. U.S. Geological Survey, Water Resources Investigations Report 85-4202, 8p.

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## VI. NWQEP Project Contacts

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# Oakwood Lakes - Poinsett - RCWP 20

**Brookings, Kingsbury and Hamlin Counties, South Dakota**
**MLRA 102-A**
**H.U.C. 101702-01,02**

## I. Major Contributions Toward Understanding the Effectiveness of NPS Control Efforts

The Comprehensive Monitoring and Evaluation project is contributing information in the following areas:
- transport of nitrates and pesticides from the soil surface to ground water
- ground water monitoring strategy design
- calibration of AGNPS and NRTM models
- determination of water and nutrient budgets for a group of small lakes

Installation of monitoring wells was completed in the fall of 1987, therefore, it may be difficult for the project to document water quality changes in the short period before RCWP ends. Preliminary analysis suggests that application of agricultural fertilizer contributes nitrate to the soil profile from which nitrate is leached to ground water on a continual basis. Results from the field site ground water monitoring study show:
- $NO_3$-N concentrations are statistically higher at three geozones: shallow sand and gravel with thin soil cover; alternating sand and silt layers with thin soil cover; and shallow weathered glacial till.
- $NO_3$-N concentrations under farmed sites are statistically higher than under non-farmed.
- No differences in water quality have been detected that can be attributed solely to BMPs.
- 44 out of 508 ground water samples scanned for pesticides have detectable levels. 22 of the 44 samples with detections were collected at sites with no recorded history of on-site pesticide use.
- Macropores appear to be a pathway for pesticide infiltration in the glacial till geozone. (ref. 10)

## II. Water Quality Goals and Objectives

The goal of this project is to improve and protect surface and ground water quality by reducing the amount of total nitrogen, pesticides, animal waste and other pollutants entering these waters.

## III. Project Characteristics and Results

**1. Project Type: RCWP, Comprehensive Monitoring and Evaluation Project**

**2. Timeframe:** 1981 – 1991

**3. Total Project Budget (for timeframe):**

| ACTIVITY: / SOURCES: | Federal | State | Farmer | Other | SUM: |
|---|---|---|---|---|---|
| Cost-share | 1,240,886 | 0 | 203,338 | 0 | 1,444,224 |
| Info. & Ed. | 125,752 | 0 | 0 | 0 | 125,752 |
| Tech. Asst. | 76,464 | 0 | 0 | 0 | 76,464 |
| Water Quality Monitoring | 1,502,000 | 0 | 0 | 0 | 1,502,000 |
| SUM: | 2,654,349 | 0 | 203,338 | 0 | $2,857,687 |

**4. Area (acres):**

| Watershed | Project | Critical |
|---|---|---|
| NA | 106,163 | 79,450 |

**5. Land Use:** (ref. 7)

| Use | % Project Area | % Critical Area |
|---|---|---|
| cropland | 61 | 60 |
| grassland | 13 | 40 |
| water | 11 | |
| other | 15 | |

**6. Animal Operations in Project Area:** (Oct. 1985, ref. 7)

(in the Priority 1 Critical Area)

| Operation | # Farms | Total # Animals | Total A.U. |
|---|---|---|---|
| Dairy | 8 | 830 | 1,162 |
| Beef | 20 | 2,550 | 2,168 |
| Hogs | 8 | 4,500 | 900 |
| Sheep | 3 | 375 | 37.5 |

**7. Water Resource Type:**

Lake Poinsett, Lake Albert, Oakwood Lakes, ground water (portions of the Big Sioux aquifer).

**8. Water Uses and Impairments:**

The project area has several lakes, sloughs and shallow ground water aquifers bordering on the Big Sioux aquifer. The lakes are heavily used for recreation (e.g., fishing, boating, swimming, water-skiing) and stock watering. Over the past five years, recreational visitations to the lakes numbered 240,000 to 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 hypereutrophic conditions in the lakes. Algal blooms, excessive aquatic weed growth, and DO depletion are common. Pesticides and excessive nitrates in ground water are also of primary concern.

**9. Water Quality at Start of Project:** (ref. 7)

Groundwater: Water quality data (1977-1978 study) from 861 private wells in the project area showed nitrate levels exceeding the federal drinking water standard (10mg/l) in 27% of the wells tested.

| | Total P (mg/l) | Total N (mg/l) |
|---|---|---|
| Lake Poinsett: | 0.12 | 4.0 |
| Oakwood Lakes: | 0.15 | 9.0 |
| Tributaries: | 0.50 | 3.2 |

**10. Meteorologic and Hydrogeologic Factors:**

a. Mean Annual Precipitation: 22 inches

b. USLE 'R' Factor: ~ 100

c. Geologic Factors: The project area has typical glacial Pleistocene morphology with many alluvial 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.

**11. Water Quality Monitoring Program:**

a. Timeframe: 1984 - ending dates below [a]

- ground water monitoring ends at end of 1990
- ag. chemical leaching study ends at end of 1989
- Oakwood Lakes study monitoring ended December 1988

[a] Request has been made for funds to extend all of above studies for three years.

b. Sampling Scheme: conducted by South Dakota Dept of Water and Natural Resources and South Dakota State University Water Resources Institute

The Comprehensive Monitoring and Evaluation project is conducting three water quality monitoring studies: 1) ground water; 2) surface water; and 3) agricultural chemcial leaching through the soil profile.

1. Location and number of monitoring stations:

*Ground water:*

7 field sites (10-80 acres in size): 6 farmed fields (1 is control) and 1 unfarmed field with nests of wells at each site. The sites are located in different parts of the project area at locations selected to represent predominant cropping practices on glacial till or outwash soils. A control site is located on non-agricultural land.

*Master site:*

1 field site for intensive study of agricultural chemical leaching and soil profile monitoring pesticide & nitrate soil water extraction / leaching-event-actuated automatic sampling

*Surface water:* Oakwood Lakes System Study

6 stations on tributaries, 3 sites between lake basins, and 1 site at the lakes' outlet. Base flow measured biweekly to monthly at tributary stations and water quality samples are taken automatically after storm events. Parameters sampled are TP, ortho P, $NO_3$-N & $NO_2$-N, $NH_3$, TKN and SS. At in-lake sites, integrated samples are taken every two weeks from May to October and every month from November to April. Parameters sampled are TP, ortho P, $NO_3$-N & $NO_2$-N, $NH_3$, TKN, pH, chl *a*, algal density, DO, temperature, and secchi disk transparency. Biological sampling of fish populations and zooplankton also takes place.

2. Sampling frequency: ground water - monthly / surface runoff - storm event based
3. Sample type: automatic and grab

c. Parameters Analyzed:

ground water- $NO_2$-N & $NO_3$-N, $NH_3$, organic N, TP, CL, $SO_4$, pesticides, pH, conductivity, DO, TKN

surface runoff - ground water parameters plus ortho P, TDS and SS

Flow is measured with surface runoff samples. Ground water levels are measured on a weekly to monthly basis.

**12. Critical Areas:**

a. Criteria: The entire 79,450 acres of cropland and grassland are considered critical. The project area was divided into three priority areas based on sediment delivery levels and the impact on ground water (e.g., regional ground water movement, distance from lakes or streams, drainage characteristics, and thickness of overburden). The first priority area covers 59,500 acres. The second and third priority areas cover 19,950 acres combined.

b. Application of criteria: The first priority area includes most of the livestock operations and encircles the lakes.

**13. Best Management Practices:**

a. 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 waste management systems

b. Quantified Implementation Goals:

- fertilizer management on 70,000 acres (66% of project area)
- pesticide management on 65,000 acres (61% of project area)
- conservation tillage for erosion control on 65,000 acres
- waste management systems on 10 livestock operations

c. Quantified Contracting/Implementation Achievements:

| Pollutant Sources | Critical Area Treatment Needs | Project Treatment Goals | % Needs / Goals Contracted | % Needs / Goals Implemented |
|---|---|---|---|---|
| Acres Needing Treatment | 79,540 | 59,590 | 56 / 74 | NA |
| Conservation Tillage | 65,000 | 52,000 | 42 / 57 | 46 / 57 |
| Fertilizer Mgmt. | 70,000 | 56,000 | 39 / 49 | 27 / 34 |
| Pesticide Mgmt. | 60,000 | 52,000 | 47 / 54 | 34 / 40 |
| Feedlots | 16 | 8 | 31 / 63 | 19 / 38 |
| # contracts | 220 | 165 | 70 / 93 | NA |

d. Cost of BMPs: Estimated cost of the three major BMPs being implemented are:

| BMP | Govt. cost share | Tech. Asst. cost | Total Gov. cost | Years of life |
|---|---|---|---|---|
| | ----------per acre---------- | | | |
| Conservation tillage | 22.50 | 1.09 | 23.59 | 3+ |
| Fertilizer management | 3.00 | 72.00 | 3.72 | 4+ |
| Pesticide management | -0- | 4.29 | 4.29 | 3 |

e. Effectiveness of BMPs:

| BMP | soil savings (tons) | applied units |
|---|---|---|
| Perm. veg.cover | 5,935 | 1,025 ac. |
| Strip cropping | 125 | 132 ac. |
| Terrace systems | 215 | 7,491 ft. |
| Waterways | 6 | 3 ac. |
| Shelterbelt | 620 | 1,489 rod rows |
| Cons. tillage | 160,700 | 24,677 ac. |

**14. Water Quality Changes:**

No water quality changes associated with BMP implementation have been documented.

Simulation with the AGNPS model indicates that all contracted BMPs implemented as of July 1986, should reduce sediment and phosphorus loadings to the four major lakes by 5 to 12 percent compared with pre-RCWP loadings. However, the model also indicates that water soluble nitrogen loadings should increase 2 to 3 percent. The model provides no estimates of changes in nitrogen infiltration.

**15. Changes In Water Resource Use:**

The projected reductions in loadings to the lakes as a result of RCWP do not appear sufficient to affect water quality and water use. No findings are yet available on ground water use.

**16. Incentives:**

a. Cost Share Rates: 75%

b. $ Limitations: $50,000 maximum per farm

c. Other Incentives: I & E program to support BMP 15 & 16 offers assistance with interpreting soil test results and pest scouting service.

**17. Economic Benefits:**

a. On-farm:

Participating farmers appear to benefit economically from reduced tillage costs, reduced fertilizer costs, and perhaps slightly lower pesticide costs. Also there may be some short and long-term yield improvement attributable to soil and moisture retention by conservation tillage.

b. Off-farm:

Recreational values are so high that reducing algae blooms could generate benefits as high as $3.5 to $5.9 million annually. Actual recreational benefits attributable to RCWP will likely be much less, however, because reductions in nutrient loadings to lakes will probably be small. Domestic water supply benefits could reach $100,000 annually if groundwater quality is maintained above public health standards.

## IV. Lessons Learned

The AGNPS model is being used to predict the effect of BMP implementation on sediment, P and N loadings to surface waters, and the project is documenting the effect of fertilizer management on the quality of ground water.

A clear statement of project goals and objectives is important for an effective ground water monitoring program.

A thorough understanding of project area geology is essential for accurate interpretation of ground water monitoring results. A geologic investigation can be time-consuming and expensive, especially in a project with complex hydrogeology.

The project area covers many geologic settings. A method was developed to aggregate ground water data for statistical analysis. The project characterized each monitoring well by the geologic stratum, or geozone, in which it is screened and the depth of the well screen. These geozones are site specific, however the method of characterization is transferable to other ground water monitoring projects. (ref. 10)

Interviews with farmers still participating in pest management indicate that the program improved their pest management practices. Many farmers believe that fertilizer management is beneficial but others consider the work involved to be greater than the benefits. (ref. 9)

An active Information and Education program using news letters, radio programs and other mass media on a regular basis keeps project participants, the general public, and agency personnel informed of project status. (ref. 9)

## V. Project Documents

1. Application for RCWP Funds, February 1981.

2. Comprehensive Monitoring and Evaluation Plan for the Oakwood Lakes - Poinsett RCWP, South Dakota State Coordinating Committee, July 1982.

3. 1982 Annual RCWP Progress Report - Project 20, Oakwood Lakes - Poinsett, South Dakota.

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10. CM&E Technical Report (Water Quality Land Use Data Analysis), Oakwood Lakes - Poinsett RCWP, 1987 Annual Progress Report - Project 20.

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# Nansemond-Chuckatuck - RCWP 21

**City of Suffolk and Isle of Wight County, Virginia**
**MLRA: T-153A**
**H.U.C. 020802-08**

## I. Major Contribution Toward Understanding the Effectiveness of NPS Control Efforts

The project provides information about the level of NPS pollution control attainable through voluntary agricultural cost sharing programs.

The project is not evaluating the effectiveness of individual BMPs but the water quality data and detailed land treatment records should make possible the analysis of the project's impact on water quality.

## II. Water Quality Goals and Objectives

The project's goals are stated as:(ref. 24)
1. To reduce the fecal coliform organisms in the water supply reservoirs, Nansemond River, and Chuckatuck Creek to within tolerable limits.
2. To reduce the total soil loss by 87,000 tons per year.
3. To reduce the turbidity and sediment loading of the 195 miles of streams and 4,850 acres of water supply reservoirs.
4. To reduce the amount of plant nutrients and pesticides being discharged into local streams and reservoirs.

## III. Characteristics and Results

**1. Project Type:** RCWP

**2. Timeframe:** 1981-1991

**3. Total Project Budget (for timeframe):**

| SOURCE: / ACTIVITY: | Federal | State | Farmer | Other | SUM: |
|---|---|---|---|---|---|
| Cost-share | 1,721,000 | 0 | 4,242,000 | 0 | 5,963,00 |
| 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 |

**4. Area:**

| Watershed | Project | Critical |
|---|---|---|
| 161,365 | 161,365 | 23,908 |

| Subwatershed | Total Acres | Critical Acres |
|---|---|---|
| Norfolk | 42,000 | NA |
| Portsmouth | 37,000 | NA |
| TOTAL | 161365 | 23,908 |

## 5. Project Land Use:

| Use | % Project Area | % Critical Area |
|---|---|---|
| cropland | 27.3 | 32.0 |
| pasture/range | 2.8 | NA |
| woodland | 62.9 | NA |
| urban | 1.2 | NA |
| wetland | 3.8 | NA |
| other | 4.2 | NA |

There are 825 farms in the project area.

**Subwatershed Data:**

| Subwatershed | Cropland | Pasture | Forest |
|---|---|---|---|
| Chuckatuck | 1,896 | 528 | 1,960 |
| Nansemond | 2,267 | 137 | 2,301 |
| Norfolk | 5,557 | 856 | 6,098 |
| Portsmouth | 3,170 | 351 | 3,941 |

## 6. Animal Operations in Critical Area: (ref. 15)

| Operation | # Farms | Total # Animals | Total A.U. |
|---|---|---|---|
| dairy | 1 | 125 | 163 |
| beef | 24 | 2,724 | 2,724 |
| hog | 40 | 24,000 | 3,600 |
| poultry | 8 | 448,000 | 1,792 |

## 7. Water Resource Type:

2 estuaries and 7 drinking water reservoirs

## 8. Water Uses and Impairments:

Reservoirs in the project area are sources of public water supply for the cities of Norfolk, Chesapeake and Virginia Beach, Virginia. Chuckatuck Creek is a successful 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.

## 9. Water Quality at Start of Project:

Estuary: 3,000 acres of shellfish beds have been condemned, chl *a* concentrations exceed 40 ug/l, and DO is frequently depleted.

Reservoirs: Phosphate-P concentrations range from 0.05 to 0.20 mg/l in fall and winter samples. Higher concentrations have been associated with high fecal coliform densities in some tributaries to the reservoirs.

## 10. Meteorologic and Hydrogeologic Factors:

a. Mean Annual Precipitation: 48 inches
b. USLE 'R' Factor: 300
c. 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 groundwater is generally 25 feet or more.

**11. Water Quality Monitoring Program:**

a. Timeframe: sampling of reservoirs was initiated October 1982; regular sampling of estuary stations initiated in June 1983.

b. Sampling Scheme: conducted by: The Hampton Roads Water Quality Agency, the cities of Norfolk and Portsmouth, VA Institute of Marine Science and the State Water Quality Control Board

1. Location and Number of Monitoring Stations: 19 sampling stations – 4 in the Nansemond River estuary, 3 in the Chuckatuck Creek estuary, and 12 stations in the upstream impoundments of the Nansemond River system
2. Sampling Frequency: at each station is conducted monthly.
3. Sample Type: grab

c. Pollutants Analyzed:

estuary: DO, salinity, TSS, $NO_3$, dissolved OP, FC, BOD

impoundments: TS, TP, pH, FC, DO, BOD, algal species

d. Other: There are no flow measurements.

**12. Critical Areas:**

a. Criteria: The boundary was originally specified to include the area one mile from the Nansemond River or its impoundments and one mile from Chuckatuck Creek. This was expanded during 1985 to include most of the remaining project area (new boundary includes 1 mile radius from all tributaries). In treating the expanded critical area, the project established a priority checklist for ranking. Weights are based primarily on distance to live stream and less than optimal soil or animal waste management. Animal waste operations are given twice the priority of croplands, and erosion problems are given the same priority as pesticide and fertilizer management problems. Farms with animal operations and no cropland treatment needs do not qualify.

b. Application of Criteria: Project reports do not contain appropriate detail to evaluate this.

**13. Best Management Practices:**

a. General Scheme: The project has concentrated primarily on animal waste management, for hog and dairy operations, and conservation tillage with fertilizer and pesticide management.

b. Quantified Implementation Goals: The project seeks to treat 17,931 acres and 115 animal operations. These goals expanded from 14,055 acres and 51 animal operations in 1985, when the critical area was expanded.

c. Quantified Contracting/Implementation Achievements: (ref. 24)

| Pollutant Sources | Critical Area Treatment Needs | Project Goals | %Needs/Goals Contracted | %Needs/Goals Implemented |
|---|---|---|---|---|
| Acres Needing Treatment | 116,710[a] | NA | NA | NA |
| Dairies | 1 | 1 | 100/100 | –[c] |
| Feedlots | 50 | 38 | 70/92 | 34/44.4[c] |
| Poultry | 8 | 6 | 37.5/50 | –[c] |
| Crops | 23,908[b] | 16,655 | 62.9/90.3 | 60.1/87.2[d] |
| # Contracts | 184 | 132 | 58.2/81 | NA |

[a] The project area is 161,365 acres, critical area has been defined to be 116,710 acres or 72% of the project area (ref. 24)

[b] There are 37,358 cropland acres in the critical area, project states that only 23,908 acres neeced treatment.

[c] Estimated from BMP 2, animal waste control system (dairies,feedlots and poultry)

[d] Estimated from BMPs 15 & 16 applied. BMP 9: 7,870 acres applied (33%/47%).

d. Cost of BMPs:

| BMP | Ave. Farmer Share ($) | Ave. RCWP Share ($) | Total Cost ($) |
|---|---|---|---|
| 1 Perm. Veg. Cover | 33/ac. | 100/ac. | 133/ac. |
| 2 Animal Waste Mgmt. | 6,670 ea. | 20,000 ea. | 26,670 ea. |
| 5 Diversion System | 0.33/ft. | 1/ft. | 1.33/ft. |
| 6 Grazing Land Protection | 1,670 ea. | 5,000 ea. | 6,670 ea. |
| 7 Waterway System | 83/ac. | 250/ac. | 333/ac. |
| 8 Cropland Protection | 5/ac. | 5/ac. | 10/ac. |
| 9 Conservation Tillage | 7.30/ac. | 22/ac. | 29.30/ac. |
| 11 Perm. Veg. on Crit. Areas | 35/ac. | 105/ac. | 140/ac. |
| 12 Sediment Retention Struc. | 750 ea. | 2,250 ea. | 3,000 ea. |

e. Effectiveness of BMPs: The project estimates that 45,108 tons of soil have been protected from erosion annually, and 56,546 tons of manure produced annually (65% of production) have been put under management. The project also states that fertilizer management on 14,536 acres will improve utilization of nitrogen phosphorus and potassium, improving crop production and preventing stream pollution.

## 14. Water Quality Changes:

Water quality data have not yet been analyzed. Improving trends in TSS and orthophosphorus have been observed for Nansemond River when compared with reports from the 1960s. An improving trend in $NO_3$-N has been observed for Chuckatuck Creek. However, these trends may not be attributable to RCWP work because they emerged in the late 1960s after point sources were removed from the project area. Analysis of water supply lakes in the project area indicates high variability in water quality data and little evidence of trends.

## 15. Changes in Water Resource Use:

Oyster production has decreased from a total of 214,000 pounds in 1980 to 95,400 pounds in 1985. Lowest production was in 1984 with 57,800 pounds. Three reservoirs in the project area are used for domestic water supply, and water treatment has not changed since RCWP began. Fishing is the primary recreational activity in the area, with approximately 30,100 user days per year, unchanged since 1980. Of 7,200 total shellfishing acres, 2,100 acres are condemned and 2,700 acres have been conditionally approved.

## 16. Incentives:

a. Cost Share Rates: 75% for most practices except cover crops and some waste application equipment cost shared at 50%. Fertilizer and pesticide management are not cost-shared.
b. $ Limitations: $50,000 per contract (some contracts cover multiple tracts)

## 17. Potential Economic Benefits:

a. On-farm: not evaluated
b. Off-farm:
1) Recreation: 0
2) Water Supply: $10,000 - $130,000 per year
3) Commercial Fishing: $30,000 per year
4) Wildlife Habitat: unknown
5) Aesthetics: unknown
6) Downstream Impacts: unknown but positive

## IV. Lessons Learned

This project shows a high degree of coordination among agencies concerned with water quality and resources. The land treatment program is implemented by SCS. SCS keeps appropriate records to identify each contract with respect to the water resource that it affects. Several water resource agencies are conducting monitoring programs that are used to assess the effectiveness of the land treatment program. The monitoring agencies interface with the land treatment program through a coordinator at the Hampton Roads Water Quality Agency. The agencies appear to maintain effective communication.

## V. Project Documents

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a. Presnell-Kidd Assoc., Inc. (for City of Norfolk, Va. Dept. of Utilities) Phase 1 Water Quality Management Study Norfolk-Western Lakes Reservoir Systems. (no date)

b. Virginia State Water Control Board. Chuckatuck Creek Non-point Source Bacteriological Study. April 24, 1980.

c. Virginia Department of Health. Notices of Shellfish Area Condemnation for Chuckatuck Creek dated: 28 June 1979; Nansemond River dated 16 August 1976, 9 March 1972, and 6 November 1963.

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9. VPI&SU Extension Division. Best Management Practices for Swine Operations. Publication 4 WCB 5. Blacksburg, Va. November 1980.

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11. VPI&SU Extension Division. Conservation Tillage a Best Management Practice. Publication 4 WCB 7. Blacksburg, VA. January 1981.

12. VPI&SU Extension Division. Integrated Pest Management - a Best Management Practice Publication 390-409. Blacksburg, VA. November 1980.

13. Nansemond-Chuckatuck RCWP Best Management Practices, as approved by EPA in letter from Peter Wise to Orin Hanson, May 14, 1981.

14. RCWP Local Coordinating Committee. Nansemond-Chuckatuck RCWP 1982 Progress Rep. Nov. 1982.

15. RCWP Local Coordinating Committee. Nansemond-Chuckatuck RCWP 1983 Progress Rep. Nov. 1983.

16. RCWP Local Coordinating Committee. Nansemond-Chuckatuck RCWP 1984 Progress Rep. Nov. 1984.

17. RCWP Local Coordinating Committee. Nansemond-Chuckatuck RCWP 1985 Progress Rep. Nov. 1985.

18. RCWP Local Coordinating Committee. Nansemond-Chuckatuck RCWP 1986 Progress Rep. Nov. 1986.

19. Neilson, B.J. Nonpoint Source Sampling in the Hampton Roads Area. A report to the Hampton Roads Water Quality Agency. Special Report No. 128 in Applied Marine Science and Ocean Engineering. Virginia Inst. of Marine Sciences. March 1977.

20. Neilson, B.J. Summary of the Hampton Roads 208 Water Quality Modeling Studies. A report to the Hampton Roads Water Quality Agency. Special Report No. 170 in Applied Marine Science and Ocean Engineering. Virginia Inst. of Marine Sciences. January 1978.

21. Bosco, C. and Neilson, B.J. Interpretation of Water Quality Data from the Nansemond and Chuckatuck Estuaries with respect to Point and Nonpoint Sources of Pollution. A report to the Hampton Roads Water Quality Agency. Virginia Inst. of Marine Sciences. May 1983.

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# APPENDIX A

## RECOMMENDATIONS FROM MIP AND 108A NPS PROGRAMS

### Model Implementation Program: USDA & EPA - 1978-1982

This program sponsored watershed projects in seven states to demonstrate soil conservation and water quality related to agricultural land management practices. State agencies monitored water quality to evaluate project results. Project goals were to reduce sediment yield from irrigation tracts, reduce animal waste pollution from barnyards, reduce cropland and pasture land erosion, and attempt to prevent groundwater contamination or stream bed erosion.

### MIP Recommendations[1]

**MIP Projects**

| Name/State | SIZE (acres) | Water Quality Problem |
|---|---|---|
| Indiana Heartland, Indiana | watersheds: Stotts Creek 39,000 Eagle Creek 103,000 | algae blooms, nutrient & sediment loads |
| Maple Creek, Nebraska | watershed 245,645 proj. area 33,088 | sediment & nutrient loads, fecal coliform & ag. chemicals |
| Delaware River W. Basin, New York | watershed 287,224 | severe algal blooms, eutrophication - P load, plankton, Chl a |
| Little Washita River, Oklahoma | watershed 154,270 | sediment load, salts, nutrients (N & P) and oil field contaminants |
| Broadway Lake, South Carolina | project area 25,183 | siltation, sediment potential N & P |
| Lake Herman, South Dakota | watershed 42,948 | sediment and nutrient loading to lake |
| South Yakima, Washington | 2 subbasins: 26,500 Sulfer Creek | sediment and high N & P concentrations |

1 National Water Quality Evaluation Project and Harbridge House. **Model Implementation Program, Lessons Learned from Agricultural Water Quality Projects.** February 23, 1983.

- Agricultural NPS control programs should state goals and objectives clearly and in precise terms.

- Agricultural NPS control programs should clearly state tasks and responsibilities for all involved agencies, and progress reports should be submitted.

- Programs should designate a program director with authority to act on behalf of all agencies in directing the project activities.

- Programs should develop a uniform criteria for the assessment of potential projects.

- Programs should limit projects to manageable project areas where quality problems are caused primarily by agricultural non-point sources. (RCWP took this simplified approach).

- A logical and detailed plan of action should be reviewed and approved before implementation begins.

- Mechanisms should be included by programs to ensure that adequate resources are allocated by or given to each agency to complete assigned tasks.

- Programs should establish a means to identify critical areas within the watershed. Critical areas are those lands that are disproportionately responsible for water use impairments.

- All agencies involved should work together to better rate and select appropriate BMPs to address problems in the project area.

- For MIP projects, the timeframe was not long enough to document water quality benefits to receiving bodies.

- In installing BMPs, many practices were not selected and applied to directly promote water quality results. This problem led to better recognition and training RCWP.

- Five of the MIP projects did demonstrate in field and plot studies that BMPs produce water quality benefits.

- Within the agencies involved in MIPs, a need was shown for increased water quality expertise. (RCWP implemented workshops and training sessions for this purpose.)

- MIP projects showed the need for one-on-one contact, cost sharing and improved information and education practices to stimulate farmer participation.
    - The South Carolina MIP found that emphasis on farm ponds below pastures and pasture improvements are not cost-effective means of increasing water quality.
    - The Washington MIP showed that significant sediment reductions in return flows can be accomplished with irrigation BMPs.

- The New York MIP showed that barnyard management practices can result in 50-90% reduction of manure P.

## Great Lakes Demonstration Program 108a: U.S. EPA

The 108a program of the 1972 to the Clean Water Act funded 31 demonstration projects to eliminate or control pollution in the Great Lakes Basin. The program objective was to reduce phosphorus pollution from point and nonpoint sources, both rural and urban. Agricultural BMP evaluations were made mainly through conservation tillage implementation in 12 projects.

## 108a Recommendations [2]

**Great Lakes Demonstration Projects - 108a**

| Name/State | Type* | Project Dates |
|---|---|---|
| Black Creek, Indiana. | Multi-dim. | 1972 - 1980 |
| Washington County, Wisconsin | Multi-dim. | 1974 - 1981 |
| Red Clay, Wisconsin & Minnesota | Multi-dim. | 1974 - 1978 |
| Allen County, Ohio | ACT | 1980 - 1985 |
| Defiance County, Ohio | ACT | 1980 - 1985 |
| Lake Erie Basin, Ohio | ACT | 1981 - 1985 |
| Six Counties in Indiana | ACT | 1981 - 1985 |
| Bean Creek, Michigan | ACT | 1981 - 1985 |
| Otter Creek, Michigan | ACT | 1982 - 1986 |
| Tuscola County, Michigan | ACT | 1980 - 1983 |
| Oswego County, New York | ACT | 1982 - 1985 |
| Wayne County, New York | ACT | 1982 - 1985 |

* Multi-dimensional projects demonstrated a variety of practices; agricultural and urban BMPs, education programs and analysis through water quality monitoring procedures. Accelerated Conservation Tillage (ACT) projects demonstrated no-till and conservation tillage practices and assisted farmers in implementing these procedures

2 Newell, A.D., L.C. Stanley, M.D. Smolen, and R.P. Maas. **Overview and Evaluation of Section 108a Great Lakes Demonstration Program.** U.S. EPA-905/9-86-001, July 1986.

- Conservation tillage practices, while effective at reducing erosion and total nutrient load concentrations, many increase the dissolved P and N loading concentrations in surface waters. This demonstrates a need for fertilizer management along with conservation tillage practices.

- Found conservation tillage and fertilizer management BMPs the most cost effective methods for phosphorus control.

- High degrees of public support and landowner participation were obtained through: 1) Education and Awareness programs (including development of grade school and high school curriculums - Washington County project in Wisconsin), 2) public input on technical solutions, 3) cost sharing and 4) technical support for participating landowners.

- Effective use of project funds can be enhanced through targeting of critical areas which contribute most to water quality problems in the project area.

  The Black Creek Project developed ANSWERS (Areal NPS Watershed Environmental Response Simulation) computer model to identify critical areas. The model was designed to estimate the amount of pollution from a given area and then simulate the effects of various BMPs.

- Differences in pollution sources do exist between individual project areas.

  The Black Creek project found that implementation of conservation tillage BMPs, tile drainage and sediment control basins could improve water quality, while streambank erosion control structures showed little improvement to water quality.

  In contrast, the Red Clay project in Wisconsin and Minnesota showed streambank erosion as the major source of their pollution problems, with agricultural BMPs addressing a very small portion of the erosion problem.

# APPENDIX B

## RCWP Best Management Practices

### BMP 1 Permanent Vegetative Cover

Purpose: To improve water quality by establishing permanent vegetative cover on farms or ranchland to prevent excessive runoff of water or soil loss contributing to water pollution.

Lifespan: minimum of 5 years

Components:

1 Fencing
2 Grasses and legumes in rotation
3 Pasture and hayland management
4 Pasture and hayland planting
5 Proper grazing use
6 Range seeding
7 Planned grazing systems

### 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:

1 Waste management system
2 Waste storage structure
3 Critical area planting
4 Dike
5 Waste treatment lagoon
6 Diversion
7 Fencing
8 Filter Strips
9 Grassed waterway or outlet
10 Waste storage pond
11 Irrigation system, sprinkler
12 Irrigation system, surface, and subsurface
13 Subsurface drain
14 Subsurface drain, field ditch
15 Surface drain, main or lateral
16 Waste utilization

### 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:

1 Obstruction removal
2 Stripcropping, contour
3 Stripcropping, field
4 Stripcropping, wind

## 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:

1 Obstruction removal
2 Terrace
3 Subsurface drain
4 Underground outlet

## 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:

1Dike
2Diversion
3Obstruction removal
4Subsurface drain
5Underground outlet

## 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:

1 Pond
2 Fencing
3 Pipeline
4 Pond sealing or lining
5 Spring trails and waterways
6 Stock trails and waterways
7 Trough or tank
8 Well

## 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:

1 Fencing
2 Grassed waterway or outlet
3 Lined waterway or outlet
4 Subsurface drain

## 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:

1 Conservation cropping system
2 Cover and green manure crop
3 Field windbreaks

## 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:

1 Conservation cropping system
2 Conservation tillage system
3 Contour farming
4 Crop residue use
5 Land smoothing
6 Stubble mulching

## 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:

1 Channel vegetation
2 Fencing
3 Filter strip
4 Streambank protection
5 Tree planting

## 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:

1 Critical area planting
2 Fencing
3 Field borders
4 Filter strip
5 Livestock exclusion
6 Mulching
7 Sinkhole treatment
8 Spoilbank spreading
9 Tree planting
10 Well plugging

## 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:

1 Sediment basin
2 Dike
3 Fencing
4 Grade stabilization structure
5 Structure for water control
6 Water and sediment control basin

## 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:

1. Installation of tailwater return systems.
2. Conversion to a different system to reduce pollutants.
3. Reorganization of an existing system to reduce pollutants.

Lifespan: minimum of 10 years

Components:

1 Irrigation water conveyance
2 Pipeline
3 Irrigation system, drip
4 Irrigation system, sprinkler
5 Irrigation system, surface and subsurface
6 Irrigation system, tailwater recovery
7 Irrigation water management
8 Irrigation land leveling
9 Structure for water control

## 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:

1 Cover and green manure crop
2 Fencing
3 Proper woodland grazing
4 Tree planting

## 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:

1 Fertilizer management
2 Waste utilization

## 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:

1 Pesticide management

# List of Abbreviations (Terms, Agencies, Programs)

ACP ............................Agricultural Conservation Program
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
ASCS..........................Agricultural Stabilization Conservation Service, USDA
A.U. ............................Animal Unit
BMP(s) .......................Best Management Practice(s)
BOD............................Biological Oxygen Demand
CES ............................Cooperative Extension Service
Chl *a*............................Chlorophyll *a*
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...................ChemicalRunoffandErosion from Agricultural Management Systems (Model)
DO ..............................Dissolved Oxygen
DP ...............................Dissolved Phosphorous
ERS.............................Economic Research Service, USDA
FC................................Fecal Coliform
FS ................................Fecal Streptococci
HUC ...........................Hydrologic Unit Code (and Cataloging Unit)
I&E .............................Information and Education Programs
IN ................................Inorganic Nitrogen
JTU .............................Jackson Turbidity Unit
MLRA ........................Major Land Resource Areas
MPN............................Most Probable Number/100 ml
NWQEP .....................National Water Quality Evaluation Project
$NO_3$.............................Nitrate Nitrogen
$NH_3$.............................Ammonia Nitrogen
NPS .............................Nonpoint Source
NTU............................Nephelometric Turbidity Unit
OP ...............................Orthophosphate
PL-566 ........................Watershed Protection and Flood Prevention Act (PL83-566)
PLUARG...................Pollution of the Great Lakes from Land Use Activities, Reference Group
RCWP.........................Rural Clean Water Program
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
STORET .....................EPA Storage and Retrieval Data Base for Water Quality
STP..............................Sewage Treatment Plant
TC ...............................Total Coliform
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, Wischmeier & Smith, 1965.
USDA .......................... United States Department of Agriculture
USEPA ........................ United States Environmental Protection Agency
USGS .......................... United States Geologic Survey
VSS ............................. Volatile Suspended Solids
WATSTORE ............ USGS Water Data Storage System