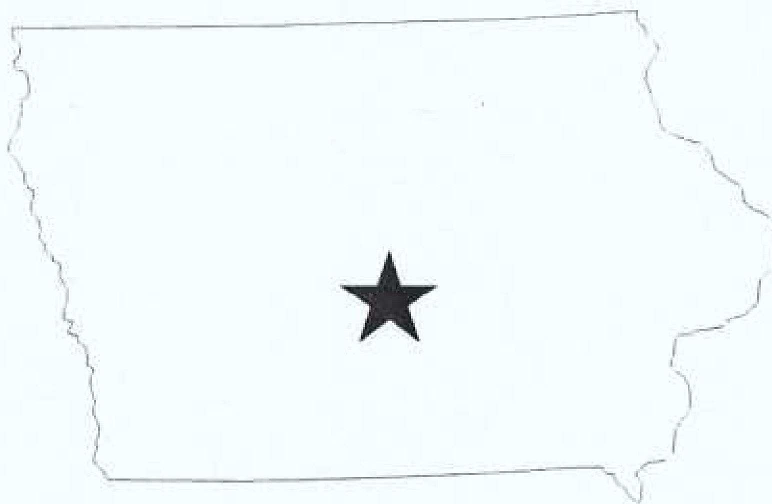
3N19

U.S. Fish and Wildlife Service
Region 3
Contaminants Program

Neal Smith National Wildlife Refuge, Iowa Contaminants Investigation Final Report



U.S. Fish and Wildlife Service
4469 - 48th Avenue Court
Rock Island, Illinois 61201

2000

Neal Smith National Wildlife Refuge Cooperative Contaminants Investigation

Iowa

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Final Report - July 18, 2000

U.S. Fish and Wildlife Service
Regional Identification Number 3N19
Divisional Identification Number 9530006

The U.S. Fish and Wildlife Service is the principal Federal agency responsible for conserving, protecting and enhancing fish and wildlife and their habitats. The Service manages 514 national wildlife refuges covering 92 million acres as well as 65 fish hatcheries. The agency also enforces Federal wildlife laws, manages migratory bird populations, stocks recreational fisheries, conserves and restores wildlife habitat, administers the Endangered Species Act and helps foreign governments with their conservation efforts. The Service oversees the Federal Aid program that funnels Federal excise taxes on angling and hunting equipment to state fish and wildlife agencies for fish and wildlife restoration programs.

The Service's environmental contaminants program includes research, field appraisals and recommendations to identify, evaluate, predict and avoid or lessen effects of contaminants in fish, wildlife and their supporting ecosystems.

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U.S. Fish and Wildlife Service Soil Quality Assessment

Summary

This document serves as the final report for the Neal Smith National Wildlife Refuge (Refuge) (formerly known as the Walnut Creek National Wildlife Refuge) contaminants investigation (DEC number 9530006b and FFS number 3N19). Staff from the U.S. Fish and Wildlife Service (USFWS) obtained funding in 1995 from the on-refuge contaminants investigation program to help develop one of Iowa's first U.S. Environmental Protection Agency (USEPA) non-point source pollution studies (Clean Water Act Section 319 grant). The study area for the project was the Walnut Creek Watershed which contains the Refuge property. The investigation was conducted and coordinated by the Iowa Department of Natural Resources.

The timing of the 319 study was beneficial to USFWS because restoration specialists working at this newly created national wildlife refuge used the 319 project to prioritize contaminant sources and problems, target water quality improvement projects and develop GIS databases for future restoration planning. A Service CAP study was also completed to assist in this effort.

The 319 study investigation team characterized water quality and non-point source pollution conditions in the Walnut Creek watershed and the paired agricultural watershed. There were large scale conversion of cropfields to grassland habitats in the Refuge that affected contaminant transport and fate. The attached report includes information on the national 319 program, other 319 projects across the country and results to date for the Walnut Creek Watershed project. Updated status reports and related activity reports for this on-going and long term watershed improvement effort can be downloaded off the Internet from the below listed URL addresses.

Internt URL Addresses for the Neal Smith NWR Watershed Investigation:

USEPA:

http://www/epa/gov/OWOW/NPS/Section319/319over.html

North Carolina University, National 319 Program:

http://h2osparc.wq.ncsu.edu/99rept319

Iowa Department of Natural Resources:

http://www.igsb.uiowa.edu/inforsch/walnut/walnut.htm

Attachment Number 1

U.S. Environmental Protection Agency
Project Report

Section 319
National Monitoring Program
Projects

1999 Summary Report

NATIONAL NONPOINT SOURCE WATERSHED PROJECT STUDIES

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

In Cooperation With.

U.S. Environmental Protection Agency
September 1999

MOVE DIRECTLY TO TABLE OF CONTENTS
RETURN TO 319 HOME PAGE

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Washington, DC

September 1999

Disclaimer

This publication was developed by the NCSU Water Quality Group, North Carolina State University, a part of the North Carolina Cooperative Extension Service, under U.S. Environmental Protection Agency (USEPA) Grant No. X825012. The contents and views expressed in this document are those of the authors and do not necessarily reflect the policies or positions of the North Carolina Cooperative Extension Service, the USEPA, or other organizations named in this report. The mention of trade names for products or software does not constitute their endorsement.

Acknowledgments

The authors would like to thank all project personnel of the 319 National Monitoring Program projects, who have provided information, updated profiles, and reviewed documents. Thanks to Terry Pollard and Janet Young, who edited this publication. Additional thanks to Jo Beth Mullens and Jill Saligoe-Simmel, formerly of Oregon State University Water Resource Research Institute, and Steven W. Coffey and Judith A. Gale, formerly of the NCSU Water Quality Group, for their contributions toward the preparation of the project profiles.

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Chapter 1

Introduction

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

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

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

Documentation of the water quality problem, which includes identification of the pollutants of primary concern, the sources of those pollutants, and the impact on designated uses of the water resources.

Comprehensive watershed description.

Well-defined critical area that encompasses the major sources of pollution being delivered to the impaired water resource. Delineation of a critical area should be based on the primary pollutants causing the impairment, the sources of the pollutants, and the delivery system of the pollutants to the impaired water resource.

A watershed implementation plan that uses appropriate best management practice (BMP) systems. A system of BMPs is a combination of individual BMPs designed to reduce a specific nonpoint source problem in a given location. These BMP systems should address the primary pollutants of concern and should be installed and utilized on the critical area.

Quantitative and realistic water quality and land treatment objectives and goals.

High level of expected implementation and landowner participation.

Clearly defined nonpoint source monitoring program objectives.

Water quality and land treatment monitoring designs that have a high probability of documenting changes in water quality that are associated with the implementation of land treatment.

Well-established institutional arrangements and multi-year, up-front funding for project planning and implementation.

Effective and ongoing information and education programs.

Effective technology transfer mechanisms.

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

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

This publication is an annual report on 23 Section 319 NMP projects approved as of September 1, 1999. Project profiles (Chapter 2) were prepared by the North Carolina State University (NCSU) Water Quality Group under the USEPA grant entitled National Nonpoint Source Watershed Project Studies. Profiles have been reviewed and edited by personnel associated with each project.

The 22 surface water monitoring projects selected as Section 319 NMP projects are Lightwood Knot Creek (Alabama), Oak Creek Canyon (Arizona), Morro Bay (California), Jordan Cove Urban Watershed (Connecticut), Lake Pittsfield (Illinois), Waukegan River (Illinois), Sny Magill Watershed (Iowa), Walnut Creek (Iowa), Warner Creek Watershed (Maryland), Sycamore Creek Watershed (Michigan), Elm Creek Watershed (Nebraska), New York City Watershed (New York), Long Creek Watershed (North Carolina), Peacheater Creek (Oklahoma), Upper Grande Ronde Basin (Oregon), Pequea and Mill Creek Watershed (Pennsylvania), Stroud Preserve Watersheds (Pennsylvania), Swatara Creek Watershed (Pennsylvania), Bad River (South Dakota), Lake Champlain Basin Watersheds (Vermont), Totten and Eld Inlet (Washington), and Otter Creek (Wisconsin). The 23rd project, Snake River Plain, Idaho, is a pilot ground water project.

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

Each project profile includes a project overview, project background, project design, and maps showing the location of the project in the state and the location of water quality monitoring stations. In the project background section, water resources are identified and water quality and project area characteristics are described. The project design section outlines the water quality monitoring program and nonpoint source control strategy. Project budgets and project contacts are also presented.

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

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

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Chapter 2

Section 319 National Monitoring Program Project Profiles

This chapter contains a profile of each of the Section 319 National Monitoring Program projects approved as of September 1, 1998, arranged in alphabetical order by state.

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

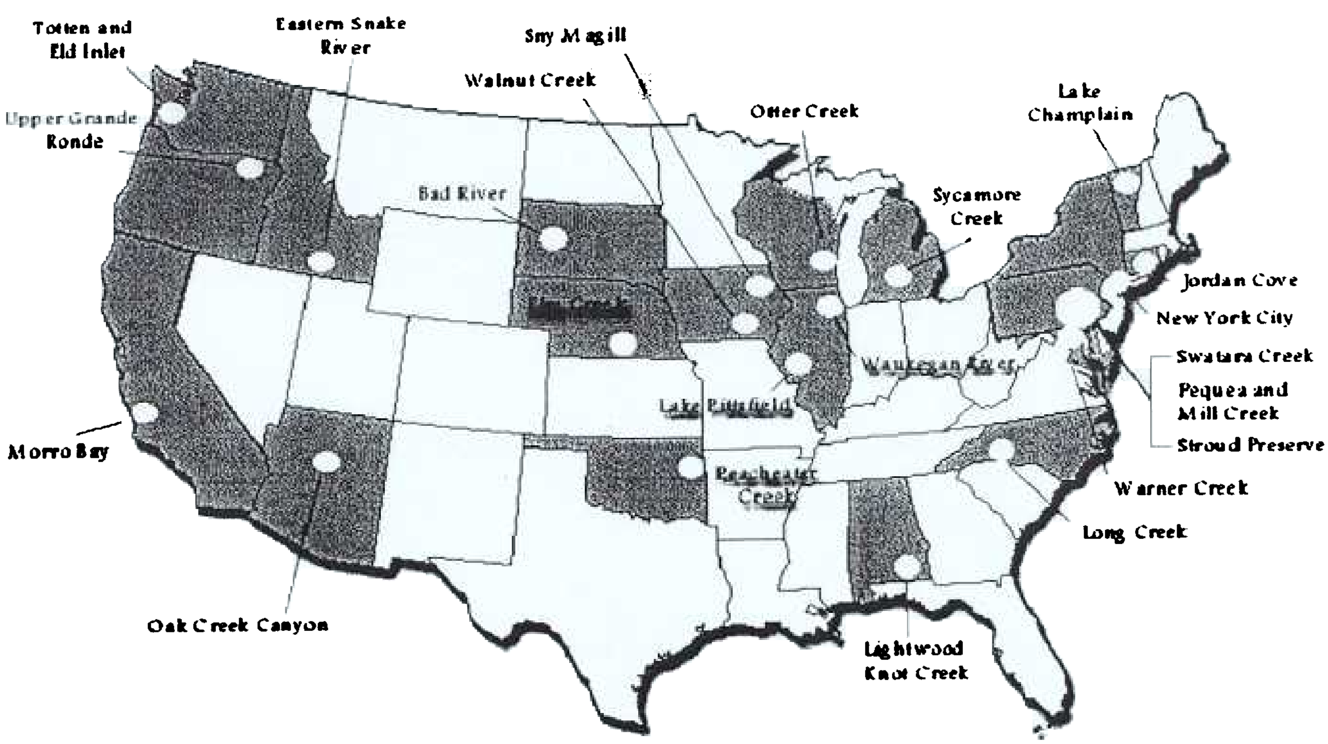
Sources used in preparation of the profiles include project documents and review comments made by project coordinators and staff.

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

Abbreviations used in the budget tables are as follows:

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

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



Totten and
Eld Inlet
Eastern Snake
River
Sny Magill
Walnut Creek
Otter Creek
Lake
Champlain
Upper Grande
Ronde
Bad River
Sycamore
Creek
Jordan Cove
New York City
Waukegan River
Swatara Creek
Pequea and
Mill Creek
Lake Pittsfield
Stroud Preserve
Morro Bay
Peacheater
Creek
Warner Creek
Long Creek
Oak Creek Canyon
Lightwood
Knot Creek

Walnut Creek
Section 319
National Monitoring Program Project

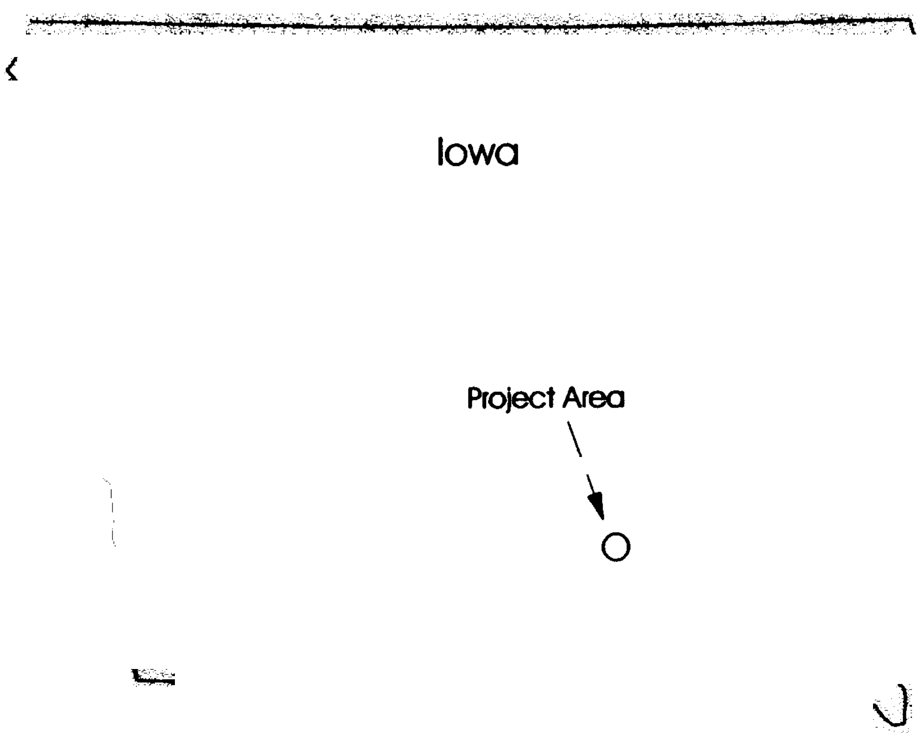
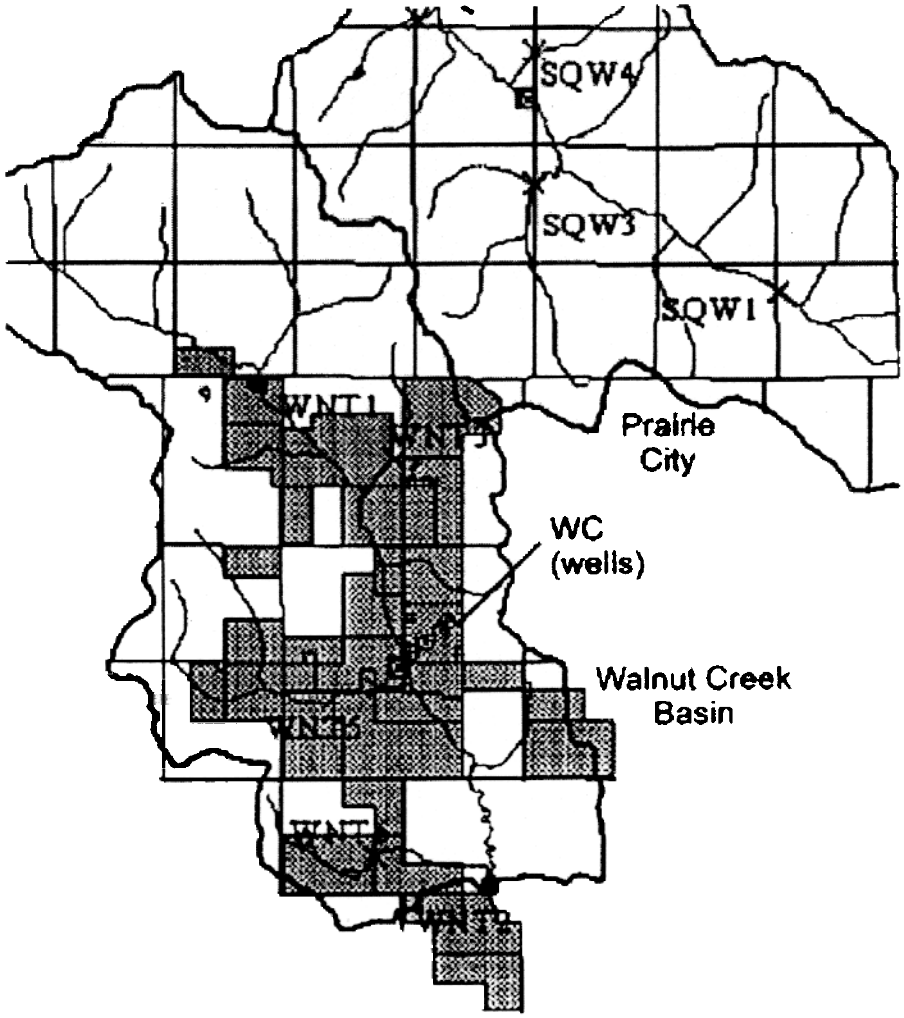


Figure 17: Walnut Creek (Section 319) Project Location



Legend

Gaging stations and surface water sampling points

Surface water sampling points

Wells

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

PROJECT OVERVIEW

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

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

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

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

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

PROJECT BACKGROUND

Project Area

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

Relevant Hydrologic, Geologic, and Meteorological Factors

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

Basin characteristics of Walnut and Squaw creek watersheeds are very similar:

Basin Characteristics	Walnut Creek	Squaw Creek
Total Drainage Area (sq mi)	20.142	18.305
Slope Class:		
A (0-2%)	19.9	19.7
B (2-5%)	26.2	26.7
C (5-9%)	24.4	25.0
D (9-14%)	24.5	22.2
E (14-18%)	5.0	6.5
Basin Length (mi)	7.772	6.667
Basin Perimeter (mi)	23.342	19.947
Average Basin Slope (ft/mi)	10.963	10.981
Basin Relief (ft)	168	191
Relative Relief (ft/mi)	7.197	9.575
Main Channel Length (mi)	9.082	7.605
Total Stream Length (mi)	26.479	26.111
Main Channel Slope (ft/mi)	11.304	12.623
Main Channel Sinuosity Ratio	1.169	1.141
Stream Density (mi/sq mi)	1.315	1.426
Number of First Order Streams (FOS)	12	13
Drainage Frequency (FOS/sq mi)	0.596	0.710

The U.S. Fish and Wildlife Service (USFWS) closely monitors land use/treatment activities within the WNT Refuge. Areas planted for native prairie restoration have been tracked since 1992 and are updated annually. Land use data for both Walnut Creek and Squaw Creek basins are available from 1994 to present. Prior to conversion, cropland management activities on farmlands are controlled and monitored by the USFWS. Land use within the Walnut Creek and Squaw Creek watersheds has been mapped by aerial photographs and field inspections on a yearly basis since 1994. Linear feet of filter strips, grass waterways and terraces have been digitized from color infrared aerial photographs for portions of the Walnut Creek watershed. Remaining areas within the Walnut Creek and Squaw Creek basins will be mapped from aerial photographs. All land use/treatment activities have been tracked using GIS and ARCINFO.

Land Use

From 1992 to 1997, 1,729 acres or 13.4% of the watershed (approximately 288 acres/year), were converted from row crop to native prairie in the Walnut Creek watershed. Land currently owned by the USFWS but still farmed is rented to area farmers on a cash-rent basis. Nearly all of the land restored to native prairie from 1992 to 1997 was derived from USFWS ground previously in row crop. In 1997, 773 acres or 6% of the watershed was farmed on a cash-rent basis. In accordance with the Cropland Management Plan for the refuge: 1) no fall application of fertilizer is allowed; 2) a maximum of 100 pounds of nitrogen per acre is allowed on conventional rotation corn acres; and 3) no pre-emergent herbicide is allowed (this includes common Iowa herbicides, atrazine, cyanazine, metolachlor, alachlor, metribuzin, and acetochlor). Combining the prairie planting areas and restricted application areas, land use changes have been implemented on 19.4% of the Walnut Creek watershed. The USFWS controls 4,343 acres, or 33.7%, of the Walnut Creek watershed above the WNT2 gaging station. From 1992 to 1997, nitrogen application in the watershed were reduced by 18.1% and pesticide application were reduced by 28%.

Land use in the watershed is as follow:

	Walnut Creek (%)			Squaw Creek (%)		
Land Use	**1996**	**1997**	**1998**	**1996**	**1997**	**1998**
Row Crop	57.1	61.1	59.6	73.2	74.8	75.5
Grass/Pasture	25.0	27.7	29.8	14.2	14	14.0
Woods	3.8	1.2	0.4	0.7	1.4	0.4
Water	5.3	4.9	5.0	4.5	4.1	4.2
Developed	2.1	1.7	1.9	2.6	2.2	2.7
Other	6.7	3.4	3.3	4.8	3.5	3.2

Water Resource Type and Size

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

Water Uses and Impairments

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

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

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

Pollutant Sources

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

Pre-Project Water Quality

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

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

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

Water Quality Objectives

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

Project Time Frame

April, 1995 to September, 2000

PROJECT DESIGN

Nonpoint Source Control Strategy

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

Project Schedule

Management Unit	Pre-BMP Monitoring Dates	BMP Installed	Date Installed/ Established	Post-BMP Monitoring Dates
Squaw Creek (control)	June 1991 – September 1994	None	None	June 1994 Current
Walnut Creek (treatment)	May 1991 – September 1994	Restoration of prairie/ savanna; Improved management practices (filter strips, no till, restricted pesticide use)	1992 Current	June 1994 Current

Water Quality Monitoring

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

Parameters Measured

Biological

Fecal coliform (FC)
Macroinvertebrates
Fisheries

Chemical and Other

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

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

Covariates

Precipitation
Water Discharge

Sampling Scheme

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

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

Modifications Since Project Start

None.

Progress To Date

Since project inception, approximately 5,500 acres of cropland have been removed from production and converted to native tall grass prairie. In the remainder of the Walnut Creek watershed, erosion control measures have been implemented and nutrient and pesticide application rates have been reduced.

The outlets of Walnut Creek and Squaw Creek, and the upstream station on the main stem of Walnut Creek, have been gauged on a daily basis for water discharge and suspended sediment. Surface water samples at upstream and downstream stations on both Walnut and Squaw Creeks, and three tributary streams in each basin, have been monitored weekly between March and July. Sampling frequency is reduced at the monitoring points throughout the remainder of the year. Land use determinations in both watersheds are conducted on an annual basis in mid-summer. Quarterly sampling of a monitoring well transect installed in an area of restored prairie monitors the effects of land use changes on groundwater quality.

Water quality monitoring data have been collected since 1994. These data are being added to STORET. Flow and suspended sediment measurements have been made since 1995 and are reported in WATSTORE.

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

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Habitat/Biological Assessment	Duration
Paired	Walnut Creek[T] Squaw Creek[C]	NO_3 Pesticides Turbidity SS	Precipitation Water Discharge	Biweekly/ Monthly; Storm events	Habitat/fisheries annually; Macroinv. bimonthly	Unknown
Upstream/ Downstream	Walnut Creek[T]	NO_3 Pesticides Turbidity SS	Precipitation Water Discharge	Biweekly/ Monthly; Storm events	Habitat/fisheries annually; Macroinv. bimonthly	Unknown

T = Treament watershed
C = Control watershed

DATA MANAGEMENT AND ANALYSIS

All United States Geological Survey (USGS) data are reported in WATSTORE, the USGS national database. The project uses ARCINFO for tracking and quantifying land use changes. Statistical analyses on water quality data for trend detection are completed as deemed necessary. Water quality parameters and land use activities will be tracked using Nonpoint Source Management System (NPSMS) software. Data management and reporting is handled by the Iowa Department of Natural Resources Geological Survey Bureau (IDNR-GSB) and follows the Nonpoint Source Monitoring and Reporting Requirements for Watershed Implementation Grants. All water quality data are entered into STORET.

NPSMS Data Summary

Not available.

Findings to Date

Pesticides. There were detections of six different compounds and two degradation products between 1994 and 1998 in Walnut and Squaw Creek surface waters. Atrazine was the most frequently detected pesticide, as is true across Iowa, with frequency of detections from 71% to 88% in the main stems. Pesticide concentrations typically peak between April and June of each year during periods of high streamflow associated with rainfall runoff. Cyanazine, acetochlor and an atrazine degradation product, deethylatrazine, were the next most frequently detected pesticide compounds. A summary of pesticide detections in the main stems of Walnut and Squaw Creeks follows:

Basin	Parameter	Atrazine (ug/L)	Cyanazine (ug/L)	Acetochlor (ug/L)	Deethylatrazine (ug/L)
Walnut Creek	Range	<0.1-2.6	<0.1-2.5	<0.1-0.76	<0.1-0.38
	Median	0.29	<0.1	<0.1	<0.1
	Detection Frequency	73%	48%	28%	71%
Squaw Creek	Range	<0.1-3.8	<0.1-5.9	<0.1-1.6	<0.1-0.33
	Median	0.28	<0.1	<0.1	0.12
	Detection Frequency	75%	43%	30%	45%

Nitrate. Nitrate concentrations are high but typical for Iowa streams. A comparison of data from the upstream and downstream paired sites between 1994 and 1998 show that the basins are similar. Ranges and averages for the stream sampling sites are:

Basin	Sample Location	Range NO_3-N (mg/L)	Avg. NO_3-N (mg/L)
Walnut Creek	WNT1	4.1-15.8	11.2
	WNT2	2.1-13.0	8.2
	WNT3	2.9-15.0	11.5
	WNT5	0.6-15.0	10.4
	WNT6	0.5-13.0	6.7
Squaw Creek	SQW1	6.8-17.0	13.0
	SQW2	3.9-13.0	8.8
	SQW3	5.6-15.0	11.0
	SQW4	0.5-4.6	2.5
	SQW5	3.6-12.0	8.2

Both basins show a similar temporal pattern of detection and an overall reduction in nitrate-N concentrations from upstream to downstream monitoring station. Higher concentrations are noted in the spring and early summer months coinciding with periods of application, greater precipitation and higher stream flows. Comparisons of nitrate-N loading data for water years 1995 to 1998 show no statistical differences between the Walnut and Squaw creek watersheds. Decrease in nitrogen concentrations between upstream and downstream stations observed in both watersheds can be caused by biological uptake, denitrification, or dilution by water lower in nitrogen. Comparison of upstream and downstream data for Walnut Creek basin suggests a reduction in nitrate-N loading between the upstream sub-basin sampled at WNT1 and the remainder of the basin. Linear regression suggests that the amount of nitrogen lost per acre of land is lower in the downstream portion of the watershed containing the land use changes. Highest nitrate-N concentrations are measured in the headwaters of both watersheds containing a high percentage of row crop.

Fecal Coliform Bacteria and BOD. Median annual fecal coliform counts varied widely between sampling sites and water years, ranging from 80 – 8,600 counts/100ml although most annual median values ranged between 100 – 800 counts/100ml. The highest individual fecal coliform detection was 7,600,000 counts/100ml at the upstream Walnut Creek site (WNT1). Highest levels of fecal colifrom bacteria typically occur in spring and early summer months during high stream flow periods associated with rainfall runoff. Little differences in fecal coliform counts were noted between the Walnut Creek and Squaw Creek basins. Less variability was observed in BOD concentrations compared to fecal coliform data. Detections of BOD averaged between 1.7 to 3.0 mg/L at all sampling sites, with median BOD concentrations near 2.0 mg/L. BOD was detected at greater frequency in Walnut Creek samples (55 – 95% of samples collected) compared to Squaw samples (38 – 62%).

Turbidity. Turbidity values have fluctuated widely between sampling periods. At both Squaw Creek and Walnut Creek drainage basins, higher median values and greater variability is noted at downstream sampling points compared to upstream samples. IN the main stems, median turbidity values were nearly two times higher in Walnut Creek (46 – 46.2 NTU) than Squaw Creek (17 – 27 NTU). Dates associated with high turbidity values coincide with elevated fecal coliform counts. Overall, turbidity trends show evidence for flashy behavior typical of surface runoff and sediment erosion following precipitation events.

Discharge and Suspended Sediment. Following is a summary of stream discharge and suspended sediment loads at the stream gauges for combined Water Years 1996 and 1997:

Parameter	WNT1	WNT2	SQW2
Mean discharge (cfs)	4.44	15.88	10.53
Mean discharge per drainage area (cfs/mi2)	0.66	0.79	0.58
Maximum discharge (cfs)	141	491	575
Total suspended sediment load (tons)	4,496	23,703	19,898
Maximum suspended sediment discharge (tons/day)	1,080	3,980	6,880
Annual suspended sediment load per square mile (tons/mi2)	334	588	548

Discharge and sediment movement through the Walnut and Squaw creek watersheds is very flashy – most of the sediment is discharged during intermittent high flow events. During 1997, a single discharge event in February accounted for 45% of the annual sediment total in the upstream Walnut Creek basin (WNT1). For the downstream gauging stations in Walnut and Squaw creeks, the maximum daily suspended sediment load comprised a smaller percentage of the annual total (18% at WNT2; 38% at SQW2). In Water Year 1996, a higher percentage of suspended sediment discharge occurred during a single event at the downstream stations (28% at WNT2; 46% at SQW2). Peaks in the discharge and sediment load, while varying in magnitude, show temporal consistency. In general, most suspended sediment discharge occurs during winter snowmelt (February and March) and during occasional storm
fo/5U [illegible]

Creek had a higher maximum discharge. On a per square mile of drainage basis, sediment loads in Walnut Creek were slightly higher than Squaw Creek. Contributions of streambank erosion and variations in rainfall patterns and intensity between the two basins may have contributed to these differences.

Biomonitoring. The 1998 biological survey identified a total of 53 distinct macroinvertebrate taxa in Walnut Creek and a total of 54 distinct macroinvertebrate taxa were collected from Squaw Creek. The total number of new taxa collected in 1998 was 14, of which 7 were collected qualitatively. Data have indicated few determinate trends with respect to the metrics used to evaluate the macroinvertebrate communities. Fifteen species of fish were collected from Walnut Creek in 1998, while 16 species were collected from Squaw Creek. Data indicated many of the fish species collected at Walnut Creek and Squaw Creek are considered to be tolerant of degraded environmental conditions, and no fish species considered to be intolerant of degraded environmental conditions were found at any of the sites. The 1998 Index of Biotic Integrity (IBI), a multimetric biological indicator used to describe the fish community, was greater for Walnut Creek than Squaw Creek, indicating a "higher quality" fish community in Walnut Creek. In addition to comparisons between creeks, Walnut and Squaw Creeks were compared to streams sampled within the same ecoregion (Southern Iowa Rolling Loess Prairies) as part of the Iowa Department of Natural Resources' biocriteria development project. Comparisons of the Walnut and Squaw Creek macroinvertebrate communities with the macroinvertebrate communities of the reference streams (12 sites that have been minimally impacted) shows a "lower quality" macroinvertebrate community, with Walnut and Squaw Creeks ranking at or near the bottom with respect to every metric. The IBI score for the fish community in Walnut Creek was similar to the mean IBI score within the ecoregion (N = 24), and was within the 95% confidence interval for this stream. The IBI score for Squaw Creek was to be less than the 95% confidence interval, implying an impaired fish community.

Stream Survey. In October 1998, a seven-mile reach of Walnut Creek was mapped using global positioning system (GPS) equipment. Channel features, streambank erosion rate, substrate materials and thickness and sinuosity were mapped in a continuous mode while traversing the stream; other channel features were located as discrete points. Debris dams (81 total), channel profiles (34), tile lines (49), tributary creeks (43), and cattle access points (14) were field located with GPS and the data exported into a Geographic Information System (GIS) format. Field descriptions were added to create a series of GIS coverages. Channel features were further coupled with existing land cover data for analysis. To evaluate statistical correlation among variables, the total length of mapped stream was divided into approximate 400m intervals, and channel features compiled in each interval.

Bank conditions varied from slightly eroded in straightened, stable segments of the channel, to severely eroded on outside meander bends and near debris dams where streamflow is diverted into the bank sides. Detailed erosion estimates from this study suggest that stream banks contribute more than 4,000 tons annually or 34% of the annual suspended sediment load in the channel. Substrate materials consisted of bare or thinly mantled pre-Illinoian till in scoured, channelized segments and thick silty muck (>1-2 feet thick) behind some debris dams. A sandy bottom was only observed downstream of a pasture area where the channel bottom was particularly disturbed by cattle crossings. Heavy trampling at cattle crossings and overgrazing in pasture areas further contributes to severe bank erosion and channel widening.

Channel profiles were measured at 34 locations along Walnut Creek. The channel depth remained relatively constant over the entire reach (approximately 10 feet deep) but varied in width from 20 feet to more than 60 feet. Profiles in channelized segments were narrow and V-shaped whereas channel widening was particularly evident at meander bends.

Approximately 75 debris dams were identified in the stream channel, ranging from fallen trees and beaver dams to several large debris dams. Large debris dams at some locations consisted of dozens of fallen trees blocking the channel and constricting stream flow. Debris dams were more prevalent in forested areas dominated by weak scrub trees (elm, silver maple) than areas typified by native oak savanna.

Numerous tile lines (49 total) and tributary creeks and ravines (43 total) were mapped as contributing flow to the main channel. Tiles were concentrated in agricultural areas of the basin, with some flowing between 10-20 gpm. Nutrient loads from tiles and tributary creeks probably contribute to water quality degradation observed in the main channel.

Results from the bank erosion and streambed assessments are being incorporated into a GIS-based sediment erosion model for the watershed. Other information obtained during the stream survey will be coupled with existing land cover, water quality, discharge and suspended sediment data for further analysis. The results of the mapping project are summarized in a poster which has been placed on the Iowa Department of Natural Resources web site: www.igsb.uiowa.edu/inforsch/walnut/wntpost/wntpost.htm

Sediment Erosion Modeling: A soil loss and sediment delivery model was applied to the Walnut Creek watershed. The total sediment load for a watershed comes from two sources, sheet and rill erosion and concentrated flow erosion. Two different procedures were used to model these sources. For the concentrated flow erosion, streambank erosion rates from the GPS survey were used to create a digital form of streambank erosion rates. For the sheet and rill erosion, the Universal Soil Loss Equation was incorporated using ArcView and Spatial Analyst. Walnut Creek was modeled using Water Year 1996 sediment load data collected at the downstream USGS gauge. The total sediment load at WNT2 (11,771 tons) was used as the upper boundary condition for the model. Unlike many other soil erosion models strictly focused on sheet and rill erosion, the Walnut Creek soil erosion model included sediment loads derived from streambank erosion and tributary gully erosion. The results of the model suggested that 4,033 tons, or 34%, of the total sediment load was derived from streambank erosion in the main channel. Gully erosion was estimated to contribute 2,239 tons annually, or 19%, of the total sediment load in the watershed. The remaining sediment load was attributed to sheet and rill erosion. This amount totaled 5,499 tons, or 47%, of the total sediment load in the watershed.

The sheet and rill erosion model (USLE) was used to initially estimate total sheet and rill erosion in the watershed at 39,652 tons, more than three times the total load measured in 1996. However, this total did not include a sediment delivery ratio. Considering the estimated contribution of sheet and rill erosion to be 4,045 tons, this translated to a sediment delivery ratio of 0.14 in the Walnut Creek watershed. This delivery ratio was consistent with local NRCS estimates and was a very reasonable estimate based on the amount of pasture and buffers in the watershed.

INFORMATION, EDUCATION, AND PUBLICITY

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

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

Progress To Date

Several tours were provided in 1996 to teacher groups, natural history organizations, and surrounding landowners. The visitor center opened in the spring of 1997. Tours have been done for a variety of different groups, including students from grade school through college; scientists from several in stitutions, including Iowa and several other states and counties; Iowa and U.S. legislators; and members of the farming community and general public.

In September 1998, the Walnut Creek watershed was a field trip tour stop for the 6th National Nonpoint-Source Monitoring Workshop. Formal oral and/or poster presentations have been given at several meetings around the Midwest both to scientific groups and to the general public.

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

The visitor center was opened in April 1997. From November 1, 1994 to July 30, 1998, 253,524 and 30000 students have visited the refuge. During the school year, approximately 150 school children participate in environmental education activities presented by refuge staff each week day. Improvement in water quality is part of one of the displays at the center.

TOTAL PROJECT BUDGET

The estimated budget for the Walnut Creek Section 319 National Monitoring Program project for 1995 through 1998 is:

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

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

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

None.

OTHER PERTINENT INFORMATION

Participating Agencies and Organizations:

Iowa Department of Natural Resources

U.S. Fish and Wildlife Service

U.S. Geological Survey   Water Resources Division

University of Iowa Hygienic Laboratory

Farm Service Agency

Iowa Department of Natural Resources   Environmental Protection Division

U.S. Environmental Protection Agency

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SECTION 319 NATIONAL MONITORING PROGRAM PROJECTS HOME PAGE

NATIONAL NONPOINT SOURCE WATERSHED PROJECT STUDIES

1999 Summary Report

1998 Summary Report

1997 Summary Report

1997 Overview Report

1996 Summary Report

1995 Summary Report

NCSU Water Quality Group

office of WATER
EPA link

Questions? Email *Laura Lombardo*

Appendix IV

Project Documents and Other Relevant Publications

This appendix contains publication references for the Section 319 National Monitoring Program projects. Project document lists appear in alphabetical order by state.

ALABAMA LIGHTWOOD KNOT CREEK SECTION 319 NATIONAL MONITORING PROGRAM PROJECT

1996. *Nonpoint Source Water Quality Monitoring Project for Lightwood Knot Creek Watershed in Southeast Alabama: A Report to the Alabama Department of Environmental Management for the Period January 1, 1996 to March 31, 1996.* Tuscaloosa, Alabama.

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World Wide Web Information:
www.igsb.uiowa.edu/inforsch/sny/sny.htm

IOWA WALNUT CREEK SECTION 319 NATIONAL MONITORING PROGRAM PROJECT

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Hubbard, T. and J. Luzier. 1999. *Walnut Creek Wildlife Refuge 1998 Biological Summary Report*. University of Iowa Hygienic Laboratory, Limnology Section. 43 pp.

Schilling, K.E. and C.F. Wolter. In Review. Application of GPS and GIS to Map Channel Features and Identify Spatial Relationships at Walnut Creek, Iowa. Submitted to *Journal of the American Water Resources Association*. June, 1999.

Schilling, K.E. and C.A. Thompson. In Review. Walnut Creek, Iowa Watershed Monitoring Project: Monitoring Water Quality in Response to Prairie Restoration. Submitted to *Journal of the American Water Resources Association*. May, 1999.

Schilling, K.E. and C.F. Wolter. 1999. Detailed GPS Survey of Walnut Creek, Iowa. *GPS World*. August 1999 issue.

Schilling, K.E. and C.F. Wolter. 1999. *Application of GPS and GIS to Map Channel Features and Identify Spatial Relationships at Walnut Creek, Iowa*. Iowa's 4th GIS User Conference, July 28-30, 1999, Storm Lake, Iowa.

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Attachment Number 2

U.S. Environmental Protection Agency
Project Overview

Section 319 National Monitoring Program: An Overview

March 1995

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

But what about pollutants from everyday activities like agriculture, residential develop These pollutants are much harder to control because they come from not-so-easily ide sources. According to the United States Environmental Protection Agency (USEPA), atmospheric deposition, contaminated sediments, and certain land use activities that ge such as agriculture, logging, small construction sites, and on-site sewage disposal.

Nonpoint sources are reported to cause the majority of water pollution problems in the Nutrients, sediment, metals, pesticides, salts, pathogens, and organic matter are deposi and estuaries from nonpoint sources. Most of these pollutants also reach ground water. understanding of how to control these nonpoint pollution sources, communities will b use practices and develop strategies to protect their water resources.

Section 319 National Monitoring Program: An Overview

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

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

To achieve these objectives, the Section 319 National Monitoring Program has selecte country to be monitored over a 6- to 10-year period to evaluate how improved land ma pollution. National Monitoring Program projects will help communities and citizens p resources by providing information on the effectiveness of tools and techniques for sol problems.

(Photo)
Sediment in stream from agricultural runoff and streambank losses.

Nonpoint Source Water Pollution: An Emerging Threat

As the Clean Water Act brings point source pollution from municipalities and industri magnitude of nonpoint source pollution throughout the United States has become mor waters assessed by States in 1992, nonpoint sources are prominent among the Nation's pollution sources. Table 1 lists the top five sources by water resource type.

Table 1 Five Leading Sources of Water Pollution in United States

Rank	Rivers	Lakes	Estuaries
1	Agriculture	Agriculture	Municipal Point S
2	Municipal Point Source	Urban Runoff/ Storm Sewers	Urban Runoff/ Storm Sewers
	Urban Runoff/ Storm Sewers	Hydrologic/Habitat Modification	Agriculture
4	Resource Extraction	Municipal Point Source	Industrial Point Source
	Industrial Point Sources	On-site Wastewater Disposal	Resource Extraction

Source: The Quality of Our Nationþs Water: 1992. 1994. United States Protection Agency (USEPA), USEPA 841-S-94-002, Washington, D.C.

The Watershed Approach to Nonpoint Source Pollution Control

Watersheds are areas of land that drain to a stream or other water body. Most nonpoint projects focus their activities around watersheds, because watersheds integrate the effe climate, hydrology, drainage, and vegetation have on water quality. Focusing pollutio activities around a watershed allows individuals living in that area to learn about the w and how to participate in its protection.

(Photo)
Stripcropping and contouring best management practices.

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

At a watershed scale, this relationship between changes inland management and water determined by following a strict experimental plan, or monitoring protocol. Although cases, detailed tracking of both land management and water quality is essential to prov decision makers about the effectiveness of nonpoint source pollution control efforts.

Section 319 National Monitoring Program: Improving Our Understanding of Pol

The Section 319 National Monitoring Program was established in 1991 to intensively and nonpoint source pollution controls in designated watershed projects. The projects funds authorized by Section 319 of the 1987 Amendments to the Clean Water Act, wh nonpoint source section of this legislation. While the USEPA funding for these project monitoring and evaluation, support from other funding sources and programs is levera needed land treatment. Coordination with other land management funding sources and within the watershed project.

The monitoring program aims to scientifically evaluate the effectiveness of control tec improve our understanding of nonpoint source pollution in these selected watersheds. comparisons, each project follows a nationally consistent set of guidelines, including t experimental design and water quality monitoring requirements. The National Monitor use the information collected from the projects to develop a national monitoring datab information for adjusting nonpoint source pollution controls to improve water quality. USEPA's Regions will use the findings from the National Monitoring Program to deve for future funding. Participating States will fine-tune their own monitoring efforts and the results from this program.

(Photo)
Technician sampling water quality in Long Creek (North Carolina).

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

Five National Monitoring Program projects are closely cooperating with the U.S. Geol USGS gauging stations monitor discharge and, in some cases, suspended sediment. At projects are located within drainage areas being intensively monitored by USGS as par Quality Assessment (NAWQA). Personnel from the USGS manage one of the Nationa projects. This coordination enhances the value of the water quality data and adds expe quality trends.

(Photo)
Buffer strips protecting a Wisconsin stream.

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

Section 319 National Monitoring Program: Project Selection

USEPA's regional offices nominate projects for the National Monitoring Program by f proposals to USEPA headquarters for review and concurrence. Section 319 National projects are selected on a competitive basis from within each of the USEPA Regions. project sponsors to develop approvable, 6- to 10-year projects. The project sponsors th State/EPA Section 319 grant process to obtain approval and funding. Proposed project many factors including:

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

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

USEPA has reviewed proposals for approximately 50 projects under the National Mon approving 11 to date (see above map). Ten of these involve monitoring surface water, is a pilot ground water project. However, the National Monitoring Program intends to water sites, lakes, and estuaries as soon as suitable project criteria are developed and p

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

Table 2 Primary and Secondary Pollutants

Projects	Nutrients	Bacter	Sediment	Organics
Arizona	o	*		o
California				
Idaho 1	*			o
Illinois	o			
Iowa	o			o
Michigan	o			
Nebraska				
North Carolina				
Pennsylvania				
Vermont				
Wisconsin				

Pilot ground water monitoring proje
Primary pollutant
Secondary pollutant

Projects can employ one of three study designs: paired-watershed, upstream-downstre downstream station (Table 3). Overall, the 11 projects currently in the Section 319 Nat Program are conducting 24 separate monitoring efforts.

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

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

The single-downstream station study design involves monitoring downstream of the e quality of the water is compared between the initial project conditions and the conditio design is not recommended because of the difficulty in isolating the effects of nonpoin other variables, such as rainfall.

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

Table 3. Water Quality Monitoring Design of Section 319 National Mon Projects

Project	Paired Watershed	Upstream/ Downstream	Single Downstream
Arizona	*		
California	*		
Idaho 1	*		
Illinois			
Iowa			
Michigan			
Nebraska			
North Carolina			
Pennsylvania			
Vermont			
Wisconsin			

1 Pilot ground water monitoring project

Monitoring requirements for National Monitoring Program projects include pre-projec baseline water quality, land management tracking, and options to collect at least 20 ev water chemistry samples during a season, sample the aquatic community at least once habitat conditions annually. The aquatic community includes habitat and aquatic orga insects) that indicate the health of water resources. Monitoring results are reported in a USEPA's NonPoint Source Management System (NPSMS) software to facilitate comp and the development of a national database.

Most projects are cooperative efforts between federal, state, and local agencies, and of federal water quality programs (Table 4). Projects with a strong local interest and high resources tend to be selected because participants in these projects often have greater i water quality.

Table 4. The Types and Number of Different Agencies Involved in the Monitoring Program Projects.

	Government Agencies					
State	Federal	State	Regional	Local	University	Industry
Arizona	5	10	1	4	4	4
California	2	2		1	4	
Idaho *	6	5		4	4	1
Illinois	2	4		2		
Iowa	7	3		1	2	
Michigan	2	1		3	1	
Nebraska	4	3	2	1		
N. Carolina	4	3		8	2	
Pennsylvania	3	1		1		
Vermont	1	1			1	
Wisconsin	3	2	1			

* Pilot ground water monitoring project

Funding for the different components of the National Monitoring Program comes fro federal, and local government agencies, as well as the private sector. Section 319 fund for water quality monitoring activities are shown in Table 5. Funds provided to project the basic monitoring requirements for National Monitoring Program projects, as well a that states include for their own purposes. For example, storm-event monitoring is not projects include such monitoring, which typically requires the purchase of automated s this reason, the funding levels shown in Table 5 significantly exceed the true cost of re the National Monitoring Program. The average funding levels are also skewed by the f years of monitoring.

Table 5. Section 319 Funding for Monitoring and Related Costs. 1

Project	S319 Funds Provided 2	Fiscal Years Funded	Total No. of Years Planned	Average Funds pe Year Fun
Oak Creek, AZ	$150,000	1994-95	6	$75,0
Morro Bay, CA	300,000	1993-95	10	100,0
Eastern Snake River Plain, ID	278,291	1992-95	6	69,5
Lake Pittsfield, IL	234,840	1992-93	10	117,4
Sny Magill Creek, IA	630,254	1991-97	8-10	90,0
Sycamore Creek, MI	261,000	1994-97	6+	65,2
Elm Creek, NE	83,150	1992-96	5+	16,6
Long Creek, NC	313,306	1993-95	8	104,4
Mill Creek, PA	516,728	1991-95	6-10	103,3
Lake Champlain, VT	273,354	1993-95	5	91,1
Otter Creek, WI	120,000	1994-1995	8	60,0
TOTAL NMP	$3,160,923			$79,0

1 Costs cover staff, equipment, supplies, and monitoring beyond the requirements for National Monitoring Program projects.
2 Actual $319 funds provided for the fiscal years funded to date.
3 Costs for early years are typically higher than for later years, du primarily to costs of establishing stations and purchasing equipmen including computers.

Section 319 National Monitoring Program: Projects

ARIZONA

Analysis of water flowing through Oak Creek Canyon, a 13-mile segment of water loc canyon portion of Oak Creek, shows that recreational activities in the Canyon are caus contamination and excess nutrient loads (Table 6). Over one-quarter of a million visito and camp at several campsites that are maintained by the Arizona Park Service.

Table 6 Fecal Coliform and Phosphorus Concentration in Oak Creek (A

Date	Fecal Coliform #/100 ml)	Phosphorus * (mg/l)
Feb.	---	0.12
March	---	0.20
April	---	0.12
June	61.2	0.14
July	463.7	0.28
August	392.5	0.41
Sept.	54.3	---

The average annual standard for phosphorus is 0.10 mg/l

The BMPs to be implemented at Slide Rock State Park (swimming hole) and Pine Flat enhancing the restroom facilities, better litter control using State Park officials to moni effectively, and the promotion of visitor compliance with park and campground regula littering, and waste disposal.

(Photo)
Swimmers at play in Oak Creek (Arizona)

The existing detention basin at Slide Rock parking lot is not removing pollutants adeq maintenance and perhaps an inadequate design. Because it was not cleaned routinely, heavy metals accumulated. Data from a single storm indicate that the sediment and zin basin and into Oak Creek (Table 7). The project team proposes to solve this problem b detention basin on a regular schedule, promoting an aerobic environment within the ba sweeping the parking lot, and if necessary, retrofitting the detention basin.

Table 7. Water Quality of Detention Basin In Parking Lot at Slide Rock State Park (Arizona Project).

Time	Dissolved Oxygen (mg/l)	pH	Zn (ug/l
Before rain	0.0	4.79	222
After rain	4.5	6.6	38

A paired-site, upstream-downstream water quality monitoring design is being used at t two campgrounds (treatment and control sites) to determine the effectiveness of BMPs will be taken on Saturday afternoons (peak tourist time) from May 15 through Septem starting in 1994. Automatic samplers, triggered by rainfall and runoff will be installed points of the Slide Rock parking lot detention basin to collect grab samples during run

CALIFORNIA

Morro Bay, one of the few intact natural estuaries on the Pacific coast of North Ameri impacted by sediment, and to a lesser extent by bacteria, metals, nutrients and organic and rangeland contribute the largest portion of the sediment that is deposited in the Ba

(Photo)
Scientist and technician analyzing water quality samples (California)

The Morro Bay Watershed Section 319 National Monitoring Program project is evalu four sediment-reducing BMP systems. A paired watershed study on tributaries of Chor Walters creeks) is evaluating the effectiveness of a rangeland BMP system -- fencing t corridor; creation of smaller pastures; installation of accessible water in each pasture; revegetation of streambanks; and installation of water bars and culverts on farm roads. quality monitoring sites have been established to evaluate the effectiveness of other B retention, cattle exclusion, and managed grazing. Water quality samples will also be ta watershed to document the changes in water quality during the life of the project.

IDAHO

The Idaho Eastern Snake River Plain is located in southcentral Idaho in an area domin agricultural land. The Eastern Snake River Plain aquifer system provides much of the approximately 40,000 people living in the project area. The aquifer also serves as an i for irrigation.

Excessive irrigation, a common practice in the area, creates the potential for nitrate an the aquifer below. Ground water monitoring has shown that nitrate levels in the shallo project area frequently exceed the drinking water standard of 10 mg/l (Table 8).

(Photo)
Installation of ground water sampling wells (Idaho).

The Eastern Snake River Plain project is the only Section 319 National Monitoring Pr evaluating the effects of agricultural BMPs on ground water quality. Twenty-four mon water samplers have been installed in two paired fields (six wells per field; four fields) will be monitored monthly. The effects of irrigation water application rates on nitroge temperature, dissolved oxygen, and pesticides will be evaluated for one paired field (crop type on these same parameters will be evaluated for the other pair (Forgeon). In a be obtained monthly to track the movement of nitrate-nitrogen over time and space.

Table 8. Ground Water Nitrate Concentrations for 1993-1994 in the Ea Plain Project Area (Idaho).

Field (each pair of fields contains 12 sample wells)	Mean Maximum Nitrate Conc (mg/l)	Ran[illegible] of the Max Nitrate Con[illegible] (mg/l)	Mean Minimum Nitrate Conc (mg/l)
Moncur (2 paired fields)	16.9	[illegible]-1.7	6.3
Forgeon (2 paired fields)	13.8	[illegible]-2.6	4.7

BDL = Below Detection Limit

ILLINOIS

Lake Pittsfield was constructed in 1961 to serve as a flood control structure and as a p the city of Pittsfield, a western Illinois community of approximately 4,000 people. The (Blue Creek Watershed) that drains into Lake Pittsfield is agricultural, consisting prim soybean cropland.

(Photo)
Aerial photography of Lake Pittsfield (Illinois).

Sedimentation is the major water quality problem in Lake Pittsfield. Sediment from fa gullies, and shoreline erosion has decreased the capacity of Lake Pittsfield by 25 perce

Based on a thorough analysis of lake problems and pollution control needs conducted Program, project coordinators developed a strategy to reduce sediment transport into L keystone of the land management strategy is the construction of settling basins throug including a large basin at the upper end of Lake Pittsfield. USDA Water Quality Incen provide for installation of additional sediment-reducing practices such as conservation management, livestock exclusion, filter strips, and wildlife habitat management. Land- geographical information system (GIS) are being used to develop watershed maps of s sediment yields.

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

IOWA

Sny Magill Creek, located in northeastern Iowa, is one of the more widely used stream fishing in the State. Sny Magill Creek drains a 22,780-acre agricultural watershed con row crops, pasture, forest and forested pasture, and farmsteads. There are approximate swine producers in the watershed, with farm sizes averaging 275 acres.

Excess sediment deposition in the Creek is harming the trout fishery. Consequently, a reduce sediment delivery to Sny Magill by one-half. To meet this goal, sediment contr stabilization, and other erosion and sediment control measures are planned. Because ni pesticide levels are also concerns, planned land management includes reducing nutrien implementing animal waste management systems.

The adjacent 24,064-acre Bloody Run Creek watershed serves as the paired compariso quality monitoring. Monitoring sites at the outlets of each watershed are documenting sediment (Table 9).

Table 9 Water Quality at Outlets of Sny Magill and Bloody Run Water 1992.

Station	Total Phosphorus mg/l	Suspended Sediment mg/l	Fecal Bacteria mpn/100ml
Bloody Run	0.1	17.0	85
Sny Magill	<0.1	27.5	110

Note All values are ıe median for the year

The water quality of areas within the Sny Magill watershed will be compared by samp upstream and downstream of probable nonpoint source areas. Annual aquatic habitat a conducted along stretches of both stream corridors. Monitoring of macroinvertebrates bimonthly basis and an annual fisheries survey will also be conducted.

(Photo)
Water quality sampling in Sny Magill Creek (Iowa).

MICHIGAN

Sycamore Creek is located in southcentral Michigan (Ingham County). The creek has acres, which includes the towns of Holt and Mason and part of the city of Lansing. Th produced in this primarily agricultural county are corn, wheat, soybeans, and some liv is a tributary to the Red Cedar River, which flows into the Grand River. The Grand Ri Michigan.

The major pollutants of Sycamore Creek are sediment, phosphorus, nitrogen, and agri Sediment deposition is adversely affecting fish and macroinvertebrate habitat and the depleting oxygen in the water column. Sycamore Creek has been selected for monitori unique characteristics; rather, it is representative of creeks throughout lower Michigan

Land management will consist primarily of sediment- and nutrient-reducing BMPs on and hayland. These practices will be funded as part of the USDA Sycamore Creek Hy (HUA) project. Water quality monitoring is being conducted in three subwatersheds: Creek, and Marshall Drain. The Haines subwatershed, where BMPs have already been control and is outside the Sycamore Creek watershed. Stormflow and baseflow water each watershed are taken from March through July of each project year. Water is samp suspended solids, chemical oxygen demand, nitrogen, and phosphorus.

(Photo)
Grassed waterways protecting water quality (Michigan).

NEBRASKA

Elm Creek drains 35,800 acres of rural land in southcentral Nebraska, near the Kansas sorghum, pasture, range, and irrigated corn cover most of the land.

Trout productivity in Elm Creek is currently limited by inadequate in-stream habitat, e temperatures, and deposition of fine sediments onto the stream substrate, mostly durin project objectives are to reduce the maximum summer water temperature, reduce in-st reduce peak flows, and improve in-stream aquatic habitat.

Modeling and field surveys were conducted to identify areas in need of BMPs such as fencing, low-head dams, tree planting, and vegetative filter strips. Many of these BMP part of the Elm Creek Hydrologic Unit Area Project, which is under the direction of th

(Photo)
Sampling for trout egg survivability in Elm Creek (Nebraska).

Physical, chemical, biological, and land management monitoring are being conducted water quality objectives are achieved. Both an upstream-downstream design as well as station study design are employed. Weekly monitoring of stream chemistry is conduct September since nonpoint source impacts are greatest during this period. Biological an typically collected in both spring and fall.

NORTH CAROLINA

The Long Creek Watershed, situated in the southwestern Piedmont of North Carolina, mixed agricultural and urban land uses. Long Creek is the primary water supply for B municipality with a population of about 4,900 people.

Water quality problems include high sediment, bacteria, and nutrient levels as shown i channel near the Bessemer City water supply intake in the headwaters area has historic dredging due to sediment accumulation. Downstream of the intake, Long Creek is liste by the North Carolina Nonpoint Source Management Program. Aquatic habitat is degr to high levels of fecal coliform and excessive sediment and nutrient loading from agri nonpoint sources.

Land management upstream of the water supply intake will focus on reducing erosion streambanks. Downstream of the intake, land management will include fencing to excl animal waste management, and implementation of sediment and rainwater runoff cont

Water quality monitoring includes weekly grab sampling just upstream of the water su after implementing erosion controls, monitoring water quality upstream and downstrea holding area on a tributary to Long Creek, and sampling the runoff from two paired dr cropland field. Water samples are being analyzed to provide the chemical, biological, needed to assess the effectiveness of the nonpoint source controls.

Table 10. Water Quality at Selected Long Creek Sampling Stations fo

(North Carolina).

Station	Total Phosphorus mg/l	Fe[illegible]l Bac[illegible]eria mpn/[illegible]00ml	Suspended Sediment mg/l
Water Supply Intake	NA	[illegible]10	5.0
Upstream of Dairy	0.20	[illegible]70	7.0
Downstream of Dairy	0.22	1[illegible]50	7.0
Watershed Outlet	0.22	1[illegible]0	7.5

Note: All values are the median for the year

(Photo)
Long Creek technician checking paired-watershed monitoring equipment (North Caro

PENNSYLVANIA

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

The main source of pollutants in the area is cows lounging in the streams; therefore, th be to fence cows out of streams. This should allow grasses and shrubs to stabilize strea filter pollutants from pasture runoff.

(Photo)
Cows lounging in a degraded stream (Pennsylvania).

The water quality monitoring effort will employ a paired watershed study design whic proposed nonpoint source control, fencing to exclude livestock from 100 percent of th implemented in a 896-acre watershed while leaving the other 1152-acre watershed unt will be collected every 10 days at the outlet of each paired watershed from April throu monitoring plan also includes sampling the streams during rainstorms, and monitoring

VERMONT

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

The Lake Champlain Basin Watersheds National Monitoring Program project is desig evaluate the effectiveness of livestock exclusion, riparian revegetation, and grazing m the concentrations and loads of nutrients, bacteria, and sediment from agricultural sour watershed (Berry Brook) and two treatment watersheds will be monitored. Samsonvill be used to evaluate the water quality benefits of streambank protection and revegetatio reduced and controlled livestock access to streams. Godin Brook watershed will be us of intensive grazing management.

Water quality data from May through September, 1994, are summarized in Table 11. data do not include the very significant spring runoff and fall storm events, it is premat inferences from the data. It is clear, however, that average bacteria counts far exceed standards. Fish and macro-invertebrate data indicate moderate to severe impacts due t matter.

Table 11. Mean values for seven measured variables in three Lake Cha Watersheds (Vermont).

Variable	Watersheds Samsonville	Godin	Berry
Total Phosphorus (mg/l)	0.124 *	0.181 *	0.138
Total Kjeldahl Nitrogen (mg/l)	0.75	0.72	0.65
Total Suspended Solids (mg/l)	35	30.4	29.7
E. Coli Bacteria (#/100 ml)	278	7863	5022
Fecal Coliform Bacteria (#/100 ml	250	7388	4688
Fecal Strep Bacteria (#/100 ml)	1200	1916	1877

Anti-log of log mean

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

(Photo)
Technician recording sampling results (Vermont).

WISCONSIN

Biological monitoring within the Otter Creek Watershed has shown that the fish com numbers of warmwater sport fish, largely due to inadequate fish habitat and polluted bacteria levels exceed Wisconsin's recreational standard of 400 fecal coliforms per 10

(Photo)
Stream depth sampling in Otter Creek (Wisconsin).

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

Improved management of barnyard runoff and manure, nutrient management and redu and shoreline and streambank stabilization will all be implemented to control sources bacteria, and streambank erosion in the watershed. State cost share funds are being use

Paired-watershed, upstream-downstream, and single-downstream station monitoring st monitoring sites are employed to evaluate the benefits of the BMPs. The Meme and Pi serves as the control site and Otter Creek is the treatment site in the paired-watershed s will also be placed above and below a dairy that will receive barnyard and streambank

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

Future Directions of the Section 319 National Monitoring Program

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

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

Local, state, and federal governments, as well as private organizations, are working to nonpoint source pollution. Reducing it will require the concerted action of farmers and urban managers, construction and mining officials, and citizens -- in other words, all o have to learn how what we do affects water quality and how we can change our action Nation's most vital resources: water. The National Monitoring Program is just one wa important lessons can be learned, demonstrated, and documented.

Glossary

Animal waste management system - A BMP designed to minimize pollution originatin poultry operations by providing facilities for the storage and handling of animal waste

Baseflow water quality sample - Water quality sample obtained during non-storm con

Beneficial uses - Desirable uses of a water resource such as recreation (fishing, boatin supply.

Best management practices (BMPs) - Practices or structures designed to reduce the qu such as sediment, nitrogen, phosphorus, and animal wastes -- that are washed by rain a farms into surface or ground waters.

Chemical oxygen demand (COD) - Quantitative measure of the strength of contaminat inorganic carbon materials.

Conservation tillage - Any tillage and planting system that maintains at least 30% of t by residue after planting to reduce soil erosion by water.

Control watershed - The watershed in which land management practices are not chang the paired-watershed study.

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

Critical area - Area or source of nonpoint source pollutants identified in the project ar significant impact on the impaired use of the receiving waters.

Culvert - Either a metal or concrete pipe or a constructed box-type conduit through wh under roads.

Designated uses - Uses specified in terms of water quality standards for each water bo

Detention basin - A pit that accepts and retains stormwater runoff in order to protect w nonpoint source pollution.

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

Fecal coliform bacteria (FC) - Colon bacteria that are released in fecal material. Speci comprises all of the aerobic and facultative anaerobic, gram-negative, nonspore-formi that ferment lactose with gas formation with 48 hours at 35 degrees Celsius.

Filter strip - A strip of varying width, left in permanent vegetation between waterways intercept and filter out pollutants before they run into the water resource.

Grab samples - A discrete volume of water collected, by hand or machine, during one

Geographic information systems (GIS) - Computer programs linking features common roads, town boundaries, water bodies) with related information not usually presented o road surface, population, type of agriculture, type f vegetation, or water quality inform information system in which individual observations can be spatially referenced to eac

Integrated crop management - A BMP system that combines a wide array of crop pro agricultural nonpoint source pollution is minimized.

Land management - The management of land through the use of BMPs in order to red runoff.

Land management monitoring - The recording or tracking of land management activiti

Macroinvertebrate - Any non-vertebrate organism that is large enough to been seen wi microscope and lives in or on the bottom of a body of water.

National Water Quality Assessment - An ongoing U.S. Geologic Survey project desig current, and future water quality conditions in representative river basins and aquifers and comparable water quality information is collected in 60 major river basins that dra landbase.

Nonpoint source (NPS) pollution - Pollution originating from diffuse areas (land surfa no well-defined source.

Nonpoint source pollution controls - General phrase used to refer to all methods empl nonpoint source pollution.

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

Nutrient management - A BMP designed to minimize the contamination of surface an limiting the amount of nutrients (usually nitrogen) applied to the soil to no more than t use. This may involve changing fertilizer application techniques, placement, rate, or ti

Paired-watershed design - In this design, two watersheds with similar physical charact land use are monitored for one to two years to establish pollutant-runoff response relat watershed. Following this initial calibration period, one of the watersheds receives lan other (control) watershed does not. Monitoring of both watersheds continues for one t

Peak flow - The maximum flow or maximum rate at which water runs off a site during

Pesticide management - A BMP designed to minimize contamination of soil, water, ai organisms by controlling the amount, type, placement, method, and timing of pesticid for crop production.

Point source pollution - Water pollution that is discharged from a discrete location suc ditch.

Rapid Bioassessment Protocol - A standard method developed by USEPA to assess aq and macroinvertebrate diversity.

Riparian corridor - The area of land along the bank or shoreline of a body of water.

Riparian vegetation - Vegetation that grows within the riparian corridor

Single-downstream station design - A water quality monitoring design that utilizes on downstream from the area of BMP implementation to monitor changes in water qualit

Stormflow water quality samples - Samples of water collected during runoff caused by

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

Turbidity - The measurement of the degree to which light travelling through a water c suspended organic (including algae) and inorganic particles.

USDA Hydrologic Unit Area and Demo Projects -Water quality projects, funded by th Agriculture, that provide education and technical assistance to producers and conduct avoiding water quality degradation from agricultural practices.

Upstream-downstream design - A water quality monitoring design that utilizes two wa sites. One station is placed directly upstream from the area where BMP implementatio second is placed directly downstream from that area.

Water quality variables - A water quality constituent (for example, total phosphorus p or other measured factors (such as streamflow, rainfall).

Watershed - The area of land from which rainfall (and/or snow melt) drains into a stre Watersheds are also sometimes referred to as drainage basins or drainage areas. Ridge generally form the boundaries between watersheds. At these boundaries, rain falling o the low point of one watershed, while rain falling on the other side of the boundary flo of a different watershed.

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Attachment Number 3

Iowa Department of Natural Resources
Project Report

Walnut Creek Watershed Restoration and Monitoring Project

Publications on this topic.

Overview

The Walnut Creek Watershed Restoration and Water Quality Monitoring Project began in April 1995 and is designed as a nonpoint source (NPS) monitoring program in relation to the watershed habitat restoration and agricultural management changes implemented by the U.S. Fish and Wildlife Service (USFWS) at Walnut Creek National Wildlife Refuge and Prairie Learning Center (WNT) in central Iowa. The watershed is being restored from rowcrop to native prairie, including restoration of native fauna (Figures 1 and 2). This monitoring project is part of the U.S. Environmental Protection Agency's National Monitoring Program.

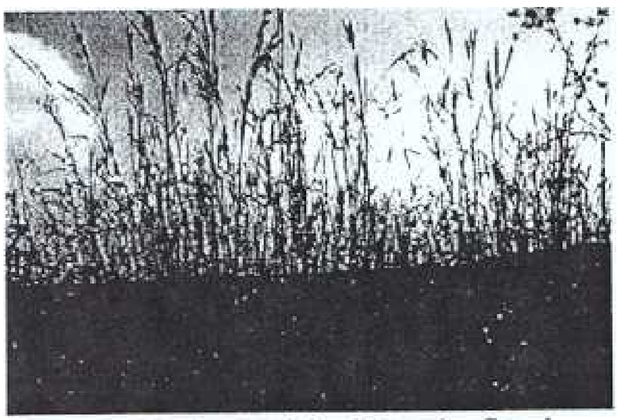
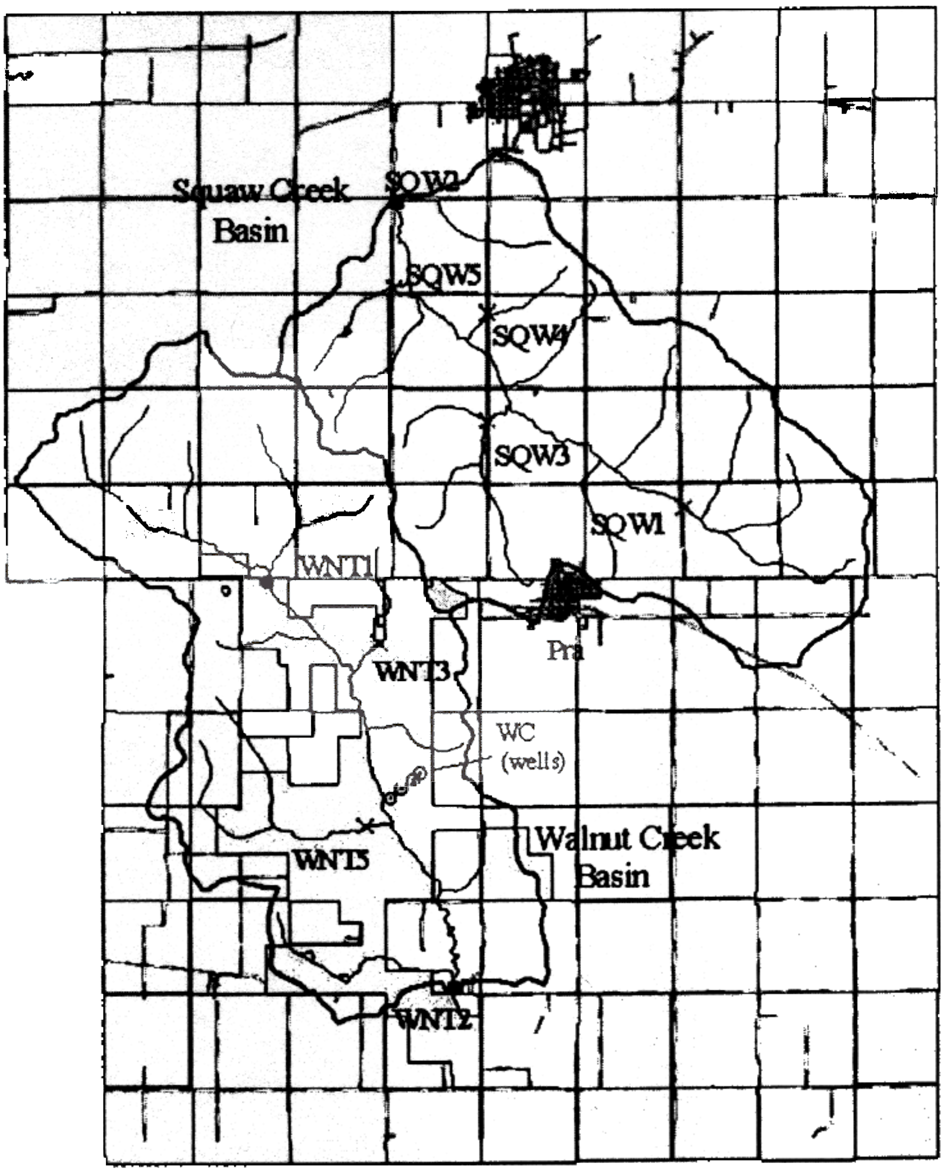


Figure 1. Native prairie. *Photo by Carol Thompson.*

Figure 2. Bison at Walnut Creek. *Photo by Jim Heemstra.*

Unlike many other projects, landuse changes will be implemented over a large percentage of the basin. The Walnut Creek watershed includes 12,860 acres (20.1 $mi.^2$) and contains the majority of the WNT Refuge area; approximately 63% of the watershed is within refuge boundaries (Figure 3). Currently, about 5,000 acres (7.8 $mi.^2$) are owned by the USFWS. Because the restoration work and improved management practices are being implemented by the USFWS, they will be implemented much more uniformly than at most other projects, both in time and spatially across the watershed. Thus, documentation of landuse and management changes within Walnut Creek watershed may allow an improved evaluation of the amount of change within a watershed that is needed to bring about significant water quality improvements and the time lags associated with any improvement.



● Gaging stations and water quality sampling points

× Water quality sampling points

⊙ Wells

⊠ Biomonitoring points

Figure Map of Walnu Creek (WNT) Squaw Creek (SQW) waters Green shows t extent USFW owned land.

Table 1. Land management changes.

System Restoration	Cropland Management
Prairie Savanna Wetlands	Integrated Crop Management Restricted Pesticide Use Mandatory Crop Scouting Nutrient Management Mandatory No-Till Production

There are two components to the landuse changes being implemented by USFWS: ecosystem resources restoration to prairie/savanna; and mandatory (contractual) use of improved agricultural management practices on farmlands prior to conversion (Table 1). All the remaining WNT Refuge cropland will be restored during the next three years. In the riparian areas, one hundred foot-wide vegetative filter strips will be seeded along all of the streams in the Refuge that are not already in grass or timber. Riparian and upland wetlands will also be restored, or allowed to revert to wetlands. Tile lines will be eliminated gradually as acreage is converted providing for restoration of wetlands in various settings. These areas will serve as important demonstration areas for local riparian and wetland restoration projects and will allow an evaluation of the effectiveness of the filter strips on a landscape scale and will provide documentation of their water-quality benefits.

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

Watershed Characteristics

Walnut Creek, a warm-water stream located in Jasper County, Iowa, drains an area of 30.7 mi^2 (19,500 acres) and discharges into the Des Moines River at the upper end of the Red Rock Reservoir. The project watershed includes 20.1 mi^2 (12,862 acres) and includes the majority of the WNT Refuge area; approximately 63% of the watershed is within the Refuge boundaries. The Walnut Creek watershed and the WNT Refuge are located in the Southern Iowa Drift Plain, an area characterized by steeply rolling hills and well-developed drainage. Most of the soils are silty clay loams, silt loams, or clay loams formed in loess and many are classified in the moderate to high erosion potential category (Figure 4). The upper portion of the Walnut Creek watershed, above the WNT Refuge, is the more gently sloping headwaters portion of the basin; the majority of Highly Erodible Land (HEL) in the watershed occurs in the Refuge area (Figure 5). Pre-Illinoian till underlies most of the Refuge area and is 50 to 100 feet thick.

Figure 4. Parent material.

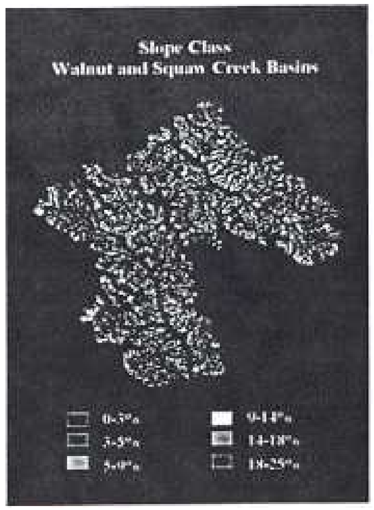


Figure 5. Slope classes.

Click on image to view full size.

Data from digital soils maps and associated Iowa Soil Properties and Interpretations Database (ISPAID; Iowa Cooperative Soil Survey).

For this monitoring project a paired-watershed design will be used. The Squaw Creek basin(SQW), adjacent to Walnut Creek (WNT), will be used as a control watershed. Squaw Creek drains 25.2 mi^2 (16,130 acres) above its junction with the Skunk River. The watershed included in the monitoring project is 18.3 mi^2 (11,683 acres) and does not include the wide floodplain area near the intersection with the Skunk River. The soils and geology of the Squaw Creek watershed are similar to those in the Walnut Creek basin.

Both creeks have been extensively channelized and are incised into their valleys. A thick package of post-settlement alluvium is present in both valleys. Discharge is similar in both streams, although Walnut Creek experiences slightly lower flows (Figure 6). Both streams are flashy (displaying rapid responses to precipitation; Figure 7). Baseflow percentages for Water Year 1996 (WY96; a water year is a 12-month period, from October 1 through September 30, designated by the calendar year in which it ends) are Walnut Creek (upstream) - 41%, Walnut Creek (downstream) - 29%, and Squaw Creek (downstream) - 37%.

Figure 6. Graph of discharge for Walnut and Squaw creeks.

Figure 7. Typical storm hydrographs.

Water Resource Problems and Earlier Data

Walnut Creek drains into a segment of the Des Moines River that is classified as *Not Supporting* its designated uses in the Iowa Department of Natural Resources' (IDNR) water-quality assessments (IDNR, 1997); Squaw Creek and the Skunk River are classed as *Partially Supporting*. Assessments in this area cite agricultural nonpoint source (NPS) pollution as the principal concern.

Walnut and Squaw Creek are affected by many agricultural NPS water pollutants, including sediment, nutrients, pesticides, and animal waste. Water quality in these streams is typical for many of Iowa's small warm water streams; water quality varies significantly with changes in discharge and runoff.

Data was collected in the Walnut Creek basin from 1992 to 1994 as part of the Tri-State Monitoring Project (Figures 8 and 9). Data was also collected during the pre-implementation period by the USFWS. Nitrate shows a slight decrease over the period, but this is not statistically significant. It may be related to climatic patterns. Turbidity, fecal coliform, and atrazine show no differences.

Figure 8. Previous data -atrazine and nitrate.

Figure 9. Previous data - fecal coliform and turbidity.

Monitoring Plan Design

There are five basic components to the project: 1) tracking of land cover and land management changes within the basins, 2) stream gaging for discharge and suspended sediment at two locations on Walnut Creek and one on Squaw Creek, 3) surface water quality monitoring of Walnut and Squaw creeks, 4) biomonitoring for aquatic macroinvertebrates and fish in Walnut and Squaw creeks, and 5) groundwater quality and hydrologic monitoring (Table 2).

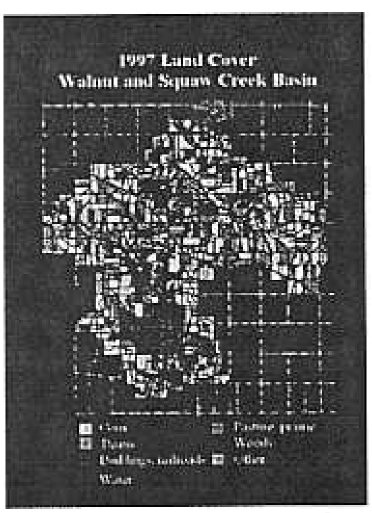
Table 2. Water quality monitoring plan.

Sampling Location	Parameters	Frequency
WNT1, WNT2, SQW2	Stage/Discharge, Suspended Sediment	Daily
WNT1, WNT2, WNT3, WNT5, WNT6, SQW1, SQW2, SQW3, SQW4, SQW5	Fecal Coliform, Ammonia-N, BOD, Anions, Temperature, Conductivity, Dissolved Oxygen, Turbidity, Alkalinity, pH Cations Common Herbicides Acid Herbicides, OP Insecticides	April (2), May (4), June (4), July (2), August (2), September (2) May, September April, May (4), June (4), July, August, September May, June
WNT1, WNT2, SQW1, SQW2	Fecal coliform, Ammonia-Nitrogen, BOD, Anions, Temperature, Conductivity, Dissolved Oxygen, Turbidity, Alkalinity, pH	January, March, July, August, September, October, November
Rain Gage Station	Pesticides	Precipitation events

Groundwater stations	Water Levels	Daily
	Temperatures, Conductivity, Alkalinity, pH	Quarterly
	Pesticides, Anions	Quarterly
	Cations	Bi-Annually
Biomonitoring Stations	Invertebrate monitoring	4x (Mar - Oct)
WNT2, SQW2	Fish sampling	1x (Sept)
WNT1, WNT2, SQW2	Sediment sampling	1x (Sept)

Land Cover

Current land use practices for both Walnut and Squaw Creeks will be tracked throughout the life of the project (Figure 10). Yearly flight pictures as well as crop plats will be obtained and analyzed for land cover changes. Data on terraces, buffer strips, grassed waterways, and other conservation practices will be included. Data will be entered into a Geographic Information System (GIS) using ARC/INFO© software and coupled with the water quality, flow, and sediment data for analysis.



Click on image to view full size.

Figure 10. Land cover for 1997.

Data on the geomorphic characteristics of the basins will also be collected. Data related to the physical nature of the stream (length, width, gradient, etc.) will be measured. In addition, analysis of post-settlement deposition will be done for both basins to enhance our understanding of sediment transport in surface water in small Iowa basins.

Stream Gaging

Three stream gaging stations have been installed by the U.S. Geological Survey (USGS). Stage is monitored continuously with bubble-gage sensors (fluid gages) and recorded by automated data collection platforms (DCP) and analog recorders. Depth-integrated sediment samples are collected daily by local observers and by USGS staff during high flow events. Suspended-sediment concentrations are determined by the USGS Sediment Laboratory using standard filtration and evaporation measurements.

Surface Water Monitoring

Surface-water chemistry will be monitored weekly to monthly at ten sites in the basin and analyzed for nitrate, ammonium-nitrogen, pesticides (in season), anions, cations (sampled twice; 2X), biological oxygen demand (BOD), dissolved oxygen (DO), turbidity, alkalinity, fecal coliform, conductivity, and temperature.

Biomonitoring

Biomonitoring is done at four sites, one at each of the lower gaging stations and two mid-reach samples. The stream reach for aquatic vegetation and fish collection will be a length seven times the stream width. The aquatic vegetation in this reach will be observed, identified, and recorded annually. Aquatic macroinvertebrates will be collected bi-monthly from April through October. A combination of natural and artificial substrates may be used to identify all aquatic macroinvertebrates present. Summary metrics will be used for comparisons with time and between sites. Stream corridor habitat changes will also be recorded.

Demonstration and Education

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

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

Monitoring Results

Pesticides

There have been detections of six different compounds between 1995 and 1997 in Walnut and Squaw Creek surface waters. Atrazine was by far the most frequently detected compound, as is true across Iowa, with frequency of detections from 77% to 89% in the main stems (Figure 11). No significant differences have been noted in atrazine concentrations from 1995 through 1997 (Figure 12).

Figure 11. Atrazine concentrations.

Figure 12. Basin comparisons of atrazine.

Nitrate

Nitrate concentrations are high, but typical for streams in Iowa. A comparison of data from the upstream and downstream paired sites show that the basins are very similar. Ranges and averages for the four main stem sampling sites are in Table 3.

A comparison of data from the three years shows no statistical differences (Figure 13). Concentrations in Walnut Creek are usually slightly less than in Squaw Creek. In addition both creeks show downstream declines in nitrate concentrations (Figure 14). This can be attributed to in-stream reductions, perhaps caused by denitrification, or by dilution from larger flow volumes (surface water and/or groundwater). Chloride and nitrate ratios are shown and may indicate that nitrate in Squaw Creek is reduced more downstream than nitrate which may be indicative of bioprocessing. Chloride and nitrate ratios in Walnut Creek both show declines which may be attributable to dilution (Figure 15).

Table 3. Nitrate-N concentrations.

Site	Range Nitrate-N (mg/L)	Average Nitrate-N (mg/L)
WNT1 (upstream)	4.1 - 15.8	11.2
WNT2 (downstream)	2.1 - 13.0	8.2
SQW1 (upstream)	6.8 - 17.0	13.0
SQW2 (downstream)	3.9 - 13.0	8.8

Figure 13. Nitrate loads - basin comparison, yearly comparison.

Figure 14. Nitrate concentrations.

Figure 15. Nitrate - chloride ratio data.

Sediment

Sediment loads in both streams are similar (Figure 16). No significant differences have been noted in sediment loads from 1995 to 1996. Most sediment moves during large runoff events. For Walnut Creek, 18 days accounted for 90% of the total annual sediment load during WY96; only 13 days were needed in Squaw Creek to carry 90% of the annual load.

Figure 16. Sediment loads from Walnut and Squaw creeks for 1995 and 1996.

Biomonitoring

The biomonitoring data indicate stream communities in both streams are indicative of disturbed habitat with at least some level of organic pollution (Table 4). The fish communities also reflect this in that all species present are tolerant of degraded conditions (Table 5).

Walnut Creek is characterized by a macroinvertebrate community that was dominated by relatively few taxa with occasional new taxa appearing at low frequencies and abundances. For example, a total of 20 taxa of Ephemeroptera have been collected in two years of sampling, but 15 of those taxa have comprised less than four percent of the specimens. This indicates the presence and the potential of other macroinvertebrates to move into the creek and become a more integral part of the biological community structure. However, because of the long term effects of disturbance of the watershed, it is likely that an adaptive community has developed that exploits this condition to maintain its dominance. The macroinvertebrate trends that occurred in both Squaw and Walnut Creek watersheds (based on 1995 and 1996 data) were similar and continued to respond in equivalent ways seasonally and approximated each other in community structure and population. The Hilsenhoff Biotic Index (HBI) values continue to show good water quality, but other metrics (percent dominant taxon; Ephemeroptera, Plecoptera, Trichoptera - EPT index, and total taxa) indicate unbalanced communities, or a community dominated by few species. Additionally, from an ecoregion perspective, both creeks rate in the lower quartile with respect to two metric indicators (EPT taxa, total number of taxa) of macroinvertebrate community health.

The fish communities retained the same dominant species as 1995, however, the less frequent species were sporadic in their occurrence. The variability of uncommon species is reasonable considering the proximity of the sampling sites to major river systems. The Des Moines River and the South Skunk River provide a pool of species of which some migrate up the respective creeks. It is apparent that the diversity of fish collected from Walnut Creek can vary dramatically and is heavily influenced by Red Rock reservoir. The dominant resident fish species are likely populations that have relied historically on the habitat for shelter and food while the infrequent species are likely just transients. It is noteworthy, however, that at any given time quite a few species may rely on the habitat of Walnut Creek.

The 1996 field season, as the previous field season, showed that aquatic macrophyte populations are not present at the biomonitoring sites and based on field observations were not likely present anywhere in the stream reaches located within the refuge.

Table 4. Benthic macroinvertebrate data from Walnut and Squaw creeks for 1995 and 1996.

Mean(n=4) Metric Data for Benthic Invertebrates (1995)

	SQWBM2	SQW2	WNTBM2	WNT2
Taxa Richness	8.46	7.75	8.06	7.83
EPT	3.96	4.33	4.13	4.42
EPT/Chironomidae	20.32	20.29	20.32	27.42
% Dominant Taxa	67.1	63.63	56.08	59.00

HBI	5.43	4.63	5.05	4.89
Scrapers/Filt. Collectors	2.37	7.11	7.69	3.47

Mean(n=4) Metric Data for Benthic Invertebrates (1996)

	SQWBM2	SQW2	WNTBM2	WNT2
Taxa Richness	8.83	7.5	10.08	5.42
EPT	5.58	4.50	6.25	3.33
EPT/Chironomidae	10.67	26.12	37.24	4.27
% Dominant Taxa	54.83	60.55	59.98	59.98
HBI	4.85	4.41	4.51	5.16
Scrapers/Filt. Collectors	1.63	4.78	1.37	1.19

Table 5. Fish data from Walnut and Squaw creeks for 1995 and 1996.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bigmouth buffalo	0.2% (1)	-	-	3.5% (6)
Bigmouth shiner	10.5% (54)	-	16.7% (23)	4.1% (7)
Black bullhead	-	4% (7)	-	0.6% (1)
Bluegill	0.2% (1)	-	-	0.6% (1)
Bluntnose minnow	37.2% (191)	49% (84)	10.9% (15)	14.6% (25)
Brassy minnow	-	2.1% (11)	5.5% (8)	-
Carpsucker (juvenile)	-	1% (1)	-	-
Central stoneroller	5.3% (27)	-	7.2% (10)	21.1% (36)
Common carp	0.4% (2)	-	2.9% (4)	0.6% (1)
Common shiner	0.2% (1)	-	-	-
Creek chub	17.1% (88)	6% (10)	34.1% (47)	15.8% (27)
Fathead minnow	4.1% (21)	-	-	0.6% (1)
Freshwater drum	-	1% (1)	-	-
Gizzard shad	0.4% (2)	-	-	1.7% (3)
Golden shiner	-	-	-	0.6% (1)
Green sunfish	.0% (18)	0.8% (4)	0.7% (1)	11% (19)
Johnny darter	3.3% (17)	-	5.8% (8)	-
Largemouth bass	0.4% (2)	4% (7)	0.7% (1)	5.8% (10)
Quillback carpsucker	-	2% (4)	-	-
Red shiner	5.6% (29)	19% (33)	3.6% (5)	8.8% (15)
River carpsucker	-	-	-	0.6% (1)
Sand shiner	9.3% (48)	-	11.6% (16)	4.7% (8)
Spotfin shiner	-	-	-	0.6% (1)
[illegible]	-	-	-	2.3% (4)

Walleye	-	-	-	0.6% (1)
White sucker	2.9% (15)	4% (7)	-	1.8% (3)

Participating Agencies and Organizations

Iowa Department of Natural Resources - Geological Survey Bureau
Provides overall monitoring project coordination and management, including annual project reporting, conducts the water quality sampling, and analyzes all data.

U.S. Fish and Wildlife Service
Provide all funds and staff necessary for implementation of landuse changes, restoration and reconstruction of habitats, monitor farming activities to ensure compliance with previously stated requirements, assist with field sampling and provide the coordination link to other monitoring and investigations underway at WNT.

U.S. Geological Survey - Water Resources Division
Install and operate surface water gages, conduct the suspended sediment sampling, provide expertise for interpretation and analysis of monitoring data.

Hygienic Laboratory, The University of Iowa
Provide laboratory analytical work, and lab QA/QC, conduct the biomonitoring and related QA/QC and provide an annual report.

Farm Service Agency
Provide access to crop plats and land use in the basins.

Iowa Department of Natural Resources - Environmental Protection Division
Provide project funding.

U.S. Environmental Protection Agency
Provides funding for project and reviews project progress.

Reference

IDNR, 1997, Water quality in Iowa during 1994 and 1995: Water Resources Section, Water Quality Bureau, Iowa Department of Natural Resources.

For further information contact Keith Schilling (kschilling@igsb.uiowa.edu) at (319)335-1575.

Walnut Creek Watershed Study Publications:

Walnut Creek Nonpoint Source Monitoring Project, Jasper County, Iowa: Water Years 1995-1997: GSB Technical Information Series 39 (Abstract)

Detailed GPS Survey of Walnut Creek: Channel Characteristics and Spatial Relationships (Poster)

Attachment Number 4

U.S. Fish and Wildlife Service
Soil Quality Assessment

Walnut Creek National Wildlife Refuge
Prairie Learning Center

Augustana College
c/o U.S. Fish and Wildlife Service

Rock Island Field Office
4469 48th Avenue Court
Rock Island, Illinois
61201-9213

Ph (309) 793-5804
Fax (309) 793-5800

April 8, 1998
Walnut Creek National Wildlife Refuge Soil Data Analyses

Enclosed are the analyses that you requested on the 65 soil samples that were collected on the Refuge. The information was organized using QuattroPro spreadsheet software and a copy of the database file is included. Also included are a statistical analyses of
the isolated control sites and a separate statistical analyses of the test sites. If you have any questions regarding this data or desire additional analyses, please feel free to call.

Sincerely,

Anna Brahmstedt

Heather Stiles

Augustana College

Methods

Soil Analysis

On December 12, 1997, 65 soil samples were collected from Walnut Creek National Wildlife Refuge and sent to MVTL Laboratories, Inc. The samples were then examined using a fertility analysis. A weak extract or solvent was poured into a sample and the free ions were leached out. The amount of these leached ions were then calculated in ppm using the plant available index. This is different than a bulk analysis in that the strong, compacted ions still in the soil after leaching were not included in the calculation.

Data Analysis

The data analysis was begun by using QuattroPro create a spreadsheet. Data from each of the samples was entered with emphasis on pH, NO3-N, Ca, Na, Zn, Fe, CEC, Kjel-N, and NH4-N. We then ran a statistical analysis of the isolated control sites and test sites. We calculated the mean, standard deviation, variance, minimum, maximum, and count.

We used two methods to analyze the data. First, we compared the control sites with the test sites; the control sites represent prairie/pasture land and the test sites represent agricultural land. Second, we analyzed the data according to an article by Arden Anderson, Ph.D. entitled "Reams' Soil Testing Methods". We compared the test values found by Reams against the values reported in the test site. Reams established nutrient levels for minimally balanced soil; however, it was reported from a bulk analysis in pounds per acre. Since our results were reported in parts per million (fertility analysis) we used the following equation to convert Reams' levels to compare with our results:

$$\text{ppm} \times 2 = \text{pounds per acre}$$

This conversion was outlined on a conversion table that included Calcium, Zinc and Iron

in an acre of mineral soil 6 ½ -7 inches deep, and weighing approximately 2 million pounds (dry weight).

Summary

Mean Elemental concentrations in surficial materials of the United States taken from: Beyer, W.N. 1990. *Evaluating Soil Contamination.* U.S. Fish and Wildlife Service., *Biol. Rep.* 90(2). 25pp. (pg 15).
Reams' Soil Testing Methods were taken from: Andersen, A., Ph.D. "Reams' Soil Testing Methods", *Acres U.S.A.,* July 1997 (pg 13).
Some values from the Walnut Creek Refuge data have been rounded-see enclosed charts for true values.

pH

The mean pH value was 5.9 for the control sites and 5.837 for the test sites. Reams' suggests that a soil pH of 6-7 is the optimum pH for maximum nutrient exchange rates. The soil at the Refuge control sites and test sites are more acidic, but the amount may not be significant enough to indicate potential problems. In addition, pH levels normally vary within the growing season and with microbial succession in the soil.

NO3-Nitrogen

The mean NO3 value was 1.166 ppm for the control sites and 1.559 ppm for the test sites. After conversion, the mean nitrate level in the control sites was 2.332 pounds per acre and 3.118 pounds per acre in the test sites. Both of these values are low compared with the 40 pounds per acre that Reams suggests for a minimum value for balanced soil.

Calcium

The mean Calcium value was 2200 ppm for the control sites and 1998.305 ppm for the test sites. Reams' nutrient level for Calcium in minimally balanced soil ranges from 2000-4000 pounds per acre. After conversion, the mean Calcium value for the control sites would be 4400 pounds per acre, which is slightly over the Reams level. Since this land was left as prairie or pasture land, the higher levels of Calcium located here correlate with what is expected. The test sites yielded 3996.61 pounds per acre after conversion. This also shows a high level of Calcium in the soil, even though the levels here should have been depleted by repeated agricultural use.

Sodium

The mean Na value was 10.5 ppm for the control sites and 7.169 ppm for the test sites

Zinc

The mean Zn value was 0.466 ppm for the control sites and 0.566 ppm for the test sites.
After conversion, the mean Zinc value for the control sites would be 0.932 pounds per acre. The test sites yielded 1.132 pounds per acre after conversion.

Iron

The mean Fe value was 46.633 ppm for the control sites and 52.903 ppm for the test sites. After conversion, the mean Iron value for the control sites would be 93.266 pounds. The test sites yielded 105.806 pounds after conversion. It may be possible that the higher Iron levels in the test sites are remnants of fertilizers that were used on the soil in the past.

CEC

The mean CEC value was 19.116 ppm for the control sites and 18.089 ppm for the test sites. The Cation Exchange Capacity is a measure of the capacity of a soil to hold exchangeable cations, including hydrogen, calcium, magnesium, potassium, and sodium. This depends largely on the amount and type of clay present, and the organic matter content of the soil. The larger this value, the more cations the soil is able to hold against leaching. For example, the control sites were higher in Calcium and Sodium than the test sites. This correlates to the fact that the CEC value was higher for the control sites. This means that the prairie/pasture land is more resistant to leaching.

Kjeldahl Nitrogen

The mean total organic nitrogen value was 1063.666 pm for the control sites and 1040.949 ppm for the test sites.

NH4-Nitrogen

The mean NH4-N value was 104.9 ppm for the control sites and 109.437 ppm for the test sites. After conversion, the Ammonia level for the test sites was 209.8 pounds per acre and 218.874 pounds per acre for the control sites. Reams gives 40 pounds as the minimum Ammonia level for balanced soil. Therefore, both of these levels are significantly higher than the minimum and indicate that the sites at the Refuge contain healthy levels of NH4.

Control Plots

	pH	*NO3-N*	*Ca*	*Na*
Mean	5.9	1.16666666666667	2200	10.5
Standard Deviation	0.35213633723318	0.408248290463863	961.249187255833	4.08656334834051
Variance	0.124	0.166666666666667	924000	16.7
Minimum	5.4	1	1400	4
Maximum	6.3	2	4000	15
Count	6	6	6	6

	Zn	*Fe*	*CEC*	*Kjel-N*
Mean	0.466666666666667	46.6333333333333	19.1166666666667	1063.66666666667
Standard Deviation	0.344480284873702	19.2860225724919	4.95072385279836	743.938079860594
Variance	0.118666666666667	371.950666666667	24.5096666666667	553443.866666667
Minimum	0.2	21.2	14.1	456
Maximum	1.1	78.9	28.1	2280
Count	6	6	6	6

	NH4-N
Mean	104.9
Standard Deviation	36.5845322506657
Variance	1338.428
Minimum	70
Maximum	154
Count	6

Test Plots

	pH	NO3-N	Ca	Na
Mean	5.83728813559322	1.55932203389831	1998.30508474576	7.16949152542373
Standard Deviation	0.827938508687181	1.52305485264363	526.370632966508	4.271608525154
Variance	0.685482174167154	2.31969608416131	277066.043249562	18.2466393921683
Minimum	0	0	0	0
Maximum	6.5	9	3400	28
Count	59	59	59	59

	Zn	Fe	CEC	Kjel-N
Mean	0.566101694915254	52.9033898305085	18.0898305084746	1040.94915254237
Standard Deviation	0.927661161663647	33.8398049950651	4.18456502560732	430.570528634485
Variance	0.860555230859147	1145.13240210403	17.5105844535359	185390.98012858
Minimum	0	0	0	0
Maximum	6.3	224.3	28.9	1960
Count	59	59	59	59

	NH4-N
Mean	109.437288135593
Standard Deviation	42.7627049010002
Variance	1828.64893045003
Minimum	0
Maximum	207
Count	59

Appendix A
Raw Data

MVTL LABORATORIES, Inc.

35 W. LINCOLN WAY • P. O. BOX 440 • NEVADA, IA 50201-0440
CHEMISTRY LAB PHONE (515) 382-5486 FAX (515) 382-3885
SOIL LAB PHONE (515) 382-3084 FAX (515) 382-5644
WATS (800) 362-0855 E-MAIL mvtl@nevia.net

MEMBER ACIL

WE ARE AN EQUAL OPPORTUNITY EMPLOYER

Submitted by: UNIVERSITY OF IA HYGIENIC LAB
JOHN MILLER
900 E GRAND-WALLACE BLDG
DES MOINES , IA 50319

Date Received: 12-12-97 Page
Date Reported: 01-13-98
Work Order No.: 91-0133

Account Number: 30059 Report To: 000

Submitted for: || WALNUT CREEK NATIONAL || 9.02

Lab No.	Field Description	Sample ID	SOIL pH	BUFF INDEX	NO3-N ppm 1	NO3-N ppm 3	% OM	B-1 P ppm	OLSEN P ppm	SALTS EC	EX K ppm	EX Ca ppm	EX Mg ppm
997005-245	WILDLIFE REFUGE		5.4	6.2		2	4.1	8		0.1	100	1700	230
997005-246	WILDLIFE REFUGE	2	5.4	6.6			2	11		0	140	2000	610
997005-247	WILDLIFE REFUGE	4	5.6	6			2.6	7		0.1	180	2200	520
997005-248	WILDLIFE REFUGE	6	5.5	6.5			3	12		0.1	210	2500	750
997005-249	WILDLIFE REFUGE	7	5.4	6.5			2.3	6		0.1	80	1000	210
997005-250	WILDLIFE REFUGE	9	5.4	6.4			5.2	8		0.	80	1600	170
997005-251	WILDLIFE REFUGE	11	5.9	6.7		1	2.8	15		0.1	170	2300	620
997005-252	WILDLIFE REFUGE	12	5.9	6.4		1	6.1	14		0.1	170	3400	660
997005-253	WILDLIFE REFUGE	13	5.8	6.5		1	0.3	7		0.1	70	1100	110
997005-254	WILDLIFE REFUGE	14	5.8	6.6		1	3.9	7		0.1	170	2800	800
997005-255	WILDLIFE REFUGE	15	5.8	6.6		1	3.4	4		0.1	130	1600	450
997005-256	WILDLIFE REFUGE	16	5.8	6.5			3.3	6		0.1	150	1600	470
997005-257	WILDLIFE REFUGE	17	5.8	6.7			2.8	15		0.1	150	2000	500
997005-258	WILDLIFE REFUGE	18	5.8	6.5		1	3.3	10		0.	90	1400	260
997005-259	WILDLIFE REFUGE	10	6.3	7.0		1	.7	4		0.1	60	1100	300
997005-260	WILDLIFE REFUGE	18E	6.3	6.7		1	3.7	17		0.	150	2100	530
997005-261	WILDLIFE REFUGE	18N	6.2	6.7			4.0	9		0.1	140	2100	460
997005-262	WILDLIFE REFUGE	18 CTR6LOT	6.3	6.9		2	6.4	12		0.	160	4000	810
997005-263	WILDLIFE REFUGE	18 CTRLOT1	6.3	6.7			4.5	11		0.1	150	2300	430
997005-264	WILDLIFE REFUGE	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]

MVTL LABORATORIES, Inc.

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Submitted by: UNIVERSITY OF IA HYGIENIC LAB
JOHN MILLER
900 E GRAND-WALLACE BLDG
DES MOINES , IA 50319

Date Received: 12-12-97
Date Reported: 01-13-98
Work Order No.: 91-0133

Account Number: 30059 Report To: 000

Submitted for: || WALNUT CREEK NATIONAL || 9.02

Lab No.	Na ppm	S ppm	Zn ppm	Cu ppm	Mn ppm	Fe ppm	B ppm	Samp Dph 3	% Na Sat	CEC	TEXT
997005-245	3	1	0.3	1.0	8.2	66.1	0.6	0-12	0.1	18.7	Med/Fine
997005-246	15		0.2	1.2	10.7	30.8	0.1	0-12	0.3	19.4	Med/Fine
997005-247	8	3	0.2		3.8	39.5	0.2	0-12	0.2	18.8	Med/Fine
997005-248	7	1	0.3	1.4	21.4	48.4	0.4	0-12	0.[illegible]	24.2	Med/Fine
997005-249	3	3	0.2	1.1	6.7	65.7	0.1	0-12	0.1	11.9	Med/Fine
997005-250	3	1	0.2	1.0	21.8	71.3	0.1	0-12	0.1	15.6	Med/Fine
997005-251	11		0.2	0.9	7.4	29.5	0.1	0-12	0.2	20.1	Med/Fine
997005-252	8	5	0.9	2.6	8.1	112.3	0.1	0-12	0.1	28.9	Med/Fine
997005-253	3	2	6.3	1.0	13.8	54.8	0.1	0-12	0.1	11.6	Med/Fine
997005-254	28	4	0.3	2.2	3.3	67.7	0.[illegible]	0-12	0.5	25.1	Med/Fine
997005-255	4		0.2	0.8	9.0	35.6	0.1	0-12	0.1	16.1	Med/Fine
997005-256	8		0.1	1.0	4.9	37.4	0.1	0-12	0.2	17.3	Med/Fine
997005-257	10	2	0.[illegible]	0.9	20.4	36.7	0.1	0-12	0.2	17.5	Med/Fine
997005-258	5	2	0.5	1.5	21.0	74.0	0.1	0-12	0.2	14.4	Med/Fine
997005-259	5	3	0.1	0.6	8.9	17.6	0.1	0-12	0.3	8.1	Med/Fine
997005-260	5	3	0.1	1.0	4.3	37.4	0.1	0-12	0.1	18.3	Med/Fine
997005-261	5	1	0.1	1.1	6.2	42.6	0.4	0-12	0.1	17.7	Med/Fine
997005-262	12	3	1.[illegible]	2.0	8.5	78.9	1.4	0-12	0.2	28.[illegible]	Med/Fine
997005-263	4	2	0.6	1.1	8.0	53.0	0.2	0-12	0.1	18.4	Med/Fine
997005-264	5	6	0.2	2.1	[illegible]	16.[illegible]	[illegible]	0-12	[illegible]	22.4	Med/Fine

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Lab No	Field Description	Sample ID	SOIL pH	BUFF INDEX	NO3-N ppm 1	NO3-N ppm 3	% OM	B-1 P ppm	OLSEN P ppm	SALTS EC	EX K ppm	EX Ca ppm	EX Mg ppm
997005-265	WILDLIFE REFUGE	21	6.2	6.7			3.4	14		0.	170	2400	620
997005-266	WILDLIFE REFUGE	22	6	6.8			3.0	32		0.	170	2100	680
997005-267	WILDLIFE REFUGE	23	5.7	6.5		1	4.4	10		0.1	180	2100	530
997005-268	WILDLIFE REFUGE	24 S	5.8	6.5		1	3.2	25		0.1	180	2100	610
997005-269	WILDLIFE REFUGE	25	5.5	6.5			3.2	27		0	180	2200	710
997005-270	WILDLIFE REFUGE	26	5.6	6.5			3.8	13		0.	170	2300	670
997005-271	WILDLIFE REFUGE	27	5.5	6.4		2	4.5	8		0	100	1600	370
997005-272	WILDLIFE REFUGE	28	5.9	6.8			3.4	9		0.1	160	2200	580
997005-273	WILDLIFE REFUGE	29	5.9	6.5		1	4.4	19		0.1	140	2000	430
997005-274	WILDLIFE REFUGE	30	5.9	6.7		1	2.6	10		0.1	140	1800	590
997005-275	WILDLIFE REFUGE	31	5.8	6.6			4.1	8		0.	150	1800	520
997005-276	WILDLIFE REFUGE	32	5.8	6.7			3.2	5		0	120	1600	350
997005-277	WILDLIFE REFUGE	34 #1	6.0	6.7			2.6	13		0.1	180	2200	640
997005-278	WILDLIFE REFUGE	34 #2	6.0	6.7		1	3.7	12		0	190	2300	670
997005-279	WILDLIFE REFUGE	37	6.3	6.9			2.5	3		0.1	130	2000	630
997005-280	WILDLIFE REFUGE	38	6.3	6.9			3.9	8		0	150	2100	540
997005-281	WILDLIFE REFUGE	39	6.3	6.8			3.2	5		0.1	170	2100	600
997005-282	WILDLIFE REFUGE	40	5.7	6.4		1	2.8	7		0	80	1100	160
997005-283	WILDLIFE REFUGE	41	6.4	6.8		1	3.5	7		0.	130	1700	400
997005-284	WILDLIFE REFUGE	42	6.1	6.5		2	5.3	15		0.1	120	2100	560

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Lab No.	Na ppm	S ppm	Zn ppm	Cu ppm	Mn ppm	Fe ppm	B ppm	Samp Dph 3	% Na Sat	CEC	TEXT
997005-265	9	2	0.1	1.1	3.9	37.6	0.2	0-12	0.2	20.6	Med/Fine
997005-266	12	2	0.1	0.9	10.5	44.9	0	0-12	0.3	18.6	Med/Fine
997005-267	4	2	0.2	1.2	6.1	48.1	0.1	0-12	0.	20.3	Med/Fine
997005-268	8	2	0.2	1.0	6.9	46.2	0.	0-12	0.2	21.0	Med/Fine
997005-269	9		0.3	0.9	8.5	41.2	0.1	0-12	0.2	22.3	Med/Fine
997005-270	5	2	.7	0.9	6.8	37.4	0.	0-12	0.	22.5	Med/Fine
997005-271	3	3	0.6	.2	19.	71.2	0.2	0-12	0.1	17.3	Med/Fine
997005-272	6	3	0.2	1.1	9.7	31.6	0.	0-12	0.	18.2	Med/Fine
997005-273	0	3	2.	1.0	9.7	50.8	0.	0-12	0.2	18.9	Med/Fine
997005-274	0	2	0.5	1.1	23.0	49.7	0.4	0-12	0.2	17.2	Med/Fine
997005-275	4	2	0.2		6.0	40.2	0.	0-12	0.1	17.7	Med/Fine
997005-276	0	2	0	0.7	2.3	30.4	0.1	0-12	0.2	14.2	Med/Fine
997005-277	7	1	0.2	0.9	11.5	38.3	0.1	0-12	0.2	19.8	Med/Fine
997005-278	6	2	0.3	0.8	13.0	40.6	0.1	0-12	0.1	20.5	Med/Fine
997005-279	14	2	0.3	0.4	4.6	10.7	0.2	0-12	0.4	16.6	Med/Fine
997005-280	4	2	0.2	.0	5.	31.5	0.9	0-12	0.1	16.3	Med/Fine
997005-281	7		0.1	0.7	7.5	29.7	0.1	0-12	0.2	17.9	Med/Fine
997005-282	2	1	0.4	0.0	5.0	38.3	0.3	0-12	0.1	13.0	Med/Fine
997005-283	7	2	0.2	0.8	14.9	34.	0.5	0-12	0.2	14.2	Med/Fine
997005-284	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Med/Fine

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Lab No.	Field Description	Sample ID	SOIL pH	BUFF INDEX	NO3-N ppm 1	NO3-N ppm 3	% OM	B-1 P ppm	OLSEN P ppm	SALTS EC	EX K ppm	EX Ca ppm	EX Mg ppm
997005-285	WILDLIFE REFUGE	43 S	6.0	6.7		2	3.2	20		0.1	180	2400	
997005-286	WILDLIFE REFUGE	44	6.	6.8			3.2	9		0.:	160	2100	620
997005-287	WILDLIFE REFUGE	45	6.2	6.8			6.2	6		0	120	1700	450
997005-288	WILDLIFE REFUGE	46	6.1	6.7			3.0	10		0.1	170	2000	600
997005-289	WILDLIFE REFUGE	47	6.1	6.7		1	3.7	5		0.1	140	1900	500
997005-290	WILDLIFE REFUGE	49	6.3	6.9		2	3.6	6		0	170	2500	620
997005-291	WILDLIFE REFUGE	51	6.0	6.7			2.3	4		0.1	140	1900	480
997005-292	WILDLIFE REFUGE	53	6.:	6.8		2	2.9	13		0..	160	2800	550
997005-293	WILDLIFE REFUGE	54	6.4	6.8		9	4.0	18		0.1	170	2400	530
997005-294	WILDLIFE REFUGE	55	6.5	6.8		8	5.3	22		0.1	150	3000	590
997005-295	WILDLIFE REFUGE	59	5.7	6.2		3	6.0	17		0.:	110	1900	430
997005-296	WILDLIFE REFUGE	60 8OZ PLA	6.2	6.7		2	2.4	7		0.1	170	2000	680
997005-297	WILDLIFE REFUGE	60 4OZ PLA	6.0	6.4		4	8.6	8		0..	130	1800	370
997005-298	WILDLIFE REFUGE	60 NO PLA	6.3	6.8			3.0	6		0.1	120	1500	370
997005-299	WILDLIFE REFUGE	61	5.8	6.5		2	4.3	13		0.1	150	2200	510
997005-300	WILDLIFE REFUGE	62	6.2	6.8		2	3.7	14		0.1	180	2200	480
997005-301	WILDLIFE REFUGE	63	6.1	6.8		2	3.0	11		0.1	180	2300	730
997005-302	WILDLIFE REFUGE	64 4OZ PLA	6.3	6.8		5	3.6	5		0.:	150	2100	520
997005-303	WILDLIFE REFUGE	64 E	5.6	6.5			1.5	12		0.1	170	2200	650
997005-304	WILDLIFE REFUGE	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]

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Lab No.	Na ppm	S ppm	Zn ppm	Cu ppm	Mn ppm	Fe ppm	B ppm	Samp Dph 3	% Na Sat	CEC	TEXT
997005-285	9	2	0.2	.0	13.1	41.1	0.5	0-12	0.2	21.5	Med/Fine
997005-286	5	2	0.2	0.9	8.4	28.8	0.2	0-12	0.1	18.0	Med/Fine
997005-287	3	4	0.3	0.9	13.9	42.2	0.1	0-12	0.1	14.5	Med/Fine
997005-288	7	3	0.3	0.8	5.5	41.6	0.1	0-12	0.2	18.4	Med/Fine
997005-289	5	2	0.3	1.1	16.	51.3	0..	0-12	0..	17.0	Med/Fine
997005-290	7	3	0.2	.0	9.9	29.4	0.1	0-12	0.2	19.1	Med/Fine
997005-291	19	4	0.2	0.8	17.2	30.2	0.1	0-12	0.5	16.9	Med/Fine
997005-292	7	6	0.5	2.0	8.1	80.1	0.1	0-12	0.1	21.0	Med/Fine
997005-293	9	4	.0	1.8	34.9	73.1	0.3	0-12	0.2	18.8	Med/Fine
997005-294	8	4	2.1	1.7	25.0	96.6	0.3	0-12	0.2	22.3	Med/Fine
997005-295	11	3	1.8	2.6	19.3	%224.3	0.5	0-12	0.2	21.4	Med/Fine
997005-296	8	3	0.3	0.7	5.6	30.7	0.2	0-12	0.2	19.1	Med/Fine
997005-297	4	3	0.4	1.2	24.0	79.7	0..	0-12	0.1	18.4	Med/Fine
997005-298	7	3	0.5	0.	5.4	35.9	0.8	0-12	0.2	12.9	Med/Fine
997005-299	8	3	1.3	2.1	20.9	%115.3	0.3	0-12	0.2	20.6	Med/Fine
997005-300	6	4	.7	1.6	29.4	85.4	0.1	0-12	0.1	17.4	Med/Fine
997005-301	6	2	0.3	1.0	13.5	32.6	0.1	0-12	0.1	20.0	Med/Fine
997005-302	6	3	0.3	1.1	20.7	33.5	0.1	0-12	0.2	17.2	Med/Fine
997005-303	7	5	0.5		8.8	51.4	0.:	0-12	0.1	21.8	Med/Fine
997005-304	4	[illegible]	0.6	1.1	[illegible]	[illegible]	[illegible]	0-12	[illegible]	[illegible]	Med/Fine

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Lab No.	Field Description	Sample ID	SOIL pH	BUFF INDEX	NO3-N ppm 1	NO3-N ppm 3	% OM	B-1 P ppm	OLSEN P ppm	SALTS EC	EX K ppm	EX Ca ppm	EX Mg ppm
997005-305	WILDLIFE REFUGE	CONEFLOWER	5.7	6.6		1	2.4	4		0.	110	1400	340
997005-306	WILDLIFE REFUGE	DOGLEG	5.4	6.5			2.0	7		0.1	100	1400	350
997005-307	WILDLIFE REFUGE	B ANT MOUN	5.8	6.6		1	3.1	12		0.1	150	2200	550
997005-308	WILDLIFE REFUGE	BADGER DIG	5.9	6.6			3.0	4		0.1	160	1900	600

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Lab No.	Na ppm	S ppm	Zn ppm	Cu ppm	Mn ppm	Fe ppm	B ppm	Samp Dph 3	% Na Sat	CEC	TEXT
997005-305	8	2	0.2	0.5	5.6	21.2	0.	0-12	0.2	14.	Med/Fine
997005-306	15	1	0.3	0.6	3.7	49.	.8	0-12	0.4	15.2	Med/Fine
997005-307	10	2	0.4	0.9	18.4	37.7	0.6	0-12	0.2	20.0	Med/Fine
997005-308	14	3	0.2	0.5	15.3	39.9	0.4	0-12	0.3	18.9	Med/Fine

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Report Date: 12 Jan 1998

Work Order #: 92-433
Account #: 030059

JOHN MILLER
UNIVERSITY HYGIENIC LAB
900 E. GRAND WALLACE BLDG
DES MOINES IA 50319

Date Received: 8 Jan 1998

SAMPLE DESCRIPTION	ANALYTE	RESULTS		METHOD	ANALYZED	ANALYST
Lab Number: 98-812	Nitrogen, Kjeldahl	1640	mg/Kg	II 4500NH3B	12-18-97	Sue
5245	Nitrogen, Ammonia	148	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-813	Nitrogen, Kjeldahl	594	mg/Kg	II 4500NH3B	12-18-97	Sue
5246	Nitrogen, Ammonia	112	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-814	Nitrogen, Kjeldahl	608	mg/Kg	II 4500NH3B	12-18-97	Sue
5247	Nitrogen, Ammonia	98.0	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-815	Nitrogen, Kjeldahl	846	mg/Kg	II 4500NH3B	12-18-97	Sue
5248	Nitrogen, Ammonia	67.2	mg/Kg as N	II 4500NH3B	12-18-97	Sue
Lab Number: 98-816	Nitrogen, Kjeldahl	750	mg/Kg	II 4500NH3E	12-18-97	Sue
5249	Nitrogen, Ammonia	109	mg/Kg as N	II 4500NH3B	12-18-97	Sue
Lab Number: 98-817	Nitrogen, Kjeldahl	1610	mg/Kg	II 4500NH3B	12-18-97	Sue
5250	Nitrogen, Ammonia	146	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-818	Nitrogen, Kjeldahl	588	mg/Kg	II 4500NH3B	12-18-97	Sue
5251	Nitrogen, Ammonia	56.0	mg/Kg as N	II 4500NH3B	12-18-97	Sue
Lab Number: 98-819	Nitrogen, Kjeldahl	1770	mg/Kg	II 4500NH3B	12-18-97	Sue
5252	Nitrogen, Ammonia	84.0	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-820	Nitrogen, Kjeldahl	801	mg/Kg	II 4500NH3B	12-18-97	Sue
5253	Nitrogen, Ammonia	75.6	mg/Kg as N	II 4500NH3B	12-18-97	Sue
Lab Number: 98-821	Nitrogen, Kjeldahl	770	mg/Kg	II 4500NH3B	12-18-97	Sue
5254	Nitrogen, Ammonia	75.6	mg/Kg as N	II 4500NH3B	12-18-97	Sue
Lab Number: 98-822	Nitrogen, Kjeldahl	997	mg/Kg	II 4500NH3B	12-18-97	Sue
5255	Nitrogen, Ammonia	89.6	mg/Kg as N	II 4500NH3B	12-18-97	Sue

All data for this report has been approved by Brenda Meyers

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Report Date: 12 Jan 1998

Work Order #: 92-433
Account #: 030059

JOHN MILLER
UNIVERSITY HYGIENIC LAB
900 E. GRAND WALLACE BLDG
DES MOINES IA 50319

Date Received: 8 Jan 1998

SAMPLE DESCRIPTION	ANALYTE	RESULTS		METHOD	ANALYZED	ANALYST
Lab Number: 98-823	Nitrogen, Kjeldahl	1200	mg/Kg	II 4500NH3E	12-18-97	Sue
5256	Nitrogen, Ammonia	134	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-824	Nitrogen, Kjeldahl	686	mg/Kg	II 4500NH3E	12-18-97	Sue
5257	Nitrogen, Ammonia	75.6	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-825	Nitrogen, Kjeldahl	1170	mg/Kg	II 4500NH3E	12-18-97	Sue
5258	Nitrogen, Ammonia	123	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-826	Nitrogen, Kjeldahl	941	mg/Kg	II 4500NH3E	12-18-97	Sue
5260	Nitrogen, Ammonia	78.4	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-827	Nitrogen, Kjeldahl	1460	mg/Kg	II 4500NH3E	12-18-97	Sue
5261	Nitrogen, Ammonia	126	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-828	Nitrogen, Kjeldahl	2280	mg/Kg	II 4500NH3E	12-18-97	Sue
5262	Nitrogen, Ammonia	123	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-829	Nitrogen, Kjeldahl	1660	mg/Kg	II 4500NH3E	12-18-97	Sue
5263	Nitrogen, Ammonia	134	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-830	Nitrogen, Kjeldahl	1300	mg/Kg	II 4500NH3E	12-18-97	Sue
5264	Nitrogen, Ammonia	118	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-831	Nitrogen, Kjeldahl	882	mg/Kg	II 4500NH3E	12-18-97	Sue
5265	Nitrogen, Ammonia	92.4	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-832	Nitrogen, Kjeldahl	714	mg/Kg	II 4500NH3E	12-18-97	Sue
5266	Nitrogen, Ammonia	53.2	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-833	Nitrogen, Kjeldahl	1370	mg/Kg	II 4500NH3E	12-18-97	Sue
5267	Nitrogen, Ammonia	112	mg/Kg as N	II 4500NH3E	12-18-97	Sue

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Report Date: 12 Jan 1998

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JOHN MILLER
UNIVERSITY HYGIENIC LAB
900 E. GRAND WALLACE BLDG
DES MOINES IA 50319

Date Received: 8 Jan 1998

SAMPLE DESCRIPTION	ANALYTE	RESULTS		METHOD	ANALYZED	ANALYST
Lab Number: 98-834	Nitrogen, Kjeldahl	750	mg/Kg	II 4500NH3E	12-18-97	Sue
5268	Nitrogen, Ammonia	78.4	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-835	Nitrogen, Kjeldahl	680	mg/Kg	II 4500NH3E	12-18-97	Sue
5269	Nitrogen, Ammonia	81.2	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-836	Nitrogen, Kjeldahl	1090	mg/Kg	II 4500NH3E	12-18-97	Sue
5270	Nitrogen, Ammonia	109	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-837	Nitrogen, Kjeldahl	1610	mg/Kg	II 4500NH3E	12-18-97	Sue
5271	Nitrogen, Ammonia	151	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-838	Nitrogen, Kjeldahl	1060	mg/Kg	II 4500NH3E	12-18-97	Sue
5272	Nitrogen, Ammonia	72.8	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-839	Nitrogen, Kjeldahl	1340	mg/Kg	II 4500NH3B	12-18-97	Sue
5273	Nitrogen, Ammonia	137	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-840	Nitrogen, Kjeldahl	529	mg/Kg	II 4500NH3E	12-18-97	Sue
5274	Nitrogen, Ammonia	75.6	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-841	Nitrogen, Kjeldahl	1190	mg/Kg	II 4500NH3E	12-18-97	Sue
5275	Nitrogen, Ammonia	154	mg/Kg as N	II 4500NH3B	12-18-97	Sue
Lab Number: 98-842	Nitrogen, Kjeldahl	826	mg/Kg	II 4500NH3E	12-18-97	Sue
5276	Nitrogen, Ammonia	115	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-843	Nitrogen, Kjeldahl	641	mg/Kg	II 4500NH3B	12-18-97	Sue
5277	Nitrogen, Ammonia	104	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-844	Nitrogen, Kjeldahl	714	mg/Kg	II 4500NH3E	12-18-97	Sue
5278	Nitrogen, Ammonia	75.6	mg/Kg as N	II 4500NH3E	12-18-97	Sue

All data for this report has been approved by Brenda Meyer

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Report Date: 12 Jan 1998

Work Order #: 92-433
Account #: 030059

JOHN MILLER
UNIVERSITY HYGIENIC LAB
900 E. GRAND WALLACE BLDG
DES MOINES IA 50319

Date Received: 8 Jan 1998

SAMPLE DESCRIPTION	ANALYTE	RESULTS		METHOD	ANALYZED	ANALYST
Lab Number: 98-845	Nitrogen, Kjeldahl	445	mg/Kg	II 4500NH3B	12-18-97	Sue
	Nitrogen, Ammonia	56.0	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-846	Nitrogen, Kjeldahl	1050	mg/Kg	II 4500NH3B	12-18-97	Sue
5280	Nitrogen, Ammonia	101	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-847	Nitrogen, Kjeldahl	720	mg/Kg	II 4500NH3B	12-18-97	Sue
	Nitrogen, Ammonia	81.2	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-848	Nitrogen, Kjeldahl	1010	mg/Kg	II 4500NH3B	12-18-97	Sue
5282	Nitrogen, Ammonia	165	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-849	Nitrogen, Kjeldahl	1140	mg/Kg	II 4500NH3E	12-18-97	Sue
	Nitrogen, Ammonia	204	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-850	Nitrogen, Kjeldahl	1640	mg/Kg	II 4500NH3B	12-18-97	Sue
5284	Nitrogen, Ammonia	154	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-851	Nitrogen, Kjeldahl	669	mg/Kg	II 4500NH3B	12-18-97	Sue
	Nitrogen, Ammonia	109	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-852	Nitrogen, Kjeldahl	722	mg/Kg	II 4500NH3B	12-18-97	Sue
5286	Nitrogen, Ammonia	95.2	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-853	Nitrogen, Kjeldahl	1430	mg/Kg	II 4500NH3B	12-18-97	Sue
5287	Nitrogen, Ammonia	160	mg/Kg as N	II 4500NH3B	12-18-97	Sue
Lab Number: 98-854	Nitrogen, Kjeldahl	720	mg/Kg	II 4500NH3B	12-18-97	Sue
5288	Nitrogen, Ammonia	89.6	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-855	Nitrogen, Kjeldahl	1190	mg/Kg	II 4500NH3E	12-18-97	Sue
5289	Nitrogen, Ammonia	157	mg/Kg as N	II 4500NH3E	12-18-97	Sue

All data for this report has been approved by Brenda Meyers

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Report Date: 12 Jan 1998

Work Order #: 92-433
Account #: 030059

JOHN MILLER
UNIVERSITY HYGIENIC LAB
900 E. GRAND WALLACE BLDG
DES MOINES IA 50319

Date Received: 8 Jan 1998

SAMPLE DESCRIPTION	ANALYTE	RESULTS		METHOD	ANALYZED	ANALYST
Lab Number: 98-856	Nitrogen, Kjeldahl	902	mg/Kg	II 4500NH3E	12-18-97	Sue
5290	Nitrogen, Ammonia	92.4	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-857	Nitrogen, Kjeldahl	479	mg/Kg	II 4500NH3E	12-18-97	Sue
5291	Nitrogen, Ammonia	53.2	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-858	Nitrogen, Kjeldahl	1230	mg/Kg	II 4500NH3E	12-18-97	Sue
5292	Nitrogen, Ammonia	86.8	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-859	Nitrogen, Kjeldahl	1520	mg/Kg	II 4500NH3E	12-18-97	Sue
5293	Nitrogen, Ammonia	168	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-860	Nitrogen, Kjeldahl	1960	mg/Kg	II 4500NH3E	12-18-97	Sue
5294	Nitrogen, Ammonia	157	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-861	Nitrogen, Kjeldahl	1900	mg/Kg	II 4500NH3E	12-18-97	Sue
5295	Nitrogen, Ammonia	182	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-862	Nitrogen, Kjeldahl	868	mg/Kg	II 4500NH3E	12-18-97	Sue
5296	Nitrogen, Ammonia	81.2	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-863	Nitrogen, Kjeldahl	1620	mg/Kg	II 4500NH3E	12-18-97	Sue
5297	Nitrogen, Ammonia	190	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-864	Nitrogen, Kjeldahl	753	mg/Kg	II 4500NH3E	12-18-97	Sue
5298	Nitrogen, Ammonia	92.4	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-865	Nitrogen, Kjeldahl	1480	mg/Kg	II 4500NH3E	12-18-97	Sue
5299	Nitrogen, Ammonia	160	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-866	Nitrogen, Kjeldahl	1740	mg/Kg	II 4500NH3E	12-18-97	Sue
5300	Nitrogen, Ammonia	160	mg/Kg as N	II 4500NH3E	12-18-97	Sue

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Report Date: 12 Jan 1998

Work Order #: 92-433
Account #: 030059

JOHN MILLER
UNIVERSITY HYGIENIC LAB
900 E. GRAND WALLACE BLDG
DES MOINES IA 50319

Date Received: 8 Jan 1998

SAMPLE DESCRIPTION	ANALYTE	RESULTS		METHOD	ANALYZED	ANALYST
Lab Number: 98-867	Nitrogen, Kjeldahl	680	mg/Kg	II 4500NH3B	12-18-97	Sue
5301	Nitrogen, Ammonia	72.8	mg/Kg as N	II 4500NH3B	12-18-97	Sue
Lab Number 98-868	Nitrogen, Kjeldahl	1030	mg/Kg	II 4500NH3E	12-18-97	Sue
5302	Nitrogen, Ammonia	81.2	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-869	Nitrogen, Kjeldahl	1050	mg/Kg	II 4500NH3B	12-18-97	Sue
5303	Nitrogen, Ammonia	126	mg/Kg as N	II 4500NH3B	12-18-97	Sue
Lab Number: 98-870	Nitrogen, Kjeldahl	1840	mg/Kg	II 4500NH3E	12-18-97	Sue
5304	Nitrogen, Ammonia	207	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-871	Nitrogen, Kjeldahl	608	mg/Kg	II 4500NH3B	12-18-97	Sue
5305	Nitrogen, Ammonia	154	mg/Kg as N	II 4500NH3B	12-18-97	Sue
Lab Number: 98-872	Nitrogen, Kjeldahl	456	mg/Kg	II 4500NH3E	12-18-97	Sue
5306	Nitrogen, Ammonia	75.6	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-873	Nitrogen, Kjeldahl	882	mg/Kg	II 4500NH3E	12-18-97	Sue
5307	Nitrogen, Ammonia	72.8	mg/Kg as N	II 4500NH3B	12-18-97	Sue
Lab Number 98-874	Nitrogen, Kjeldahl	496	mg/Kg	II 4500NH3B	12-18-97	Sue
5308	Nitrogen, Ammonia	70.0	mg/Kg as N	II 4500NH3E	12-18-97	Sue
Lab Number: 98-875	Nitrogen, Kjeldahl	501	mg/Kg	II 4500NH3E	12-18-97	Sue
5259	Nitrogen, Ammonia	47.6	mg/Kg as N	II 4500NH3E	12-18-97	Sue

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SOIL ANALYSIS SUMMARY

Summary To: 30059
UNIVERSITY OF IA HYGIENIC LAB
JOHN MILLER
900 E GRAND-WALLACE BLDG
DES MOINES , IA 50319

Date: 01-13-98
Work Order #: 91-0133

From Lab #: 997005-245
To Lab #: 997005-308

Farmer	Samples	Cost	Farmer	Samples	Cost
WALNUT CREEK NATIONAL	64	1,920.00			

WORK ORDER TOTAL --> 64 Sample(s) $1,920.00

DO NOT PAY FROM THIS SUMMARY !!
THIS IS NOT AN INVOICE !!
An Invoice will be sent from
MVTL in New Ulm.

V9.02 941115

Walnut Creek National Wildlife Refuge Soil Sample ID and Collection Date Data

Site ID Code	Date Collected
1	21-Sep
2	14-Sep
4	12-Sep
6	18-Nov
7	11-Oct
9	11-Sep
10	28-Aug
11	8-Sep
12	12-Sep
13	11-Oct
14	11-Oct
15	14-Sep
17	28-Aug
18	21-Sep
18E	24-Sep
18 Far West	
18 N	24-Sep
18 Ctr. S. Lot	26-Sep
18 Ctr. Lot 1	11-Oct
20	21-Sep
21	24-Sep
22	26-Aug
23	1-Sep
24 S	1-Sep
25	29-Aug
26	14-Sep
27	21-Sep
28	25-Sep
29	18-Sep
30	19-Oct
31	4-Sep
32	7-Sep
34 #1	18-Nov
34 #2	18-Nov
37	22-Oct
38	11-Oct
39	16-Oct
40	8-Sep
41	1-Sep
42	1-Sep
43 S	3-Sep
44	3-Sep
45	7-Sep
46	18-Nov
47	20-Nov
49	18-Nov
51	18-Oct
53	18-Oct
54	18-Oct
55	20-Nov
59	20-Nov
60 8 oz. Plateau	18-Nov
60 4 oz. Plateau	18-Nov
60 No Plateau	18-Nov
61	18-Nov
62	19-Oct

Series 5

	Site ID Code	Date Collected
530 1	63	18-Oct
2	64 4 oz. Plateau	20-Nov
3	64 E	20-Nov
4	68	
5	Coneflower Prairie	19-Nov
6	Dogleg	19-Nov
7	Big Ant Mound	19-Nov
8	Badger Digs	19-Nov

FY 1996 CONTAMINANT STUDY PRE-PROPOSAL

I. TITLE IA - Contaminant Problem Identification at Union Slough National Wildlife Refuge

2a. YEAR OF STUDY: 2 of 4 2B. PROJECT CODE INDENTIFIER: 3N17

3. SUBMITTED BY: Region 3, Rock Island Field Office

4. PROPOSAL SUMMARY:

The primary objective is to develop alternative management strategies to reduce the inputs of agricultural chemicals. The potential strategies include diversion streams, nutrient treatment wetlands, integrated pest management and precision farming programs. Union Slough National Wildlife Refuge contains 2845 acres of wetland and upland habitats in the prairie pothole region. The refuge is narrow and eight miles long. The wetland habitats in the refuge are within two watersheds and are surrounded by private row crop fields. Parts of the refuge are not protected from direct upland run-off. Numerous agricultural tile outlets and drainage ditches empty into the refuge. The surface and subsurface water sources likely transport agricultural chemicals to the refuge. There may be contaminated groundwater inputs and air deposition of pesticides. The timing, concentrations and effects from the contaminants are not known. We will complete the Contaminants Problem Identification Manual for this refuge during the winter of 1995/1996. The worksheet format for the Manual will help us organize, prioritize and report contaminant problems. We will continue to collect water samples for chemical analysis according to the water quality monitoring program set up in 1995. In addition, a water quality study will be set up for newly created treatment wetland and tile drainage system that will discharge into the refuge starting in 1996. We will use biomarker methods to confirm if organophosphate insecticides are transported to the refuge and affect fish and wildlife. We will use two strategies to test for biomarkers in birds. The first strategy includes the collection of blood from fledgling wood ducks that are trapped as part of refuge operations. The second strategy includes the collection of brain tissue from passerine birds. The passerine birds (house wrens and/or tree swallows) will be collected by mist netting and within artificial nest boxes. Cultured juvenile bluegill will be placed in cages at tributary inlets, run-off sites and reference areas prior to insecticide application season for corn production and livestock husbandry. Bluegill will be removed every two weeks for biomarker analysis. Microtechniques are available to monitor ChE activity in large aquatic invertebrates. Biomarker tests on aquatic invertebrates may be used in wetlands that do not support fish.

5. PRINCIPAL INVESTIGATOR: Mike Coffey

6. **REFUGE:** Union Slough NWR

7 **FUNDING REQUESTED:** $59,750 Operational | $30,000 Analytical (Non-PACF) | $89,750 Total

8. **FUNDING SOURCES:** Refuge

9. **ANALYTICAL SUPPORT REQUIREMENTS**

TYPE	NUMBER	INORGANIC	TOTAL	
Water	100	$200	$20,000	Non-PACF
Tissue	200	$50	$10,000	Non-PACF

11. **APPROVED:** [signature] 7/31/95
EC Coordinator & Date

PROJECT CODE IDENTIFIER: 3N17
STUDY YEAR 2 OF 4

FY 1996 CONTAMINANT INVESTIGATION PROPOSAL

I. TITLE IA - Contaminant Problem Identification at Union Slough National Wildlife Refuge

II. OBJECTIVES

A. MANAGEMENT OBJECTIVES

The primary objective is to develop alternative management strategies to reduce the inputs of agricultural chemicals. The potential strategies include diversion streams, nutrient treatment wetlands, integrated pest management and precision farming programs.

B. TECHNICAL OBJECTIVES

The technical objectives are to 1) identify contaminant sources and confirm contaminant problems related to surface water, groundwater, air and biotic pathways; and 2) investigate the function of a contaminant treatment wetland recently developed for the refuge.

III. BACKGROUND and JUSTIFICATION

The Union Slough National Wildlife Refuge (Refuge) contains 2845 acres of wetland and upland habitats in the prairie pothole region. The Refuge is narrow and eight miles long. The wetland habitats in the Refuge are within two watersheds and are surrounded by private row crop fields.

Parts of the Refuge are not protected from direct upland run-off. Numerous agricultural tile outlets and drainage ditches empty into it. The surface and subsurface water sources likely transport agricultural chemicals and nutrients to the Refuge. There may also be contaminated groundwater inputs and air deposition of pesticides. The timing, concentrations and effects from all sources have not yet been identified.

During a 1990 investigation, a 48-hour larval fathead minnow bioassay resulted in 50% and 98% mortality to organisms exposed to sediments from two of five agricultural outlets to the Refuge (1). Analyses performed before and after completion of those bioassays indicated that ammonia was the probable cause of that acute mortality. The 1990 study and an earlier study also identified somewhat elevated heavy metal concentrations in the substrate.

In 1995, a water quality monitoring program at the Refuge was initiated as part of this multi-year contaminants investigation The monitoring program was integrated with a sediment transport and water budget study by the U.S. Geological Survey (Enclosure A).

We are concerned about nutrient loading and herbicide inputs which have the potential to alter the structure and function of wetlands. These alterations may deteriorate habitat quality for waterfowl and other migratory birds.

Also, we want to determine whether insecticides are being transported onto the Refuge and whether they are harming migrating shorebirds, breeding grassland birds and waterfowl

IV. METHODS

The proposed 1996 field season includes three activities as outlined below. The first activity involves organizing and prioritizing potential contaminant problems by means of the BEST Contaminants Problem Identification Manual. The other two activities involve Refuge water and biomarker analyses to further characterize and quantify agriculture-related inputs to the Refuge and the threats they pose.

A. CONTAMINANTS PROBLEM IDENTIFICATION MANUAL

We will complete the Contaminants Problem Identification Manual for this refuge during the winter of 1995/1996. There are many sources, types of contaminants and pathways for Union Slough National Wildlife Refuge. The worksheet format for the Manual will help us organize, prioritize and report contaminant problems. Guidance from the Manual and the BEST Detailed Plan will be used to develop additional confirmatory sampling methods

The principle investigator for the contaminants investigation is familiar with the Manual and has completed a Manual pilot study for the National Biological Survey. Geographical Information Systems (GIS) data are available for the refuge and GIS analysis will help in the problem identification process.

B. WATER QUALITY MONITORING

In 1996, we will continue to collect water samples for chemical analysis according to the water quality monitoring program set up in 1995 (Enclosure B). In addition, a water quality study will be set up for newly created treatment wetland and tile drainage system that will discharge into the refuge starting in 1996 (Enclosure C).

C. BIOMARKER ANALYSIS

We elected to confirm insecticide inputs and injury to organisms using biomarker (health index) methods. Biomarker analysis is the preferred approach versus analytical chemistry to show if insecticides are transported to the refuge. It is preferred because insecticides may be difficult to detect by analytical chemistry for two reasons. Insecticides are often present in the system below analytical chemistry detection limits. They are transported in pulses and break down quickly in water.

Biomarkers or health effects may persist for up to a few weeks in organisms after exposure to very low concentrations of organophosphate compounds. The biomarker tests for this project are considerably less expensive than analytical chemistry tests and are sensitive to the insecticides used in the watershed. We will monitor cholinesterase (ChE) activity in birds and aquatic organisms such as fish and large invertebrates to document injury to resources. Biomarker methods will also be used to map the spatial distribution and timing of organophosphate insecticide inputs to the refuge.

Limited biomarker data are available for passerines and aquatic organisms. Therefore, the data from the biomarker analysis will be used to calculate requisite sample sizes, power and minimum detectable difference values. Power tests will estimate the probability of correctly rejecting false null hypotheses. Minimum detectable difference or accuracy tests will help us place limits on the interpretations for the 1996 data.

Birds

We will use two strategies to test for biomarkers in birds. The first strategy includes the collection of blood from fledgling wood ducks that are trapped as part of refuge operations. The second strategy includes the collection of brain tissue from passerine birds. The passerine birds (house wrens and/or tree swallows) will be collected by mist netting and within artificial nest boxes.

The fluids and tissue will be analyzed by the National Wildlife Health Center, Veterinary Services and Diagnostic Laboratories for the States of Iowa and Illinois. The specimens will be analyzed using the updated Ellman method.

A subset of the samples for ChE analysis will be split in the field and replicates sent to quality assurance laboratories for analysis.

Aquatic Organisms

Cultured juvenile bluegill will be placed in cages at tributary inlets, run-off sites and reference areas prior to insecticide application season for corn production and livestock husbandry. Bluegill will be removed every two weeks from the fish cages for analysis. The bluegill will be randomly chosen. The fish will be weighed and length measured. Water quality will be monitored at the fish cages.

The specimens will be analyzed by researchers at the Department of Animal Ecology at Iowa State University. Standard operating procedures and quality assurance measures for the analysis are outlined in Enclosure D. Enzyme reactivation procedures will be used for additional quality assurance tests.

Microtechniques are available to monitor ChE activity in large aquatic invertebrates. Biomarker tests on aquatic invertebrates may be used in wetlands that do not support fish.

V. ROLES, RESPONSIBILITIES AND PARTNERSHIPS

A. ROLES/RESPONSIBILITIES

The principle investigators for this project are Refuge Manager Barry Christenson (Union Slough National Wildlife Refuge) and Contaminants Specialist Mike Coffey (Rock Island Field Office).

The Manual will be completed by Coffey. The water quality monitoring program will be completed by refuge staff supported by Coffey.

The bird biomarker survey will be completed by Coffey. The aquatic organism biomarker survey will be completed by the Department of Animal Ecology, Iowa State University.

GIS analysis, interim and final reports will be completed by Coffey.

B. PARTNERSHIPS

There have been numerous partners (mostly State and Federal resource agencies) over the past year used to support this contaminants investigation. The contributions range from periodic consultation concerning our methods and results to continual field support for the collection of data.

VI. RANKING FACTORS

A. APPLICABILITY OF RESULTS TO MANAGEMENT ACTIONS/SOLUTIONS

The results of water quality monitoring and biomarker assessments will be used to identify and prioritize contaminant inputs to the Refuge and characterize the threat to its resources. On-Refuge Remedial projects can then be developed for the priority sources. Also, in return for accepting agricultural subsurface drainage to the Refuge, the Manager has the latitude to require that adverse water quality conditions be mediated at their source (see attached Special Use Permit). Remedial measures may include diversion streams, sediment retention basins, treatment wetlands (Enclosure E), grass filter strips, buffer zones and intergrated pest management (IPM) practices. Individually and collectively, these practices can result in significant improvements to Refuge water quality.

B. THREATS TO RESOURCES

We believe Refuge resource diversity and function are being significantly degraded by inputs of agricultural pesticides and nutrients, resulting in cultural eutrophication and, perhaps, chemical toxicity to aquatic organisms. Hypereutrophic conditions have produced ammonia which, in Refuge sediments, has been shown to be toxic to aquatic life.

Migratory birds may also be at risk from insecticide poisoning due to the proximity of the Refuge to crop fields and the volume of agricultural drainage water entering it.

C. IMPACTS TO SERVICE TRUST RESOURCES

1. & 2. Biological Organization and Measurement of Contaminant Effects

This multi-year contaminants investigation will evaluate impacts to organism, population, community and ecosystem levels of biological organization using several bioassessment methods. The methods include analytical chemistry, toxicity tests, biomarkers, community structure analysis and habitat modelling.

The contaminants of concern include highly toxic chemicals (ammonia and insecticides) and chemicals that cause indirect problems such as nutrients which can alter community structure

We plan to integrate analytical chemical data with the other bioassessment methods to help show injury to organisms and impacts to higher levels of biological organization. Biomarker and toxicity tests will be the most useful methods to show direct biological injury to aquatic life and wildlife from insecticides and ammonia. Community structure analyses along with the biological injury data will help describe the contaminant related effects on populations, communities and ecosystems.

The populations and communities of the refuge ecosystem have likely been altered by high productivity related to fertilizer run-off and elimination of sensitive species from exposure to ammonia and pesticides. The indirect contaminant problems related to this may include shifts in benthic macroinvertebrate populations and aquatic plant communities which in turn decrease optimal habitat conditions for migratory birds.

3. & 4. Contaminant Sources and Pathways

Sampling plans for the contaminant investigation will be developed for the primary purpose to identify sources and pathways. This will be accomplished by using guidance from the BEST Contaminants Problem Identification Manual. The data from the sampling plan is also needed to prioritize remedial actions to reduce non-point source pollution because there are numerous sources and multiple pathways.

The sources include agricultural pesticides and fertilizer products used for corn and soybean production. The pathways include: secondary poisoning, livestock feed lots, subsurface tile systems, surface water ditches and streams, run-off, aerial application of agricultural chemicals and possibly groundwater.

D. PARTNERSHIPS

The partners from the scientific community are needed to help collect a wide range and sufficient sample size of field data for statistical analysis. The study is comprehensive and requires more people and technical resources than the field offices have available. This contaminants investigation is an integrated ecosystem assessment. The study team needs to collect and evaluate abiotic and biotic parameters simultaneously to strengthen ecosystem level interpretations.

VII. SCHEDULE:

BEST Manual review	. Winter 1995/1996
Water quality studies . . .	Spring & Summer 1996
OP biomarker analysis . . .	Spring & Summer 1996
Analytical and GIS analysis	. Winter 1996/1997
Reports	. . . . Summer 1997

VIII. REPORTS, PUBLICATIONS AND PRESENTATIONS:

The Field Office will issue interim reports each year of the project and the final report. University cooperators may present the results of the fish biomarker study at scientific conferences.

IX. OPERATIONAL COST ESTIMATES:

A. PREVIOUS OPERATIONAL EXPENDITURES

1995 $20,000

B. FY 1996

1 Personnel Costs

Rock Island Field Office . $29,250

[$450/day]

Manual Review	10 days
Field Sampling	25 days
GIS Analysis	. 5 days
Analysis, Interpretation and Reports	25 days

Union Slough National Wildlife Refuge:

Project Planning & Field Support . $7500

2. Misc. Supplies and Shipping Costs . $3000

3. Non-PACF Analytical Costs for Pesticide and Nutrient Chemical Analysis:

The University of Iowa Hygienic Laboratory will do all of the water and sediment analysis because they can analyze unpreserved samples immediately after collection. This is critical for pesticide analysis.

Refuge Water Quality Plan . $20,000
Treatment Wetland Monitoring $10,000

4. Other

Cooperative Agreements

Iowa State University, biomarker analysis . $10,000

5. Operational Total $79,750

6. Regional Office Overhead . $10,000

C. FUTURE OPERATIONAL COSTS

Continue water quality studies and report writing . $50,000

X. ANALYTICAL COST ESTIMATES:

A. PREVIOUS ANALYTICAL COSTS

1995 . $41,900

B. FY 1996

Listed above under non-PACF analytical costs

C. FUTURE ANALYTICAL COSTS

Water quality studies . $25,000

GRAND TOTAL OF REQUESTED FUNDS FY 1996 $89,750

XI. **APPROVALS:**

Submitted by: ______________________ Date 7-5-95
Mike Coffey, Rock Island Field Office

Reviewed by: ______________________ **Date** 7-6-95
Field Supervisor Rock **Island Field Office**

Reviewed by: ______________________ **Date** 7-6-95
Union Slough National Wildlife Refuge

Reviewed by: ______________________ **Date** 7/31/95
Environmental **Contaminants Coordinator**

SCIENTIFIC PEER REVIEW CHECK LIST

NOTE See computer file "ATTACH_3" for a clean soft copy of this checklist

✓ Experimenta design is well thought out and scientifica y valid

If no please comment

✓ There is a good probabi ty of achieving the objectives of the investigation.

If no please comment

✓ The investigation uses accepted methodologies to measures exposure and effects of contaminants (i.e., it includes more than simple abiotic measures such as chemical analysis of sediments or water).

If no please comment

✓ The costs are well researched clearly spelled out and defensible

f no, please comment

✓ Commensurate with investigation objectives, the proposal describes or cites scientifically acceptable operating procedures that include QA/QC sufficient to ensure the integrity of the data.

If no please comment

PROPOSAL TITLE FY 1996 Contaminant Investigation Proposal - Union Slough NWR

REVIEWER Angelo Capparella TITLE Assistant Professor DATE 7/10/95

Angelo Capparella

Dept Biological Sciences
Illinois State University

#3N17
Year 2 of 4

SCIENTIFIC PEER REVIEW CHECK LIST

✓ Experimental design is we thought out and scientifica y valid

If no, please comment

✓ There is a good probability of achieving the objectives of the investigation.

If no, please comment

✓ The investigation uses accepted methodologies to measures exposure and effects of contaminants (i.e., it includes more than simple abiotic measures such as chemical analysis of sediments or water).

If no please comment

✓ The costs are wel researched clearly spelled out and defensible

If no, please comment

✓ Commensurate with investigation objectives, the proposal describes or cites scientifically acceptable operating procedures that include QA/QC sufficient to ensure the integrity of the data. BEST

If no, please comment:

PROPOSAL TITLE IA - Contaminant Problem ID at Union Slough NWR

REVIEWER [signature] TITLE Asst Field Sup. DATE 7-31-95

UNION SLOUGH NATIONAL WILDLIFE REFUGE

1710 - 360th Street
Titonka, Iowa 50480
515-928-2523
FTS 751-1523
FAX 515-928-2230

Date: 7-6-95
No. of Pages: 2
FAX: 612 725 3526

TO: Stan Smith
FROM: Barry Christenson
SUBJECT: 1996 Contaminant Study Proposal

Attached please find a copy of the signature page from a proposal prepared by Mike for work here at Union Slough. I

× and

urge continued Our work to date

this benefits already as I work

on the Refuge i Protection Plan.

I understand from Mike that an original signature page will be forwarded next week.

Barry Christenson

Interim Report - Contaminants Investigation
Union Slough National Wildlife Refuge
DRAFT - 1995

by Mike Coffey, Rock Island Field Office,
Rock Island, Illinois

Introduction

This interim report provides updated information for a multi-year contaminants study at Union Slough National Wildlife Refuge. The study is conducted by the U.S. Fish and Wildlife Service's Division of Environmental Contaminants and Division of Refuges.

Study Area

Union Slough National Wildlife Refuge contains 2845 acres of wetland and upland habitats in the prairie pothole region of north central Iowa. The refuge is eight miles long. The wetland habitats in the refuge are within two watersheds and are surrounded by private row crop fields.

Background

In 1990, a contaminants study indicated poor sediment quality conditions at the refuge. Poor sediment quality was indicated by elevated ammonia concentrations and some mortality in toxicity tests. The 1990 study and an earlier study indicated slightly elevated concentrations of some heavy metals in the substrate.

Parts of the refuge are not protected from direct upland run-off. Numerous agricultural tile outlets and drainage ditches empty into the refuge. The surface and subsurface water sources likely transport agricultural chemicals to the refuge. There may be contaminated groundwater inputs and areal deposition of pesticides. The timing, concentrations and effects from the contaminants are not known.

We are investigating nutrient loading and herbicide inputs which have the potential to alter the structure and function of wetlands. These alterations may deteriorate habitat quality for migratory birds.

We also want to determine if insecticide chemicals are transported to the refuge and if they harm migrating shorebirds, breeding grassland birds and waterfowl.

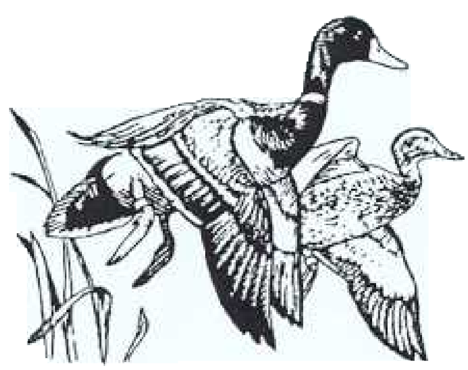
Status

In 1995, we started a water quality monitoring program at the refuge as part of the contaminants investigation (Appendix A). The monitoring program was integrated with a sediment transport and water budget study by the U.S. Geological Survey (Appendix B). The U.S. Geological Study was supported by Ecosystem Management funds.

We are using Geographical Information Systems (GIS) methods to help with the contaminants investigation. Water chemistry data from initial sampling times are displayed in Figure 1 on a reclassified National Wetland Inventory map.

We plan to start benthic macroinvertebrate and aquatic plant community assessments later in 1995. A reconnaissance survey at a refuge wetland protected from surface water chemical inputs yielded chorus frog tadpoles, abundant fingernail clams, crawfish, leeches, dragonfly nymphs, damselfly nymphs, chironomids, coleopterids and hemipterids.

In a separate permit action, a neighbor to the refuge will construct a contaminant treatment wetland as part of agricultural tile drainage system into the refuge (Appendix C). We will provide some technical support for the treatment wetland and monitor water quality. The concept of a treatment wetland is provided in a journal article in Appendix D.



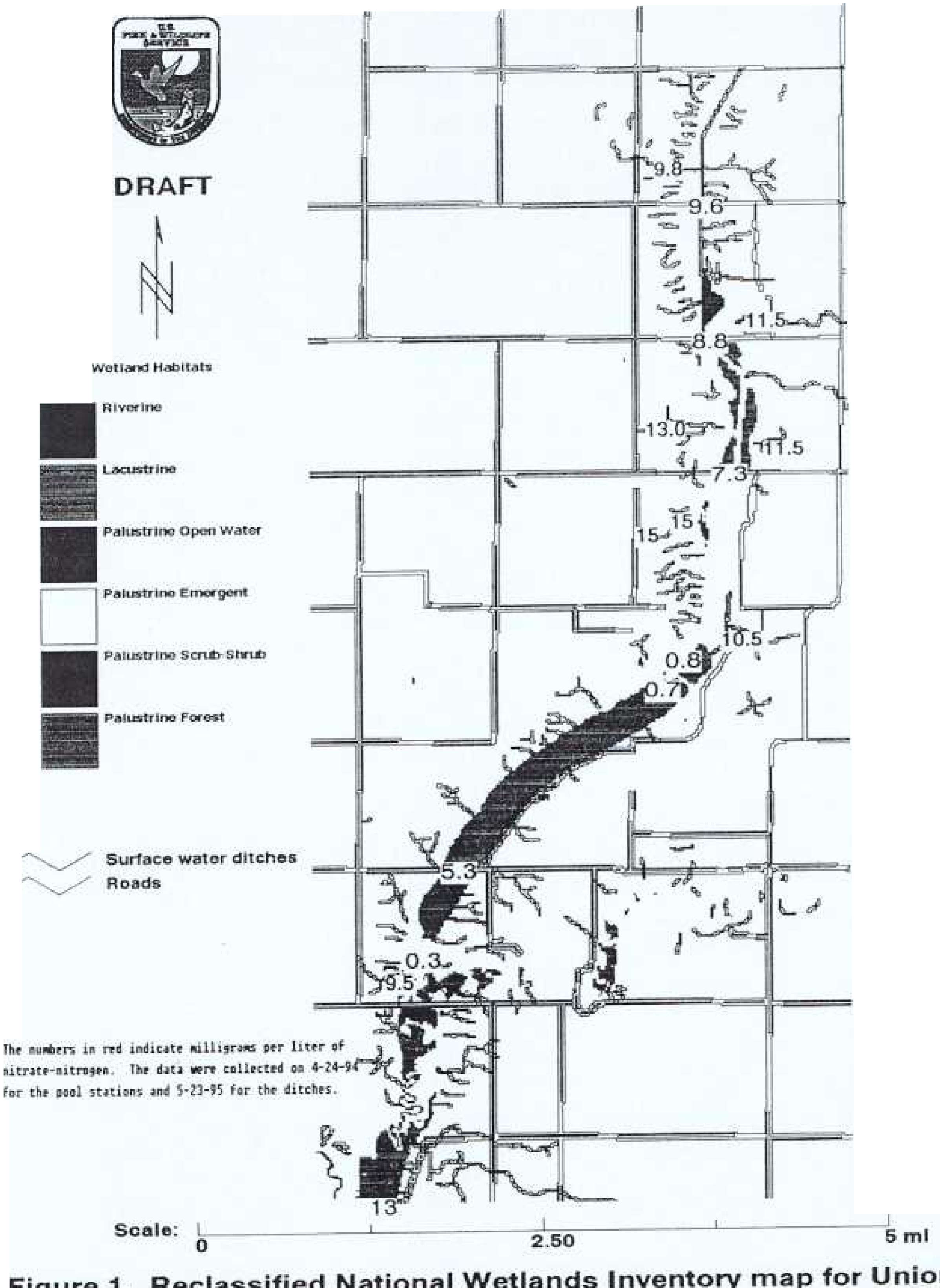


Figure 1. Reclassified National Wetlands Inventory map for Union Slough National Wildlife Refuge with water quality data (USFWS-RIFO, 1995).

Appendix A

Refuge Water Quality Monitoring Plan

Water Quality Work Plan
Union Slough National Wildlife Refuge
DRAFT Version 2 - 1995 & 1996 Field Seasons

by Mike Coffey, Rock Island Field Office,
Rock Island, IL

This work plan is one in a series of work plans for field activities related to a contaminants study at Union Slough National Wildlife Refuge.

Introduction

In 1995, staff from the U.S. Fish and Wildlife Refuge initiated a detailed contaminants investigation at Union Slough National Wildlife Refuge.

The study was funded by the U.S. Fish and Wildlife Service's refuge-contaminants program. The purpose of the refuge-contaminants program is to describe contaminant problems and develop alternative management strategies to reduce the impacts of pollution.

Goals and Objectives

The goal for the study is to identify contaminant sources and pollution-related problems at Union Slough National Wildlife Refuge. Two objectives to meet this goal are listed below.

1. Monitor water chemistry at the wetland habitats within the refuge.

2. Characterize the contaminants in tile drainage effluent, subsurface water discharge points, ditch and tributary inlets to the refuge.

Methods

The methods include regular monitoring of water quality in the management pools and periodic screening at water input points.

Regular Monitoring in Management Pools

Herbicide chemicals used for corn production and nutrients will be measured at eight stations. The stations are located at the pool outlet points. Five of the sampling stations correspond to stations established by the U.S.

Geological Survey (USGS) for a 1995 study to characterize sediment transport and develop a water budget. Analysis for major ions and an additional sampling station (Buffalo Creek bridge) will be added to our schedule according to the USGS study sampling schedule.

Water samples will be collected monthly from mid March to mid November. The schedule will change to weekly sampling from mid April to mid June for the spring run-off season.

The water samples will be collected with a pole sampler placed at one foot below the water surface or in the middle of the water column for depths less than one foot. The samples will be forwarded to the University of Iowa Hygienics Laboratory for analysis according to the Chemical Data Acquisition Plan (CDAP) (Table 1).

The collection bottle for the pole sampler will be decontaminated between uses by rinsing three times with wetland water at the station to be sampled followed by distilled water.

Water quality parameters will be noted at time of sampling with a Solomat® multi-function meter. The water quality parameters include pH (*units*), temperature (*°C*), conductivity (*μS*) and turbidity (*NTU*).

Table 1. Chemical Data Acquisition Plan for Water, Union Slough National Wildlife Refuge.

Analyte	Method	Preservation
Ammonia-nitrogen	Phenate method	Sulfuric acid
Nitrate-nitrogen	Automated Cadmium reduction method	Sulfuric acid
Phosphate-phosphorus	Automated ascorbic acid method	Sulfuric acid
Alachlor	ELISA[1]	
Atrazine	ELISA	Fresh
Metolachlor	ELISA	
Major ions[2]	ICP[3]	Nitric acid

[1] Enzyme-Linked Immunosorbent Assay
[2] Calcium, magnesium and potassium
[3] Induced Coupled Plasma Emission Spectroscopy

A field data sheet will be completed at time of sampling. The information for the data sheet includes weather, days since last storm event, flow direction, water and substrate conditions (*ie.* aquatic plant blooms, muddy water, etc.).

Periodic Screening at Inlets

About a dozen primary water inlet points to refuge will be screened for water chemistry in March, May, June, September. The inlets were selected by resource managers and contaminant specialists because they represent the important sources of water for the refuge wetlands.

These months were selected because two of the months correspond to the schedule for the U.S. Geological Survey study (May and September) and all four months represent the most likely maximum discharge times for agricultural chemicals and nitrates.

A single grab sample will be collected from the outfall effluent and series of grab samples along the length of the ditch inlets. Selected samples will be analyzed for herbicides listed in the CDAP in addition to those used for soybean production. Local agricultural businesses will provide information on the popular brands of pre-emergent and post-emergent herbicides used for soybean production in the watershed (*eg.* Prowl, Pursuit, Pinnacle and Treflan). The selection of water samples for herbicide analysis will be based on crop rotation schemes and the size of the drainage area for each refuge inlet.

All of the water samples from the refuge inlets will be analyzed for nitrates. All of the water samples from the ditches leading from confined livestock operations will be analyzed for nitrates and ammonia.

Solomat® meter readings and water depth will be collected at the inlet sampling stations as mentioned above.

Data Analysis

Graphical and Geographical Information Systems (GIS) procedures will be used to illustrate when, where and at what concentrations contaminants enter and flow through the refuge.

The analytical data analyses will also include a combination of descriptive procedures and tests for differences between distributions or means.

Additional guidance for the statistical analysis of the water chemistry data may be found in the U.S. Environmental Protection Agency's publication entitled Statistical Methods for the Analysis of Lake Water Quality Trends (EPA# 841-R-93-003).

The water quality data will be compared to ecotoxicological bench mark values in the "Gold Book" (EPA# 440/5-86-001) and Aquatic Toxicity Information Retrieval Database (AQUIRE). This comparison will help determine if the water quality parameters are within established criteria to protect aquatic life.

Quality Assurance and Quality Control Plan

The Quality Assurance and Quality Control Plan (QAQCP) will include field documentation, instrument calibration and additional sample analysis to assess precision and accuracy.

The positions of the sampling stations will be taken with a Rockwell Precise Positioning System unit (PPS). The PPS unit decodes the Department of Defence selective availability error with the satellite signals.

The water quality meter will be calibrated when drift occurs or every four months. The meter is calibrated with chemical standards using procedures from the manufacturer.

Field samples for the QAQCP will include randomly selected samples for chemical analysis. The QAQCP samples will include splitting water samples from three sampling stations for herbicide and nutrient analysis. The QAQCP samples will include three distilled water rinse blanks from the sampler bottle for herbicide and nutrient analysis. Three water samples for the inexpensive Enzyme-Linked Immunosorbent Assay (ELISA) herbicide analysis will also be analyzed by high-pressure-liquid-chromatography.

Three sample duplicates, high and low standards for the nitrate and ammonia ion selective electrode analysis or for HACH kit analysis will be submitted to the contract laboratory to validate field procedures.

Cost Structure per Year

Analyte	Total Number[1]	Cost per Test	Total Cost
Ammonia	124[1]	$15	$1860
Nitrate	124[1]	$15	$1860
Phosphates	124[1]	$15	$1860
Major ions	36[2]	$30	$1080
ELISA test	148[3]	$45	$6660
Herbicide "A"	24[4]	$150	$3600
Herbicide "B"	24[4]	$150	$3600
QAQCP	9	$90	$ 810
Total			$21,330

9 monthly sampling times + 6 weekly sampling times X 8 stations 120 (+ 4 USGS sampling times X 1 station) = 124 samples

2 4 USGS sampling times X 9 stations = 36 samples

3 Same as [1]above + [4]below = 148 samples

4 2 sampling times (May & June) X 12 sampling points = 24 samples

Appendix B

U.S. Geological Survey
Sediment Transport and Water Budget Study

Proposal for Hydrologic Study

Hydrologic Investigation at Union Slough National Wildlife Refuge, Kossuth County, Iowa

Background

Union Slough National Wildlife Refuge was created in the early 1940's with man-made control structures to establish a waterfowl nesting and habitat area. Wetlands are associated with the slough, which is approximately 9 miles long and covers an area of about 2845 acres. The slough watershed is about 18,000 acres and tile drainage systems also discharge into the slough. Control features in the middle areas of the slough regulate drainage and water flows both north and south out of the slough. The boundary of the slough consists of mostly row crops.

Sedimentation of the slough is diminishing the wetlands area and may be causing a deficiency in the waterfowl nesting and habitat. In response to the waterfowl nesting and habitat deficiency, the U.S. Fish and Wildlife Service (USFWS) is beginning a water-quality and land-use study to develop a refuge restoration protection plan.

Purpose and Objectives

The purpose of the proposed study is to evaluate the present hydrologic conditions of the Union Slough National Wildlife Refuge. Specific objectives of the study are to:

(1) determine the amount of water, sediment, and selected chemical constituents discharging from six selected study areas, and

(2) estimate a range for water residence time in selected areas of the slough.

Benefits of the Study

Knowledge of the water discharge, sediment and agrichemical inputs to selected areas, and water residence time will provide useful in managing specific areas of Union Slough Refuge for soil loss and water quality. The water discharge measurements and sediment load portion of the study will aid in identification of primary water and sediment source areas. By incorporating water-quality sampling with the discharge measurements, the load or mass of agrichemicals discharging from a given area of the slough can be calculated for a selected time. The water residence time in the slough may be useful in estimating the length of time a mass of water with large concentrations agrichemicals could remain in the slough and affect the ecosystem.

Approach

In order to determine the water discharge and sediment and selected chemical constituent loads in selected areas of the slough, six sites shown in figure 1 will be used to measure discharge and collect sediment and water samples. Reconnaissance of the proposed sites is necessary to insure suitability for measuring discharge and collecting sediment. The six discharge measurement and sediment collection sites divide the slough into six areas of study (fig. 1). Three of the study areas lie to the north of the Smith Pool divide and the remaining three areas to the south. For each of the study areas, the water discharge and suspended sediment load in the water will be determined. Selected chemical constituent data provided by the USFWS will be used with discharge data to compute loads for selected constituents. Combining data from the six study areas will allow differences in water discharge and sediment and selected chemical constituent loads between the selected study areas to be determined. The U.S. Geological Survey (USGS) data base will be searched for information on ground-water wells in the vicinity of the slough to describe the hydrogeology.

Discharge measurements and sediment collection by the USGS will occur and coincide with USFWS water-quality sample collection in May and July. Since sediment load, relative percentages of water input, and agrichemical runoff amounts potentially differ between normal and high flows, one discharge measurement and sediment collection will occur during or shortly after a rainfall event. An event of about 1 inch in late May or June, shortly after agrichemical application, is preferred and should be coordinated with USFWS water-quality sampling. After evaluation of data by USGS and USFWS personnel, if further data collection is necessary and water flow is adequate, one more discharge measurement and sediment collection will coincide with USFWS water-quality sampling in August or September.

Dividing the discharge by the volume of the water in the slough will provide a residence time estimate for water in the slough. Residence times for both water flowing to the north and south of the divide will be estimated. The volume of water in the slough will be calculated using the area of the slough for a given water level using Geographical Information System (GIS) coverages and an average depth to the slough bottom. In May or June a boat or canoe and a surveying measuring staff will be used to measure depth. The measured data will be entered into a GIS data base and a volume for the given water level will be calculated. A range of water residence time estimates can be calculated assuming a uniform movement of the water mass (piston flow).

Deliverables and Timeframe

Table 1 shows a project schedule for USGS personnel. A reconnaissance of Union Slough will introduce USGS field personnel to the study area as well as make sure proposed discharge measurement and sediment sample collection locations are suitable. Regularly scheduled discharge measurements and sediment collections will occur in May and July and, if appropriate, in August or September. One high flow discharge measurement and sediment sampling will occur in late May or June, preferably after a significant rainfall. All discharge measurements will be accompanied by sediment collection and coordinated with USFWS water-quality sampling, if possible. In May or June the depth to slough bottom from the water surface will be measured. All collected data will be analyzed and the estimated water discharge, sediment and selected chemical constituent loads, and slough water residence time for selected areas of the slough will be documented in a letter report that will be delivered to USFWS in December, 1995.

Budget

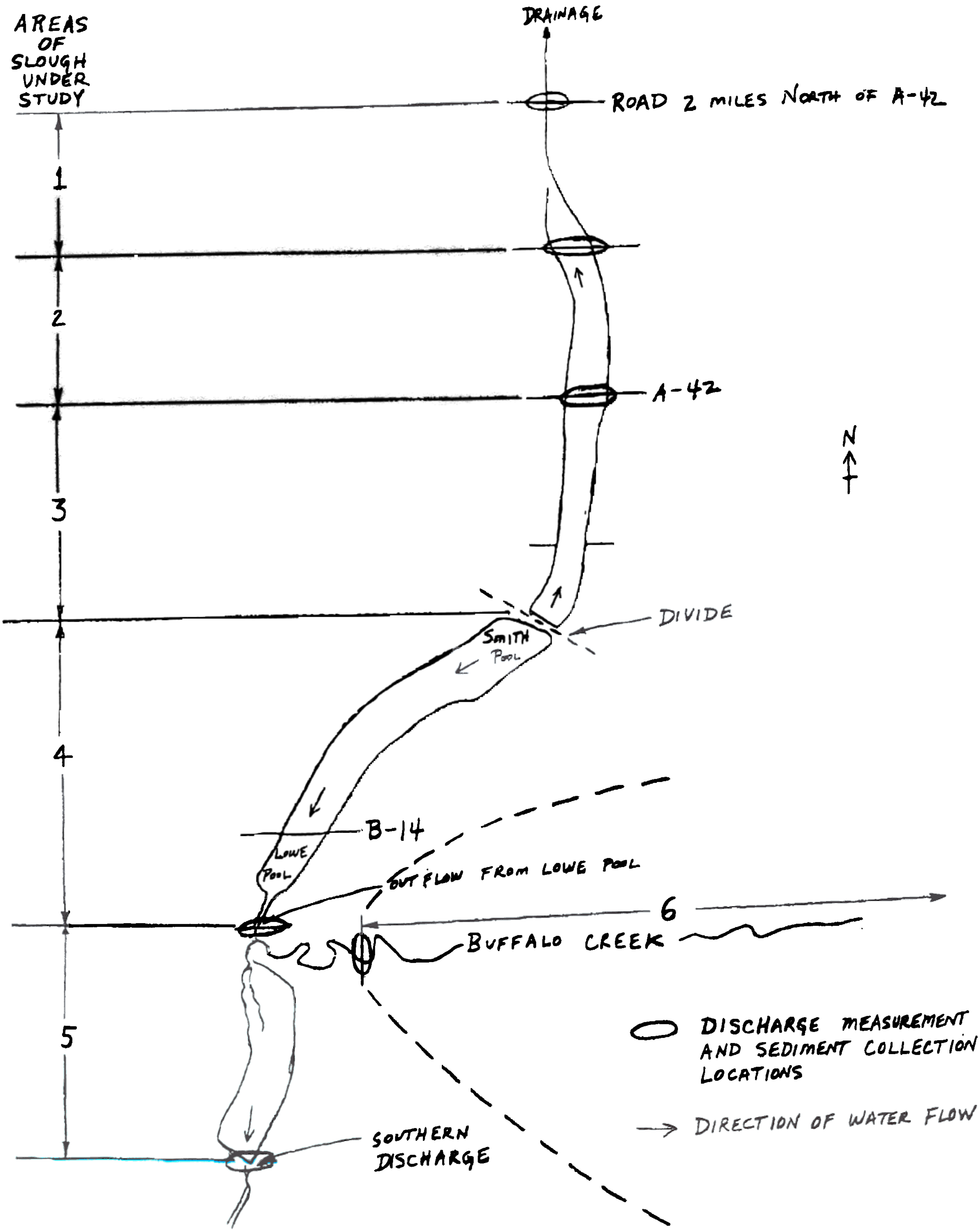
	FY 95	FY 96	Total
STAFFING			
- 2 Hydrologic Technicians (Field Work)	7,250	0	7,250
- Hydrologist (field work, prj. mgt., data analysis, report)	8,000	7,000	15,000
- GIS Support	250	500	750
EXPENSES			
- Travel	400	0	400
- Vehicles	400	0	400
- Sediment Analysis	1200	0	1,200
TOTAL	17,500	7,500	25,000

Table ion Slough ational Wildlife Refuge Project Schedule

Activity	Task	FY95 O	N	D	J	F	M	A	M	J	J	A	S	FY96 O	N	D	J	F	M	A	M	J	J	A	S	FY97 O	N	D	J
1. Field Work	1. Reconnaissance							■																					
	2. Depth Measurements								■	■																			
	3. High-Flow Discharge								■	■																			
	Measurement																												
	4. Normal Stage Discharge								■		■		■																
	Measurements																												
	5. Sediment Collection								■	■	■		■																
2. Data Analysis	1. Water Discharge											■	■	■															
	2. Sediment and Selected											■	■	■															
	Chemical Constituent Loads											■	■	■															
	3. Water Residence Time											■	■	■															
3. Reports/Letters	1. Letter Report													■	■	■													

Project: Union Slough National Wildlife Refuge | Project Leader: Matthew [illegible] | Revision Date: 03-31-95

Fig. 1 Proposed Discharge Measurement and Sediment Collection Locations



Enclosure B

Water Quality Work Plan
Union Slough National Wildlife Refuge
DRAFT Version 2 - 1995 & 1996 Field Seasons

by Mike Coffey, Rock Island Field Office,
Rock Island, IL

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Atrazine	ELISA	
Metolachlor	ELISA	
Major ions[2]	ICP[3]	Nitric acid

Enzyme-Linked Immunosorbent Assay
[2] Calcium, magnesium and potassium
[3] Induced Coupled Plasma Emission Spectroscopy

A field data sheet will be completed at time of sampling. The information for the data sheet includes weather, days since last storm event, flow direction, water and substrate conditions (*ie.* aquatic plant blooms, muddy water, etc.).

Periodic Screening at Inlets

About a dozen primary water inlet points to refuge will be screened for water chemistry in March, May, June, September. The inlets were selected by resource managers and contaminant specialists because they represent the important sources of water for the refuge wetlands.

These months were selected because two of the months correspond to the schedule for the U.S. Geological Survey study (May and September) and all four months represent the most likely maximum discharge times for agricultural chemicals and nitrates.

A single grab sample will be collected from the outfall effluent and series of grab samples along the length of the ditch inlets. Selected samples will be analyzed for herbicides listed in the CDAP in addition to those used for soybean production. Local agricultural businesses will provide information on the popular brands of pre-emergent and post-emergent herbicides used for soybean production in the watershed (*eg.* Prowl, Pursuit, Pinnacle and Treflan). The selection of water samples for herbicide analysis will be based on crop rotation schemes and the size of the drainage area for each refuge inlet.

All of the water samples from the refuge inlets will be analyzed for nitrates. All of the water samples from the ditches leading from confined livestock operations will be analyzed for nitrates and ammonia.

Solomat® meter readings and water depth will be collected at the inlet sampling stations as mentioned above.

Data Analysis

Graphical and Geographical Information Systems (GIS) procedures will be used to illustrate when, where and at what concentrations contaminants enter and flow through the refuge.

The analytical data analyses will also include a combination of descriptive procedures and tests for differences between distributions or means.

Additional guidance for the statistical analysis of the water chemistry data may be found in the U.S. Environmental Protection Agency's publication entitled Statistical Methods for the Analysis of Lake Water Quality Trends (EPA# 841-R-93-003).

The water quality data will be compared to ecotoxicological bench mark values in the "Gold Book" (EPA# 440/5-86-001) and Aquatic Toxicity Information Retrieval Database (AQUIRE). This comparison will help determine if the water quality parameters are within established criteria to protect aquatic life.

Quality Assurance and Quality Control Plan

The Quality Assurance and Quality Control Plan (QAQCP) will include field documentation, instrument calibration and additional sample analysis to assess precision and accuracy.

The positions of the sampling stations will be taken with a Rockwell Precise Positioning System unit (PPS). The PPS unit decodes the Department of Defence selective availability error with the satellite signals.

The water quality meter will be calibrated when drift occurs or every four months. The meter is calibrated with chemical standards using procedures from the manufacturer.

Field samples for the QAQCP will include randomly selected samples for chemical analysis. The QAQCP samples will include splitting water samples from three sampling stations for herbicide and nutrient analysis. The QAQCP samples will include three distilled water rinse blanks from the sampler bottle for herbicide and nutrient analysis. Three water samples for the inexpensive Enzyme-Linked Immunosorbent Assay (ELISA) herbicide analysis will also be analyzed by high-pressure-liquid-chromatography.

Three sample duplicates, high and low standards for the nitrate and ammonia ion selective electrode analysis or for HACH kit analysis will be submitted to the contract laboratory to validate field procedures.

Cost Structure per Year

Analyte	Total Number[1]	Cost per Test	Total Cost
Ammonia	124[1]	$15	$1860
Nitrate	124[1]	$15	$1860
Phosphates	124[1]	$15	$1860
Major ions	36[2]	$30	$1080
ELISA test	148[3]	$45	$6660
Herbicide "A"	24[4]	$150	$3600
Herbicide "B"	24[4]	$150	$3600
QAQCP	9	$90	$ 810
Total			$21,330

1 9 monthly sampling times + 6 weekly sampling times X 8 stations = 120 (+ 4 USGS sampling times X 1 station) = 124 samples

2 4 USGS sampling times X 9 stations = 36 samples

3 Same as [1]above + [4]below = 148 samples

4 2 sampling times (May & June) X 12 sampling points = 24 samples

Appendix C

Refuge Special Use Permit

DRAFT

Special Use Permit and Agreement

Union Slough National Wildlife Refuge
William Goche (Primary Permittee)

Off-Site Agricultural Drainage

BACKGROUND

This permit is issued as a result of an Application for Secondary Use Permit for off-site agricultural drainage submitted to the Union Slough National Wildlife Refuge in August 1994. On November 1, 1994, U.S.F. & W. issued preliminary written approval for the Secondary Use Permit. During the period of time since the issuance of the preliminary approval letter, the Applicant, his attorney, the Refuge Manager and other U.S.F. & W.S. personnel have had meetings and discussions and exchanged information regarding the proposed contents and requirements of this Permit. As part of this process, an Environmental Assessment and Compatibility Determination have been prepared and approved by the U.S.F & W.S.

This permit is a direct result, encompasses and includes all of the information and data which has been produced through the foregoing process. Accordingly, all of the foregoing documents are to be considered part of this permit as if they were fully set out herein.

PURPOSE

The purpose of this permit is:

To permit and allow the Permittee and their agents, heirs, successors and assigns the privilege to construct and maintain an off-site subsurface agricultural drainage system with its outlet in the Union Slough National Wildlife Refuge in accordance with the following general terms and conditions:

A portion of the water drained through the drainage system will pass through an artificially created ~~woodland~~ wetland designed to serve as a pesticide and nitrogen sink.

The water draining through the system, as monitored at the outflow of the constructed woodland shall not contain agricultural chemicals, fertilizers, pesticides, insecticides, or fungicides at levels which will cause harm to any component of the refuge ecosystem.

The U.S.F. & W. is granted certain privileges to monitor and sample the inflow and outflow of the drainage water through the artificial wetland.

The application of agricultural chemicals, fertilizers and pesticides within the drainageshed served by the drainage system will be made in accordance with established plans and, if necessary, in accordance with a professionally prepared integrated crop management plan.

The U.S.F. & W. will be provided with detailed information regarding farm chemical, fertilizer, and pesticide application in the drainageshed by the Permittee, his heirs, successors and assigns.

GRANT OF PERMIT -- LICENSE

Subject to the terms, conditions and requirements to be fully set forth below, U.S.F. & W. hereby grants unto William Goche, Mary Goche, William Ford, and Richard Goche, the present owners of the land located within the drainageshed described by the survey identified as "Map 2" in the Application for Secondary Use Permit [hereinafter "drainageshed"], their agents, heirs, successors and assigns, a Permit and License to construct and maintain a subsurface agricultural drainage tile system with its outlet in the Union Slough National Wildlife Refuge.

CONSTRUCTION OF SYSTEM

The drainage tile system permitted herein shall be constructed in accordance with "Proposed Drainage Plan B., Alternative 2 -- Construction of a System Utilizing Drainage Tile and a Constructed Wetland as a Filtration Device" as is contained in the Application for Secondary Use Permit. "Illustration 5" referred to in said section shall be modified by this Agreement and Permit in accordance with the construction diagram attached hereto as "Exhibit A" which by this reference is made part hereof.

The parties hereto specifically recognize that the drainage tile system described herein will be constructed during the summer and fall of 1995. The System will not, however, become operational until the constructed wetland is completed in the Spring of 1996. Further, it is recognized by the parties hereto that the constructed wetland will not necessarily provide optimal filtration and sink services during the 1996 crop year.

RECIPROCAL GRANT OF PERMIT -- LICENSE

Subject to the terms, conditions and requirements to be fully set forth below, William Goche and Mary Goche, their agents, heirs, successors and assigns, hereby grant unto the U.S.F. & W.S., a Permit and License to conduct research, monitor and sample water and vegetation at the constructed wetland filtration device. This permit and license shall include rights of ingress and egress to and from the constructed wetland over and across the land of William and Mary Goche.

MONITORING AND SAMPLING

The Primary Permittee shall construct the wetland with a test pipe located in the tile outflowing from the wetland. This test pipe shall be the location at which monitoring and sampling by U.S.F. & W.S. personnel shall be made for drainage discharge standard purposes. U.S.F. & W.S. personnel shall also be permitted to monitor and sample water in the constructed wetland for purposes of comparison to the discharge standard sampling.

REQUIRED AGRICULTURAL PRACTICES -- FARM MANAGEMENT

For the duration of this Agreement, including all renewals and extensions, all of the land located within the drainageshed shall be farmed or managed only in the manner as may be permitted by this section or any amendments hereto.

The primary goals and objectives of this section are twofold: to minimize or eliminate concentrations of agricultural chemicals, fertilizers, pesticides, insecticides or fungicides which may be contained in the drainage water and which may be harmful to the Union Slough National Wildlife Refuge ecosystem while at the same time allowing for farming and management practices within the drainageshed which will provide for a reasonable investment backed return.

In furthering these goals and objectives the U.S.F. & W.S. hereby encourages the use of non-persistent herbicides which have been, or may be pre-approved by the U.S.F. & W.S., for use on its Refuges. Only in very limited circumstances to be set forth below, shall the U.S.F. & W.S. ever mandatorily require the use of the pre-approved herbicides in the drainageshed.

Initially, in Crop Years 1996 and 1997, the Permittee(s) shall be permitted to farm and manage the drainageshed in the manner generally described as "Proposed Management Plan, A., Alternative A - Farm Management Using the Pesticide Potential Loss to Leaching Matrix." Changes from the chemicals, pesticides and herbicides therein described shall be permitted when the chemicals, pesticides or herbicides to be used are generally promoted or advertised as being environmentally friendly. Application of fertilizers during the crop year 1996 shall be made at rates which may be dictated by the results of soil testing.

The results of the sampling and monitoring of the drainage water passing through the constructed wetland in 1997 shall be used to determine the farming and management practices for all subsequent crop years.

If the results of the 1997 monitoring and sampling show discharges in excess of the discharge standards (to be established in the following section), but less than two times the discharge standard (for any chemical, fertilizer, herbicide or pesticide), the permittee shall be allowed to modify their farming and management practices on their own for the 1998 crop year. The modifications shall be designed to eliminate the discharges which may be in excess of the standards. If, after the 1998 crop year, the results of 1998 monitoring and sampling show any discharges in excess of the discharge standards, the future farming and management practices in the drainageshed shall be directed by the recommendations of a professional integrated crop management specialist.

If the results of the 1997 monitoring and sampling show discharges in excess of twice the discharge standard, future farming and management practices in the drainageshed shall be directed by the recommendations of an integrated crop management specialist.

The integrated crop management specialist shall be provided with a copy of this permit and the discharge standards and goals herein. The crop management plan produced by the specialist shall be designed to meet the discharge standards and goals. During the first crop year in which an integrated crop management specialist may be used, the choice and application of chemicals, fertilizers, pesticides and herbicides shall be made by the specialist from all available products. If, during a year in which integrated crop management is used, the results of monitoring and sampling show discharges of herbicides (only) in excess of the discharge standards, the integrated crop management specialist shall use only Refuge pre-approved herbicides for the following year.

This section may be modified in writing by the parties at any time during the life of this agreement.

AVERAGE ANNUALIZED DRAINAGE DISCHARGE STANDARDS AND GOALS

The U.S.F & W.S. has identified the following agricultural drainage contaminants which are of specific concern to the Refuge as they relate to this permit:

Nutrients -- Ammonia; Phosphates; Nitrates.

Herbicides -- All products.

Insecticides -- All products.

Fungicides -- All products.

With the assistance of U.S.F. & W.S. water quality and contaminant personnel, Average Annualized Discharge Standards for each of the foregoing contaminants have been established.

goals or criteria

CONTAMINANT	AVERAGE ANNUALIZED MAXIMUM DISCHARGE STANDARD[2]	REASON FOR LEVEL OF STANDARD
Ammonia	0.5 PPM[1]	Established Water Quality Standard
Phosphates	.05 PPM	Established Water Quality Standard
Nitrates	1 PPM yearly X of ppm	Natural Background Concentration
Herbicides	Determined by LC_{50} data available in recent scientific literature	
Insecticides	~~0.0~~ (No discharge permitted) unless first consulted	United States Fish & Wildlife Service considers all insecticides as biocides
Fungicides	~~0.0~~ (No discharge permitted)	United States Fish & Wildlife Service considers all fungicides as biocides

[1] Parts per million

[2] Initial criteria ~~will use 1 PPM~~ recognizes that fluctuations will occur due to changing efficiency of the constructed wetland. This standard may be subject to review and change. pending

The foregoing average annualized standards represent maximum permitted levels of discharge as may be sampled or monitored at the test pipe. The average annualized method of determining levels of discharge shall require sampling and monitoring of the discharge from the wetland at least three times per year. The monitoring or sampling for each chemical, fertilizer, herbicide, pesticide shall first occur within two weeks of application. The two additional samples or monitoring shall then occur three months and six months, respectively, after the initial sampling or monitoring. The three sampling or monitoring results shall then be averaged and the result shall be considered the average annualized standard.

The standards established by this section are those to be used in conjunction with the Section entitled "Required Agricultural Practices -- Farm Management" and the Section entitled "Duration of Permits and Licenses."

This section may be modified in writing by the parties at any time during the life of this agreement.

PROVISION OF INFORMATION

Prior to March 1st of every year this Permit and Agreement is in force and effect, the Primary Permittee shall provide the U.S.F. & W.S. with a list of all chemicals, fertilizers, herbicides and pesticides and estimated rates of application in the drainageshed for the coming crop year. The list shall be accompanied by a sketches or drawings depicting the locations of the various crops which

050. • 0

10 ppb atrazine
10 ppb alachlor

will be planted in the drainageshed as well as a listing of the chemicals, fertilizers, herbicides and pesticides which will be applied to each crop.

Within two days before, or on the day of application of any chemical, fertilizer, herbicide or pesticide, the Primary Permittee shall further provide the U.S.F. & W.S. with a confirmation of the application including the rate and location applied.

The provision of information required by this section is to be used by the U.S.F. & W.S. for monitoring, sampling and study purposes.

RECORDING OF ABSTRACT OF PERMIT

Upon its execution, the Primary Permittee shall cause an abstract of this document to be recorded in the Office of the Kossuth County Recorder. Said abstract shall describe the property located in the drainageshed.

DURATION OF PERMITS -- LICENSES

Unless terminated by other provisions of this agreement, or by separate mutual agreement of the parties hereto, the Permits and Licenses granted herein shall run for a five year period commencing on March 1, 1996 and ending on February 28, 2001. The Permits and licenses herein shall automatically be renewed for like periods of time provided all of the other terms and conditions of this Agreement are then being met.

If, at the expiration of any five year permit period, the conditions of this permit are not then being met, the U.S.F. & W.S. shall notify the Primary Permittee, his agent, heirs, successors or assigns of the noncompliance in writing at least forty-five (45) days prior to the expiration of the five year term. Such notification shall clearly state the section or sections of this agreement which are not being complied with by the permittee(s).

In the case where such a notice of noncompliance is prepared and served on the Primary Permittee by the U.S.F & W.S., the Permits and Licenses herein granted shall automatically be renewed for a period of only one year. During said one year period, the Permittee(s) shall work with the U.S.F & W.S., to achieve compliance.

If compliance is achieved during the one year period, the agreement shall automatically renew for an additional five year period in the manner previously stated. If compliance is not achieved during the one year period, the U.S.F. & W.S. shall again cause the written notice of noncompliance to be served or delivered upon the Primary Permittee in the same manner and at the same time as is previously stated. Upon the service or delivery of the notice of noncompliance at the end of the one year period, this Agreement and the Permits and Licenses herein granted shall terminate and become of no force or effect.

FEES

The fee for the Permits and Licenses granted herein shall be $50.00 per year for the first five years. Thereafter, the fees charged for the Permits and Licenses herein shall be established by the U.S.F. & W.S. for the next one year or five year period (See Permit Duration Section) at the time this agreement is renewed and extended. The future yearly fees to be charged for the next period of renewal or extension shall be in equal amounts. The maximum increase in fees from the previously set yearly fees to the newly set yearly fees shall be no greater than the inflation rate over the previous five year period.

The payments required hereunder shall be payable on a yearly basis on or before the 1st day of March in each year.

GOVERNING LAW

This Agreement and the Permits and Licenses granted herein shall be governed by the laws of the United States and the laws of the State of Iowa, where not preempted by the laws of the United States.

____
William Goche, Primary Permittee

____
Mary Goche

____
Richard Goche

____
William Ford

Enclosure D

Standard Operating Procedure for the Determination of Cholinesterase Activity in Bluegill (*Lepomis macrochirus*) Brain Tissue

I. Introduction - Justification

Cholinesterase activity is a measure of the amount/effectiveness of cholinesterase in tissues. Cholinesterase is an essential enzyme in the central and peripheral nervous systems, which hydrolyzes acetylcholine, a primary neuro-transmitter. The determination of cholinesterase activity can be used as a biomarker to determine if organisms have been exposed to organophosphorus, or carbamate insecticides, since both types of insecticides primary mode of action is the inhibition of cholinesterase activiy.

A spectrophotometric assay using a plate reader will be used to determine cholinesterase (ChE) activity in fish brain tissue (Ellman et al. 1961; Hill and Fleming 1982; Corvallis Environmental Research Laboratory 1987; The Institute for Wildlife and Environmental Toxicology 1991). ChE activity is determined from the result of two reactions occurring in the assay solution: acetylthiocholine hydrolysis and the nucleophilic attack by the reagent. The assay solution consists of a portion of the brain sample (ChE enzyme), acetylthiocholine (ATCH substrate), and 5,5-dithiobis(2-nitrobenzoic acid) (DTNB reagent).

ATCH is an analogue of the natural ChE substrate, acetylcholine and the analogue has a sulfur atom which replaces the esteric oxygen of acetylcholine. The first reaction is the hydrolysis of ATCH by ChE which proceeds at the same rate as ChE hydrolysis of acetylcholine. Hydrolysis of ATCH results in the formation of a negatively charged thiocholine complex and an acetate ion.

The second reaction is the nucleophilic attack of the thiocholine complex on DTNB, generating a stable, yellow-colored anion (5-thio-2-nitrobenzoate) which absorbs light strongly at 412 nm. For every molecule of ATCH hydrolyzed, approximately one molecule of the anion is generated. The rate of formation of the yellow-colored anion can be measured and subsequent calculations can determine the ChE activity for the sample.

II. Materials

A. Chemicals

1. Acetylthiocholine iodide (ATCH)
2. 5,5-dithiobis-2-nitrobenzoic acid (DTNB)
3. Sodium bicarbonate
4. Trizma 7.4 pH pre-set crystals
5. Trizma 8.0 pH pre-set crystals
6. 1.0 N HCl
7. 1.0 N NaOH

B. Equipment

1. Spectrophotometer: e.g., automated kinetic microplate reader, Molecular Devices Corporation, Thermo max interfaced with a desk top computer (e.g. Zenith z-386/20) loaded with appropriate software package to run spectrophotometer (e.g. Softmax).

2. Constant temperature water bath set a 25°C.

3. Ice bucket and/or ice chest.

4. Crushed ice.

5. Disposable test tubes (13x100 mm).

6. Multi-aliquot, variable volume pipette (e.g., Eppendorf Combitip Pipette) with disposable tips 10 µl, 50 µl, 100 µl and 1000 µl (e.g., Eppendorf Combitips).

7. Single aliquot, variable volume pipette, 10-1000 µl range, with disposable tips.

8. Vortex mixer

9. Magnetic stirrer and stir bars

10. pH meter and standards

11. 96 multi-well microplates, e.g., Dynatech Microtiter.

12. Analytical balance.

13. Volumetric flasks, 5-50 ml and 1000 ml.

14. Weigh boats, glass and plastic.

III. Preparation of buffers, reagents and substrate.

Nanopure or distilled water is used to mix solutions. Bottles containing solutions are labeled with chemical name, date, and preparer's name. Solutions are prepared according to the following procedures:

Trizma 7.4 pH buffer solution

1. Weigh 7.58g Trizma 7.4 pre-set crystals in a glass weigh boat and transfer to a 1-liter volumetric flask.

2. Make a complete transfer of chemical by rinsing the weigh boat with water.

3. Add water until the volumetric flask is approximately 1/3 full and shake until buffer is dissolved.

4. Bring the volumetric flask to volume.

5. Check pH and adjust to pH 7.4 with HCl or NaOH.

6. Pour buffer solution into a labeled bottle and store in the refrigerator (4°C). Buffer solution will be good for one week.

Trizma 8.0 pH buffer solution

1. Weigh 8.02g Trizma 8.0 pre-set crystals in a glass weigh boat and transfer to a 1-liter volumetric flask.

2. Make a complete transfer of chemical by rinsing the weigh boat with water

3. Add water until the volumetric flask is approximately 1/3 full and shake until buffer is dissolved.

4. Bring the volumentric flask to volume.

5. Check pH and adjust to pH 8.0 with HCl or NaOH.

6. Pour buffer soution into a labeled bottle and store in the refrigerator (4°C). Buffer solution will be good for one week.

ATCH substrate

1. Weigh 0.4512g ATCH in a glass weigh boat and transfer to a 10 ml volumetric flask (make a complete transfer).

2. Fill the flask approximately 1/2 full and mix until ATCH is dissolved.

3. Bring the flask to volume.

4. Transfer to a labeled amber bottle and store in the refrigerator (4°C). Substrate solution will be good for 3 days.

DTNB reagent

1. Measure 50 mL of 7.4 trizma buffer solution in a graduated cylinder.

2. Weigh 0.198g of DTNB in a glass weigh boat and transfer to a labeled amber bottle.

3. Make a complete transfer using part of the measured buffer solution.

4. Weigh 0.075g sodium bicarbonate in a glass weigh boat and transfer to the same amber bottle. Again, make a complete transfer using part of the measured buffer solution.

5. Add the remaining buffer solution to the bottle and mix until dissolved. Store in the regrigerator (4°C). Solution will be good for 3 days.

IV. **Analysis procedure:**

1. Turn on ice machine and water bath $\geq$ 1 h prior to analysis.

2. Place appropriate volume of Trizma 8 pH buffer in water bath. If Trizma is cold (4°C) allow appropriate time in water bath for it to come to temperature (25°C).

3. Turn on the spectrophotometer (Thermo Max) and control computer. Run the controling software (double click the Softmax icon). Turn the incubator on and set the temperature to 25° C under the control heading. Open the appropriate file (bgche) with the analysis parameters as listed below.

A. wavelength: 405 nm
B. run time: 2:00 min
C. read interval; 7 s
D. OD limit: 0.500 OD
E. lag time: 0.00 s
F. auto mix ON

4. Remove check standards from liquid nitrogen freezer and place in ice to thaw.

5. Euthanize sample fish by severing the spinal column. Remove brain tissue by cutting away the top of the skull, severing the optic nerves and then lifting out the tissue. Keep the brain tissue in iced pH 7.4 Trizma buffer until analysis. Homogenize tissue in pH 7.4 Trizma buffer with a motorized teflon pestle and glass tube. Dilute tissue homogenate using Trizma 7.4 pH to an activity appropriate for the spectrophotometer (usually 200-fold). Record the fish size data on form #1 and the weights of the brain tissue and appropriate dilutions on form #2.

6. Prepare cholinesterase assay plate reader set-up form (#3) indicating the positions of the various samples and check standards and their respective dilution factors.

7. Mark microplate to indicate where particular samples will be placed.

8. Pipette appropriate amounts of reagent into each well for each determination to be performed. Place the DTNB and ATCH on ice next to the analysis station. All samples should be assayed in triplicate.

Volumes of reagents for the various wells are as follows (in μl):

	Blank	ChE
Trizma 8.0 pH	200	170
DTNB	20	20
Enzyme	0	30
ATCH	30	30

9. Add compounds to wells in the order shown in the table. Once the ATCH is added the reaction begins. Immediately select read under the control heading in the software. The drawer will then open for a few seconds to allow for locking of the plate into place.

10. After the analysis is complete, type in comments on the data screen and save the file under an appropriate name. Print off a hardcopy of the file.

 Check the data for any signs of error. Samples with a coefficient of variance (CV) greater then 10 % should be rerun. Also check if the check standards are in control.

 Convert mOD output units into international units of enzyme activity using the following equation:

(((enzyme mOD/min)-(blank mOD/min))/1000) x 0.817 x dilution factor = (μmoles ATCH hydrolyzed/min) / gram tissue.

The above equation is derived from Ellman et al. (1961).

REFERENCES

Corvallis Environmental Research Laboratory. 1987. Cholinesterase determination procedure. Wildlife Toxicology Team SOP No. 5.5.1. U.S. EPA, Corvallis, OR. 17 pp.

Ellman, G.L., K.D. Courtney, V. Andres, Jr., and R.M. Featherstone. 1961. A new and rapid colorimetric determination of acetylcholinesterase activity. Biochem. Pharmacol. 7:88-95.

Hill, E.F., and W.J. Fleming. 1982. Anticholinesterase poisoning of birds: field monitoring and diagnosis of acute poisoning. Environ. Toxicol. Chem. 1:27-38.

The Institute for Wildlife and Environmental Toxicology. 1991 Cholinesterase activity determination procedure. SOP No. 202-06-03. TIWET, Clemson, SC. 7pp.

Form No. 1

CHOLINESTERASE ASSAY FISH SIZE DATA SHEET

Date:____________
Study:____________
Species:

Id. Number	Length (mm)	Mass (g to 10^{-1})	Id. Number	Length (mm)	Mass (g to 10^{-1})

Initials:

Form No. 2

CHOLINESTERASE ASSAY TISSUE PREPARATION DATA SHEET

Date:____________
Study:____________
Species:____________
Tissue:____________

Id. Number	[Vessel + sample + buffer] wt. (g)	Vessel wt. (g)	Sample wt. (g)	Dilution factor [d.f.] (fold - 1)	Buffer added [d.f. * sample wt.] (ml to 10^{-3})	Comments (i.e.dilution used, sample condition , etc.)

Initials:

NCRAC-ISU

Form No. 3

CHOLINESTERASE ASSAY PLATE READER SET-UP

Date:___________
Study:__________
Species:________
Tissue:_

	1	2	3	4	5	6	7	8	9	10	11	12
A												
B												
C												
D												
E												
F												
G												
H												

		Blank	Sample
Buffer	200 µl		
Buffer	150 µl		
Buffer	20 µl		
DTNB	20 µl	____	____
Enzyme	30 µl		
C. Standard	30 µl		
AThCh	30 µl	____	____

Initials:____________
Filename:___________
Comments:________________________

Enclosure E

NSCS Settles, Strains and Filters

by Bob Oertel, Contributing Writer

MUCH like a string of pearls, Long Lake in Northern Maine is the first gem in line, with Mud Lake next, then Cross, Square and finally Eagle. Water entering Long drains through each of these picturesque lakes in succession and eventually empties into St. John River, separating the U.S. from Canada.

Whatever happens to the water in Long Lake, either good or bad, sooner or later affects the recreation value of each lake downstream.

Several years ago, a heavy algea bloom severely threatened water quality in Long, prompting local individuals and groups to form the "Fish River Chain of Lakes Water Quality Association". Joined by the St. John's Aroostoock Resource Conservation & Development Council (RC&D), the two organizations set out to imporve the quality of the water in the string of lakes, with particular attention going to Long and Cross.

Sportsmen, fishermen, campers, civic groups and individuals pitched in to do what they could to clean up the lakes. But, one more concern had to be addressed. That was the quality of the water draining off the surrounding land and into the lakes.

This concern led to the development by the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS), of a unique filtering system to clean up the runoff water. The patented system, the brainchild of Robert Wengrzynek, SCS biologist, Orono, Maine, is designed to remove plant nutrients and sediment remaining in the water that runs off farm land. It is called "Nutrient and Sediment Control System" (NSCS).

"NSCS combines the settling and straining abilities of wetlands with the accelerated biological filtering and breakdown principles of sewage treatment systems," explains Wengrzynek.

The effectiveness of the first five systems installed from 1988 to 1990 in Maine by the NRCS has been quite encouraging. Over 90 percent of total phosphorus and suspended solids were removed during all monitored storms in the spring, summer and fall.

Wengrzynek also says, "These systems have application for treatment of urban strom water and runoff from livestock concentration areas with little modification."

Watershed Largely Agricultural

About 9,600 acres of cropland (potatoes being the chief crop) shed waer into Long and Cross Lakes. Studies estimate that about 70% of the phosphorus carried by runoff water comes from agricultural land, 10-15% from road ditches, 10-15% from forests, 5-7% from sewage treatment plants, 2-4% from individual septic systems and up to 5% from new residential construction.

For years, NRCS has been helping landowners develop and apply conservation plans on most of the land. "This holds soil loss down to an acceptable minimum," says David Tingley, NRCS District Conservationist at Fort Kent. "These farmers are doing a good job protecting their soil base and going a long way towards helping water quality.

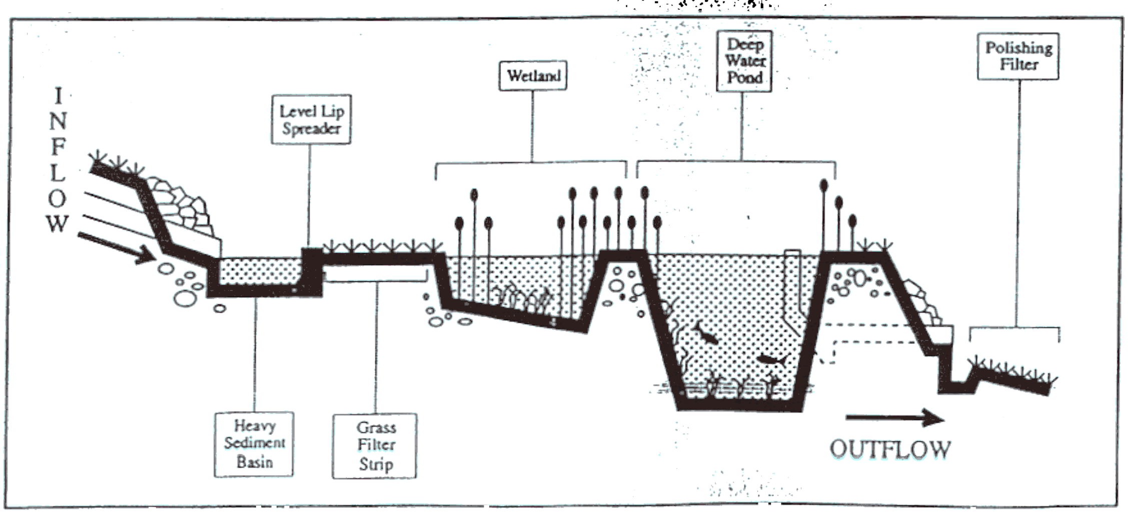
"But," Tingley continues, "despite all the practices that farmers apply, the water that finally leaves their land will still have some little residue of soil sediment, plant nutrients and possibly chemicals that were used to treat crops. NSCS is designed to remove these items that would otherwise become pollutants downstream."

The System Settles, Strains and Filters

NSCS are tailored to each specific site, however, each system contains general design standards and five basic components.

The systems are located at the edge of a farm, where runoff water is directed first into a heavy sediment basin, then progressively across a level grass filter strip, into a manmade wetland, into a deep water pond and finally across a polishing filter such as a wetland or a grassed or wooded area before entering into a natural lake or stream.

Heavier soil and organic matter sediments settle out in the first basin. Typically, these basins are about 50' to 60' long (across the slope) with an 8' bottom width and are 4' to 5' deep.



The basin is large enough to hold runoff from lighter rains. However, when runoff from heavier rains fills, and overflows, the basin, the water spills onto a level grass filter strip. Here, further settling and filtering of finer particles takes place as the water spreads across the grass.

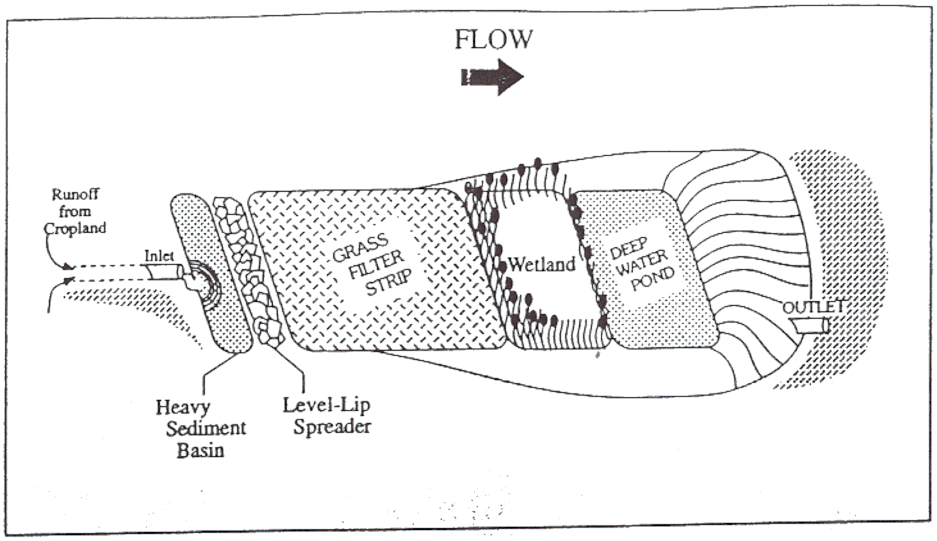
Next, the water enters a constructed

wetland where it moves slowly through a stand of cattails or other water-loving plants. Microorganisms thriving among the plant roots further remove nutrients and other pollutants.

Upon leaving the wetland, the water, and whatever sediments, nutrients or chemicals it is still carrying, enters a pond 8 to 12 feet deep. Stocked with freshwater mussels (filter feeders) and minnows that are native to the watershed, the pond is essentially a "living filter" that effectively removes remaining nutrients and fine sediments.

Each mussel filters about 10-12 gallons of water per day, according to Wengrzynek. "Having a dependable, clean and economic supply of freshwater mussels to stock in the pond," he says, "has added a dimension of biological treatment never considered before."

Rarely, and then only during extra heavy rain storms, does water ever drain from the pond. Whenever it does, it drains across the final "polishing" filter strip.



Footing the Bill

Construction costs of the NSCS have varied from $14,000 to $38,000, depending on the site of the installation, the size of the watershed and the amount of runoff to be treated.

The answer to the question "who pays for such systems?" leans heavily towards the question "who benefits?". The landowner, on whose land the systems are installed, has done all he can by applying appropriate conservation practices and following sound fertility and pest management practices.

Benefits from installing a NSCS to clean up the runoff accrue largely to others downstream who use or enjoy the water. Yet, some might say, "The farmer should pay because he is the one who causes the problem in the first place."

David Musselman, NRCS State Conservationist, Orono, Maine, says this question is best answered when all segments of the public willingly work together. "I am pleased to see how all have cooperated, and done what they could, to help clean up the lakes. We all enjoy clean water and are willing to do our part to make it that way."

The first major break in finding money to start installing NSCS's came when the Aroostock Soil and Water Conservation District obtained an $85,000 grant from the Maine State Soil and Water Commission. This is used to supplement a special water quality 75% cost share payment by the USDA Agricultural Stabilization and Conservation Service (ASCS).

"With these funds available," relates Tingley, "we looked around for the best possible locations for such systems and then contacted the landowners. Most are willing to give up the use of a few acres of land for the installation and agree to carry on minimum maintenance while the actual costs are paid by someone else. They do this as good citizens as their part in cleaning up the runoff water.

Since money for costsharing is limited, only one or two NSCS can be funded each year. Thus far, 10 have been built while 6 are planned in the next few years.

Tingley points out that not all runoff water from cropland has to be filtered. "With the number of systems already installed, plus the high priority ones being planned, we should be treating enough runoff to maintain an acceptable level of water quality in the lake. It would not be economical to pass all runoff through an NSCS."

Everyone Pleased

NSCS's are a proven conservation device that have removed 90% and more of sediment, nutrient and chemical pollutants from water running off farm lands. Improved and diverse wildlife habitat at the sites of the installations is another benefit from a NSCS. Black ducks and mallards have nested at all sites in Maine. Herons, bitterns and kingfishers feed on minnows and frogs in the ponds. Raccoon and mink eat aquatic life, thus harvesting nutrients.

Water from the NSCS ponds can sometimes be used as a water supply for livestock, fire protection, and chemical spray. In some cases, farmers can sell minnows for bait fish.

Certainly, the Fish River Chain of Lakes Water Quality Association is much encouraged by the successful removal of pollutants by NSCS. Although difficult to quantify, it is hoped that NSCS installations will reverse the long term deterioration of water quality in the lakes that reduces their attractiveness for recreation.

NSCS appears to be a practical and economic alternative for achieving maximum reduction of phosphorus and sediments in runoff water thus protecting aquatic resources. The system, with appropriate design changes, offers an effective method of removing nitrates, ammonia nitrogen, organic matter and bacteria as well as phosphorus and sediment. **L&W**

For more information, contact Robert Wengrzynek, NRCS, 5 Godfrey Drive, Orono, ME 04473, (207)866-7241. Or contact David Tingley, NRCS, 96 Market St., Fort Kent, ME 04743, (207)834-3311.

Everett Wilson
01/02/2003 10:32 AM

To: Frank Horvath/R3/FWS/DOI@FWS
cc: Kenneth Seeley/ARL/R9/FWS/DOI@FWS, Lynn M Lewis/R3/FWS/DOI@FWS
Subject: Re: Communications with DoD

Frank:

The guidance that has been given is that any FORMAL communication with DOD must go through the Asst. Secretary. We interpret formal communication to be letters stating Service and/or DOI positions on issues with DOD. No one seems to know what percipitated this issue or if it was just a general complaint from DOD. Clint Riley, is the person giving guidance on this issue, his pledge is to get the letters through the Asst. Secretaries Office as quickly as possible. I doubt that the Asst. Secretary or even our own Directorate have any idea how much communication the Regions and Field Offices have with DOD on these issues, but I am sure that they will quickly come to understand the volume.

Everett F. Wilson

Frank Horvath

Frank Horvath
01/02/2003 10:47 AM

To: Everett Wilson/ARL/R9/FWS/DOI@FWS, Kenneth Seeley/ARL/R9/FWS/DOI@FWS
cc: Lynn M Lewis/R3/FWS/DOI@FWS
Subject: Re: Communications with DoD

Ev, Ken - Do you have any better read on this issue than before the holidays? We have several field offices and an NPL: site which have become accustom to dealing directly with our DOD and DOA counterparts on heretofore local issues. If no clear guidance is likely within relevant timeframes (aka a timeframe in which we have an opportunity to get ourselves cross-wise with the DOI policy), do you have any words of wisdom about actions which would minimize the impacts of our foibles?

We have a ES Field Office Supervisor meeting coming up next week and this question will be raised then -- I would like to give them the best answer possible.

Thanks
Frank
----- Forwarded by Frank Horvath/R3/FWS/DOI on 01/02/2003 09:17 AM

Michael Coffey
12/26/2002 01:07 PM

To: Richard C Nelson/R3/FWS/DOI@FWS
cc: Frank Horvath/R3/FWS/DOI@FWS, Kevin de la Bruere/R3/FWS/DOI@FWS
Subject: Re: Communications with DoD

I have read thru all of the recent msgs on the subject. I did not walk away with clear instructions on how to proceed. I interpret that it is ok to continue business as usual in dealing with the USACOE for CERCLA clean up at Formerly Used Defense Sites (FUDS) and for water resource projects. I interpret that it is ok to deal directly with the Department of the Army (DoA) over Section 7 consultation and migratory bird issues. I understand that we should direct our communications with DoA over CERCLA issues through DOI (ie. Rick -> Lynn/Frank ->RD?). This leaves me with the following questions for our CERCLA related high DoD contact rate activities:

1) How should we proceed with the Savanna Army Depot, IL SMART Team participation? We are a charter member of the SMART Team which was formed to deal with CERCLA clean up issues and transfer property to NWRS. The Team is led by and contains many DoA types including staffers to Asst. Sec. of DoA. This typically involves e-mails, conference calls and meetings with little letterhead correspondences. Do we not communication with them except through letter via DOI?

2) We have two sites with heavy BTAG involvement directly with DoA (Rock Island Arsenal, IL and Iowa

Army Ammunition Plant, IA). Both sites have an ESA Section 7 driver and consultation component. Do we not communication with them except through letter via DOI?

Thanks,
Mike

DEC ID# 9730006 Walnut Creek NWR Investigation (3N19) IA

We still cannot offer a final report at this time. We attached some correspondence and related project status information for your information. Note, that the 1261 funding for this project was a cost share for a much larger investigation by the Iowa Geological Survey that was ultimately funded by the U.S. Environmental Protection Agency (USEPA). A final report will be issued to my understanding no later than next year. We ask for a variance in the performance scores as we wait for USEPA and the State to issue the final report. We plan to issue a letter report after the final USEPA report is available to the refuge manager with any relevant management recommendations.

3N 19

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RANKING CRITERIA FOR INVESTIGATION PROPOSALS*

TITLE: IA - Impacts of Improved Biotic Health, Walnut Creek NWR

A. APPLICABILITY OF MANAGEMENT ACTION OR SOLUTION	*Points are not additive* Select only 1 of 3 (15 Points Possible)	POINTS
	Direct (15 points) or	
	Indirect (10 points)	10
B. THREAT TO RESOURCE IS DOCUMENTED OR ONLY SUSPECTED	*Points are not additive* Select only 1 of 2 (20 points possible)	
	Documented (20 points) or	
	Suspected (15 points)	15
C. DETERMINATION OF IMPACTS TO SERVICE TRUST RESOURCES	*Points are additive* Score all four categories (20 points possible)	
	Biological Organization (1, 4, or 7 points)	7
	Biological Effects (1, 4, or 7 points)	7
	Pathway (0 or 3 points)	3
	Source (0 or 3 points)	3
D. REGIONAL PRIORITY	(20 Points Possible)	
	Regional Rank (0-20 points)	16
E. NATIONAL PRIORITIES (Scored by DEC)	*Points are additive* Score both categories (25 points possible)	
	Performance (3-15 points)	
	Partnerships (0-10 points)	
	GRAND TOTAL SCORE FOR PROPOSAL	[illegible]

*[illegible]

FY 1996 Contaminant Study Pre-Proposal

1 **STUDY TITLE**: IA-Impacts of improved biotic health of the watershed on Walnut Creek in Walnut Creek National Wildlife Refuge

2a **YEAR OF STUDY**: 2 of 5. 2b. **PROJECT CODE IDENTIFIER**: 3N19

3. **SUBMITTED BY**: Region 3, Rock Island Field Office

4. **PROPOSAL SUMMARY**:

Walnut Creek NWR, in central Iowa, is converting 8000 plus acres of agricultural land back to native prairie/savanna. We are offered a unique opportunity to monitor and assess water quality improvements in a stream and its tributaries as land use practices in the immediate area change drastically. In conjunction with a Section 319 monitoring study, currently being conducted by the Iowa Geological Survey Bureau, USGS and the refuge, we propose to continue to monitor changes in the biodiversity of the refuge, both aquatic and terrestrial, over a four year period. This proposal is a continuation of a study funded and initiated during FY95. The study will include tissue, water, sediment and soil samples for residue analysis to determine if a long term benefit may be observed during and immediately following a land use change. This project may be used to support the concept of ecosystem management on other refuges.

5 **PRINCIPAL INVESTIGATOR**: Tracy A. Copeland

6. **REFUGE (if applicable)**: Walnut Creek National Wildlife Refuge

7. **FUNDING REQUESTED**: 39,600.00 (Operational) + ____ (Analytical) 39,600.00 (Total)

8. **FUNDING SOURCE(s)**: X (Refuges) ____ (Ecological Services) ____ (Other)

9. **ANALYTICAL SUPPORT REQUIREMENTS**:
(Include both Field Office and PACF analytical costs) **analysis is to be conducted by the Iowa Hygienic Lab (water) and a state veterinary health lab (blood)**

Type of Samples	Number of Samples	Estimated Analytical Costs (Organic)	(Inorganic)	Total Cost
water	28	5,600		5,600
blood	20	500		500

10. **NON-ROUTINE CHEMICAL ANALYSES**: ____ Yes XX No

11. **APPROVED**: ____________ EC Coordinator 7/31/95 Date

I. **STUDY TITLE**

IA-Impacts of improved biotic health of the watershed on Walnut Creek in Walnut Creek National Wildlife Refuge

II. **OBJECTIVE**

A. Management Objective(s)

To determine, over a four year period, if the biodiversity and biotic health of Walnut Creek improves while the surrounding agricultural land is converted back to its native prairie/savanna vegetation.

B. Technical Objective(s):

To determine 1) if aquatic macroinvertebrate and lepidopteran biodiversity increases as a result of decreased use of pesticides, 2) if Indiana bats are undergoing cholinesterase inhibiting stress, by use of a surrogate bat species, and 3) if water quality of five intermittent tributaries, composing the watershed, improves.

III **BACKGROUND and JUSTIFICATION**

The current emphasis of Walnut Creek National Wildlife Refuge is the conversion of acquired cropland back to native prairie and savanna. The refuge will consist of 8,654 acres, once acquisition is complete, and is currently comprised of over 5,000 acres.

Walnut Creek runs roughly northwest to southeast through the refuge. The Iowa Geological Survey Bureau (IGSB) initiated a Clean Water Act Section 319 study of this water body in 1995. This state project has established two streamflow/sediment U.S. Geological Survey (USGS) gaging stations along Walnut Creek and one along Squaw Creek. Water quality, including herbicide monitoring, nutrient loading, fecal coliform levels, dissolved oxygen, pH and other parameters, are being monitored in Walnut Creek and Squaw Creek. Squaw Creek is being used as the reference site, as it is not undergoing any significant surrounding land use changes.

During 1994, USGS, with matching funds through Walnut Creek NWR and the Iowa University Hygienic Laboratory (IHL), established one gauging station along the lower reach of Walnut Creek, as it leaves the refuge boundaries. The Rock Island Field Office supported herbicide and nitrogen analysis of five tributaries to Walnut Creek. Rain event water samples were collected in June and September. Trace amounts of the herbicides atrazine, two of its metabolites, and cyanazine were detected. A maximum concentrations of 3.1 and 7.8 μg/l atrazine and cyanazine, respectively, were found in June, 1994, in tributary number four.

In 1995, two more gauging stations were established. One gauge was set at the upper end of Walnut Creek, before it enters the refuge, and one gauge was established at the lower end of the paired watershed, Squaw Creek. Biodiversity studies were established and conducted, by the Iowa Hygienic Laboratory, on both creeks, and are scheduled to continue throughout the following three years.

Sediment sampling for metals will be conducted in triplicate at each gauging station, in August 1995. Amphibian choral breeding surveys were conducted between April and July.

The establishment of Walnut Creek National Wildlife Refuge offers a unique opportunity to demonstrate water quality improvements with increased biodiversity and improved biotic health, as an ecosystem undergoes a major land use change.

METHODS

In 1994 water quality was monitored at Walnut Creek, Squaw Creek, and five intermittent tributaries to Walnut Creek. Sediments are being sampled in 1995 to determine metal residue concentrations.

Section 319 Project.

The Iowa Geological Survey Bureau received funding from US EPA Region 7 to establish a Section 319 water quality project on the watershed at Walnut Creek National Wildlife Refuge. This project is expected to last through 1999.

The following parameters are being used as an integral part of the 319 project: IGSB has established three USGS gauging stations between the two watersheds, and has begun to intensively monitor sediment loading, surface water quality, groundwater quality and soil quality. The project also includes a biomonitoring study in the vicinity of the gaging stations on both creeks.

Biodiversity census.

The Iowa Hygienic Laboratory has been contracted by the IGSB to conduct biodiversity surveys at three sites, two on Walnut Creek and one on Squaw Creek. The Service is funding IHL to conduct two additional biodiversity surveys, one on each creek, to increase the statistical significance of the findings. The following organisms are being sampled: macrobenthic invertebrates, fish, and amphibians The Iowa Hygienic Laboratory is also documenting vegetative growth and cover along the stream banks.

IHL is using three Hester-Dendy artificial substrate sampling devices at each benthic diversity site. After a two month period, the artificial substrates are collected and the organisms removed. A 100 organism subsample from each sampler is being identified to the genus level. The Section 319 project has funded and will continue to fund three reaches of the creeks. This project will continue to fund the two addition sites identified and sampled during 1995.

RIFO is assessing amphibian populations along Walnut Creek using breeding choral censuses of frogs, according to the methods established by the Iowa Department of Natural Resources. Six locations have been randomly identified. These locations are and will continue to be surveyed at night, during breeding seasons. Biodiversity reaches of seven times the stream width have been established for vegetation and will be used for fish sampling, to be conducted by RIFO and partners later this year.

1996

In fiscal year 1996, this study will again examine amphibian diversity, through breeding choral surveys, according to IA DNR protocol. RIFO will also contract with IHL to continue the two benthic biodiversity sites, and the four intermittent streams, surveyed in 1994, will again be analyzed for herbicides.

Lepidopteran Surveys

We are proposing to add lepidopteran surveys to the current biodiversity sampling. As pesticide use decreases on and around the refuge, the numbers and varieties of butterflies and moths should increase. Lepidopterans serve as the food base for several different organisms, and a healthy lepidopteran population should indicate an increase in the diversity of their predator organisms. We anticipate contacting several sources, including the Xerces Society and the Iowa State University for standard sampling protocols.

Bat Surveys

There is a documented Indiana bat (*Myotis sodalis*) maternity colony located on Walnut Creek NWR. The Indiana bat is an endangered mammal which prefers small streams, with well developed riparian corridors for summer habitat. The bat uses trees with shag bark for maternity sites.

In 1995, as part of a two year study, refuge personnel and endangered species specialists from the Iowa Department of Natural Resources conducted bat surveys. The objectives of this two year study are to determine the number and types of roost trees, describe the habitat types within a 1 km area of the roost trees, and refine existing state guidelines for identification and protection of summer Indiana bat habitat in Iowa.

We propose to add a cholinesterase test to the current bat survey Cholinesterase levels can indicate impacts from certain organophosphate or carbamate pesticides. The bats would not be sacrificed for these tests.

Because of the rarity of the Indiana bats, we propose to use a surrogate species, the big brown bat (*Eptesicus fuscus*). Both of these species will feed on moths and beetles, with slight variations The benefits of using the big brown bat are that it is more numerous on the refuge, and is the most widely distributed bat species in Iowa.

With the proper permits, State and Federal, we propose to take blood samples from mist netted bats. The blood would then be immediately frozen, or drawn into a preservative prepared vial, and shipped to a contract laboratory.

Continued bat surveys, with contaminant monitoring, can yield important data about Indiana bats, which may aid in its recovery

ROLES, RESPONSIBILITIES and PARTNERSHIPS

IGSB is responsible for the collection of water samples along Walnut Creek and Squaw Creek. They also have sole responsibility for analytical costs associated with this sampling.

It is the responsibility of IGSB to report to US EPA as required under their Section 319 grant. At the conclusion of this project, IGSB will be requested to supply comments on a final report.

USGS is responsible for installing and maintaining the stream gauges on Walnut and Squaw Creeks. They are also responsible for distributing the data acquired by these gauges.

The Iowa Hygienic Laboratory is responsible for conducting the aquatic diversity studies on Walnut and Squaw Creeks. The Lab is also responsible for analyzing any samples submitted for herbicide or residue analysis. IHL will distribute the results of their work and chemical analyses to the appropriate agencies in a timely manner.

The refuge will be requested to supply comments on this proposal and future proposals related to this project. At the conclusion of this project the Refuge will be requested to comment on a final report.

The Rock Island Field Office is working with IHL in the establishment and implementation of two biodiversity surveys along Walnut and Squaw Creeks. RIFO is responsible for the paperwork associated with the cooperative agreement with IHL and timely payment of any bills associated with this study. The field office will also make the appropriate collections and dissections (if needed) for tissue and blood residue analysis. RIFO personnel will coordinate with the contract laboratories for sample submission. The field office will also be responsible for interim and final report preparation, specifically related to Service funding of this study.

PARTNERSHIPS

This project will be conducted in conjunction with the Iowa Geological Survey Bureau, U.S. Geological Survey, Walnut Creek National Wildlife Refuge and the University System of Iowa.

VI RANKING FACTORS

A Applicability of Study Results to Management Actions/Solutions

Direct management actions can result from this study. As information about the biodiversity and biota on the refuge is uncovered, reclamation efforts can be adjusted. Adjustments to the current strategy may be required to aid in the recovery of the Indiana bat, or to increase species diversity throughout the refuge.

The results of this study may be pertinent to the management of other refuges or natural areas, particularly those undergoing land use or habitat alteration strategies. For this reason other government and non government agencies may find the results of this study of interest.

B Threats to Resource - Documented or Suspected:

There are no documented threats to the resources located on Walnut Creek NWR. By the very nature of current land use activities in the area, there is a suspected threat to natural resources through agricultural chemical use. These chemicals include fertilizers, herbicides, insecticides and other pesticides and fungicides. There is a high probability of runoff of these chemical to the creek, and from there uptake into the food chain.

C. Determination of Impacts to Service Trust Resources:

1. Biological Organization: Ecosystem

2. Measurement of Contaminant Effects: Toxicological effect or true injury. This study is monitoring the biodiversity of the refuge, by definition the structure.

3. Contaminant Source(s): It is suspected that agricultural activities contribute to low species diversity. As agricultural activities lessen to almost 0%, an increase in species diversity is anticipated.

4. <u>Contaminant Pathway(s):</u> With the addition of bat cholinesterase level monitoring, one pathway of contaminant exposure is being pursued. Should the data from the cholinesterase study indicate exposure, in 1997 we will propose to conduct food chain residue analysis of Indiana bat prey items.

VII. SCHEDULE/STATUS

FY 1996	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Sample Collection	X	X	X	X
Sample Analyses	X	X	X	X
Data Analyses		X	X	X
Report Writing	____	____	X	X
Progress Report (Due June 15 each year of multi-year studies)			X	
Final Report Complete				
Customer Briefing: (ex. Refuge, RO, State/Federal Agency etc.)			X	

FY 1997	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Sample Collection	X	X	X	X
Sample Analyses	X	X	X	X
Data Analyses		X	X	X
Report Writing	____	____	X	X
Progress Report (Due June 15 each year of multi-year studies)			X	
Final Report Complete				

Customer Briefing:
(ex. Refuge, RO,

FY 1998	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Sample Collection	X	X	X	X
Sample Analyses	X	X	X	X
Data Analyses		X	X	X
Report Writing	______	______	X	X
Progress Report (Due June 15 each year of multi-year studies)			X	
Final Report Complete				
Customer Briefing: (ex. Refuge, RO, State/Federal Agency, etc.)			X	

FY 1999	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Sample Collection				
Sample Analyses				
Data Analyses	X	X		
Report Writing	X	X	X	
Progress Report (Due June 15 each year of multi-year studies)				
Final Report Complete	______	______	X	
Customer Briefing: (ex. Refuge, RO, State/Federal Agency, etc.)			X	

VIII REPORTS, PUBLICATIONS, and PRESENTATIONS

An interim report has been completed and submitted to the Region as of June 22, 1995. Additional interim reports will be submitted as required by future funding of this study.

Interim reports were submitted to the Regional Office, Walnut Creek National Wildlife Refuge, the Division of Environmental Contaminants IA Geological Survey Bureau, Iowa Hygienic Laboratory. A final report will be completed within one year of the completion of sampling (anticipated to be 1999). Future interim and final reports will be sent to all previously listed cooperators, plus additional cooperators, as partnerships are formed. At this time no plans are being made for submission of the report for publication.

State/Federal Agency, etc.)			X

Presentations on the findings of this study will be given to the management staff of Walnut Creek NWR, and to the partners of this effort. Presentations to the Regional Office and Washington Office will be offered, and available upon their request.

IX OPERATIONAL COST ESTIMATES

Personnel Costs (salaries and benefits)

RIFO personnel	$20,000.00
Refuge personnel	$ 3,000.00
Travel	$ 3,000.00
Supplies	$ 1,500.00
Equipment	$ 0.00
Non-PACF Analytical (28 water samples, 20 blood samples)	$ 6,100.00
Other	$ 0.00
SUB-TOTAL for Operational Costs	$33,600.00
Operation Overhead:	
Field Office	$ 0.00
Regional Office (15%)	$ 6,000.00
TOTAL Operation Request for FY 1996	$39,600.00
Future Operational Costs	
1997	$ 38,410.00
1998	$ 39,675.00
1999	$ 23,000.00

X. ANALYTICAL COST ESTIMATES

Past Analytical Costs FY 1995	$ 19,200.00
FY 1996	$ 0.00
Total Analytical Request for FY 1996	$ 0.00

Future Analytical Costs

Future analytical costs are expected to be spent at non PACF facilities and have been included in the future operational costs projected above.

GRAND TOTAL OF REQUEST FUNDS FOR FY 1996	$ 39,600.00

XI. APPROVALS

Submitted by: Tracy A. Copeland Date: 7/6/95

Reviewed by: Richard Birger, Refuge Manager Date: 7/7/95

Reviewed by: Richard C. Nelson, Field Supervisor Date: 7/13/95

Reviewed by: Contaminants Coordinator Date: 7/31/95

Walnut Creek NWR 3N19

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Rock Island Field Office (ES)
4469 - 48th Avenue Court
Rock Island, Illinois 61201

IN REPLY REFER TO:
FWS/RIFO

COM: 309/793-5800
FAX: 309/793-5804

July 12, 1995

Memorandum

To: Stan Smith (AES-EC)

From: Tracy Copeland, Fish and Wildlife Biologist

Subject: Signature Pages

Attached are the original signature page, and the two peer review checklists for the "Biotic Health of Walnut Creek NWR. . ." (3N19) study proposal. I have also attached one copy of the interim report, previously submitted to the Regional Office.

Re partnerships: The vast majority of work for this study is being conducted by the Iowa Geological Survey Bureau with support from USGS and the Iowa Hygienics Laboratory. RIFO is supplying additional funding and sampling to support their effort. I am attaching a copy of the Section 319 study, being conducted by IGSB, along with their budget pages. I have also attached copies of correspondence between IGSB, the Service, and IHL detailing who is doing what. Please forward this documentation, with the proposal, to satisfy the partnership criteria in Washington.

Thanks Stan, please call if you have any more questions regarding my proposals.

Tracy

Attachments

TC:am

SCIENTIFIC PEER REVIEW CHECK LIST

X Experimental design is we thought out and scientifically valid

f no please comment

There is a good probability of achieving the objectives of the investigation.

If no, please comment

The investigation uses accepted methodologies to measures exposure and effects of contaminants (i.e., it includes more than simple abiotic measures such as chemical analysis of sediments or water).

f no please comment:

X The costs are wel researched clearly spelled out and defensible

If no please comment

X Commensurate with investigation objectives, the proposal describes or cites scientifically acceptable operating procedures that include QA/QC sufficient to ensure the integrity of the data.

If no, please comment:

PROPOSAL TITLE IA- Impacts of Improved biotic Health of the Watershed. .Walnut Cre NWR. (3N19)

REVIEWER [signature] TITLE Refuge Biologist DATE 7-7-95

SCIENTIFIC PEER REVIEW CHECK LIST

Yes Experimenta design is we thought out and scientifically valid

f no, please comment

Yes There is a good probability of achieving the objectives of the investigation.

f no, please comment

Yes The investigation uses accepted methodologies to measures exposure and effects of contaminants (i.e., it includes more than simple abiotic measures such as chemical analysis of sediments or water).

f no please comment

Yes The costs are well researched, clearly spelled out and defensible

If no, please comment

Yes Commensurate with investigation objectives, the proposal describes or cites scientifically acceptable operating procedures that include QA/QC sufficient to ensure the integrity of the data.

If no, please comment

PROPOSAL TITLE IA- Impacts of improved biotic health of the watershed on Walnut Creek in Walnut Creek National Wildlife Refuge (3N19)

REVIEWER Gerald Bad TITLE F&W Biologist DATE 7/7/95

THE UNIVERSITY OF IOWA

March 27, 1995

Jody Millar
Fish and Wildlife Service
4469 48th Avenue Court
Rock Island, IL 61201

Dear Ms. Millar:

Regarding your request for our laboratory to perform benthic sampling on Squaw Creek and Walnut Creek near Prairie City, Iowa, we propose to:

- collect benthic macroinvertebrates from one site on Squaw Creek and one site on Walnut Creek.
- organisms will be collected using artificial substrates (3 per site) on four separate occasions (April, June, August and October).
- from each sample a 100 organism sub-sample will be obtained and specimens identified to the lowest practical taxon.
- provide you with a listing of the organisms identified and number of each by sampling site and sampling date on or before April 1, 1996.

The cost associated with this activity would be $2,400.00 per site.

If you have any questions regarding the proposed work or cost estimate, please contact me at (515)281-5371.

Sincerely,

Jack Kennedy
Principal Limnologist

JK/dp

JL 6/15
Aprils complete
June being picked up.

HYGIENIC LABORATORY

Henry A. Wallace Building
Des Moines, Iowa 50319

Iowa's Environmental and Public Health Laboratory

Telephone: 515/281-5371
Telefax: 515/243-1349

Correspondence detailing duties

STATE OF IOWA

Geological Survey Bureau
109 Trowbridge Hall
Iowa City, IA 52242-1319
319/335-1575

TERRY E. BRANSTAD, GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
LARRY J. WILSON, DIRECTOR

DATE: March 13, 1995

TO: Jodi Millar, Melanie Kruse, George Hallberg, Jack Kennedy, Bob Libra, Dick Birger, Pauline Drobney

FROM: Carol Thompson

RE: Walnut Creek meeting 2-27-95

The following is a brief summary of the meeting to discuss coordination of sampling at WNT. Please comment on the enclosed.

The contaminants program of the USFWS has some funding to supplement monitoring at WNT. This money is available on a year-by-year basis. Funding is available for FY95; DNR has approval for 4 years of monitoring under Section 310 from USEPA - Region VII.

Biodiversity sampling

Both the USFWS and 319 proposals are funded for biomonitoring. Five biomonitoring sites (reaches) will be chosen on both Walnut Creek and the control Squaw Creek. Two of the sites will be those selected by the UHL limnology group near the downstream gaging stations and will be the main sites assessed bi-monthly April-October. Since the DNR has received funding for a duration of four years these sites will be continued should other funding not be available. UHL will conduct the biomonitoring at those two sites for continuity over time and to ensure compatibility with the state biocriteria studies. Three Hester-Dendy samplers will be employed at each site. These and other protocols (e.g. for other types of sampling; possible summary matrices) will be coordinated between USFWS and UHL (Melanie and Jack) to ensure compatible methods. Additional sites will be chosen after the area has been visited and assessed; UHL has done some preliminary work in the area and may have some insights. USFWS will identify organisms to family; some organisms may need to be identified to genus; Jack and Melanie will discuss what is needed for the data to be meaningful. Because of the size of the streams it may not be necessary to continue all of the sites in subsequent years, but this supplemental work will provide an excellent baseline for these watersheds.

Annual fish collections will be done on both Walnut and Squaw Creeks in upstream and downstream locations using electro-shock techniques. Only sampling at the downstream site is covered in the 319 plan; USFWS will cover the upstream sampling. Sampling will be coordinated between UHL and USFWS.

USFWS may add an amphibians survey as appropriate. Jack and Melanie will discuss possible methods. WNT should be encouraged to set of choral surveys for frogs along the creeks; perhaps volunteers could be recruited.

Jack and/or Melanie should get in touch with Bruce Menzel to see if any of his data can be reviewed and where his sites were and what fish, benthics he has identified. This may be of use to the continuing work.

CT, Jack, and Melanie should also discuss coordination for the annual report on the biomonitoring work.

Funded bat study on-going at refuge to support Cholinesterase study

Region 3 Endangered Species Grant Proposal

I. **Project Title:** IA. Summer Habitat Requirements of the Indiana Bat (*Myotis sodalis*) in Iowa.

II. **Year of Project:** Year 1 of 2

Recovery Plan Task: (5.1) Summer Habitat Requirements

Project Objectives: The project objectives will be to:
1. Determine the number and types of roost trees used by maternity colonies on Walnut Creek National Wildlife Refuge and one other area in southern Iowa by radio-tagging 10 lactating Indiana bats at each area.
2. Describe the habitat types within a 1 km circle of the roost trees located.
3. Compare the results of the vegetation studies at the two sites and with the studies in Illinois and Missouri.
4. Refine existing state guidelines for identification and protection of summer habitat for the Indiana bat in Iowa.

V. **Background/Justification:** The Indiana bat populations which hibernate in Missouri have declined in the 1980's according to the hibernacula counts. These declines occurred even though various protection efforts have been implemented and disturbance to hibernacula does not appear to be the reason for the declines. It is not clear if disturbance, habitat degradation, or the loss of habitat for maternity colonies is causing the apparent population decline.

Telemetry studies in Illinois (Garner and Gardner, 1992) and Missouri (Callahan, 1993) described the various types of trees used by maternal colonies. Although Indiana bats used similar roosts in both states there were differences, such as the distance of roosts from roads. Gardner et. al. (1991) suggested that Indiana bats avoided heavily traveled roads when selecting roost sites. Callahan (1993) found that 22% of the roost trees identified during his study were within 100 m of a road. Because of these and other differences it is valuable to collect and compare information about summer habitat use across the range for this species. Range-wide data is needed to determine the summer habitat requirements for this species.

Walnut Creek National Wildlife Refuge in Jasper County is the northern most known location of a maternity colony in Iowa. The refuge has about 15% forest cover, most of which occurs along Walnut Creek. Based on the habitat descriptions of previous studies in Iowa (Bowles, 1982 and Klaas, 1986) this is probably at the lower limit of suitable habitat. The second study area will be selected to have forest cover of at least 30% and be located in what can be considered the main portion of the summer range for the Indiana bat in Iowa.

IX. Budget:

Radio transmitters (20) @ $140.00 each	$ 2,800.00
Salaries: 400 hours Research Scientist @ $14.05/hour	$ 5,620.00
160 hours Field Technician @ $8.00/hour	$ 1,280.00
Travel:	
Lodging 19 days @ 50.00/day	$ 950.00
Meals 20 days @ $38.00/day	$ 760.00
Mileage 8,000 miles @ $.21/mile	$ 1,680.00
TOTAL	$13,090.00
Federal Share 75%	$ 9,817.50
State Share 25%	$ 3,272.50

All salary and travel costs are for outside contractors none of these funds will be used for IDNR or Service employees.

X. References:

Bowles, J. B. 1981. Ecological studies on the Indiana bat in Iowa. Final Report to the Iowa Conservation Commission, Des Moines, Iowa. 17pp.

Callahan, E. V. 1993. Indiana bat summer habitat requirements. Unpubl. M.S. thesis, Univ. Missouri, Columbia, MO 74pp.

Gardner, J. E., J. D. Garner, and J. E. Hofmann. 1991. Summer roost selection and roosting behavior of *Myotis sodalis* (Indaina bat) in Illinois. Final Report. Illinois Nat. Hist. Survey, Champaign, IL 51pp.

Klaas, E.E. 1986. Determination of presence and habitat suitability for the endangered Indiana bat (Myotis sodalis) in portions of Soap Creek watershed, Iowa. Final Report to U. S. Soil Conserv. Serv. , Des Moines, IA 25pp.

165B budget
& identification of duties

Walnut Creek Water Quality Project Budget

Budget Category	Project Funding				
	Year 1	Year 2	Year 3	Year 4	Total
Personnel, including fringe benefits and indirects	$3,100	$30,900	$33,400	$34,630	$102,030
Travel	$500	$800	$800	$950	$3,050
Supplies	$200	$400	$400	$420	$1,420
Equipment	$5,000	$800	$800	$800	$7,400
Contractual Services					
Gage construction	$34,000	$0	$0	$0	$34,000
Streamflow records	$9,900	$11,500	$12,100	$12,700	$46,200
Sediment load	$12,100	$14,500	$15,200	$16,000	$57,800
Surface water quality, precip.	$14,500	$14,600	$15,500	$16,400	$61,000
Groundwater quality	$7,200	$7,200	$7,800	$8,300	$30,500
Biomonitoring	$17,000	$17,600	$18,500	$19,400	$72,500
Soil quality	$3,000		$3,200		$6,200
Financial Incentives	$0	$0	$0	$0	$0
Other *					
well installation/development	$10,000	$0	$0	$0	$10,000
reports, printing	$200	$1,100	$1,200	$1,200	$3,700
Total	$116,700	$99,400	$108,900	$110,800	$435,800

*Provide explanation

319 Study

WALNUT CREEK WATERSHED RESTORATION AND WATER QUALITY MONITORING PROJECT

WALNUT CREEK NATIONAL WILDLIFE REFUGE AND ENVIRONMENTAL LEARNING CENTER

JASPER COUNTY, IOWA

Prepared by:

C.A. Thompson[1], J.O. Kennedy[2], and G.R. Hallberg[2]

[1] Iowa Department of Natural Resources - Geological Survey Bureau

[2] University of Iowa Hygienic Laboratory

January, 1995

Iowa Department of Natural Resources

Larry J. Wilson, Director

Schedule:

Activity	Agency	Completion Date
"Pre-Project" Activities:		
Initiate limited water quality sampling	IDNR-GSB, USFWS, UHL	July 1994
Conduct surveys and plan for gage installation	USGS	June - September 1994
Install primary gage on Walnut Creek	USGS, USFWS, UHL	July 1994
Project Activities:		
Install stream gages	USGS	October 1994
Install sediment samplers	USGS	November 1994
Initiate water-quality sampling	IDNR-GSB, USFWS, UHL	Ongoing
Develop complete design plan specifications	IDNR-GSB	December 1994
Develop rating for gage sites	USGS	October 1994 - September 1995
Choose locations for well installation	IDNR-GSB	March 1995
Initiate Biomonitoring	UHL	April 1995
Install wells and monitoring equipment	IDNR-GSB	May 1995
Review and summarize all past water-quality baseline data; develop data base for project	IDNR-GSB, UHL	October 1995 - April 1996
Prepare annual report	IDNR-GSB, USGS, UHL, USFWS	October 1995 - April 1996
Annual Activities:		
Collect and maintain gaging and sediment data	USGS	
Monthly water quality sampling	IDNR-GSB, UHL	
Conduct runoff, event sampling	IDNR-GSB, USFWS, UHL, USGS	
Conduct bi-monthly and annual biomonitoring	UHL	
Monitor implementation activities, land use changes	USFWS, IDNR-GSB	
Prepare annual report	IDNR-GSB, USGS, UHL, USFWS	

LIST OF FIGURES

Figure 1. Location of Walnut Creek and Squaw Creek basins.....3

Figure 2. Monitoring sites for Walnut and Squaw Creeks.....7

ACKNOWLEDGMENTS

The Walnut Creek Nonpoint Source Pollution Monitoring Project is supported by Region VII of the U.S. Environmental Protection Agency through a 319-Nonpoint Source Program Grant to the Iowa Department of Natural Resources. Analytical support is provided by the University Hygienic Laboratory in Iowa City and Des Moines. The design of this workplan is modeled after those developed for the Big Spring and Sny Magill Watershed Projects.

watershed habitat restoration and land management changes implemented by WNT. Several other component objectives can be expressed: 1) to evaluate the changes in agricultural practices that will occur as a result of a change in management; 2) to monitor and develop an understanding of the hydrologic changes that will accompany a large scale restoration program such as is occurring at WNT; 3) to quantitatively measure changes in flow and water quality and evaluate their impacts on biological habitat; 4) to use the water-quality and habitat monitoring data to increase our understanding of what implementation measures are successful and will be useful in similar areas, and for public education to expand awareness of the need for nonpoint source pollution-prevention implementation.

The project will be a coordinated inter-agency effort. This workplan outlines the initial development year of the project and its first four years of implementation for which funding has been provided.

WATER RESOURCE DESCRIPTION

Walnut Creek, a warm-water stream located in Jasper County, Iowa, drains 30.7 mi^2 (19,500 acres) and discharges into the Des Moines River at the upper end of the Red Rock Reservoir. The Walnut Creek National Wildlife Refuge and Prairie Learning Center (WNT) was established in this watershed by Congress to restore a significant preserve of tallgrass prairie. Ultimately over 8,000 acres in the WNT watershed will be restored to native prairie and/or savanna, the rarest of North America's major natural landscapes. Riparian zones and wetlands will be restored in context. The Refuge has an approved acquisition boundary of 8,654 acres (13.5 mi^2). Only the upper part of the watershed will be included in the monitoring project because of possible backwater effects from the reservoir. The project watershed includes 12,860 acres (20.1 mi^2) and includes the majority of the WNT Refuge area (Fig. 1); approximately 63% of the watershed is within the Refuge boundaries. Currently, about 5,000 acres (7.8 mi^2) are owned and controlled by the U.S. Fish and Wildlife Service (USFWS).

Walnut Creek drains into a segment of the Des Moines River that is classified as *Not Supporting* its designated uses in the Iowa Department of Natural Resources (IDNR) water-quality assessments; Squaw Creek and the Skunk River are classed as *Partially Supporting*. Assessments in this area cite agricultural nonpoint source (NPS) as the principal concern. It is anticipated that the ecosystem restoration, improved crop production and conservation practices, and other proposed efforts will lead to significant improvements in water quality and habitat in the Refuge, both for terrestrial and aquatic organisms.

For this monitoring project a paired-watershed design will be used. The Squaw Creek basin, adjacent to Walnut Creek, will be used as a control watershed (Fig. 1). Squaw Creek drains 25.2 mi^2 (16,130 acres) above its junction with the Skunk River. The watershed included in the monitoring project is 18.3 mi^2 (11,710 acres) and does not include the wide floodplain area near the intersection with the Skunk River. The very upper part of the watershed incudes part of the town of Prairie City, population of about 1,140. Sewage effluent from Prairie City is discharged to the south into a different watershed.

Watershed Characteristics

The Walnut Creek watershed and WNT Refuge is located in the Southern Iowa Drift Plain, characterized by areas of steeply rolling hills and well-developed drainage. Soils on the Refuge fall primarily within four soil associations: Tama-Killduff-Muscatine; Downs-Tama-Shelby; Otley-Mahaska; and Ladoga-Gara. Most of the soils are silty clay loams, silt loams, or clay loams formed in loess and till. Many of the soils are characterized by moderate to high erosion potential. The upper portion of the Walnut Creek watershed, above the WNT Refuge, is the more gently sloping headwaters portion of the basin; the majority of highly-erodible land in the watershed occurs in the Refuge area. Pre-Illinoian till underlies most of the Refuge area and is 50 to 100 feet thick. Bedrock is at an approximate elevation of 850 to 700 feet above mean sea level and is primarily Pennsylvanian Cherokee Group shale, limestone, sandstone, and coal.

The entire watershed is agricultural with no industry or urban areas. Prior to the establishment of theRefuge, about 80% of the watershed was cropland (predominantly corn and soybeans), 13% grassland or pasture, 3% forest, and 4% roads, farmsteads, and other uses. Most farms include small livestock operations. Currently, only 37% of the area under Refuge control is in cropland (predominantly corn and soybeans), 33% is grassland, 5% CRP, and 25% woodland, wetlands, or prairie. There are currently seven individuals farming on Refuge owned lands under a cash rent, contract basis.

The soils and geology of the Squaw Creek watershed are similar to that in the Walnut Creek basin. Landuse is primarily agricultural, and essentially the same as the Walnut Creek basin prior to changes implemented by the establishment of the Refuge. As noted, the very upper part of the watershed incudes part of the town of Prairie City, but the municipal sewage effluent is discharged to the south into a different stream.

Average yearly rainfall is approximately 31 inches in the area. Groundwater discharge to similar Iowa streams in the region is generally between 40 and 60% of total flow. Thus, groundwater quality is also an important factor in management considerations for streams in the area.

MONITORING PROJECT DESCRIPTION

The intent of the design of the Walnut Creek Water Quality Monitoring Project is to meet USEPA's criteria for "Nonpoint Source Monitoring and Reporting Requirements for Watershed Implementation Projects." The Walnut Creek Watershed is well suited for such a project. The area is amenable to various comparative water-quality approaches, including paired-watershed design. Because of the intimate linkage of groundwater and surface water in the region, the watershed has a very responsive hydrologic system and should be relatively sensitive to the changes induced through the implementation programs. The restoration program is comprehensive and long-term and will affect 53% of the Walnut Creek Watershed. Restoration will proceed slowly, however during the interim, substantial improvements in land, nutrient, and chemical management will be implemented on the remaining agricultural land.

Restoration has begun at WNT as well as implementation of agricultural programs. However, the acreage affected by these measures is still minimal compared to basin size. Landuse will be altered extensively over the next 5-10 years.

Pre-Implementation Data

Water quality data has been collected as part of the U.S. Environmental Protection Agency (EPA) sponsored "Tri-State NPS Project" (personal communication, B. Menzel). In 1992, mean reactive phosphate (0.3 mg/l) and total dissolved solids (310 mg/l) were low to average, while nitrate-N (15 mg/l) and turbidity (73 NTU) were high compared to other streams. The maximum alachlor concentration was 10 µg/l and atrazine was 4 µg/l. These pesticide concentrations were very high compared to other streams in the study. Primary biological productivity was low and Walnut Creek had one of the most depauperate fish communities of all the streams under study in the three-state area. This study includes

Water Quality Parameters

Various agencies will be involved in the collection and analysis of data for this project. Below are descriptions of the major project elements and the agency involved. Figure 2 shows the sampling locations which have been selected to this point.

USGS Stream Gaging Stations

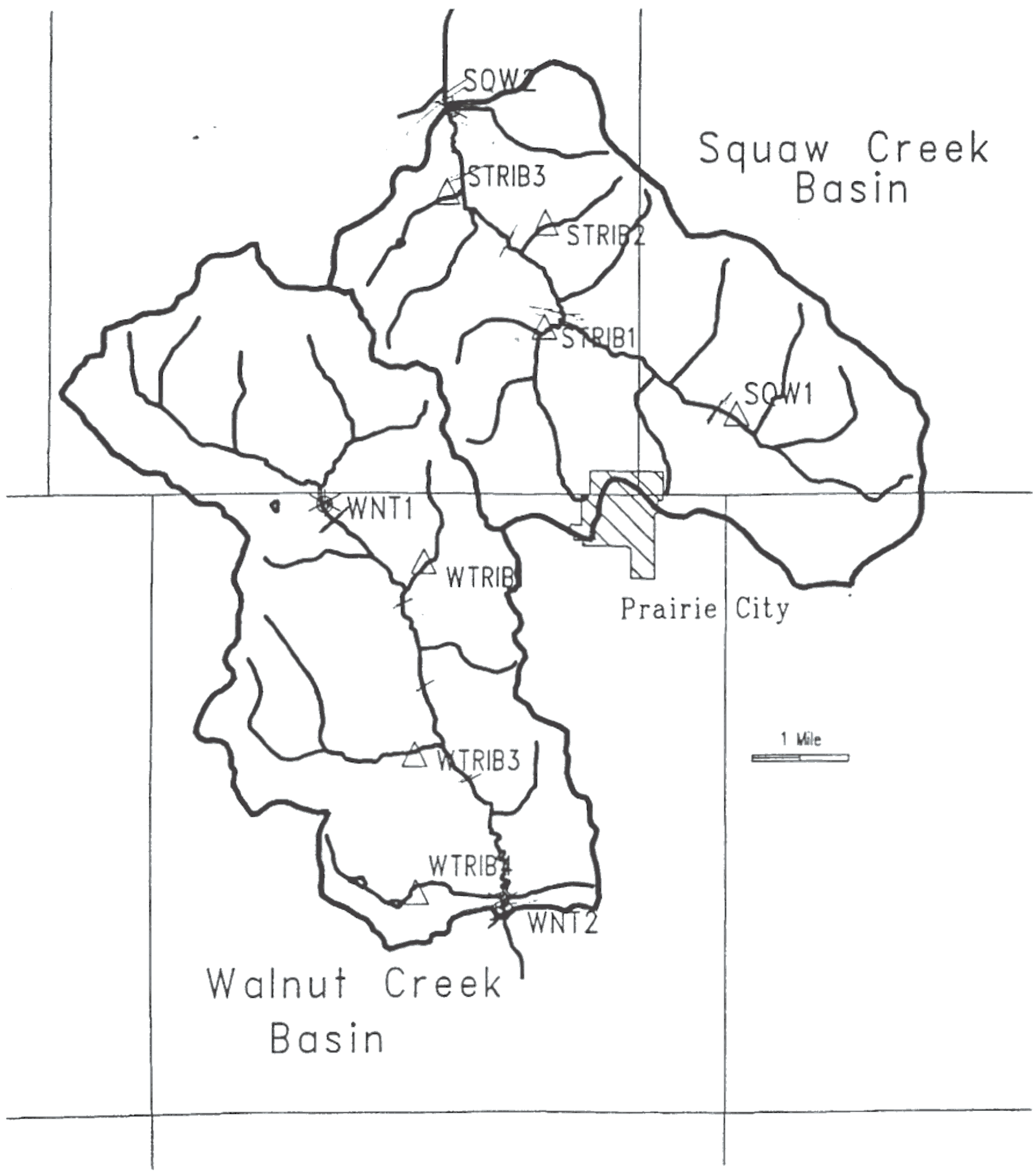
Stream gaging will be done to provide stage and discharge measurements for the monitoring effort. Stream discharge records will allow the assessment of changes in the hydrologic response of the watersheds, evaluation of groundwater effects through baseflow analysis, and estimation of basin mass losses, and balances when coupled with concentration data. Monitoring daily suspended solids is expensive and difficult, but if sediment loading and sediment yield are to be evaluated, such detail is necessary. Suspended sediment load is highly flow-dependent and highly variable. There would be little chance of measuring any significant changes without daily, and event-related records for computation of sediment yield over time. Gaging stations, while expensive, are essentially required by the EPA protocols, and enhance all other information.

Standard USGS gaging facilities will be constructed at the three major stream sites (WNT1, WNT2, and SQW1). Stage is monitored continuously with bubble-gage sensors (fluid gages) and recorded by data collection platforms (DCP) and analog recorders (Rantz and others, 1982). The DCPs digitally record rainfall and stream stage at 15-minute intervals. Stevens A-35 strip-chart recorders also register stage continuously. The recording instruments are housed in 5 by 5 foot metal buildings. The equipment is powered by 12 volt gel-cell batteries which are recharged by solar panels or battery chargers run by external power. Reference elevations for all USGS gage stations are established by standard surveys from USGS benchmarks. Stage recording instruments are referenced to outside staff plates placed in the streambeds, or to type-A wire-weights attached to the adjacent bridges. Rainfall is recorded using standard tipping bucket rain gages.

Stream discharge is computed from the rating developed for each site (Kennedy, 1983). The stream-gaging and calibration is performed by USGS personnel, using standard methods (Rantz and others, 1982; Kennedy, 1983). Current meters and portable flumes are used periodically to measure stream discharge and refine the station ratings.

Suspended Sediment

Suspended sediment samples are collected daily by local observers and weekly by water quality monitoring personnel. The observers collect depth integrated samples at one vertical section at one point in the stream using techniques described by Guy and Norman (1970). Samples are collected daily at all three stations. During storm events, suspended sediment samples will be collected with an automatic water-quality sampler installed by the USGS at the gaging stations. Sampling is initiated by the DCP when the stream rises to a pre-set stage, and terminates when the stream falls below this stage. Suspended sediment concentrations are determined by the U.S. Geological Survey Sediment Laboratory in Iowa City, Iowa, using standard filtration and evaporation methods (Guy, 1969). Discharge, rainfall, and sediment data are stored in the USGS Automatic Data Processing System (ADAPS) and published in the Iowa District Annual Water-Data Report.



Basin Divide

Streams, Lakes

● Gaging Stations

* Monthly Sampling Sites

△ Additional Event Sampling Sites

Figure 2. Monitoring Sites for Walnut and Squaw Creeks.

Table 2. Laboratory methods used for analyzing Walnut and Squaw creek water-quality analytes.

1) fecal coliform bacteria: Based on Standard Methods for Water and Wastewater, Method 9222D (APHA, 1985) using media fecal coliform at 44.5°C.

2) nitrate and nitrite-nitrogen: automated, copper-cadmium reduction and colorimetric quantitation using a Technicon auto-analyzer system. The method is based on U.S. EPA Method 353.2 (USEPA, 1983 and revisions).

3) ammonia-nitrogen: automated phenate reaction, and colorimetric quantitation, using Technicon auto-analyzer IM 780-86T. Based on U.S. EPA Method 350.1 and 350.2 (USEPA, 1983 and revisions).

4) organic-nitrogen: total Kjedahl procedure with K_2SO_4, and $HgSO_4$ pre-treatment using Technicon IM 780-86T; semi-automated block digester, AAII, colorimetric quantitation. Organic-nitrogen is defined as the sum of ammonia-nitrogen and organic nitrogen compounds which are converted to ammonium sulfate, less the ammonia-N determined in procedure for ammonia-nitrogen (see above). Based on U.S. EPA Method 351.2 (USEPA, 1983 and revisions).

5) anions: ion chromatography using a Dionex ion chromatograph with ionic supression with conductivity detection. Based on U.S. EPA Method 300.0 (USEPA, 1983; 1991 revision).

6) cations: inductively-coupled plasma , atomic-emission spectroscopy using a Thermo-Jarrell Ash 61E simultaneous/sequential instrument. Based on U.S. EPA Method 200.7 (USEPA, 1983 and revisions).

7) 5-Day BOD: samples incubated in dark for 5 days at 20 °C, Standard Method 507 (APHA, 1985).

8) suspended sediment: standard filtration and evaporation methods (Guy, 1969).

9) common herbicides, multi-residues: methylene chloride extraction; extract partitioned, using silica gel, into two fractions for gas chromatograph-nitrogen-phosphorous capture detector and/or GC-NPD analysis, employing two-column confirmation. Based on U.S. EPA methods, EPA-600/8-80-038, Section 10, A (USEPA, 1980 and revisions).

10) IMA triazines: immuno-assay using spectrophptometric measurement and analysis; Millipore triazine kit.

REFERENCES

Agena, U., Bryant, B., and Oswald, T., 1991, Agriculture: environmental problems and directions: IN Proceedings of the 1990 Crop Production and Protection Conference, Iowa State University, p. 219-229.

APHA, 1985, Standard methods for the examination of water and wastewater (16th ed.): Washington, D.C., American Public Health Association, Water Works Association, and Water Pollution Control Federation, 1268 p.

Guy, H.P., 1969, Laboratory theory and methods for sediment analysis: U.S. Geological Survey Techniques of Water-Resources Investigations. Book 5, Chapter C1, 58 p.

Guy, H.P., and Norman, V.W., 1970, Field methods for measurement of fluvial sediment: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter C2, 59 p.

Kennedy, D.J., 1983, Computation of continuous records of streamflow: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter A13, 53 p.

Rantz, S.E., and others, 1982, Measurement and computation of streamflow: Volume 1. Measurement of stage and discharge: U.S. Geological Survey Water-Supply Paper 2175, p. 1-284.

University Hygienic Laboratory, 1993. Limnology section-standard operating procedures.

University Hygienic Laboratory, 1994. Limnology section-quality assurance plan

USEPA, 1980 and revisions, Manual of analytical methods for the analysis of pesticides in humans and environmental samples, Washington, D.C., U.S., Environmental Protection Agency, EPA-600/8-80-038, 557 p.

USEPA, 1983 and revisions, Methods for chemical analysis of water and wastes: Cincinnati, OH, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, EPA-600/4-79-020.

USEPA, 1989, Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish, EPA/444/4-89-001.

VI. On-Site Field Measurements

Temperature, specific conductance, dissolved oxygen, pH, alkalinity, and turbidity are the field parameters measured at each site. This discussion of techniques is for equipment in current use at GSB. If new equipment is obtained, procedures will be updated.

<u>A. Temperature:</u>
A precision thermistor built into the conductivity probe will be used to record the temperature of the stream water and groundwater. In-stream measurement of temperature will be collected within 3 meters of the stream bank. Groundwater temperature will be measured in the well bore after purging, but prior to sample collection. The thermistor has a range of -5 to 50^{o}C in 1^{o}C increments with an error of +/- 0.4^{o}C. Temperature, to the nearest degree C, will be recorded on the Field Measurement Form.

<u>B. Specific Conductance:</u>
Specific conductance will be measured with a YSI model 3000 T-L-C meter. Two platinized electrodes measure conductivity and will accurately measure changes in 10 seconds. Calibration is done at the factory and will be checked monthly using a standard conductivity solution.

Measurement:
1.-.To measure temperature compensated conductivity set the function switch to 2 mS/cm TC to 25^{o}C.
2. - Completely submerge the probe and wait 40-60 seconds for probe to stabilize.
3. - Read the value from the appropriate scale.

Maintenance:
The probe will be stored in deionized water between uses.
The O-rings will be replaced annually

<u>C. Dissolved Oxygen:</u>
Dissolved oxygen will be measured using a YSI Model 58 dissolved oxygen meter.

Calibration:
1. - The oxygen probe should be in a partially filled BOD bottle
2. - Set the function switch to ZERO and adjust O2 ZERO until display reads 00.0
3. - Turn function switch to %; Wait 15 min for probe to stabilize
4. - Adjust the O2 CALIB knob until the meter reads the proper calibration value from the chart on the back of the meter

Measurement:
1. - Completely fill a BOD bottle under water
2. - Place the probe in the bottle and turn the stirrer on
3. - Set salinity control
4. - Switch to desired accuracy (0.1 or 0.01 mg/l) and read the dissolved oxygen value in mg/l

<u>D. Turbidity:</u>
Turbidity will be measured using a HACH turbidimeter.

Calibration:

VII. Delivery of Samples to Labs

GSB personnel will deliver samples collected each week to appropriate labs within 24 hours of sample collection. Once samples are collected they will be stored in Coleman coolers until delivered to the labs. Ice will be used to cool samples if the air temperature is greater than 0°C.

VIII. Data Management Form

A data management form will be completed by GSB personnel and delivered with samples to the University Hygienic Lab. This form will include analyses desired, samples collected, date, time, and bottle identification numbers and allows the logging and tracking of sample possession and transmittal.

IX. Equipment Problems/Supply Needs

All equipment problems or supply needs will be addressed to Carol Thompson, GSB.

Table A-2. Samples bottles for groundwater sampling for the Walnut Creek Monitoring Project

Analyte	Type of bottle	# of bottles quarterly
Pesticides	1 quart glass jar with teflon-lined lid	8
IMA-triazines	50 ml glass tube with septum lid	4
Anions	quart plastic bottle with plastic lid	8
Cations	250 ml disposable plastic bottle with plastic lid, contains sulfuric acid preservative	8 (bi-annual)
Nitrate	50 ml amber-colored glass bottle wit plastic lid	4