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Middle Fork of the East Fork of the Whitewater River Watershed Management Plan

Watershed Management Plan
August 2004
Last update: July 2005

Prepared by: Friends of the Middle Fork Watershed Steering Committee
and the Wayne County Soil and Water Conservation District
823 S. Round Barn Road, Richmond IN 47374

Funded through the Indiana Department of
Environmental Management Section 319 grant program

Our Vision: *Enhanced water quality in the Middle Fork Watershed.*

Our Mission: *To provide stewardship by involving and educating the Middle Fork Watershed Community to protect the water and land resources.*

Executive Summary

In 1995 of group of concerned citizens formed a watershed committee to focus their attention on the Middle Fork Reservoir's Watershed (HUC: 05080003-070-030; 05080003-070-040). This 50 square mile area of land is a multi-state watershed located in Wayne and Randolph Counties in Indiana and Drake and Preble Counties in Ohio. The health of the reservoir is vital as it provides more than 50 percent of the city of Richmond's drinking water. In 1999 the committee applied for and received a Lake and River Enhancement (LARE) Grant to hire a part-time technician and provide cost-share money for landowners making improvements to their land. The group decided that they would like to gather additional information about the watershed to sharpen their focus. Through the Wayne County Soil and Water Conservation District (SWCD) they applied for and were awarded an Environmental Protection Agency (EPA) Section 319 grant to continue public outreach and create a management plan for the Middle Fork of the East Fork of the Whitewater River Watershed. The project steering committee reorganized as Friends of the Middle Fork, hired a project coordinator to help carry out the project in September 2002.

Water monitoring conducted during the initial 319-grant phase flagged sedimentation rates, *E. coli,* nutrient, and atrazine contamination has major concerns which will be addressed during Phase II of the project. Phase II will be funded through a second Section 319 grant which will fund implementation of the management plan through the spring of 2007.

Stakeholders have played a vital role in the creation of the management plan by giving input at public meeting and attending other watershed events. This is important because the second phase will rely on landowners' willingness to implement conservation projects on their properties to improve local water quality.

Copies of the management plan will be available for viewing at the Wayne County Soil and Water Conservation District office and at Morrison-Reeves Library in Richmond. Interested citizens can also obtain a personal copy of the management plan by contacting the Wayne County Soil and Water Conservation District.

Project Overview

Finished Tasks:

1995 – Middle Fork Watershed Steering Committee Forms

1999 – Committee applies for and receives Lake and River Enhancement (LARE) Grant which allowed a part-time watershed coordinator and provided cost-share for landowners

Fall 2001 – Steering Committee applies for EPA Section 319 Grant

Summer 2002 – LARE grant position ends; committee is awarded Section 319 grant

Fall 2002 – Committee reorganizes as Friends of the Middle Fork and hires a full-time watershed coordinator for two-years to complete a watershed management plan and to provide watershed education and outreach.

Fall 2002-Summer 2004 – Watershed outreach events including: public meetings, Forage Field Day, Forestry Field Day, and Wetland Clinic. The technical committee also completed a watershed inventory and water quality monitoring.

Fall 2003 – Committee applies for Second Phase Section 319 grant

Summer 2004 – Committee receives Second Phase Section 319 grant

Summer 2004 – Watershed Management Plan Complete

January 2005 – Phase II begins

Projected Task Dates:

March 2007 – End of Phase II grant

For additional information concerning the Middle Fork Watershed Project contact:

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Table of Contents

List of Tables:

List of Figures:

<u>Appendixes:</u>

1.0 Introduction

The Middle Fork Watershed Management Plan addresses the current conditions of the Middle Fork Watershed which have been determined by the preliminary assessment of the watershed conducted by the Friends of the Middle Fork Steering Committee (FOMF) and assisting partners. The watershed drains into the Middle Fork Reservoir which provides more than 50 percent of the water which more than 40,000 Richmond residents rely on.

The project is voluntary-based and is overseen by the Wayne County Soil and Water Conservation District (WSWCD). The obtained information provides guidance for future projects within the watershed boundaries (hydrologic unit codes: 05080003-070-030; 05080003-070-040) and will help educate stakeholders about current conditions of the watershed. The watershed plan will be updated by the committee on an annual basis to include any changes, including work completed or currently in progress.

During the fall of 2002 an in-depth study of the Middle Fork Watershed began by FOMF. Information was gathered through visual observations, public meetings and surveys, water monitoring, and compiling existing data. Public outreach and education was an important component of the study and was completed through field days, workshops, and other public events. It is important to note that the majority of the management plan only covers information about the Indiana portions of the watershed, due to the fact that the monies allotted during the implementation phase of the project can only be utilized within Indiana.

FOMF has involved the public in the planning stages of the watershed project in order to obtain additional information and provide education. The implementation phase of the project has been widely supported by the public. Efforts of FOMF, WSWCD, and local partners and citizens have been vital to compiling the information contained within this document.

This management plan will serve as a document to help guide future activities within the Middle Fork Watershed, as well as future goals and objectives to meet these management needs.

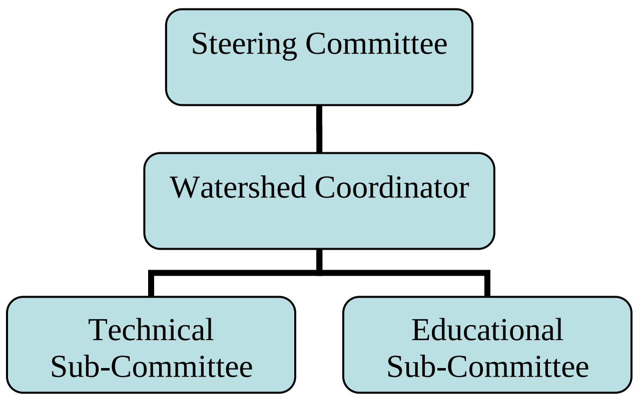
Steering Committee Structure

In 1995, a group of concerned citizens joined together to study the water quality within the watershed and determine the cause of water quality concerns. Concerns of the committee included chemical and nutrient inputs from agricultural land and high sedimentation rates of the reservoir. The group was formed through the cooperation of the Wayne County Soil and Water Conservation District with residents of the watershed, the county surveyor, Indiana-American Water Company personnel, and local college representatives.

The group received a Lake and River Enhancement Grant (LARE) in 1999 through which they hired a part-time watershed coordinator. Many agricultural Best Management Practices (BMPs) were installed using cost-share funds during this grant period, including waterways, establishment of riparian buffers, and grass plantings. In 2001 the watershed committee applied for and received an Environmental Protection Agency Section 319 grant through IDEM. The grant allowed them to hire a full-time watershed coordinator to create a management plan to address concerns within the watershed. At the same time, the committee reorganized as Friends of the Middle Fork and began work on gathering information about the watershed to create a management plan. The group currently meets monthly, with additional planning and technical meetings held periodically.

FOMF is the governing body of the Middle Fork project and oversees the watershed coordinator's activities. The chairman of the committee leads the monthly steering committee meetings. All actions are approved by majority vote of the committee members. Technical and educational sub-committees were also created to help conduct and analyze water monitoring activities within the watershed. The group includes local residents, college professors, and water quality professionals. For a full listing of committee and sub-committee members see Appendix A.

Figure 1.1 – This organizational chart is a representation of the structure of the Middle Fork Watershed Project.



Mission and Vision Statements

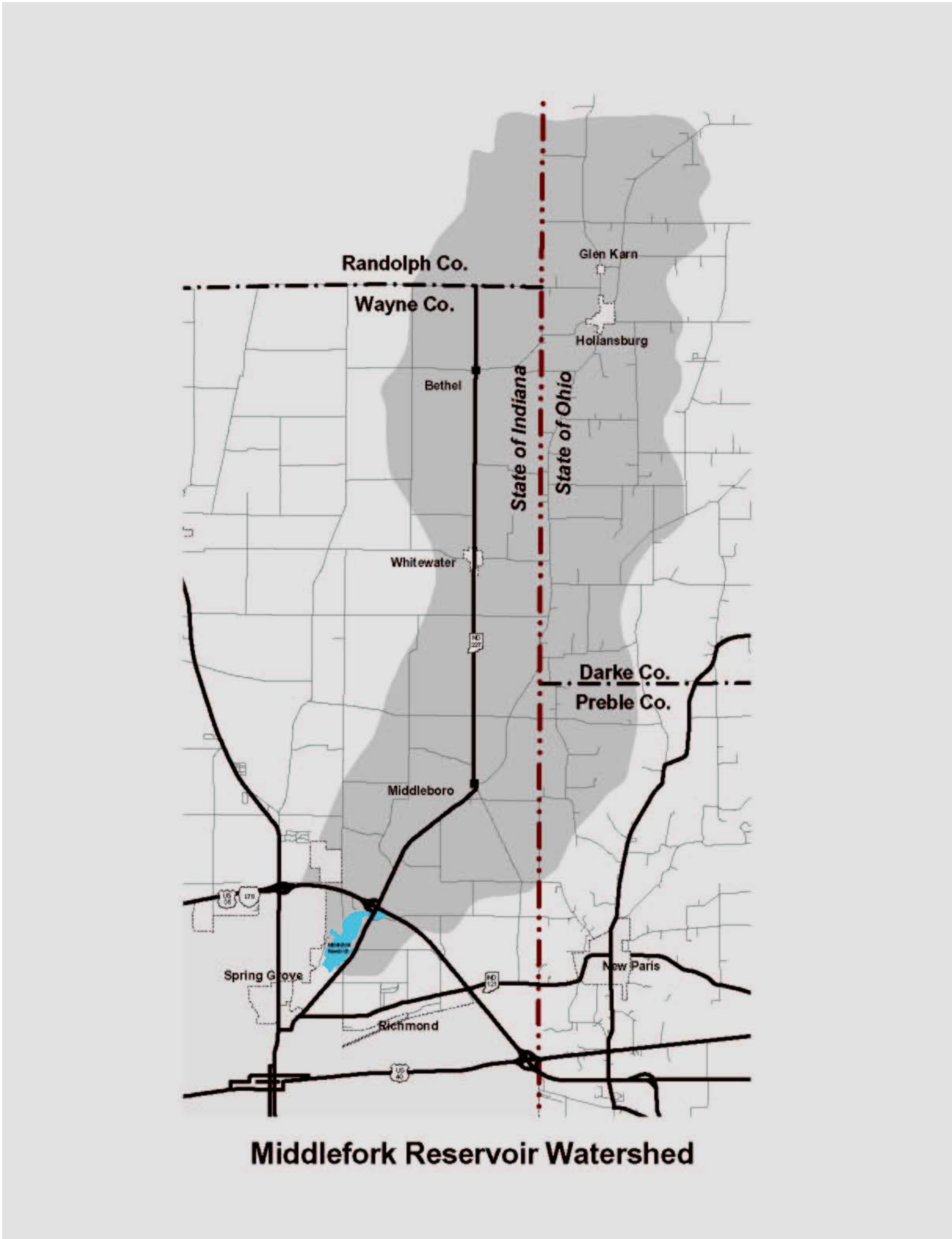
Vision and mission statements were developed by the Friends of the Middle Fork to guide the committee in developing a focus for the management plan and other programs which aim to improve the water quality within the Middle Fork Watershed. Sarah Berger, a student at Northeastern Wayne Elementary School and watershed resident, won a watershed logo contest sponsored by FOMF. Her hand-drawn logo was digitized by a local graphic artist (Figure 1.2).

Figure 1.2

Our Vision: Enhanced water quality in the Middle Fork Watershed.

Our Mission: To provide stewardship by involving and educating the Middle Fork Watershed Community to protect the water and land resources.

Figure1.3: Middle Fork Watershed Map



The boundaries of the watershed were determined with the assistance of the Wayne County Surveyor's Office.

Watershed Overview

The Middle Fork of the East Fork of the Whitewater River watershed consists of 48.7 square miles of land (Table 1.1) which drain into the Middle Fork Reservoir. The watershed includes about 16,000 acres in Wayne and 2,000 acres in Randolph County in Indiana. Approximately 12,000 acres of the watershed are located across state borders into Ohio's Drake and Preble Counties. The river flows south into the Middle Fork Reservoir, which is located in Richmond, Indiana and provides more than half of the city's drinking water. The decline of the water quality in the reservoir has been a cause of major concern in recent years.

The watershed land use is predominantly agricultural with nearly 85 percent of the Indiana land being used for row crops and pasture. Forestry comprises approximately 12 percent of the watershed and urban areas only comprise about one percent of the Indiana land area.

The small amount of urban areas include five small communities located within the boundaries of the watershed. The town of Whitewater, Bethel, and Middleboro are located within Wayne County, Indiana. The towns of Glen Karn and Hollansburg are located within the watershed boundaries in Ohio.

A major point of interest within the watershed include Barrett Paving Materials. This lime stone quarry is the only point-source located within the watershed and is monitored by IDEM through the National Pollution Discharge Elimination System (NPDES) Program. Other points of interest within the boundaries include an Interstate-70 exchange, State Road 227, Ivy Tech State College, Indiana University East, Grandpa's and KOA Campgrounds, Highland Golf Course, and the Middle Fork Reservoir Gatehouse & Fun Park.

Formation and Determination of Stakeholders

Using a list of the parcels located within the watershed from the Wayne County Surveyor's Office the committee created a Wayne County stakeholder mailing list. The existing Randolph County mailing list was also updated. People on the mailing list receive bimonthly newsletters, which include project information and event announcements. FOMF have sign-up sheets at each of their activities for additional names to be added to their mailing list.

1.1 Watershed partnerships

Steering Committee

The Middle Fork Watershed Steering Committee, otherwise known as Friends of the Middle Fork, is comprised of key stakeholders from around the community. This diverse group of individuals includes educators, technical experts, farmers, and other concerned citizens. Current committee member are listed below.

Friends of the Middle Fork:

Donald Berger, dairy farmer, Wayne County SWCD supervisor
Gene Berry, watershed farmer
George Bihl, watershed farmer
Bill Brown, Wayne County Surveyor
Mark Campbell, watershed farmer

Bruce Hartman, watershed farmer
Duane Hieger, watershed farmer
Kirby Hiller, conservationist and watershed landowner
Rich Nicholson, Water Specialist Indiana-American Water Company
Shirley Rodgers, local conservationist
Richard Roeper, Biology Professor at Indiana University East
Harold Routson, Wayne County SWCD supervisor, past Farm Bureau president
Dale Spencer, watershed farmer

Partnerships

Many watershed partnerships were established prior to and have continued their support through the 319 grant phase. These partners have assisted with gaining information about the watershed, which have been useful to the creation of this plan.

Community Partners assisting with the creation of the management plan include:

- Wayne County SWCD: provide office space and supplies
- Wayne County Surveyor's and GIS Office: assisting with the creation of maps and mailing list
- Wayne County Natural Resources Conservation Service: technical support and assistance
- IDNR – Wayne County Resource Specialist: technical support and assistance
- Wayne County Farm Service Agency: statistics and records
- Wayne County Health Department: septic system information
- Indiana Department of Natural Resources: technical support, records
- Indiana-American Water Company: water monitoring records and technical support.
- Wayne County Purdue Extension: Educational information and assistance
- Local residents: voicing questions and concerns and assisting with watershed events and water monitoring.
- Harvest Land Co-op
- Other community groups and businesses that are involved with the project include: Richmond Parks and Recreation Department, the Society for Preservation and Urban Resources (S.P.U.R.), and Richmond's Resource Inventory Council (RIC), Meijer, and Barrett Paving and Materials.

Public Participation

Friends of the Middle Fork held their first two public meeting during the winter of 2003. These meetings allowed the committee to explain the watershed project and allowed citizens to voice their opinions about their concerns. Public meetings continued throughout the duration of the watershed project allowing the committee to update stakeholders on their findings and discuss new information. Meetings were well attended and provided a good baseline of what people living in the watershed were concerned about, which is a vital component of the management plan.

Media Partners

Local media sources were vital in advertising stakeholders about the project and public events. The Palladium-Item, Richmond's Daily newspaper, published a story about the project and printed several press releases about watershed events. Local radio stations WFMG- 101.3 and Kicks 96 also helped publicize events. These advertisements helped make watershed activities successful.

1.2 Public participation

Public outreach in the watershed began with meetings which were held at the Middleboro Christian Church in 2000 to promote the LARE Project. Coordinator Don Berger and IDNR resource specialist Dale Leising continued to make personal contacts with landowners throughout the project. Approximately $180,000 of LARE cost-share monies were allocated during the life of the project. Table 1.2 shows the projects through the LARE grant.

Table 1.1

Watershed Projects Completed 2000-2002
through the Lake and River Enhancement Grant

1. Waterways…………………...45 projects (totaling 47,750 feet)
2. Grade Stabilization…………3 structures installed
3. Riparian buffers……………..9.8 acres
4. Filter strips…………………...3 acres
5. Wind breaks………………....1.6 acres
6. Grass plantings………………30 acres
7. Spring developments………..1 project

Friends of the Middle Fork held their first two public meetings during the winter of 2003 where they discussed the watershed planning process and provided an opportunity for landowners to voice their concerns. The open-forum sessions at each meeting allowed the committee to gain baseline information about the watershed. The majority of the publics concerns included: negative effects of agriculture, failing septic systems, and negative visual effects of the river. Many residents were also concerned about Barrett Paving Material's impact on the River. A list of public concerns is shown below:

Public stakeholder concerns:

1. Bacterial contamination
    a. human source from failing septic systems
    b. livestock source from stream access
2. Manure application to fields: is it being done properly?
3. Visual degradation of the river
4. Sedimentation problems:
    a. high turbidity
    b. cut banks
    c. siltation
    d. streambank erosion

5. Suburban homeowner’s contribution to pollution: oil, fertilizer, herbicides, etc.
6. Barrett Paving Material’s effect on water quality
7. Ohio’s impact on the river’s quality

In addition to public meetings, local residents were also involved in other events such as watershed field days and workshops. Events taking place in the watershed included: a Forage Field Day, Wetland Clinic, Watershed Field Day, and Forestry Clinic (See Appendix B for details). Experts discussed the important of healthy watersheds and gave examples of good ways to promote clean water at each meeting. Many watershed residents and other concerned residents attended these well-publicized events, many of which were co-sponsored with the Wayne County SWCD.

FOMF have also been visible in the community by having informative displays and children’s educational events including: Conservation Ag Days, Hook-a-Kid on Fishing, Middle Fork Reservoir Clean-ups, Kid’s Create, America Recycles Day, a Boy Scout Troop Presentation, Cope Environmental Center’s Earth Day event, school group education, and the Wayne County 4-H Fair. Through these events more than 3,000 local residents and children have been informed about the watershed project.

Watershed landowners and other concerned parties receive a bi-monthly newsletter which informs and educates about water quality issues. The mailing list is kept up-to-date and additions are made on a regular basis. All watershed events are advertising through mailings, radio announcements, and newspaper press releases.

Stakeholder Survey
Friends of the Middle Fork conducted a mail survey during summer 2003 which asked for information about landowner practices within the watershed boundaries. Approximately 15 percent (88 of 650) of surveys mailed were returned. A copy of the survey questionnaire is located in Appendix F.

Results from the surveys gave good information concerning landowner’s management of their land both residential and agricultural. They also helped us determine areas that need to be addressed, which are listed below.

1. **Lack of septic system maintenance**- Many people responded that they were unaware of the last time their septic systems had been inspected or that it had been at least five years since the last inspection. Also, many comments were made concerning fear of biological contamination due to failing septic systems. The majority of the concerns came from landowners living near to town of Middleboro.

2. **Agricultural Effects**- Livestock having access to the river was another of the steering committee’s concerns after reviewing the returned surveys. Six returned surveys stated that livestock had access to the river and/or its tributaries during certain times of the year. These totaled to a potential of more than 250 cattle and horses with access to waterbodies at any given time, which is a possible cause of bacterial contamination.

3. **Forested Lands-** The surveys also showed that many residents were interested in timberstand improvement and tree plantings. As a result of the surveys, District Forester, Jayson Waterman, was invited to speak about timberstand improvements and tree plantings at the public meeting held during November 2003.

Information was mailed to residents by request and many newsletter articles addressed stakeholder concerns which arose through the surveys. An original copy and all returned surveys are on file at the Wayne County SWCD office, along with a spreadsheet containing the survey results (see Appendix F).

1.4 Total Maximum Daily Load

When a waterbody is listed on the Section 303(d) list the Clean Water Act requires that the state creates a total maximum daily load (TMDL) for the waterbody in order to achieve compliance with the water quality standards. The Middle Fork Reservoir (14-digit hydrologic code #050800003070040) is listed as #194 on the 2004 IDEM 303d list. The parameters of concern for the reservoir are taste, odor, and algae. A TMDL has not yet been developed within the watershed. When it is time for IDEM to create a TMDL the Friends of the Middle Fork will assist in making any information or data about the watershed available. See section 3.1 for additional TMDL information.

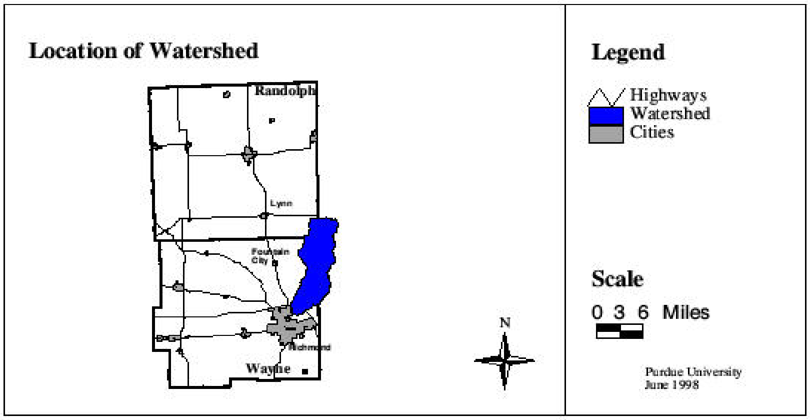
2.0 The Watershed

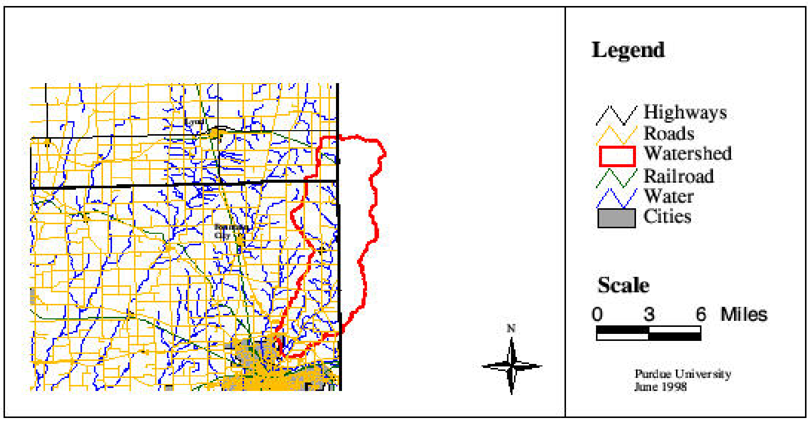
2.1 Watershed location

The Middle Fork Watershed is located in Northeastern Wayne County and extends north into the southeastern corner of Randolph County. The watershed also continues into Darke and Preble counties in Ohio. The total watershed consists of nearly 30,000 acres, which are nearly evenly divided between Indiana and Ohio. The watershed lies within the 1,329 square mile Whitewater River Basin. About two miles east of the Indiana-Ohio state line, the Whitewater River joins the Miami River, which empties into the Ohio River at the intersection of Indiana, Ohio, and Kentucky (DNR, 1988).

Figure 2.1: Public Water Supply Watershed Map

Indiana - American Water Company, Inc. (Richmond Division)





Source: Purdue's Safe Water Website
www.ecn.purdue.edu/safewater/watershed/maps/community/richmond

2.2 Description and History

Natural History

The watershed is comprised of glacial outwash deposits of silty sand and gravel. The parent material of the soils in Wayne and Randolph counties were deposited by glaciers or by meltwater from glaciers which covered the county 10,000-20,000 years ago. The stream network becomes more deeply incised into the valleys at downstream locations. The region is part of the till plains section of the Central Lowland Province of the United States, with the watershed being located in the Tipton till plain. The bedrock geology consists of Silurian Rocks of limestone, dolomite, siltstone, and shale. The watershed is within the southern limit of the Wisconsin Glacial Movement (Indiana Water Resources, 2003).

Watershed Climate

The Middle Fork Watershed's average annual temperature lies between 49-50 degrees Fahrenheit, with average annual precipitation between 39-41 inches. The graphs below show normal monthly temperature and precipitation rates for the watershed.

Table 2.1: Watershed Precipitation Norms

Monthly 1971-2000 Precipitation norms for Richmond according to Purdue Meteorology Climate data sets

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
2.44	**2.33**	**3.35**	**4.19**	**4.89**	**4.41**	**4.18**	**3.51**	**2.80**	**2.81**	**3.55**	**3.05**	**41.41**

Table 2.2: Watershed Temperature Norms

Monthly 1971-2000 Mean Temperature (degrees F) norms for Richmond according to Purdue Meteorology Climate data sets

Jan	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
25.7	**29.9**	**40.3**	**50.4**	**61.0**	**69.6**	**73.1**	**71.0**	**63.8**	**52.1**	**41.4**	**30.8**	**50.8**

2.3 Land Use

The watershed land area was originally obtained by the United States of America on August 13, 1793 in the Treaty of Greenville. The first settlement in Wayne County was made in the early 1800s when settlers from Kentucky and Pennsylvania took up land along the river. Quaker settlers from North Carolina settled near the area which is now the town of Middleboro. The river furnished water power mill sites within the watershed which began operating during the 1820s. One of the areas first businessmen was Jeremiah Cox, Jr., son of Richmond founder, Jeremiah Cox, Sr. Mills became abundant throughout the watershed due to the gradient drop which allowed ideal locations for linseed oil, flax, grist, and saw mills. Today few businesses remain within the watershed boundaries, but agriculture remains prevalent.

Of the total land area within the boundaries, Indiana and Ohio land practices consist of the following according to land-use records from IDEM found in Table 2.3.

Table 2.3: Indiana and Ohio Land Use Data

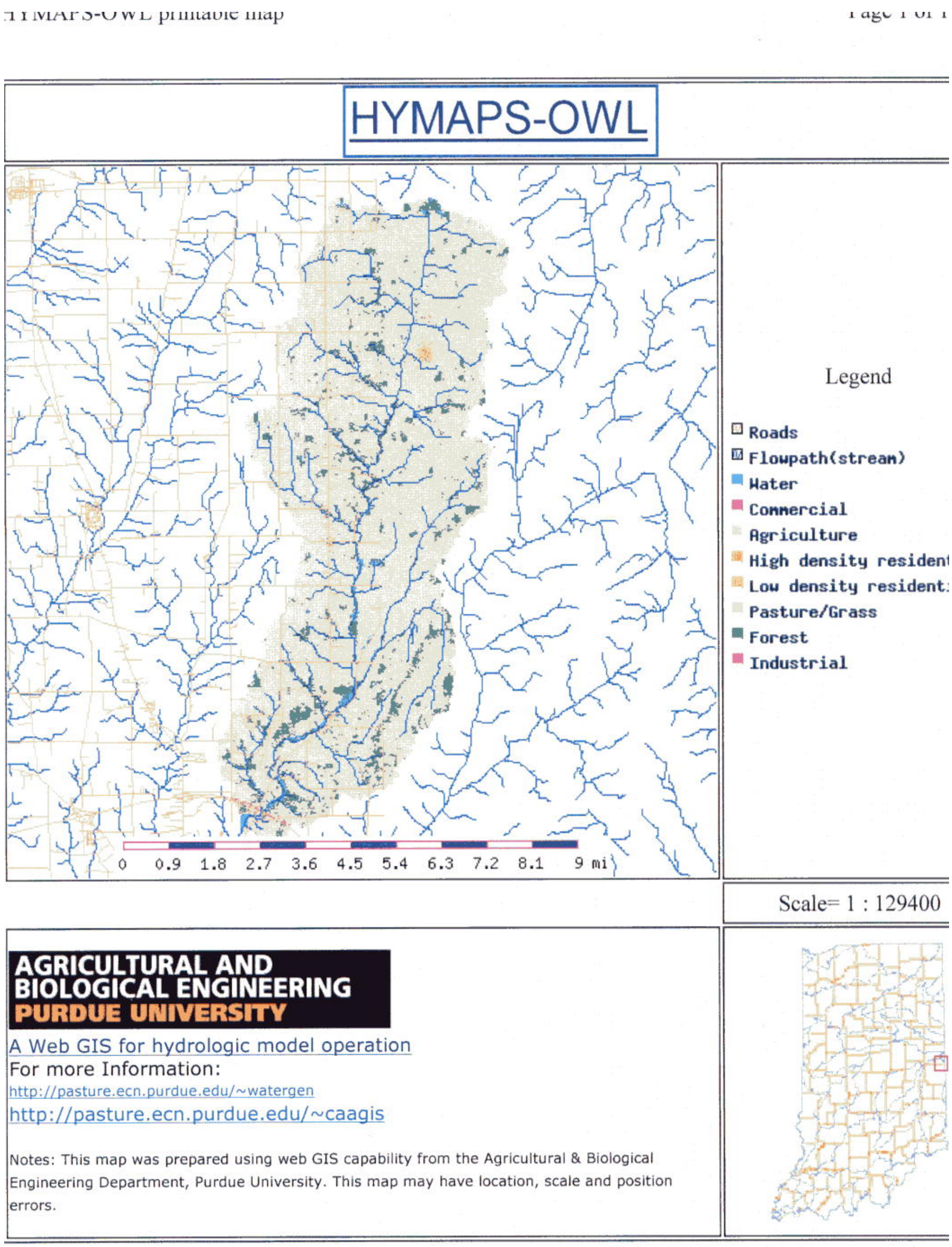
Watershed Land Use for Indiana and Ohio

Agricultural (row crops)	**23,434.3 acres**

Agricultural (pasture)	**3,652 acres**
Residential	**81.8 acres**
Commercial	**30.3 acres**
Forest	**2,379.5 acres**
Water	**253.8 acres**
Total	**29,831.7 acres**

(Statistics from Purdue University, Watershed Delineation Program)

Figure 2.2 Watershed Land Use Map



Watershed Delineation Program by Jin-Yong Choi and Bernard A. Engel,
Agricultural & Biological Engineering Department, Purdue University

2.3.1 Agriculture

Agriculture is by far the most abundant land use within the watershed consisting of more than 78 percent (23,434.3 acres) of the total land use for row crops and another 12 percent (3,652 acres) for pasture, according to Purdue University's watershed delineation program. Agricultural lands are distributed nearly evenly throughout all locations of the watershed, but slightly more predominant to the north. Due to the vast amount of farmland, agricultural areas have been a major focus of the watershed planning process. Throughout the project information has been gathered concerning the status of farmland and farming practices which could have possible negative effects on local water quality. More than 50 percent (6,160 acres) of row crop acres in Indiana and Randolph County are classified as highly erodible land. Even with the best management this land can create significant erosion leading to water quality problems.

Tillage Practices

A major concern of the steering committee is excess soil erosion from improperly managed cropland. Soil erosion not only decreases the quality of the farmland, but it also pollutes local waterbodies by transporting sediment, pesticides, herbicides, and nutrients to waterways. Conservation tillage is an ideal approach to reducing soil erosion within the watershed. Conservation tillage benefits farmers by reducing the amount of topsoil lost each year and increasing local water quality. These practices keep more residue in place on the soil surface which traps water and creates shade to reduce evaporation. During recent years conservation tillage practices have dramatically increased throughout the watershed area.

According to Wayne County tillage transects conducted during the spring of 2004, approximately 85 percent of corn and 92 percent of soybeans fields within the county are planted using conservation tillage practices (leaving at least 30% residue). Through visual observations we assume that tillage rates are similar within the watershed. Although tillage practices are relatively good throughout the area, the need for improved tillage practices continues. When conducting watershed surveys the steering committee noted cropland throughout the watershed which would have benefited from more residues being left on the surface. The increase of conservation tillage practices will be focused on farmland located near the Middle Fork Reservoir as well as sub-watersheds with the highest percentages of cropland.

The committee will continue to educate landowners on the benefits of switching to conservation tillage practices. Through education and offering financial incentives through the cost-share program we should continue to see an increase in these practices within the watershed.

Livestock Practices

Figure 2.3: Cattle with access to Mud Creek

There are approximately 20 cattle producers within the watershed. Of these, at least 10 producers have more than 30 head. There is one large hog operation with more than 200 animals and a few small horse operations within the watershed, most with less than a dozen animals. All together there are approximately 1,228 livestock animals located within the Indiana boundaries of the watershed including dairy cattle, beef cattle, swine, horses, and chickens. Currently no Confined Animal Feeding Operations (CAFOs) are located within the watershed.

Due to the number of animals within the watershed boundaries livestock has become a major concern of the steering committee. Through visual observations made by committee members and results of public surveys we know that many of the animals have access to the river or its tributaries during the year. This direct contact allows contamination to the river and other waterways. Manure is a source of nutrients such as nitrogen and phosphorus. The fecal matter can also transport *E. coli* bacteria and other pathogens which can cause illness in humans. In addition to the bacterial pollution through fecal material, livestock with water access also destroy streambank and streambank vegetation when accessing the waterways.

Figure 2.4: Streambank erosion and loss of vegetation due to livestock access

2.3.2 Developed/Residential Areas

Approximately 252 acres of the watershed are urbanized according to landuse information. In addition, using the watershed delineation program L-THIA on the Purdue website it was determined that 595.6 acres or 1.99 percent of the entire watershed land area is classified as impervious surface.

The small urban centers of less than 100 residents include the towns of Middleboro, Whitewater, and Bethel. It's also important to mention the small towns of Hollansburg and Glen Karn located within Ohio. Several small urban housing developments have also been constructed during the past 20 years. Country housing additions, as with any construction within the watershed boundaries, pose a threat to sedimentation and loss of natural habitat. The addition of households and residents can also mean added threats of household hazardous waste, which has the potential of contaminating water if disposed of or applied incorrectly. We know this development does create some added stressors upon the watershed, but at the current time does not seem to pose a serious threat.

Although the highly populated regions of Richmond do not lie within the watershed boundaries it is important to note that the Middle Fork Reservoir provides more than 50 percent of the drinking water to the city of more than 40,000 people which ranks 15th on Indiana's Most Populated Places in Indiana. (Wilson, 2003)

There is concern about the maintenance of septic systems within the watershed because every residence is responsible for maintaining their own system. The Wayne County Health Department was contacted about this issue, but had no useful information concerning watershed septic issues.

2.3.3 Wetlands

Wetlands are biologically diverse and serve as an important component of the environment. They provide wildlife habitat, act as water filtration systems, and help to control flooding. There are very few existing natural wetlands in Wayne or Randolph County. Assuming that wetland trends for Wayne County and Randolph County hold true for the watershed, we assume that natural wetlands only make up between 2.5-2.9% of the land area and is among the lowest of the Indiana's counties. It has been estimated that Indiana has lost 87% of its original wetlands since the time of European Settlement (Wilson, 2003).

At least two wetlands have been created within the watershed boundaries during the past six years. Don Berger created a wetland to act as a manure filtering system for his dairy farm east of the town of Whitewater. Robert Corrigan created a wetland at his residence on Turner Road for aesthetic and wildlife purposes. He also held a public field day during the summer of 2004, which was hosted by Friends of the Middle Fork.

Figure 2.5: Kevin Tungesvick discusses hydrophilic plants at a Wetland Clinic held at Robert Corrigan's during the summer of 2004.

2.3.4 Industrial/Commercial Locations

The only industry located within the Indiana boundaries is Barrett Paving Materials. Barrett's is one of the largest limestone quarries in the state producing crushed limestone an gravel to the construction industries located in the region.

Industry with discharge permits

All point source discharges into United States waters must be regulated by the National Pollution Discharge Elimination System (NPDES) according to the Clean Water Act. Point sources include channels such as pipes or man-made ditches that flow directly into surface water.

The Permit Compliance System is a national information system designed to support the NPDES program. Permits established by the program and managed by each individual state provide pollution limits and specify monitoring requirements for these point sources. IDEM has permitted one facility, Barrett Paving Materials (IN0030988), within the watershed boundaries, as of January, 2005. Located at 5834 Inke Road, Barrett's has not exceeded acceptable water quality parameters according to IDEM's reports. The facility has permits to discharge the following chemicals/substances through the points (pipes) listed: pH, total suspended solids, in conduit flow, chemical oxygen demand, storm water flow, oil & grease, nitrogen, nitrite plus nitrate, and phosphorus.

Figure 2.9: One of two sediment ponds located at
Barrett Paving Materials Stone Quarry.

Other businesses located within the watershed are the KOA and Grandpa's Farm Campgrounds which advertises fishing and recreation within the Middle Fork River in located along the river on State Road 227 North. Highland Lake Golf Course, which is managed by Richmond Park's Department, is another recreational business located within the watershed.

2.3.5 Forestry

Approximately 12 percent of the watershed land area is forested. Forests provide many benefits including slowing rainwater so that it can be absorbed into the ground, as well as filtering pollutants and sediments from the water. They also help replenish aquifers and keep annual streamflows steady. Forests contain diverse plant and tree species and provide habitat for local wildlife.

Indiana's classified forest program is designed to preserve private forests. Forests of 10 acres or more are current eligible to be entered into the program, previously only three acres were required for the program and some of these small tracts were grandfathered into the current program. The classified forests must support growth of native or planted trees, which have been set aside for the production of timber and wildlife, protection of watersheds, and the control of erosion. (DNR, Division of Forestry – Classified Forest Program) These acres cannot be pastured or burned and must be posted with signs.

Information provided by the local DNR district forester Jayson Waterman showed that eight tracts comprising of 151.019 acres of forested land within the watershed have been classified. Current landowners of classified forest include: Kirby Hiller, Lena Callahan, Carol Everman, Robert Marcum, Mark Campbell, Dale Spencer, and John Pearson.

2.4 Soils

According to tillage transects complied in 1996 by the Natural Resources Conservation District the Wayne County cropland within the watershed was eroding an average of 5.2 tons of soil per year and more than 6,000 acres were eroding above tolerable (T) levels. Although improvements have been made during more recent years, we assume that these calculations remain fairly consistent.

Table 2.4: Watershed soil erodibility

Soil Erodability within the Middle Fork

(gathered from Wayne and Randolph County Farm Service Agencies)

	Wayne Co.	Randolph Co.	Total
Size	15,500	1,850	17,400
Cropland	9,680	1,720	11,400
Highly Erodible Cropland (acres)	5,230	930	6,160
Agricultural tract 10 acres or more	162	25	187

General soil classifications can be used to compare the suitability of large areas for general land uses. The major soil classifications give a general idea of soil conditions located within the watershed. The parent materials of the soils in the watershed were deposited by glaciers or by meltwater from the glaciers, which covered the watershed area from 10,000-20,000 years ago. Some of the materials were worked and redeposited by the subsequent actions of water and wind.

The dominate soil type within the watershed is the Crosby series. This series consist of deep somewhat poorly drained, slowly permeable soil on till plains and moraines. Almost all of the soils within the watershed have severe limitations for septic systems including poor filtering and slow peculation. These unfavorable conditions often require special design and increased maintenance for properly running systems. The major soil classifications which exist in the watershed are listed below.

Major soil classifications:

Eldean-Oakley association: Nearly level to strongly sloping, well drained soils that are moderately deep and deep to sand and gravel and formed in outwash and in loess and outwash; on uplands

Miami-Crosby-Strawn association: Deep, nearly level to very steep, well drained and somewhat poorly drained soils formed dominantly in glacial till, on uplands.

Crosby-Treaty association: Deep, nearly level and gently sloping, somewhat poorly drained and very poorly drained soil formed in loess and glacial till; on uplands.

Crosby-Losantville-Treaty association: Deep, nearly level to moderately sloping, somewhat poorly drained, well drained and very poorly drained soils formed in glacial till and in loess and glacial toll, on uplands.

(Source USDA, Soil Survey of Wayne County, Indiana, 1987)

2.5 Topography

The watershed is located within the Tipton Till Plain and has nearly flat to gently rolling topography characterized by morainal deposits. The table below taken from the USDA's Flood Hazard Analyses study shows the average gradient change within different locations of the watershed.

State's Highest Point

At 1,257 feet the highest elevation point in Indiana is located within the boundaries of the watershed in Wayne County. This location is in a wooded area northwest of the town of Bethel on Elliott Road and is marked by a pile of field stones supporting a wooden sign. The highest point attracts hundreds of people each year. A logbook for guests is located at the site for people to sign their names and share any interesting tales.

Table 2.5: Watershed Topography

Middle Fork of the East Fork of the Whitewater River Topography

	Average gradient (feet/foot)	Average 100-year floodway velocity (feet/second)	
		Channel	Overbank
Mouth to Reservoir	0.0035	5-7	2
Reservoir to Inke Road	0.0030	4-7	2-3
Inke Road to Wallace Road	0.0020	2-4	1-2
Wallace Road to Ohio Line	0.0025	3-4	2-3

(Source: Flood Hazard Analyses, USDA SCS, December 1976)

Floodplain Information

The 100-year flood plain along the Middle Fork encompasses 1,150 acres. Even though this hazard area is primarily agricultural land, damages to urban properties near the stream are a concern. The reservoir provides a small amount of flood control, but was not designed for that purpose. (Source: Flood Hazard Analyses, USDA SCS, December 1976)

2.6 Hydrology

The watershed has a strong network of streams consisting of more than 50 miles of both perennial and intermittent tributaries. The largest tributary is Mud Creek, which is located almost entirely in Ohio. Other large stream networks include: Evans Creek and White Creek. Many small streams, many unnamed, drain directly into the Middle Fork Reservoir. The streams within the watershed have remained generally unaltered in most Indiana locations of the watershed. There has been some significant channalization done along to headwaters in Ohio. Fortunately the headwaters generally have low water flows year-round and all are well-buffered. The entire drainage area of the watershed is nearly 49 square miles with nearly 29 located within the state Indiana boundaries. The table below shows the drainage area of the watershed at different locations.

Table 2.6: Drainage Area of Watershed

Drainage Areas of the Middle Fork of the East Fork Whitewater River

	Drainage Area – Square Miles			
Stream Location	**Indiana**	**Ohio**	**Total**	River
above Mud Creek	16.2	13.0	29.2	
River including Mud Creek	16.6	19.5	36.1	
River at mouth	28.5	20.2	48.7	

(Source: Flood Hazard Analyses, USDA SCS, December 1976)

Sub-watersheds

In order to gain more information about the watershed the steering committee enlisted the help from the Wayne County Surveyor's Office to create a sub-watershed map. By using Purdue's Watershed Delineation Program the committee was also able to determine the landuse for each of the 16 delineated sub-watersheds. The graph located in Figure 2.7 also shows sub-watershed land distribution. It's important to note that there are more sub-watersheds within the study location which were too small to be delineated by the Purdue Program.

The watershed has a strong network of streams consisting of more than 50 miles of both perennial and intermittent tributaries. The largest sub-watershed by far is the Mud Creek sub-watershed which drains more than 4,000 acres, mostly in Ohio. Two other large sub-watersheds worth mentioning include: Evans Creek, which drains 1,510 acres and White Creek which drains 2,033 acres. The map in Figure 2.6 created by the Wayne County Surveyor's Office, shows the delineated sub-watersheds with available names and acreage.

Figure 2.6: Sub-watershed Map

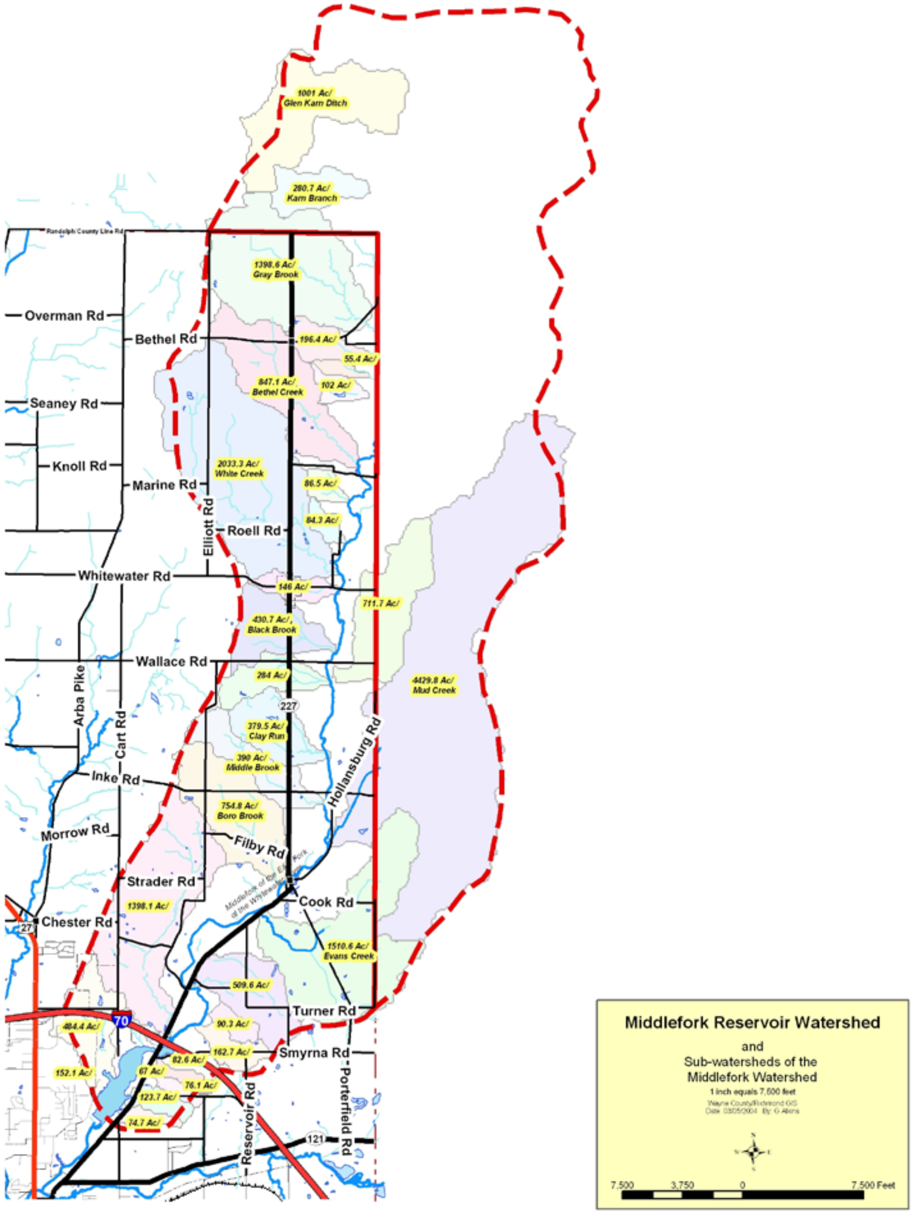


Table 2.7: Sub-watershed Land Use Data

Sub-watershed Land Use

	Watershed Name	Total Acreage	Agriculture (Row Crops)	Pasture – Grassland	Forest	Residential, Commercial & Water
1	No Name 1	1,409.3	946 (67.13%)	287.2 (20.4%)	161.5 (11.5%)	14 (1.0%)
2	No Name 2	514.5	356 (69.19%)	109.6 (21.3%)	46.1 (8.9%)	2 (0.4%)
3	Evans Creek/Spring Run	1,428.1	917.3 (64.2%)	295.6 (20.7%)	200.3 (14.0%)	14.8 (1.0%)
4	Boro Creek	768.2	582.1 (76.3%)	105.4 (20.7%)	72.1 (9.5%)	3.3 (0.4%)
5	Mud Creek	4,475.8	3,677 (82.2%)	438.6 (9.8%)	341.1 (7.6%)	18.2 (0.4%)
6	Middle Brook	391.7	317.3 (81.0%)	55.7 (14.2%)	116.4 (4.2%)	1.9 (0.5%)
7	Clay Run	373.9	231.9 (62.0%)	96.0 (25.7%)	40.9 (10.9%)	4.6 (1.2%)
8	No Name 3	720.2	624.1 (86.7%)	65.6 (9.1%)	18.7 (2.6%)	11.5 (1.6%)
9	Black Brook	410.2	358.5 (87.4%)	42.7 (10.4%)	7.9 (1.9%)	1.1 (0.3%)
10	No Name 4	114.9	104.7 (72.3%)	24.1 (16.6%)	3.8 (2.6%)	12.0 (8.3%)
11	White Creek	2,065.1	1,771.3 (85.8%)	186.6 (9.0%)	110.8 (5.4%)	8.1 (0.4%)
12	Bethel Creek	838.8	647.1 (77.2%)	90.6 (10.6%)	98.5 (11.7%)	2.4 (0.3%)
13	No Name 5	185.7	156.8 (84.4%)	19.0 (10.2%)	7.9 (4.3%)	2.1 (1.1%)
14	Gray Creek	1,377	1,224.3 (88.9%)	87.4 (6.3%)	63.7 (4.6%)	1.1 (0.1%)
15	No Name 6	552.7	524.8 (95.0%)	23.9 (4.3%)	3.7 (0.7%)	0.2 (0.1%)
16	Horn Ditch	308	273.1 (88.7%)	17.0 (5.5%)	13.0 (4.2%)	4.3 (1.4%)
Total Acres		15,959.1	12,712.3 (79.7%)	1,945 (12.2%)	1,206 (7.6%)	101.6 (0.64%)

* Note: not every intermittent stream was able to be calculated, so this graph does not represent the total watershed. Some watersheds include land in Ohio.

Figure: 2.7: Sub-watershed land distribution

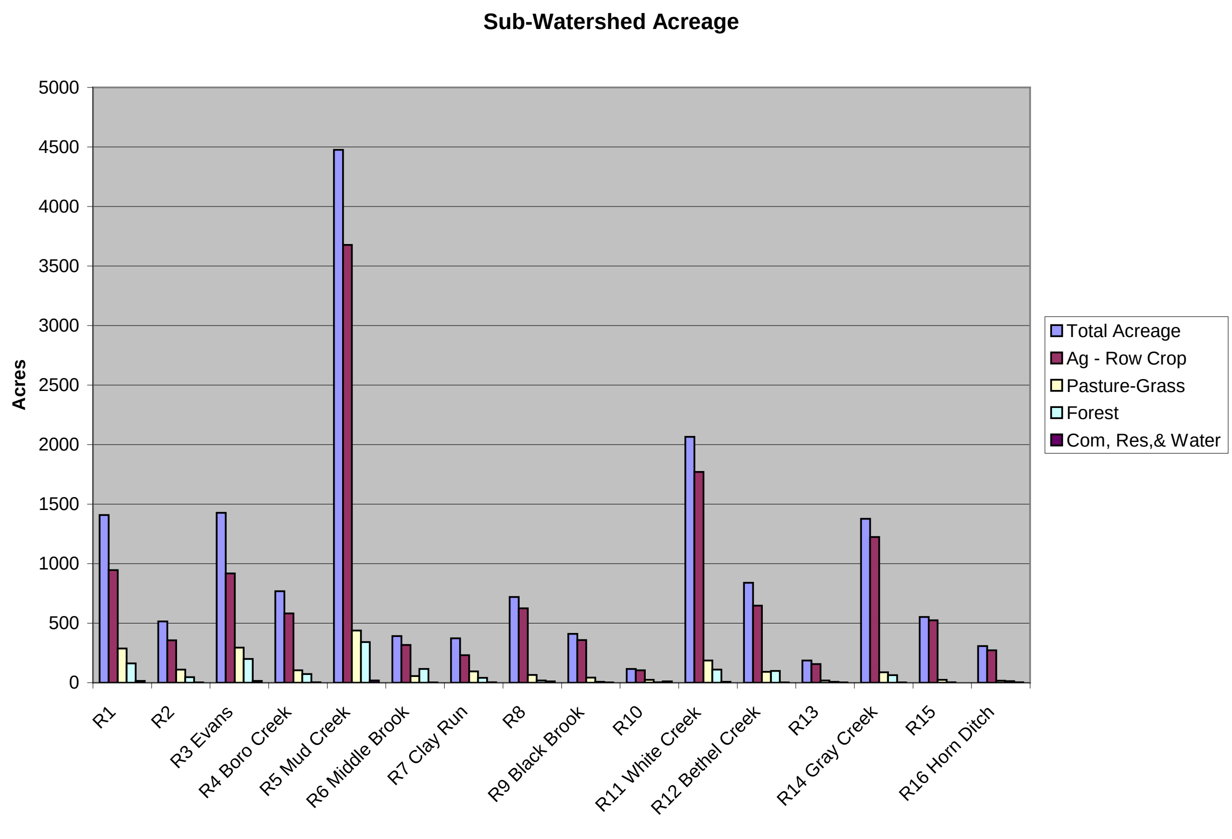


Figure 2.8: The Middle Fork Reservoir

Aerial photo courtesy of Indiana American Water Company

The 177-acres Middle Fork Reservoir (Public Water Supply #5289012) was built in 1960 and had an original holding capacity of 1.1 billion gallons. The reservoir was created to serve as a municipal water supply, but it also has a minor flood reduction benefit and provides a public area for recreational opportunities. The Middle Fork of the East branch of the Whitewater River flows into the north end of the reservoir. The northernmost section of the reservoir consists of a wetland area with many hydroponics plants and animals.

The reservoir was purchased by the Indiana-American Water Company in 1980. The water company uses the reservoir as its main supply for the city of Richmond's drinking water. On average, the water company withdraws three million gallons of water per day which is slightly more than 50 percent of the average daily usage rates.

The 350 acres of land surrounding the reservoir are managed by Richmond Parks and Recreation. In addition to water activities the property also provides a playground, sand volleyball courts, fish cleaning station, three shelters, and a main office. The Indiana Department of Natural Resources regularly stocks and inventories the fish within the Reservoir. The latest report conducted in 2003 showed that the reservoir contains northern pike, large mouth bass, bluegill, channel catfish, white crappie, longeared sunfish, golden shiner, brown bullhead, green sunfish, tiger muskie, pumpkin seed sunfish, and hybrid sunfish. The reservoir is well-used by recreational anglers and for yearly fishing tournaments for adults and children.

During its first 25 years (1960-1985) the Indiana-American Water Company estimated that nearly one-quarter of its original holding capacity was lost due to sedimentation. According to this figure the reservoir has lost 5.2 million gallons of water capacity each year since its creation.

In 1998 the reservoir was added to IDEM's 303d list of impaired water bodies citing the restriction of fish consumption due to mercury contamination. In 2004, the reservoir was removed for the mercury contamination and listed as impaired due to algae, taste, and odor. High levels of the herbicide atrazine which have been detected within the reservoir by the Indiana-American Water Company is another cause for concern

2.7 Land Ownership

The watershed consists of nearly all private lands. The size of properties range from small house lots within the small towns to large farms consisting of hundreds of acres.

Indiana-American Water Company owns the 177-acre Middle Fork Reservoir and 350 surrounding acres. The surrounding property is managed as a public park by Richmond Parks and Recreation. The Park's Department also owns and operates the public Highland Lake Golf Course which is located north of the Reservoir. Part of Indiana University East's campus is also located within the watershed boundaries.

Another large landowner and the only company located within the watershed is Barrett Paving Materials. The large stone quarry is expected to expand their acreage of excavated land they already own by purchasing surrounding land.

2.8 Endangered and Exotic Species

A list of endangered species of each Indiana county was developed by the Indiana Department of Natural Resources, Division of Nature Preserves in 1999. Tables 2.8 and 2.9 below list species for Wayne and Randolph counties which have been placed on the state and/or federal endangered, threatened, or rare species list. Loss of natural habitat is the greatest cause of many animals to be placed on this list. Many of the animal species suffer due to the loss of wetlands, forestlands, and other natural areas. Aquatic species are often listed due to increased sedimentation of waterways, channelization, and increased water pollution.

Figure 2.10 – Rusty Crayfish

It is also important to note that Rusty crayfish (Orconectes rusticus), an invasive crustacean, have been found numerous times during water monitoring events. These crayfish are recognized by the rusty-red spots located on their carapace. These crayfish are more aggressive than native crayfish and can harm native fish populations by eating their eggs and young.

Table 2.8: Endangered Threatened and Rare Species from Wayne County
(Indiana Department of Natural Resources, Nature Preserves 1999)

Common Name	State Rank	Federal Rank
Vascular Plant		
Butternut	WL	**
Ground Juniper	SR	**
Heart-Leaved Plantain	SE	**
Calamint	SE	**
Shining Ladies'-Tresses	SR	**
Softleaf Arrowwood	SR	**
Barren Strawberry	SR	**
Arthopoda: Beetles		
Cobblestone Tiger Beetle	SE	**
Arthopoda: Caddisflies		
A Northern Casemaker Caddisfly	SE	**
Fish		
Popeye Shiner	SX	**
Amphibians		
Northern Leopard Frog	SSC	**
Reptiles		
Kirtland's Snake	SE	**
Blanding's Turtle	SE	**
Butler's Garter Snake	SE	**
Birds		
Upland Sandpiper	SE	**
Least Bittern	SE	**
Black-Crowned Night-Heron	SE	**
King Rail	SE	**
Barn Owl	SE	**
Mammals		
Bobcat	SE	**
Indiana Bat	SE	LE
American Badger	SE	**
High Quality Natural Community		
Mesic Floodplain Forest	SG	**
Dry Upland Forest	SG	**
Dry-Mesic Upland Forest	SG	**
Mesic Upland Forest	SG	**
Limestone Cliff	SG	**

Fen	SG	**
Shrub Swamp	SG	**

State: SE= endangered, SR= rare, SSC= special concern, SG= significant, SX = extirpated, WL= watch list
Federal: LE = endangered, **= not listed

Table 2.9: Endangered Threatened and Rare Species from Randolph County (Indiana Department of Natural Resources, Nature Preserves 1999)

Common Name	State Rank	Federal Rank
Vascular Plants		
Heavy Sedge	SE	**
A Hawthorn	SE	**
Small Yellow Lady's-Slipper	SR	**
Small White Lady's-Slipper	SR	**
Orange Coneflower	SR	**
False Asphodel	SR	**
Marsh Arrow-Grass	ST	**
Mollusa: Bivalvia (Mussels)		
Purple Lilliput	SSC	**
Reptiles		
Kirtlands Snake	SE	**
Birds		
Sedge Wren	SE	**
Loggerhead Shrike	SE	**
Barn Owl	SE	**
Mammals		
Indiana Bat	SE	LE
American Badger	SE	**
High Quality Natural Community		
Central Till Plain Flatwoods	SG	**
Fen	SG	**

State: SE= endangered, SR= rare, SSC= special concern, SG= significant
Federal: LE = endangered, **= not listed

Section 3.0 Establishing Benchmarks

3.1 303(d) list of impaired waters

IDEM conducts a state-wide monitoring program to determine water bodies with major impairments. Section 303(d) of the Clean Water Act requires states to identify waters that don't meet applicable water quality standards. States are required to develop a priority ranking for these waters taking into account the severity of the pollution and the designated uses of the waters. Water quality assessment includes: physical/chemical water results, fish community assessment, benthic aquatic macroinvertebrate community assessments, fish tissue and surficial sediment contaminant results, habitat evaluation, and E. coli monitoring results. Once this listing and ranking of waters is completed, the state is required to develop Total Maximum Daily Loads

(TMDLs) for these waters in order to achieve compliance with the water quality standards. The Middle Fork Reservoir (14-digit hydrologic code #050800003070040) is listed as #194 on the 2004 IDEM 303d list. The parameters of concern for the reservoir are taste, odor, and algae.

According to IDEM's website the EPA has set secondary standards established through the National Drinking Water Regulations for taste and odor. These secondary standards are impairments which are not health threats and public water systems test them on a voluntary basis. The EPA monitors these parameters because they can cause people to quit using water from their public water system, even if the water if safe to drink. Present methods of measuring taste and odor are subjective. Causes of odor and taste impurities can be due to a variety of sources. Due to the fact that algae are also listed as impairment, it is assumed that algae located in the water are causing the foul taste and odor. For a complete listing of IDEM's methodology please refer to http://www.in.gov/idem/water/planbr/wqs/notice04.pdf.

Until 2004 the Middle Fork Reservoir was listed on IDEM's 303d List of impaired water bodies for a fish consumption advisory due to high levels of mercury contamination. The primary source of mercury is through industrial actives such as fossil fuel burning, waste combustion, and smelting metals. Many factories in and around the city of Richmond produce mercury as a waste product, but none are located within the watershed boundaries.

3.2 Section 305(b) Report

Section 305(b) of the Clean Water Act requires state to prepare and submit to the EPA a water quality assessment report of state water resources. Yearly approximately 20 percent of the waterbodies in the state are assessed and reported the following year. The Office of Water Quality determines the status for each stream and waterbody according to guidelines provided by the EPA. The results from four tests are complied to provide an assessment for each waterbody, these tests include: (1) physical/chemical water column results, (2) benthic macroinvertebrate community assessment, (3) fish tissue and surficial aquatic sediment contaminant results, and (4) *E. coli* monitoring results.

The 2000 Indiana Water Quality Report (IDEM/34/02/001/2000) reported findings of data collected within the Middle Fork Watershed and Reservoir. The report found the river and Mud Creek to be in full support of aquatic life. The report also found the reservoir to be in partial support of fish consumption due to mercury contamination.

3.3 Fish Consumption Advisories due to Mercury Contamination

Each year since 1972, three state agencies have collaborated to create the Indiana Fish Consumption Advisory. These agencies include the IDNR, IDEM, and the Indiana State Department of Health (ISDH). The Advisory, published annually by the ISDH, provides anglers with health information about eating fish caught from Indiana waters.

The 2003 advisory is based on levels of polychlorinated biphenyls (PCBs) and mercury found in fish tissue. Below is a list of fish consumption advisories within our study area.

Table 3.1

Middle Fork Reservoir - 2003 Fish Consumption Advisory

Fish Species	Fish Length	Contaminant	Group (1-5)
Largemouth Bass	12-18 inches	Mercury	Group 2 – 1 meal/week
Largemouth Bass	+18 inches	Mercury	Group 3 – 1 meal/month

Ranking : Group 1, Unrestricted consumption; Group 2, Limit consumption to 1 meal/week; Group 3, Limit Consumption to 1 meal/month; Group 4, Limit Consumption to 1 meal/2 months; Group 5, Do not eat.

3.4 Biological Monitoring

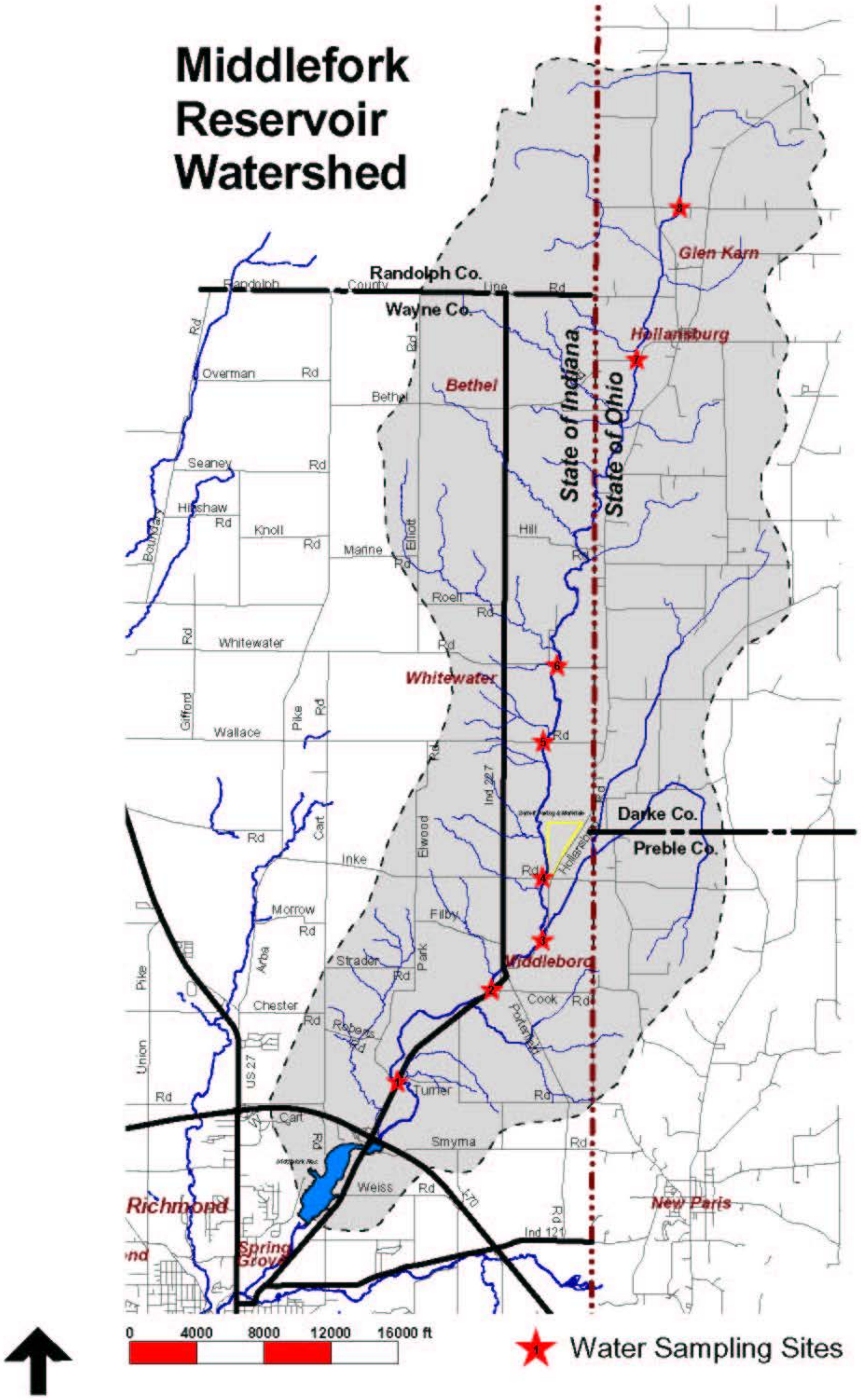
Figure 3.1: Dick Roeper was vital in the collection and organization of water monitoring data for the watershed project.

The Middle Fork Watershed Project included a water monitoring requirement for the 319 grant. Before monitoring began, a Quality Assurance Project Plan (QAPP) was developed to assure that data was obtained with a high degree of accuracy. The technical committee chose eight sites within main channel of the river which bracketed some of the initial concern areas of the watershed. The concern areas include: the town of Middleboro, the town of Hollansburg, and Barrett Paving Materials. The locations, distributed throughout the watershed, were also chosen to give a good overall representation of water quality within the Middle Fork River.

When the Friends of the Middle Fork steering committee formed they listed their top potential water quality concerns. This list included: effects of Barrett Paving and Materials, sedimentation of the reservoir, Atrazine within the water, and failing septic systems within the town of Middleboro.

In order to determine if these concerns were justified the group set out to investigate these potential problems and their sources. Additional monitoring during the planning phase included: nutrients, sedimentation rates, total suspended solids, *E.coli* and biological monitoring through macroinvertebrate monitoring (sampling results found in Appendix M). The monitoring was headed by committee member Richard Roeper, who was assisted by the technical committee and independent study students from Indiana University East. The Indiana-American Water Company also conducts weekly monitoring of the reservoir itself and periodic testing within the watershed. Results of some of this data are included in the plan. Earlham college students also completed a watershed metals study during 2003 with the direction of Chemistry Laboratory Instructor, Mary Hagerman.

Figure 3.2: Watershed Monitoring Locations



Middle Fork Water Monitoring Sites

Site #1: Park Elwood Road and Ind. 227
N39 52.600'

W084 51.275'

Site #2: Above Grandpa's Campground and input of Evans Creek
N39 53.503'
W084 50.060'

Site #3: In Middleboro
N39 53.711'
W084 49.911'

Site #4: Inke Road Bridge
N39 54.115'
W084 49.334'

Site #5: Wallace Road Bridge
N39 54.580'
W08449.384'

Site #6: Whitewater Road Bridge
N 39 55.923'
W084 49.384'

Site #7: East of Hollansburg
N39 59.671'
W084 48,120'

Site #8: Northeast of Glen Karn
N40 01.162'
W084 47.568'

Biological monitoring is an excellent assessment of the overall health of a waterbody. The diversity and presence of intolerant/tolerant macroinvertebrates gives an indication of the waterbodies overall health. The technical committee completed two rounds of macroinvertebrate collections during 2003 and from this they determined a basic assessment of the eight testing locations. In order to complete guidelines set forth in the Quality Assurance Project Plan that was created for the biological monitoring two collection dates were also completed in 2004. The monitoring was based upon Hoosier Riverwatch methods.

Macroinvertebrate Collection Methods
Two methods are used to collect macroinvertebrates at each testing site. The Kick Seine Method is used in riffle areas and requires at least two people to complete. One person holds the net perpendicular to the flow at a slight downstream angle. The net should stretch approximately three feet across with the bottom edge lying firming against the streambed. The second person walks downstream and kicks a three-foot area for about three minutes allowing the substrate to

flow into the net. This method is repeated in at least three locations. The aquatic sweep net method is used in areas without riffles. Using these nets the person collecting should "jab" at least 20 areas of varying substrate around the test site. After 3-4 jabs the net should be dumped into a pan.

After both techniques are completed the monitors should remove all large objects before picking macroinvertebrates out of pans with tweezers. At least 50 macroinvertebrates were collected at each site.

The macroinvertebrates should be immediately placed into jars with a minimum of 25 percent ethyl alcohol for perservation. Within a two-week period the samples should be sorted, counted, and recorded.

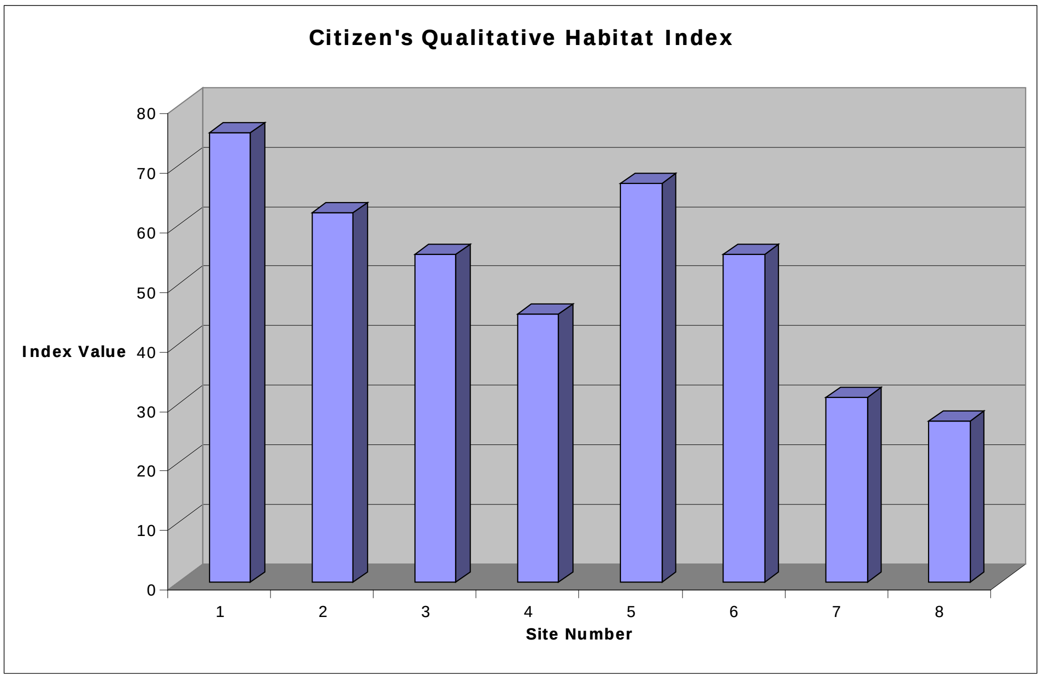
At each test site Hoosier Riverwatch's habitat index was also be completed. If habitat scores are low this could affect the variety and quality of species collected. Once organisms are sorted and counted a pollution tolerance index can also be completed. This data added with other results is also used to determine the average water quality index at each site.

Citizen's Qualitative Habitat Index

The Citizen's Qualitative Habitat Index was used to determine physical health of the testing locations. This Hoosier Riverwatch method measures the condition of the river and its riparian areas by assessment of the following parameters: substrate, fish cover, stream and human alteration, riparian areas, depth, velocity, and riffles/runs. The index values are used to compare conditions between sites. A value over 100 is considered to be a “high quality” stream; while below a value of 60 units are generally reflective of warm water fauna. A set range (excellent, medium, poor, very poor) has not been developed for this index.

Results shown in Figure 3.4 indicate that sites 4, 7, and 8 have the lowest habitat index. Site 4 passes through a pastured area and the channelization of the stream within Ohio (Sites 7 & 8) are the main reasons for their lower index values. Overall the conditions of the stream seem to be in good quality and supports macroinvertebrate organisms.

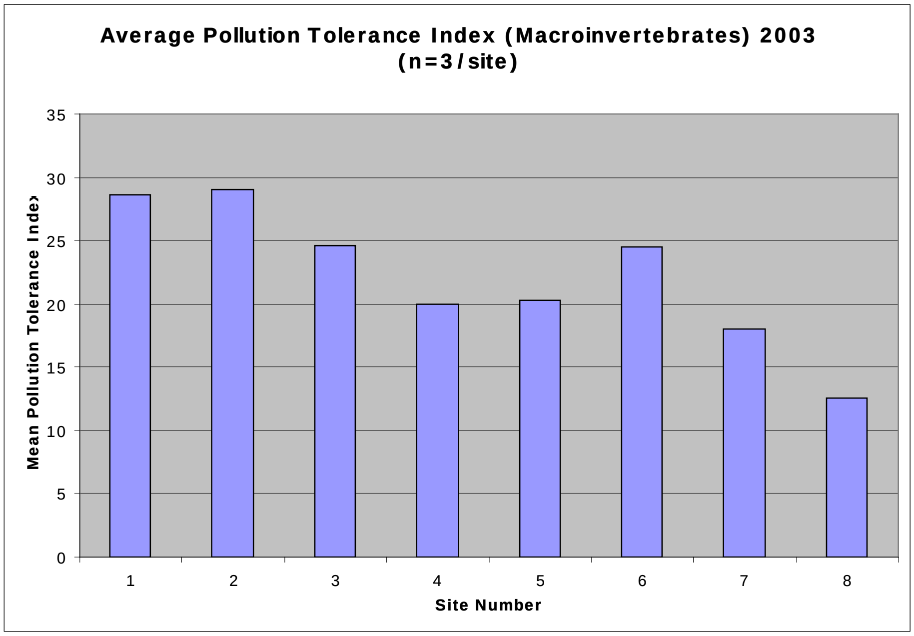
Figure 3.3:



Pollution Tolerance Index

Pollution Tolerance Index (PTI) rankings were completed during the spring and summer of 2003 (Figure 3.5). Pollution intolerant organisms (mayflies and caddisflies), if present, produce a higher index value than pollution-tolerant organisms (midges and bloodworms). Developed by Hoosier Riverwatch this index analyses the collections of macroinvertebrates to determine the health of the stream. The presence or absence of indicator organisms is thus an indirect measurement of pollution. The index scale is: 23 or more = excellent, 17-22 = good, 11-16 = fair and 10 or below = poor. Four of the eight sites (Sites 1, 2, 3, and 6) averaged in the excellent range. Three sites (Sites 4, 5, and 7) were found to be good and only Site 8 was found to be in fair condition. Site 8 is located nears the Middle Fork River's origin, which consists of a channelized ditch and lacks habitat quality to support a healthy macroinvertebrate community. The poor habitat of the testing sites is believed to be the cause of the low PTI index, not severe pollution.

Figure 3.4:

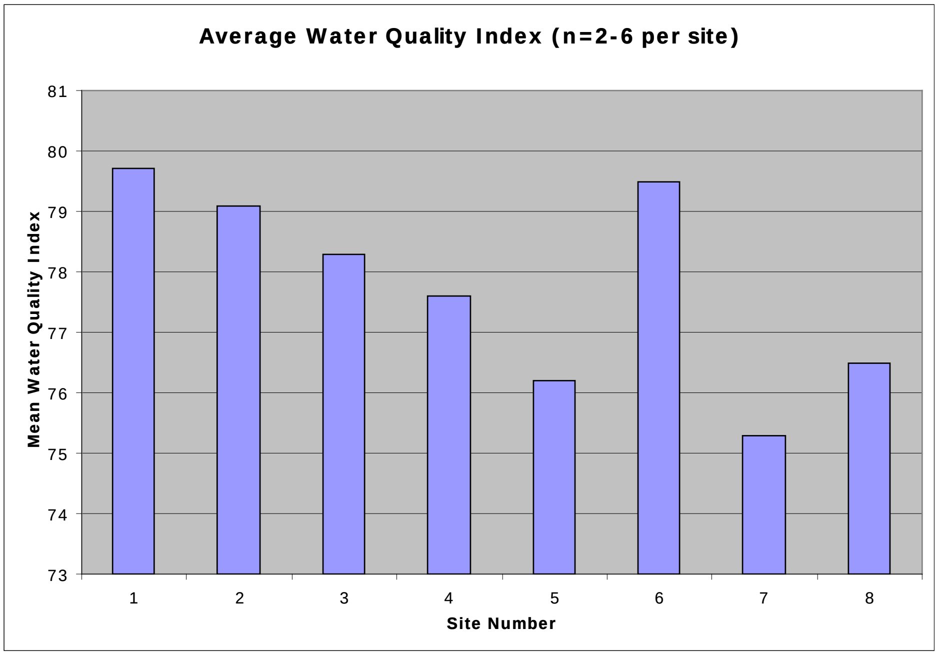


Water Quality Index

The Water Quality Index is a Hoosier Riverwatch method derived from use of eight tests (dissolved oxygen, pH, BOD_5, water temperature change, total phosphates, nitrates, turbidity, and coliform counts). Each test is weighted based on its predetermined importance value and the index indicates the health of the stream. The scale index values are 90-100% = excellent, 70-89% = good, 50-69% = medium, 25-49% = bad, and 0=24% = very bad.

None of the eight sites along the main course of the Middle Fork River were found to be in excellent condition according to the water quality index scale. All sites did range within the good level between 75-80% on the index scale (Figure 3.6). This is an overall indication that although the river has room for improvement, it is healthy and capable of supporting aquatic life.

Figure 3.5: Water Quality Index of eight test sites

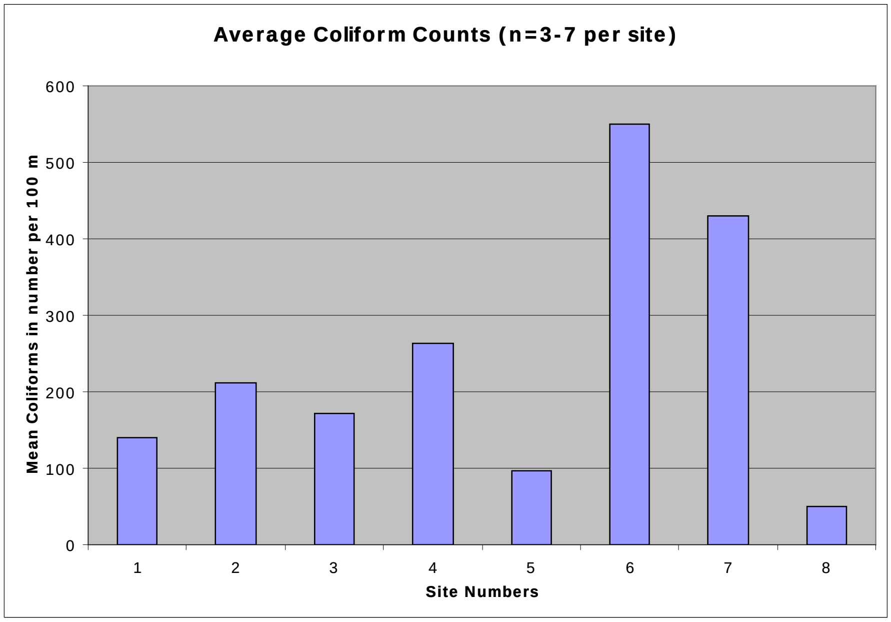


E. coli Bacteria

E. coli bacteria are located within the intestinal tract of warm-blooded animals and can exit the body through fecal material. These bacteria are used as an indicator of the potential presence of other waterborne disease-causing bacteria because of its ease of monitoring. Standards of *E. coli* in water have been established to ensure safe use of water for water supplies and recreation. Standard 327 IAC 2-1-6 Section 6(d) (327 IAC 2-1.5-8(e)(2) for Great Lakes System) states that *E. coli* bacteria should not exceed 235 colonies per 100 milliliters in any one day sample during a 30-day period. In order to determine if bacterial pollution was present with the Middle Fork the technical committee decided to add *E. coli* to parameters being monitored.

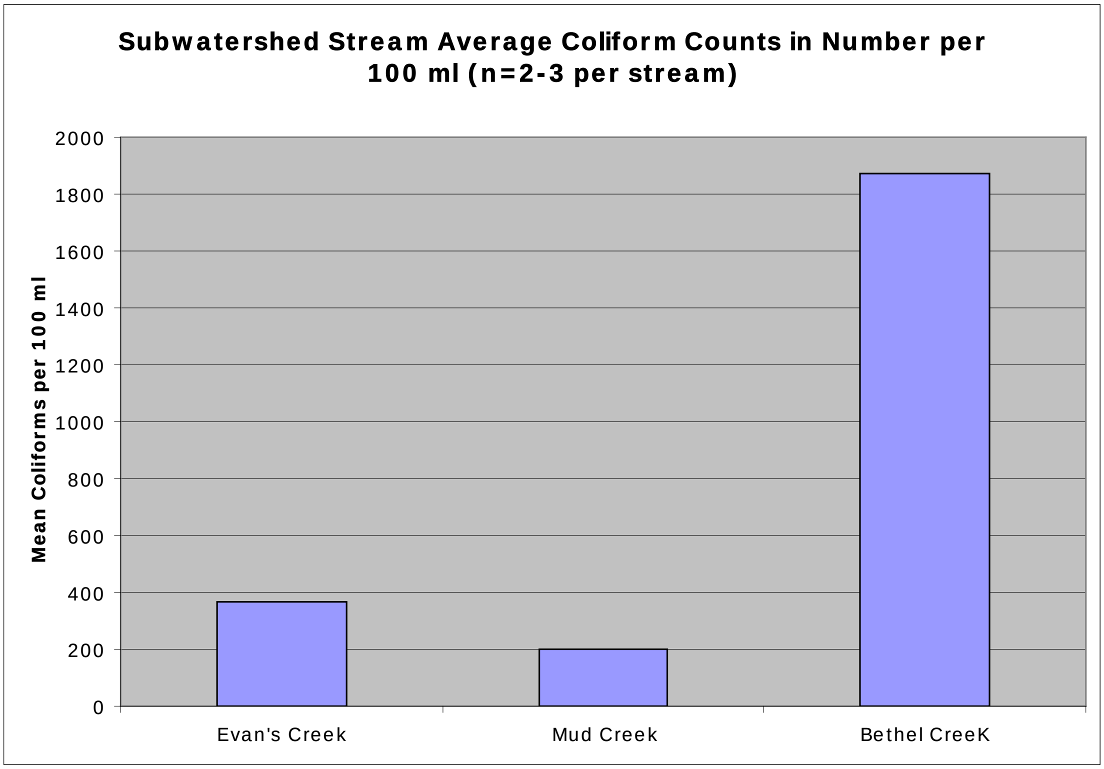
To investigate the issue, the technical committee collected numerous water samples and tested for the presence of coliform bacteria. The *E. coli* tests did not confirm any major problems within the town of Middleboro, which residents had voiced as one of their concerns. The *E. coli* tests did reveal that there is major bacterial contamination located along the river, which most likely comes from a combination of both livestock operations and failing septic systems.

Figure 3.6:



Of 49 coliform tests taken in the watershed 19 (38 percent) were found to exceed the state *E. coli* water standard of 235 colonies per 100 mL (Figure 3.7). Along the main course, average excessive counts were found at Sites 4, 6, and 7. The steering committee believed the main cause for bacteria contamination at these sites is the presence of livestock. Two sub-watersheds, Evan's Creek and Bethel Creek, were tested during the Spring of 2004 were also found to exceed standards. Levels recorded at Bethel Creek exceed 3,500 colonies/100mL. These elevated levels are believed to be caused by large livestock operations located within this sub-watershed. Results are listed in Figure 3.8.

Figure 3.7:



3.5 Chemical Monitoring

3.5.1 Atrazine Monitoring

Indiana-American Water Company has conducted Atrazine tests since 1997. These tests have showed levels well above the state standard of 3 ppm during certain times of the year. The water company conducted their latest study during the Spring of 2004, when elevated levels would be expected due to pre-planting applications and run-off from storm events. They used the same eight monitoring sites that the technical committee uses. The results show elevated levels highest during the months of May and June. It is likely that the numbers fluctuate year to year depending on when rain episodes which cause runoff into the water occur. The results in Figure 3.9 show April-July levels in 2004. Peak levels in May are associations with rainfall episodes.

The water company also completes weekly monitors the raw water that enters into their treatment plant from the reservoir. The April-July results from the past 5 years are included in Figure 3.10. Most of the results of this monitoring from May-July exceed the 3 ppm state standard.

Figure 3.8:

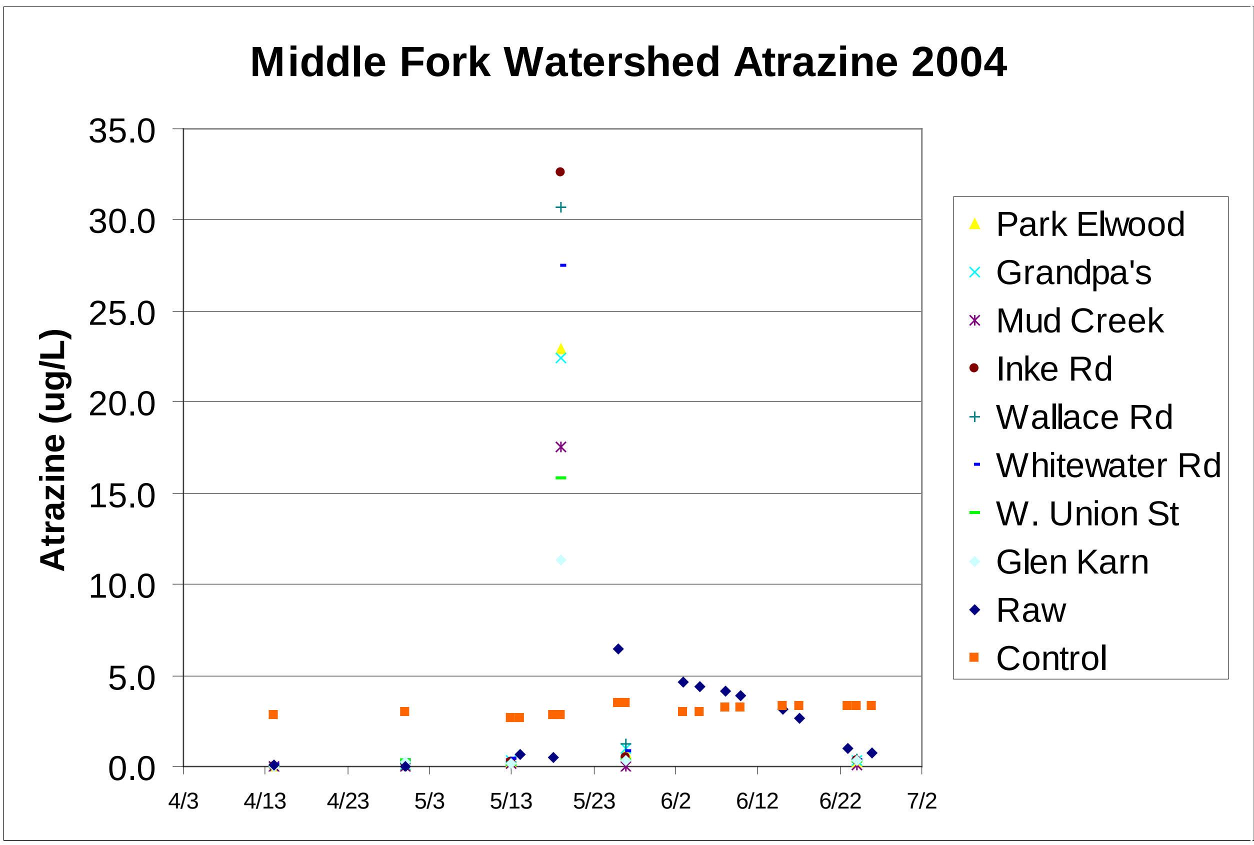
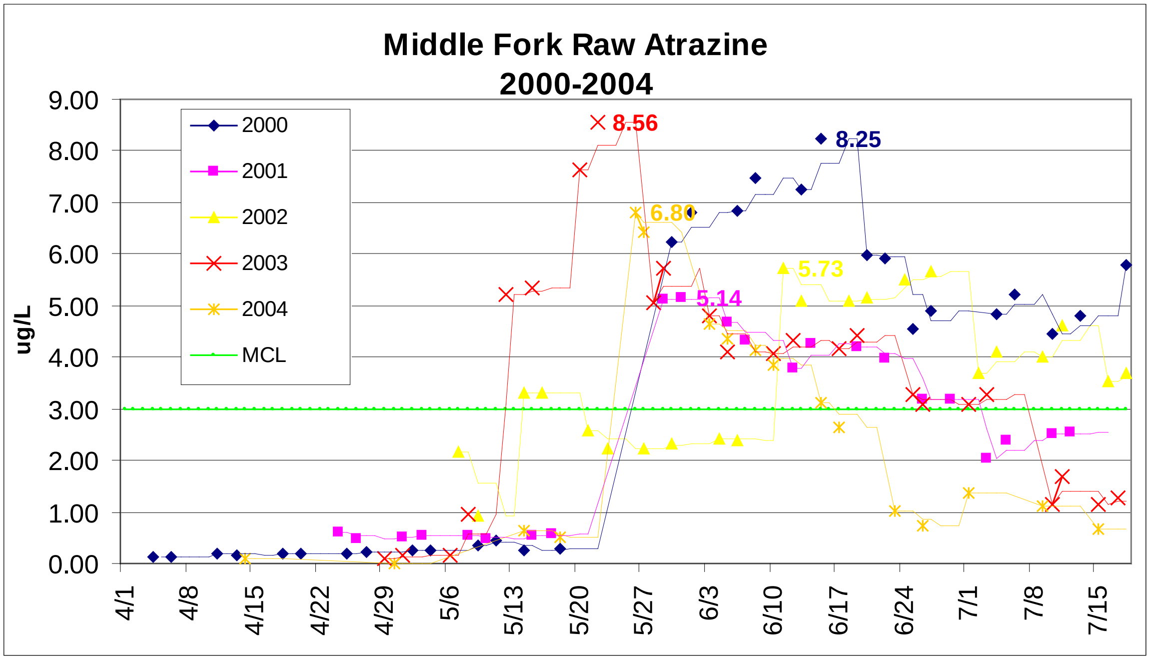


Figure 3.9: Raw Atrazine Graph 2000-2004



3.5.2 pH

An average pH of 8.3 was calculated from 80 measurements taken throughout the watershed with ranges from 7.2-8.6. With alkalinity and hardness readings usually exceeding 240 mg/l, the waters of the Middle Fork River are obviously buffered into the alkaline range. The limestone rocks in the streambed that the flowing water of the river expose on occasion provides the buffering alkalinity.

Although the turbidity from Barrett Paving Materials point discharge probably adds alkalinity to the river, it does not seem to significantly raise the pH. Measurements taken downstream of the plant didn't show any difference in pH levels then those taken at other locations in the watershed.

3.5.3 Dissolved Oxygen

The average of 72 dissolved oxygen samples taken in the Middle Fork River revealed an average of 104% saturation and ranged between 60-170% saturation. With adequate riffle habitats and primary production via photosynthesis, dissolved oxygen would not be limiting in invertebrates and fish in the main course of the river. Super-saturated oxygen conditions generally occurred in the upstream reaches of the Middle Fork where sun-exposed habitats are photosynthetically productive. Excess nitrate and phosphate levels allow of algal communities to develop and thus produce super-saturated oxygen conditions.

3.5.4 Total Phosphates

Measurements of total phosphates utilizing the HACH testing method ranged between 0-2.3 mg/l with a mean of 0.5 mg/l with 26 samples being taken during various times of the year. These readings indicate that phosphorus loading is a problem within the Middle Fork Watershed. The state standard for total phosphates is 0.2 mg/l. The highest readings were located at sites #4, 5, 6, and 7. The land draining above these four sites have a high percentage of row cropping and a large concentration of livestock are located slightly upstream of sites 5.

Calculations based on the number of livestock within the watershed reveal that approximately 300 lb/day (54.65 tons/year) of phosphorus are produced by livestock within the watershed.

3.5.5 Nitrates

Measurements of nitrates within the watershed where completed using the HACH testing methods. Eleven samples taken during various times of the year were tested. The nitrate range was found to be between 1.7 and 14.6 mg/l with a mean of 4.6 mg/l. Using the HACH test strip method, nitrates averaged 1.56 mg/l and ranged between 0 and 5 mg/l. The strong variance in results made it difficult for the technical committee to determine the extent of the nitrate pollution. The test strip method average was well below state standard of 3 mg/l, while the HACH methodology produced results averaging 1.6 mg/l above the state standard. Nitrate levels were fairly consistent throughout the watershed, with the highest reading of 14.6 mg/L at site #4. Again these levels are believed to be due to high levels of row cropping within the watershed.

Calculations based in the number of livestock within the watershed reveal that approximately 500 lb/day (90 tons/year) of nitrogen are produced by livestock within the watershed.

3.5.6 Total Suspended Solids

Total Suspended Solids (TSS) consist of clay, silt, and other small particles in the water. High levels of TSS create high turbidity, which turn the river chocolaty-brown. Turbid water can be the effects of soil erosion, algal blooms, and streambed disturbance. Elevated levels of turbidity reduce light transmission which hinders plants from photosynthesizing and makes feeding difficult for filter feeding macroinvertebrates. Twelve calculations were taken at Park Elwood Road, which is the southernmost sampling location.

The highest rate of total suspended solids was measured in March and April of 2004 even though rainfall amount were rather low at the time (Figure 3.11, 3.12). The technical committee assumes this elevated levels are due to the lack of vegetation in early spring and not rain episodes. The heaviest rainfall amount occurred in June (Figure 3.11), but total suspended solids rates were much lower. This is probably due to adequate vegetative cover, which is present at this time of the year. This supports the tremendous need for adequate riparian buffers between agricultural land and waterways.

Figure 3.10: TSS Graph

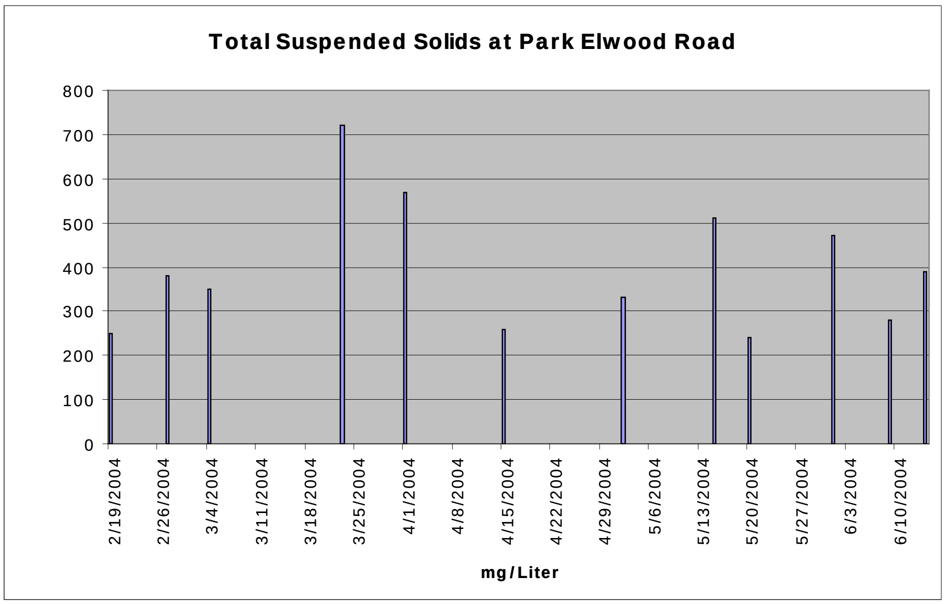
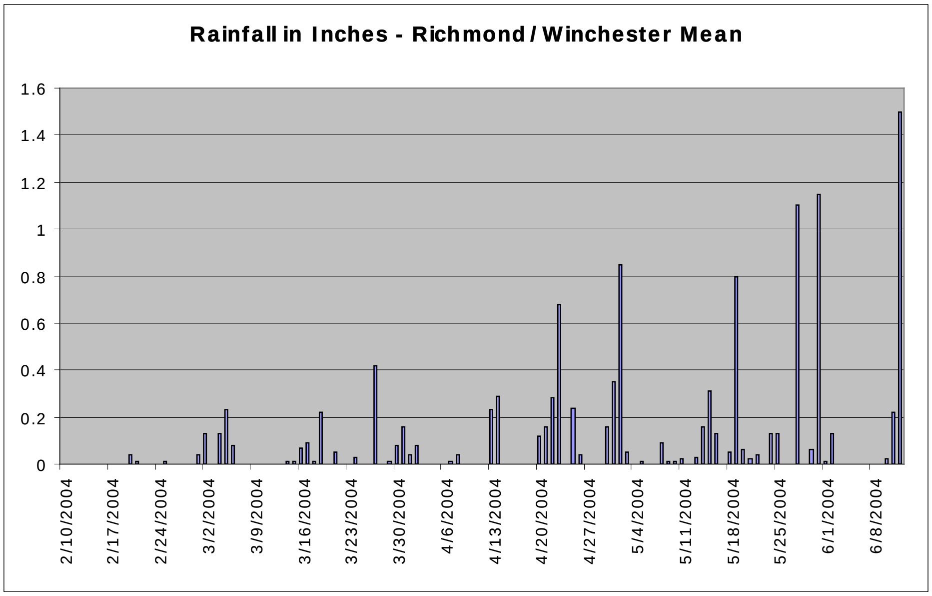


Figure 3.11: Rainfall Graph 2004



3.5.7 Metals Study:
Stream standards have been established for many heavy metals including copper, nickel, zinc, mercury, cadmium, and chromium. These standards are listed in 327 ISC 2-1-6 (327ISC 2-1.5-8 for Great Lakes System).

A watershed metals study was conducted during the spring of 2003 by Devin O'Leary and Mary Hagerman, Earlham College and Richard Roeper, Professor of Biology at Indiana University East. The eight sites chosen by the watershed technical committee were used. All metal concentrations were within limits of healthy surface water standards and below limit concentration of the EPA Watershed Indictor Metals. No significant difference was found between results upstream and downstream of Hollansburg, Middleboro, or Barrett Paving Materials, which indicates no significant input from these three sites. Raw data of metals testing and a poster of the results are located in Appendix G.

3.6 Additional Water Quality Information

3.6.1 Algal Blooms

Algal blooms have been observed throughout areas of the river and within the reservoir during the project's study. The major cause of these blooms is believed to be from excess nutrients (nitrogen and phosphorus) which have been confirmed through water monitoring.

The major source of nutrients within the watershed is believed to come from cropland run-off and less significantly from watershed livestock. In addition, mud flats creating areas of stagnant water have become an increasing problem at the northern end of the reservoir where the river contributes large amounts of sedimentation. When the reservoir's water levels lower, typically during summer months, the mud flats are exposed this often causes an increase in the production of blue-green algae, according to the Indiana-American's Water Quality Specialist Richard Nicholson. The water company attributes its listing on IDEM's 303d list for taste, odor, and algae to blue-green algae and their subsequent decomposition. According to Nicholson compounds released from blue-green algae, even at extremely low concentrations, contribute to taste and odor complaints from customers served by the water company.

Figure 3.12: **Pictures of algal blooms taken in September 2002 at the Middle Fork Reservoir**

3.6.2 Urbanized Areas

Rates of water discharge from the watershed has been studied during the previous two years. Discharge rates show that 50 percent of the water entering the river comes from the lower third of the watershed which is dominated by urban/small landowners. Due to these findings FOMF have decided to begin a stronger educational focus of urban issues during the second phase of the project.

3.6.3 Geese

Geese have become an increasing problem at the Middle Fork Reservoir. The water company aerates the reservoir to increase water quality, but this also creates open water for geese during the winter. People also feed the geese giving them no reason to head south during winter months. In addition to creating water quality problems through fecal matter, they also create a mess in the picnic and recreational areas of the park.

Geese have become such a major problem during recent years that in 2003 the Richmond Parks Department requested permits to destroy nests. The Federal Government gives a set amount of these permits to each state and the state distributes them to District Wildlife Biologist. The Richmond Park's Department received two permits to be used at Middle Fork Reservoir. They used the oiling method which doesn't destroy the egg, but prevents it from hatching. This also prevents the goose from laying another nest, which they'll often do after a nest has been destroyed.

The Richmond Parks' Department is also promoting a "No Feeding" Campaign, which will include signs posted around the reservoir and informational brochures. These attempts will hopefully discourage people from feeding the geese, so they will return to their natural migration patterns.

3.6.4 Ohio's Impact

Residents voiced concerns about Ohio's impact upon the watershed. Although the Ohio portions of the watershed were not a major focus of the watershed project, visual observations and water monitoring show that in most cases the Ohio portion of the watershed is in as good or often better condition then Indiana. The stream channel, although altered by channelization, has vegetative filter strips along farmland and there does not seem to be any livestock having instream assess. A concern that the committee would like to further investigate is the stormwater system in Hollansburg to determine if it's contributing bacterial contamination to the river.

3.6.5 Point Source Discharge

Point source discharge sites in Indiana must obtain a National Pollutant Discharge Elimination System (NPDES) permit which is overseen by the Indiana Department of Environmental Management. As of August 2004 one company, Barrett Paving Materials, Inc., had a NPDES permit (IN0030988) to discharge within the watershed. Barrett pumps water from their holding pond into the river. Barrett's was initially a major concern of residents and the steering committee, which is why a testing location was chosen just downstream of where the industry discharges water into the river. Although this discharge does affect the color of the water, often turning it a chalky white, results from water monitoring do not indicate any negative effect upon the river's water quality.

3.6.6 Trash and Litter

Figure 3.13: Picture taken during fall of 2003 showing litter located along streambank near bridge on Turner Road

Litter has been observed along riverbanks throughout the watershed. Although it doesn’t have a major effect on water quality, it does take away from the aesthetic qualities of the watershed. The visual degradation of the river was a concern that stakeholders expressed at public meetings.

Trash in and around the Middle Fork Reservoir has been a growing problem during recent years. The Richmond Park’s Department holds reservoir clean-up days and provides canoes, gloves, and trash bags to those volunteering their time to cleaning up the reservoir and surrounding land area. Beginning in 2003, Friends of the Middle Fork began assisting with the annual clean-up days. The majority of litter in the reservoir comes from bait and food packaging. Dozens of tires have also been removed during these clean-ups each year. The clean-ups are scheduled to continue, once in the spring and fall each year.

3.6.7 Watershed Flooding Episodes

Although flood episode water monitoring has not been completed the technical committee has observed flooding episodes within the watershed on numerous occasions. Even relatively light rains cause the river to often rise several feet. This flooding ceases very quickly, but the effects of sedimentation can be seen within the river and further downstream within the Middle Fork Reservoir.

3.7 Agricultural Impacts

Agricultural activities can be potential sources of water pollution. Considering the high percentage of agricultural landuse within the watershed its impact has become a major focus of the project. Possible problems associated with agriculture include chemicals and manure applications, which often erode from fields and are transported to waterways. Tillage practices also have a great effect on how much soil erodes from farm fields. Livestock operations, which are present throughout the watershed, are a possible source of water pollution. The cattle and swine located within the watershed can cause nutrients and *E. coli* bacteria to contaminate the local waterways.

Tillage Practices
Approximately 85 percent of corn and 92 percent of soybeans crops within the watershed are planted using conservation tillage practices. Although these numbers are good this still means that more than 1,000 acres are being planted using conventional tillage practices. Some of this conventional tilled land is highly erodible, which further increases watershed sediment rates. FOMF would ideally like to see all tilled crops using conservation tillage practices which leave high residues.

Fertilizer Application

Farmers within the watershed apply fertilizer to obtain optimal soil conditions for crop growth. Fertilizer and manure applied to crops can benefit yields, but if applied incorrectly can create major problems to the local water supply. Livestock producers who collect manure in uncovered or uncontained facilities risk manure run-off before the manure is applied to cropland. Also farmers applying manure to fields must be aware of specific soil conditions to not over apply. Chemicals such as ammonia nitrogen can be over-applied if farmers are unaware of proper application rates.

Estimations of fertilizer applications within the watershed were calculated using Purdue University's Guide for Watershed Partnerships. The total nitrogen applied within the watershed is 378 tons/year, with phosphorus application exceeding 193 tons/year. The chart below shows the estimated pounds of fertilizer applied within the watershed according to 2002 application averages.

Table 3.2:

Estimated Fertilizer Application within Watershed

Crop Type	Fertilizer Type	Indiana Watershed Crop Acres*	X	Percent Acres treated (2002 Ind. Figure)+	X	Rate per treatment (lbs/acre) 2002 Ind. Figure+	X	Average # of treatments +	=	Estimated amount of fertilizer applied (lbs)
Corn	Nitrogen	5,319.27	x	0.99	x	78		1.8	=	**739,357.23**
	Phosphorus	5,319.27	x	0.92	x	55		1.2	=	**322,986.07**
Soybeans	Nitrogen	5,625.73	x	0.18	x	17		1.0	=	**17,214.73**
	Phosphorus	5,625.73	x	0.24	x	48		1.0	=	**64,808.41**

Total Nitrogen applied in watershed = 756,571.96 lb
Total Phosphorus applied in watershed = 387,794.48 lb

*Percentages estimated from 2004 Wayne County Farm Service Agency data.
+ Data from Indiana State Chemist, Department of Biochemistry, Purdue University and 2002 Indiana Agricultural Statistics

Pesticide Application
There are a wide-variety of products used to control weed growth (herbicides), insects (insecticides), fungi (fungicides), and other organisms on agricultural land. Each of these products contain different amount of chemicals which could negatively impact water quality. Pesticides most commonly enter waterbodies through runoff from agricultural lands and urban

areas. The estimated pounds of pesticides applied to cropland within the watershed using 1998 average application rates are listed in Table 3.3. Using this table we estimate that more than 378 tons of nitrogen and 193 tons of phosphorus are applied to watershed cropland each year.

Table 3.3:

Estimated Pesticide Application within Watershed

Crop Type	Crop Acres in Watershed	Pesticide Type	X	Fraction of acres treated in the state (1998 figure)	X	Average rate of application (lbs/acre) 1998 figure	=	Estimated amount of pesticide applied (lbs)
Corn	5,319.27	Atrazine	x	0.89	x	1.36	=	**6,438.44**
	5,319.27	Metalachlor	x	0.42	x	2.04	=	**4,557.55**
	5,319.27	Acetochlor	x	0.32	x	1.97	=	**3,353.27**
	5,319.27	Primisulfuron	x	0.14	x	0.03	=	**22.34**
	5,319.27	Cyanazine	x	0.13	x	1.43	=	**988.85**
Soybean	5,625.73	Glyphosate	x	0.55	x	0.85	=	**2,630.03**
	5,625.73	Chlorimurone-thyl	x	0.27	x	0.02	=	**30.38**
	5,625.73	2,4-D	x	0.26	x	0.39	=	**570.45**
	5,625.73	Imazethapyr	x	0.25	x	0.04	=	**56.26**
	5,625.73	Paraquat	x	0.19	x	0.89	=	**951.31**

Total pounds of pesticide applied: 19,598.88 pounds

Livestock Practices

Livestock operations allowing instream access serve as a direct source of nutrients and pathogens to the Middle Fork Watershed. In addition, livestock often create steep, unvegetated banks through the repeated entering and exiting of streams which cause an increase in streambank erosion.

Through visual observations and data collected from watershed surveys the steering committee determined that more than 1,200 livestock animals are located within the watershed boundaries. Of these, approximately 75 percent have regular access to streams. Many of these animals have access throughout the year, while others only have part-time access. Whether there contact is direct or indirect, livestock pose a serious threat to the health of the river. In order to determine the amount of manure and nutrients produced by livestock within the watershed calculations were preformed using the Watershed Inventory Tool for Indiana and statistics from Purdue University's Department of Agricultural and Biological Engineering. Below are the calculations of manure and amount of nutrients produced by livestock within the watershed are listed in 3.4 According to the table, the committee estimates that more than 16,000 tons of manure is produced in the watershed each year. This results in an additional 90 tons of nitrogen and 54 tons of phosphorus per year in the watershed each year.

Table 3.4: Manure and Nutrients produced by livestock within the watershed

Livestock	# of animals	x	Avg. Amount of manure produced	=	Amount of manure produced (lbs/day)	Fraction of N in a pound of manure	Fraction of P in a pound of manure	=	Pounds of N in the Manure	Pounds of P in Manure
Cattle	331	x	75 lbs/day	=	24,825	0.008	0.0065	=	198.6	161.36
Dairy Cattle	550	x	115 lb/day	=	63,250	0.0045	0.002	=	284.63	126.5
Swine	248	x	11.7 lb/day	=	2901.6	0.0045	0.004	=	13.06	11.61

Total amount of manure produced: 90,976.6 lb/day
Total amount of nitrogen produced: 496.29 lb/day (90.57 tons/year)
Total amount of phosphorus produced: 299.47 lb/day (54.65 tons/year)

3.8 Riparian Buffers

Lack of adequate riparian buffers is a major concern within the Middle Fork Watershed. Not only do riparian buffers lessen sedimentation rates, but they also serve as filters for contaminates. By increasing the amount of riparian buffers along waterways nutrients and sediments will be trapped, lessening algae blooms and sedimentation rates of the river and reservoir.

The steering committee used aerial photographs to conduct a riparian study which determined the amount of adequate riparian cover within the watershed along the Middle Fork River and its tributaries. The following conclusions were made based on 0-100 feet = insufficient buffer width, 100 feet + = sufficient buffer width. Of the tributaries measured we found that only 44 percent have adequate riparian areas. We also found that the river, measured from the reservoir to the Ohio State Line, has adequate riparian along 75 percent of the total length. Approximately fifty percent of the watershed's tributaries were measurable using aerial photographs.

Middle Fork River

- Insufficiently buffered lengths – 12,387 ft (2.35 miles)
- Sufficiently buffered lengths – 36,733 ft (6.96 miles)

Tributaries

- Insufficiently buffered lengths – 78,280 ft (14.83 miles)
- Sufficiently buffered lengths – 62,072 ft (11.76 miles)
- Undetermined lengths – 140,352 ft (26.58 miles)

Figure 3.14: Middleboro house located near Middle Fork River

House located within a few feet of the Middle Fork River in the town of Middleboro where the river lacks adequate riparian buffers.

3.6 Septic Systems

Lack of proper septic system maintenance is another concern of FOMF. None of the residences located within the watershed are hooked up to sanitary sewer systems. There are major concerns about septic failure and/or leakage as most of the homes located within the watershed are more than 20-years-old. Small towns which lie along the river and its tributaries are the areas of greatest concern. Stakeholders expressed their concerns at public meetings and through the public survey about failing septics and direct drainage into the river in the town of Middleboro. To investigate the issue, the technical committee collected numerous water samples and tested for the presence of coliform bacteria. The Wayne County Health Department was contacted concerning this issue, but did not have any current data on septic systems within the watershed.

Section 4.0: Identifying Problems

Original stakeholder concerns were addressed and researched by the Middle Fork Steering and Technical Committees. The committees found the bacterial contamination from livestock and septic systems were valid worries. Improper manure application continues to be a concern as the watershed survey indicated that many agricultural producers don't have nutrient management plans on file with the Wayne County Natural Resources Conservation Service. Visual degradation continues to be a problem as trash and debris have been noted in areas around the river throughout the 2-year phase. Unstable streambanks are also a cause of concern. There are many sections along the river which have undercut banks which are lacking vegetation to help control further lose of soil into the river. The contributions of suburban landowners to the pollution within the watershed has been difficult to validate, but the steering committee feels that continued education of proper fertilizer application and disposal of chemicals is equally important to all residents.

Two initial concerns within the watershed have been ruled out following water monitoring. These concerns were: Barrett Paving Materials and major impact coming from the Ohio portion of the watershed.

Some issues within the watershed were not initial concerns, but water monitoring by the technical committee has revealed these additional problems. Problems identified through water monitoring include: elevated *E. coli*, nutrient, and atrazine levels. After analyzing information and data collected during and previous to the watershed project the following problem statements were developed by the steering committee.

1. **High sedimentation rates of the reservoir**
   According to load calculations, the current average sedimentation rate of the Middle Fork Watershed is 43,050 tons/year (see Appendix K for calculation.) Lack of sufficiently-buffered riparian areas and the use of conventional tillage practices throughout the watershed contribute to siltation of the river and high sedimentation rates of the Middle Fork Reservoir. Unsecured streambanks and instream livestock access also contribute to this problem.

2. **Elevated E-coli levels**
   More than 30 percent of *E. coli* samples taken in the watershed surpassed the state standard of 235 colonies/100 mL (see Appendix M for monitoring results.) Livestock and wildlife contribute to bacteria contamination of the river at numerous sites. There are also concerns about failing septic systems, especially in small towns located and older houses located within the watershed, which may be contributing to the bacterial contamination. Public surveys showed that many residents have not properly inspected their systems in the past five years.

3. **Elevated Atrazine levels**
   The herbicide atrazine is applied to most corn fields by many farmers within the watershed. Indiana-American Water Company has detected levels well above standard during the previous seven years. Levels during the spring of 2004 were as high as 10 times the state standard (see appendix H for monitoring results.)

4. **High nutrient levels causing algal blooms within the river and reservoir.**
   Levels of both phosphorus and nitrogen exceeded state standards at many locations within the watershed (see appendix M for monitoring results.) Algal blooms are associated with excess nutrients entering the water. These nutrients are believed to be caused by run-off from cropland and manure inputs from livestock. When decaying the algal blooms create poor taste and odor in drinking water that people are able to detect at low levels. In 2004, the reservoir was added to IDEM's 303d list due to this problem.

5. **Mercury contamination of fish**
   The Middle Fork Reservoir has been listed on both the 303(d) and 305(b) list for mercury contamination of fish. Mercury is transported through wet deposition (precipitation), most commonly from industrial sources. The sources of mercury are not located within the watershed boundaries and therefore cannot be addressed by this project. The steering committee will help promote residents about the fish consumption advisories within the watershed.

6. **Watershed flood episodes**
   The average baseline discharge of the watershed is 50 ft^3 per second, but during storm events this rate has been as high as 383 ft^3 per second.
   A low holding-capacity of the watershed contributes to flooding episodes during periods of rain. The steering committee has observed flash flood episodes when small amounts of rain have occurred.

7. **Lack of educational opportunities within the watershed.**
   People have expressed interest in learning more about the watershed and water related problems through surveys and at public meetings.

8. **Lack of natural habitat areas within the watershed.**
   Less than 3 percent of total land area within the watershed is comprised of wetlands according to the National Wetlands Inventory conducted by the United States Fish and Wildlife Service. Also, only approximately 12 percent of the watershed is comprised of forested land. Of these acres only a few are Federally protected through the Classified Forest Program.

Section 5.0: Sources of Water Quality Problems

1. **High sedimentation rates of the reservoir**
   Cause: Lack of sufficiently riparian buffers and stable streambanks along the river and many of its tributaries. Approximately 25 percent of the river and 56 percent of tributaries are not sufficiently buffered (see Appendix I for riparian study results).
   Cause: Although conservation tillage practices are widely used within the watershed there continues to be a need for reducing conventional tillage practices on agricultural lands. Tillage transect revealed that 15 percent of corn and eight percent of soybean fields were conventionally tilled in 2004.
   Cause: Livestock with instream access which causes streambank erosion. Through watershed surveys and observations it was determined that approximately 550 animals had access to the river and/or its tributaries (see Appendix F for survey results).

2. **Elevated E. coli levels with the watershed**
   Cause: Instream access of livestock throughout the watershed. Approximately 550 animals have access to the river and/or a tributary. These animals contribute major bacterial contamination to the water.
   Cause: Improperly maintained septic systems in small towns and older house located within the watershed. Public surveys showed that many people within the watershed haven't inspected their septic systems within the past 5 year or are unaware of the last time it was inspected (see Appendix F for survey results).
   Cause: Large numbers of geese year-round at the Middle Fork Reservoir. Geese have become an increasing problem to the point that Richmond Parks Department who manage the area around the reservoir has started a "No Feed" campaign.

3. **Elevated atrazine levels located throughout the watershed during application times**
   Cause: Run-off into streams during rain episodes due to lack of riparian buffer. Lack of sufficient riparian buffers and stable streambanks along the river and many of its tributaries. Approximately 25 percent of the river and 56 percent of tributaries are not sufficiently buffered (See Appendix I for riparian study).
   Cause: Wide use of atrazine application onto farmland. Atrazine continues to be one of the most widely used herbicides in Indiana. It's estimated that 89 percent of cropland within the watershed receive 1.3 pounds of atrazine per acre.
   Cause: Application of atrazine close to waterways.

4. **Algal Blooms within the reservoir**
   Cause: Nutrients entering the water from farm fields. Using average application rates from Indiana Agricultural Statistics it is estimated that 194 tons of phosphorus and 378 tons of nitrogen are applied to farmland within the watershed each year.

Cause: Instream access of livestock throughout the watershed. Instream access of livestock throughout the watershed. Approximately 550 animals have access to the river and/or a tributary. These animals contribute approximately 7.67 tons of nitrogen and 6.22 tons of phosphorus per year.
Cause: Large numbers of geese year-round at the Middle Fork Reservoir. Geese have become an increasing problem to the point that Richmond Parks Department who manage the area around the reservoir has started a “No Feed” campaign.

5. **Mercury contamination of fish has created a fish consumption advisory for fish within the Middle Fork Reservoir**
   Cause: Transported through precipitation from industries located outside of the watershed.

6. **Flood episodes within the watershed.**
   Cause: Lack of sufficient riparian buffers and stable streambanks along the river and many of its tributaries. Approximately 25 percent of the river and 56 percent of tributaries are not sufficiently buffered (see Appendix I for the riparian study).
   Cause: Lack of woodland acres. Land use statistics show that only 12 percent of the watershed is forested.
   Cause: Lack of wetlands. Less than three percent of the total area of Wayne and Randolph counties is covered by wetland. Few remaining wetland exist within the watershed boundaries.

7. **Lack of water quality understanding.**
   Cause: Lack of environmental educational opportunities within the watershed. People have expressed their interest in the watershed project and have requested additional information concerning local water quality.

8. **Lack of natural habitat located within the watershed.**
   Cause: Lack of wetlands and forested land located within the watershed boundaries.

Section 6.0: Identifying Critical Areas

6.1 Target Locations

Target areas within the watershed are locations that we have indications of the greatest problem source of sedimentation rates, nutrient input, lack of vegetative buffers, and sources of bacterial contamination. These sites have been selected based on the sources causing the greatest negative effect on water quality. Target areas chosen to be addressed for the Middle Fork Watershed include:

- Cattle operations, especially those with direct access to the river.
  Targeted area: Livestock operations near the Middle Fork Reservoir.
  Targeted sub-watersheds: Bethel and Evans Creek where levels of *E. coli* have exceeded the standard of 235 colonies/100 ml.

- Farmland currently being row cropped using conventional tillage practices, especially near the reservoir.

- Highly erodible cropland within the watershed

- Stream courses lacking sufficient riparian vegetation
  Targeted locations along river: Mud Creek to Inke Road and Hill Road to Indiana/Ohio State Line.
  Target sub-watersheds: White Creek, Bethel Creek, Evans Creek

- Farmers applying atrazine to farmland, especially those areas in close proximity to the river and reservoir.
  Targeted area: Highly erodible fields

- Older homes, with possible failing septic systems throughout the watershed.

- Farmers applying manure and other nutrients to farmland.
  Targeted area: Highly erodible farmland.

- Urban land areas, especially those in the southern third of the watershed where more than 50 percent of the water flow comes from.

6.2 Prioritization of Target Areas

The targeted management practices have been prioritized due to their impacts on water quality and the likelihood that improvement can be made during the next 5 years. One of the major concerns of the committee is sedimentation entering the river. By installing riparian buffers, decreasing livestock with access to streams, and increasing conservation tillage sedimentation rates can be reduced. These target areas and others are listed below in order of importance.

1. **Installation of vegetative riparian buffers**
   - Riparian buffers are an excellent way to reduce the amount of water and nutrients entering waterbodies. Buffers are lacking in many areas throughout the watershed.

2. **Fencing livestock out of water/manure storage facilities**
   - The majority of Indiana livestock operations within the watershed are located within Wayne County. In addition, many of these operation's livestock have access to the river and/or one of its tributaries. Livestock with stream access is a direct source of nutrient contamination. The livestock also destroy riparian vegetation and cause streambank erosion. In addition, many livestock operations do not have adequate manure storage facilities.

3. **Conventional tilled farmland**
   - Conventional tillage practices increase the sedimentation rates within the watershed. This also allows fertilizers and pesticides to enter the stream courses at an accelerated rate.

4. **Septic Systems**
   - The majority of houses within the watershed are more than 20 years old. These older homes are more likely to have bacterial contributions through failing septic systems.

5. **Nutrient and Fertilizer Application Rates**
   - By conducting farm inventories and offering cost-share farmers can evaluate the amount of nutrients and fertilizers being applied to farmland.

9. **Education**
   - There is continued need of water-related education within the watershed, with an increase in urban issues that effect water quality.

10. **Increase natural habitat**
    - The development and protection of woodlands and wetlands is vital to the preservation of local animal and plant species within the watershed.

Section 7.0: Setting Goals and Selecting Indicators

Goal Development

Goals have been developed based on problem statements listed in Section 4 and the causes listed in Section 5 of the management plan. The steering committee first analyzed data, then determined possible causes, and finally advised possible solutions for the problems. Goals which will help improve the quality of the Middle Fork Watershed were developed and are listed below to address each problem statement. All measures implemented and any changes in water quality will be recorded and noted in updated versions of the management plan. The goals (#1-6) are listed in order of importance with #1 being the most important according to consensus of the steering committee during the planning phase. The committee also determined which indicators they would use to tract the watershed goal.

Goal #1: By 2009 reduce the high sedimentation rates of the Middle Fork River and reservoir by 20%.

According to baseline load calculations approximately 42,700 *tons of soil is transported through the river which end up in the Middle Fork Reservoir. The steering committee would like to see this number reduced by 20 percent (8,540 tons) by 2009. Through watershed assessment the committee determined the following causes of sedimentation:*

Cause 1: Lack of riparian buffers and stable streambanks along the river and many of its tributaries. Approximately 25 percent of the river and 56 percent of tributaries are not sufficiently buffered.
Location: Insufficiently buffered riparian areas throughout the watershed.

Cause 2: Although conservation tillage practices are widely used within the watershed there continues to be a need for reducing conventional tillage practices on agricultural lands. Tillage transect revealed that 15 percent of corn and eight percent of soybean fields were conventionally tilled in 2004.
Location: Farmland located throughout the watershed.

Cause 3: Livestock with instream access which causes streambank erosion. Through watershed surveys and observations it was determined that 550 animals had access to the river and/or its tributaries.
Location: Livestock farms throughout the watershed

Indicators: Sedimentation rates can be monitored through the number of BMPs installed, number of acres being improved, and reduction of sediment using the load reduction calculation.

Goal #2: Reduce E. coli bacteria levels below the state standard of 235 colonies/ 100 mL at all testing locations by 2009.

E. coli monitoring during the watershed project has revealed major bacterial contributions in many locations of the watershed, especially those located downstream of livestock operations. Results as high as 3,500 colonie/100 mL were recorded. The steering committees goal is to reduce bacteria entering the water and have all E. coli tests below standard by 2009. Through watershed assessment the committee determined the following causes of bacterial contamination:

Cause 1: Instream access of livestock throughout the watershed. Approximately 550 animals have access to the river and/or a tributary. These animals contribute major bacterial contamination to the water
Location: Livestock operations throughout watershed

Cause 2: Improper storage and application of manure.
Location: Livestock operations and cropland using manure as fertilizer

Cause 3: Improperly maintained septic systems in small towns and older house located within the watershed. Public surveys showed that many people within the watershed haven't inspected their septic systems within the past 5 year or are unaware of the last time it was inspected.
Location: Small towns and households over 20 years old

Cause 4: Large numbers of geese year-round at the Middle Fork Reservoir. Geese have become an increasing problem to the point that Richmond Parks Department who manage the area around the reservoir has started a "No Feed" campaign.
Location: Middle Fork Reservoir

Indicators: The number of people reached thought septic system education programs, the number of BMPs installed, number of acres being improves, amount of livestock excluded from waterways, water quality monitoring results, and reduction of bacterial contamination through *E. coli* water monitoring.

Goal #3: Reduce atrazine levels in the watershed and reservoir below the state standard of 3 ppb by 2009.

Atrazine monitoring completed by the Indiana-American Water Company has revealed significant pollution during the past 7-years. Monitoring during the Spring of 2004 showed levels as high as 10 times the state standard (30 ppb). The steering committee would like to see all atrazine levels drop below the standard of 3 ppb by 2009.

Cause 1: Run-off into streams during rain episodes due to lack of riparian buffer.

Lack of sufficient riparian buffers and stable streambanks along the river and many of its tributaries. Approximately 25 percent of the river and 56 percent of tributaries are not sufficiently buffered.
Location: Insufficiently buffered riparian throughout watershed.

Cause 2: Wide use of atrazine application to farmland. Atrazine continues to be one of the most widely used herbicides in Indiana. It's estimated that 89 percent of cropland within the watershed receive 1.3 pounds of atrazine per acre.

Cause 3: Application of atrazine close to waterways.
Location: Farmland within 200 feet of river or other waterway

Indicators: Atrazine application reduces by amount and acreage, number of riparian acres planted as field borders, number of people reaches through educational programs, water quality monitoring results, and the reduction of atrazine in water according to ongoing water monitoring.

Goal #4: Reduce algal blooms within the Middle Fork River and Reservoir by lowing nutrient levels.
High levels of nitrogen and phosphorus recorded during the past 2 year are believed to be the cause of algal blooms within the watershed.

Cause 1: Nutrients entering the water from farm fields. Using average application rates from Indiana Agricultural Statistics it estimated that 194 tons of phosphorus and 378 tons of nitrogen are applied to farmland within the watershed each year.
Location: Throughout watershed.

Cause 2: Instream access of livestock throughout the watershed. Instream access of livestock throughout the watershed. Approximately 550 animals have access to the river and/or a tributary. These animals contribute approximately 7.67 tons of nitrogen and 6.22 tons of phosphorus per year.
Location: Livestock operations within watershed

Cause 3: Large numbers of geese year-round at the Middle Fork Reservoir. Geese have become an increasing problem to the point that Richmond Parks Department who manage the area around the reservoir has started a "No Feed" campaign.
Location: The Middle Fork Reservoir

Indicators: Water quality monitoring, number of riparian acres planted as field borders, number of people reached through educational programs.

Goal #5: Reduce flood event sedimentation and run-off occurring in the watershed.
The river's discharge rate during storm events has been up to 8 times greater then the normal base flow. These events cause the river to rapidly rise and erode large amounts of soil from surrounding land.

Cause 1: Lack of sufficient riparian buffers and stable streambanks along the river and many of its tributaries. Approximately 25 percent of the river and 56 percent of tributaries are not sufficiently buffered.
Location: Insufficiently buffered riparian areas throughout the watershed

Cause 2: Lack of woodland acres. Land use statistics show that only 12 percent of the watershed in forested.
Location: Throughout watershed, focusing on Black Brook, No Name #3, #4, and #6 sub-watersheds.

Cause 3: Lack of wetlands. Less than three percent of the total area of Wayne and Randolph counties is covered by wetland. Few remaining wetland exist within the watershed boundaries.
Location: Throughout the watershed

Indicators: Number of acres planted as riparian buffers, increased natural habitat areas within the watershed, and observations during flood episodes

Goal #6: Increase knowledge of local watershed/water quality education.
The steering committee would like a strong educational program to continue within the watershed throughout the watershed. Public events thus far have been well-attended and stakeholders have expressed the need for understanding more about protecting the local water quality.

Cause 1: Lack of environmental educational opportunities within the watershed. People have expressed their interest in the watershed project and have requested additional information concerning local water quality.
Location: Throughout the watershed, increasing focus on urban/small landowner Issues

Indicators: Number of people attending watershed events, number of local school children reached through educational events, and number of educational products produced (newsletters, fliers, etc.).

Section 8.0: Choosing Measures to Apply

In order to reach the goals documented in Section 7.0 the steering committee developed measures to address the problems. Each measure is listed below the appropriate goal. All BMP measures installed should meet the Natural Resources Conservation Service's technical guide standards. All accomplishments will be recorded by the project coordinator and updated within the watershed management plan.

Problem #1: High sedimentation rates of the reservoir

Cause 1: Lack of riparian buffers located along the river and its tributaries
Location: Insufficiently buffered riparian areas throughout the watershed.

Measure #1: Use volunteers to install of bank stabilization methods, using willow tree plantings throughout the next 3 years at the rate of 1 acre per year.
Measure #2: The steering committee will promote riparian buffer plantings around agricultural land through the Conservation Reserve Program, with a goal of 25 acres during the next two years.
Measure #3: Provide cost-share to those wanting to establish riparian areas that aren't eligible for the Conservation Reserve Program.

Cause 2: Traditional farming methods used on cropland in the watershed.
Location: Conventionally farmed fields located throughout the watershed.

Measure #1: Increase best management practices on cropland and increase conservation tillage practices by 200 acres.
Measure #2: Encourage farms to plant cover crops on their fields which lay bare during times of the year.
Measure #3: Work on conservation planning and nutrient & pest management with at least 10 watershed landowners each year beginning in the fall of 2004.
Measure #4: Educate farmers about the effects of cropping practices on water quality.

Cause 3: Livestock with instream access which causes streambank erosion.
Location: Livestock farms throughout the watershed.

Measure #1: Fence 150 livestock out of waterways by 2006.

Problem #2: Elevated E-coli levels

Cause 1: Instream access of livestock throughout the watershed.
Location: Livestock operations throughout watershed

Measure #1: Fence 150 head of the cattle which have regular access to the river and/or its tributaries.
Measure #2: Develop springs for any livestock which have been fenced out of the river and/or its tributary and need a source of drinking water.
Measure #3: Schedule meeting with grazing specialist to develop rotation grazing for a livestock operations.

Measure #4: Develop a demonstration site which highlights an exclusion and watering system for livestock and includes a manure management system.

Cause 2: Improper storage and application of manure
Location: Livestock operations and cropland using manure fertilizer
Measure #1: Offer cost-share money to installed manure holding facilities
Measure #2: Conduct nutrient/pest management planning with 10 farmers each year.

Cause 3: Improperly maintained septic systems in within the watershed
Location: Households over 20 years old
Measure #1: Steering Committee will schedule a public meeting with guest speakers from the Wayne County Health Department to discuss proper maintenance and testing of septic systems.
measure #2: Watershed Coordinator will develop a brochure and explore existing information about septic systems.
Measure #3: Steering Committee will explore any possible grants that people could apply for to replace or improve existing septic systems.
Measure#4: Watershed Coordinator will write a septic system press release which will be submitted to local news media.

Cause 4: Large amounts of geese within the Middle Fork Reservoir.
Location: Middle Fork Reservoir
Measure #1: Assist the Richmond Parks Department in their "No Feeding" campaign by including articles in newsletters and distributing brochures.

<u>Problem #3: Elevated Atrazine levels</u>
Cause 1: Lack of riparian buffers
Location: Insufficiently buffered riparian throughout watershed
Measure #1: Continue installation of bank stabilization methods, using willow tree plantings through the next 3 years at the rate of 1 acre per year.
Measure #2: The steering committee will promote riparian buffer plantings around agricultural land through the Conservation Reserve Program, with a goal of 25 acres per year for the next two years.

Cause 2: Wide usage and large amounts of atrazine being applied to farmland.
Measure #1: Included proper application of chemicals in middle Fork Memos Newsletters.
Measure #2: Discuss the need for proper application and care when applying atrazine at public meeting and/or field day.
Measure #3: Offer cost-share to farmers reducing application rates of atrazine to ½ lb/acre.

Cause 3: Application of atrazine close to waterways
Location: Farmland within 200 feet of river or other waterway

Measure #1: Offer cost-share to farm not applying atrazine to cropland within 200 feet of river or waterway

Measure #2: Educate farmers about the negative water quality impacts of applying atrazine close to waterways.

Problem #4: High nutrient levels causing algal blooms within the river and reservoir.

Cause 1: Excess nutrients coming from cropland and livestock.
Location: Throughout the watershed

Measure #1: Work with 10 farmers each year on conservation planning and nutrient/pest management

Measure #2: Fence 150 head of the cattle which have regular access to the river and/or its tributaries.

Measure #3: Develop springs for any livestock which have been fenced out of the river and/or its tributary and need a source of drinking water.

Measure #4: Encourage landowners to enter there cropland into the Conservation Reserve Program, especially along riparian areas.

Cause 2: Instream access of livestock throughout the watershed.
Location: Livestock operations throughout watershed

Measure #1: Fence 150 head of the cattle which have regular access to the river and/or its tributaries.

Measure #2: Develop springs for any livestock which have been fenced out of the river and/or its tributary and need a source of drinking water.

Measure #3: Schedule meeting with grazing specialist to develop rotation grazing for a livestock operations.

Measure #4: Develop a demonstration site which highlights an exclusion and watering system for livestock and includes a manure management system.

Cause 4: Large amounts of geese within the Middle Fork Reservoir.
Location: Middle Fork Reservoir

Measure #1: Assist the Richmond Parks Department in their “No Feeding” campaign by including articles in newsletters and distributing brochures.

Problem #5: Mercury contamination of fish

Cause 1: Transported through precipitation from industries located outside of the watershed.
Location: Outside of the watershed boundaries
No measured will be taken concerning mercury contamination due to the fact that the cause is located outside of the watershed boundaries.

<u>Problem #6: Watershed Flood Episodes</u>

Cause 1: Low holding capacity of the watershed due to lack of riparian areas.
Location: Insufficient riparian area throughout watershed.

> **Measure #1**: Use volunteers to install of bank stabilization methods, using willow tree plantings throughout the next 3 years at the rate of 1 acre per year.
> **Measure #2**: The steering committee will promote riparian buffer plantings around agricultural land through the Conservation Reserve Program, with a goal of 25 acres during the next two years.
> **Measure #3**: Provide cost-share to those wanting to establish riparian areas that aren't eligible for the Conservation Reserve Program.
> **Measure #4**: Decrease the amount of overgrazed pasture/hayland areas and encourage rotational grazing within the watershed.

Cause 2: Lack of wetlands, forests, and classified forests
Location: Throughout the watershed

> **Measure #1:** Educate landowners about the importance that wetlands and forest provide in reduce water entering the river.
> **Measure #2:** Encourage landowners to enter there cropland into the Conservation Reserve Program
> **Measure #3:** Encourage landowners to enroll existing forested land into the classified forest program at a rate of 20 acres each year through 2006. Targeted sub-watersheds: Evans Creek, Bethel Creek, and No Name 1.

<u>Problem #7: Lack of local watershed/water quality education</u>

Cause: Lack of educational opportunities for watershed landowners
Location: Throughout the watershed

> **Measure #1:** Increase watershed awareness through continued community outreach through informational booth set-ups at 4-H Fairs, American Recycles Day, Earth Day Events, and other relevant activities.
> **Measure #2:** Continue mailing quarterly newsletters to all stakeholders containing relevant information pertaining to water quality issues.
> **Measure #3:** Increase information about urban/small landowner issues which effect local water quality.

Section 9.0: Calculating load reductions

The estimated sediment loading of the Middle Fork River was based upon 12 measurements of total suspended solids taken during the winter and Spring of 2004. These measurements were correlated with measurements of turbidity (2003-2004) and discharge readings from the Park Elwood Site (2003) and at the Middle Fork Reservoir Dam (Indiana-American Water Company readings). The stream flow statistics from the USGS gauge at Abington IN (USGS 0375600) were used. It was found that approximately 31 percent of the Abington discharge was contributed by the Middle Fork Watershed.

The estimated yearly average of the watershed's suspended solids was found to be 369 mg/liter. Estimated yearly average discharge of the watershed was calculated to be 117.5 cubic feet per second. Thus the estimated loading of sediments from the watershed is calculated to be 43,050 tons/year (see load calculations in Appendix K). This means that 43,050 tons or an average of 1.423 tons/acre of sediment are transported downstream into the river on an annual base. Erosion rates coming from cropland are believed to be much greater than the 1.423 tons/acre, which would be the case if all the land within the watershed were eroding at even rates.

<u>Crop and Riparian Reductions Methods</u>
Waterways
Riparian Buffers
Establishment of Cover Crops
Conservation Tillage
Field Boarders
Conservation Farming Planning

<u>Livestock Reductions</u>
Alternative Watering Systems
Fencing
Stream Crossings
Manure Holding Facilities
Manure Management Planning

Table 9.1:

Load Reduction of Manure

Livestock	# of animals	x	Avg. Amount of manure produced*	=	Amount of manure produced (lbs/day)	Fraction of N in a pound of manure	Fraction of P in a pound of manure	=	Pounds of N in the Manure	Pounds of P in Manure
Cattle	150	x	35 lbs/day	=	5,250	0.008	0.0065	=	42.0 lbs	34.1 lbs

(*information is determined by an estimate of 35 lbs/cow/day directly entering the water)

According to the Watershed Inventory Tool for Indiana, if 200 head of cattle are excluded from waterway access as much as 5,250 pounds (assuming 35 lbs of 75 lbs produced by each cow per day) of approximately of manure could be reduced from entering the river. This will reduce nitrogen and phosphorus contamination of the watershed, as seen in the calculation above.

IDEM Load Reduction Calculations

In order to determine the water quality improvements made by converting conventional tilled farmland and installing filter strips the IDEM load reduction calculation worksheets were used. In order to estimate these changes we averaged the "C" value of switching from clean-till to no-till of corn before beans and beans before corn. We also changed the worksheet "LS" value to correlate with the value most appropriate for the watershed. It's also important to note that the values represent those that would be expected for Crosby soils, which are the predominant soil type within the watershed. Using the Agricultural Fields and Filter Strip Worksheet Calculations we determined estimated load reductions

It is projected that changing 200 acres of conventional tillage cropland with a 0% residue after planting to a no-till system with 40-50% residue after planting will reduce the load of sediment by 445 tons/year. Moreover, the phosphorus load will be reduced by 504 lbs/year and the nitrogen load will be reduced by 1,008 lbs/year.

It is also projected that the installation of 25 acres of filter strips/riparian buffers will reduce sediment by 99 tons/year, the phosphorus load will be reduced by 119 lbs/year and the nitrogen load will be reduced by 238 lb/year.

Section 10.0: Implementing the measures

Goals set forth by the Middle Fork Watershed Plan aim to improve local water quality for a positive impact on both landowners and the environment. Through educational efforts and implementation of proper conservation practices the goals formulated within this document can be accomplished.

The main goal of the entire watershed project is to increase local water quality through improved land practices. Lack of riparian buffers and water contamination through farm chemicals and livestock are major concerns of Friends of the Middle Fork and many local residents. By addressing these problems and installing best management practices we can make a difference in the local environment.

Educational goals aim to show adults and children ways that they impact local water quality. These goals should also aim to provide solutions to identified problems. Educating about non-point source pollution, watersheds, and solutions to water quality problems will hopefully impact people's view on their impact of the local environment. By working to attain our goals within the Middle Fork Watershed we are also doing our part in positively impacting downstream waterbodies which flow into the Great Miami River and the Ohio River.

The following goals have been organized according to the land area of focus. The steering committee also adopted targets in order to measure the success of the implementation phase of the project.

10.1 Cropland Goals

Objective	Action	Person Responsible/ Funding Sources	Date/ Budget	Baseline	Target	Objective Indicators
Increase conservation tillage practices and install other cropland BMPs	Develop criteria for cost-share program Advertise cost-share program Encourage landowners to apply for EQIP	Project Coordinator 319 grant and Watershed landowners	Nov '04'-06' $10,000	85 % of corn and 92% of soybeans being conservationally tilled	Increase conservationally tilled farmland by 200 acres by 2006.	Number of projects funded Number of acres converted to conservation tillage practices Water quality indicators improved Number of people applying for EQIP
Encourage farmers to attend Wayne County's Annual conservation workshop	Advertise through newsletters and press releases	Project Coordinator and Wayne County SWCD staff/ 319 grant	February each year $500/ annually	Unknown	20 watershed farmers attending the event each year	Number of farmers attending the conservation workshop
Educate landowners about cropping and water quality issues	Educate through newsletters and press releases.	Project Coordinator 319 grant	Ongoing $2,000	None	At least two publications each year	Number of mailings sent out Number of press releases used
Research information about using cover crops to prevent erosion to share with farmers	Use various sources to develop informational packet and share with farmers	Project Coordinator 319 grant	Fall 2004 $2,000	None	Share information with at least 20 watershed farmers	Number of people receiving information
Increase farmers knowledge of proper conservation farming methods	Conduct and/or review conservation planning and nutrient/pest management with 10 farmers per year	Project Coordinator and NRCS staff 319 grant	Ongoing $5,000/ annually	—	Review existing plans or create new plans for 10 people each year	Number of farmers creating and reviewing conservation plans

10.2 Livestock Goals

Objective	Action	Person Responsible/ Funding Sources	Date/ Budget	Baseline	Target	Objective Indicators
Encourage livestock exclusion and increased quality of pasture land with cost-share program , create alternative watering systems for excluded animals and manure holding facilities	Develop criteria for cost-share program Advertise cost-share program	Watershed Committee/ Coordinator 319 grant and Wayne SWCD	Nov. '04-'06 $42,000	Livestock with access to river *E.coli* levels as high as 3,500 colonies/100mL	Exclude 200 animals from the river and its tributaries *E. coli* levels below state standard of 235 colonies/100 mL	Number of farmers participating Number of livestock excluded from waterways
Develop demo. site to highlight a fencing & watering system and manure management system.	Develop criteria for demonstration site. Pick location for the site Host tour of the site to highlight successes	Watershed Coordinator/ NRCD Staff Wayne SWCD, landowner, and 319 grant	Nov. 04 - 05 $40,000	—	Develop demonstration site which highlights livestock exclusion and a manure	Number of livestock exclusion Number of people attending farm tour.
Education livestock producers about alternative watering systems, manure management systems, rotational grazing and livestock exclusion	Contact livestock producers about meeting with NRCS grazing specialist. Schedule a meeting with specialist for livestock owner Include information in newsletters and at public events	Watershed Coordinator/ NRCS Grazing Specialist 319 grant	Nov. 04 - Nov. 05 $2,000	—	Educate 10 livestock produces about conservation livestock practices each year.	Number of producers meeting with grazing specialist Number of articles published

10.3 Septic System Goals

Objective	Action	Person Responsible/ Funding Source	Date/ Budget	Baseline	Target	Objective Indicators
Hold public meeting concerning septic system maintenance	Schedule members of the Wayne County Health Department to speak at meeting Advertise meeting through press releases and newsletters	Project Coordinator and Wayne County Health Department 319 grant and Wayne County Health Depart.	Winter 2005 $5,000	—	Fifty people in attendance at public meeting	Attendance at public meeting
Develop educational campaign about importance of septic system maintenance	Gather existing septic systems information Develop newsletter or brochure giving information about septic maintenance. Develop press release concerning septic system maintenance for the newspaper	Watershed Coordinator 319 grant and Wayne County Health Dept.	Winter 2004 $12,000	—	Distribute information to landowners through mailing list and at watershed event	Number of people receiving information
Research possible grants for septic system repair and maintenance	Gather information about possible grants to fund septic system projects. Distribute information through public meetings & newsletter	Steering Committee 319 grant	Winter 2005 $2,000	—	Distribute information found at public meeting and in newsletter	Number of people receiving information

10.4 Riparian Goals

Objective	Action	Person Responsible/ Funding Sources	Date/ Budget	Baseline	Target	Objective Indicators
Create riparian buffers using willow trees plantings	Plant willow trees along riparian corridors.	Watershed Coordinator, Richard Roeper, volunteers 319 grant and landowners	Ongoing $2,000	—	Plant at least one acre of trees using the help of volunteers each year.	Amount of riparian land planted with willows.
Promote tree planting along agricultural fields through the Conservation Reserve Program.	Include information about the CRP program in newsletters and include information with display	Watershed Coordinator 319 grant	Ongoing $1,000 annually	None to date	Discuss the CRP riparian program with 5 landowners each year Enroll 25 riparian acres into the CRP program by 2006.	Number of people informed about CRP program
Encourage riparian buffers and filter strip plantings	Develop cost-share criteria Promote cost-share program Develop a riparian buffer demo plot	Watershed Coordinator 319 grant and landowners	Nov. 2004-2006 $13,300	75% of river sufficiently buffered 56% of sub-watersheds sufficiently riparian/buffer	Increase buffer areas along river by 5% Increase buffer areas along sub-watersheds by 10%	Numbers of riparian acres planted Number of people participating

10.5 Atrazine Goals

Objective	Action	Person Responsible/ Funding Sources	Date/ budget	Baseline	Target	Objective Indicators
Educate farmer about proper land application and consequences of spills	Include information about atrazine through newsletter and press releases	Watershed coordinator 319 grant	Ongoing $2,000	As high as 30 ppb and averaging above the state standard of 3 ppb during the spring of 2004.	Atrazine levels below 3ppb	Number of people receiving newsletter Number of press releases published
Offer cost-share money to farmers decreasing their application rates of atrazine and those not applying within 200 ft of waterbodies.	Develop cost-share program Promote cost-share program	Watershed Steering Committee/ Coordinator 319 grant	Nov. 04-06 $16,300	Atrazine currently by applied at a rate of 1.3 lb/acre Atrazine levels more than 10 times the state standard of 3 ppb	Atrazine levels below 3 ppb	Number of farm acres not receiving atrazine spray Number of farmers decreasing atrazine application rates.

10.6 Habitat Goals

Objective	Action	Person Responsible/ Funding Sources	Date/ Budget	Baseline	Target	Objective Indicators
Educate landowners about the importance of wetlands and forests	Educate through publications	Watershed coordinator 319 grant	Ongoing $400/ annually	Low percentage of wetlands and forested land	Addition of forest acres an/or wetland	Number of people receiving newsletter
Encourage landowners to classify existing forests	Personal meetings with landowners	Watershed Landowners/District Forester DNR staff/319 grant	Ongoing $900/ annually	Current classified forest	Goal 20 acres of additional classified forest by 2006	Number of people met with to discuss classifying their forest
Encourage landowners to convert cropland to grassland and forestland	Educate landowners about the CRP program	Watershed coordinator/ NRCS Staff Wayne Co. SWCD and 319 grant	Ongoing/ $1,000/ annually	Approximately 15 percent of cropland enrolled in CRP	25 additional acres entered into CRP	Increase of acreage in the CRP program

Figure 10.1: Coordinator Kelly Dungan teaches children about watershed protection using an Enviroscape Model at the 2004 Conservation Ag Days held by the Wayne County SWCD for local 3rd and 4th grade students.

10.7. Overall Education Goals

Objective	Action	Person Responsible/ Funding Sources	Date/ Budget	Baseline	Target	Objective Indicators
Educated about watershed concerns to adults and children, including information about fish consumption advisories.	Set-up informational booth at 4-H Fair, Conservation Days, American Recycle Days, and Earth Day Activities.	Watershed Coordinator/ Steering Committee Wayne County SWCD and 319 grant	Ongoing $7,000 annually	To-date 2,000 people have been educated about the Middle Fork Reservoir Project	5,000 people educated about the Middle Fork Watershed Project	Number of events participated in. Number of children and adults receiving information.
Conduct an urban/small landowner workshop	Plan a watershed meeting which addressed urban issues such as tree plantings, erosion control, and, chemical disposal	Watershed Coordinator/ Steering Committee 319 grant	Spring 2006 $5,000	--	50 people attending urban landowner workshop	Number of people attending event.
Educate about urban water quality issues	Create an urban homeowner brochure to be passed out at watershed events.	Watershed Coordinator/ Steering Committee 319 grant	Winter 2005 $5,000	--	100 watershed residents receiving brochure	Number of people receiving brochure.

11.0 Measuring Progress

11.1 Progress Indicators

In order to determine the success of the project and how efforts will improve water quality. Below is a list of items, which will help determine the progress throughout the program.

1. The Coordinator will track attendance to all field days, workshops, and public meetings held within and concerning the watershed project. In addition, the coordinator will also provide quarterly newsletters, brochures, and press releases for local news media to promote the project.

2. Success of educational programs will be measured by the increased participation of each activity, including programs, water monitoring, field days, and presentations.

3. The steering committee will evaluate the management plans and make any changes or adjustments to ensure all changes and improvements remain current within the management plan.

4. Success of cost-share program will be measured by several different criteria:
   a. number of people and amount of land enrolled in the 319 cost-share program
   b. number of people and amount of land enrolled in EQIP, LARE, and other federal conservation programs.
   c. Sediment saved from erosion calculated by using IDEM's Load Reduction Calculation Program.

5. Water quality changes and improvements conducted throughout the grant period will aid in determining the success of the project.

11.2 Monitoring Progress

Water Monitoring Plan

The technical sub-committee will be responsible for conducting water monitoring in the Middle Fork Watershed during Phase II. The parameters that will be tested include: temperature, pH, dissolved oxygen, total dissolved solids, nitrate, total phosphorus, hardness, conductivity, and *E. coli*. Testing materials from the first phase will be used and any additional supplies will be purchased through the grant. A quality assurance project plan (QAPP) will be written for the monitoring methods. The testing schedule and locations will change in order to monitoring the effectiveness of BMPs installed during the project. Changes and improvements in water quality will be updated in the watershed management plan.

Additional Monitoring

1. Atrazine - Indiana-American Water Company will continue monitoring atrazine levels within the watershed and that of the raw data entering the treatment plant. These records will be compared to existing data. The data will be compared to established management goals.
2. Sediment - Load reduction calculations will be completed for applicable management practices installed within the watershed. Overall sediment reductions will be calculated and compared to previous calculations.

Operation and Maintenance
Landowners are responsible for properly installing and maintaining any management practice installed on their property through the cost-share program. Practices must be implemented for a period of 5 years and must meet NRCS technical guide standards. Each installed practice will be checked annually throughout the duration of the project. Local agencies will provide technical assistance to landowners for practices installed within the watershed.

12.0 Plan Evaluation

As a living document the management plan will be updated annually to reflect accomplishments and changes in project scope. Friends of the Middle Fork Steering Committee will review and approve any updates to the Watershed Management Plan on a regular basis. Updated copies will be kept on file at the Wayne County Soil and Water Conservation District Office and at Richmond's Morrison-Reeves Library.

A Total Maximum Daily Load is required to be completed for the watershed, as it's listed on the 303(d) list of waterbody impairments. The TMDL has not yet been developed for the watershed, but when completed this document will be updated to reflect this information.

Contact Information

All documents and records concerning this management plan will be kept at the Wayne County Soil and Water Conservation District. Record requests can be directed to Wayne County's district coordinator. The current watershed coordinator can be reached at:

Wayne County Soil and Water Conservation District
823 S. Round Barn Road, Suite 1
Richmond, IN 47374
Phone: (765) 966-0191 Ext. 3
Fax: (765) 966-0455

Sources Cited

Choi, Jin Yong and Benard A. Engel. Watershed Delineation Program. Purdue University, Agricultural and Biological Engineering Department.

Environmental Protection Agency. Surf your Watershed website. http://www.epa.gov/surf/

Faulkenburg, Alyson and Jane Frankenberger. 2000. Watershed Inventory Tool for Indiana: A guide for Watershed Partnerships. Department of Agricultural and Biological Engineering, Purdue University.

Indiana Department of Environmental Management. 2000. Indiana Water Quality Report 2000. (IDEM/34/02/001/2000)

Indiana Department and Environmental Management, Load Reduction Estimate Worksheets.

Indiana Department of Environmental Management. 2004. 303(d) List of Impaired Waterbodies. http://www.ai.org/idem/owm/planbr/wqs/303dlst.htm

Indiana Department of Environmental Management, Office of Water Quality. August 2003. Indiana Watershed Planning Guide.

Indiana Department of Natural Resources. 1999. Endangered, Threatened and Rare Species from Randolph County, Indiana.

Indiana Department of Natural Resources. 2004. Wayne County, Indiana: Tillage Transect Data 1998-2004.

Indiana Department of Natural Resources. 1999. Endangered, Threatened and Rare Species from Wayne County, Indiana.

Indiana Department of Natural Resources, Division of Forestry. Classified Forest Brochure.

Indiana Water Resources Association. 2003. Exploring the Whitewater River Basin: Past and Present.

Indiana Department of Natural Resources, Division of Forestry. Classified Forest Brochure.

Indiana State Chemist, Department of Biochemistry, Purdue University

Natural Resources Conservation Service. 2000. Unified Watershed Assessment for Indiana.

Purdue Meteorology Climate Data Sets. 2000. Mean Temperature normals for Richmond, Indiana 1971-2000. http://shadow.apry.purdue.edu/sc/index.html

Purdue University, Department of Agricultural and Biological Engineering. Watershed Inventory Tool for Indiana.

Hoosier Riverwatch. 2003. Volunteer Stream Monitoring Training Manual

United States Department of Agriculture and Purdue University. 2002. Agricultural Statistics 2002.

United States Department of Agriculture. 1987. Soil Survey of Wayne County, Indiana.

United States Department of Agriculture. 1987. Soil Survey of Randolph County, Indiana.

United States Department of Agriculture, Soil Conservation Service, Lincoln, Nebraska. 1977. Flood Hazard Analysis: East Fork Whitewater River including Middle Fork and West Fork.

United States Department of Agriculture Website, www.nass.usda.gov/in

United States Geological Survey, Reston, Virginia. 2004. Water Quality in the Great and Little Miami River Basins: Ohio and Indiana, 1999-2001.

United States Geological Survey. 1994. Hydrogeologic Atlas of Aquifers in Indiana; Water-Resources Investigations Report 92-4142.

United States Geological Survey. 1992-1993. GAP Data. Middle Fork Watershed Land Use Map.

Wilson, Jeffery. 2003. Indiana in Maps: Geographic Perspectives of the Hoosier State.

Wittman Hydro Planning Associates, Inc. 2002. Watershed Restoration Action Strategy for the Whitewater Watershed.

Wisener, J. Rhett. 2003. Department of Natural Resources, Division of Fish and Wildlife. Middle Fork Reservoir: Fish and Wildlife Research and Management Notes.

Appendix A: List of Committee Members and Sub-committee

A. Friends of the Middle Fork Members

Don Berger, chairman
Gene Berry
Bill Brown
Bruce Hartman
Duane Hieger
Kirby Hiller
Dale Leising, IDNR Resource Specialist
Rich Nicholson
Shirley Rodgers
Richard Roeper, vice chairman
Harold Routson
Dale Spencer
Bruce Hartman
George Bihl

B. Water Monitoring Committee Members

Richard Roeper, chairman
Kelly Dungan
Jim Fahlsing
Mary Hagerman
Hopi Hawk

Duane Hieger
Louis Hubble
Michael Morris
Rich Nicholson
Brook Pagac
Gene Berry

C. Educational Sub-committee Members

Richard Roeper
George Bihl
Kelly Dungan
Hopi Hawk
Shirley Rodgers
Sheryl Brown

D. Technical Sub-committee Members

Don Weaver, District Conservationist
Raquel Baker, SWCD technician
Dale Leising, IDNR Resource Specialist
Dick Roeper
Rich Nicholson
Mark Campbell
Harold Routson
George Bihl
Gene Berry
Don Berger
Kelly Dungan

Appendix B: Summary from Watershed Stakeholder Meetings, Field Days and Workshops

January Public Meeting

Date: January 27, 2003
Attendance: 24
Summary: Friends of the Middle Fork explained the 319-grant phase, residents voiced their questions and concerns about the watershed.

February Public Meeting

Date: February 10, 2003
Attendance: 18
Summary: Friends of the Middle Fork explained the 319-grant phase, residents voiced their questions and concerns about the watershed.

Watershed Field Day

Date: June 26, 2003
Attendance: 10
Summary: David Little discussed water quality concerned of the Middle Fork Reservoir, residents expressed their water quality concerns

Barrett Paving and Materials Tours

Date: May 20, 2003
Attendance: Don Berger, Dick Roeper, Kirby Hiller, Rich Nicholson, Bill Brown, Kelly Dungan, Mark Alexander, LuAnne Holeva, Shirley Rodgers, and Harold Routson.
Summary: Steering Committee members along with a few guests had a guided tour at Barrett Paving and Materials.

Forage Field Day Event

Date: August 26, 2003
Attendance: More than 80 people, including two expert speakers
Summary: Hosted by Donald Berger, highlighted bailing wrapping, wetland manure remediation system, and rotational grazing. Speakers discussed fencing options, manure management, and other topics.

November Public Meeting

Date: November 17, 2003
Attendance: 28
Summary: District Forester Jayson Waterman was the guest speaker. He discussed both large and small tree plantings and their benefits to water quality.

April Public Meeting

Date: April 14, 2004
Attendance: 12
Summary: Discussed second phase of the watershed project, willow tree plantings for streambank stabilization.

June Pond Field Day

Date: June 23, 2004
Attendance: 52
Summary: Attendees listens to a wetland plant expert, water quality specialist, and wetland engineer.

Beginning of project's second phase

Date: January 1, 2005
Summary: The Section 319 grant monies for the implementation phase of the Middle Fork Project are allocated.

Appendix C: Glossary

303d Listed Waterbody – a waterbody identified to be impaired by one or more water quality element which limits its use of designated beneficial uses, as determined by the Indiana Department of Environmental Management.
Best Management Practices (BMP) – practices implemented to control or reduce nonpoint source pollution.
Channelization – straightening of a stream, often the result of human activity.
Coliform – intestinal bacteria used as an indicator of fecal contamination.
Designated Uses – state established uses that waters should support.
Dissolved Oxygen – oxygen dissolved in water that is available for aquatic life to use for respiration.
Downstream – in the direction of a stream's current.
Ecology – the study of the relationships of living organisms and their interrelated physical and chemical environment.
Ecosystem – a community of living organisms and their interrelated physical and chemical environment.
Erosion – the removal of soil particles by the action of water, wind, ice, or other agent.

Escherichia coli (E. coli) – a type of coliform bacteria found in the intestines of warm-blooded organisms, including humans.
Floodplain – any normally dry land area that is susceptible to being inundated by water from any natural source, usually low land next to a stream or lake.
Gradient **–** measure of a degree of incline; the steepness of a slope.
Groundwater **–** water that flows or seeps downward and saturates soil or rock.
Riffle – an area of shallow, swift moving water in a stream.
Riparian Zone – an area, adjacent to a waterbody, which is often vegetated and constitute a buffer zone between the nearby land and water.
Riprap – rocks used on streambanks to protect against erosion.
Run – a stretch of fast, smooth current, deeper than a riffle, with little or no turbulence on the surface.
Run-off – water from precipitation, snowmelt, or irrigation that flows over the ground to a waterbody. Run-off can pick up pollutants from the air or land and carry then into streams, lakes, and rivers.
Sediment – sol, sand and minerals washed from the land that settles to the bottom of a waterbody
Sedimentation – process by which soil particles (sediment) enter, accumulate, and settle to the bottom of a waterbody.
Soil Association -- a landscape that has a distinctive pattern of soil in define proportions. typically named for the major soils.
Storm Drain – constructed opening in a road system through which run-off from the road surface flows on its way to a waterbody.
Stormwater – the surface water run-off resulting from precipitation falling within a watershed.
Substrate – the material that makes up the bottom layer of a stream.
Topographic Map – map that marks variations in elevation across a landscape.
Tributary – a stream that contributes its water to another stream or waterbody
Turbidity – presence of sediment or other particles in water, making it unclear, murky, or opaque.
Upstream – against the current
Water Quality – the condition of water with regard to the presence or absence of pollution.
Water quality standard – recommended or enforceable maximum contaminant levels of chemicals or materials in water.
Wetlands – lands where water saturation is the dominant factor in determining the nature of soil development and the types of plant and animal communities.

Appendix D: List of Acronyms

BMP Best Management Practice
BOD Biological or Biochemical Oxygen Demand
CRP Conservation Reserve Program
CWA Clean Water Act
CWP Center for Watershed Protection
EPA Environmental Protection Agency
EQIP Environmental Quality Incentives Program
FMF Friends of the Middle Fork
GAP Gap Analysis Program
GIS Geographic Information System
GPS Global Positioning System
HUC Hydrologic Unit Code
IAC Indiana Administrative Code
IDEM Indiana Department of Environmental Management
IDNR Indiana Department of Natural Resources
ISDH Indiana State Department of Health
NPDES National Pollutant Discharge Elimination System
NPS Non-point Source
NRCS Natural Resources Conservation Service
NWI National Wetland Inventory

PCB Polychlorinated Biphenyls
QHEI Qualitative Habitat Evaluation Index
SWCD Soil and Water Conservation District
TMDL Total Maximum Daily Load
USDA United States Department of Agriculture
USGS United State Geological Survey
UWA Unified Watershed Assessment

Appendix E: Public Comment

January 27th

1. Dead livestock disposal
2. High bacteria levels within the river
3. Legality of river walking
4. Proper manure application
5. Possible dredging of the Middle Fork Reservoir
6. Hollansburg's storm water system, possible septics tied in.
7. Barrett Paving Materials impact
8. Groundwater quality
9. Negative changes of river visually
10. Siltation around Barrett Paving Materials
11. Stream course changes, cut banks
12. Chemical spill report procedures
13. Effect of water company treatment on fish populations
14. High turbidity in Middle Fork Reservoir

February 10, 2003

1. Possible dredging of the Middle Fork Reservoir
2. Erosion along riverbanks in Middleboro

3. Ohio’s effect on the water quality
4. Suburban landowner’s effect on water quality
5. Farm chemicals, including Atrazine

Appendix F: Landowner Survey

Middle Fork Landowner Survey 2003

1. **How many acres of land do you own or farm within the watershed.**
   a. less than 10   b. 10-50   c. 50-100   d. more than 100

2. **Do you own land next to the Whitewater River?** Yes / No

3. **Do you fish, recreate, or have any direct contact with any of the following within the watershed boundaries?**
   a. Whitewater River?
   b. A stream flowing into the Whitewater River?
   c. Middle Fork Reservoir?

Questions #4-8 for agricultural producers only…

4. **a. What types of chemicals do you apply to your farmland?**
   b. What types of chemicals do you hire an applicator for?
   c. Are you currently using a nutrient management plan?

5. **How many acres do you plant in…**
   Corn____________________
   Soybeans_________________
   Other____________________

6. **How many of the following livestock do you maintain within the watershed?**

7. **Of you livestock, how many have regular access to the Middle Fork River or a connecting waterway (pond, river, etc.)**

8. **What, if any, projects within the watershed have you completed on your land in conjunction with the Soil and Water Conservation District (LARE, EQIP, CRP, Etc.)**

9. **Do you know how to properly dispose of household and/or agricultural chemicals and containers? (circle one) Yes/No**

10. **Do you dispose of motor oil, paint, and other solvents on your property? yes / no**

11. **When was the last time you have your septic system checked?**
    a. 1-2 years   b. 2-5 years   c. more than 5 years   d. I don't know

12. **How many acres of the following are located on or adjacent to your property?**

a. Pond	d. Woodland
b. River	e. Grassland
c. Wildlife area	f. Wetland

13. **Do you have regular access to the Internet? (circle one) yes / no**

14. **Circle the numbers of any topic you would like more information?**

1. livestock disposal	5. proper septic maintenance
2. streambank protection	6. timber stand improvement
3. nutrient management plans	7. general environmental protection info.
4. conservation farming practices	8. other______________________

15. **May we contact you if we have any questions? ______________________________**

16. **Do you have any questions and concerns for us?_____________________________**

Summary of Watershed Survey Results

Summary of Watershed Survey Responses

1. How many acres do you own within the watershed boundaries?

Acreage	
less than 10	41
10-50	24
50-100	7
100+	13

2. Do you live adjacent to the river?

Yes	31
No	53

3. What waterbodies within the watershed do you have direct contact with?

River	19
Resevoir	27
Stream	23
None	38

4. Do you know how to properly dispose of chemicals?

Yes	67
No	13

5. Do you dispose of chemicals on your property?

Yes	4

No	76
No answer	4

6. Do you have internet access?

Yes	50
No	32

7. What natural features do you have on your property? (multiple answers allowed)

pond	18
woodland	29
grassland	33
wildlife	17
river/stream	10
wetland	10

8. What Farm chemicals do you apply within the watershed?

Round-up	7
Harness	2
Northstar	2
Tordan	1
Bruch Killer	1
Degree Extra	1
Atrazine	1
24D	2
Lasso	1
Potash	1
Balance Pro	1
Princep	1

9. What farm chemicals do you hire an applicator for?

Fertilizer	3
Round-up	4
Nitrogen	2
Herbicide	1
Biocep	1
24D	1

10. Do you have a nutrient management plan?

Yes	6
No	6

11. What livestock do you have within the watershed?

Cattle	326
Swine	8
Horses	9
Chickens	30

12. How long has it been since you've had your septic system checked?

1-2 years	23
2-5 years	25
5+ years	17
Don't Know	11

Appendix G: Metal Testing Results

Middle Fork Watershed Sample Results, ppm
Spring 2003

Element	EPA Method	Detection Limit, ppm	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
Aluminum	**200.7**	**0.200**	**0.327**	**0.592**	**0.403**	**0.437**	**0.439**	**0.406**	**0.428**	**0.364**
Arsenic	206.2	0.010	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Barium	**200.7**	**0.050**	**0.076**	**0.078**	**0.077**	**0.080**	**0.081**	**0.075**	**0.068**	**0.061**
Beryllium	200.7	0.005	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium	200.7	0.005	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Calcium	**200.7**	**0.500**	**72.1**	**90.6**	**79.6**	**77.3**	**92.4**	**85.0**	**68.6**	**99.6**
Chromium	200.7	0.020	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cobalt	200.7	0.050	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Copper	200.7	0.020	BDL	BDL	0.02	BDL	BDL	BDL	BDL	BDL
Iron	**200.7**	**0.050**	**0.080**	**0.079**	**0.110**	**0.130**	**0.166**	**0.131**	**0.171**	**0.139**
Lead	239.2	0.005	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Magnesium	**242.1**	**0.500**	**29.6**	**30.6**	**31.0**	**30.1**	**29.6**	**28.2**	**27.1**	**26.4**
Manganese	200.7	0.015	BDL	BDL	0.016	0.017	0.021	0.018	0.016	BDL
Molybdenum	200.7	0.050	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Nickel	200.7	0.050	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Potassium	**258.1**	**0.200**	**0.890**	**0.957**	**0.924**	**1.04**	**1.03**	**0.861**	**0.749**	**0.532**
Silver	200.7	0.010	BDL	BDL	BDL	BDL	0.019	BDL	BDL	BDL
Sodium	**273.1**	**0.500**	**8.55**	**8.51**	**8.12**	**9.53**	**9.31**	**8.57**	**9.34**	**5.57**
Vanadium	200.7	0.050	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc	200.7	0.050	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Samples collected by Devin O'Leary (Earlham College) and Dick Roeper (Professor, Indiana University East) in April 2003. Sites used same as those used during the grant monitoring project.

Determination of Metals at Eight Sites in the Middle Fork Reservoir Watershed

EARLHAM COLLEGE

Techniques of Water Analysis, Chemistry 230

Earlham Analytical Laboratory, Earlham College, Richmond, IN

Introduction

The Wayne County Soil and Water Conservation District was awarded a two year grant from the Environmental Agency to study the health of the Middle Fork Watershed and design a management plan.

The Middle Fork Watershed is the entire land area that drains to the Middle Fork Reservoir. The watershed reflects the quality and quantity of water in the Reservoir. The Reservoir, in turn, supplies about half of the drinking water for the city of Richmond in Wayne County Indiana.

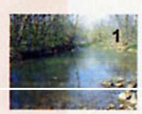
This study is the first on the metals content in the waters of the entire watershed. Results for 20 metals at 8 sites were determined. The metals analyzed included the suite of 4 toxic pollutants - Copper, Chromium, Nickel and Zinc - listed in the EPA Index of Watershed Indicators.

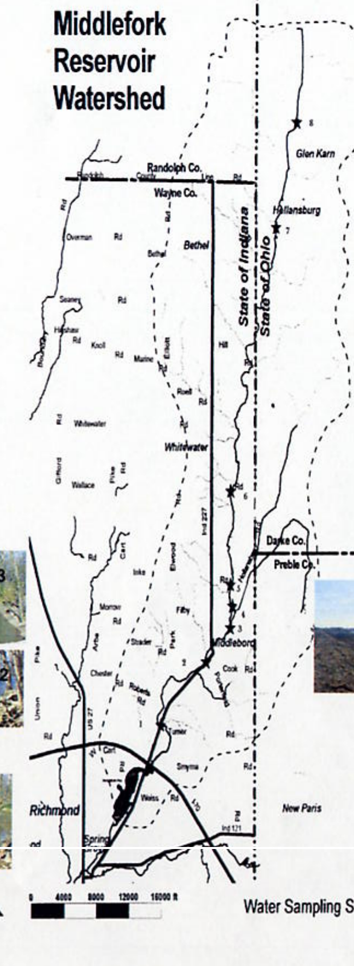
Methods

Samples were collected April 15, 2003 from the eight sites shown on the map to the right by Devin O'Leary, Earlham College and Dick Roeper, Professor of Biology at Indiana University East. The samples were collected in plastic and preserved with nitric acid for analysis.

Sampling sites were chosen to bracket areas of concern – the towns of Middleboro and Hollandsburg – which are situated directly on the whitewater river. Samples also were collected immediately upstream and downstream of Barrett Paving and Materials, a quarry, and the only industry located within the watershed which holds a permit to discharge directly into the river.

Samples were analyzed using EPA Methods. Instrumentation used included a Perkin-Elmer Optima 4100DV Inductively Coupled Plasma - Atomic Emission Spectrophotometer (ICP-OES) and a Perkin-Elmer 5100 Flame Atomic Absorption (FAAS) and Graphite Furnace Atomic Absorption Spectrophotometer (GFAAS), for a total determination of 20 metals.



Water Sampling Sites





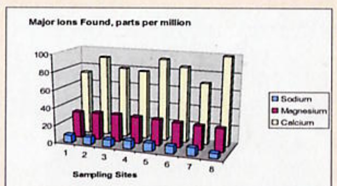


Results

Middlefork Watershed Sample Results, ppm

Element	EPA Method	Detection Limit, ppm	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
Aluminum	200.7	0.200	0.327	0.392	0.403	0.437	0.439	0.406	0.439	0.364
Arsenic	200.7	0.010	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Barium	200.7	0.050	0.076	0.079	0.077	0.080	0.081	0.071	0.068	0.061
Beryllium	200.7	0.005	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium	200.7	0.005	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Calcium	200.7	0.500	72.1	90.8	79.8	77.3	82.4	65.0	48.6	96.6
Chromium	200.7	0.020	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cobalt	200.7	0.050	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Copper	200.7	0.020	BDL	BDL	0.02	BDL	BDL	BDL	BDL	BDL
Iron	200.7	0.050	0.080	0.079	0.110	0.130	0.166	0.121	0.171	0.138
Lead	239.2	0.005	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Magnesium	242.1	0.500	29.8	30.6	31.0	30.1	29.6	28.2	27.1	38.4
Manganese	200.7	0.015	BDL	BDL	0.016	0.017	0.021	0.018	0.016	BDL
Molybdenum	200.7	0.050	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Nickel	200.7	0.050	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Potassium	258.1	0.200	0.890	0.957	0.924	1.04	1.03	0.861	0.749	0.533
Silver	200.7	0.010	BDL	BDL	BDL	BDL	0.019	BDL	BDL	BDL
Sodium	273.1	0.500	8.58	8.51	8.12	8.53	9.31	8.57	9.34	5.57
Vanadium	200.7	0.050	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc	200.7	0.050	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

BDL: Below Detection Limit



Conclusions

The determination of metals in the Reservoir supplements a larger study of the overall health of the watershed. The metal concentrations are within limits for healthy surface waters, including below limit concentrations of the EPA Watershed Indicator metals.

No significant difference was found between results upstream and downstream of Hollansburg, Middleboro or the quarry, indicating there is not significant metal impact from these sites. Data will be given to the Watershed Coordinator, Kelly Dungan for future reference.

The Pollution Tolerance Index ratings (left) courtesy of Dick Roeper, show biological health disparities among sites not evident in the metal analysis.

Further investigation should include analysis of Mercury, in both water and fish; and Atrazine, an herbicide, which has exceeded the EPA limit several times in the Reservoir, so that drinking water from the Middle Fork Reservoir must be filtered before release into the public supply.

Acknowledgments

Dick Roeper, IU East, Professor of Biology

Kelly Dungan, Watershed Coordinator, SWCD

Friends of the Middle Fork

Appendix H: Atrazine Data

	Middle Fork Raw Atrazine 2000-2004 Data collected by Indiana-American Water Company					
Date	**2000**	**2001**	**2002**	**2003**	**2004**	**MCL**
1-Apr						3.00
2-Apr						3.00
3-Apr						3.00
4-Apr	0.13					3.00
5-Apr						3.00
6-Apr	0.13					3.00
7-Apr						3.00
8-Apr						3.00
9-Apr						3.00
10-Apr						3.00
11-Apr	0.20					3.00
12-Apr						3.00
13-Apr	0.16					3.00
14-Apr					0.08	3.00
15-Apr						3.00
16-Apr						3.00
17-Apr						3.00
18-Apr	0.19					3.00
19-Apr						3.00
20-Apr	0.19					3.00
21-Apr						3.00
22-Apr						3.00
23-Apr						3.00
24-Apr		0.59				3.00
25-Apr	0.20					3.00
26-Apr		0.48				3.00
27-Apr	0.23					3.00
28-Apr						3.00
29-Apr				0.11		3.00
30-Apr					0.00	3.00
1-May		0.52		0.16		3.00
2-May	0.25					3.00
3-May		0.53				3.00
4-May	0.27					3.00
5-May						3.00
6-May				0.16		3.00
7-May			1/2/1900			3.00
8-May		0.53		0.96		3.00
9-May	0.36		1/0/1900			3.00
10-May		0.47				3.00
11-May	0.45					3.00
12-May				5.23		3.00
13-May						3.00
14-May	0.25		1/3/1900		0.65	3.00
15-May		0.55		5.35		3.00

16-May			1/3/1900			3.00
Date	**2000**	**2001**	**2002**	**2003**	**2004**	**MCL**
17-May		0.56				3.00
18-May	0.28				0.52	3.00
19-May						3.00
20-May				7.64		3.00
21-May			2.58			3.00
22-May				8.56		3.00
23-May			2.24			3.00
24-May						3.00
25-May						3.00
26-May					6.80	3.00
27-May			2.23		6.42	3.00
28-May				5.05		3.00
29-May		5.11		5.71		3.00
30-May	6.22		2.32			3.00
31-May		5.14				3.00
1-Jun	6.81					3.00
2-Jun						3.00
3-Jun				4.79	4.65	3.00
4-Jun			2.43			3.00
5-Jun		4.66		4.10	4.37	3.00
6-Jun	6.85		2.40			3.00
7-Jun		4.32				3.00
8-Jun	7.46				4.12	3.00
9-Jun						3.00
10-Jun				4.08	3.86	3.00
11-Jun			5.73			3.00
12-Jun		3.8		4.32		3.00
13-Jun	7.26		5.08			3.00
14-Jun		4.25				3.00
15-Jun	8.25				3.11	3.00
16-Jun						3.00
17-Jun				4.18	2.65	3.00
18-Jun			5.1			3.00
19-Jun		4.19		4.41		3.00
20-Jun	5.97		5.15			3.00
21-Jun						3.00
22-Jun	5.90	3.97				3.00
23-Jun					1.02	3.00
24-Jun			5.51			3.00
25-Jun	4.55			3.29		3.00
26-Jun		3.19		3.1	0.72	3.00
27-Jun	4.89		5.65			3.00
28-Jun						3.00
29-Jun		3.18				3.00
30-Jun						3.00
1-Jul				3.07	1.37	3.00
2-Jul			3.69			3.00
3-Jul		2.03		3.28		3.00

Date	2000	2001	2002	2003	2004	MCL
4-Jul	4.82		4.11			3.00
Date	**2000**	**2001**	**2002**	**2003**	**2004**	**MCL**
5-Jul		2.38				3.00
6-Jul	5.21					3.00
7-Jul						3.00
8-Jul						3.00
9-Jul			4.02		1.12	3.00
10-Jul	4.44	2.5		1.15		3.00
11-Jul			4.61	1.67		3.00
12-Jul		2.54				3.00
13-Jul	4.79					3.00
14-Jul						3.00
15-Jul				1.15	0.66	3.00
16-Jul			3.54			3.00
17-Jul				1.26		3.00
18-Jul	5.79		3.7			3.00
19-Jul						3.00
20-Jul	4.77					3.00
21-Jul						3.00
22-Jul				0.9	0.8	3.00
23-Jul						3.00
24-Jul		1.63	3.5	0.78		3.00
25-Jul	3.75		3.6			3.00
26-Jul		1.76				3.00
27-Jul	3.92					3.00
28-Jul						3.00
29-Jul				0.37		3.00
30-Jul			3.47			3.00
31-Jul		1.78				3.00
1-Aug	3.37		3.98			3.00
2-Aug		1.84		0.31		3.00
3-Aug	3.81					3.00
4-Aug						3.00
5-Aug			4.06			3.00
6-Aug						3.00
7-Aug		1.69				3.00
8-Aug	3.35		4.15			3.00
9-Aug		1.92				3.00
10-Aug	3.31					3.00
11-Aug						3.00
12-Aug						3.00
13-Aug			3.77			3.00
14-Aug		1.74				3.00
15-Aug	2.82		5.79			3.00
16-Aug		1.37				3.00
17-Aug	2.67					3.00
18-Aug						3.00
19-Aug						3.00
20-Aug			3.25			3.00
21-Aug		1.66				3.00

22-Aug	2.56		3.66			3.00
Date	**2000**	**2001**	**2002**	**2003**	**2004**	**MCL**
23-Aug		1.67				3.00
24-Aug	2.57					3.00
25-Aug						3.00
26-Aug						3.00
27-Aug			3.44			3.00
28-Aug		1.28				3.00
29-Aug	2.33		4.26			3.00
30-Aug		1.42				3.00
31-Aug	2.59					3.00
1-Sep						3.00
2-Sep						3.00
3-Sep			3.37			3.00
4-Sep	2.17					3.00
5-Sep		1.15	3.46			3.00
6-Sep		1.25				3.00
7-Sep	2.27					3.00
8-Sep						3.00
9-Sep						3.00
10-Sep			3.16			3.00
11-Sep		0.91				3.00
12-Sep	1.86		3.33			3.00
13-Sep		0.97				3.00
14-Sep	2.01					3.00
15-Sep						3.00
16-Sep						3.00
17-Sep		0.86	1.2			3.00
18-Sep						3.00
19-Sep	1.98		0.82			3.00
20-Sep		0.9				3.00
21-Sep	2.03					3.00
22-Sep						3.00
23-Sep						3.00
24-Sep			2.9			3.00
25-Sep		0.78				3.00
26-Sep	1.91		2.71			3.00
27-Sep		0.79				3.00
28-Sep						3.00
29-Sep	2.08					3.00
30-Sep						3.00

Indiana-American Water Company
2004 Middle Fork Watershed -- Atrazine (ug/L)

Date	Park Elwood Site 1	Grandpa's Site 2	Mud Creek Site 3	Inke Rd Site 4	Wallace Rd Site 5	Whitewater Rd Site 6	W. Union St Site 7	Glen Karn Site 8	Plant Raw	(3.0 ug/L) Control
14-Apr	0.00	0.01	0.00	0.01	0.00	0.05	0.03	0.03	0.08	2.84
30-Apr	0.06	0.09	0.00	0.14	0.18	0.37	0.31	0.28	0.00	2.97
13-May	0.22	0.35	0.15	0.21	0.26	0.39	0.12	0.17		2.63
14-May									0.65	2.63
18-May									0.52	2.81
19-May	22.95	22.40	17.52	32.59	30.70	27.45	15.82	11.36		2.81
26-May									6.42	3.51
27-May	0.75	1.00	0.03	0.47	1.22	0.83	0.37	0.31		3.51
3-Jun									4.65	3.00
5-Jun									4.37	3.00
8-Jun									4.12	3.25
10-Jun									3.86	3.25
15-Jun									3.11	3.29
17-Jun									2.65	3.29
23-Jun									1.02	3.28
24-Jun	0.28	0.34	0.06	0.33	0.40	0.31	0.28	0.31		3.28
26-Jun									0.72	3.28
1-Jul									1.37	2.73
10-Jul									1.12	2.43
15-Jul									0.66	2.39
22-Jul	1.23	0.16	0.11	0.03	0.05	0.01	0.19	0.10	0.80	2.92

Appendix I: Riparian Study of the Middle Fork Watershed

Whitewater River - Middle Fork
Length and Non-Buffered lengths

		Total Length (ft)	Length not Buffered	Length 1/2 Buffered	% not Buffered
1	Reservoir to Park Elwood	5,320	375		35%
2	Park Elwood to Middleboro Bridge	11,000	3900	(500)	35% (4.5%)
3	Middleboro Bridge to Mud Creek	3,800	0		0%
4	Mud Creek to Inke Road	3,400	2600		75%
5	Inke Road to Wallace	8,400	2000		23.80%
6	Wallace to Whitewater	5,200	875		16.80%
7	Whitewater to Hill Road	9,000	2600		28.80%
8	Hill Road to State Line	3,000	1800		60%
	Total Reservoir to Ohio State Line	**49,120**	**12,387.5**		**25.20%**
	Hill Road to Hollansburg	12,200			
	Hollansburg to Weaver Ft. Jefferson	22,200			
		34,400			
	Total River Length in miles				
	Indiana Only	**9.30 miles**			
	Indiana and Ohio	**15.25 miles**			

Sub-watershed Riparian Areas

	Total Length	Non-Riparian	% non-riparian
Boro Creek			
Main Stem	7600	630	8.30%
1st Branch (crosses Filby)	400	0	0%
2nd Branch (Ends at Inke)	3200	550	17.20%
Total	11,200	1180	10.50%
Bethel Creek			
Main (to split)	9200	2550	27.70%
East Fork	2800	2800	100.00%
West Fork	1800	1000	55.60%
Side Tributary	400	200	50%
Total	14200	4000	28.20%

Evans Creek					
Main	4200		4200		100%
South Branch (intermittent)	4000		4000		100%
Crosses Porterfield Road	1800		1800		100%
North Branch	5200		5200		100%
Total	15200		15200		100%
Middle Brook					
Main Stem	7800	*		*	
All three tributaries	1200	*		*	
Total	9000		5600		62.20%
Clay Run					
Main Stem	1200	*		*	
North Tributary	2400	*		*	
West Tributary	3400	*		*	
Total	7000		3000		42.90%
No Name 3W (234 acres)					
Main Stem	800		800		100%
South Fork	1400		1400		100%
North Fork	3800		3800		100%
Branch off north fork	1200		1200		100%
Total	7200		7200		100%
Black Brook					
Main Stem	3000	*		*	
North Branch	2400	*		*	
Middle Branch	1600	*		*	
South Branch	3600	*		*	
Total	10600		7700		73%
No Name 4 - toward Whitewater (146 acres)					
Main Stem	1200		1200		100%
White Creek					
Main Stem	18200		10000		54.90%
North 1	4400		2000		45.50%
North 2	3400		3400		100%
North 3	7600		7600		100%
South 1	1600		400		25%
Total	35200		23400		66.50%
Gray Brook					
Main Stem	13000		3000		23.10%
North Branch	3200		0		0%
South Branch	1600		0		0%
Total	17800		3000		16.90%

No Name (N. of Bethel 102 acres)	3400	600	17.60%
No Name (55.4 acres)	3000	2600	86.70%
No Name (196.4 acres)	5200	3600	69.2
Mud Creek			
Main Branch	6,125	-	-
North Branch	14,784	-	-
East Fork of North Branch	10,560	-	-
West Fork of North Branch	3,800	-	-
South Branch	24,077	-	-
Total	59,346		
No Name (S. of Hill Rd, runs E.)	9,504	-	-
Karn Branch			
Main Stem	4,435	-	-
Glen Karn Ditch			
Main Stem	14,784	-	-
No Name below Hill Rd (86.5 acres)			
Main Stem	5,000	-	-
Reservoir Tributary	2,323	-	-
No Name (1398 acres)			
Main Stem	16,000	-	-
East Fork	4,000	-	-
Upper West Fork	2,200	-	-
Middle West Fork	1,600	-	-
Lower West Fork	3,000	-	-
Total	26,800		
No Name – Highland Road (484.4 acres)			
Main Stem	4,646	-	-
No Name – South of Turner Rd 509.6 acres			
Both Forks	13,514	-	-
Total Tributary length (feet)	280,552 ft	78,280 of 140,200 measured (55.8%)	
Total Tributary (miles)	53.13 miles	14.8 miles non-riparian	

*= riparian calculated for total sub-watershed only
- = data unknown

Appendix J: Water Quality Parameters

Water Parameter Tested	Form of measurement	Natural Reading	State water quality standard	Possible sources/influences	Possible Solutions
Dissolved Oxygen	Amount of oxygen dissolved in water	Typically less than 10 mg/L	Minimum of 4 mg/L for aquatic invertebrates Less than 5 mg/L causes stress on fish	Atmosphere via aeration (wind, running water, riffles)	Control algae by limiting nutrients (N,P)
pH	Acidity/Alkalinity Of the water	Generally 6.5-9.0	Between 6.0-9.0	Industrial pollution, chemical spills, acid rain	Pollution controls
Nitrate	Principal from of nitrogen found in natural waters, most oxidized stable form	Less than 0.3 mg/L	Consistent readings above 3.0 mg/L	Fertilizer, human sewage, animal waste, industry output,	Vegetated riparian zones, limit use of fertilizers, properly maintained septic systems
Total Phosphorus	Measure of organic and inorganic forms, essential and often lost limiting nutrient	0.0-0.2 mg/L	Consistent readings above 0.2 mg/L	Fertilizer, animal waste, human waste	Vegetated riparian zones, limit use of fertilizers, properly maintained septic systems
Total Dissolved Oxygen	Amount of dissolved material in water, amount of filterable residue	0-1000 mg/L	Consistent readings of 1000 mg/L or more	Soil runoff, industrial effluent, road salts, etc.	Sediment controls, riparian buffers
E. coli (Escherichia Coli)	Bacteria found in intestine tracts of warm blooded animals	0.2 or greater	More than 235 colonies/ 100 mL	Human, animal, wildlife, and pet waste	Prevent manure from entering waterways, maintained septic systems.

Appendix K: Sediment load calculation

Calculations below based on the following average concentration and flow rates:
Average concentration: 369 mg/L
Average flow rate: 117.5 ft3/sec

369 mg/L * 1 g/1000mg = 0.369 g/L

0.369g/L * 1 lb/454g = 0.000813 lb/L

0.000813 lb/L * 1L/0.035 ft^3 = 0.0232 lb/ft^3

0.0232 lb/sec * 117.5ft^3/sec = 2.73 lb/sec.

2.73 lb/sec * 3,600 sec/hour = 9828 lb/hr

9828 lb/hour * 24 hr/day = 235,872 lb/day

235872 lb/day * 365 days/year = 861 x 10^5 lb/year

861 x 105 lb/ year * 1 ton/2000 lb = 43.050 tons/year

Appendix L: 2004 Rainfall Data

10-Feb	0	31-Mar	0.16
11-Feb	0	1-Apr	0.04
12-Feb	0	2-Apr	0.08
13-Feb	0	3-Apr	0
14-Feb	0	4-Apr	0
15-Feb	0	5-Apr	0
16-Feb	0	6-Apr	0
17-Feb	0	7-Apr	0.01
18-Feb	0	8-Apr	0.04
19-Feb	0	9-Apr	0
20-Feb	0.04	10-Apr	0
21-Feb	0.01	11-Apr	0
22-Feb	0	12-Apr	0
23-Feb	0	13-Apr	0.23
24-Feb	0	14-Apr	0.29
25-Feb	0.01	15-Apr	0
27-Feb	0	16-Apr	0
28-Feb	0	17-Apr	0
1-Mar	0.04	18-Apr	0
2-Mar	0.13	19-Apr	0
3-Mar	0	20-Apr	0.12
4-Mar	0.13	21-Apr	0.16
5-Mar	0.23	22-Apr	0.28
6-Mar	0.08	23-Apr	0.68
7-Mar	0	24-Apr	0
8-Mar	0	25-Apr	0.24
9-Mar	0	26-Apr	0.04
10-Mar	0	27-Apr	0
11-Mar	0	28-Apr	0
12-Mar	0	29-Apr	0
13-Mar	0	30-Apr	0.16
14-Mar	0.01	1-May	0.35
15-Mar	0.01	2-May	0.85
16-Mar	0.07	3-May	0.05
17-Mar	0.09	4-May	0
18-Mar	0.01	5-May	0.01
19-Mar	0.22	6-May	0
20-Mar	0	7-May	0
21-Mar	0.05	8-May	0.09
22-Mar	0	9-May	0.01
23-Mar	0	10-May	0.01
24-Mar	0.03	11-May	0.02
25-Mar	0	12-May	0
26-Mar	0	13-May	0.03
27-Mar	0.42	14-May	0.16
28-Mar	0	15-May	0.31
29-Mar	0.01	16-May	0.13
30-Mar	0.08	17-May	0

18-May	0.05
19-May	0.8
20-May	0.06
21-May	0.02
22-May	0.04
23-May	0
24-May	0.13
25-May	0.13
26-May	0
27-May	0
28-May	1.1
29-May	0
30-May	0.06
31-May	1.15
1-Jun	0.01
2-Jun	0.13
3-Jun	0
4-Jun	0
5-Jun	0
6-Jun	0
7-Jun	0
8-Jun	0
9-Jun	0
10-Jun	0.02
11-Jun	0.22
12-Jun	1.5

Appendix M: Raw Water Monitoring Data