Rice Creek Watershed Management Plan

Updated September, 2004

Coordinated through the

Calhoun Conservation District
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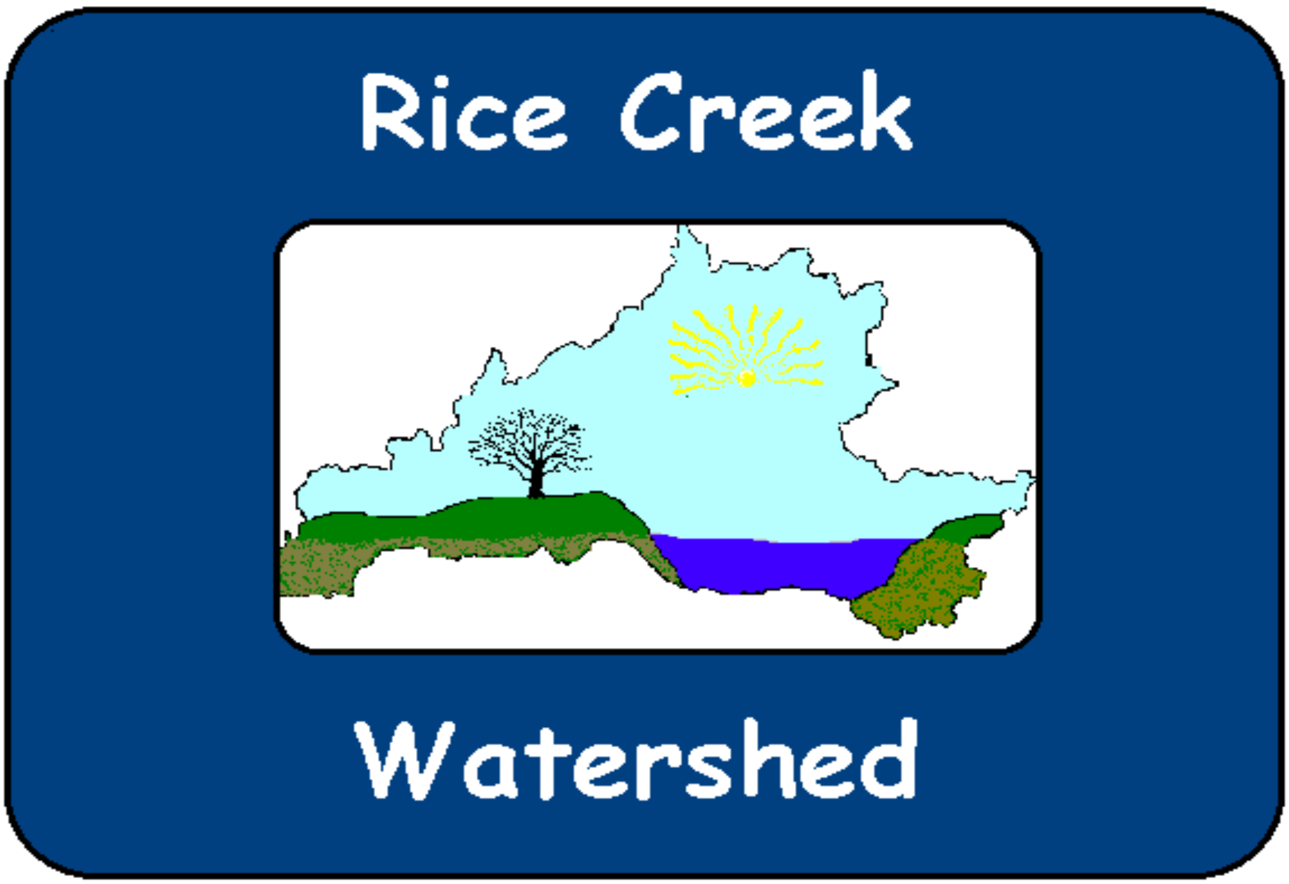

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Introduction

The overall goal of this planning project is to develop an evolving but comprehensive watershed management plan (CWMP) that identifies and analyzes the resource conditions, problems, and solutions for the Rice Creek Watershed. This management plan should be routinely updated and expanded to represent current conditions and land use if it is to be used to guide implementation of conservation measures that minimize the environmental impact of any one designated use. In effect, this plan outlines solutions that will improve and maintain conditions so that *all* designated uses in the watershed are restored and maintained to the greatest extent possible. Collectively, the purpose of this management plan is to help stakeholders in the watershed answer this question: *How do we balance the expressed public desire for a healthy resource base with the desire, and necessity, to exploit it?*

Local Agency and Citizen Involvement

The Rice Creek Watershed Advisory Committee was formed in 2001 and consisted of a diverse group of resource professionals, farmers, landowners, agency staff, township officials, and concerned citizens. Their dedication and hard work over the past few years has guided the planning process, and most of them remain committed to serving on the Committee into the implementation phase of the watershed plan. Their names are Richard Robilliard, farmer Sheridan Township; Wendy Chamberlain, Parma Township Supervisor; Tracy Bronson, Calhoun Conservation District Executive Director; Rachel Grades, Calhoun County Drain Commission Office; Greg Potter, Trout Unlimited and Business Owner; Linda Kubiak, Farmer, Calhoun Conservation District Board; Scott Hanshue, Michigan Department of Natural Resources, Fishery Division; Doug White, Professor of Biology at Albion College and Manager of water quality monitoring for the project; James Coury, Potawatomi Resource Conservation & Development; Chris Bauer, Michigan Department of Environmental Quality-Water Division; Jennifer Bomba, Calhoun County Community Development, Planning Director; Daniel Kesselring, Retired District Conservationist, United States Department of Agriculture Natural Resources Conservation Service; Charles (Chuck) Elzinga, Professor of Stream Ecology, Michigan State University and Manager of Lake studies for the project; Ben Lark, Chairman of the Calhoun Conservation District Board and Sportsman; Mike Metzger, Jackson County-Michigan State University Extension; Bob Battel, Calhoun County-Michigan State University Extension; Blaine VanSickle, Calhoun County Drain Commissioner, Farmer in Marengo Township; Ken Lauer, Sheridan Township Supervisor; James Tech, Landowner, Sportsman; Steve Hall, Jackson County Health Department; Sue Hauxwell, Calhoun County Health Department; Robert Brownell, Marengo Township Board, Farmer in Marengo Township; Mike Lehtonen, City of Marshall engineer; Jack Knorek, Lee Township Board; Cyndi Twichell, Manager of the Village of Springport; Robert Neumann, Consumers Energy; Sharon Parker, Jackson Conservation District, Executive Director; Don Franklin, Marshall Township Planning Commission and retired engineer; Craig Gill, Village of Springport Department of Public Works; Tara Egnatuk, Conservation Education Director, Calhoun Conservation District; Rick Pierson, Coordinator for the Rice Creek Watershed Planning Project, Calhoun Conservation District.

The Rice Creek Watershed Advisory Committee met quarterly, while the steering committee (made up of 12 of the above individuals) met most months. Many of the Advisory Committee Members also served on various sub-committees during the planning process and all of their contributions are much appreciated.

Public Involvement

The Original Rice Creek Watershed Planning Project communicated directly with the 1200 watershed residents on many occasions through newsletters, questionnaires, workshops, public meetings and site visits.

Newsletters were mailed in the fall of 2001, spring 2002, winter 2002, and spring 2003 with many educational articles on watersheds, land use, lakes, watershed history, drinking water, stream ecology, water quality monitoring, project updates and results from meetings and questionnaires. There were also several press releases announcing project details and events to the public.

Questionnaires were mailed to all watershed residents in the winter of 2001 and again in the spring of 2003 to gather concerns about the watershed. The results of the questionnaires are included in this plan (See Appendix A). Generally, folks in the watershed are concerned about the water quality of Rice Creek and its corridor for hunting, fishing, viewing wildlife, and especially for managing storm water and functioning as an agricultural drain. On the other hand, there also was an apparent lack of information and communication as it relates to resolving resource conflicts that exist between the various land uses.

Workshops and conferences were utilized to promote public education and involvement. Soil sampling and lawn fertilization practices were taught, septic system maintenance and replacement options were shared, and a session with an overview of the home*a*syst program was held to help homeowners assess and reduce their risk of impact to groundwater contamination.

On July 25, 2002 a workshop specifically geared toward farmers was held. Topics included an overview of the watershed planning project, discussions about county drains, manure and nutrient management, septic system maintenence and an overview of the farm*a*syst program, which helps farmers reduce their risk of impact to groundwater contamination. Conservation tillage, filter strips and other conservation measures were also included in the discussions.

On February 27, 2003 a follow-up conference entitled "*On the Edge*: Stream Issues and Answers Conference" was held for all watershed residents. The workshop was held in cooperation with the Battle Creek River Watershed Planning Project. The conference agenda was established based on comments made by watershed residents who attended earlier workshops. They wanted a conference that focused on stream issues and desired an opportunity to ask questions and get answers on specific topics. Professional speakers were found for each of the desired topics.

All of the workshops and the conferences were very well attended. Public presentations, site visits and one-on-one meetings were also effective to incorporating public input into the planning process. This process also brought all those involved along a path of education related to watershed management, conservation of natural resources, application of best management practices and in piquing their interest in reducing and/or eliminating sources of pollution.

Data Collection

Various methods were used in the gathering of data concerning the watershed description and subsequent chapters. Specific inventories conducted include the following: Historical and current resources; land uses; soil types; topography; hydrology; an aerial photographic catalog; population; critical areas and sites, including pollutants, sources, and causes; and Best Management Practices (BMP's) appropriate to contamination issues. The findings in this plan are a direct result of these inventory activities, which were conducted by the watershed project coordinator, Albion College and many others.

A comprehensive field study was conducted including inspections of the main tributaries, lakes, and potential groundwater contamination sites. This physical inventory provided an opportunity to identify significant water quality pollutants, sources, and causes. The inventory included photographic documentation of each of the 68 road/stream crossings and critical areas, along with complete video documentation.

A thorough review of the historical data existing on Rice Creek and its watershed was compiled from files at the Calhoun County Drain Commission office. Other significant files of historical data are available from Marengo Township, Calhoun & Jackson County Health Departments, and the Calhoun County USDA-NRCS office.

An aerial photographic catalog was developed of the entire stream corridor, including all major tributaries. A separate portion of this catalog contains all of the soil maps for the entire stream corridor. This catalog allows the investigator to always know what is around the next bend when access or navigability is not possible.

The following maps were developed and used to complete the inventory: topographic maps, soils maps, corridor map, stream/road crossing map, stream & lake flow map, a township overlay map, and a land use/land cover map. Most of the data, maps, and reports that are a part of the files of the Rice Creek Watershed Project have been reproduced and are available for review by the public in the historical room at the Albion Public Library. As a partner, the Albion Public Library has committed to help us properly preserve the historical data gathered during this project, and they have graciously allowed us to make that information available to the public for future reference. Other information related to this project is also available at the Michigan Department of Environmental Quality-Water Division.

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Chapter I - Description of the Watershed

Introduction

The Rice Creek Watershed covers 58,200 acres (90.9 square miles) in western Jackson and eastern Calhoun Counties. By definition, a watershed is the geographic area consisting of all land that water flows across, under and through on its way to a particular body of water, much like a bath tub or a funnel directs all water that falls within its rim to a common drain (in this case Rice Creek). A watershed can be broken down into smaller and smaller sub-basins, or they can be on the scale of the Mississippi River Basin that drains water from 41% of the continental United States into the Gulf of Mexico.

Rice Creek itself is a sub-basin and tributary to the Kalamazoo River, which flows into Lake Allegan and then Lake Michigan; so what happens in the Rice Creek Watershed affects conditions all across southwestern Michigan and beyond. Rice Creek includes a North and South Branch and main stem, and it is the primary drainage system in the watershed. Flowing from east to west, its beginnings, or headwaters, are a network of small, vegetated channels located in western Jackson County. Flowing west into Calhoun County, these smaller tributary channels merge to form the North and South Branches of Rice Creek, which then combine to form the main stem in Marengo Township. Rice Creek then joins with the Kalamazoo River in Marshall.

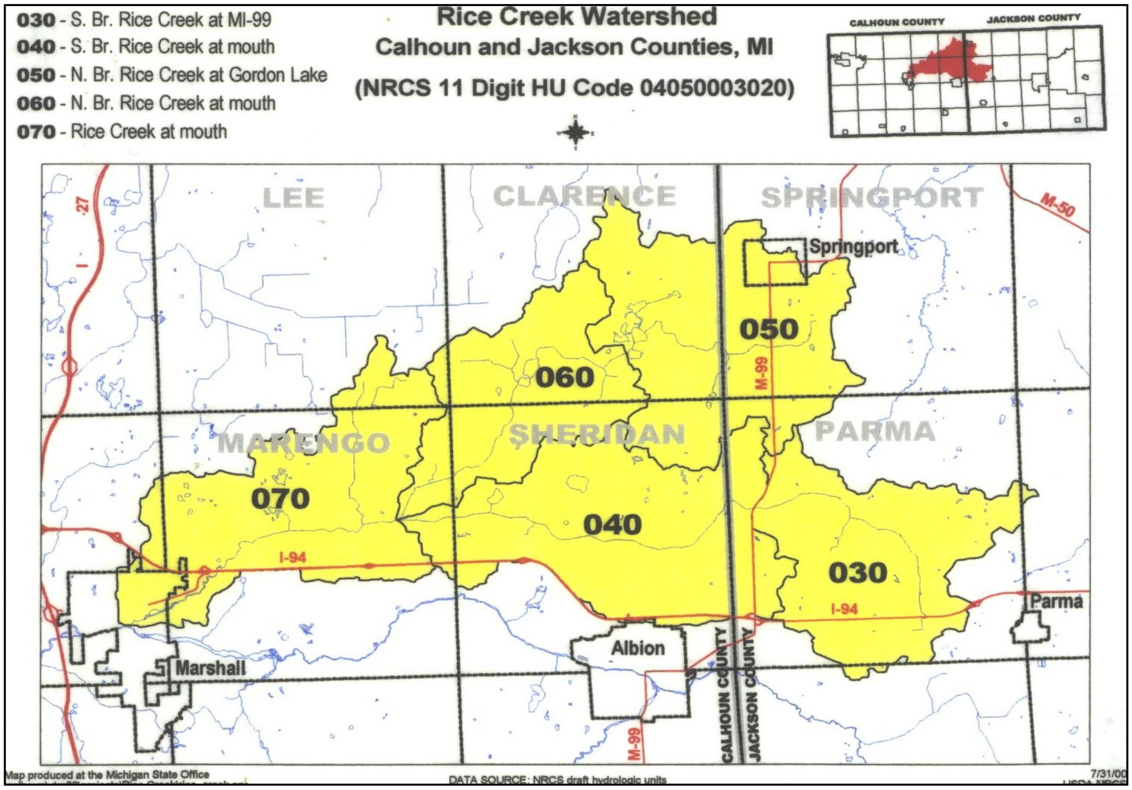
The North Branch of Rice Creek is approximately nineteen miles long. The character of the North Branch is marked by several popular lakes, including Prairie Lake and the Gang Lakes, some of which are impacted by seasonal nuisance algal and weed growth stemming from excess nutrients. These lakes affect the creek in different ways. One way is they act as a sediment trap, often to the point of needing to be dredged in order to maintain their recreational and habitat functions – the amount of sediment in the lakes is a direct result of streambank erosion and the lack of floodplain or wetland depositories for those sediments. A second effect of the abundance of lakes in the North Branch is they increase the amount of surface water exposed to sun, heating the waters and distinguishing them from the relatively cold-water qualities of the South Branch where there are fewer lakes.

The South Branch of Rice Creek is approximately seventeen miles long, and it is marked by cold waters due to fewer lakes than the North Branch and also groundwater infiltration into the creek. These conditions have resulted in the South Branch being a designated trout stream. Sediment and nutrient problems, as well as a lack of cover for shade and temperature control, are prevalent issues.

From the main stem of Rice Creek, the point where the North and South Branches merge, to the outlet at the Kalamazoo River, the Creek is approximately another six miles long.

The Rice Creek Watershed includes the following Townships in Calhoun County: Clarence Township sections 10, 11, 13, 14, 15, 21 – 36; Lee Township sections 25, 26, 34 – 36; Sheridan Township sections 1 – 28; Marengo Township sections 1 – 3, 7, 8 – 24, 30; and Marshall Township sections 12, 13, 24, 25. The following Townships in Jackson County are also included: Springport sections 17 – 21, 28 – 33; Parma Township sections 4 – 9, 13, - 35; and Concord Township section 4. Also included are the Villages of Springport and Devereaux and the northeast corner of the City of Marshall, east of Brewer Street and Kalamazoo Avenue and north of Pearl, Walnut, and Washington Streets.

Map A: The Rice Creek Watershed

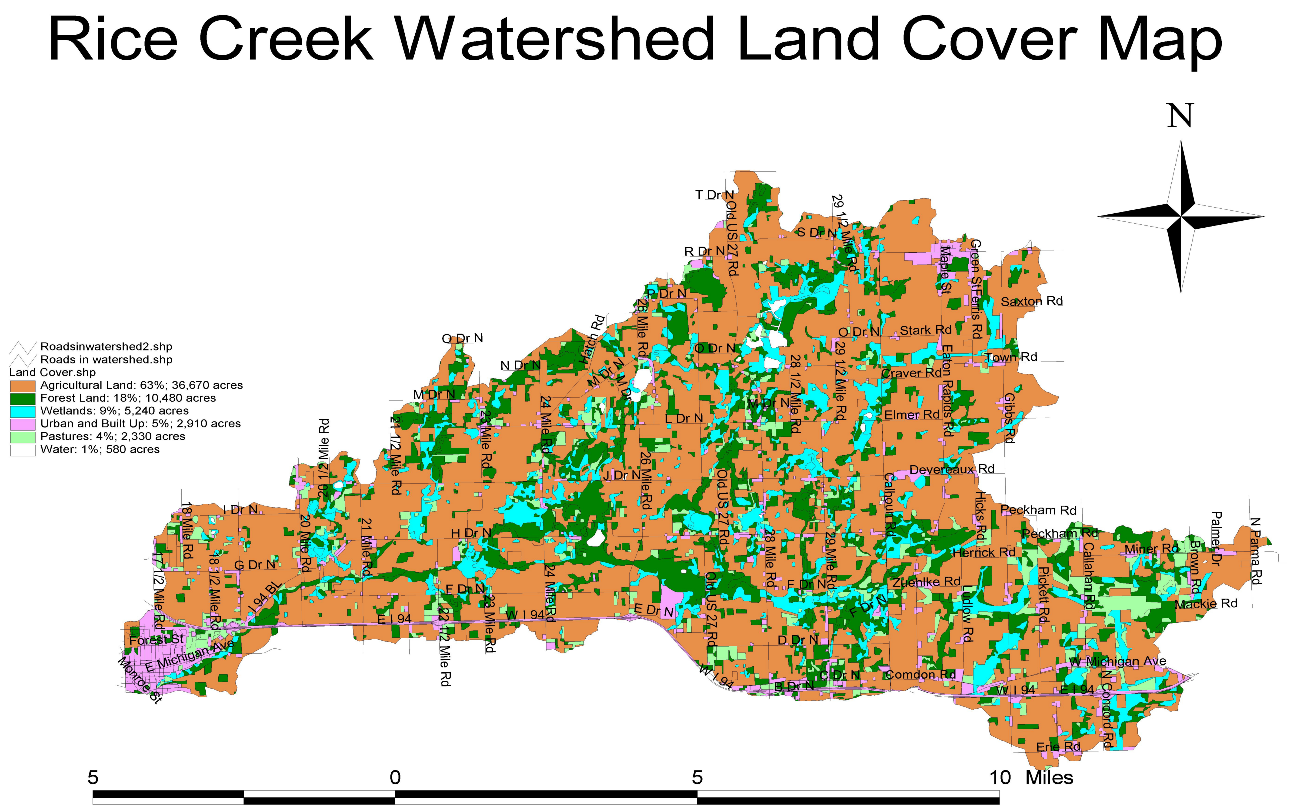


Land Cover / Use

Land is the one commodity for which supply is absolutely limited; consequently, land use is what gives the watershed its social, economic and environmental character. The most prevalent designated uses in the watershed today are livestock and produce agriculture, forestry, urban and commercial development, warm and cold-water fisheries, habitat for indigenous wildlife, public water supply (groundwater recharge) and recreation.

Currently, agriculture is the dominant land use (63%) in the watershed. Forest land represents 18%, wetlands 9%, urban and built up land 5%, pasture lands 4%, and water surface area covers 1% of the watershed. In Calhoun County, where the largest portion of the watershed lies, there was more than a 4% reduction in the number of land in farm acres from 1987 to 1997, most of which was a result of urban growth. Over the past twenty years the increase in rural residential homes is probably the most significant land use change.

Map B: Land Cover Map



Population

Land use in the Rice Creek watershed, at least during its history as a rural agricultural landscape, is largely reflected by human population trends. Because census data are based on political boundaries and not watersheds, it is not practical to construct an absolute population history for the watershed. However, a reasonable approximation of population trends can be made by compiling the U.S. census records for the rural sections of the four townships (Marengo, Sheridan, Clarence and Parma) that encompass the bulk of the watershed. From a relatively stable base during the first century of American settlement, the population more than doubled between 1920 and 1970. This growth spurt occurred after the major period of drain construction. Since 1970, population has been relatively stable, although it appears to be starting to grow again.

The evidence for population stability during recent decades may be surprising to anyone who has noted the many newer homes sprinkled across the watershed. A recent comprehensive study of patterns in land use in Michigan conducted by Public Sector Consultants, Michigan State University, the University of

Michigan and others (available at www.publicsectorconsultants.com) found that rates of land development exceed population growth by a factor of 2 to 27 times (average about 8 times). Thus, recent population stability in the watershed is probably a falsely reassuring indicator of land use trends that can impact the Rice Creek watershed. The watershed is exceptionally well situated to experience continued sprawl growth in coming decades. In fact, the study forecasts substantial increases in developed land use in the watershed in 2020 and 2040 based on sophisticated computer simulation models developed by Michigan State scientists. The watershed is located between the cities of Marshall and Albion and the residential hubs of Duck Lake and Springport, and the southern boundary of the watershed is nearly coterminous with a busy Interstate highway (I-94); there are six Interstate exits in, or nearly in, the watershed.

Topography

Topography is the lay of the land, which is also a story of a given area's physical history. The Great Lakes basin topography can be attributed almost completely to glaciers which pulverized, moved and shaped bedrock across the landscape. The present surface features of the Rice Creek watershed are mostly a result of the Wisconsin Glaciation. This glacial deposition event began approximately 23,000 years ago. The Saginaw ice lobe, a sub-lobe of the larger Huron ice lobe, retreated across the watershed between 16,000 and 14,000 years ago, and it was during this retreat that the sediments, which constitute the surficial geology of the watershed, were deposited. These glacial sediments (drift) range from 0 to 100 feet in thickness. Paleozoic age bedrock lies beneath the glacial sediments except where the bedrock is exposed at the surface.

The Paleozoic Era is represented by the Mississippian Period, which began approximately 355 million years ago, and the Pennsylvanian Period, which began approximately 310 million years ago. The Mississippian bedrock can be subdivided into five unique rock formations, four of which are represented in the Rice Creek Watershed. They are: Saginaw Formation, Bayport Limestone, Michigan Formation, and Marshall Sandstone. Each of these represents a unique depositional event.

Predominant Soil Types

General Soil Map Units
Soil types within the watershed are represented in Map C at the beginning of this document. The primary soil associations are as follows:

In Jackson County there are three soil associations in the watershed.

- Hillsdale-Riddles association: approximately 7% of the watershed, deep well drained, loamy soils that formed in glacial till
- Hillsdale-Eleva-Riddles association: approximately 4% of the watershed; deep and moderately deep, well drained and somewhat excessively drained, loamy soils that formed in glacial till, in material that weathered from sandstone, or in glacial drift over sandstone
- Riddles-Teasdale-Palms association: approximately 15% of the watershed; deep, well drained, somewhat poorly drained, and very poorly drained, loamy and mucky soils that formed in glacial till or in organic material and the underlying loamy glaciofluvial deposits.

In Calhoun County there are six soil associations in the watershed.

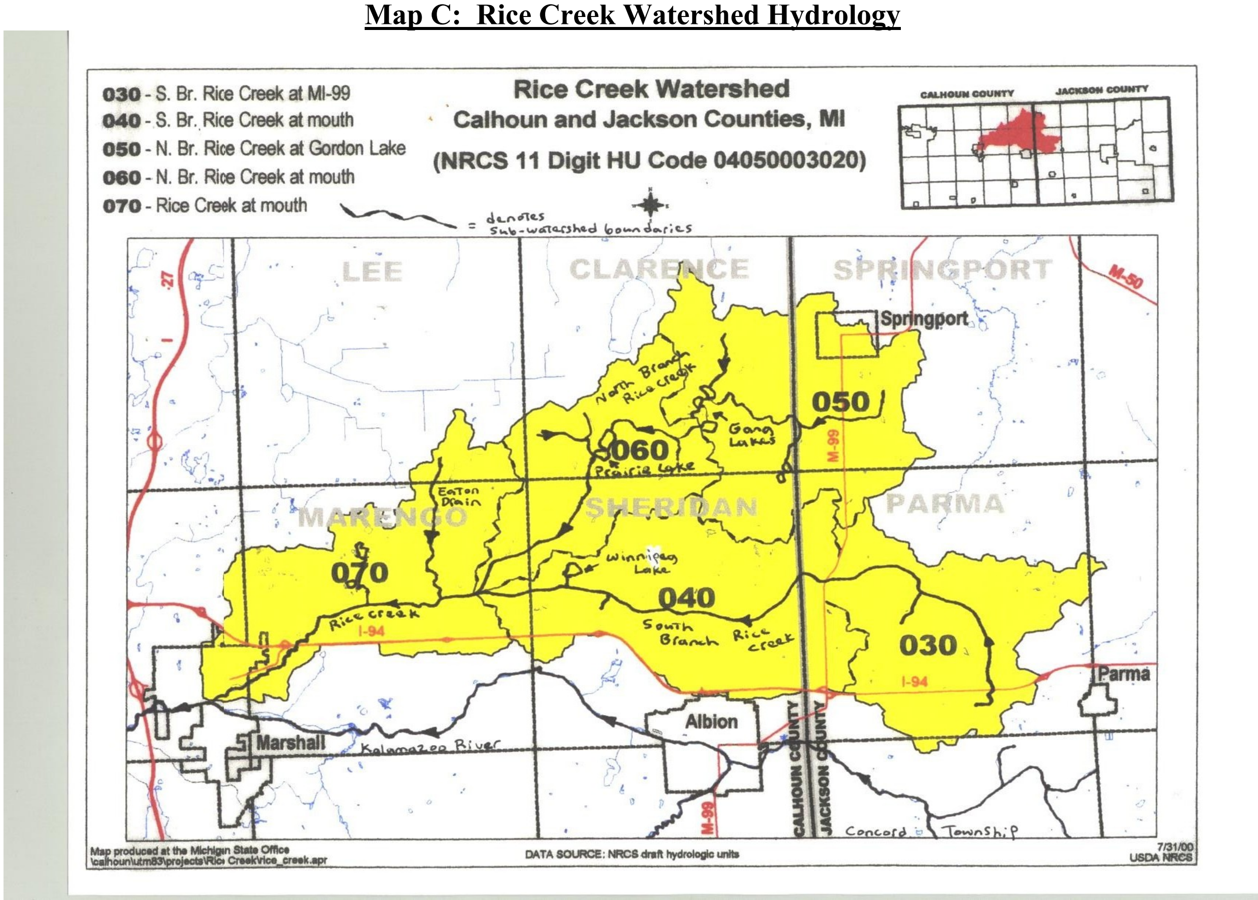
- Hillsdale-Kalamazoo-Oshtemo association: approximately 30% of the watershed, nearly level to steep, well drained, loamy soils on moraines, till plains, outwash plains, and terraces
- Houghton-Oshtemo-Coloma association: approximately 25% of the watershed, nearly level to steep, very poorly drained to excessively drained, mucky soils on flood plains and loamy and sandy soils on outwash plains, moraines, and stream terraces and in glacial drainageways

- Oshtemo-Kalamazoo association: approximately 7% of the watershed, nearly level to steep, well drained, loamy soils on outwash plains and stream terraces
- Bronson-Sebewa-Houghton association: approximately 7% of the watershed, nearly level to gently rolling, moderately well drained, poorly drained, and very poorly drained, loamy soils on lake plains and mucky soils in glacial drainageways
- Morley-Blount association: approximately 3% of the watershed, nearly level to strongly sloping, well drained to somewhat poorly drained, loamy soils on till plains and moraines
- Houghton-Blount-Pewamo association: approximately 2% of the watershed, nearly level or gently undulating, very poorly drained to somewhat poorly drained, mucky and loamy soils on till plaines and moraines.

Hydrology

Albion College studied the hydrology of the South Branch of Rice Creek as part of the monitoring work they were contracted to complete for the watershed planning project. A significant portion of this section is a summary of their reports and the data gathered.

Map C: Rice Creek Watershed Hydrology



Introduction

The physical and biological character of a stream is a function of its water budget and hydrology. Hydrology encompasses the general patterns of water flows and the variability in flow or flashiness in response to storms. In a flashy stream, flow spikes abruptly following a storm as water runs off quickly instead of infiltrating the ground and contributing to a prolonged swell in base flow. Spikes in flow can cause erosion, turbidity and flooding and consequently damage stream life. In a sense, water itself can be a pollutant if it comes in quick excess. Documentation of discharge patterns is also a prerequisite for establishing patterns of mass flow of nutrients and suspended solids, another issue in the watershed.

In relating precipitation and stream flow it is important to recognize that a large fraction of precipitation does not end up in streams but is instead returned to the atmosphere by evaporation and transpiration. Impervious surfaces increase stream flow not only by increasing immediate runoff, but also by reducing evaporation and transpiration losses, an important component in the hydrologic cycle.

Because streams tend to increase in erosive force as they gain flow, the model stream profile is smoothly concave with steeper slopes at the headwaters that level off gradually towards the mouth. Variations in landform geology naturally control this pattern; but milldams and drainage ditches are created specifically to alter it.

When settlers came to the area, much of the Rice Creek Watershed was inundated with wetlands. As a means to make the land conducive to agriculture and settlement, countless drain tiles and ditches were dug to modify the hydrology, lower the water table and expose the land. This trend was formalized when Rice Creek was designated an agricultural drain in the 1920's.

An important step in understanding the fluvial geomorphology (how the stream course and flow change over time) is to establish its long profile. A long profile is the elevation of the surface of the water of the creek, measured on one day, at all road crossings. A long profile may be useful in identifying areas where erosion or deposition of sediment will take place and may be problems. It may also be helpful in planning infrastructure improvements and in planning remedial projects such as basins or engineered wetlands that could accommodate floodwaters.

Rice Creek's glacial geology, ramp-and-flat topography, and reengineering as an agricultural drain have made it somewhat flashy and prone to turbidity and excess suspended solids. In places, the creek bottom is buried under thick layers of fine sediments and the benthic (bottom-living) macroinvertebrate community is impoverished. Repeated retrenching of drains in the headwaters regions has led to the transfer of sediments to downstream middle reaches where they raise the streambed and contribute to flooding.

Rice Creek Hydrograph

The steepest crossroad-to-crossroad intervals are above 20 Mile Rd (80 cm/km), 29 Mile Rd (75 cm/km), and M99 (71 cm/km). Stream gradients are less than half the maximum for the intervals above Pickett Rd (15 cm/km), Gibbs Rd (22 cm/km), 27 Mile Rd (24 cm/km), 28 Mile Rd (34 cm/km), and 22½ Mile Rd (39 cm/km). The flatness in the upper reaches is due in part to lowering of the stream channel by dredging. Thus, two "flat" sediment buffers occur in Rice Creek's profile: one in the middle reaches of the South Branch, and the other at the confluence area of the North and South Branches. Although beyond the range of this data set, the reach below 20 Mile Rd and the Interstate is an obvious third "flat" spot. The North Branch was not included in this study, but other results suggest the Gang Lakes and Prairie Lake are key sediment traps.

Winter 2002 hydrographs were compiled for the lower Main Stem at 20 Mile Rd and for the upper South Branch at Gibbs Rd. Discharge on the Main Stem reached a peak of 6.3 cubic meters per second (cms) on February 22, about as much water as is carried on average by the entire Kalamazoo River at Marengo (the Marengo station is a long term data collection point that was used as a comparison site). The major precipitation and snowmelt events caused discharge at 20 Mile Rd to double and triple from a base of 2.5 cms to peaks of 5 and 6 cms. On the upper South Branch, stream flow was highly erratic with as many as

13 sharp peaks in discharge each lasting 1-2 days or less versus 6 rounded, multi-day peaks seen downstream. Overall, discharge at Gibbs Rd was about 13% that at 20 Mile Rd (0.43 vs. 3.21 cms, respectively). These strong winter flows likely constitute the chief erosive and sediment-moving events of the year.

Summer 2002 hydrographs were compiled for six stations on Rice Creek: on the Main Stem at 20 Mile Rd; on the North Branch below Prairie Lake at J Dr, below Gang Lake at 27 Mile Rd, and above the lakes at 29 ½ Mile Rd; and on the lower South Branch at 24 Mile Rd, and the upper South Branch at Gibbs Rd.

On the North Branch, discharge at 27 Mile Rd. above Prairie Lake accounted for 82% of the flow at J Drive below Prairie Lake (0.326 vs. 0.398 cms, respectively, between June 19 to July 10), indicating that tributaries and groundwater contributed relatively little new flow between these stations. In contrast, the upper North Branch at 29 ½ Mile Rd. varied in its contribution to downstream flow. In early June, discharge at 29 ½ Mile Rd. was about one third that at J Drive, but by mid July the fraction had climbed to about one half. The recession in base flow in the dredged upper North Branch was less rapid than that seen downstream.

On the South Branch, there was a repeat of the tendency for slower recession in base discharge in the dredged headwaters section. After the beginning of July, discharge at 24 Mile Rd. was only about 10% greater than at Gibbs Rd., 14 km upstream (0.282 vs. 0.258 cms, respectively). By late July, discharge at Gibbs Rd. was about 40% that at 20 Mile Rd.
(compared to 13% in winter), indicating the increasing importance of dredged sections to overflow during dry periods. (The combined discharge at Gibbs Rd. and 29 ½ Mile Rd. on July 22nd was greater than half that at 20 Mile Rd.). Two striking features existed in the hydrograph for the South Branch at 24 Mile Rd.: First, daily cycles in stage that were evident to some degree in all summer hydrographs were especially large here; second, discharge dropped abruptly by 15-39% (mean=27%) on at least nine occasions.

The pattern is consistent with water withdrawals for irrigation, perhaps by the golf course
upstream from this station. A diversion of one quarter of 0.25 cms would be roughly 1000 gallons per minute, a reasonable rate to expect from an irrigation pump. The golf course installed a new irrigation system two years ago.

Discharge at Callahan Rd, 22 ½ Mile Rd, and Eaton Drain at H Dr were also gauged. Discharge on the South Branch at Gibbs Rd averaged about 3 times that at Callahan Rd, 2.7 km upstream, indicating heavy groundwater input in the entrenched upper South Branch. Discharge on the Main Stem at 20 Mile Rd averaged about 1.5 times that at 22 ½ Mile Rd, 3.9 km upstream, indicating substantial groundwater input in this interval of rapidly dropping elevation. Discharge from Eaton Drain added to the Main Stem an amount equal to only about 3% of the flow at 22 ½ Mile Rd.

Drain hydrology

Dredging can make a channel more efficient, but it can also confine storm water between high banks, make a stream flow peak higher and faster and trigger more erosion. To evaluate the flashiness of the entrenched upper reaches of Rice Creek, variation in stream stage at Gibbs Rd. in late summer 2000 was compared with that at Bangham Rd. on nearby Spring Brook, which has never been dredged. Rainfalls of 6mm on 7/28, 15mm on 7/30, 10mm on 8/2, and 28mm on 8/5 through 8/6 were recorded in Albion. At both sites, long tails of elevated stage followed the storms, indicating that most non-evaporated rainfall infiltrated the ground and did not run off directly into the streams. But as expected, Rice Creek rose and fell more quickly and reached higher peak flows than did Spring Brook.

The implications of the creek being a designated drain are key to understanding the hydrology of Rice Creek. Yes, a creek is a drain, but a designated drain doesn't always resemble a creek. When a water channel is designated a drain, the elected drain commissioner is given the authority, as well as the *responsibility*, to keep the creek free of any obstructions or conditions that impede its function as a drain. This is vital to many landowners, specifically agricultural producers, who depend on open lands for their livelihood. But as research and experience prove, natural stream form and function, in some cases, can be maintained along with drainage. A study in the Battle Creek River is examining the geomorphic tendencies of the river system; in other words, it is studying how the river responds to current conditions and modifications, and how we can restore stream function, stream stability, *and* maintain drainage. Humans have historically underestimated the power of rivers and waterways, and it is through studies such as this one that we can find out where we can integrate our needs with natural processes.

Of primary concern to this plan is to outline solutions to a historical drainage problem. Most resource experts support vegetative and structural best management practices by the drain commission and landowners that will stabilize stream banks, or properly designed culverts by the road commission that avoid perched, improperly sized and angled culverts which scour banks and restrict fish passage. This plan considers the failures and successes of drain management, and the willingness and desire by Drain Commissioners responsible for Rice Creek to seek out and apply innovative techniques that address stormwater and agricultural run-off while reducing degradation to aquatic habitat.

Significant Natural Resources

Wetlands

One of the most significant natural resources in the watershed is wetlands. There are approximately 5,240 acres of undisturbed wetlands across the watershed. Wetlands are complex ecosystems that provide many ecological functions that are valued by society. In Michigan, these functions become increasingly apparent as we continue to learn more about the 'free services' that wetlands provide. The primary benefits of wetlands are stormwater flood storage, filtering of sediments, and habitat for fish, wildlife, and many migrating birds. The aesthetically pleasing open space they provide helps to enhance the quality of life for all watershed residents and visitors.
Marshes, swamps and bogs are all terms used for wetlands. Marsh is a term that represents a broad array of wetlands that are dominated by grass-like vegetation. Typically, marsh plants include rushes, reeds, sedges, cattails, and grasses. Swamps are simply wooded wetlands. Based on dominant vegetation, swamps can generally be divided into three different types: conifer, hardwood and shrub. A conifer swamp contains trees such as tamarack, cedar, or balsam fir; a hardwood swamp has trees such as red maple, black ash, American elm, or balsam poplar; and a shrub swamp consists of primarily shrubs such as tag alder, willows, or red osier dogwood. Swamps are usually inundated or saturated by water periodically during the growing season. Bogs occur as thick peat deposits in old lake basins or as blankets of peat across a landscape. Bogs form in lake basins isolated from groundwater. Because normal rain water is slightly acidic, bog water tends to be slightly acidic. The acidic nature of bogs supports acid-loving vegetation, especially sphagnum mosses.

With fewer wetlands, we can expect an increase in flooding and erosion and a decrease of animal and plant species diversity, poorer water quality and economic challenges.

Fishery (lakes and streams)

Rice creek and its lakes are home to some excellent fishing, including trout in the South Branch and excellent pan fishing in the warmer North Branch lake system. Of the fifteen lakes in the watershed, eight are accessible to the public and seven have access by State maintained public access sites; with restrooms, docks, and boat launch areas. All of the lakes accessible to the public are an excellent warm water fishery resource.

The *Gang Lakes* located in Clarence Township, approximately 6 miles north of Albion in eastern Calhoun County is part of the Rice Creek and Kalamazoo River Watersheds. Among them are Gordon, Bolt, Silvers, Bell, Clark, and White Lakes.
All but White Lake are accessible for fishing from a public access located on Gordon Lake. These lakes have a reputation for good bass fishing and consistent catches of acceptable size panfish. Local MDNR conservation officers report steady angler pressure throughout summer months and light ice fishing pressure. Gamefish species sampled included bluegill, pumpkinseed, black crappie, largemouth bass and northern pike. The Gang of Lakes fishery was last evaluated in 1996.

Prairie Lake, located in sections 32 and 33 of Clarence Township, was evaluated for its fishery in 1993. Reports revealed the following species: black crappie, bluegill, bowfin, bullhead (catfish family), carp and minnows, golden shiners, hybrid sunfish, largemouth bass, northern pike, pumpkinseed, warmouth, white suckers, and yellow perch.

Lake Winnipeg, located in sections 8 and 17 of Sheridan Township, was evaluated for its fishery in 1999. Reports revealed the following species: black bullhead, black crappie, bluegill, bowfin, brown bullhead, central mudminnow, common carp, golden shiners, grass pickerel, hybrid sunfish, largemouth bass, longear sunfish, northern pike, pumpkinseed, warmouth, white sucker, yellow bullhead, and yellow perch.

The mainstream and south branch of Rice Creek is designated as a type 1 trout stream by the MDNR. The mainstream and the lower section of both branches have fair populations of northern pike and suckers. The lakes connected by the north branch are a warm water fishery consisting of primarily sunfish and bass.

Sources of food available to fish, according to MDNR surveys, included abundant crayfish, aquatic and terrestrial insects and other small fish. Several inland lakes that are part of the headwaters of the north branch as well as a general lack of cover appear to be contributing to warm water marginal conditions. Surface water temperatures taken at the 20 Mile Road stream crossing site during the MDNR surveys on 7/17/2000 were 66 degrees Fahrenheit and in 1999 were 68 degrees Fahrenheit. Those temperatures are near the upper limit for temperatures that can support trout.

Rice Creek has been stocked with various species of trout since 1935. In the early 1970’s, MDNR Fishery Division changed its policy from stocking legal size brown trout (approx. 8 inches) to stocking only yearling browns that averaged between 5 and 6 inches. The stocking then was an attempt to create a stream trout fishery in southern Lower Michigan where trout fishing opportunities are limited. Limited survival of brown trout in Rice Creek prompted a request from the hatcheries for stocking larger, but fewer, brown trout. In 1998 and 1999, “accelerated growth brown trout” (wild rose strain) were stocked into Rice Creek. A survey in 1999 revealed brown trout ranging in size from 7.9 to 10.5 inches and over sixty-percent were larger than 8 inches. The trout appeared very healthy and robust and were found to have excellent growth rates, 3 inches above the state average.

The lack of both spawning areas and juvenile trout habitat, however, limits natural reproduction of brown trout in Rice Creek. Dams in the lower section prevent migration of all fish to and from the Kalamazoo River and the impoundments limit the overall health of Rice Creek.

Other species found in Rice Creek were: blackside darter, grass pickerel, mottled sculpin, northern pike, rock bass, central mudminnow, common shiners, green sunfish, johney darter, largemouth bass, white sucker, yellow bullhead, and yellow perch. The other lakes mentioned above are all interconnected to Rice Creek explaining the various species found.

Forestry Resources

Another significant treasure is the watershed's forestry resources. Still the Rice Creek Watershed has a decreasing forested area and what remains is often fragmented and limited in terms of habitat potential. Practices that seriously impact forested areas are development, expansion of farm fields, and clear-cut timber harvests. These issues are difficult to remediate in the watershed because forests, like wetlands, are collectively owned by many different landowners making unique, but often economically based, resource decisions. The Calhoun Conservation District and USDA-NRCS continue to work with landowners to promote reforestation through various programs and funds. Of particular concern, however, is the stream corridor.

On the land cover map of the Rice Creek Watershed it is very evident that the stream corridor is mostly forested. This creates excellent habitat for wildlife. This forested corridor is therefore a unique resource worth protecting. This watershed management plan promotes the voluntary protection and enhancement of the area within the Rice Creek corridor (the area within ¼ mile of the stream and its tributaries). The primary tree species in the watershed are oak, hickory, ash, soft maple, elm, hard maple, beech, and some aspen. The primary problem for some wildlife species in the Rice Creek Watershed is the fragmentation of many of the forested areas

Many woodlots are also cut incorrectly on a diameter limit basis, usually being 16" to 18" on the stump rather than breast height diameter (bhd). This means that all marketable trees that are cut should meet or exceed this bhd recommendation, leaving younger trees to age to maturity and avoiding cutting of all potential sawlog and veneer trees that could be managed for the future. Proper forest management recommendations combine the many goals and objectives of the landowner with sound silvicultural recommendations for each forest type. Again, forests are cut for additional or sole income, but what many landowners don't realize is that properly managed forests will be healthier *and* more economically profitable.

Whether a landowner is interested in long or short term management of the woodlot, it is important to start out with a management plan. This plan should be written by a professional that is able to explain the present and future values of the forest crop along with available incentive programs to help meet the landowner's goals and objectives.
Many landowners have sold their timber without seeking professional advice and only received a fraction of the true value of their timber, and some also are left with a very big mess of their woodlot, all because a proper harvest plan was not in place.

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Chapter II – Watershed Resources,Activities, and Issues

A Brief History

Shared from the history of Clarence Township book "Then and Now" and other Township, County and District sources.

The area known as "Rice Creek" is located at the corners of Sheridan, Marengo, Clarence, and Lee Townships. Indian trails once crossed the creek there. The first settlers also used those trails as well as ones following the path of the creek. One of the first water well-drilling operations was started in 1913 by Charles Sebastien Sr. and Charlie Wilson. Some of the drains in Clarence Township were started as early as 1880. Since much of the area was inundated by wetlands, drainage ditches were dug to improve and increase tillable acres. In fact, Lee Township is said to have once been half swampland.
In 1958 it is reported that the City of Kalamazoo gave $5,000 to the "River Basin Corporation" to help finance a study on water conservation and that the City of Battle Creek was expected to match the donation. The River Basin Corporation was reported to make a complete study of potential water-retention facilities from Albion to Lake Michigan, one of which would have been a dam reservoir on Rice Creek near Marshall.

In simple terms, there was a need to flush significant pollutants from the Kalamazoo River during low summer flow periods. The above proposed solution would have used the flooded Rice Creek Basin to flush the pollutants from the Kalamazoo River.

A group of folks formed the Rice Creek Control Association and brought to the public's attention the facts concerning flooding of the basin. Among the many reasons listed were that it would have destroyed many acres of farmland and many other resources, destroyed fishing, polluted existing wells, and cut-off some roads to traffic.

With pollutants still a major concern in 1966, the idea of flooding the Rice Creek Basin was again explored at the request of Rep. Paul H. Todd of Kalamazoo. After yet another critical review, the proposed project was finally put to rest. Due to these historical actions in the past, the concerns of area landowners persist to this day; and any significant changes proposed to the Rice Creek Basin area are met with much speculation.

The Rice Creek Watershed Project began in 2001 and through education and communication has begun work with area residents to promote the wise use of the rich natural resources within the watershed. Resident cooperation will be expanded upon during implementation by using volunteers to investigate and interview watershed landowners and collect further historical data on the Rice Creek Watershed.

The data will enhance the file on the Rice Creek Watershed being developed at the Albion Public Library – Historical Room. The primary purpose of the interviews though is to create a "watershed-wide public awareness campaign". With the management plan and best management practices being promoted by watershed residents, it is anticipated that we will receive greater participation in the project.

Dredging History

For nearly its entire span, Rice creek has been dredged and cleared of what were seen as pestilent swamps, opening land to cultivation and improving crop rooting by lowering spring water tables. Draining also altered the hydrology and vegetation of the watershed. Some idea of the impact of the dredging can be gleaned from old maps and comparisons with other watersheds. A historic Clarence Township property map from 1837 suggests that a single large lake named Prairie Lake originally covered today's interconnected Bell, Silvers, Clark, and Gordon Lakes, collectively known now as Gang Lake.

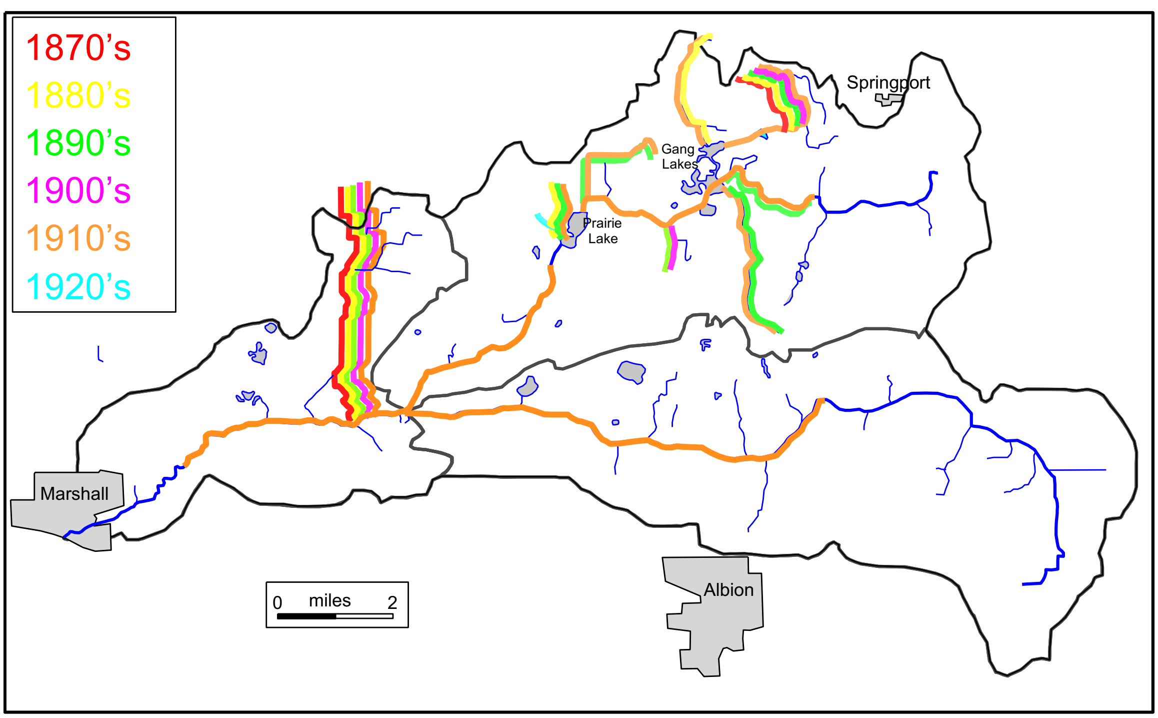
By 1858, waters had been lowered to expose today's Gang Lake array, and the Prairie Lake name had been moved downstream to its current location. An 1858 map of Parma Township shows extensive wetlands and meandering along the upper South Branch of Rice Creek. Today, the stream in this area is straightened and well below grade following repeated dredging. Rice Creek must have resembled the situation seen today in the upper reaches of the adjacent Spring Brook, which retains some of its wooded wetlands and meandering course. A capsule history of draining efforts was assembled by examining records in the office of the Drain Commissioner for Calhoun County.

The first official records of specific drains date back to 1878 with the clearing and establishment of the Chappel drain, Deforest & Chittendon drain, and Poole, Bryant, Eaton & Baker Drains. In the 1880s, another series of drains were established. The pace of clearing new drains and cleaning old ones reached a peak in the 1890s, when 9 drains were either established or cleaned. The flurry of such activity did not subside until 1919.

Only nine drains were established or cleaned between 1920 and 1969, a fifty-year span. Essentially all the current drains in Calhoun County had been established by 1969. Dredging activity has been repeated most often in the smaller tributaries, which directly drain cropland. The dredging of the main branches of the Creek was done primarily in the 1910s.

The majority of Rice Creek being designated a county drain occurred through a legal process coordinated between the Michigan Department of Agriculture and the Calhoun County Drain Commission. This includes all of the headwaters of Rice Creek in both the north branch and the south branch and then downstream to section 17 of Marengo Township. Only the portion of the creek from section 17 of Marengo Township down stream to the outlet at the Kalamazoo River in the City of Marshall Rice Creek is not a designated drain.

Map D: Dredging History of Rice Creek (Calhoun only)



Artificial Stream Impoundments

The only major stream impoundment (aside from the 68 road stream crossings) that is blocks Rice Creek completely is the Millrace dam in Marshall along with an upstream diversion. The City of Marshall Dam has expressed interest in the removal of these structures as opposed to a costly repair. The removal project is still in the evaluation stage. The Michigan Department of Environmental Quality, Michigan Department of Natural Resources Fisheries Division, and the Rice Creek Watershed Project are all involved with the City of Marshall to finalize a plan to remove the dams. A Rice Creek Dam removal feasibility study was completed in March 2002. A copy of the plan can be reviewed by contacting the City of Marshall.

In May of 2004 a grant was submitted to the MDNR Inland Fisheries Grant fund and received high recommendation for funding. If funding is approved, work could begin as early as fall 2004.

Additional stream impoundments include 68 stream/road crossings. The stream and road crossing inventory evaluated each crossing and ranked it as a low, medium, or high priority for needing re-stabilization or other best management practices. The inventory revealed that of the 68 crossings 53 ranked as a low priority, being fairly stable and vegetated.

Agriculture

Farmers are some of our countries first conservationists; they are at the forefront to implement conservation practices to prevent erosion and protect water quality. Farmers continue today to hold in trust most of the essential natural resources we care about and upon which we depend. For this reason, this plan acknowledges and emphasizes the important role of the farmer in conservation.

Approximately 12,957 acres of productive farm land lies within a one mile corridor of Rice Creek and its primary tributaries. The conservation or neglect of these lands has an enormous impact on the water quality throughout the watershed and beyond.

AGRICULTURE IN CALHOUN COUNTY, MICHIGAN

Based on 1997 Census of Agriculture, the most recent available

Out of the 459,776 acres (718 square miles) in Calhoun County, nearly 53%, or 243,151 acres, are used for agriculture. According to the 1997 Census of Agriculture, the market value of all agricultural products sold in Calhoun County was $60,985,000. Yet from 1987 to 1997 cropland in Calhoun County disappeared nearly twice as fast as the state's average rate.

Number of Farms: 1085 (farm definition=$1000 or more in gross sales)
Average Size of Farms: 224 acres

In addition to agricultural crops, livestock are also raised on Calhoun County farms. In 1997 there were 10,575 beef cattle, 4,987 dairy cows, 41,965 hogs and 1,593 sheep and lambs.

Type of Farm Business Organization	Farms: 1997 vs 1987		Acres 1997 vs 1987	
	1997	1987	1997	1987
Individual or family	**942**	**1048**	**174,241**	**198,441**
Partnership	**98**	**88**	**48,844**	**42,649**
Corporation (family held)	**29**	**25**	**17,571**	**12,035**
Corporation (other)	**7**	**0**	**825**	**0**
Cooperative, estate, trust, etc.	**9**	**5**	**1,670**	**258**
Total	**1085**	**1166**	**243,151**	**253,383**

Selected Harvest Crops	Farms	Acres	Bushels
Corn for grain or seed	533	71,687	6,883,919
Soybeans	459	48,722	1,837,575
Wheat for grain	256	13,675	638,998
Hay	474	17,979	44,728
Vegetables for sale	24	447	n/a

Value of Selected Products Sold	Farms	Value
Corn	389	$12,833,000
Soybeans	374	$10,716,000
Wheat	226	$1,894,000
Dairy Products	74	$10,781,000
Hogs	68	$8,944.000

Farms by Size	# of Farms
1-9 acres	40
10-49 acres	225
50-179 acres	462
180-499 acres	239
500-999 acres	85
1000 acres or more	34

For Farms with $10,000 of Gross Sales or More

Number of Farms:	547 (50% of Total)
Total Acreages	202,976 acres (76% of Total)
Average Size farm:	371 acres
Total Sales:	$59,483,000 (97.5% of Total)

Operators by Principal Occupation	
Farming	493 (46%)
Other	592 (54%)

Average Age by Year	
1997	54.4 years
1987	52.0 years

Farmland Preservation

On April 15, 2003 the Calhoun County Board of Commissioners unanimously supported the adoption of a "farmland preservation ordinance". The ordinance focuses on the Purchase of Development Rights (PDR). After researching land use trends, available planning tools, existing state and Federal laws, as well as the economic impact of the agricultural industry in Calhoun County, it was decided that local zoning efforts could be complimented by a PDR program. A work group comprised of local farmers, township officials, realtors, citizens and county planning and conservation staff worked for 16 months to develop the ordinance. Their work included development of the selection criteria, easement provisions, appraisal and payment options, and program administration.

Taken from the ordinance: "It is the purpose of the Calhoun County Farmland Preservation Program and this development rights ordinance to preserve productive farmland in order to maintain a long-term business environment for agriculture in the county, to preserve the rural character and scenic attributes of the county, to enhance important environmental benefits and to maintain the quality of life of county residents. Further, it is recognized that this ordinance is but one of several farmland preservation strategies encouraged throughout the County. Other strategies include agricultural zoning, quarter-quarter zoning, sliding scale zoning, and various overlay techniques."

Land Use Planning

A municipality's authority with zoning and land use regulations can play a large role in how natural resources are impacted. Appropriate land use planning can provide the foundation for improved water quality for both surface water and ground water. A natural resource inventory is a process that determines areas within a community that are best suited for development and those areas that may be best left in their natural state. The natural resource inventory is then compared to the municipality's zoning and land use documents for consistency. Because the local units of government have the authority over zoning and land use they really are absolutely vital to involve in this process. Land uses that are incompatible with natural resources cause degradation and require much more time, effort, and money to restore than if preventive measures are implemented up front.

Calhoun County Community Development (CCCD) is in the process of conducting a county-wide natural resource inventory. The Rice Creek Watershed Coordinator will be actively involved in facilitating the process within the townships in the Rice Creek Watershed.

In an effort to bring adjacent municipalities together for land use planning, the local units of government, including townships and villages, have been assembled into five "neighborhoods". The Rice Creek Watershed lies within two of the neighborhoods as defined by County Planning Department staff. Each local unit of government has been asked to select two planning commissioners and a board member to represent them in the process. The neighborhoods will meet within their vicinity to collectively analyze their neighborhood with respect to natural resources such as: soil conditions, land cover (forested, cropland, wetland, etc.), flood plain, etc. Draft maps and text will be presented to the participants and then finalized by CCCD. The process will end by bringing together all the participants for a county-wide presentation of the final product.

The information collected during the natural resource inventory process is intended to provide a guide for the townships to utilize when making decisions regarding specific planning and zoning issues. The neighborhood concept is intended to create awareness among local leaders that decisions made in one community can have direct effects on adjacent communities, especially land use issues. Creating a foundation for the decision makers in these local units of government that is natural resource based will help to address a variety of the environmental concerns within the watershed.

In addition to the natural resource inventory, the Watershed Coordinator will work closely with Calhoun County Community Development to ensure that the natural resource inventory data is implemented, and foster a new way of thinking for local leaders with respect to development of natural resources. The Cost of Community Services study conducted in Calhoun County by American Farmland Trust revealed the fiscal impact that development has on local government budgets. For every $1.00 generated by residential property, $1.47 must be spent to provide services to those lands (Marshall Township, 2000). Whereas, for every $1.00 generated from farm, forest, or open land uses only 27 cents are required to provide the necessary services to those lands (Marshall Township, 2000). While residential development contributes a large percentage of revenue to the tax base, it does not pay for all the public services it receives from the local unit of government/county. Other factors do play into the equation, and the point here is not to promote "no development" campaigns; rather this is to show that natural resources have function and value that is often externalized from formal economic rationality. The Cost of Community Services study demonstrates that farm, forest, and open lands are of great fiscal value to the local community and should therefore be addressed with care during the planning process.

Resource materials and workshop opportunities regarding low impact development designs, soil erosion, sedimentation control measures, and farmland preservation techniques will be offered to the local units of government in an effort to educate decision-makers on the use of such tools. With the appropriate training local officials will be better equipped to make decisions where natural resources are of utmost concern.

Soil Erosion Control

According to *1994 Public Act 451, Part 91, Soil Erosion and Sedimentation Control Law of Michigan,* Michigan Law provides for the control of soil erosion and protects the waters of the state from sedimentation. A permit is generally required for any earth change activity which disturbs one or more acres of land or which is within 500' of a lake or stream. Once a permit is obtained it validates that a soil erosion control plan is in place to protect adjacent landowners and the waters of the state of Michigan from off-site sedimentation. A survey conducted by grading and excavation contractors found that the costs of implementing planned soil erosion control measures was only 25% of the costs needed for cleanup at the end of a project without planned soil erosion control measures. For more information on proper soil erosion control practices contact your local county enforcing agency or MDEQ.

New Development

This plan supports regional land use planning efforts that will limit increases in runoff and erosion. The finding of this project was that new residential developments biggest risk of negatively impacting water quality in the Rice Creek Watershed was because of soil erosion and the resultant off-site sedimentation. Many new rural homes are built in the watershed on an annual basis. Most have only a minimal impact on the overall watershed water quality. Collectively, however, some of the newly developed areas *can* have a negative impact on water quality. One way they can have a negative impact is the lack of storm water management requirements on newly developed sites. New developments are not required to limit their off-site runoff to pre-developed run-off rates. This can allow an increase in the overall amount of run-off entering Rice Creek and increases the peak flows downstream.

Another problem that can occur on newly developed sites is erosion and resultant off-site sedimentation. Permits are required from the County for any earth changes within 500' of a lake or stream or an acre or larger in size, but many times these permits are not acquired.

A third way that collectively increasing development within the watershed can negatively impact water quality is simply the increased improper disposal of household products, garbage, yard waste, etc.

A much larger concern related to new development is the risk of increased storm water run-off, erosion and off-site sedimentation from larger, concentrated commercial development sites. The risks are magnified greatly and impacts from even one site improperly managed can be devastating to water quality, the fishery, and greatly increase the potential for flooding. The Calhoun County Drain Commission has been working with Townships to require a storm water discharge permit. This program, if expanded could greatly reduce the risk from these sites. Like the residential projects, commercial projects within 500' of a lake or stream or an acre or larger in size also require a permit from the County, but are sometimes not obtained, or if obtained, the soil erosion control plans are not properly followed.

Another new area within the watershed that is proposed for development is the 175 acres of land just east of the Calhoun County Fairgrounds. It will become an addition to the Fairgrounds and will allow them to expand and grow. Plans include four primary components: a new road and exit which would cross Rice Creek east of Marshall and provide a new entrance to the Fairgrounds along the east end of this new property; an approximately 400 site campground for fair and event camping, the camping area would be located on the portion of the land towards Rice Creek and proposes to include canoe launch sites into Rice Creek and walkout areas to the shoreline of Rice Creek; an all purpose/all season building with an educational wing for a regional science center; and a general evaluation of the entire Fairground facility for any general improvements, including updates to floral hall, the oldest fair building in Michigan.

Storm Water Management

Managing the amount, timing, pollutant loading and destination of storm water is what makes up storm water management. Storm water management can take on many forms from controlling the amount of water, delaying the transport time of the water flow, or diverting the flow to other destinations.

One important storm water management tool is a "storm water management ordinance". This is an ordinance that requires a person performing a new development on a parcel of land to manage the storm water coming off of their parcel. The goal is to manage storm water so that no more water comes off of the parcel after the development has occurred than the amount of storm water that came off of the parcel prior to the development.

A storm water ordinance also restricts a parcel of land from being over-developed. Using a new 10-screen movie theater development as example, local zoning would require a certain number of parking spaces for the business. The storm water ordinance would also require that water be released from the site at the pre-development rate. The amount of storm water storage or infiltration capacity on site may then only allow room for enough parking spaces for a 6 screen movie theatre. Storm water is managed, over-development is controlled and downstream peak flow flooding impacts are eliminated.

Phosphorus in the Water: The Role of the TMDL (Total Maximum Daily Load)

Like many other elements, phosphorus is necessary to sustain all living organisms. Problems are typically created when phosphorus is present at elevated levels in our lakes and streams – as is the case for Lake Allegan, which the Kalamazoo River drains into after its confluence with Rice Creek. High phosphorus levels in Lake Allegan have resulted in undesirable growths of algae. These algae blooms have caused high dissolved oxygen levels in the daytime when plants are releasing oxygen from photosynthesis and low dissolved oxygen levels at night when plant respiration is high. This has resulted in a significant negative impact to the invertebrate communities and to the fishery of Lake Allegan.

Historically, reductions of total phosphorus in the Kalamazoo River upstream of Lake Allegan have resulted in a shift of the aquatic community from a nuisance condition to a more diverse and desirable aquatic community. Therefore, controlling the amount of total phosphorus entering Lake Allegan, which is the role of the TMDL, should also result in the improvement of Lake Allegan water quality. Rice Creek is also plagued by areas with seasonal algae blooms and could benefit from Phosphorus reductions. Due to these impacts and the fact that Rice Creek plays a role in flushing phosphorus into the Kalamazoo River and Lake Allegan, phosphorus reduction and the TMDL is a priority for the Rice Creek Watershed as well.

Treated Wastewater Discharge

The primary source of treated wastewater discharged into Rice Creek is from the Village of Springport's lagoons at Gibbs Road, which are discharged for several days at a time in the spring and then again in the fall. The lagoons are designed to hold wastewater long enough for much of the solids to settle and for many disease-causing bacteria, parasites, and viruses to either die off or settle out. Aerobic bacteria convert wastes into carbon dioxide and ammonia phosphates, which in turn are used by the algae as food. Anaerobic bacteria convert substances in wastewater to gases such as hydrogen sulfide, ammonia, and methane. Many of these byproducts are then used as food by both the aerobic bacteria and algae in the layers above.

A tour of the entire Springport lagoon and discharge system revealed that they have mechanisms in place to meet all limitations set forth by MDEQ. They take samples and submit them to an independent laboratory service to make sure they meet requirements. Once the lab notifies them that they meet discharge requirements the results are sent to MDEQ for their review and approval to discharge. Upon receiving permission from MDEQ the discharge begins. Every other day during the discharge period they are required to collect samples at the discharge pipe at morning, mid-day, and evening. These three samples are refrigerated, mixed together and submitted to the lab for testing. If there are any negative changes in the lab results the discharge stops. This extensive testing occurs throughout the entire discharge period.

An additional concern related to treated wastewater discharge entering the stream system exists at Prairie Lake, where approximately 37 homes line the shores. An unknown number of the houses were built years ago with the septic system located between the home and the lake because of a lack of room to locate septic systems upland. During times of spring and fall flooding on Prairie Lake many of these systems are under water with an unknown impact to water quality.

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Chapter III – Lake Analysis

Preliminary Observations and Background

Charles Elzinga, Ph.D. Michigan State University, worked on a study of the seasonal algal blooms on lakes with the help of his students and many volunteers. A summary of the study is provided here. The full study can be reviewed at the Calhoun Conservation District and at the Albion Public Library Historical Room. Water quality of lakes in the Rice Creek Basin and identifying probable anthropogenic threats to these waters is one of the primary goals of this management plan. Initial work on Rice Creek Basin lakes was focused on the Gang Lakes, a chain of six lakes near Springport, Michigan, that are part of Rice Creek's North Branch headwaters. These lakes include White Lake, Bell Lake, Clark Lake, Bolt Lake, Silver Lake, and Gordon Lake. Water from the upper five lakes eventually empty into Gordon Lake before it flows out via the North Branch of Rice Creek.

On-site observations of these lakes showed that several of them and their interconnecting channels exhibited heavy, early-summer blooms of nuisance algae and macrophytes. A survey of lake shorelines and channels revealed the following potential contributors to this phenomenon:

- Nutrient and sedimentation pollution from residential and agricultural runoff, tiled fields, and drains that empty directly into the lakes.
- Invasions of exotic species that clog the waterways and spread into the adjacent wetlands.
- Bank erosion along the shorelines and channels caused by boat wakes and the lack of effective erosion control.

Interestingly, these potential factors seem to be interrelated. Eurasian Milfoil (*Myriophyllum spicatum*) and Curly Pondweed (*Potamogeton crispus*), two invasive species that are choking the channels and margins of the Gang Lakes, are known to be dependent upon high levels of nitrogen and phosphorous. In the Gang Lakes, these submergent plants achieve their greatest abundance from early June to mid-July (Figure 1) but they die back over the rest of the summer (Figure 2). Although no direct connection between a particular land use and this pattern of weed growth has yet been made, the maximum aquatic vegetation biomass seems to occur a few weeks after the application of fertilizers on row crops adjacent to the lakes. Furthermore, it appears that the influx of sediments from the surrounding landscape, coupled with severe bank erosion, are causing certain parts of these lakes to rapidly fill-in and the channels to widen and become shallower. As shallow areas increase, they become more susceptible to weed encroachment.

Aquatic plant (including algal) growth in lakes is generally limited by the availability of nutrients, light, and heat. Plant growth in soft-water lakes is sometimes limited by inorganic carbon availability, but otherwise nitrogen- and phosphorous-limited systems are common.
Most Michigan lakes are phosphorous limited. Dissolved, suspended, and floating substances in the water influence the amount and quality of light reaching plants. These substances in turn affect how much heat reaches the plants, and therefore control how fast plants can grow.

Gang Lakes Studies

Over the last two years, more in-depth studies of five of the six lakes—White Lake was excluded due to unavailable access—were conducted in order to: 1) find out which species were involved in the nuisance algal and plant blooms of the Gang Lakes 2) record their growth pattern, and 3) evaluate the roles nutrients, light, and heat in their production. The goal was to use the above information for designing corrective measures to address the nuisance weed problem.

Large stagnant vegetation mats ringed Bell Lake (Figure 1) and portions of the other Gang Lakes by early June. These mats also extended into their connecting channels to the point where boat traffic between Bell and Clark Lakes was severely hampered. By late July these mats were beginning to die back (Figure 2) and they were almost completely gone by the end of August. Table 1 shows results of vegetation samples from the mats surrounding several of the Gang Lakes and their connecting channels. *Cladophora*, Eurasian Milfoil (*Myriophyllum spicatum)*, and Curly Pondweed (*Potamogeton crispus)* were the dominant macrophytes in these samples, and they are common indicators of nutrient enrichment.

The pattern of macrophyte growth, particularly in Bell Lake and its connecting channels, is consistent with what one might expect from nutrient enrichment occurring as the result of agricultural runoff from row crops. Row-crop agriculture is common on adjacent lands and much of the land is tiled for increased drainage. Sections of Bell, Silver, and Bolt Lakes have little or no buffer between them and the row crops, and tile drains empty directly into Silver and Bolt Lakes. In addition, tile drains empty into the county drains, which in turn, empty directly into Bell, Clark, and Gordon Lakes.

In summary, there is ample opportunity for agricultural activity on the surrounding landscape to have an immediate impact on the Gang Lake’s nutrient levels, and the pattern of nuisance weed growth in consistent with row-crop runoff.

It should be noted that agricultural activities on the adjacent landscape are not the sole cause of the nuisance weed growth in the lakes. Lawn fertilizers and leachates from household and campground septic systems might also make important contributions to the nutrient load of the lakes. Moreover, endogenous nutrient recycling also account for the observed pattern of weed growth, where nutrients captured by macrophytes over the spring and summer are liberated by decomposition over the winter and made available to macrophytes after spring turnover.

Light Penetration

Water clarity differences among the lakes can at least partially be explained by differences in the levels of dissolved organic compounds they contain. Previous studies have shown that Bell Lake consistently has the poorest light penetration whereas Bolt Lake consistently had the highest water clarity. As expected, Bell Lake had significantly higher dissolved organic compound levels than any of the other lakes. Dissolved organic compound levels were also high in Clark, Gordon, and Silver Lakes, but it was significantly lower in Bolt Lake. High dissolved organic carbon is generally associated with waters that drain extensive areas of peaty soils, which is the case for Bell, Clark, and Gordon Lakes. Bolt and Silver Lake do not drain peaty soils. This explains why Bolt Lake should exhibit both high water clarity and lower dissolved organic compound levels, but it does not explain the higher dissolved organic compound levels that were indicated in Silver Lake.

Suspended solids also influence water clarity. Lakes that are wide and shallow often exhibit low water clarity during windy days. Suspended solids associated with brief periods of high winds are commonly non-living particles. High concentrations of living plankton, which is often caused by waters having high nutrient inputs, can also reduce water clarity. Low water clarity due to living plankton is usually a more chronic phenomenon. Silver Lake’s water clarity is highly variable and wind-associated. It is also extremely shallow (maximum depth < 2 m). Bell Lake’s low water clarity can be attributed to three factors: 1) high dissolved organic compound levels, 2) being wide and shallow, and 3) high concentrations of phytoplankton within the top 0.5-m layer of water.

Temperature and Dissolved Oxygen

Bell, Clark, and Gordon Lakes have similar temperature and dissolved oxygen profiles during the summer. All have shallow epilimnions and their dissolved oxygen levels decline abruptly after the upper 1-2 meters. Similarities in dissolved oxygen and temperature among these lakes can be attributed to their comparable light profiles. Bolt Lake has a much deeper epilimnion and corresponding gradual dissolved oxygen profile, which are associated with higher water clarity.

<u>Groundwater and Runoff</u>

Groundwater in the Jackson-Calhoun County area contains fairly high concentrations of calcium carbonate. Waters that are primarily derived from groundwater in this region therefore have a high Total Alkalinity, high Specific Conductivity signature; whereas, those waters primarily driven by runoff typically have low alkalinity and conductivity.

Bell, Clark, and Gordon Lakes have significantly higher alkalinity and conductivity than do Bolt and Silver Lakes. These data suggest that Bell, Clark, and Gordon Lakes have a greater groundwater inputs than do the other two lakes.

Table 1: Predominant taxa comprising the thick vegetative mats surrounding Bell Lake, Silver Lake, and Bolt Lake during the summer of 2001 and 2002. These taxa were also dominated the channel that connects Bell and Clark Lakes, as well as the channel that runs from Bell Lake towards the campground. Nuisance taxa are indicated with an asterisk (*).

Habit	Division- Common Name	Taxon
Phytoplankton	Blue-greens	*Anabaena*
		*Aphanizomenon**
		Gloeotrichia
		*Microcystis**
		Oscillatoria
	Diatoms	*Cyclotella*
		Fragilaria
		Tabellaria
		Nitzschia
Benthic Algae	Green Algae	*Cladophora**
		Mougeotia
		Spirogyra
		Zygnema
Submergent Macrophytes	Flowering Plants	*Ceratophyllum demersum*
		Elodea canadensis
		*Myriophyllum spicatum**
		*Potamogeton crispus**
		Potamogeton pectinatus
		Potamogeton zosteriformis
		Utricularia vulgaris


Figure 1. Photograph of Bell Lake taken on June 15, 2002, showing the extensive weed mat that rings the shoreline.

Figure 2. Photograph of Bell Lake taken on July 28, 2002, showing how the mat is dying back.

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Chapter IV - Water Quality Monitoring

A water quality monitoring study was conducted by Albion College Watershed Research Group. Study findings are summarized here. The full report can be reviewed at the Calhoun Conservation District and at the Albion Public Library Historical Room. A summary of the water quality monitoring findings include the following observations:

A) The Rice Creek watershed and stream system have been substantially altered from pre-settlement conditions, largely by land clearance and stream dredging and straightening to support agriculture.

B) Because the North Branch of Rice Creek passes through Gang Lakes and Prairie Lake, the waters of the North Branch tend to be substantially warmer and cleaner than the waters of the South Branch.

C) Much of the Main Stem and South Branch of Rice Creek are sufficiently cool, well oxygenated, and biologically intact to justify a long-standing program of trout stocking by the Michigan Department of Natural Resources. Ironically, Rice Creek's status as a marginal cold-water fishery may depend in part on levels of cold groundwater intrusion and dissolved oxygen input that are promoted indirectly by dredging.

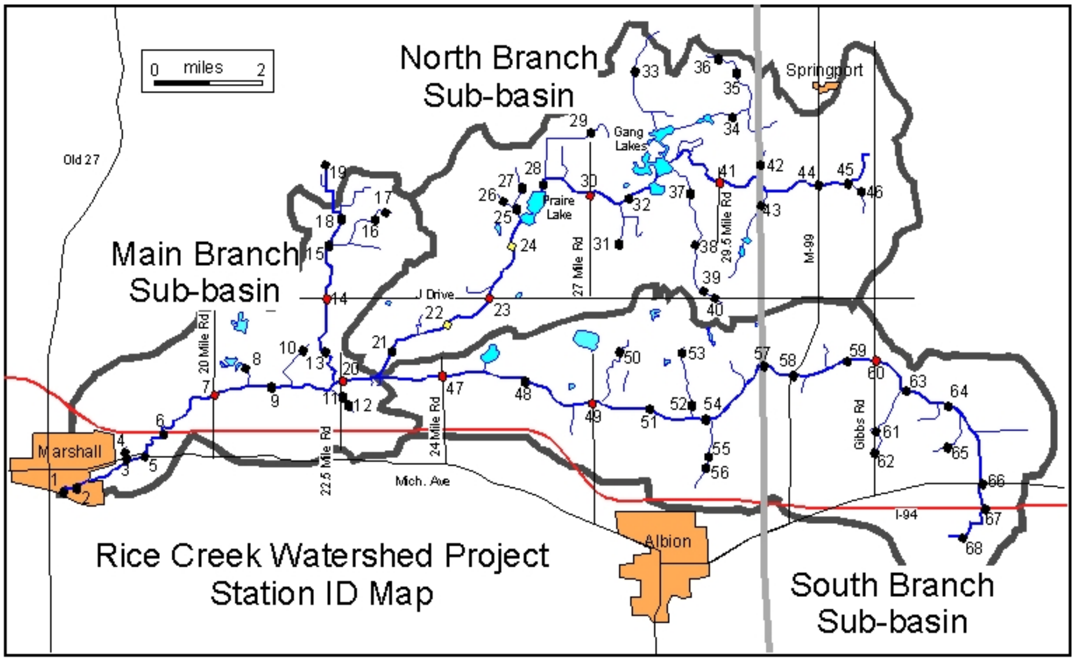
D) Maintaining cool water temperatures, reducing suspended solids and turbidity levels, and managing the flashiness of the Creek are major ongoing concerns for water quality.

Naming conventions

For the purpose of the water quality monitoring study, the watershed was divided into three sub-basins and associated stream sections: North Branch, South Branch, and Main Stem (or Main Branch) (Map E). Data were also collected in the Eaton Drain (or Eaton Branch), which empties into the Main Stem below 22 ½ Mile Rd. Following the protocol established by MDEQ/SWQD Stream Crossing Watershed Survey Procedure, each road crossing on the Creek was given a number in sequence beginning near the outlet into the Kalamazoo River, and then proceeding upstream with digressions for tributaries. The numbers run up the North Branch before returning to the base of the South Branch. And include 68 stream/road crossings. The stream and road crossing inventory evaluated each crossing and ranked it as a low, medium, or high priority for needing re-stabilization or other best management practices.

The inventory revealed that of the 68 crossings 53 ranked as a low priority, being fairly stable and vegetated; 9 crossings were ranked as medium priority, needing some work; and 6 crossings ranked as a high priority, needing immediate attention.

Map E: Stream Monitoring Stations



Rice Creek Watershed Project Station ID Map. The Rice Creek watershed and sub-basins were delineated on 1:24000 USGS topographic maps. Station ID numbers were assigned for each road crossing according to the MDEQ/SWQD Watershed Survey guidelines. Stations in red denote gauging/sampling stations that are part of the study array.

Main sites

Although sampling sites varied somewhat among our studies, most of our work centered around eight main sampling stations. There were three main stations each on the North and South Branches and two main stations on the Main Stem. Each of these sites is pictured in Figure 4 below, and it's location is identified on the site map by a red dot on Map E above.

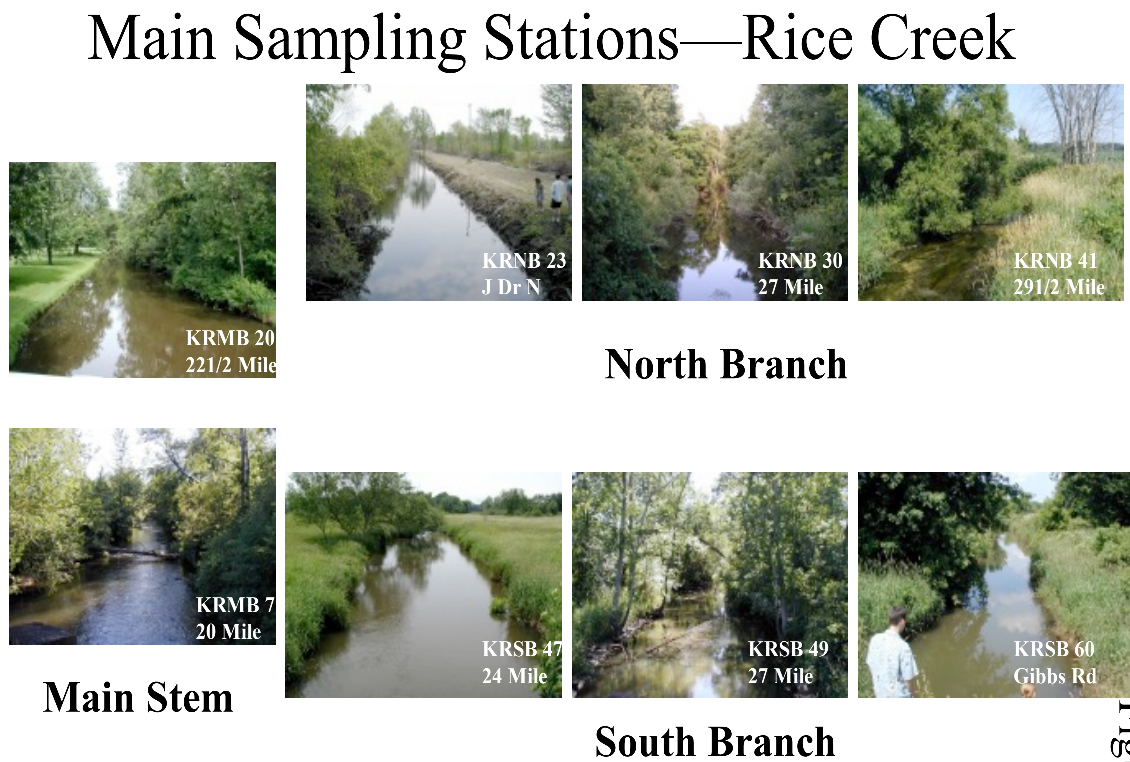


Figure 4

Physical properties

Water temperature

Temperature is a key water-quality parameter. Water temperature varies with air temperature, exposure to sunlight, and the mix of ground water and surface runoff contributing to the stream; hence, clearing vegetation, especially gallery forests, and land development can lead to stream warming. Elevations in water temperature are stressful to some fish because such warming increases metabolic rates while reducing the capacity of water to hold dissolved oxygen. Water temperature is particularly significant to Rice Creek because of the Creek's status as a marginal cold-water fishery. Brown trout prefer temperatures below 19º C, and cannot long tolerate temperatures above 22º C.

To reveal how the water temperature of the stream varied in space and time, we monitored temperature in several ways. First, we used a Quanta multi-parameter probe to assess spatial patterns in temperature.
In eight weekly sweeps between June 3, 2002 and July 16, 2002, we measured temperature (and other parameters, described later) at a total of 28 road crossings on the North Branch, South Branch, Main Stem, and Eaton Drain.

To emphasize spatial patterns in these sweeps, we minimized variation due to daily cycles by beginning at the headwater road crossing of one branch and visiting stations in order downstream until reaching the station below the conjunction of the two branches. We then moved to the head of the other branch and sampled downstream in order on that branch, continuing on through the main stem and Eaton drain. To balance time-of-day effects, we alternated starting branches between weeks.

Summer daytime temperatures in the lower South Branch and Main Stem were between 17-23º C. Temperatures at the most upstream stations were 4-6º C colder than those on the lower Main Stem, reflecting a high input of subsurface ground water in these entrenched sections. In-stream Gang Lake and

Prairie Lake on the North Branch elevated temperatures in the North Branch by 4-6° C over comparable stations on the South Branch. Thus, different parts of the stream regularly differed by 10° C or more. The lowest stations on the North and South Branches differed by over 2.5° C; the mixing of the two branches essentially elevated the temperature in the South Branch about 2° C. Temperatures in the shallow Eaton Drain were especially variable. The impacts of variations in solar heating are evident along the South Branch. Temperature increases spiking at 30 Mile Road followed especially open reaches in Jackson County; a cooling trend in subsequent stations reflected the more wooded character of the stream in Calhoun County.

A second source of temperature data was the automatic logging devices deployed in stilling wells at gauging stations to assess stream depth. Six of these devices were equipped to log temperature at half-hour intervals and thus provided a rich picture of spatial differences in temperature and temperature variability throughout the watershed. Average mean temperatures in summer on Rice Creek were between 18.8-19.9 degrees Celsius except below Gang Lakes where it was substantially warmer at 25.1 degrees Celsius. In summer, the dredged headwaters sections of Rice Creek were about 3.5 degrees Celsius cooler on average than the Spring Brook reference stream. Rice Creek's headwaters also experienced a daily temperature range that was 4 degrees Celsius less than that in Spring Brook.

Overall, daily and day-to-day fluctuations in water temperature were contained within narrow bounds at the most downstream site on the Main Stem. Early-season records (Jan. 28-Mar. 7) from Gibbs Road and 20 Mile Road showed temperatures hovering about 4° C above freezing (near the maximum density of water) despite prolonged freezing weather. This resistance to freezing demonstrates the dominance of ground water sources. Rice Creek did not begin major warming in 2002 until mid-April.

Dissolved Oxygen

An adequate supply of dissolved oxygen (DO) in stream water is necessary to support the metabolism of fish and other animal life. Species differ in their tolerance for low DO levels. The recommended minimum average DO is 5 mg/L for a warm-water fishery and 7 mg/L for a cold-water fishery; the minimums are 4 mg/L and 6 mg/L, respectively. Differences in DO tolerances are reflected also in the community composition of stream macroinvertebrates. Oxygen enters streams from the atmosphere by diffusion and especially physical agitation in moving water and as a by-product of photosynthesis by submerged aquatic plants. The oxygen holding capacity of water declines rapidly as water warms. We assessed spatial patterns in dissolved oxygen in the same sweeps with the Quanta meter used to assess temperate patterns.

Average summer daytime DO levels at different stations along the Creek were 6-12 mg/L. Rank stands of submerged aquatic vegetation in unshaded portions of the upper North and South Branches and in the in-stream lakes elevated DO to supersaturated levels. Oxygen content tended to decline downstream from the headwaters until reaching 20 Mile Rd and Michigan Ave where agitation in large riffles reversed the losses. A spike in DO along the South Branch peaking at 30 Mile Rd reflected the open exposure of that reach of the stream. The Michigan Department of Natural Resources Fisheries Division has yearly stocked thousands of brown trout in the Main Stem and South Branch of Rice Creek between Michigan Ave and 29 Mile Rd. Within this section, every station fell below the standard of 7 mg/L for a cold water fishery during at least one of the weekly sweeps. Oxygen levels appeared most marginal for trout at 21 Mile Rd and 22½ Mile Rd.

PH

Acidity can be damaging to stream life. As with oxygen, species differ in their tolerances to acidity. A stream can be acidified by sulfates and nitrates in air pollution, by industrial or mine wastes, by sulfates in soil amendments, or by leaching from naturally acid soils or bogs. Acidity is measured on the pH scale where 7 is neutral, <7 is acidic, and >7 is basic. The pH scale is logarithmic, in other words each unit step in the pH scale represents a 10-fold difference in the concentration of the acidic hydrogen ion, so pHs near 7 are only weakly reactive. For instance, carbon dioxide dissolves in water to form carbonic acid, a weak acid. Photosynthesis by submerged aquatic plants removes carbon from the water making it slightly less acidic. Thus, pH can be a surrogate index for in-stream photosynthesis and weed density. We assessed spatial patterns in pH in the same sweeps with the Quanta meter. Michigan water quality standards call for a pH between 6.5 and 9.

There is no evidence of acid impairment in Rice Creek; all pH values observed in summer daytime sweeps were >7.2 and mildly basic. Observed patterns in pH did reveal several aspects of watershed function, however. First, the headwaters of the South Branch, and to a lesser extent the North Branch, tended towards lower pHs.

To see if these differences could be attributed to differences in dissolved oxygen content, we calculated regressions between DO and pH and adjusted station mean pHs for a fixed DO of 8 mg/L. If anything, high DO in headwater reaches somewhat obscured underlying lower pH. Based on analyses of water chemistry, it appears that the pH trend is due to elevated levels of sulfates in the headwaters, which are diluted downstream. The source of the additional sulfates is uncertain, but it might represent leaching from drained peaty wetlands. Second, pHs in the North Branch were distinctly elevated by Gang Lake and Prairie Lake. This result is evidence for abundant photosynthesis in these shallow open lakes. Third, a spike in pH along the South Branch peaking at 30 Mile Rd again reflected the open exposure of that reach of the stream.

Specific Conductance

Spatial patterns in specific conductance were assessed in the same sweeps with the Quanta meter described above. The headwaters of the South Branch, and to a lesser extent the upper North Branch, had distinctly higher specific conductance values than the Main Stem. There was no evidence of a spike to suggest a previously unrecognized pollution source in the watershed. The declining conductance trace on the South Branch parallels differences in sulfate content found in chemical sampling.

Turbidity

Turbidity is an index of suspended solids and cloudiness. High turbidity can damage stream life by clogging gills, smothering bottom-dwelling organisms, obscuring vision, and reducing photosynthesis. Turbid water also absorbs more sunlight and heats more quickly.

The Quanta and YSI probes we used measured turbidity in NTU, normal turbidity units. There is no set turbidity standard, but studies comparing NTU values to indices of biological integrity have found impairment above 50 NTU, a level where water is distinctly cloudy. Turbidity, a classic non-point source pollutant, may be caused by bank erosion, surface runoff, and disturbances in the stream, such as wading cattle. A tendency for small disturbances to generate high turbidity reflects a high load of fine particles in the streambed. Spatial patterns in turbidity were assessed in the same sweeps with the Quanta meter. Occasional spikes in turbidity, often on the hottest days, occurred downstream from areas where livestock had access to the Creek. Turbidity levels were distinctly lower on the North Branch than the South Branch, evidence that the in-stream lakes acted as sediment traps to cleanse the Creek. A small rise in turbidity occurred at 22½ Mile Rd, the station just below the confluence of the two branches. The broad mudflats and wetlands in the region of the confluence have been described as the "bayou" of Rice Creek. Elevated turbidity at 22½ Mile Rd might reflect a high load of easily mobilized sediments in this confluence region.

Suspended Solids at main sampling stations

Another measure of turbidity is total suspended solids (TSS), the mass of particles suspended in water that can be removed by a filter. TSS and turbidity were listed as water quality impairments in the Creek in 1998. We collected water samples for TSS determinations at our main stations in conjunction with gauging. Thus, we can multiply TTS concentrations and stream discharge to calculate flux in suspended solids at the times of gauging. Differences in TSS fluxes between sequential gauging stations could potentially reveal regions of deposition or erosion of solids; however, most movement of sediments, especially larger particles, must occur irregularly during floods. The erosive force of the stream, and hence the concentration and flux of suspended solids, should be correlated with the amount of water flowing in the stream.

Concentrations of TSS in Rice Creek in daytime samples in summer 2002 and summer 2001 were mostly below 20 mg/L, in the "clear" range. Most stations showed the expected seasonal declines in TSS concentrations in both years. In 2002, however, TSS concentration increased unexpectedly with season on the upper South Branch at Gibbs Rd, and to a lesser extent at 27 Mile Rd. The evidence is consistent with some nonpoint source of sediment pollution on the upper reaches of the South Branch. Peaks in station records for TSS concentration correlated well with rainstorms in the watershed. For instance, the TSS peak on 7//26/01 at 24 Mile Rd on the South Branch occurred following a 25 mm storm the previous day. The stream was generally clearer in North Branch than the South Branch, again most likely because of the filtering effects of the in-stream lakes.

Fluxes in TSS showed clear seasonal declines in both 2002 and 2001. The North Branch transported only a small fraction of the TSS carried by the South Branch, even though the discharges of the two branches are similar. Flux in TSS at J Dr below Prairie Lake the lower North Branch was low at the earliest sampling dates and remained low. In comparison, at 24 Mile Rd on the lower South Branch, over a 1000 Kg/day of suspended solids were being transported at our earliest of sampling dates. These data suggest that the North Branch is adding many tons of sediment annually to Gang Lake and Prairie Lake. The TSS loads in the Main Stem in June 2002 were 1000-2000 Kg/day. Currently, a substantial portion of sediment carried in the Main Stem must end up at the bottom of the millpond behind the Ketchum Park dam in Marshall or in the braided, undredged portion of the Creek just north of I94. Beyond the obvious role of North-Branch lakes as sediment traps, the fluxes of TSS further suggest that the area of the confluence of the two branches, the so-call "Rice Creek bayou," may function as a sediment buffer. The big drop in TSS flux observed between our lowest station on the South Branch and the station immediately below the confluence on June 20, 2001, suggested sediment deposition in the bayou region. During the same period in 2002, the bayou reach apparently contributed sediment to the Main Stem.

Temporal variation and correlation of physical properties at four specific sites were specifically evaluated for all of the above described concerns and using all of the above described monitoring methods. The areas specifically evaluated were the South Branch of Rice Creek at the Gibbs Road stream crossing, the South Branch at the 27 mile road stream crossing, the North Branch at the 27 mile road stream crossing, and the South Branch at the Hicks Road stream crossing. All four of these evaluations completed by the Albion College Watershed Research Group for this project can be reviewed in their May 5, 2003 report at the Albion Public Library Historical Room or at the Calhoun County Conservation District.

Water Chemistry

Anions

Nitrate and nitrite are regulated water pollutants. Potential sources of these within the watershed include agricultural fertilizers and animal wastes, septic systems, and residential lawn and garden fertilizers. Water samples collected chiefly at the main gauging stations (Fig. 4) were analyzed for nitrate, nitrite, sulfate, and chloride using an ion chromatograph in the Dow Lab at Albion College. Sulfate and chloride are less reactive inorganic species that are useful to measure as tracers and indices of dilution. Nitrate concentrations in waters of Rice Creek were generally below the standard for drinking water, 10 ppm. Nitrate levels tended to be higher in April and May than in June and July. In June and July, levels above the lakes on the North Branch were higher than elsewhere in the watershed. Analyses for nitrite were uniformly <0.5 ppm, well below the standard for drinking water of 1 ppm.

Sulfate concentrations were uniformly between 42-54 ppm in the North Branch and Main Stem, but in the South Branch, concentrations began at 2-3 times typical watershed values and fell downstream. This pattern was also seen in 2001 and reflected in spatial patterns of specific conductance. Chloride concentrations were 12-31 ppm and showed no clear spatial or temporal trends.

Phosphorus

Inorganic phosphorus is the element most likely to limit primary productivity in freshwater streams and lakes. A substantial reduction in phosphorus loading for the Kalamazoo River is called for under the phosphorus TMDL plan for the Kalamazoo watershed. We used a sensitive colorimetric technique to measure total phosphorus in water samples collected at major gauging stations. As a point of reference, Michigan Water Quality Standards limit point source discharges to 1 mg/L total phosphorus. Long-term eutrophication may require total phosphorus levels above 0.5 mg/L. Overall, average phosphorus levels in Rice Creek were 0.066 mg/L and a maximum of 0.209 mg/L. In the North Branch, in-stream lakes did not consistently increase or decrease phosphorus concentrations in the stream. Nor was there a consistent pattern for phosphorus to be high in one part of the watershed versus another.

Effects of wastewater discharge on stream chemistry

Rice Creek was sampled in March 2002 to see the effects of the Springport sewage lagoon discharge at Gibbs Rd. Phosphate was the key concern, as previous work suggested that P levels in the creek during discharge events exceeded EPA recommended levels, which is 0.1 µg/l (=100 ppb) for surface waters not draining into a lake (*http://h2osparc.wq.ncsu.edu/info/phos.html*). The primary goal was to see if high P levels occurred in the Creek and if so to determine the fate of the Phosphorus (i.e. was it deposited? Or did it remain in the water, and flush from the Creek?)

Data were collected on the 30th, when we believe discharge had been continuous throughout the preceding day. On this day, 13 stream samples were collected and *in situ* measurements were made from Callahan Road to 20 Mile Rd, a stream distance of approximately 23.5 km to the west. The wastewater outfall was also sampled, as was one location (J-Drive) on the North Branch. The Creek at the point of discharge was sampled on the east side of the bridge, about 10 m upstream from the point of discharge, and from the south bank, roughly 10 m downstream from the point of discharge.

Foam on the surface suggested that this water contained at least some admixed discharge; our analysis suggests that the stream was not thoroughly mixed at this point, as the samples slightly further downstream contain higher levels of components high in the discharge (Cl^-, and phosphorus).

In-stream measurements were made with the YSI sonde. Phosphorus was measured with the inductively coupled argon plasma spectrometer (ICP). This method gives total phosphate, here reported as mg/l HPO_4. The detection limits are near the background levels in the stream; background equivalent concentration was 0.012 mg/l, so practical limit of quantification with reasonable degree of certainty is estimated at about 0.03 mg/l. Other anions were analyzed with the ion chromatograph (IC).

The discharge contained high levels of phosphorus exceeding the levels in the Creek where the outfall occurred by roughly 200 fold. Elevated phosphate was detectable throughout the portion of the creek sampled, and was measured in levels near or in excess of the EPA standard for 13 km downstream. The highest chlorophyll values occurred downstream from the discharge, suggesting a fertilizing effect on algae. Chloride levels were also elevated in the outfall, and were about 10x those in the Creek at the point of discharge. This is not a serious environmental concern, but does provide us with an interesting tracer, as Cl^- is not expected to react to a significant degree with chemicals or organisms within the stream. The object is to compare the behavior of Cl^-, thought to be conservative, to P to see if it behaves in the same way. If P behaves the same, it also is subject only to dilution. If P suggests lower contributions of sewage to flow downstream, it suggests that actually P was being removed from the stream (thus appearing to be diluted more).

Using a mixing model, the calculated trends in phosphate and chloride dilution were strikingly similar. This result suggests that phosphorus, like salt (Cl^-), seems to stay dissolved and wash out of the Creek. If phosphorus was being deposited, its curve would have fallen below that for chloride. The observed divergence in the lines is thought to be due primarily to limitations in the two assumptions of the model. For example, the North Branch may have a slightly different chemistry from the South, and there may be additional sources of Cl or P along the course of the Creek.

It should be noted that it rained the day these samples were collected, and the Creek was relatively high. Thus these results represent if not a best-case situation, at least a good case situation, where the Creek had quite high flow with which to dilute and carry phosphate down stream. Also, stream assimilation of phosphorus may be greater for discharges made in May when temperatures are higher and growth of stream organisms is greater.

The discharge and stream were sampled again on two days during the discharge (October 15 and 16), and results were averaged. A dilution model was calculated in the same manner as for the spring discharge. Measured at Hicks Rd, wastewater constituted about one fifth of the stream volume, a 3-4 times larger percentage than seen in spring. This increase reflected the joint effects of a lower fall stream volume and a higher discharge rate of wastewater from the pipeline (because of intervening repairs to Springport's pumps). Unlike the spring discharge, phosphate fell more quickly downstream than did the marker chemical chloride. This pattern suggests that phosphorus was partly being taken up as it traveled downstream rather than being simply diluted and flushed from the Creek.

Biological properties

Bacteria

We sampled for fecal coliform bacteria as an index of possible fecal pollution of the Creek. Sampling targeted sites where there was an *a priori* suspicion of contamination by feces from livestock, humans, or fowl. On the South Branch we sampled below the hog farm and below the discharge pipe for wastewater from the sewage lagoons of the Village of Springport, both sites of concern to basin residents. On the North Branch we sampled the stream below Prairie Lake and Gang Lake to test for effects of leaking or flooded septic systems. We tested the lower South Branch and Main Stem, the best fishing and canoeing sections of Rice Creek, because these areas are among the most likely sites for human exposure to pathogenic microbes. Levels of fecal coliforms high enough to make full or partial body immersion dangerous would limit some recreational uses of the Creek.

Contrary to early concerns, in-stream lakes on the North Branch appeared to have a cleansing effect, so much so that water below the lakes was usually safe for full body contact. Elsewhere in the watershed, waters generally fell safely within the range for partial body contact but above the standard for full body contact. High readings at 29 Mile Rd and Eaton Drain may have been due to livestock in the stream and low flow, respectively.

Biological Oxygen Demand

We evaluated Biological Oxygen Demand (BOD) at major gauging stations on three dates to screen for high levels of biodegradable organic wastes such as aquatic plants, agricultural or livestock runoff, or septic system pollution that could deplete dissolved oxygen in the stream. Levels of 5-day, carbonaceous BOD in July 2002 were low, and presented no threats to stream dissolved oxygen levels given the large photosynthetic inputs from aquatic plants. There was a weak trend for BOD to decline downstream from headwaters areas.

Algal communities

Algal communities were investigated as a possible cause of turbidity and secondarily as a potential indicator of pollution. As short-lived primary producers that respond readily to phosphorus levels, algae may serve as good bio-indicators of non-point source pollution. We sampled and identified algae at two upstream sites on the South Branch where algal turbidity was suspected (Callahan Rd and Gibbs Rd) and at two control sites (Main Stem at 20 Mile Rd and Bangham Rd on Spring Brook, an adjacent but less disturbed headwaters stream). As the summer proceeded, the number of microscopic algal diatoms decreased drastically. Possible causes of the collapse in diatom abundances include turbidity, high summer fluctuations in the physical and chemical water parameters, and competition for nutrients from dense stands of submerged aquatic plants.

Stream macroinvertebrates

Stream macroinvertebrate communities are an excellent indicator of overall stream health. Benthic macroinvertebrates such as mayflies, caddisflies, and stoneflies are key prey items for fish and other vertebrates and are particularly sensitive to environmental degradation. Poor macroinvertebrate communities have been an important non-attainment issue for Rice Creek.

Between May 20, 2002 and July 19, 2002, we sampled benthic macroinvertebrates near 15 sites, including each of the eight gauging stations plus three additional sites on the upper South Branch, three additional sites on the North Branch, and one site in the Eaton Drain (J Dr). We returned to take repeat samples at 22 ½ Mile Rd on the Main Stem and 24 Mile Rd on the South Branch. We used two similar protocols to sample macroinvertebrates at each site: a "qualitative" method and a "quantitative" method.
The qualitative method was the Great Lakes and Environmental Assessment Section rapid bio-assessment protocol for wadable streams (GLEAS Procedure #51), which is based on a mixed-habitat sample of 100 organisms. The qualitative protocol was chosen to give results that would be directly comparable to previous macroinvertebrate studies of the Creek by the MDEQ.

For the quantitative method, three separate sub-samples of macroinvertebrates were obtained at each site from the best habitats in the stream (as defined by GLEAS #51). For each sub-sample, the stream bottom within 1 foot by 1-foot quadrate was agitated for 60 seconds, and the dislodged organisms were collected in a 18" x 10" rectangular aquatic kick net with a 10" deep mesh nylon net. The GLEAS index of biological integrity allows the macroinvertebrate community observed in a qualitative sample to be compared to the community expected at an excellent site in our ecoregion (Southern Michigan Northern Indiana Till Plains) based on a set of nine metrics. For each metric, the score can be +1 (excellent), 0 (acceptable), or -1 (poor), with a negative score generally indicating a metric that differs by more than two standard deviations from the mean for an excellent site. Because there are 9 metrics, total scores can range from +9 to -9. Total scores above +4 are considered excellent, scores below -4 are considered poor, and intermediate totals are acceptable.

A total of 59 taxa of macroinvertebrates were collected in qualitative samples at 15 sites in summer 2002. Metric evaluation scores for the qualitative samples ranged from –7 to +5. Only 20 Mile Rd on the Main Stem was rated excellent. Three sites had macroinvertebrate communities rated poor: L Dr on the North Branch below Prairie Lake (-5); Hicks Rd on the South Branch below a pasture where cattle sometimes gained access to the stream (-6); and 22 ½ Mile Rd on the Main Stem downstream from the confluence of the two branches (-7).

Hicks Rd is the first site downstream from the wastewater discharge outlet at Gibbs Rd, so the discharge of wastewater at Gibbs Rd cannot be excluded as a contributor to the poor score at Hicks. Nevertheless, heavy sedimentation of the bottom appears to be the principle problem, and if nutrient pollution were a contributor, it would be difficult to distinguish between cattle and wastewater inputs. The community at 22 ½ Mile Rd was rated acceptable (-2) when it was resampled. The 22 ½ Mile Rd site was placed on the 2000 non-attainment list because the macroinvertebrate community rated poor.

Recent changes in the Creek help explain differences between our study and the Biological Survey Staff Report from MDEQ/SWQD in 1999. The decline in the macroinvertebrate community at J Dr from +2 to –2 may reflect the drain maintenance that occurred along this reach in spring 2002. In contrast, macroinvertebrate recovery at Callahan Rd (and perhaps Gibbs Rd downstream) may reflect bottom stabilization and colonization of submerged aquatic plants following drain maintenance along this reach in early 2000.

No macroinvertebrate evidence exists that the old commercial hog farm operation in Parma Township is damaging the Creek at Callahan Rd. Our results agree with previous work in suggesting that the best macroinvertebrate community occurs at 20 Mile Rd on the Main Stem, and that the status of macroinvertebrates at 22 ½ Mile Rd is fair to poor.

A total of 59 taxa of macroinvertebrates were collected in quantitative samples at 15 sites in summer 2002. (Counting both qualitative and quantitative samples, 72 taxa were encountered overall.) Provisional metric evaluation scores for the quantitative samples ranged from –5 to +6. Again, only 20 Mile Rd on the Main Stem rated excellent. Only Hicks Rd (downstream from a pasture) rated poor, although negative scores at J Dr and 24 Mile Rd on the North Branch suggested a negative effect from drain maintenance in spring.

Despite our concern that calculation of metrics from the quantitative samples would spuriously inflate scores, quantitative scores were better than qualitative scores in matching results from the MDEQ report of 1999. At the two sites that were sampled twice, quantitative scores matched while qualitative scores jumped 4-5 spots. A moderate correlation existed between the scores from the two protocols ($r = 0.46$); the largest disparity existed at 29 ½ Mile Rd on the North Branch.

In addition to collecting macroinvertebrate samples in 2002, we also evaluated macroinvertebrate habitat characteristics at the sampling stations. The highest habitat score was recorded at 20 Mile Rd on the Main Stem, just where the best macroinvertebrate communities are typically found. Conversely, nearly the worst habitat was found at Hicks Rd, where the macroinvertebrate community was found to be poor.
Overall, however, habitat score was not significantly correlated with metric scores from either the qualitative or quantitative protocols ($r = 0.26$ and $r = 0.21$, respectively), suggesting that habitat factors alone cannot explain differences in Rice Creek's macroinvertebrate communities.

Watershed-wide, macroinvertebrate community quality assumed an unexpected pattern with higher metric scores in the headwaters and lower Main Stem reaches and lower scores in the midsections of the North and South Branches. The presence of abundant patches of submerged aquatic vegetation (especially *Chara* and *Potamogeton*) and cold groundwater inputs in the upper sections of both branches apparently provided suitable cover and dissolved oxygen to support an array of benthic insects despite generally poor abiotic substrates. The general depression of macroinvertebrates in the midsections may be due to sediment and turbidity.

Water quality summary discussion

The following discussion is taken from the final report prepared by Albion College:

Rice Creek suffers from impairments to designated water uses. Generally, though, water quality is acceptable and much of the Creek retains an engaging rural charm. Those factors that did occasionally and locally rise above or near regulatory levels of concern are poor macroinvertebrate communities, excess fecal coliforms, and suspended solids and turbidity. The probable root causes for these impairments include livestock in the stream and instability of sediments caused by a long history of drain work. The existence of daily cycles in turbidity vividly demonstrates the abundance of easily mobilized sediments in the Creek.

Several factors that were perceived concerns at the outset of this study were not confirmed as major problems in the monitoring efforts. In particular, no statistically significant problems could be attributed to (1) residual effects of a large concentrated animal operation (hog farm) near Callahan Rd, (2) faulty residential septic systems, particularly near lakes, (3) waterfowl wastes, or (4) excess nitrates and phosphates running off specific cropland, residences, or golf courses. Basin residents had also voiced concerns about wastewater from Springport's sewage treatment lagoons being discharged into the Creek at Gibbs Rd in spring and fall. Studies raised two flags of concern. First, the water that is discharged from the pipe at the outset of the season may be excessively turbid and anoxic. It was recommended that the management of the pipeline be improved to sweeten this first foul slug of water.

Second, it was not confirmed that the large phosphorus loads introduced into the South Branch remained in solution to be flushed from the system. Phosphorus released in spring 2002 apparently cleared the South Branch, but phosphorus released in fall 2002, when the discharge flow was greater relative to stream flow, appeared to be taken up in the watershed. The mixed results suggest that it may be advisable to reduce pumping rates when stream flow is low.

The North Branch of Rice Creek includes two in-stream lakes, Gang Lake and Prairie Lake, while the South Branch flows uninterrupted. For this reason, the down-lake sections of the North Branch were warmer, cleaner, and more uniform in flow than the South Branch. North and South Branches behaved differently in parameter after parameter including temperature, dissolved oxygen, pH, specific conductance, turbidity, total suspended solids, fecal coliforms, sulfate concentrations, daily variability in flow, and variability in flow in response to storms. For the North Branch, the lakes acted as settling basins, filters, and buffers. We did not investigate how these stream inputs affected the lakes.

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Chapter V – Designated Uses and Desired Uses of the Watershed

Designated uses for surface water in the Rice Creek Watershed are warm water fishery, cold water fishery, habitat for other indigenous aquatic life and wildlife, agriculture (especially drainage and irrigation), public drinking water supply (groundwater), and partial or total body contact recreation. Industrial water supply and navigation designated uses were not found to be prevalent in the watershed.

In addition to the designated uses, the residents of the watershed added to the list the following enhancements and/or **Desired Uses:**

- Enhancement of the cold water fishery,
- Improved access to warm water fishery / recreation,
- Effective land use policies to maintain & improve water quality
- Healthy functioning wetlands
- Reconnection of creek to wetland/floodplain
- Improved storm water management to provide storm water buffers & limit the need for continuous dredging for agricultural uses

Water Quality Threats and/or Impairments in the watershed

(k) = known pollutant (s) = suspected pollutant

Designated Uses	**Impairing Pollutants / conditions**	**Threatening Pollutants**
Warm water fishery	Sediments (k) Nutrients (k) Salts (k) Hydrologic alterations (k)	Pesticides (s) Oils, Grease, and metals (s)
Aquatic Life/Wildlife	Sediments (k) Nutrients (k) Salts (k) Hydrologic alterations (k) Temperature (k)	Pesticides (s) Oils, Grease, and metals (s)
Agriculture	Sediments (k) Hydrologic alterations (k)	
Partial/Total Body Contact Recreation	Nutrients (k) Bacteria (k)	Pesticides (s) Oils, grease, and metals (s)
Public Water Supply Groundwater (Cr*itical area only)*	Nutrients (k)	Nutrients (in other areas) (s)

Water Quality Threats and/or Impairments in the watershed (continued)

(k) = known pollutant (s) = suspected pollutant

Desired Uses	Pollutant / Impairment
Cold water fishery	Temperature (k) Hydrologic Flow (k) Sediment (k) Nutrients (k) Salts (k)
Warm water fishery access	* Lack of dock access (k)
Land Use Planning Policy	Sediment (s) Hydrologic Flow (s) Nutrients (s) Temperature (s)
Water Quality	Sediment (k) Salts (k) Hydrologic Flow (k) Pesticides (s) Nutrients (k) Oils, grease, metals (s) Temperature (k) Bacteria (k)
Healthy Functioning Wetlands	Sediment (k) Nutrients (k) Hydrologic Flow / connection (k) Land Use Changes (k)

* Residents of the Rice Creek Watershed desire fishing access for all residents. Currently only those with boats can fish at the three lakes with public access and restrooms. L or T shapes docks would provide access for all residents. The three lakes would include Winnipeg Lake in Sheridan Township and Prairie and Gordon Lakes in Clarence Township.

** Residents of the watershed would also like to promote healthy functioning wetlands in the watershed. The primary wetlands targeted would include those wetlands that lie in the floodplain of the creek. Where possible, it would be advantageous to reconnect the creek to wetland floodplains for two reasons: The first being the ability to store storm water peak flows that are destructive to the fishery and aquatic habitat and many times lead to downstream flooding and the need for dredging; The second benefit being the restoration of the natural inhabitatants and function of the wetlands, such as the plants, wildlife, groundwater recharge and pollutant filtration.

Designated Uses Impaired and Threatened

This section describes designated and desired uses for the watershed. Sources of pollutants associated with threats and impairments are listed for each use. A general goal is also identified for each use. In chapter 8, proposed methods for meeting the general goals are broken down into objectives and specific best management practices by the sources listed on the following pages.

Warm Water Fishery - Impaired Use
Sediments, nutrients, salt, and modified hydrologic flows all have a negative impact on the warm water fishery in Rice Creek. These pollutants are a result of the following sources:

- sediment from stream bank erosion
- construction erosion
- livestock in the waterways
- poorly designed culverts and road/stream crossings

- residential and agricultural lands
- parking lots, roads, storm drains
- septic systems & treated wastewater
- loss of wetlands
- dredging/channelization
- increasing development
- deer/geese impacts
- flooding

The goal is to restore and improve the warm water fishery, which is a very important resource to residents across the watershed and the region.

Warm Water Fishery – Threatened Use

Pesticides, oils, grease, and metals are all pollutants that threaten the warm water fishery designated use. These pollutants are not known to have impacted the designated use, though they threaten to impact the designated use if not properly managed. These pollutants are suspected to come from the following sources:

- residential run-off
- agricultural run-off
- road-stream crossings
- parking lots/storm drains

The goal is to reduce and/or eliminate the pollutants threatening the warm water fishery designated use.

Aquatic Life/Wildlife - Impaired Use

Sediments, nutrients, salt, and hydrologic flows all have a negative impact on the aquatic life/wildlife in and along Rice Creek. These pollutants are a result of the following sources:

- parking lots, roads, storm drains
- sediment from stream bank erosion
- construction erosion
- septic systems & treated wastewater
- livestock in the waterways
- road/stream crossings
- residential and agricultural lands
- channelization
- deer/geese impacts
- loss of wetlands
- flooding
- increasing development

The goal is to restore the aquatic life/wildlife and their habitat. Twenty-two percent of watershed residents that responded to the questionnaire expressed that viewing wildlife and nature was their number one activity and use of the watershed.

Aquatic Life/Wildlife – Threatened Use

Pesticides, oils, grease, and metals are all pollutants that threaten the aquatic life/wildlife designated use. These pollutants are not known to have impacted the designated use, though they threaten to impact the designated use if not properly managed. These pollutants would likely come from the following sources:

- agricultural run-off
- residential run-off
- parking lots/storm drains

- road-stream crossings

The goal is to reduce and/or eliminate the pollutants that threaten to impact the aquatic life/wildlife designated use.

Partial/Total Body Contact Recreation - Impaired Use

Nutrients and bacteria both have a negative impact on the designated use partial/total body contact recreation. These pollutants are the result of the following sources:

- livestock in stream
- deer/geese impacts
- septic systems & treated wastewater
- agricultural & residential run-off

The goal is to reduce and/or eliminate the pollutants impacting the partial/total body contact recreation designated use.

Though only five percent of folks questioned in the watershed expressed swimming as a personal use of the lake and stream resource, children are typically those most likely to pertain to such use. Also, any impairment and/or threat to body contact recreation is a concern as directed by the State of Michigan.

Partial/Total Body Contact Recreation – Threatened Use

Pesticides, oils, grease, and metals are all pollutants that threaten the partial/total body contact recreation designated use. These pollutants are not known to have impacted the designated use, though they threaten to impact the designated use if not properly managed. These pollutants would likely come from the following sources:

- residential run-off
- agricultural run-off
- parking lots/storm drains
- road-stream crossings

The goal is to restore the designated use by reducing and/or eliminating the pollutants threatening partial/total body contact recreation.

Drinking Water - Impaired Use

Nutrients are the only known pollutants having a negative impact on drinking water in the Rice Creek watershed and in a very limited area. (Marengo Township Sections 8, 9, 16, 17) High nitrates have been reported by the Calhoun County Health Department in this area. These pollutants are likely the result of the following sources:

- septic systems
- agricultural practices

The goal is to restore the designated use by reducing and/or eliminating the pollutants impacting the drinking water designated use. Only the critical area identified above is known to have a high nitrate level in some of the area wells sampled. A voluntary annual drinking well water monitoring program for the critical area is proposed.

Drinking Water – Threatened Use

Nutrients are the pollutants that threaten the drinking water designated use. Nutrients typically threaten drinking water in areas where proper agricultural management practices and septic system placement and maintenance practices are not followed. High nitrates in drinking water can be easily monitored with annual drinking water testing. This pollutant would likely come from the above mentioned sources.

The goal is to reduce and/or eliminate nutrients from threatening the risk to the drinking water designated use. This will be accomplished by implementing a series of educational as well as best management practices to address the threat of this pollutant.

Desired Uses Impaired

Desired Use – Agriculture Use Impaired
Hydrologic Flow is the only known pollutant having a negative flooding impact on agriculture in the Rice Creek watershed. This pollutant is the result of the following sources:

- loss of wetlands
- natural obstructions
- farming in the floodplain

The goal is to reach a balance between the need for drainage and the increase of peak flows and flashy conditions in the creek.

Desired Use – Cold Water Fishery Impaired
Temperature, hydrologic flow, sediment, nutrients, and salts are all pollutants that have a negative impact on the cold water fishery desired use. These pollutants are the result of the following sources:

- loss of wetlands
- loss of stream canopy
- Plentiful lakes
- treated wastewater
- artificial drainage
- channelization
- artificial impoundments

The goal is to reduce and/or eliminate the pollutants impacting the desired use of cold water fishery. This will be accomplished by implementing a series of best management practices to increase stream canopy, reconnect to floodplains, promote filter strips, route runoff through natural filter areas, and improve stream habitat. The South Branch of Rice Creek from 21 Mile Road to 26 Mile Road is portion of the creek most likely to respond to treatment.

Desired Use – Land Use Planning/Water Quality Use Impaired
Sediment, hydrologic flow, nutrients, and water temperature are all pollutants that impact water quality because of the lack of proper "land use planning for water quality". These pollutants are the result of the following sources:

- construction
- residential runoff
- loss of wetlands
- increasing development
- septic systems

The goal is to reduce and/or eliminate the pollutants impacting the desired use of water quality by implementing best management land use planning practices.

Protection and enhancement of the wetlands, forestlands, wildlife/aquatic life habitat and water quality within the Rice Creek watershed stream corridor will be accomplished by implementing a "corridor preservation plan". The plan will be developed in cooperation with the six townships in the watershed. A ¼ mile wide area along the Rice Creek floodplain will be designated as a high priority for all applicable desired and designated uses and those BMP's identified to protect and enhance those uses. Additionally, the Rice Creek Watershed Management Plan has a goal of working with twenty-four landowners within the Rice Creek corridor to help them develop professional forest management plans.

Desired Use – Warm Water Fishery Access Use Impaired

No additional pollutants or sources affect this desired use. The desired use is for additional public access to the warm water fishery to address the lack of public access where possible.

Desired Use - Healthy Functioning Wetlands Use Impaired

Land use changes and diverted hydrologic flow and sediment and nutrient loads all impact the ability for wetlands in the watershed to be healthy functioning wetlands. The following sources contribute to the impacts by these pollutants.

- Artificial drainage
- Increasing development
- Septic Systems
- Channelization
- Livestock in wetlands
- Restricted flows
- Loss of wetlands (land use changes)

The goal to reconnect Rice Creek to the natural wetlands/floodplains would reduce and/or eliminate many of the pollutants negatively impacting the water quality of Rice Creek. This desired use would be implemented by using best management practices approved by USDA-NRCS and MDEQ.

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Chapter VI –Pollutants, Sources, and Causes

The pollutants and sources identified by designated use in Chapter V have been further analyzed to identify specific causes. A denotation of (k) indicates a known pollution source or cause and a denotation of (s) indicates a suspected pollution source or cause.

Pollutants, Sources & Causes

Pollutants	Sources	Causes
Nutrients	Septic Systems (k)………………………	Improperly sited, designed, maintained (k)
	Livestock (k)……………………………	Unrestricted access to stream / riparian area(k)
	Wildlife (deer)(geese) (k)………………	Crossing and watering of excessive populations (k)
	Agricultural Run-off (k)…………………	Improper manure management practices (k) Lack of conservation tillage methods (k) Improper nutrient application & storage (k)
	Residential Run-off (k)…………………	Inadequate buffer areas between fields/yards & streams (k) Improper and/or unnecessary fertilizer application and storage (k)
Pesticides	Residential Run-off (s)…………………..	Improper pesticide application, storage, disposal (s)
	Agricultural Run-off (s)…………………	Lawns/fields to stream edge (k)
Sediment	Stream Banks (k)………………………...	Flow fluctuations (k) Lack of vegetative protection (k) Dredging, straightening and destabilization (k)
	Livestock (k)……………………………	Unrestricted access to stream / riparian area (k)
	Construction sites (k)……………………	Improper construction practices (k) Inadequate construction planning (k) Poor land use planning (k)
	Residential/Agricultural Runoff (k)…….	Lack of buffer strips (k) Lack of agricultural mgmt. practices (tillage, etc.) (k)
	Urban (stormwater) runoff (k)…………..	Impervious surfaces (k)
Temperature Issues		(+) = increase in temp. (-) = decrease
	Urban (stormwater) runoff (k)…………..	Impervious surfaces (+) (k)
	Lack of wetlands (k)…………………	Draining, filling, converting to other uses (-) (k)
	Dredging (k)……………………………	Groundwater infiltrating the creek (-) (s) Loss of canopy (+) (k)
	Natural features (k)………………………	Abundant lakes exposed to sun (+) (k)
	Artificial impoundments (k)……………..	Dams increasing surface area, decreasing flow (+) (k)
	Point-source discharge (k)………………	Treated wastewater discharge (+) (k)
Poor Hydrologic Flow	Artificial drainage (k)…………………...	Flood management (k)
	Loss of wetlands (k)……………………..	Wetland filling and/or drainage (k) Poor land use planning (k)
	Flashy flow conditions (k)……………….	Channelization / dredging (k)
	Impervious Surfaces (k)………………….	Increased development (k)
	Natural Obstructions (k)…………………	Inadequate storm water management (k)
	Restricted flows (k)………………………	Artificial impoundments (k)
	Treated wastewater discharge (k)………..	No access to wastewater treatment center (k)

Pollutants	Sources	Causes
E. coli bacteria	Live stock in stream (k)………………. Wildlife (deer)(geese) (k)…………….. Septic Systems (s)…………………….. Agricultural Run-off (s)……………….	Uncontrolled access (k) Crossing & watering of excessive populations (k) Improperly sited, designed, or maintained septics (k) Illicit discharge (s) Improper manure management practices (s)
Oils, grease, and metals	Road-stream crossings (s)…………….. Parking lots, roads - storm drains (s)…. Residential/Agricultural Lands (s)…….	Unrestricted road drainage (s) Inadequate stormwater ordinances (k) Improper car maintenance (s) Improper disposal (s)
Salt	Roads and Parking Lots (k)……………	Improper application (s) Excessive application (k)

Pollutants, Sources, and Causes were prioritized by the Rice Creek Advisory Committee based on impact to water quality, likelihood of being corrected, frequency of impact, and by being a known rather than a suspected pollutant. Most impacts by pollutants in the watershed negatively affecting water quality are related to sources and causes within the Rice Creek Corridor. The corridor is defined as the area within ¼ mile of the floodplain of Rice Creek or those lakes connected to Rice Creek. Those pollutants, sources and causes that represent the most significant impact to water quality are rated as a “high priority”. Those that represent an impact but not a significant impact are rated as “medium priority”. And those that are a minimum impact or only suspected but not known are rated as “low priority”.

The following charts show the priority ranking of the pollutants, sources, and causes:

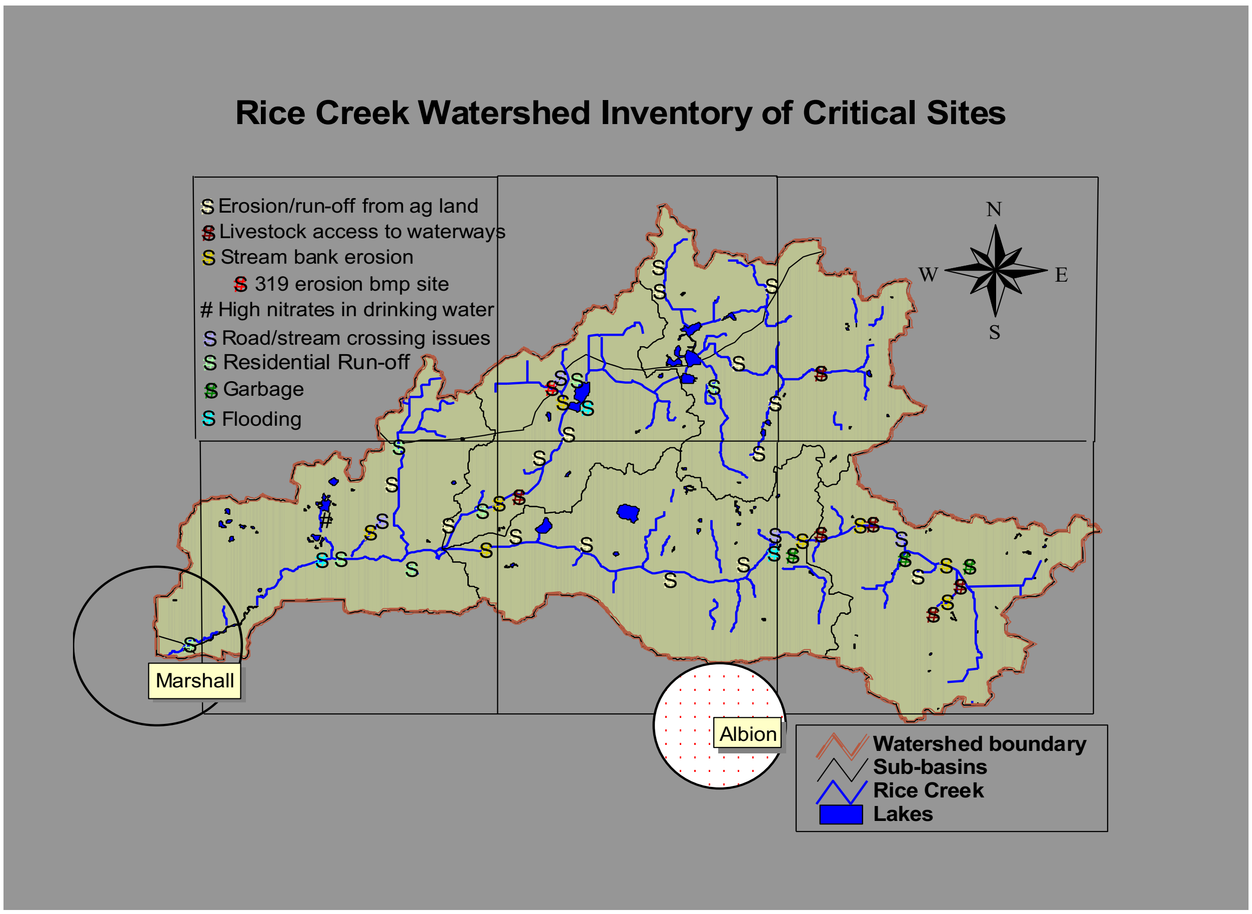
Prioritizing Pollutants / Impairments

Pollutants	Priority
Nutrients	H
Pesticides	L-M
Sediments	H
Temperature	H
Hydrologic Flow	H
E.coli bacteria	M
Oils, grease, metals	L-M
Salt	L-M

Chapter VII – Inventory of Critical Sites

The critical sites identified in this chapter came from site visits and also from a comprehensive road/stream crossing field survey that was completed by Albion College. A lack of accessibility to many parts of the watershed limits the inventory, but information gathered from landowner interviews, aerial photos and public files allowed for a relatively comprehensive inventory. Sites are all located in the ¼ mile corridor of Rice Creek and main tributaries stream corridor, which has been designated as the critical area for the watershed due to the likely impact to surface water. Lakes connected to Rice Creek are also included as part of the watersheds critical area.

Map F: Rice Creek Watershed Inventory of Critical Sites



Site Assessment

*The following site assessments are based on the MDEQ Pollutants Controlled Calculation and Documentation as well as the USDA-NRCS Revised Universal Soil Loss Equation (RUSLE). Specific landowners names were kept out of this plan to ensure confidentiality.

Critical Site Assessment Worksheet

The worksheets on the following pages were formatted to fit this document and they do not correspond to page numbers in the table of contents.

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Chapter VIII- Evaluation Process and Sustainability

Evaluation

Routine evaluation of this watershed project will allow stakeholders to judge the effectiveness of the planning process and to modify efforts as needed. This process will also formalize sustainable relations among watershed stakeholders, who can better assure that the plan and the planning process are carried on indefinately. This plan is in many ways a 'checklist' procedure and routine evaluation and modifications of its contents as well as the adoption of policies, ordinances and other institutional operational procedures designed to protect environmental quality will be the key to sustainability.

Interim Milestones:

Interim Milestones are measures of action and progress. They do not necessarily measure environmental improvement, but they do provide an indication that progress towards environmental improvement is being made. The following interim milestones will be tracked:

- Number and types of BMPs implemented
- Before and after photographs or videos will be compiled for all physical BMPs as well as GIS tracking that will monitor the types and location of various projects that occur in the watershed.
- Phosphorus and sediment pollutant reduction estimates for all physical BMPs
- Number and types of educational materials distributed and target audiences
- Number and types of educational events and number of recipients; event follow-up evaluations will be conducted to determine if behaviors were modified
- Adoption of policies, ordinances and other institutional operational procedures designed to protect environmental quality

Long Term Environmental Indicators:

The following environmental indicators will be used to develop a broad overview and evaluation of the overall water quality of Rice Creek. A technical committee will be formed of several key groups including MDNR, MDEQ, Albion College, landowners and others. This committee will meet annually and more often if needed to assess and synthesize data collected for the following environmental indicators.

1) Hydrology / Geomorphology

Rice Creek has long been altered through dredging and other hydrologic modifications. Returning the creek to its natural course and hydrology is not feasible in many stretches, so it is the goal of this project to evaluate to what extent the altered hydrology impacts stream form and function and also to locate stretches that are potentially restorable. Level III geomorphic data collection and design parameters will be established using the Rosgen IV methodology. This involves identifying the causes (or potential causes) of stream instability, identifying the morphological character of the natural form (reference reach), and then working to emulate a stable flow regime and biological condition of the stream.
By mid 2005 the Steering Team will have developed a technical advisory committee consisting of 1) the relevant drain authorities, 2) hydrologists from MDNR, MDEQ and Albion College, and 3) landowners who are impacted by the recommendations of this committee. The role of the committee will be to coordinate any efforts to correct and maintain the hydrology of Rice Creek for all designated uses.

Monitoring stations and protocols will be established early in the process to assure consistent and sound data collection.
Albion College's hydrology studies during the writing of this plan were directed to the hog farm effluent as well as the Springport discharge. Although stage data were collected at 6 locations, the rating curves did not serve as good indicators since they were taken during summer low flows (when the college does its research). New data have been collected but currently are still not available. MDEQ and Albion College, along with MDNR and the Calhoun Conservation District, will be collecting more stage data and MDEQ will create a flow model that relates rainfall to flow and stages. Although this is not the long term indicator, the model will serve as a foundation for future monitoring. Collectively, these groups will then be selecting several locations in the watershed where stream width, depth, and other geomorphic variables will be annually evaluated and serve as the long-term indicator data.

2) Temperature

Since Rice Creek is in part a cold water trout stream, temperature data will also be vital to assessing the health of the stream and its fishery. Temperatures have been and will be monitored and recorded throughout the creek, but the primary area of concern is the south branch and main stem where the trout fishery is predominately located. Temperature data will be collected at established locations within those sections of the creek that hold trout with mean thermometers that will record the range of temperature which is occurring houly, daily and seasonally specific to each site. Some of these sites are already established on the main branch, but others will be established in the south and north branches. These sites will also be established by mid 2005. MDNR, MDEQ and trained volunteers will be coordinated to establish site locations and assure that monitoring efforts are carried out indefinitely. These data will help project coordinators focus efforts to locations where water temperature is an issue, especially as it relates to the fishery and to storm water. The technical committee can then recommend site-specific measures to control temperatures with actions to improve stream canopy for shading, reduce the amount of impounded waters and recommend ordinances for storm water inputs.

3) Total Phosphorus

Currently, there is a Total Maximum Daily Load (TMDL) for phosphorus in the Kalamazoo River watershed, of which the Rice Creek watershed is a sub-basin. The purpose of the TMDL is to reduce point and non-point sources of phosphorus. Using total phosphorus as a long-term environmental indicator in the watershed was integral in this management plan.

The Albion wastewater treatment facility is responsible for conducting phosphorus monitoring of the treated waters in the facility, and they have agreed to aid in a routine assessment of ambient concentrations of phosphorus in the Rice Creek watershed. This is being undertaken as part of their participation in the Kalamazoo River/Lake Allegan phosphorus TMDL Cooperative Agreement. It is planned to establish routine phosphorus monitoring through the City's facility by early 2005.

4) Land Use

Evaluating land use within the watershed depicts the overall choices that landowners are making and provides vital information from which to make inferences about the environmental, ecological and even economic integrity of the watershed. Calhoun County Community Development (CCCD) can established good baseline land use data for its master plan and has evaluated implementation strategies to protect open space and critical natural resources. Population density, wetland acres, and prime farmland will all be referenced from this inventory and others such as the National Wetlands Inventory (NWI) for a baseline. CCCD plans to gather similar data routinely, and any other reliable sources of urban development, wetland acres, and prime farmland data will be incorporated into the land use database.

5) Biota

Through MSU-E/KBS, adult volunteers will be trained to do hands-on physical and biological stream monitoring at various locations within the watershed. These trained volunteers will be utilized to conduct biological monitoring at different locations within the watershed to monitor macro-invertebrates on a yearly basis. Data will be interpreted using a standard community index. In addition, information from Department of Environmental Quality biosurveys and Department of Natural Resources fisheries assessments will be used to evaluate the health of biota in the watershed. Along with the hydrology / geomorphology and temperature indicators, biological monitoring teams and sites will be established by 2005. Lead groups will need to be those who can continue oversight and training of new and existing volunteer groups.

Sustainability

The Rice Creek Watershed Project will continue to receive oversight by a Rice Creek Watershed Steering Committee. This advisory team is made up of key stakeholders and will be established as a self-sustained group that can carry the Rice Creek Watershed Project into the future. The team will be chaired by various volunteer community representatives who in turn are elected by the overall Steering Team. Subcommittees, which will be the technical support cells for the Steering Team, will ensure that decisions are well informed and up-to-date. These technical subcommittees will be made up of those in the watershed that in many cases already provide the relevant data and resources required. For example, by incorporating community development organizations into an "urban issues" committee the steering team will be linked directly to the source of such information. A long-term budget will also be established early in the implementation of this plan so efforts can be carried beyond the scope of EPA 319 implementation funding. Grant administration can occur through various organizations represented on the team, including the Calhoun Conservation District, Trout Unlimited, Pheasants Forever and CCCD.

Clean Water Act section 319 funding was awarded in July 2004 and secures at least one implementation coordinator until January of 2007. Although this better assures the implementation of at least part of this management plan, sustainability will be based on the coordination of partner agencies, organizations, volunteers and landowners who incorporate the long term goals of this plan into their efforts. To accomplish this, the "watershed partnership project" was formed for the Rice Creek and Battle Creek River watersheds by those groups and individuals that are involved in and committed to conservation in both watersheds.

Over thirty partners have signed on to the voluntary agreement to commit their own resources and expertise to the greatest extent possible. Already by the end of the planning project these groups have proven their commitment to coordinate efforts, avoid duplication, and maximize results. The watershed partnership project will be coordinated in such a way that otherwise independent groups begin to work together routinely and form a sustainable relationship with each other. Annual partnership meetings with representatives and continual interim communication will be used to coordinate and formalize sustainable relationships that will benefit the environmental quality of the Rice Creek watershed for years to come.

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Appendix A

The following chart can act as a guide for others who will address, reduce and/or eliminate the causes of the pollutants identified in this report through the implementation of the designated tasks or "best management practices" (BMP's).

Objectives by source	***Task/BMP***
Reduce septic nutrient impacts to water	*Promote septic system maintenance *Assist in coordinating several rural septic areas with a regional wastewater facility
Reduce or eliminate livestock access to stream; reducing nutrient and sediment impacts to stream	*Fencing for livestock exclusion *Alternate watering systems *Stabilized livestock stream crossings
Reduce or eliminate livestock manure impacts to water	*Promote manure management practices *Waste storage facilities *Roof water runoff management *Buffer strips
Reduce nutrient, pesticide, and sediment runoff from agricultural lands	*Irrigation scheduling *Grassed waterways *Buffer strips *Tile inlet filter areas *Nutrient/Pesticide management *Agri-chemical containment facility *Diversions *Riparian Buffer *Critical area plantings *Residue Management – no till, mulch till *Cover crops *Incorporate land use planning tools *Soil testing *In-field mix/load systems
Reduce nutrient, pesticide, and sediment runoff from residential lands	*Buffer strips (native plantings) *Nutrient/Pesticide management *Tree/shrub establishment *Incorporate land use planning tools
Reduce sediments from stream bank erosion by implementing stormwater management practices	*Storm water management ordinance with appropriate regulatory / enforcement components *Reconnect wetlands/floodplains *Stream bank stabilization
Reduce excessive storm water flows from new development	*Storm water management ordinance *Promote land use planning tools such as Low Impact Development

Objectives by source	***Task/BMP***
Reduce sediments from roads and lots	*Education and maintenance
Reduce offsite sedimentation from construction development sites by requiring onsite sediment control	*Strengthen County soil erosion control enforcement program *Hold soil erosion control workshops *Temporary sediment control basins *Require pre-construction planning *Require adequate erosion control practices on construction sites
Reduce storm water and sedimentation draining directly to stream	*Wetland/Floodplain restoration *Grade stabilization structure *Storm water conveyance channel *Stabilized outfalls *Diversions *Grassed waterways
Eliminate artificial drainage/filling of wetlands through implementation of new land use programs	*Wetlands ordinance *Promote Rice Creek Corridor Protection *Storm water management ordinance
Reduce loss of key natural resources by improving planning practices	*Conduct natural resources inventories *Conduct visioning sessions with township residents *Update master plans *Promote land use planning tools
Reduce over-development of land parcels and future storm water management impacts	*Promote storm water management ordinance to limit parcels to pre-developed runoff flows
Restore stream canopy on Rice Creek	*Riparian buffer
Improve stream channels by implementing restoration practices	*Dam removal *Stream Channel Improvement
Promote fishery/aquatic life habitat by implementing various bmp's and improving public access	*Fishery habitat improvement *Wetland development/restoration *Storm water management ordinance *T and L shaped docks at public access' *Soil Erosion Control enforcement *Reconnect to wetland/floodplain
Reduce soil erosion on pasture lands	*Pasture/hayland management
Promote wildlife habitat by protecting and enhancing wetlands, forest lands, and upland habitats	*Wetland development/restoration *Forest land management practices *Upland wildlife habitat/food plots
Reduce downstream flooding and need for dredging via restoration practices	*Fluvial Geomorphic design *Reconnect wetlands/floodplain
Reduce over-application of road salts at stream/road crossings	*Information & Education targeted at road commissions *Sediment basins at critical sites
Reduce/Eliminate treated wastewater discharges to creek.	*Connect Springport and Duck Lake treatment ponds to Albion wastewater treatment facility. *Assure proper steps to at a minimum meet compliance with MDEQ discharge permits.

Objectives by source	***Task/BMP***
Reduce phosphorus levels entering Rice Creek	*Buffer strips *Grassed waterways *Tile inlet filter areas *Nutrient Management *Diversions, *Soil testing *Created wetlands *Cover crops *Manure testing *Wastewater treatment facility
Promote General Watershed Education: Reduce potential of pollutants such as oil, grease, metals, and fuel from entering stream & groundwater via education, promotion of cost/share practices and making drop-off sites more accessible	*Newsletters *Maintenance Practices such as home'a'syst program activities, street sweeping, parking lot maintenance, etc. *Workshops/Conferences *Demonstration Projects *Promote household hazardous waste drop-off sites *Fuel containment facilities *Well decommissioning *Automatic shut-off gas dispensing unit
Increase fishing access for all residents	*Build L or T shaped fishing docks
Restore and protect natural hydrologic regime	*Drain maintenance practices that restore and preserve hydrology. *Stormwater management program that protects hydrology

Appendix B – BMP's/Systems/Lead Groups/Audience

The following chart lists the system of best management practices that may be needed to address a particular source and cause of pollution when applicable. Also included are the partners involved with the practice and the lead organization or group. Descriptions of individual bmp's are provided in Appendix C. Some of the recommended bmp's relate to suspected issues that may not have been identified by specific sites but rather inferred from statistical information for the watershed or region. The reason for including these is that they apply directly to designated or desired uses in the watershed and for reference when the need or opportunity to implement them arises.

Note: The target group audience for each BMP is listed in parenthesis in the Partners/audience column

Physical BMP	System of BMP's	Lead Groups	Partners/Audience
Fencing for Livestock exclusion	~Alternate watering systems ~Stabilized livestock stream crossings	CCD/NRCS	~Watershed Action Committee (Agricultural Producers)
Irrigation Scheduling	N/A	NRCS/CCD	(Agricultural Producers)
Waste storage Facilities	~Engineering ~Site Preparation ~Roofwater runoff management ~Manure management plan	NRCS/CCD	~MSUE (Agricultural Producers)
Install Buffer Strip Practice	~Diversions ~Riparian Buffer ~Critical area plantings ~Grassed waterway	NRCS/CCD	~Drain Commission ~Pheasants Forever (Agricultural Producers) (Stream and Lake shore landowners)
Grassed Waterways	~Diversions ~Tile inlet filter areas ~Buffer strips	NRCS/CCD	(Agricultural Producers)
Install tile inlet filter areas	~Diversion ~Grassed waterway ~Buffer strips	NRCS/CCD	(Agricultural Producers)
Agri-chemical containment facility	~Engineering ~Site Preparation ~Emergency management plan	~NRCS/CCD ~GSP	~MSUE ~Fire Dept. (Agricultural Producer)
Install Diversions where needed	~Grassed waterway ~Tile inlet filter areas ~Buffer strips	~NRCS/CCD	(Agricultural Producers)
Install Riparian Buffer Practice	~Buffer strips ~Critical area plantings ~Awareness programs	~NRCS/CCD	(Watershed Lake and stream shore landowners)
Install critical area plantings	~Buffer strips ~Riparian buffers	~NRCS/CCD	(Watershed landowners)

Promote Residue Management practices	~no-till ~mulch-till ~Ridge-till	~NRCS/CCD	MSUE (Agricultural Producers)
Install Cover Crops Practice	Crop rotation	~NRCS/CCD ~GSP	(Agricultural Producers)
Soil Testing Practice	Nutrient Management	~MSUE ~GSP	(Agricultural Producers) (Watershed Residents)
Tree/shrub establishment	~Critical area planting ~Riparian buffers ~Soil erosion control ~Stream canopy restoration ~Wildlife habitat	~CCD/NRCS	~Pheasants Forever ~Trout Unlimited (Watershed Landowners)
Well Decommissioning	~Site evaluation	~GSP	(Landowners)
Stream Channel Improvement	~Fishery habitat ~Aquatic life habitat ~Stream bank restoration	~MDNR/MDEQ ~Drain Commission	~CCD ~Trout Unlimited ~Volunteers
Stream bank Stabilization	~In-stream fisheries habitat ~Drainage district management ~Stream bank soil erosion control	~CCD ~Drain Commission	~Trout Unlimited ~Private Landowners (Riparian stream bank owners)
Storm water management	~Grassed waterway ~Buffer strips ~Diversions ~Rain gardens (on site management)	~CCD/NRCS ~Drain Commission	~Calhoun County Community Development ~Townships (Landowners)
Dam Removal	~Engineering Plans	~City of Marshall	~MDEQ/MDNR
Grade stabilization Structure	~Grassed waterway ~Diversions ~Buffer strips ~Stabilized outlet	~NRCS/CCD	(Agricultural Producers)
Stabilized outfalls	~Grade stabilization structures ~Grassed waterway	~NRCS/CCD ~County Road Commission	(Agricultural Producers) (Private landowners)
Fishery Habitat Improvement	~Stream channel improvements ~Aquatic life habitat	~Tout Unlimited ~MDNR	~CCD ~Volunteers (Areas identified in assessments)

I & E	Output	Lead Groups	Partners/Audience
Teach septic system maintenance	Home*A*Syst Program	~Americorp ~Health Department	~Volunteers ~CCD (Lake & stream shore landowners)
Assist landowners with manure management practices	~Manure testing ~Soil testing ~Spreader Calibration	CCD/NRCS MSUE	~Watershed Action Committee (Agricultural Producers)
Nutrient/Pesticide Management	~Conservation Planning ~Practices specified in plan	~NRCS/CCD ~MSUE ~GSP	~Americorp (Agricultural Producers) (Watershed Residents)
Establish Education related to the maintenance of impervious surfaces, to reduce sediment and other pollutant transport to stream	~Awareness education for residential and business residents ~Newsletter articles ~Drains to stream stencil program	~CCD ~Volunteer groups	~Volunteer groups ~(Area businesses) ~(City of Marshall)
Hold Soil Erosion Control Workshops	~Demonstration sites	~CCD ~CCCD	~NRCS ~Potawatomi RC&D (Excavators) (Contractors)
Help Establish Land Use Planning Tools	~Purchase of development rights ~Land Use planning workshops ~Articles	~CCCD ~Townships	~CCD ~Potawatomi RC&D (County Landowners)
Forest Lands Management	~Reforestation ~Timber stand improvement ~Wildlife habitat ~Timber harvests	~CCD ~Private Consultant	(Watershed Landowners)
Pasture/hayland management	~Stabilize highly erodible lands	~NRCS	~CCD (Agricultural Producers)
Project WET	~Classroom water quality education	~CCD	(Watershed Schools) (Volunteers)
Historical Documentation Program	~ Data sources ~Residents ~Historical files	~Volunteers ~CCD	(Watershed Residents)
Groundwater Stewardship Program Assessments	~Residential/Farm Assessments ~Cost share BMP's	~GSP	~CCD (Residential Landowners) (Ag Producers)
Stream Ecology Program	~Data collecting equipment ~Data gathering ~Data Reporting	~Marshall High School ~CCD	(Mar Lee Schools) (Volunteer Group) (Springport Schools)

I & E	Output	Lead Groups	Partners/Audience
Newsletters, water sampling, landowner assessments, waste collection events, adopt*a*stream, presentations to townships, t-shirts, hats, "action committee", watershed tour, before & after slides	~Communication & feedback ~watershed clean-up and protection ~ongoing education ~watershed awareness ~project implementation ~BMP implementation	~CCD ~Volunteers ~Schools	~NRCS ~CCCD ~Townships (Watershed residents)
Update Township master plans	~Natural Resource Inventory ~Township visioning sessions ~Consultant assistance	~Townships ~CCCD	(Watershed Townships)

Contractual BMP	System of BMP's	Lead Groups	Partners/Audience
Reconnect wetlands and Floodplains	~Stormwater management ~Fisheries Habitat ~Aquatic life habitat ~Stream bank erosion control	~CCD ~MDNR Fisheries Division ~MDEQ ~USFWS	~Watershed residents (Floodplain/Rice Creek Riparian Landowners)
Fluvial Geomorphic design	~Hydrologic evaluation ~Source stabilization system ~Reconnection to wetlands/floodplain	~MDNR ~CCD	~Volunteers ~Trout Unlimited ~Riparian Landowners (Critical areas identified)
Wetland creation And restoration	~Stormwater management ~Wildlife/aquatic life habitat ~Groundwater recharge	~NRCS ~CCD ~MDNR ~USFWS	(Watershed Residents)
Forest Management Plans	~Wildlife Mgmt. ~Erosion Control	~CRM	(Watershed Landowners)

Land Use BMP	System of BMP's	Lead Groups	Partners/Audience
Stormwater management program	~Flood management ~Stream restoration ~Streambank erosion control ~Land-use planning	~Calhoun County Community Development(CCCD) ~Drain Commission ~Watershed Townships	(County Townships) (Township residents)
Program to help Enforce County Soil Erosion Control Program	~Require approved plan prior to permit ~Require bond for soil erosion control measures ~Pursue violations	~Calhoun County Community Development (CCCD)	~CCD ~MDEQ ~Drain Commission (New earth changes within 500' lakes and streams or acre or larger in size)
Wetlands Ordinance <management of wetland resource>	~Stormwater management ~Groundwater recharge ~Wildlife habitat	~Townships ~CCCD	~CCD/NRCS (County Landowners)
Natural Resource Inventory	~Township visioning sessions ~Master plan revisions	~CCCD ~Townships	~Potawatomi RC&D ~NRCS/CCD (Watershed Townships)
Natural Resource Inventory Implementation Workshops	~Community visioning sessions ~Master plan revisions	~CCCD ~Townships	~CCD ~NRCS (Townships)
Low Impact Development program	~Implementation of new development ideas	~CCCD ~Townships ~CCD	~MDEQ ~Key Developers (Developers)

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Appendix C - Description of Best Management Practices / Definitions

Agrichemical Containment Facility
To contain/store pesticides or fertilizer in an enclosed area to prevent groundwater contamination from a potential spill.

Automatic Shut-off Gas Dispensing Unit
A gas dispensing handle that automatically shuts off when fuel enters the nozzle.

Conservation Cover
The temporary use of grasses, legumes, or small grain to control erosion, improve soil structure and infiltration. May also be used in nutrient management to provide a nitrogen source for future crops or to utilize excess nutrients from previous crops.

Conservation Cropping Sequence
Provides extended periods of live vegetative cover by growing row crops and/or small grains in combination with hay. This improves soil structure and reduces soil erosion and runoff potential

Critical Area Planting
Planting of trees, grasses or legumes on highly erodible areas to stabilize soil and reduce erosion and sedimentation in and along waterways.

Diversion
A channel with a supporting ridge on the lower side constructed across the slope to divert water from areas where it is in excess to sites where it can be used or disposed of safely. This reduces effects of erosion, pathogens, nutrients and pesticides on water quality. This can influence volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation and groundwater recharge.

Fencing for Livestock Exclusion
Restricts access to surface water, resulting in streambank protection; reduction of organic matter, fecal coliform and nutrient loadings; and prevents shallowing and widening of streams to keep water cooler.

Filter or Buffer Strip
Areas of vegetation, usually perennial grasses or legumes, adjoining a stream, ditch, lake, wetland or flood plain. These aid in removal of sediment, organic matter and other pollutants from entering the water supply.

Fish Stream Improvement
Improving a stream channel to create or enhance fish habitat. This is done by improving food, cover and or spawning conditions, as well as reducing erosion and sedimentation.

Floodplain Restoration
The process of conducting the proper survey analysis and hydrologic evaluation of a stream system and then based on the survey analysis reconnecting the stream system to the corridor floodplain and wetlands.

Fluvial Geomorphic Assessment
The study of the form and structure of the surface of the earth as affected by the flow of water.

Forestry/Wildlife Habitat Enhancement
The planning and implementation of practices specifically designed for the purpose of improving forest management and/or wildlife habitat.

Fuel Containment
Above ground storage or containment of fuel in an enclosed area to prevent groundwater contamination from a potential spill.

Grade Stabilization Structure
This is used to control the grade and cutting in natural or artificial channels. This aids in prevention of gullies, enhances environmental quality and reduces pollution hazards.

Grassed Waterway
To shape, grade and establish vegetation on a natural watercourse to reduce erosion and sedimentation.

In-field Mix/Load System
Usually running gear with a water tank, pump, motor, and transfer hose used for transporting water to the field, so that the mixing and loading of pesticides and fertilizers can occur away from the wellhead. Reducing the risk of groundwater and/or surface water contamination.

Irrigation Water Management
Determines and controls rate, amount and timing of irrigation water in a planned and efficient manner. This minimizes soil erosion, loss of plant nutrients and salt accumulation. Irrigation water management also controls undesirable water loss and protects water quality.

Lawn Maintenance
The proper nutrient and pesticide management practices and lawn clipping disposal pactices to reduce and/or eliminate pollutants from entering surface waters.

Livestock Stream Crossing
A structure enabling livestock to cross from one side of the stream to another minimizing streambank erosion.

Nutrient Management
Used to maximize nutrient potential in soil to reduce threat to groundwater and surface water quality. Practices may include nitrate soil sampling (to measure nitrogen levels); soil testing for N, P, and K; use of cover crops; reduced starter fertilizer, etc.

Pasture and Hayland planting
Provides long-term establishment of perennial and biennial forage plants, improving soil structure and infiltration capacity as well as reducing soil erosion and surface water runoff.

Pest/Pesticide Management
A tool using alternative measures aimed at reducing pesticide use. Practices may include: sprayer calibration, field scouting for insects or disease, crop rotation, conservation tillage, etc. Implementation of pesticide management practices to promote the proper use and storage of pesticides. This protects both groundwater and surface water from excess pesticides.

Residue Management (Mulch-till)
Growing crops where field is tilled prior to planting, leaving some residue. This practice will help reduce sheet, rill and wind erosion, improve surface water quality by reducing pesticide/sediment movement, conserve soil moisture and provide food and escape cover for wildlife.

Residue Management (no-till)

Growing crops in previously untilled soil and residue to: reduce sheet, rill and wind erosion; improve surface water quality by reducing pesticide/sediment movement; conserve soil moisture; and provide food and escape cover for wildlife.

Riparian Buffer Strip
A created stabilized area for collecting, controlling and disposing of runoff water from roofs and excessive overland flows. The goal is to prevent runoff water from flowing across concentrated waste areas and barnyards or reduce erosion and improve water quality.

Sediment Basin
A barrier is constructed to form a basin designed to capture sediments. This structure can reduce costs to watershed residents by preserving the capacity of streams, ditches, etc., resulting in less cleaning and maintenance. This can also reduce pollution and improve stream habitat by providing a place for deposition of sand, silt and other waterborne materials.

Soil Testing
Analysis of soils to determine the amount of nutrient content present, to determine the balance of nutrients needed for a specific purpose.

Stabilized Outlets
Geo-textile fabric and rock used to dissipate energy at the outlet of a created concentrated flow.

Storm Water Conveyance Channel
A stabilized channel created for the purpose of transporting storm water run-off. Usually down an otherwise erosive slope.

Storm Water Management Ordinance
Established rules for managing the difference between the pre-development and the post-development storm water run-off created on a parcel of land.

Stream bank Protection
To stabilize and protect banks of waterways, by reducing erosion and sedimentation caused by livestock access, surface water runoff, pedestrian, wildlife and vehicle traffic.

Stream Channel Improvement
Stabilization and enhancement practices that occur in the stream channel, guided by proper hydrologic and stream survey analysis.

Tile Surface Inlet Filter Areas
Areas of vegetation, usually perennial grasses or legumes, around a surface inlet to aid in the removal of sediment, organic matter and other pollutants.

Tree/Shrub Establishment
Planting trees and shrubs provides erosion control, reduces air pollution (by taking in soil and waterborne chemicals and nutrients), conserves energy, protects groundwater and surface water quality, provides wildlife habitat, reduces noise pollution and enhances the beauty of the watershed.

Trough or Tank
Provides alternative water source to livestock (besides surface water) and serves as a portable watering system designed to move from one pasture to another. This reduces impact to surface water quality from livestock access.

Updated Township Master Plans
The process of evaluating the build-out analysis of the current zoning master plan, determining needed changes to fit the current and future desires of the Township, and rewriting the master plan to meet the new changes.

Use Exclusion
Excluding animals, people or vehicles from an area in order to protect, maintain or improve water quality in that area.

Waste Storage Facility
A waste impoundment made by constructing an embankment and/or excavating a pit or structure. The purpose of this is to temporarily store wastes such as manure, wastewater and contaminated runoff to protect water quality.

Well
To provide an alternative water source for livestock, irrigation, wildlife or recreation if no other source is available (ie., pond). This reduces heavy use impact on surface water supply and keeps livestock out of waterways.

Well Decommissioning
Consists of plugging and permanent closure of a well no longer in use. This prevents the entry of contaminated surface water and debris. It also eliminated the physical hazard of an open hole to people, animals and farm machinery.

Wetland Development or Restoration
To restore, create or enlarge wetlands to filter runoff from surrounding areas, reduce flood potential, improve wildlife habitat and recharge groundwater.

Appendix D - Acronyms

BMP Best Management Practice

CCD Calhoun Conservation District

CCCD Calhoun County Community Development

CFS Cubic Feet/Second

CRM Conservation Resource Management

GLEAS # 51 Great Lakes Environmental Assessment Section
Survey Protocols for Wadable Rivers

GSP Groundwater Stewardship Program

MDEQ Michigan Department of Environmental Quality

MDNR Michigan Department of Natural Resources

MSU-E Michigan State University-Extension

NPS Non-point Source Pollution

NRCS Natural Resources Conservation Service

Potawatomi RC&D / Potowatomi Resource Conservation and Development

RC&D Resource Conservation & Development

RMS Resource Management System

USDA United States Department of Agriculture

USLE Universal Soil Loss Equation

WHPP Wellhead Protection Plan

WQRMP Water Quality Resource Management Plan

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Appendix E – Questionnaire Results

The following questionnaire was mailed to every resident in the Rice Creek Watershed. A return rate of over 15% was achieved with no reminders sent. Below is the questionnaire that was sent and the collective response from the watershed residents in the form of pie charts. The purpose of the questionnaire was to collect information about the resident's awareness and concerns about water quality problems in the watershed. Willingness to participate in the project was also determined. Forty percent of those responding expressed an interest in volunteering their time and/or resources.

Rice Creek Watershed Questionnaire

1. Are you familiar with the land area that drains into the Rice Creek?
   _________yes _________no

2. What are your current activities with regard to the Rice Creek Watershed? Please check all that apply.
   a. _____Fishing
   b. _____Irrigating crop fields/pastures
   c. _____Swimming
   d. _____Drainage
   e. _____Watering lawn/garden
   f. _____Canoeing
   g. _____Drinking water for livestock, pets
   h. _____Household water supply
   i. _____Viewing wildlife/nature
   j. _____Hunting
   k. _____Irrigating commercial vegetable crops
   l. _____Other (please specify)____

3. Does your lawn or field extend to the edge of the creek or drain?
   a)___yes
   b)___no

4. How often do you have your soil tested to determine lime and/or fertilizer needs?
   a)___regularly, on some type of schedule
   b)___occasionally, or only when needed
   c)___never

5. Is your yard or field drained by a subsurface tile system?
   a)___yes
   b)___no
   c)___don't know

6. Does your property have a strip of grass, bushes, or trees along the stream or drain?
   a)___yes If yes, how wide? ________feet
   b)___no
   c)___no stream or drain on my property

7. Compared to 10 years ago, how much **better** or **worse** is the Rice Creek Watershed in the following categories? Circle the number that best applies to each.

	Much Worse	Worse	Same	Better	Much Better
a. fishing	1	2	3	4	5
b. hunting	1	2	3	4	5
c. swimming	1	2	3	4	5
d. canoeing	1	2	3	4	5
e. drainage	1	2	3	4	5
f. observing wildlife	1	2	3	4	5
g. water clarity	1	2	3	4	5
h. pollution	1	2	3	4	5
i. stream bank erosion	1	2	3	4	5
j. flooding	1	2	3	4	5
k. littering	1	2	3	4	5
l. household water supply	1	2	3	4	5

8. Rank the following sources, according to their degree of importance. Where do you think that most of the problems originate in the watershed.

a. ___faulty septic systems (H=high, M=medium, L=low)
b. ___household chemicals
c. ___storm water runoff
d. ___soil erosion from farmlands
e. ___livestock access to streams
f. ___construction site erosion
g. ___fertilizer, pesticides, and other chemicals from lawns and gardens
h. ___fertilizer, pesticides, and other chemicals from agriculture
i. ___nitrates in drinking water
j. ___old dump sites
k. ___soil erosion from road crossings
l. ___urban sprawl
m. ___other (please specify)_____________________________________

9. Rate your level of concern for the water quality of the Rice Creek Watershed and its major tributaries. Please circle one choice.

Very concerned   Slightly concerned   Not at all concerned

10. Please indicate your priorities on each of the following issues:

	High Priority	Moderate Priority	Low Priority	Not a Priority
a. planning development	1	2	3	4

b. environmental education	1	2	3	4
c. farmland preservation	1	2	3	4
d. hunting & fishing	1	2	3	4
e. parks & outdoor recreation	1	2	3	4
f. preserving woodlands	1	2	3	4
g. water quality	1	2	3	4
h. preserving wetlands	1	2	3	4
i. drainage	1	2	3	4
j. wildlife preservation	1	2	3	4
k. promoting development	1	2	3	4
l. watershed protection	1	2	3	4
m. flooding concerns	1	2	3	4
n. septic systems concerns	1	2	3	4
o. other (________________)	1	2	3	4

11. Who do you think is responsible for protecting the Rice Creek Watershed?
a. _____citizens
b. _____local government (twp., village, etc.)
c. _____state government
d. _____federal government
f. _____other (please specify)

11. If cost were not a factor, of the following management practices, which ones would you like to learn more about for your property?
    a. _____ conservation tillage, crop residue management
    b. _____ grassed waterway
    c. _____ managing riparian area (streamside filter strips etc.)
    d. _____ animal waste management
    e. _____ pasture management (excluding livestock from streams)
    f. _____ wildlife habitat management/wetland restoration
    g. _____ integrated crop management (crop scouting, pesticide & fertilizer mgmt.)
    h. _____ structures for erosion or water control
    i. _____ septic system maintenance
    j. _____ composting
    k. _____ lawn care
    l. _____ other (please specify) _______________________________

12. Please circle below the response that best reflects your opinion of the overall water quality of Rice Creek.

    1 = excellent 2 = good 3 = fair 4 = poor

13. Is there a specific problem affecting the watershed that is of the greatest concern to you? Please circle

    No Yes If yes, what is it? _______________________

14. If given the opportunity, would you volunteer your services to help this project?

    Yes No

15. Where do you typically look to find reliable information about water quality and resource protection practices?

    a. Local Newspapers
    b. TV/Radio
    c. University or Extension services
    d. Magazines
    e. Local Organizations
    f. Workshops/Seminars
    g. FSA/NRCS/Conservation District

Questions 16 – 20 seek information that will help us better interpret your responses to the survey. All of your answers will be kept confidential.

16. Where do you live?

_____ On a farm
_____ Rural, non-farm
_____ Within village or city limits

If on a farm, please circle the type of farm operations.

a. cultivated row crops
b. pastured livestock
c. confined livestock/poultry
d. horses
e. sheep
f. other _____________

17. How many acres do you own? ___________acres

18. How many people live in your household?

a. _____ 1 – 2
b. _____ 3 – 4
c. _____ 5 or more

19. What is your age?

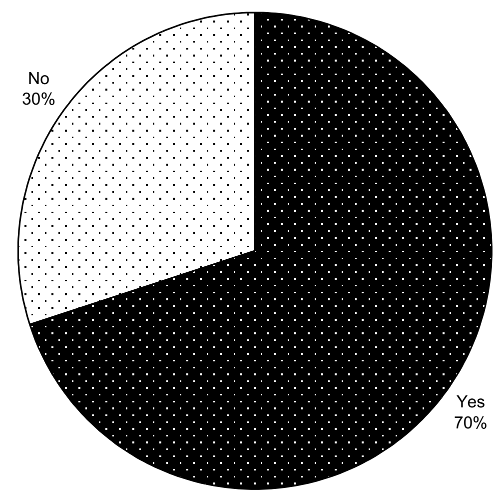
a. _____ under 25
b. _____ 26 – 35
c. _____ 36 – 45
d. _____ 46 – 55
e. _____ over 55

20. What is your occupation?

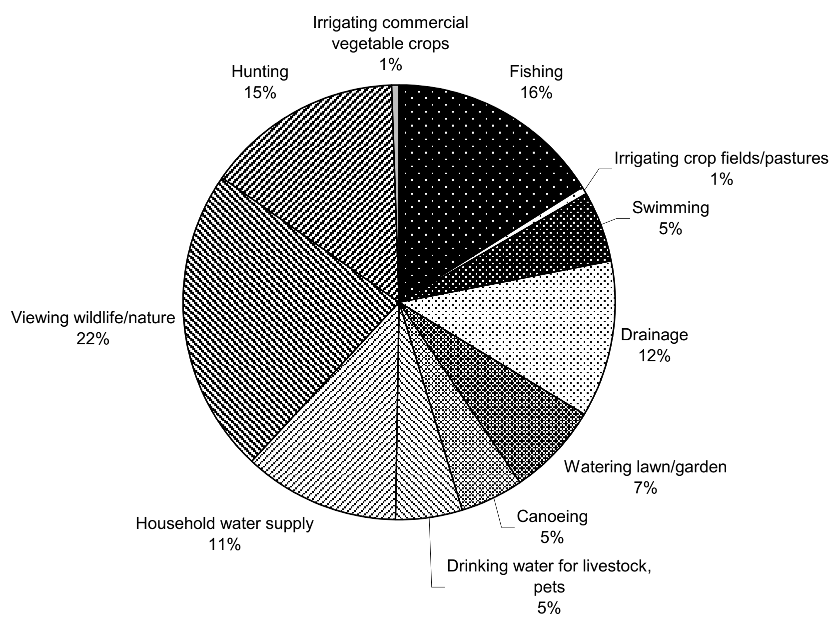
Please include any comments or concerns you have concerning the Rice Creek Watershed

Note: Below are pie charts revealing the results of the questionnaire conducted with the residents of the Rice Creek Watershed at the beginning of the project in 2001. For copies of the results of the post planning project questionnaire being conducted at the time of the finalization of this plan contact the Calhoun Conservation District.

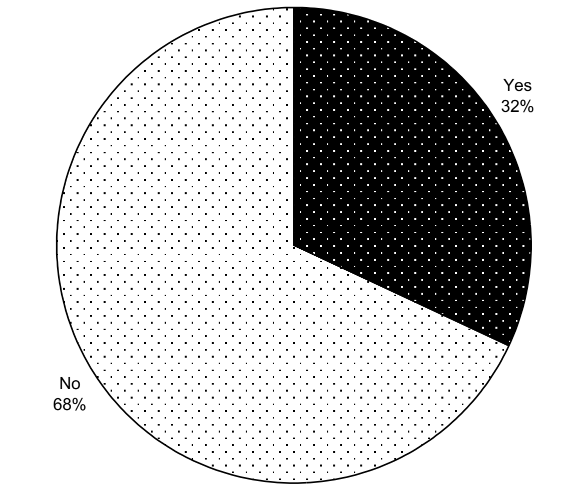
Are you familiar with the land area that drains into the Rice Creek?



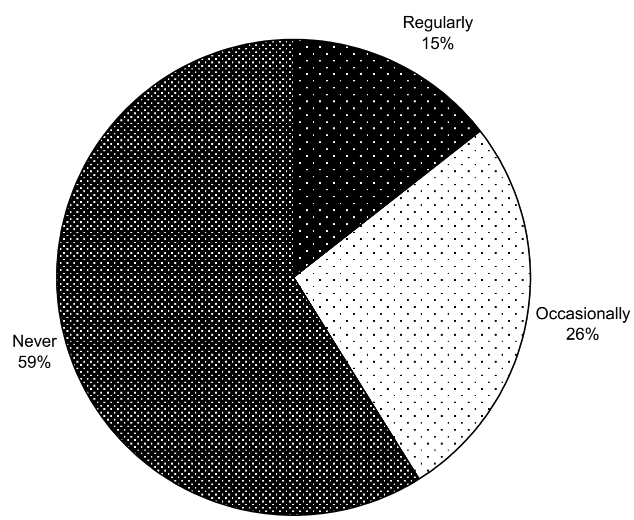
What are your current activities with regard to the Rice Creek Watershed?



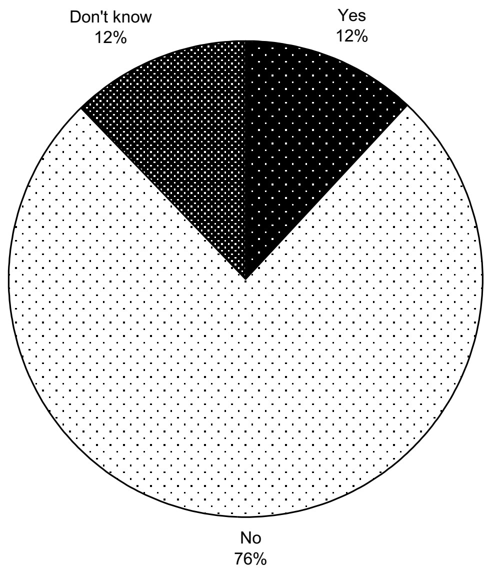
Does your lawn or field extend to the edge of the creek or drain?



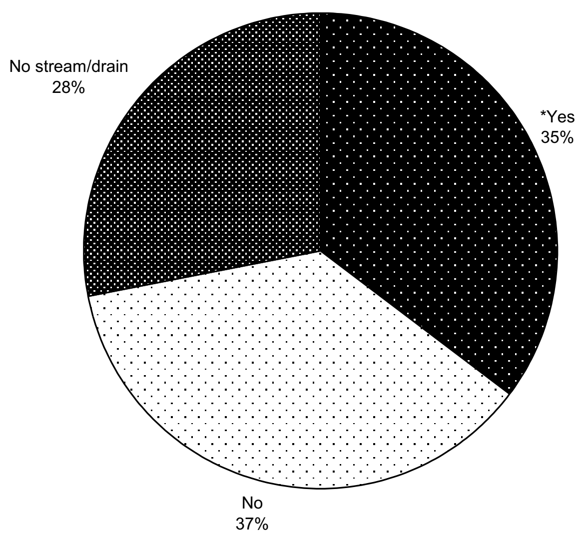
How often do you have your soil tested to determine lime and/or fertilizer needs?



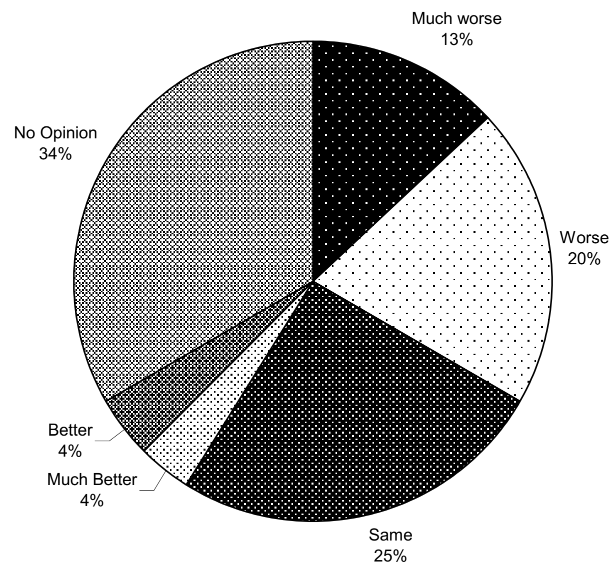
Is your yard or field drained by a subsurface tile system?



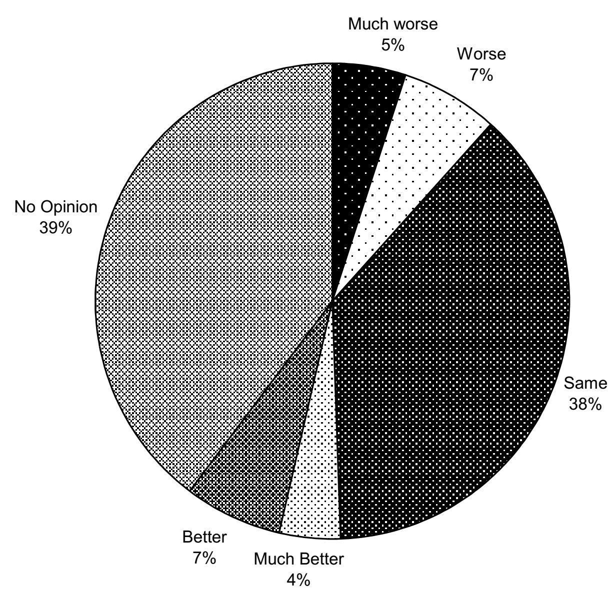
Does your property have a strip of grass, bushes, or trees along the stream or drain?



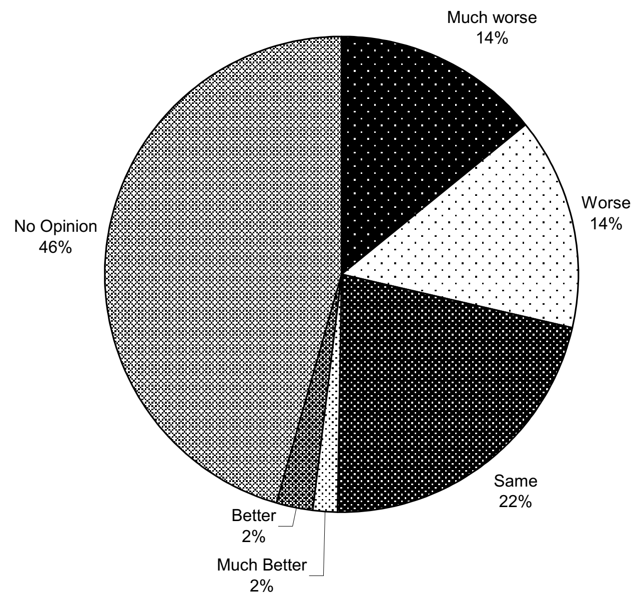
Fishing



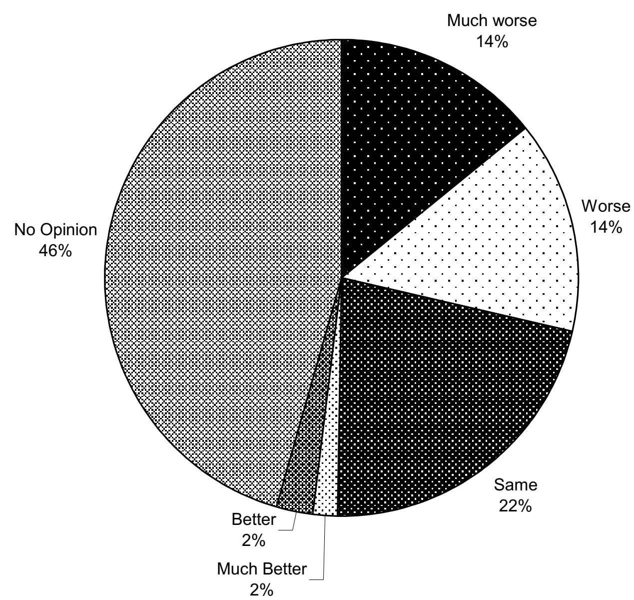
Hunting



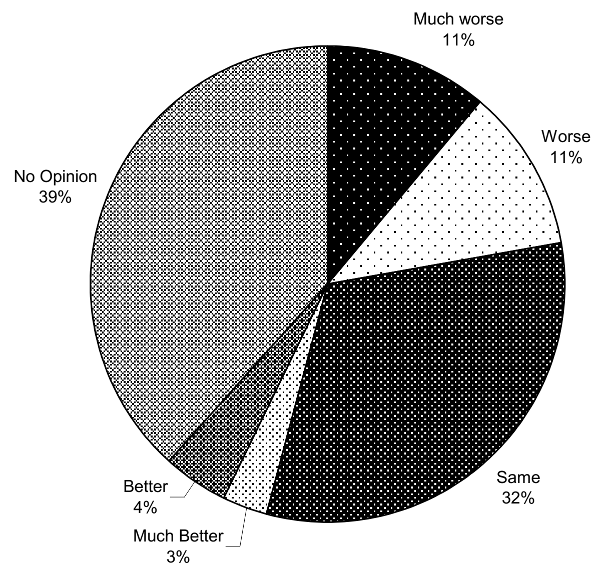
Swimming



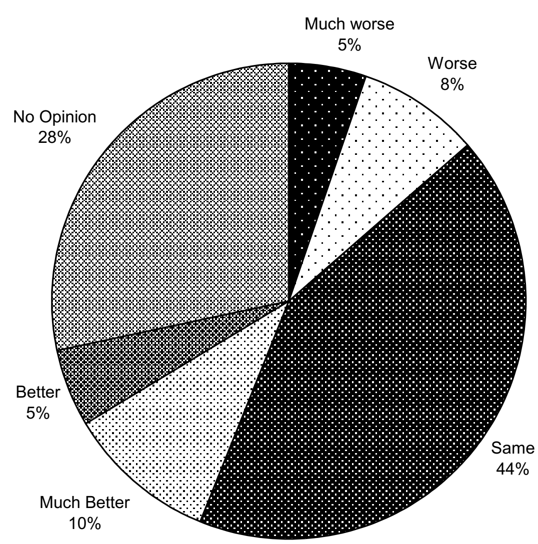
Canoeing



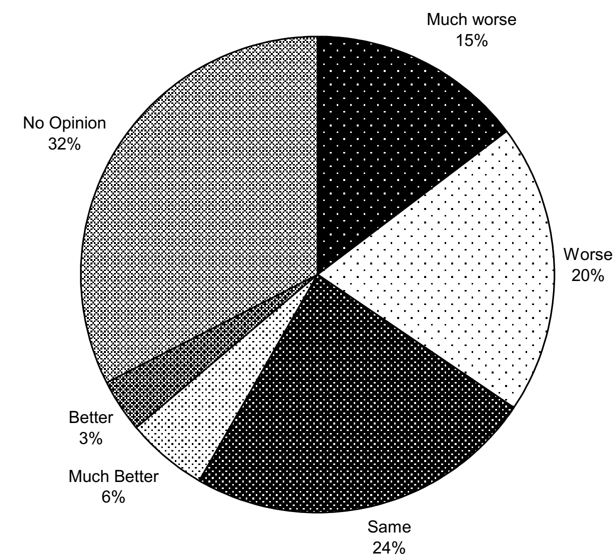
Drainage



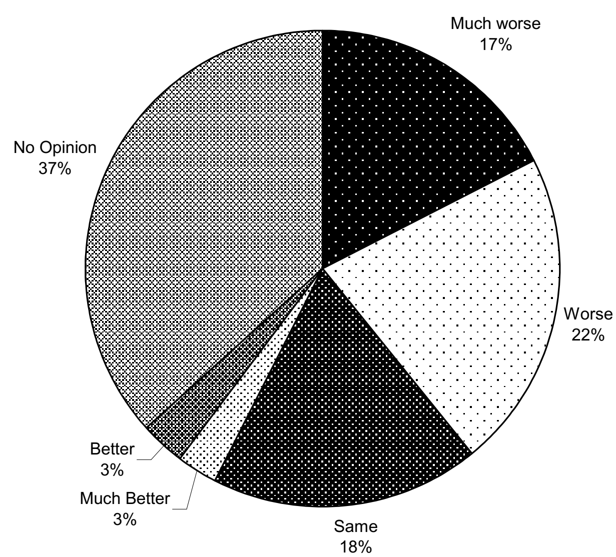
Observing Wildlife



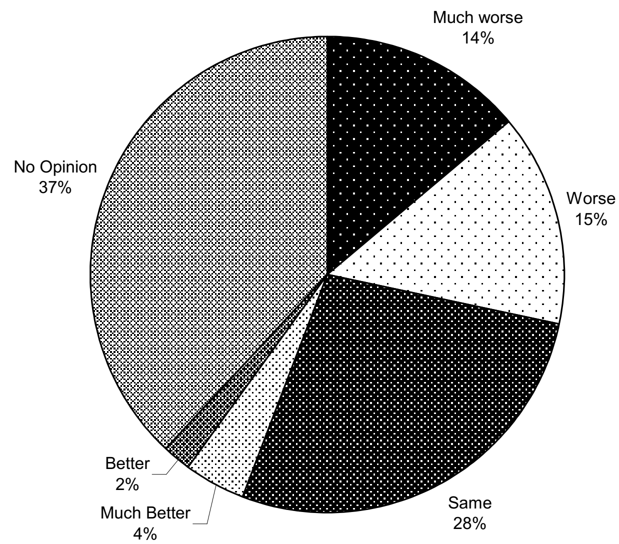
Water Clarity



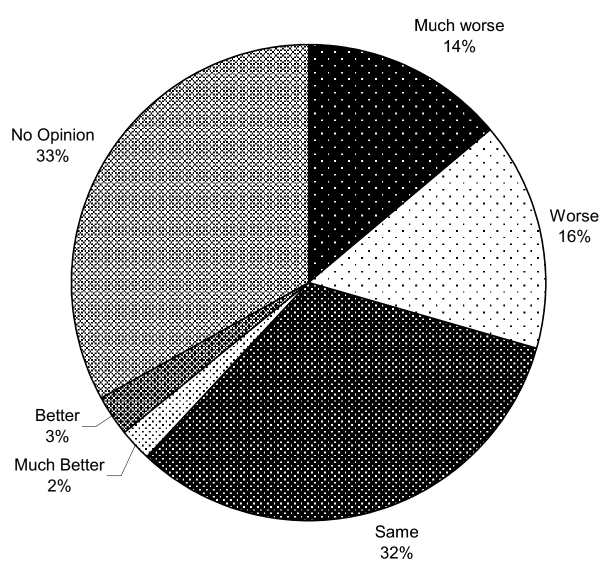
Pollution



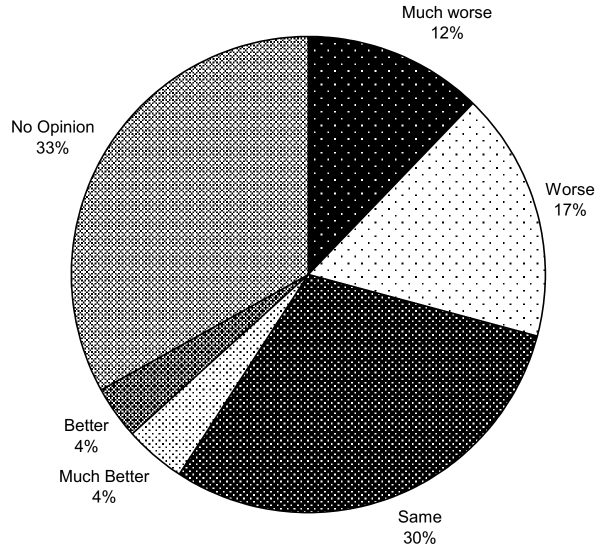
Stream Bank Erosion



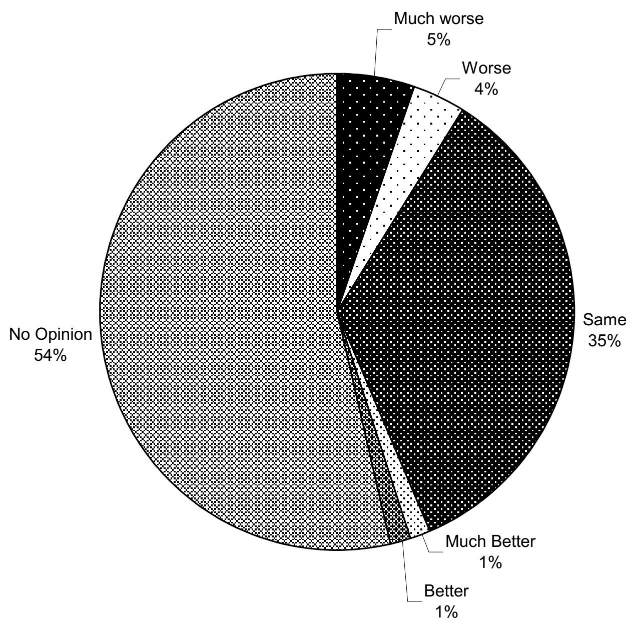
Flooding



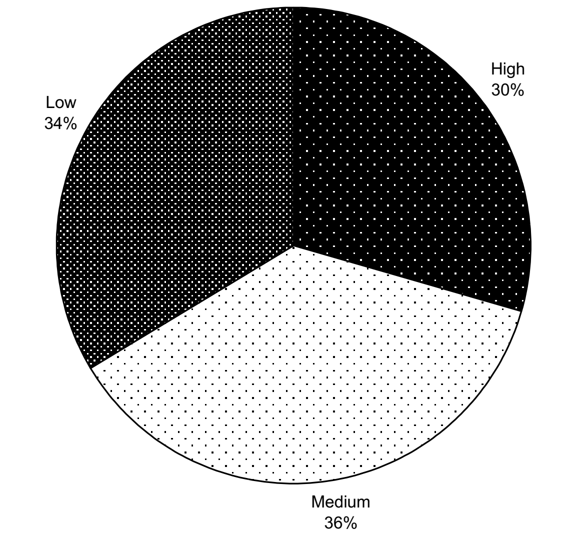
Littering



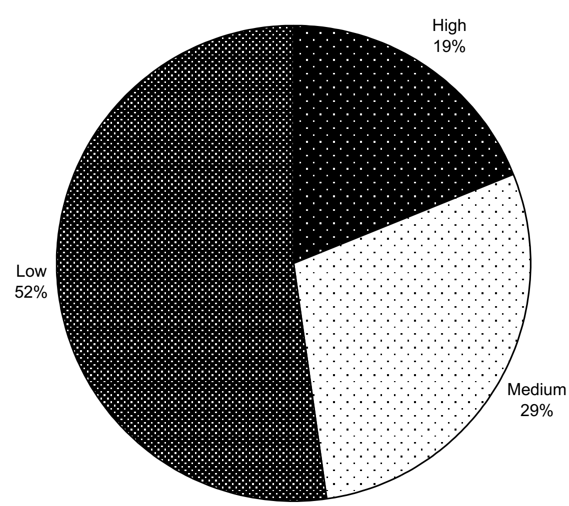
Household Water Supply



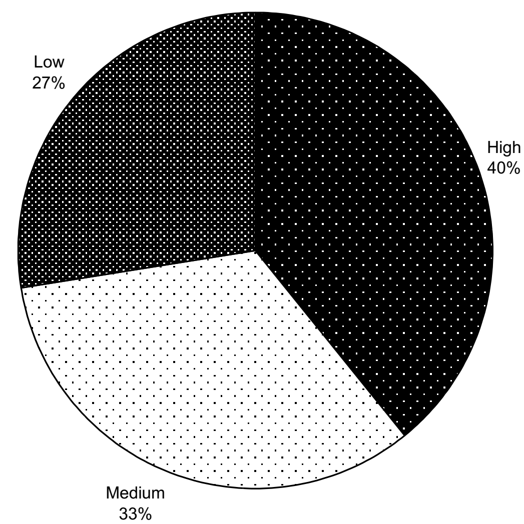
Faulty Septic Systems



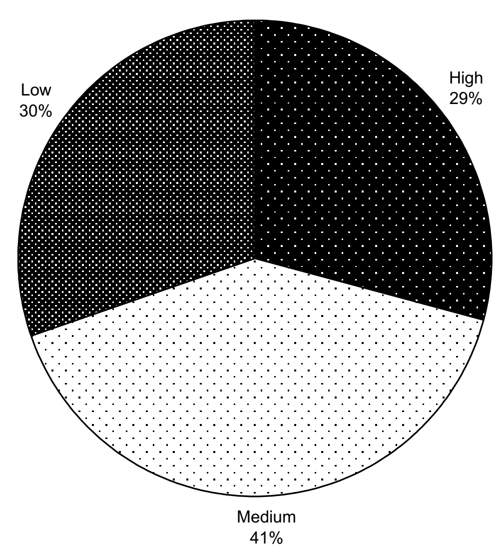
Household Chemicals



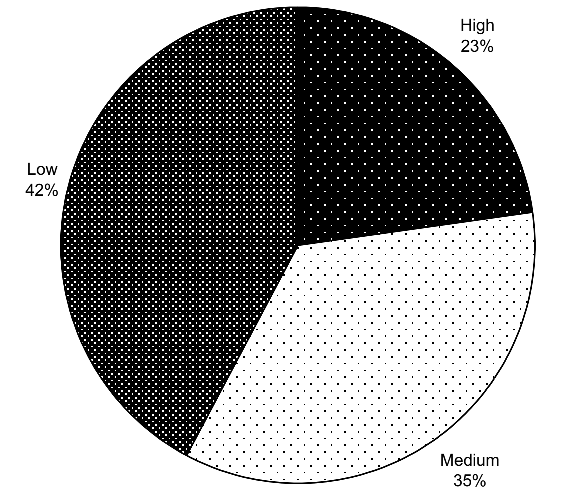
Storm Water Erosion



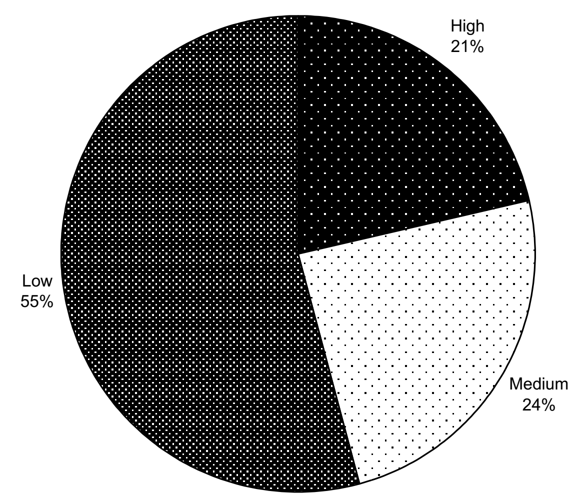
Soil Erosion From Farmlands



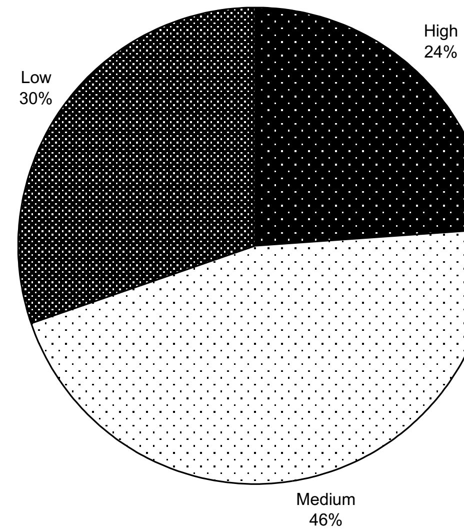
Livestock Access to Streams



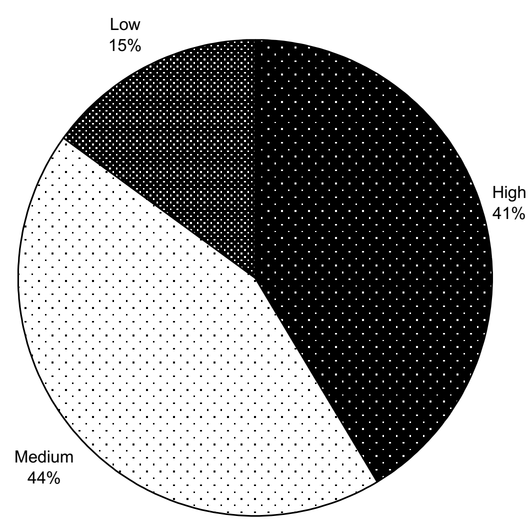
Construction Site Erosion



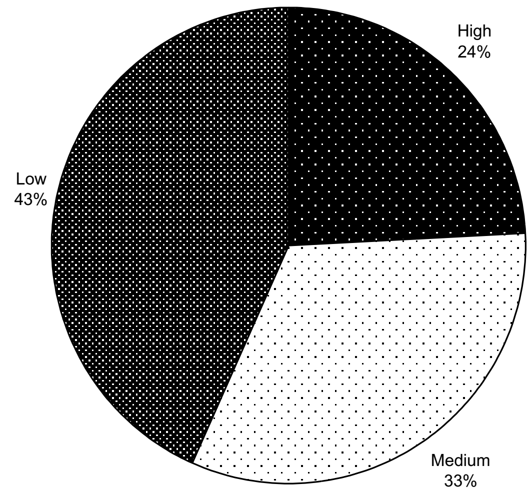
Fertilizers, Pesticides, Other Chemicals from Lawns & Gardens



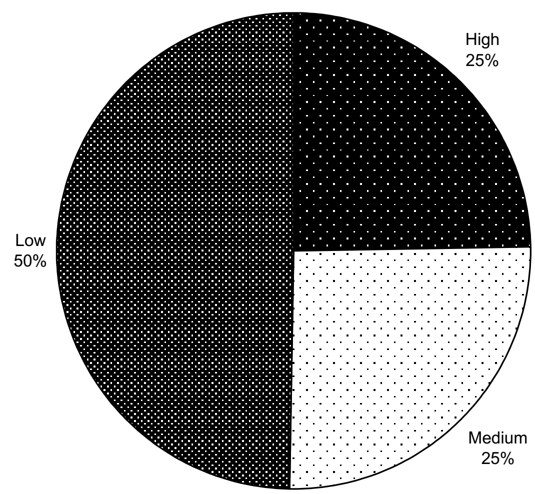
Fertilizers, Pesticides, Other Chemicals from Agriculture



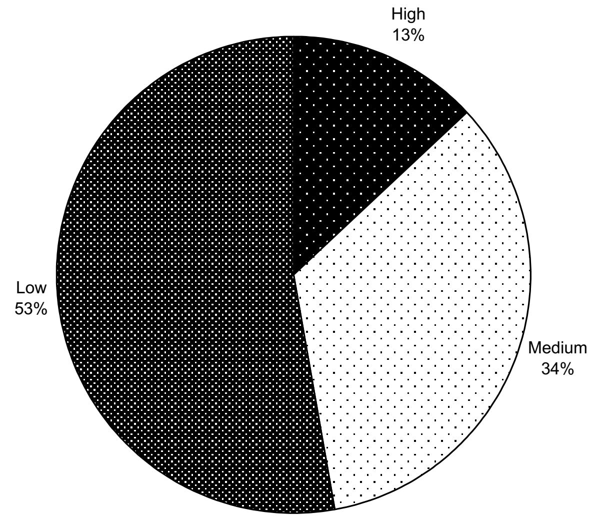
Nitrates in Drinking Water



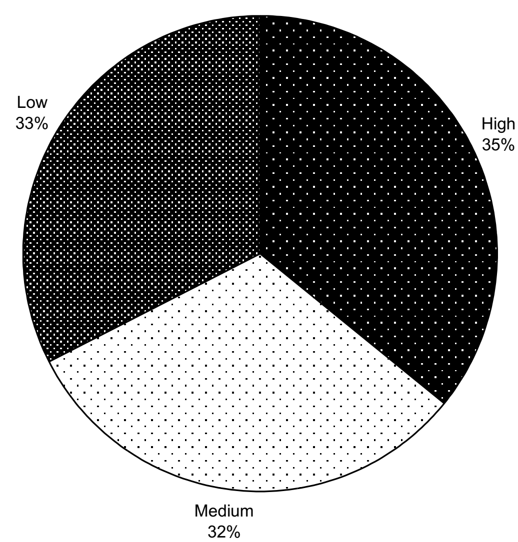
Old Dump Sites



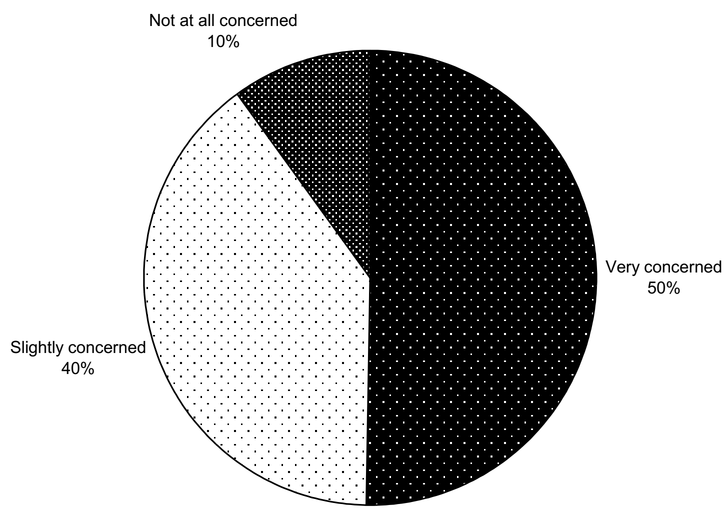
Soil Erosion From Road Crossings



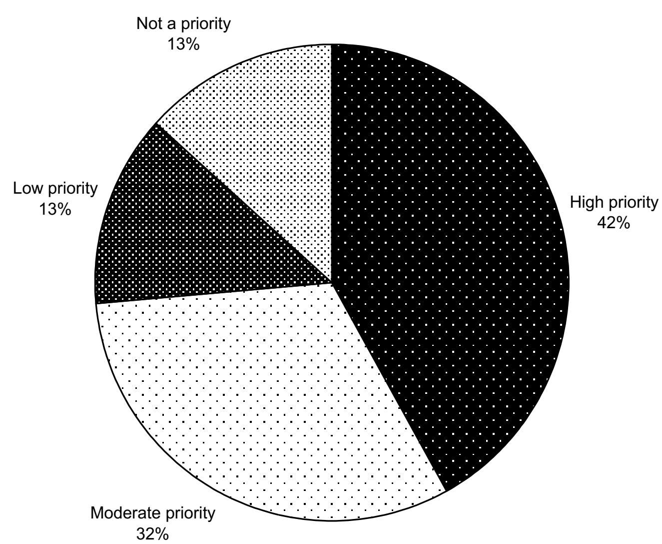
Urban Sprawl



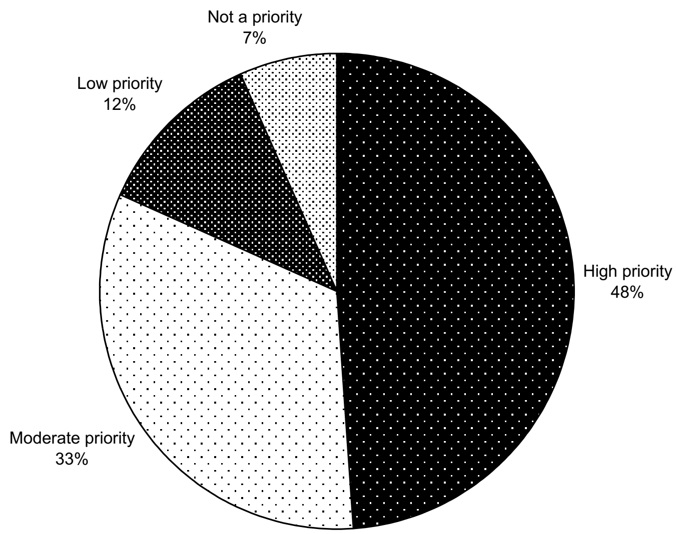
Rate your level of concern for the water quality of the Rice Creek Watershed and its major tributaries



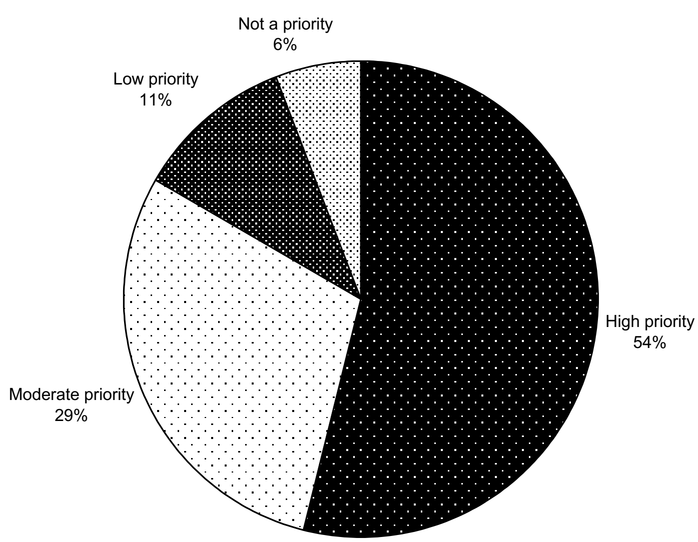
Planning development



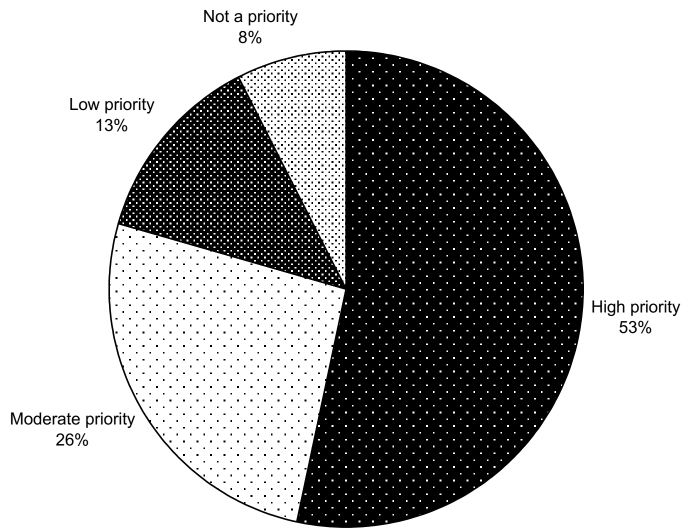
Environmental Education



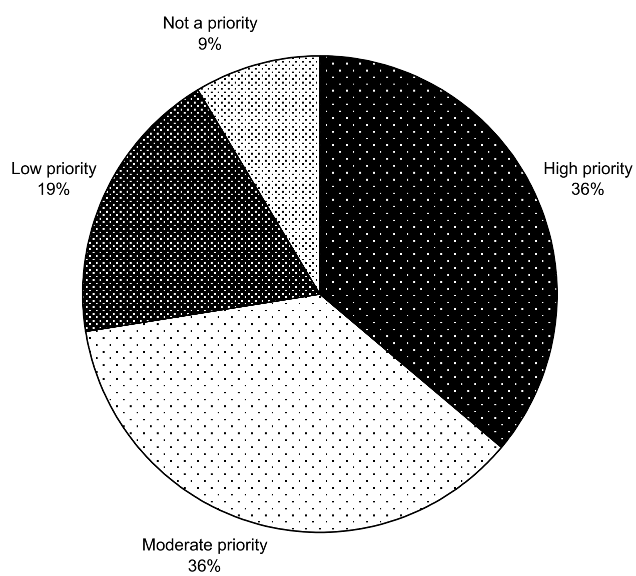
Farmland Preservation



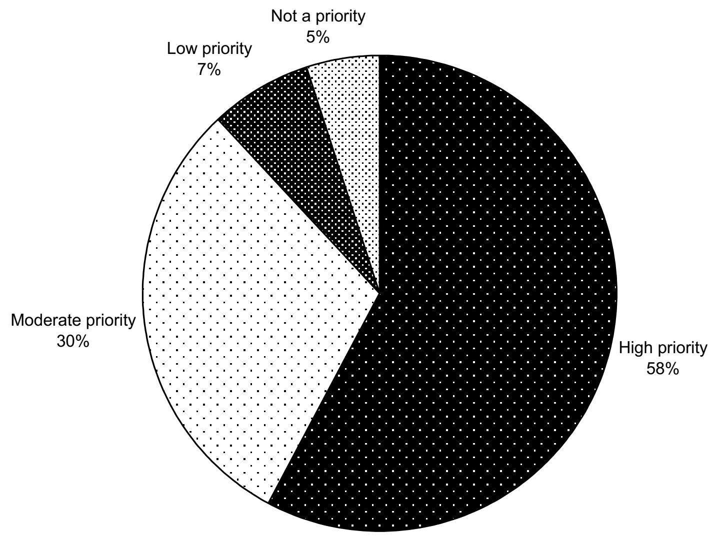
Hunting & Fishing



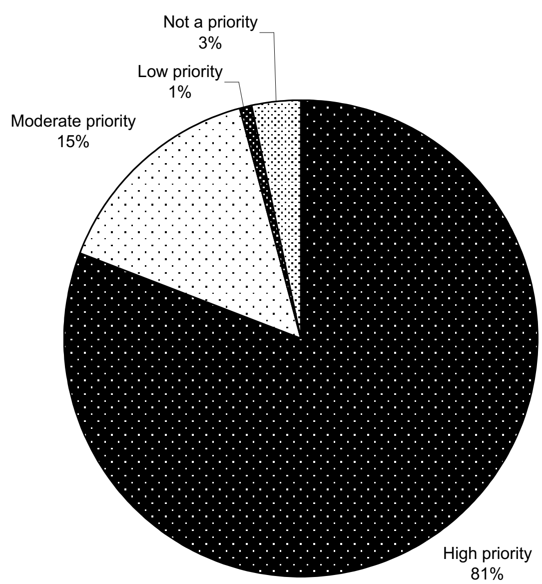
Parks & Outdoor Recreation



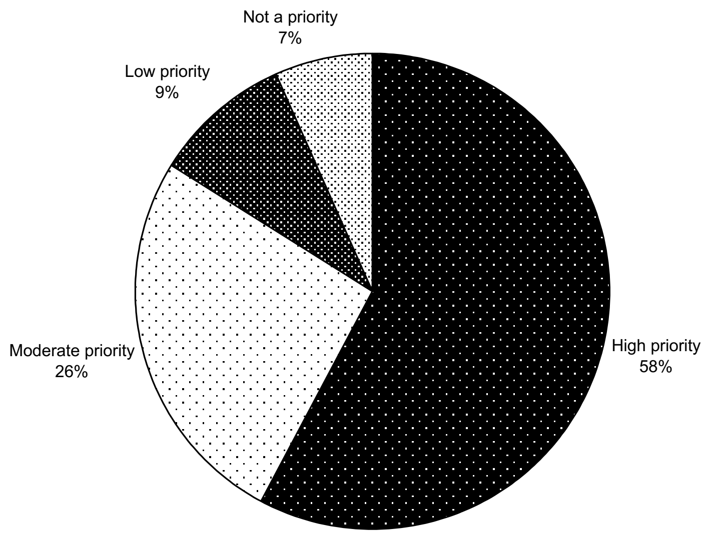
Preserving Woodlands



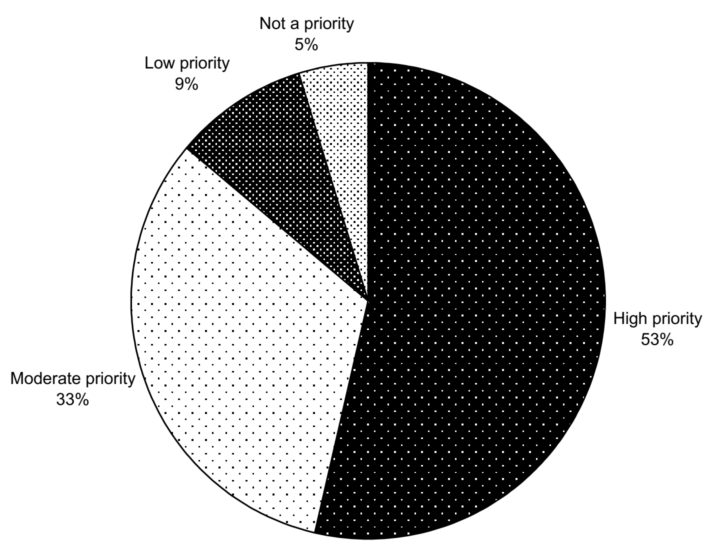
Water Quality



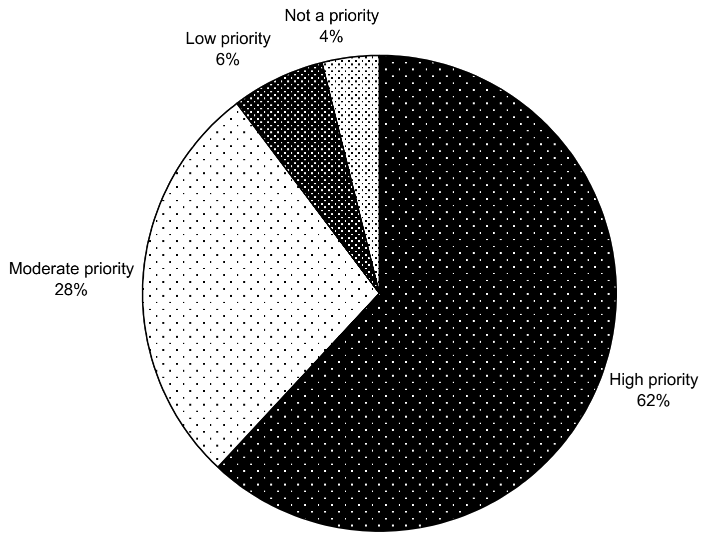
Preserving Wetlands



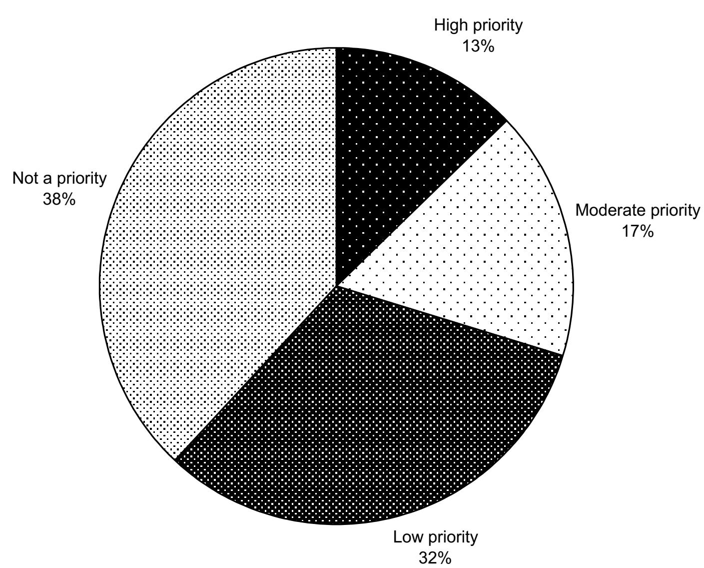
Drainage



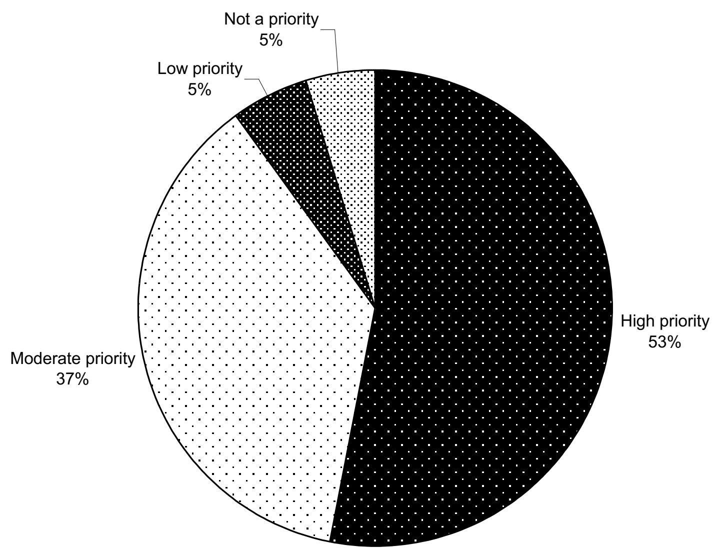
Wildlife Preservation



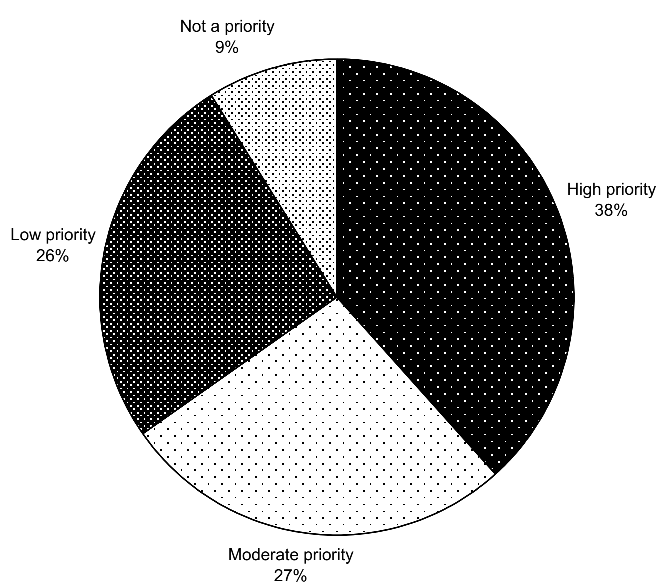
Promoting Development



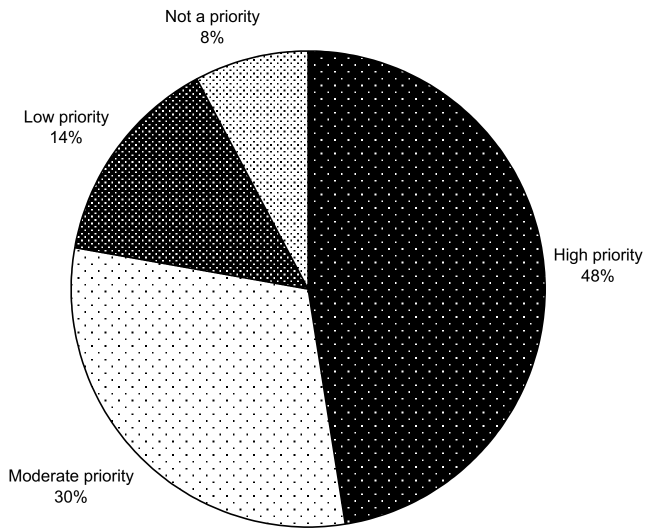
Watershed Protection



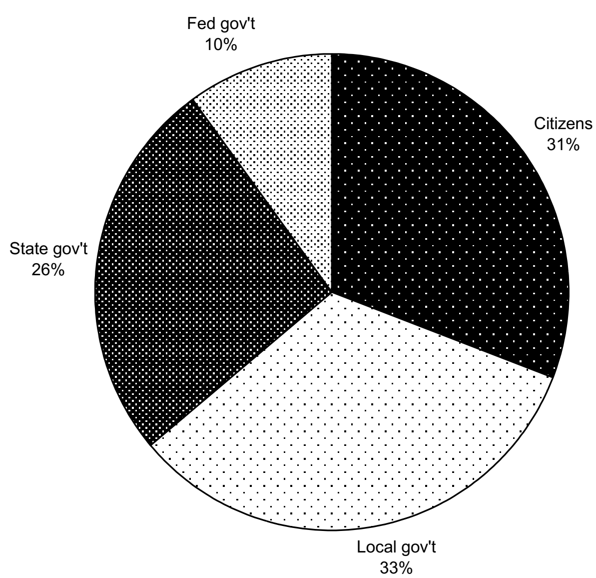
Flooding Concerns



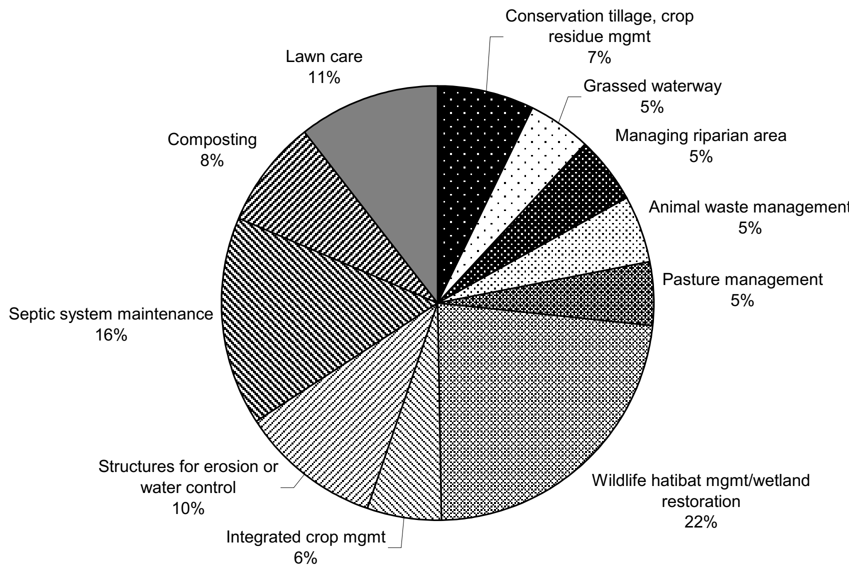
Septic Systems



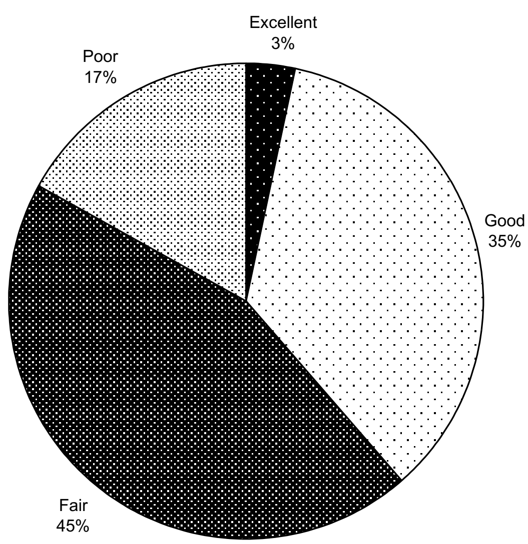
Who is responsible for protecting the Rice Creek Watershed?



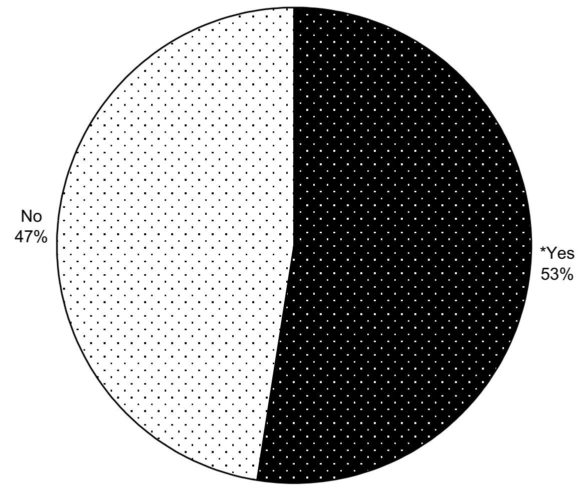
Which management practices would you like to learn more about?



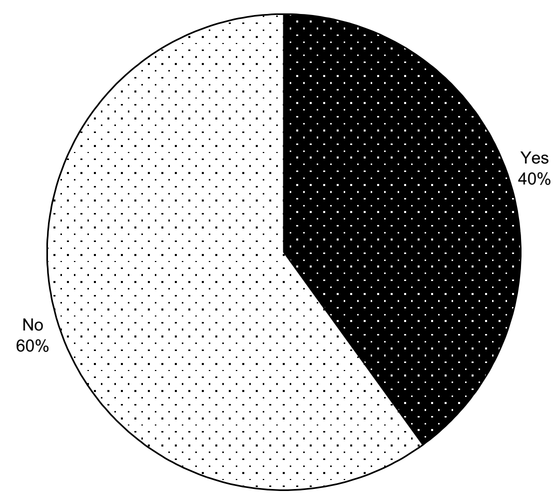
Your opinion of the overall water quality of Rice Creek



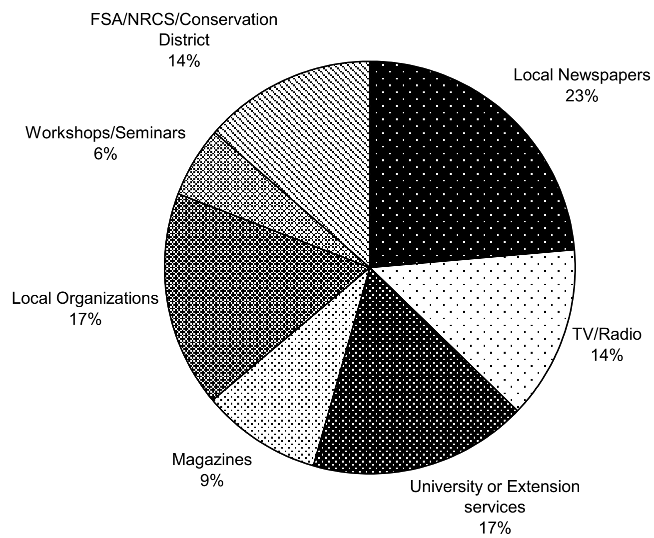
Is there a specific problem affecting the watershed that is of the greatest concern to you?



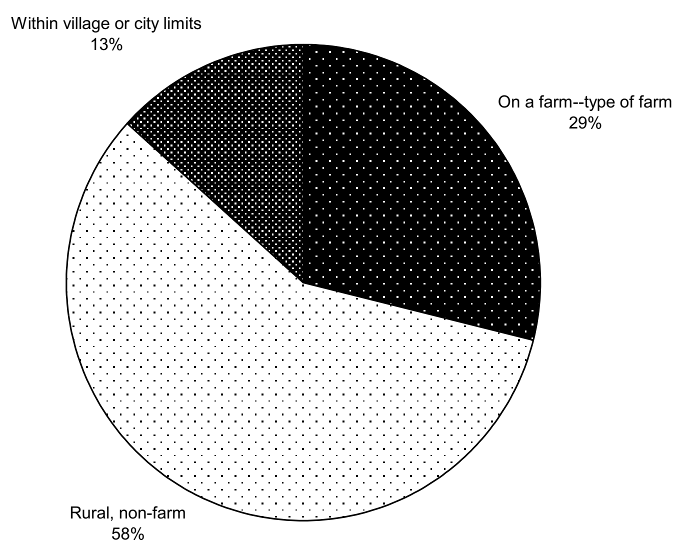
Would you volunteer your time and/or services to help this project?



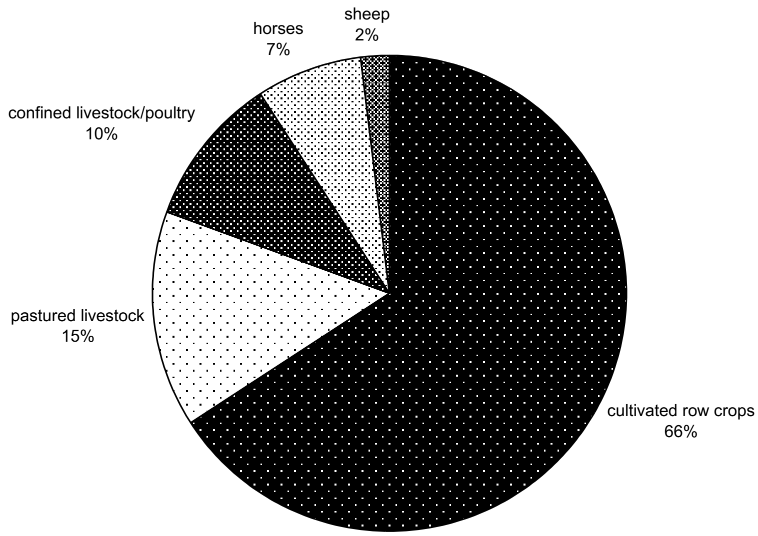
Where do you typicaly look to find reliable information about water quality and natural resource protection practices?



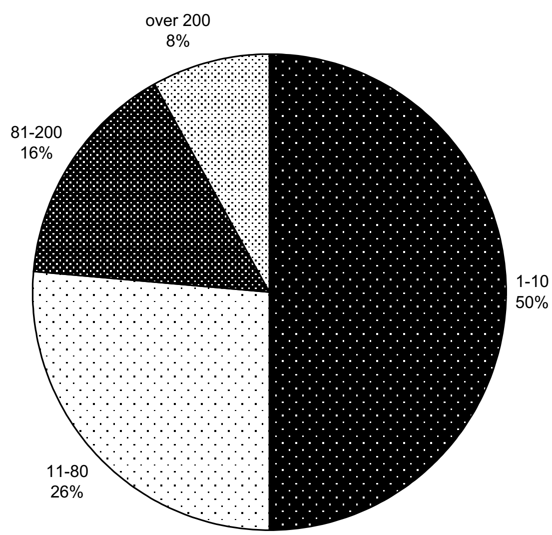
Where do you live?



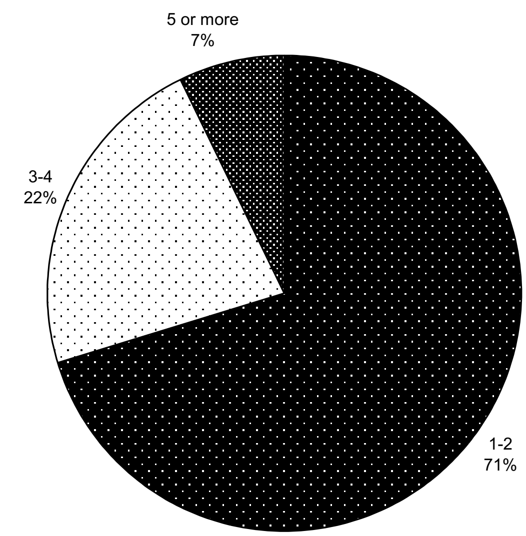
Type of Farm



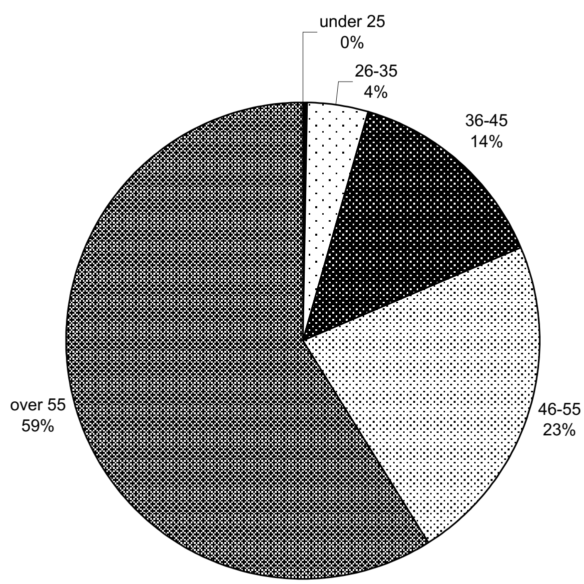
Number of Acres



How many people live in your household?



What is your age?



What is your occupation?