VFC Index - Watershed (Plan)

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LAKE MANITOU WATERSHED MANAGEMENT PLAN
FULTON-MIAMI COUNTY INDIANA

1.0 MISSION STATEMENT:

To identify and develop useful educational information for stakeholders to help improve the quality of water as it travels through our watershed.

Motto:

Leave the water quality better than we found it for future generations

1.1 GOALS:

- Produce educational brochures causing the stakeholders to become aware of lifestyles around the lake that impact the quality of the water.
- Develop action plan to replace the Mt. Zion Dam, reducing the sediment coming from the pond into Lake Manitou.
- Obtain grant money to hire biologist to study the effects of the 42 acre Eco-Zone established last year by the lake association**.**
- Conduct a fifteen minute educational radio show one time per month on the idea of cleaner water in the watershed.
- Stakeholders to write one article per month to be published in the local newspapers in Fulton and Miami Counties.
- Eradicate the invasive weed Hydrilla verticillata from Lake Manitou.

1.2 STAKEHOLDERS:

A group of stakeholders has been formed and have chosen to meet on the third Thursday of every month to identify the direction of the watershed plan. The meetings are held at 6:00 P.M. at the Rochester City Hall Building. The stakeholder group is small but has identified several items to be studied and developed the information listed above.

The group will develop action plans and identify the person or persons responsible for getting the action plan completed. Every quarter the meeting will focus on review of our mission statement, goals, and what we have completed in our action plans. Any changes to the action plans will be amended during this meeting.

A radio program will air on WROI in Rochester, Indiana following the monthly meeting of the Lake Manitou Association.

1.3 VISION:

Maintain and improve our watershed by monitoring land and water management practices while educating and informing the people within the watershed.

2.0 Introduction

The Lake Manitou watershed management plan addresses non point source pollution and other water quality concerns for a portion of the Tippecanoe watershed (HUC 05120106). Specifically, the Lake Manitou Rain Creek/Graham Ditch (HUC 05120106050020) subwatershed and the Robbin Taylor/Strebe Ditch (HUC 05120106050010) subwatershed located southeast of Rochester, Indiana[1]. The main tributaries to Lake Manitou are Rain Creek and Graham Ditch with Whittenberger/Eiler Ditch, Mastellar Ditch, Weaver and Kitchen Ditch playing a lesser role. The Lake Manitou watershed encompasses approximately 27,700 acres located southeast of Rochester, Indiana in Fulton County and Miami County. This watershed management plan documents the concerns stakeholders have as well as the vision they possess for the watershed area. The watershed plan describes the goals, strategies and necessary actions to achieve this vision. Methods for measuring stakeholder progress are included in the plan.

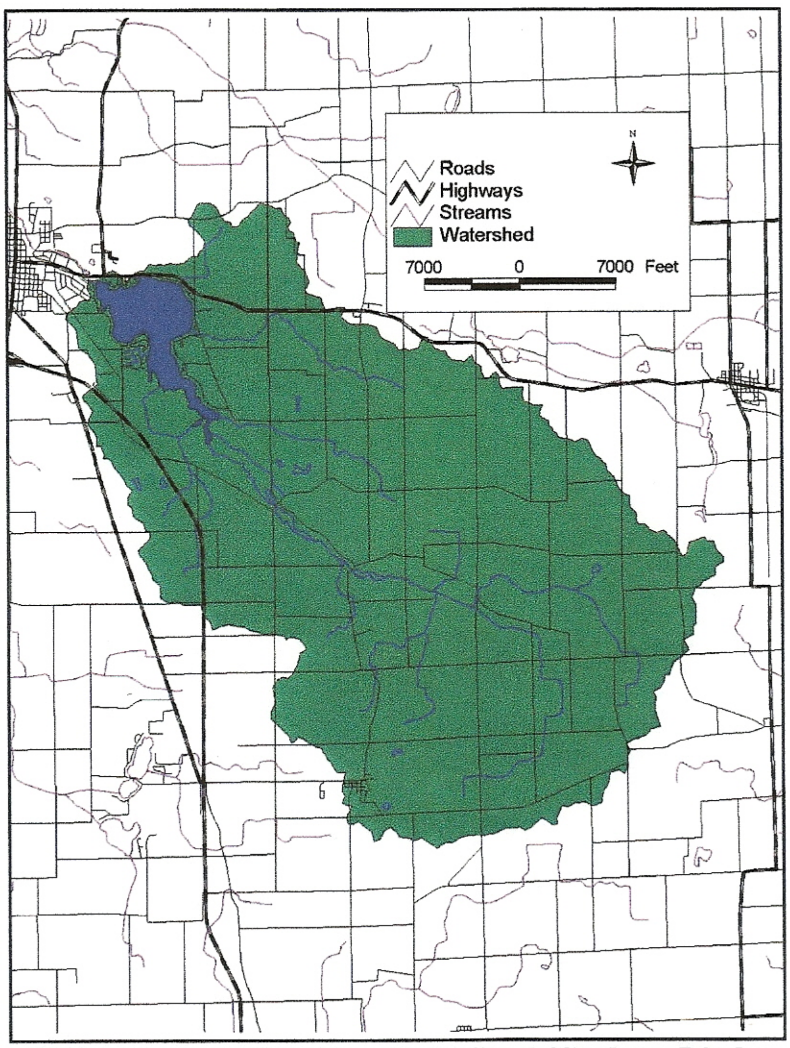

Figure 1. Lake Manitou-Rain Creek/Graham Ditch Physical Setting

[1] Figure I

2.1 Physical Setting

The Lake Manitou watershed encompasses approximately 27,700 acres (43.3 square miles) southeast of Rochester, Indiana in the heart of the northern Indiana lakes region (figure 2). Following Indiana state highway 31 Lake Manitou is located approximately 50 miles south of South Bend, Indiana and 100 miles north of Indianapolis, Indiana . The watershed includes the Lake Manitou/Rain Creek/Graham Ditch subwatershed (HUC# 05120106050020) and the Robbin Taylor/Strebe Ditch subwatershed (HUC# 05120106050010) located in Fulton and Miami counties(see figure 2). Lake Manitou itself is a 713 acre lake located on the northwestern edge of the watershed area. Lake Manitou is both spring fed and stream fed with a large wetland area located on the southern border. This wetland area is approximately 250 acres and includes the Bob Kern Nature Preserve, the Judy Burton Nature Preserve, and the Manitou Islands Wetland. The Lake Manitou watershed includes five perennial waterways,(1)Rain Creek, (2)Graham Ditch, (3)Whittenberger/Eiler Ditch, (4)Masteller Ditch, and (5)Weaver/Kitchen Ditch (figure 3).

Rain Creek runs approximately 10 miles from the southern edge of the Lake Manitou watershed in Miami county near the town of Macy and flows north into Fulton County where it then flows northwest into Lake Manitou. Graham Ditch flows approximately 3.8 miles west into Lake Manitou beginning at county road 500 east in Fulton County. itou. Whittenberger/Eiler Ditch is located south of Mastellar Ditch beginning just east of the intersection of county roads 250 south and 350 south and flowing 1.6 mile northwest into Lake Manitou. Mastellar Ditch begins near Fulton County roads 200 south and 600 east flowing approximately 3 miles to the northwest into Lake Manitou. Weaver/Kitchen Ditch begins near the town of Green Oak in Fulton County and flows north approximately 2.5 miles into the wetland area located at the southwest portion of Lake Manitou. Lake Manitou is largely surrounded by single dwelling homes, however the vast majority of the watershed is rural. Agriculture is the predominant land use in the watershed and therefore a factor in non point source pollution for the watershed. Water exits Lake Manitou via Mill Creek which flows into the Tippecanoe River and then to the Wabash. The Wabash meets the Ohio River which flows to the Mississippi and to the Gulf of Mexico.

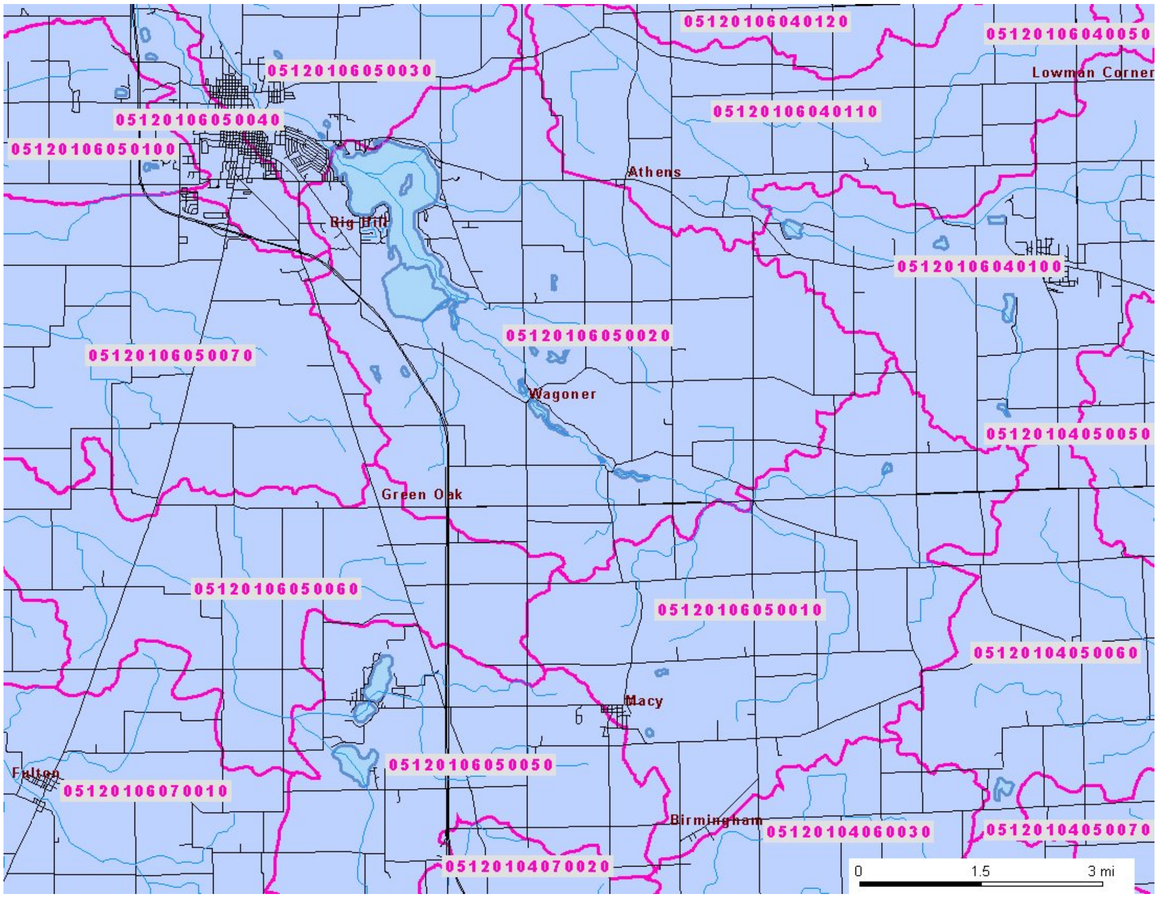
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Figure 2

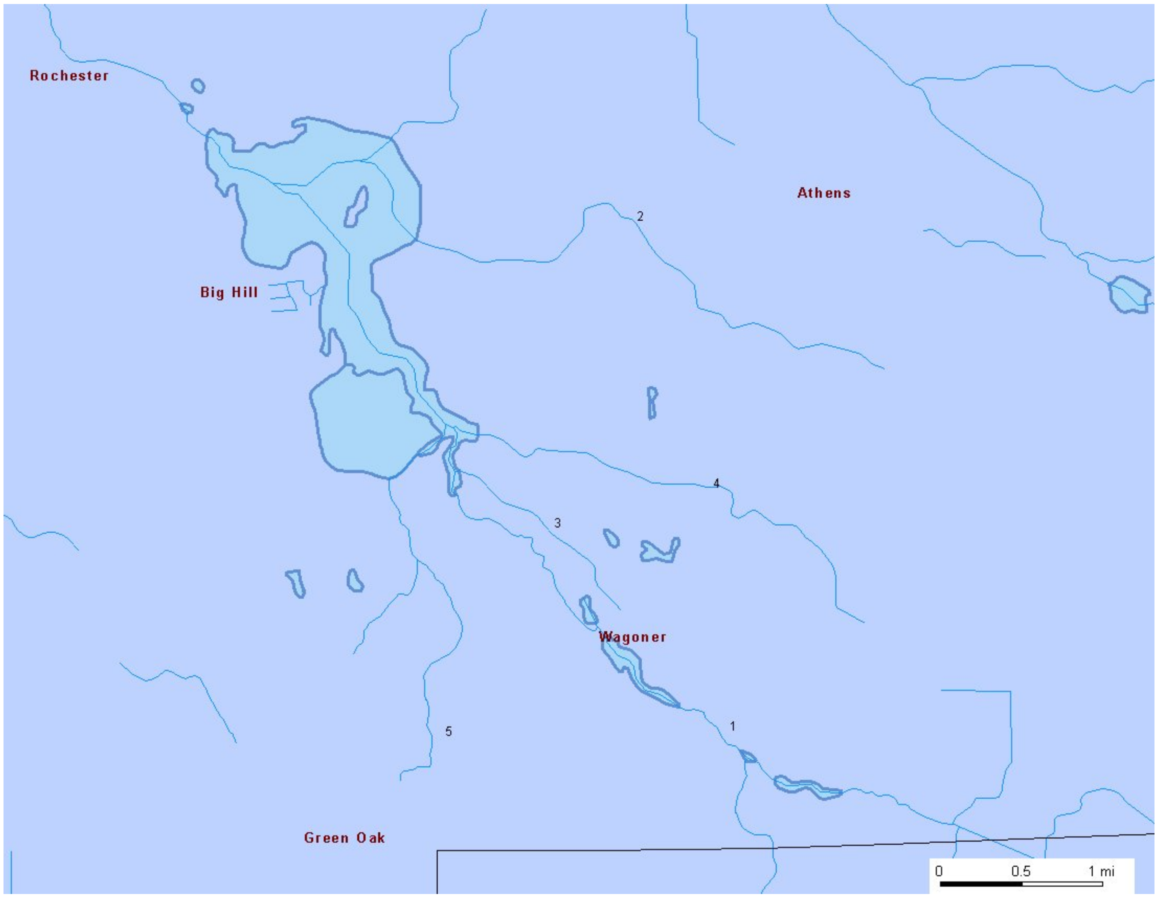


Figure 3

2.2 Climate

Fulton and Miami counties due to their location in northern Indiana experience cold winter months and warm summer months. The average winter temperature is 28 degrees Farenheight while the average summer temperature is 71 degrees Farenheight. Winter precipitation is usually adequate to discourage any summer drought for most soil types in the summer months. Annual snowfalls average approximately 25 inches. Approximately 60% of precipitation occurs between April and September which is the growing season for most crops in this area. The average annual rainfall for the Lake Manitou watershed is approximately 38.5 inches (see chart #1).

Chart 1

Lake Manitou Watershed Precipitation Chart 2004-2006

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
2004													
Rain	1.8	0.8	3.5	0.5	6.3	4.5	4.0	9.6	1.0	3.0	5.0	2.4	42.4
Snow	12	2	0	0	0	0	0	0	0	0	3	7	24
Total 2004													
2005													
Rain	0	0	1.5	1.6	2.3	3.5	4.0	2.6	4.4	1.1	3.1	2.0	26.1
Snow	21	5	4	0	0	0	0	0	0	0	0	14	44.0
Total 2005													
2006													
Rain	2.6	1.4	2.9	4.4	6.0	2.6	6.1	5.4	2.7	3.8	2.9	3.7	44.5
Snow	2	0	2	0	0	0	0	0	0	0	0	1	5
Total 2006													

2.3 Natural History

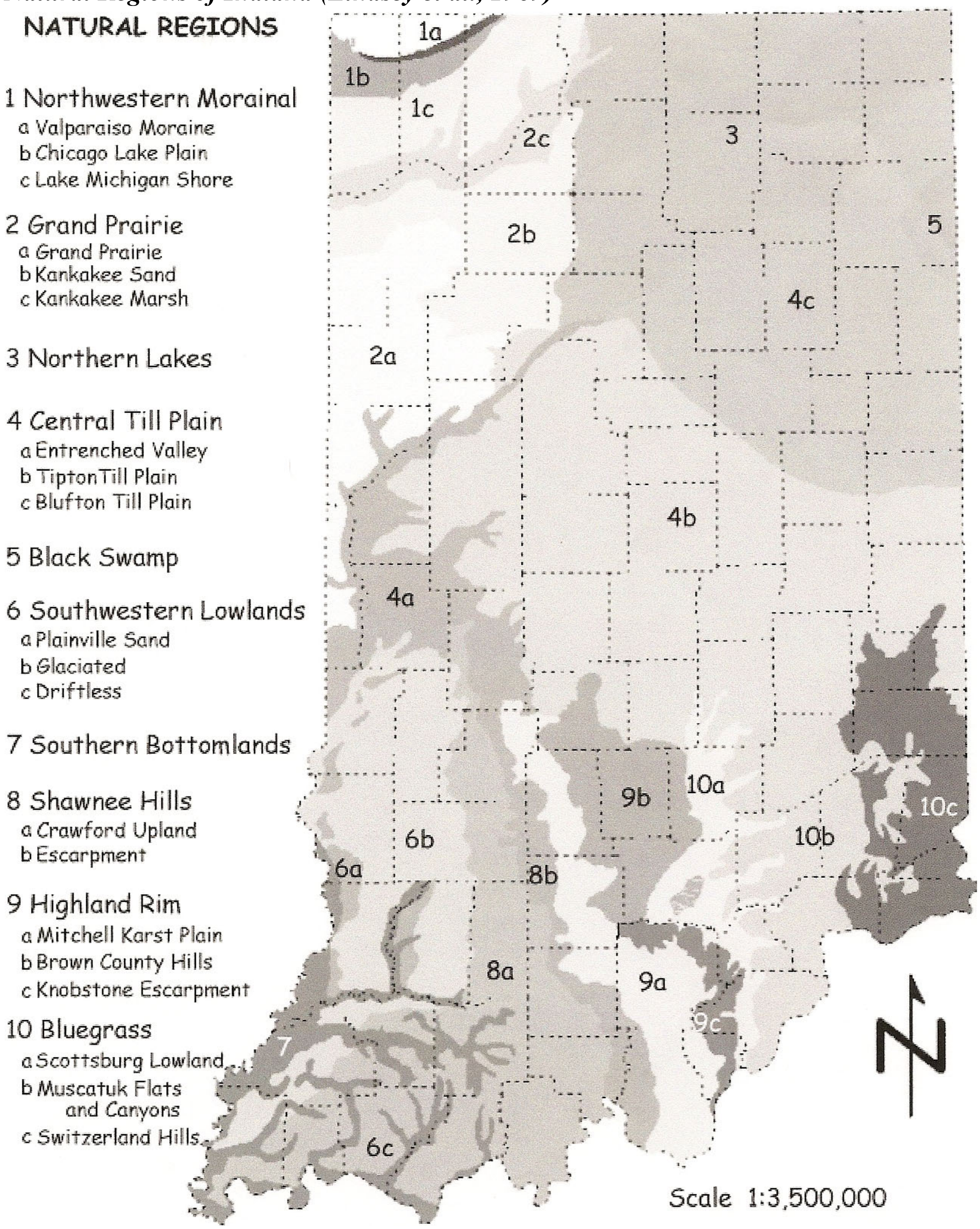
Geographic location, geology, climate, topography, soils, and other factors play a role in shaping the native floral and faunal communities in a particular watershed. Various ecologists (Dean,1921; Petty and Jackson,1966; Homoya,1985; Omernik and Gallant,1988) have divided Indiana into several natural regions or ecoregions, each with similar geologic history, climate, topography, and soils. Because the groupings are based on factors that ultimately influence the type of vegetation present in an area, these natural areas or ecoregions tend to support characteristic native floral and faunal communities. Under the Natural Regions of Indiana Classification Communities (Lindsey et al. 1969) the Lake Manitou watershed lies entirely in the northern lakes area of the Natural Regions of Indiana (see figure 3) bordering the Grand Prarie/Kankakee Sand Region to the west. The Lake Manitou watershed is located in the Eastern Cornbelt Plains (ECBP) ecoregion (Omenrik and Gallant) and the floral and faunal community is consistent with that area of Indiana.

Prior to European settlement dense oak-hickory forests covered a large part of the Lake Manitou watershed. Chamberlain (1849) describes the area as being heavily timbered with oak openings covered by wet or dry praries and lakes. White oak was the dominant component of the heavily timbered areas with shagbark hickory, maple, beech, elm, walnut, butternut, red oak and black oak also present (McDonald 1908; Petty and Jackson, 1966; Omernik and Gallant, 1988). Petty and Jackson (1966) list pussy toes, common cinquefoil, wild licorice, tick clover, blue phlox, waterleaf bloodroot, joe-pyeweed, woodland asters, goldenrods, wild geraniums, and bellwort as common components of the forest understory in this watershed.

In 1832 a grist mill and dam was built in Fulton County after signing a treaty with the Potawatomie Indians to provide them corn processed from the grist mill. This dam brought together five smaller lakes into what is now Lake Manitou.

Figure 4

Natural Regions of Indiana (Lindsey et al., 1969)



2.4 Aquifers

The Lake Manitou Watershed aquifers are both buried and surficial. These unconsolidated aquifers were probably formed by sediments from glacial melt water during the last glacial retreat and are capable of producing large quantities of water. Most of the surficial sand and gravel is located in the Kankakee outwash and lacustrine plain in the Upper Wabash River Basin. Buried sand and gravel aquifers underlie much of the watershed where they are interbedded with till deposits from 10-400 feet in depth. These sand and gravel deposits are present as isolated pieces in glaciated areas. The Lake Manitou Rain Creek Graham Ditch and Robbin Taylor/Strebe Ditch subwatershed aquifers contain sand and gravel, unconsolidated non-aquifer material, limestone and dolostone (USGS atlas of aquifers). Most of the sand and gravel deposits in the watershed are buried. These buried aquifers are continuous although they are not deposited uniformly. There can be large variations in intertill aquifer thickness and distribution. Glacial scour and shoving contribute to this. Most buried aquifers were at one time on the surface but are now enclosed within the drift and are covered by silty, clay-loam to loam tills.

2.5 Soils

The Lake Manitou watershed's geologic history described in the previous sections determine the soil types found in the watershed and is reflected in the major soil associations that cover the Lake Manitou watershed. The soil types found in the Lake Manitou watershed are a product of the original parent material deposited by glaciers in the last ice age approximately 12,000 to 15,000 years ago. The majority of the materials found in the watershed are glacial outwash, glacial till, alluvium, and organic materials that were left as the glaciers retreated. The interaction of these parent materials with the physical, chemical, and biological variables found in the area (climate, plant and animal life, time, landscape relief and the physical and mineralogic composition of the parent material) formed the soils in the Lake Manitou watershed which can be described as loamy glacial till.

The concept of soil associations identifies distinct proportional groupings of soil units. Typically this results in the identification of several distinct patterns of soil units. These patterns are the major soil associations of the watershed. Each soil association usually consists of two or three soil units that dominate the area along with several soil units that occupy a small portion of the soil landscape. Soil associations are named for their dominant components. For example, the Crosier-Barry-Gilford soil association is made primarily of Crosier loam, Barry loam, and Gilford loam soil types and is the largest soil association in Fulton County. In Miami County the Blount-Pewamo-Morley soil association is the most prevalent and consists of Blount silt loam, Pewamo silty clay loam and Morley silt loam. These two soil associations (Crosier-Barry-Gilford and Blount-Pewamo-Morley cover over 40% of the Lake Manitou watershed (See table # 1).

Acreage and Proportionate Extent of the Soils

Fulton County, Indiana

Map symbol	Map unit name	Acres	Percent
Ad	Adrian muck, drained	2,752	1.2
Ah	Algansee loamy sand, frequently flooded	1,016	0.4
Bb	Barry loam	27,601	11.6
BlA	Blount loam, 0 to 2 percent slopes	625	0.3
Br	Brady sandy loam	4,999	2.1
BsA	Branch loamy sand, 0 to 2 percent slopes	4,169	1.8
BtA	Brems loamy sand, 0 to 3 percent slopes	1,581	0.7
ChB	Chelsea fine sand, 2 to 6 percent slopes	1,160	0.5
Co	Cohoctah fine sandy loam, occasionally flooded	4,537	1.9
CrA	Crosier loam, 0 to 2 percent slopes	31,546	13.3
Ed	Edwards muck, drained	1,587	0.7
Gf	Gilford fine sandy loam	17,356	7.3
Gh	Gilford fine sandy loam, loamy substratum	2,575	1.1
Hh	Histosols-Aquolls complex, ponded	1,807	0.8
Hk	Homer fine sandy loam, 0 to 2 percent slopes	2,873	1.2
Hm	Houghton muck, drained	8,847	3.7
Ho	Houghton muck, undrained	4,078	1.7
KoA	Kosciusko-Ormas complex, 0 to 2 percent slopes	7,826	3.3
KoB	Kosciusko-Ormas complex, 2 to 6 percent slopes	5,894	2.5
KoC	Kosciusko-Ormas complex, 6 to 12 percent slopes	5,208	2.2
MaA	Markton loamy sand, 0 to 2 percent slopes	9,860	4.1
MeA	Metea loamy sand, 0 to 2 percent slopes	2,382	1.0
MeB	Metea loamy sand, 2 to 6 percent slopes	9,535	4.0
MeC	Metea loamy sand, 6 to 12 percent slopes	1,416	0.6
MrB2	Morley loam, 2 to 6 percent slopes, eroded	1,941	0.8
MsC3	Morley clay loam, 6 to 12 percent slopes, severely eroded	1,654	0.7
Mu	Morocco loamy sand	848	0.4
Mx	Muskego muck, drained	1,832	0.8
Ne	Newton fine sandy loam	2,592	1.1
OmA	Ormas loamy sand, 0 to 2 percent slopes	6,020	2.5
OmB	Ormas loamy sand, 2 to 6 percent slopes	2,877	1.2
Pe	Pewamo clay loam	440	0.2
Pk	Pits, gravel	295	0.1
PlA	Plainfield sand, 0 to 2 percent slopes	1,262	0.5
PlB	Plainfield sand, 2 to 6 percent slopes	1,695	0.7
PlC	Plainfield sand, 6 to 12 percent slopes	1,956	0.8
RlA	Riddles fine sandy loam, 0 to 2 percent slopes	4,129	1.7
RlB2	Riddles fine sandy loam, 2 to 6 percent slopes, eroded	9,280	3.9
RlC2	Riddles fine sandy loam, 6 to 12 percent slopes, eroded	3,259	1.4
Se	Sebewa sandy clay loam	8,779	3.7
Usl	Udorthents, rubbish	88	*
W	Water	2,580	1.1
Wa	Wallkill silt loam	1,262	0.5

USDA Natural Resources Conservation Service

Tabular Data Version: 6
Tabular Data Version Date: 11/30/2006

* See footnote at end of table.

Acreage and Proportionate Extent of the Soils

Fulton County, Indiana

Map symbol	Map unit name	Acres	Percent
Wh	Washtenaw silt loam	2,079	0.9
WkB	Wawasee fine sandy loam, 2 to 6 percent slopes	16,289	6.9
WkC2	Wawasee fine sandy loam, 6 to 12 percent slopes, eroded	4,644	2.0
WkD	Wawasee fine sandy loam, 12 to 18 percent slopes	678	0.3
Total		237,709	100.0

* Less than 0.1 percent.

Table1

Acreage and Proportionate Extent of the Soils

Miami County, Indiana

Map symbol	Map unit name	Acres	Percent
Au	Aubbeenaubbee sandy loam, 0 to 2 percent slopes	886	0.4
Ba	Blount loam, 1 to 3 percent slopes	6,629	2.7
Bc	Blount silt loam, 0 to 2 percent slopes	47,807	19.8
Br	Brookston loam	4,961	2.1
ChB	Chelsea fine sand, 2 to 9 percent slopes	1,448	0.6
Cr	Crosier loam, 0 to 2 percent slopes	5,185	2.1
Fn	Fincastle silt loam, 0 to 2 percent slopes	8,766	3.6
FsA	Fox silt loam, 0 to 2 percent slopes	4,049	1.7
FsB	Fox silt loam, 2 to 6 percent slopes	1,086	0.4
FzC3	Fox clay loam, 8 to 15 percent slopes, severely eroded	1,006	0.4
Ge	Gessie silt loam	6,605	2.7
Gr	Gilford sandy loam	1,302	0.5
HeG	Hennepin silt loam, 25 to 50 percent slopes	4,471	1.9
Hx	Houghton muck, drained	3,629	1.5
MaA	Martinsville sandy loam, 0 to 2 percent slopes	818	0.3
MeB	Metea loamy fine sand, 2 to 6 percent slopes	3,333	1.4
MhB	Miami silt loam, 2 to 6 percent slopes	1,391	0.6
MhC3	Miami clay loam, 6 to 12 percent slopes, severely eroded	361	0.1
MhD3	Miami clay loam, 12 to 18 percent slopes, severely eroded	196	*
Mk	Milford silty clay	903	0.4
Mm	Millsdale silty clay loam	470	0.2
Mp	Milton silt loam, 0 to 2 percent slopes	272	0.1
MrB	Morley sandy loam, 2 to 6 percent slopes	1,132	0.5
MsB	Morley silt loam, 2 to 6 percent slopes	26,781	11.1
MsC	Morley silt loam, 6 to 12 percent slopes	1,946	0.8
MsD	Morley silt loam, 12 to 18 percent slopes	1,068	0.4
MtC3	Morley silty clay loam, 6 to 12 percent slopes, severely eroded	12,962	5.4
MtD3	Morley silty clay loam, 12 to 25 percent slopes, severely eroded	3,245	1.3
OcA	Ockley silt loam, 0 to 2 percent slopes	2,201	0.9
OcB	Ockley silt loam, 2 to 6 percent slopes	874	0.4
Omz	Orthents, earthen dam	56	*
Or	Orthents, loamy	1,079	0.4
OsB	Ormas-Oshtemo loamy sands, 2 to 8 percent slopes	2,013	0.8
OtA	Oshtemo sandy loam, 0 to 4 percent slopes	5,150	2.1
Pm	Palms muck, drained	1,502	0.6
Pt	Patton silty clay loam	890	0.4
Pw	Pewamo silty clay loam	33,140	13.7
Pz	Pits, Quarry, Limestone	157	*
Re	Rensselaer loam	4,467	1.9
Ro	Ross loam	921	0.4
Se	Sebewa loam	978	0.4
Sh	Shoals silt loam	9,441	3.9
Sn	Sleeth loam	1,549	0.6

Acreage and Proportionate Extent of the Soils

Miami County, Indiana

Map symbol	Map unit name	Acres	Percent
So	Sloan silty clay loam	1,641	0.7
St	Stonelick sandy loam	959	0.4
Tr	Treaty silt loam	7,442	3.1
W	Water	1,817	0.8
Wh	Washtenaw silt loam	1,866	0.8
WsB	Wawasee sandy loam, 2 to 6 percent slopes	6,772	2.8
WsC	Wawasee sandy loam, 6 to 12 percent slopes	999	0.4
WsC3	Wawasee loam, 6 to 12 percent slopes, severely eroded	2,247	0.9
WsD3	Wawasee loam, 12 to 18 percent slopes, severely eroded	571	0.2
Total		241,440	100.0

* Less than 0.1 percent.

Table 2

Because soil scientists developed county soil association maps at different times the soil associations in one county may not be consistent with the soil associations in the next county. These differences may be due to one or more of the following explanations:
1. A change or changes occur in the concept of a soil series.
2. Variations in the extent of the soils occur.
3. Variations in the slope range allowed in a soil association occur.

(Smallwood 1980)
These explanations may help explain the different soil associations in Fulton and Miami counties. Portions of both counties are included in the Lake Manitou watershed.

2.5.1 Erodible Soils

Highly erodible and potentially highly erodible are classifications used by the Natural Resources Conservation Service (NRCS) to describe the potential of certain soil units to erode from the landscape. The NRCS examines common soil characteristics such as slope and soil texture when classifying soils. The NRCS maintains a list of highly erodible soil units for each county. Soil erodibility for the Lake Manitou watershed is represented by what is known as the K factor. The K factor may vary from approximately 0.0 to 0.6. A K factor of 0.17 has very low erosion potential. A K factor of 0.32 has a moderate erosion potential, and a K factor of 0.43 has a very high erosion potential. Table 3 lists the highly erodible and potentially highly erodible soils for Fulton County and Miami County.

Table 3

Fulton County Erodible soils

Map Symbol/Soil Name	K Factor	Highly Erodible/ Potentially Highly Erodible
BlA / Blount	0.37	PHES
CrA / Crosier	0.37	PHES
Wa / Wallkill	0.37	PHES
Wh / Washtenaw	0.43	HES

Miami County Erodible Soils

Map Symbol/Soil Name	K Factor	Highly Erodible/ Potentially Highly Erodible
Ba / Blount	0.37	PHES
Bc / Blount	0.43	HES
Cr / Crosier	0.37	PHES
Fn / Fincastle	0.49	HES
FsA / Fox	0.37	PHES
FsB / Fox	0.37	PHES

Miami County Erodible Soils Cont.

Map Symbol/Soil Name	K Factor	Highly Erodible/ Potentially Highly Erodible
Ge / Gessie	0.43	HE
HeG / Hennepin	0.43	HE
MhB / Miami	0.43	HE
Mp / Milton	0.49	HE
MsB / Morley	0.43	HE
MsC / Morley	0.43	HE
MsD / Morley	0.43	HE
OcA / Ockley	0.43	HE
OcB / Ockley	0.43	HE
Sh / Shoals	0.37	HE
Wh / Washtenaw	0.43	HE
WsC3 / Wawasee	0.37	PHES
WsD3 / Wawasee	0.37	PHES

Of the forty seven soil types listed in Fulton County only four are considered highly erodible or potentially highly erodible and of the four only Crosier (CrA) takes up an area greater than 1% of the county (CrA takes up 13.3%) with a K factor of 0.37. None of the erodible soils were found along side the main tributaries (Rain Creek and Graham Ditch) in Fulton County. This would indicate that even though much of the county and watershed is a silty loam erodibility is not as big a problem as it is in some neighboring areas. This may be due in part to the relatively flat nature of Fulton County and the Lake Manitou watershed.

The northern portion of Miami County which is included in the Lake Manitou watershed contains thirty-five different soil types. Twelve of the soil types are considered highly erodible or potentially highly erodible with K factors ranging from 0.32 to 0.43. These twelve soil types make up approximately 26% of the area. This portion of the watershed contains more highly erodible soils which makes it more susceptible to surface and stream bank erosion as well as sedimentation. Careful land use should be considered and best management practices (BMP) for croplands should be in place to help deal with any soil erosion issues.

2.5.2 Soils Used for Septic Tank Absorption Fields

Much of the Lake Manitou watershed uses septic tanks and septic tank absorption fields as a means for treating wastewater. This method of wastewater treatment uses the septic tank for primary treatment to remove solids and the soil for secondary treatment to reduce the remaining pollutants to levels that protect surface and groundwater from contamination. The soils ability to hold and break down pollutants in the septic discharge will ultimately determine how well surface and ground water is being protected.

Many factors can affect a soil's ability to function as a septic absorption field. Seven characteristics are currently used to determine soil suitability for on-site sewage disposal systems (Thomas, 1996):

1. Position in the landscape
2. Slope
3. Soil texture
4. Soil structure
5. Soil consistency
6. Depth to limiting layers
7. Depth to seasonal high water table

The ability of soil to treat waste discharge depends on four factors (Cogger, 1989):

1. The amount of accessible soil particle surface area
2. The chemical properties of the surfaces
3. Soil conditions (temperature, moisture, oxygen content)
4. The type of pollutants present in the waste discharge

Most of the effluent of concern is safely removed if a septic system is set up correctly. Most soils have the ability to hold large amounts of some things in the septic effluent (like phosphates) while other things (like nitrates) pass through the soil much easier and may leach into groundwater. Factors like these must be taken into account in order to avoid contamination of wells. Organic material in wastewater is biodegradable in the presence of oxygen. Pathogens can be contained and inactivated in the soil as long as conditions are right. Since bacteria and viruses are smaller than other pathogenic organisms in wastewater they have the ability to move through the soil faster. Soils like clay may retain the bacteria or virus but this retention may be temporary. Increased water flow through the soil due to a storm may resuspend the pathogen. As stated earlier the presence of oxygen in the soils increases it's ability to inactivate the pathogens largely due to the presence of microorganisms naturally found in soil. These soil microorganisms are aerobic (in the presence of oxygen). If the pathogens are in a part of the soil where anaerobic (without oxygen) conditions exist they may live longer due to the reduced presence of the natural soil microorganisms.

The NRCS has classified septic tank absorption fields into three categories: slightly limited, moderately limited, or severely limited (See table # 4). If a septic tank absorption field is rated moderately or severely limited special planning, design, or maintenance may be required to make sure it functions properly.

Septic Tank Absorption Field Classification
For Fulton County Indiana Soils

Soil name and map symbol		**Septic tank absorption field rating**
Adrian	Ad	Severe: ponding, poor filter
Algansee	Ah	Severe: flooding, wetness, poor filter
Barry	Bb	Severe :ponding
Blount	BlA	Severe: wetness, percs slowly
Brady	Br	Severe: wetness
Branch	BsA	Severe: wetness, poor filter
Brems	BtA	Severe: wetness, poor filter
Chelsea	ChB	Severe: poor filter
Cohoctah	Co	Severe: wetness, flooding
Crosier	CrA	Severe: perce slowly, wetness
Edwards	Ed	Severe: ponding, percs slowly
Gilford	Gf	Severe: ponding, poor filter
Gilford	Gh	Severe: ponding, percs slowly
Homer	Hk	Severe: wetness
Houghton	Hm, Ho	Severe: wetness, poor filter
Kosciusko	KoA, KoB, KoC	Severe: poor filter
Markton	MaA	Severe: wetness
Metea	MeA, MeB, MeC	Severe: poor filter
Morley	MrB2	Severe: wetness, percs slowly
Morocco	Mu	Severe: wetness, poor filter
Muskego	Mx	Severe: ponding, subsides
Newton	Ne	Severe: ponding, poor filter
Ormas	OmA, OmB	Severe: poor filter
Pewamo	Pe	Severe: percs slowly, ponding
Plainfield	PlA, PlB, PlC	Severe: poor filter
Riddles	R1A, R1B2, RiC2	Moderate: percs slowly
Sebewa	Se	Severe: poor filter, ponding
Wallkill	Wa	Severe: ponding, poor filter
Washtenaw	Wh	Severe: ponding, percs slowly
Wawasee	WkB	Moderate: percs slowly
Wawasee	WkC2	Moderate:slope, percs slowly
Wawasee	WkD	Severe: slope

Septic Tank Absorption Field Classification
For Northern Miami County Indiana Soils

Soil name and map symbol		Septic tank absorption field rating
Aubbeenaubbee	Au	Severe: wetness
Brookston	Br	Severe: wetness, floods
Chelsea	ChB	Slight:
Crosier	Cr	Severe: percs slowly, wetness
Fox	FzC3	Moderate: slope
Gilford	Gr	Severe: wetness, floods
Houghton	Hx	Severe: wetness, floods
Martinsville	MaA	Slight
Metea	MeB	Severe: percs slowly
Morley	MrB, MsB, MsC	Severe: percs slowly, wetness
Morley	MtC3, MtD3	Severe: percs slowly, wetness
Ormas	OsB	Slight
Oshtemo	OtA	Slight
Palms	Pm	Severe: wetness, seepage, floods
Patton	Pt	Severe: wetness
Pewamo	Pw	Severe: percs slowly, floods, wetness
Rennseleef	Re	Severe: wetness, percs slowly, floods
Sebewa	Se	Severe: wetness, floods
Sloan	So	Severe: wetness, floods
Washtenaw	Wh	Severe: wetness, percs slowly, floods
Wawasee	WsB	Slight
Wawasee	WsC, WsC3	Moderate: slope
Wawasee	WsD3	Severe: slope

Table 4

2.5.3 Hydric Soils

A hydric soil is a soil that is formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. The concept of hydric soils includes soils developed under sufficiently wet conditions to support the growth and regeneration of hydrophytic vegetation. Soils that are wet due to artificial means are included in the concept of hydric soils. Soils in which the hydrology has been artificially modified are also hydric if the soil, in an unaltered state, was hydric. Possessing a list of hydric soils for the Lake Manitou watershed could be useful in terms of land use planning, conservation planning, and assessment of potential wildlife habitat. Table # 5 indicates the hydric soils in the Lake Manitou watershed. All the soil types listed are found in Till plains or Outwash plains where depressions are located with the exception of Cohoctah soil type which is found in flood plains.

Hydric Soil Types

Fulton County		Northern Miami County	
Soil name and map symbol		**Soil name and map symbol**	
Adrian muck, drained	Ad	Brookston loam	Br
Barry loam	Bb	Gilford sandy loam	Gr
Cohoctah fine sandy loam	Co	Houghton muck	Hx
Edwards muck, drained	Ed	Palms muck, drained	Pm
Gilford fine sandy loam	Gf	Patton silty clay loam	Pt
Gilford fine sandy loam substratum	Gh	Pewamo silty clay loam	Pw
Histosols-Aquolls complex ponding	Hh	Rensselaer loam	Re
Houghton muck drained	Hm	Sebewa loam	Se
Houghton muck undrained	Ho	Sloan silty clay loam	So
Muskego muck, drained	Mx	Washtenaw silt loam	Wh
Newton fine sandy loam	Ne		
Pewamo clay loam	Pe		
Sebewa sandy clay loam	Se		
Wallkill silt loam	Wa		
Washtenaw silt loam	Wh		

Table 5

2.6 Cultural Resources

Prior to European settlement of the area in the mid 1820's the Lake Manitou watershed was inhabited by Native American Indians from the Miami and Pottawatomie tribes. Both tribes lived in the area year round hunting, fishing, trapping, gathering food from nature and cultivating gardens for certain staples in their diet. In 1827 an Indian agent named Lindley signed a treaty with the Pottawatomie Indians to build a grist mill along what is now Rain Creek. In return Lindley would provide corn processed through the mill to the Indians. A dam was built along Rain Creek and this dam brought together five smaller pond areas into what is now Lake Manitou. A blacksmith shop and trading post was also built next to the mill and this was the first settled area of what would become Fulton County.

In 1836 a treaty was signed with the Pottawatamie Indians which moved them north to Marshall county near the Twin Lakes area, This land was coveted by the increasing number of white settlers but the Pottawatamie chief Menominee would not sell the land or move to another location. Indiana Governor Wallace authorized General John Tipton to raise an army and "keep the peace" which meant remove the Indians from the land. On September 4th 1838 general Tipton met with the Indians at a catholic church where they were disarmed and marched away at gunpoint. The Indians were lined up while their villages were burned and were forced to move to Osage, Kansas. This journey passed through Fulton and Miami County and is historically called the "Trail of Death". Approximately 150 deaths were recorded on the 61 day journey. This is the only case in the history of Indian affairs where force was used to remove the Indians.

At the time of European settlement in Indiana the majority of the state was forest (approximately 90% or 20 million acres), this includes the Lake Manitou watershed area. Even when Indiana received statehood in 1816 the vast majority of the state was still forest land. By the early 1900's things had changed. Indiana contains approximately 22.4 million acres of land. In 1917 the Yearbook of Indiana counted 1.7 million acres of forest in the state, that changed to 1.3 million acres in 1920 (approximately 6%). The driving force that created this change was the European settlement of the state and the farmland that was created by these settlers.

With the settlement of the Lake Manitou area the city of Rochester was formed and became a thriving resort town in the early 1900's. Thousands would come to Lake Manitou to swim, fish, or dance under the stars to music from well known big bands. Amusement centers were present and a paddleboat called the "Pastime" would take passengers for a cruise around the lake. The Lake Manitou area has evolved into a largely residential area while the lake Manitou watershed remains agricultural.

2.7 Physiography

The Lake Manitou watershed is located in the Northern Moraine and Lake Region of the Upper Wabash River Basin. This area is characterized by moraines, outwash and lake (lacustrine) plains. The area can be divided into two parts:

A. The Stueben Morainal Lake area
B. Kankakee Outwashed and Lacustrine Plain[2]

The Stueben Morainal Lake area is an interlobate moraine topography. "Interlobate moraine" describes the assemblage of moraines between two lobes of glacial ice. The topography of the Steuben Moraine Lake area is considered hummocky terrain with numerous kettle lakes. Glacial stratigraphy is very complex within the interlobate morainal deposits. This is largely due to the fact that slumping and ice thrusting obscure much of the original structure. The slumping occurred when entrapped ice melted, creating surface depressions. Some of the depressions filled with water, others were drained. Hills composed of blocks of reworked till as well as ice-contract stratified sand and gravel (kames) are common, as well as meltwater channels and outwash plains.
The Kankakee Outwash and Lacustrine Plain can be described as a flat and poorly drained area. Sand deposited as outwash from glacial meltwater is found at or near the surface throughout the area. Most sand deposits are in valley trains or outwash plains.

2.8 Geology

Bedrock deposits in the Upper Wabash River Basin are composed of Paleozoic limestone, dolomites, sand stone and shale. The Cincinnati Arch is the dominant bedrock structure cutting northwest through the Wabash Basin. Along the axis of the arch land dips 4 to 13 feet/mi (0.04 to 0.14 degree). Most of the Upper Wabash River Basin is on the northeast dipping flank of the Cincinnati Arch. Althought Paleozoic bedrock crops out at numerous locations in the Upper Wabash River Basin it is covered by drift in most places. The age of bedrock exposed the preglacial erosion ranges from 315 to 440 million years. Older Paleozoic rocks are present in the basin but they were not exposed to past Paleozoic erosion. A thick sequence of Cambrian sandstone, siltstone, shale, limestone and dolomites overlay Precambrian igneous and metamorphic basement rocks. In the Upper Wabash River Basin Cambrian rocks range from 2,000 to 3,500 feet in thickness. The Cambrian rocks are overlain by younger Ordovician sandstones, shales and carbonate rocks. Ordovician rocks in the Upper Wabash River Basin area are 1,000 to 1,400 feet thick. Carbonate rocks are relatively resistant to weathering there for they form the bedrock surface across the top of the Cincinnati Arch. Carbonate rocks are the bedrock surface in about seventy five percent of the Upper Wabash River Basin and the present throughout the basin. Shale and limestone were added in the Devonian and Mississipian and Pennsylvanian periods

2.9 Endangered/Threatened Species

The Indiana Natural Heritage Center provides information on endangered, threatened, or rare species, high quality natural communities and natural areas in Indiana. The Indiana Department of Natural Resources (IDNR) developed the database to assist in documenting the presence of special species and significant natural areas and to serve as a tool for setting management priorities in areas where special species or habitats exist. The database relies on observations from individuals rather than systematic field surveys by the IDNR. For this reason the Indiana Natural Heritage Center does not document every occurrence of special species or habitat. At the same time the listing of species or natural area does not guarantee that the listed species is currently present or that the listed area is in pristine condition. The database includes the date that the species or special habitat was last observed in a specific location.
The list of endangered, threatened, and rare species for Fulton County Indiana (see list 1) include:
17 Mollusks
8 Fish
2 Amphibians
3 Reptiles
10 Birds
5 Mammals
11 Vascular Plants
There were also 5 High Quality Natural Communities on the list.

Miami County's list of endangered, threatened, and rare species (see list 2) include:
12 Mollusks
2 Fish
2 Reptiles
2 Birds
2 Mammals
3 Vascular plants
There were 2 High Quality Natural Communities listed in Miami County.

There are four species in the Lake Manitou watershed that are considered endangered by the federal government, the Clubshell, Rough Pigtoe, and Northern Riffleshell mollusks as well as the Indiana Bat. These four as well as 25 other species in the Lake Manitou watershed are considered endangered by the state of Indiana.

List 1

Indiana County Endangered, Threatened and Rare Species List

County: Fulton

Species Name	Common Name	FED	STATE	GRANK	SRANK
Mollusk: Bivalvia (Mussels)					
Alasmidonta viridis	Slippershell Mussel			G4G5	S2
Epioblasma torulosa rangiana	Northern Riffleshell	LE	SE	G2T2	S1
Fusconaia subrotunda	Longsolid		SE	G3	S1
Lampsilis fasciola	Wavyrayed Lampmussel		SSC	G4	S2
Lampsilis ovata	Pocketbook			G5	S2
Ligumia recta	Black Sandshell			G5	S2
Obovaria subrotunda	Round Hickorynut		SSC	G4	S2
Plethobasus cyphyus	Sheepnose	C	SE	G3	S1
Pleurobema clava	Clubshell	LE	SE	G2	S1
Pleurobema plenum	Rough Pigtoe	LE	SE	G1	S1
Pleurobema pyramidatum	Pyramid Pigtoe		SE	G2	S1
Ptychobranchus fasciolaris	Kidneyshell		SSC	G4G5	S2
Quadrula cylindrica cylindrica	Rabbitsfoot		SE	G3T3	S1
Simpsonaias ambigua	Salamander Mussel		SSC	G3	S2
Toxolasma lividus	Purple Lilliput		SSC	G2	S2
Villosa fabalis	Rayed Bean	C	SSC	G1G2	S1
Villosa lienosa	Little Spectaclecase		SSC	G5	S2
Fish					
Ammocrypta pellucida	Eastern Sand Darter			G3	S2
Coregonus artedi	Cisco		SSC	G5	S2
Etheostoma camurum	Bluebreast Darter			G4	S1
Etheostoma maculatum	Spotted Darter		SSC	G2	S1
Etheostoma tippecanoe	Tippecanoe Darter		SSC	G3G4	S1
Hybopsis amblops	Bigeye Chub			G5	S2
Ichthyomyzon bdellium	Ohio Lamprey			G3G4	S2
Percina evides	Gilt Darter		SE	G4	S1
Amphibian					
Necturus maculosus	Common mudpuppy		SSC	G5	S2
Rana pipiens	Northern Leopard Frog		SSC	G5	S2
Reptile					
Clemmys guttata	Spotted Turtle		SE	G5	S2
Emydoidea blandingii	Blanding's Turtle		SE	G4	S2
Sistrurus catenatus catenatus	Eastern Massasauga	C	SE	G3G4T3T4	S2

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Indiana Department of Natural Resources
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Fed: LE = Endangered; LT = Threatened; C = candidate; PDL = proposed for delisting
State: SE = state endangered; ST = state threatened; SR = state rare; SSC = state species of special concern; SX = state extirpated; SG = state significant; WL = watch list
GRANK: Global Heritage Rank: G1 = critically imperiled globally; G2 = imperiled globally; G3 = rare or uncommon globally; G4 = widespread and abundant globally but with long term concerns; G5 = widespread and abundant globally; G? = unranked; GX = extinct; Q = uncertain rank; T = taxonomic subunit rank
SRANK: State Heritage Rank: S1 = critically imperiled in state; S2 = imperiled in state; S3 = rare or uncommon in state; G4 = widespread and abundant in state but with long term concern; SG = state significant; SH = historical in state; SX = state extirpated; B = breeding status; S? = unranked; SNR = unranked; SNA = nonbreeding status unranked

Bird					
Ardea herodias	Great Blue Heron			G5	S4B
Botaurus lentiginosus	American Bittern		SE	G4	S2B
Buteo platypterus	Broad-winged Hawk	No Status	SSC	G5	S3B
Cistothorus palustris	Marsh Wren		SE	G5	S3B
Cistothorus platensis	Sedge Wren		SE	G5	S3B
Gallinula chloropus	Common Moorhen	No Status	SE	G5	S3B
Ixobrychus exilis	Least Bittern		SE	G5	S3B
Rallus limicola	Virginia Rail		SE	G5	S3B
Sterna forsteri	Forster's Tern			G5	SHB
Tyto alba	Barn Owl		SE	G5	S2
Mammal					
Condylura cristata	Star-nosed Mole		SSC	G5	S2?
Lynx rufus	Bobcat	No Status		G5	S1
Myotis sodalis	Indiana Bat or Social Myotis	LE	SE	G2	S1
Spermophilus franklinii	Franklin's Ground Squirrel		SE	G5	S2
Taxidea taxus	American Badger			G5	S2
Vascular Plant					
Bidens beckii	Beck Water-marigold		ST	G4G5T4	S1
Carex atlantica ssp. capillacea	Howe Sedge		SE	G5T5?	S1
Carex bebbii	Bebb's Sedge		ST	G5	S2

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Indiana County Endangered, Threatened and Rare Species List

County: Fulton

Species Name	Common Name	FED	STATE	GRANK	SRANK
Carex pseudocyperus	Cyperus-like Sedge		SE	G5	S1
Carex sparganioides var. cephaloidea	Thinleaf Sedge		SE	G5	S2
Cirsium hillii	Hill's Thistle		SE	G3	S1
Crataegus succulenta	Fleshy Hawthorn		SR	G5	S2
Eriophorum viridicarinatum	Green-keeled Cotton-grass		SR	G5	S2
Geranium bicknellii	Bicknell Northern Crane's-bill		SE	G5	S1
Lathyrus venosus	Smooth Veiny Pea		ST	G5	S2
Stenanthium gramineum	Eastern Featherbells		ST	G4G5	S1
High Quality Natural Community					
Forest - upland mesic	Mesic Upland Forest		SG	G3?	S3
Savanna - sand dry	Dry Sand Savanna		SG	G2?	S2
Savanna - sand dry-mesic	Dry-mesic Sand Savanna		SG	G2?	S2S3
Wetland - fen	Fen		SG	G3	S3
Wetland - marsh	Marsh		SG	GU	S4

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County: Miami

Species Name	Common Name	FED	STATE	GRANK	SRANK
Mollusk: Bivalvia (Mussels)					
Epioblasma triquetra	Snuffbox		SE	G3	S1
Lampsilis fasciola	Wavyrayed Lampmussel		SSC	G4	S2
Lampsilis teres	Yellow Sandshell			G5	S2
Ligumia recta	Black Sandshell			G5	S2
Obovaria subrotunda	Round Hickorynut		SSC	G4	S2
Plethobasus cyphyus	Sheepnose	C	SE	G3	S1
Pleurobema clava	Clubshell	LE	SE	G2	S1
Ptychobranchus fasciolaris	Kidneyshell		SSC	G4G5	S2
Quadrula cylindrica cylindrica	Rabbitsfoot		SE	G3T3	S1
Toxolasma lividus	Purple Lilliput		SSC	G2	S2
Venustaconcha ellipsiformis	Ellipse		SSC	G3G4	S2
Villosa fabalis	Rayed Bean	C	SSC	G1G2	S1
Fish					
Ammocrypta pellucida	Eastern Sand Darter			G3	S2
Moxostoma valenciennesi	Greater Redhorse		SE	G4	S2
Reptile					
Emydoidea blandingii	Blanding's Turtle		SE	G4	S2
Thamnophis proximus	Western Ribbon Snake		SSC	G5	S3
Bird					
Ardea herodias	Great Blue Heron			G5	S4B
Circus cyaneus	Northern Harrier		SE	G5	S2
Mammal					
Lynx rufus	Bobcat	No Status		G5	S1
Taxidea taxus	American Badger			G5	S2
Vascular Plant					
Crataegus succulenta	Fleshy Hawthorn		SR	G5	S2
Hypericum pyramidatum	Great St. John's-wort		ST	G4	S1
Napaea dioica	Glade Mallow		SR	G3	S2
High Quality Natural Community					
Forest - upland dry-mesic	Dry-mesic Upland Forest		SG	G4	S4
Forest - upland mesic	Mesic Upland Forest		SG	G3?	S3

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2.10 Hydrology

As is characteristic of much of the glaciated portion of the state, hydrologic characteristics including lakes streams and wetlands are important components of the Lake Manitou watershed. Lake Manitou is a 713 acre lake that was formed from five smaller lakes when a grist mill was built in 1832 and Rain Creek was dammed. There are three nature preserves/wetlands adjacent or near to Lake Manitou which are approximately 200 acres in size. These wetlands are very efficient at filtering sediment and nutrients from runoff while also storing water for future release. The wetland area also serves as a spawning site for many fish, a nesting habitat for many types of waterfowl, and a rich environment for many plant species.

Lake Manitou is fed from natural spring aquafers as well as five streams. Rain Creek runs from the southeastern part of the watershed to the northwest. The watershed area of Rain Creek is 15,399 acres which is approximately 56% of the Lake Manitou watershed.. Graham Ditch flows from the east to the west and into Lake Manitou. The Graham Ditch watershed occupies 1,931 acres which is approximately 7% of the watershed. Whittenberger/Eiler Ditch, Mastellar Ditch, and Weaver/Kitchen Ditch make up the remaining area of the watershed (See the Physical Setting section and the Aquifer section for further information).

2.11 Land Use

The Lake Manitou watershed area contains 27,700 acres with approximately 80% (22,000 acres) of the area classified as "land in farms" (USDA census 2002). 73% of the watershed is farmland in the form of row crops and the average size of a farm is approximately 300 acres. Grassland, pasture, forest, and water/wetland account for approximately 4% each of land use (Indiana Farm Land Use History nass.usda.gov) with the remaining categories accounting for less than 1% each (See land cover figure# 5). USDA Agricultural Census indicates corn occupies 39% of the watershed, soybeans 30% and crops used for forage (hay, grass etc..) 10% (See crop use figure# 6). Impervious surfaces are not a large part of the watershed. The residential areas located around Lake Manitou are the largest contributor. The scattered residences and roadways within the watershed are also minor contributors.

Figure 5
Land Use for Lake Manitou Watershed HUC# 05120106050020 and 05120106050010.

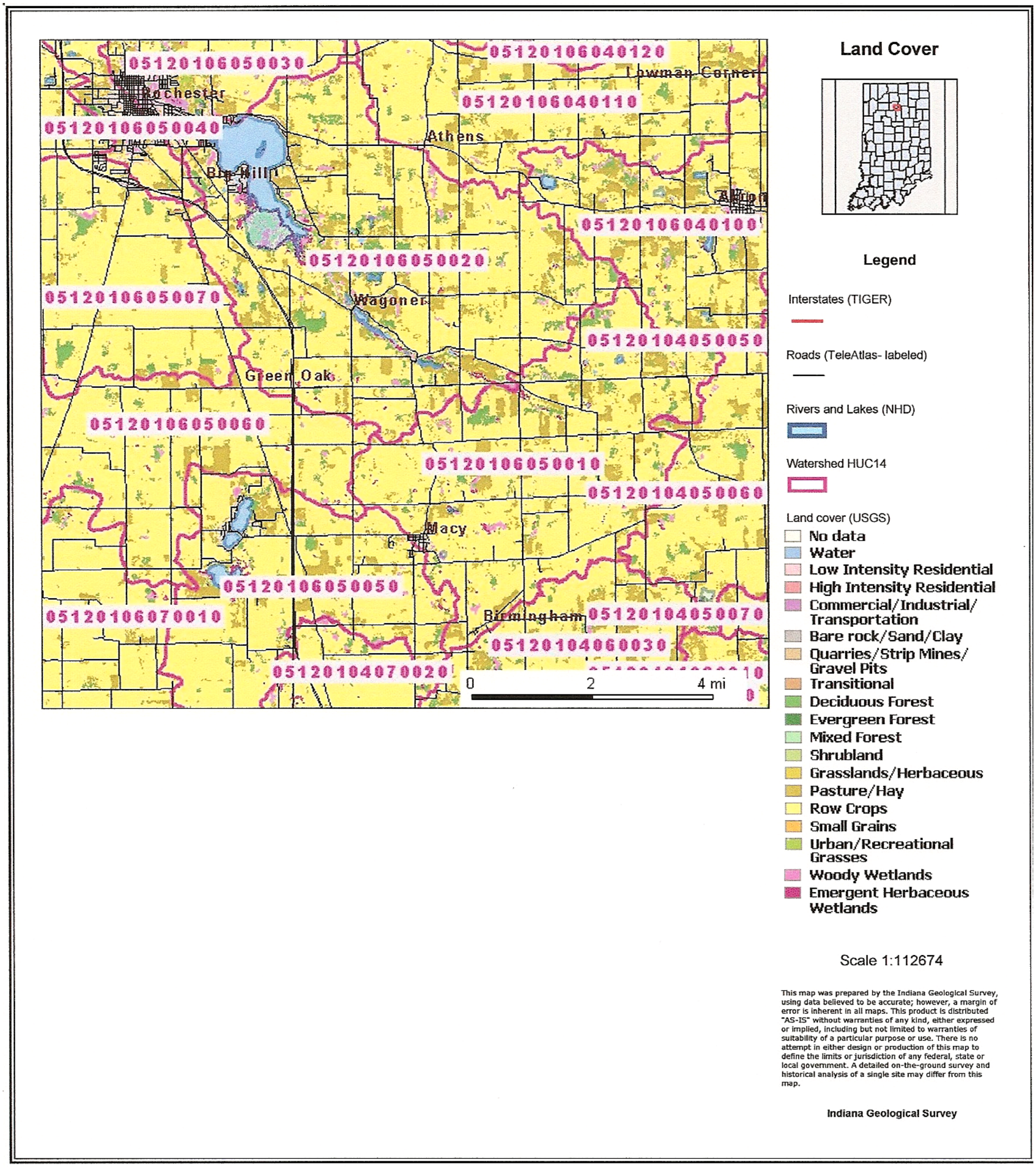


Figure 6
Crop Use for Lake Manitou Watershed HUC# 05120106050020/HUC# 05120106050010

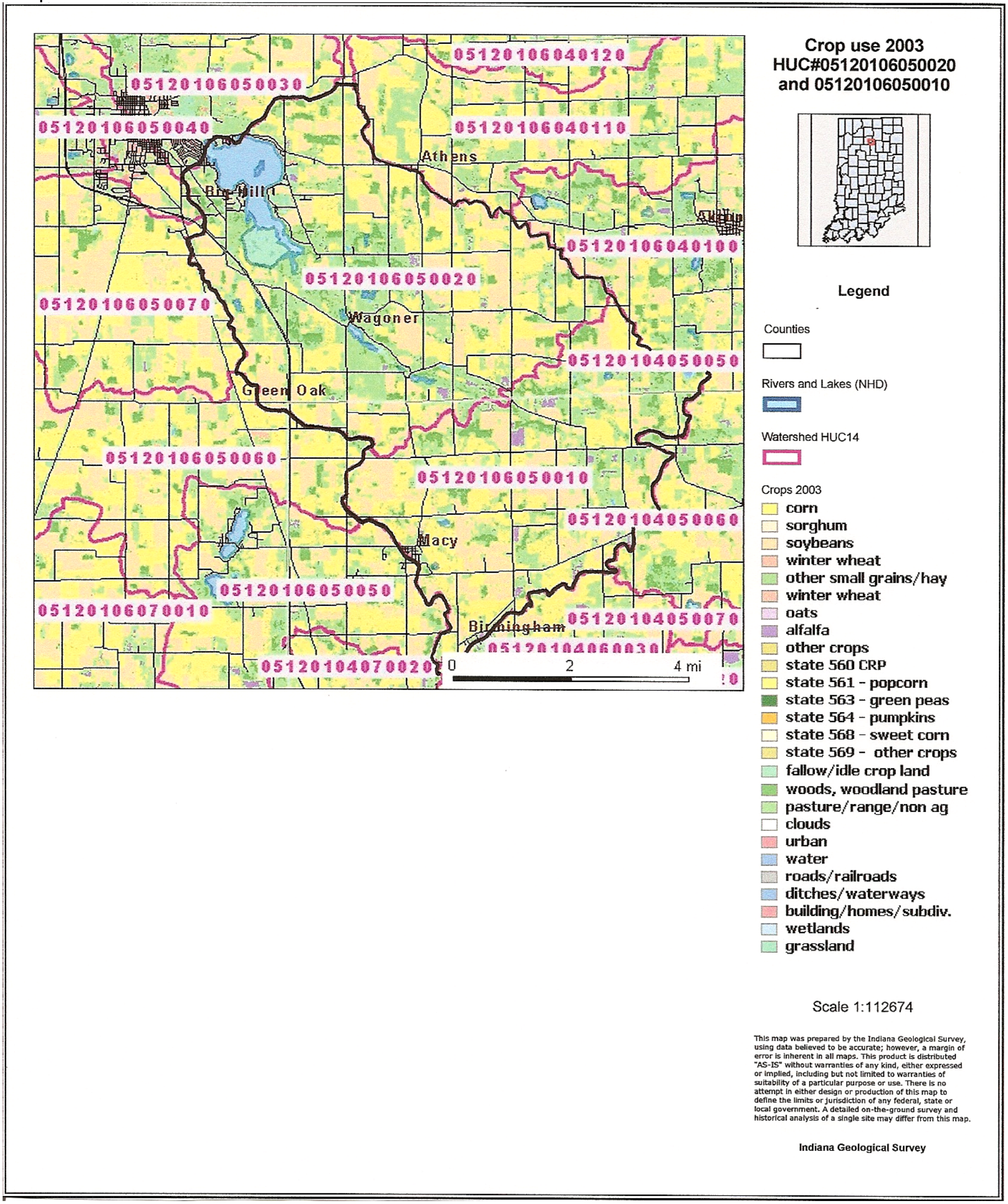
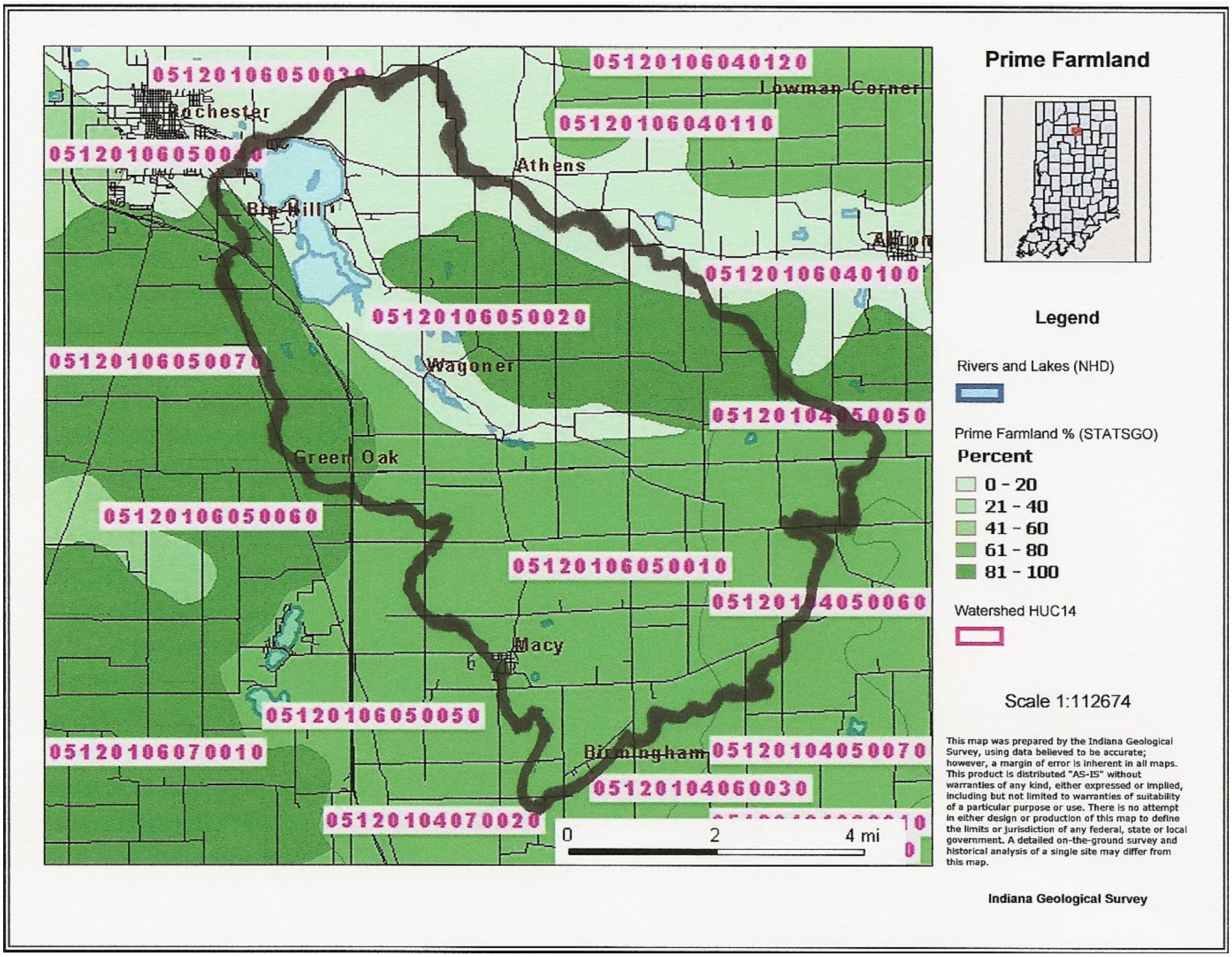


Figure 7
Prime Farmland in Lake Manitou Watershed



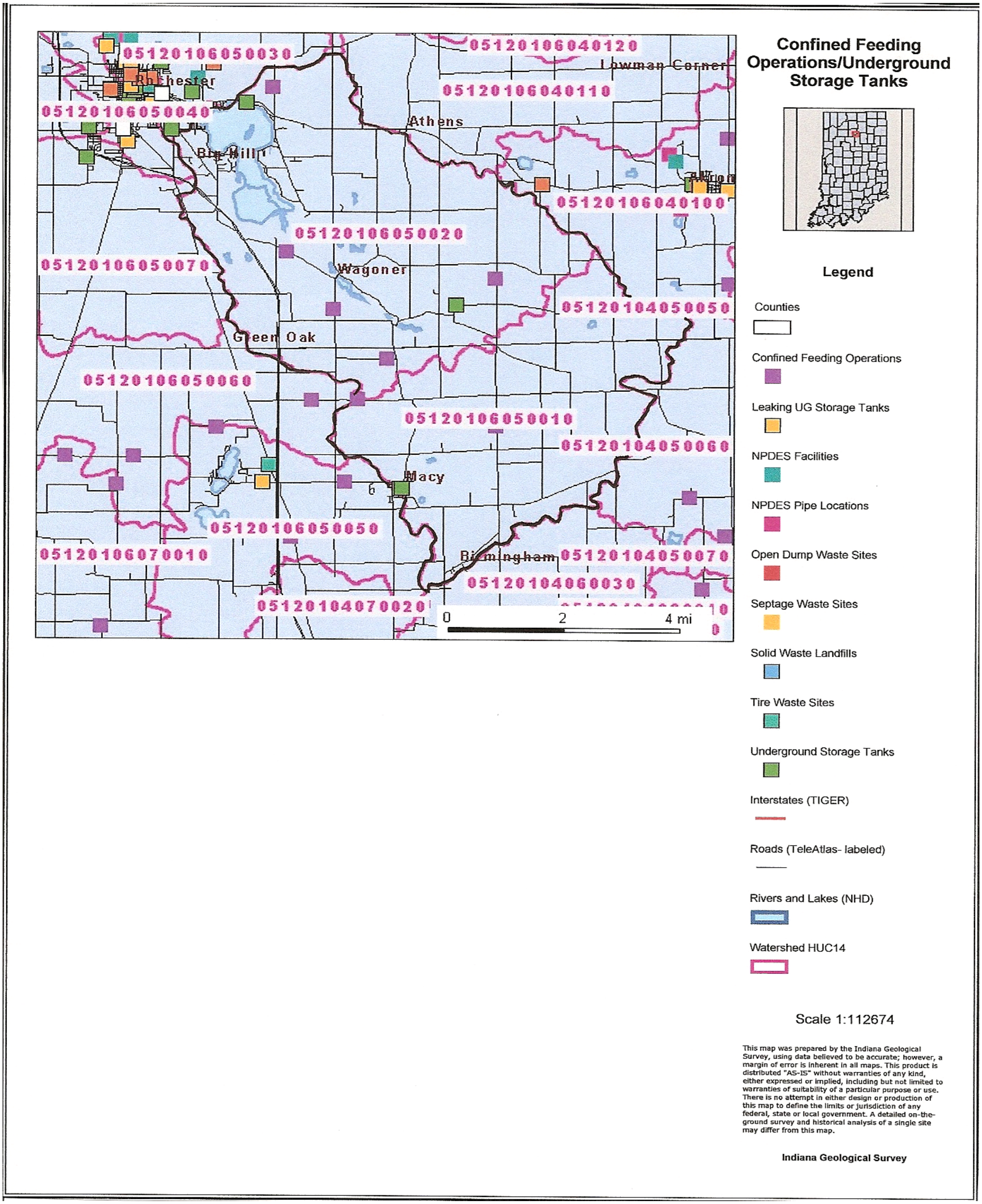
The prime farmland rating for the Lake Manitou watershed indicates the majority of the area is rated as good for farming 61-80% or 81-100%. The area east of Lake Manitou and the area southeast of Lake Manitou (which is largely wetland) are the least productive lands in terms of farm use (See figure 7).

2.12 Potential Point Source Pollution

CAFO's (Concentrated Animal Feeding Operations) have become a popular idea among some animal farmers, particularly in hog and dairy operations. The presence of a large amount of animals in a small area of land can present some serious issues in terms of surface pollution, regulating and storing manure, safe and proper ways to manage the land, soil erosion, storm water runoff and ground water contamination just to mention a few. The EPA (Environmental Protection Agency) and IDEM (Indiana Department of Environmental Management) have regulations in place for CAFO operations and the CAFO owners would be financially liable for any cleanup from a spill however the damage of a spill to a watershed area could be much greater than money. The potential consequences to public health and the ecology of the area should be carefully considered by the people living near the CAFO. While regulations are in place for CAFO's if the animal farmer has met all the regulatory requirements the chances are very good that a CAFO permit would be granted. It is up to the local community to decide whether this is a good idea for them. CAFO's are often stopped at the grass roots level by concerned citizens who band together to sign petitions, start an ad campaign in the community and let their feelings be known at the local zoning board meeting. Waiting for the state to deny a permit for a CAFO could prove to be a serious mistake. The Lake Manitou watershed has no CAFO's currently although there have been inquiries made regarding a hog farm CAFO. At this time no paperwork has been filed. There are six CFO's (confined feeding operations) in the Lake Manitou watershed (See figure #8). None of them have direct access to streams. Soil erosion and runoff do not appear to be a significant factor.

Underground storage tanks (UST's) are another concern in terms of possible sources of pollution. The vast majority of UST's were installed by the petroleum industry although some rural homes and farms also use UST's. There are 3 UST's in the Lake Manitou watershed and 2 others located just outside the watershed in the city of Rochester (See figure). Problems with UST's begin when they start to leak (LUST's). It was common practice in the past to bury the tanks and forget about them but when hydrocarbons begin leaking from an underground tank into the soil it becomes a problem for the entire community. Nature has the ability to break down these hydrocarbons over time, however the hydrocarbons may pass quickly into an aquifer and contaminate the groundwater before being broken down. The potential public health and environmental problems could persist for years and be extremely costly to deal with. In 1994 it was estimated that 1.2 million UST's were in the US. A clean-up program is in effect for older UST's and LUST's funded by Congress, EPA, and states (CRS report 97-471Library of Congress). Today any new UST's are required to meet federal and state laws. The owner of a UST must show that they are financially able to clean up any leak or spill. Most states have funds set aside to deal with LUST's.

Figure 8


Confined Feeding Operations/Underground Storage Tanks
Legend
Counties
Confined Feeding Operations
Leaking UG Storage Tanks
NPDES Facilities
NPDES Pipe Locations
Open Dump Waste Sites
Septage Waste Sites
Solid Waste Landfills
Tire Waste Sites
Underground Storage Tanks
Interstates (TIGER)
Roads (TeleAtlas- labeled)
Rivers and Lakes (NHD)
Watershed HUC14
Scale 1:112674
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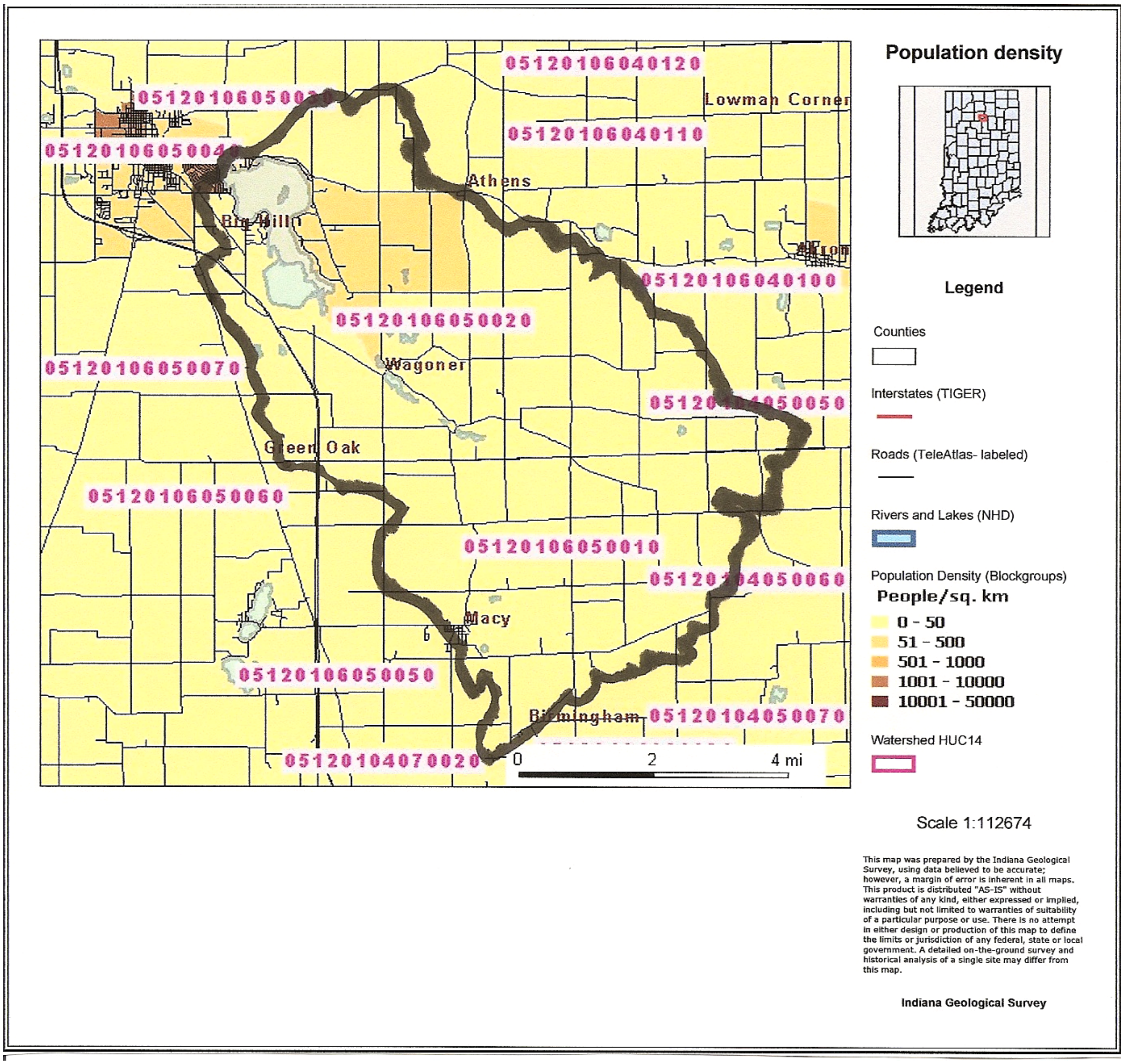
Indiana Geological Survey
05120106050030
05120106040120
Lowman Corner
Rochester
05120106040110
05120106050040
Athens
Big Hill
05120106040100
05120106050020
05120106050070
Wagoner
05120104050050
Green Oak
05120106050060
05120106050010
05120104050060
Macy
05120106050050
05120106070010
Birmingham
05120104050070
05120104060030
05120104070020
0
2
4 mi

2.13 Population

The Lake Manitou watershed is a sparsely populated area where the population density is 0-50 people/square kilometer for the majority of the watershed with the exception of the area east of Lake Manitou in which the population density falls in the 51-500 people/square kilometer (See figure 9). The median age for the area is 37 years and the median income is approximately $ 38,000.00 per year. There are approximately 8% of the population which live below the poverty line.

Figure 9



3.0 Baseline Water Quality Within the Lake Manitou Watershed

This section deals with water conditions in Lake Manitou, Mount Zion Millpond, Rain Creek, and Graham Ditch. This data was collected in hopes of recognizing any strengths and weaknesses which in turn would improve the overall health and stability of the watershed. Stake holders can use this data to take action when needed and set realistic goals for the short and long term improvement of the watershed. The data within this section was collected in accordance with the Lake Manitou Watershed Quality Assurance Project Plan submitted by J.F. New and approved by IDEM in May 2006.

3.1 Tributaries

Rain Creek and Graham Ditch were assessed by JFNew on July 25th, 2006. A second reading was taken after a storm in which at least one inch of rain fell in a 24 hour period on August 29th, 2006 (See chart 2 and 3). Water chemistry, biotic communities and habitat were studied. The water chemistry in the two tributaries was good. Temperature, dissolved oxygen, pH, conductivity, as well as total suspended solids were all below state standards or generally accepted levels. The Nitrate-nitrogen and Ammonia-nitrogen levels were also low however the Ammonia-nitrogen in Graham Ditch was elevated after storm flow conditions suggesting that decomposition may be taking place upstream of the sampling point. Total phosphorus levels were elevated in both streams during both the sampling events. With the exception of Graham Ditch during base flow, all of the stream data placed phosphorus levels in excess of what is considered to be eutrophic (highly productive).

When the parameter concentrations are multiplied by the flow rate of the stream a loading rate is calculated (See chart 6). Rain Creek possesses the highest loading rate of the two streams with the exception of Nitrate-nitrogen loading rate in Graham Ditch during base flow conditions. It is not surprising that Rain Creek has a higher loading rate since the watershed surrounding it is much larger than the Graham Ditch watershed. When nutrient and sediment loading rates are normalized by watershed area, Graham Ditch possesses the highest areal loading rates during base and storm flow conditions for all parameters except nitrate-nitrogen during storm flow and total Kjeldahl nitrogen during base flow (See chart 7).

The QHEI (Qualitative Habitat Evaluation Index) is used to evaluate stream characteristics, as opposed to the characteristics of a single sampling site. Individual sites may have poorer physical habitat due to a localized disturbance and still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores indicate that values greater than 60 are generally conducive to the existence of warm water faunas. Rain Creek had a QHEI score of 64 indicating that it supports a good variety of moderately tolerant warm water biotic communities. Graham Ditch had a QHEI score of 41 indicating conditions are less conducive for warm water faunas. Graham Ditch had less pool-riffle development and a poorer substrate along with limited channel morphology and a narrow riparian zone.

The Index of Biotic Integrity was used to evaluate the macroinvertebrate populations in both Rain Creek and Graham Ditch (Chart 4 and 5). In general the macroinvertebrate communities rated relatively poorly with Rain Creek scoring a 4.2 rating indicating moderate impairment. Graham Ditch received a score of 1.3 indicating severe impairment. The lack of macroinvertebrate presence and diversity in Graham Ditch may indicate further investigation is needed to improve water quality and macroinvertebrate habitat. The elevated E.Coli presence in Graham Ditch (See chart 3) could be a contributing factor in the lack of macroinvertebrates living there. Investigating upstream for a source of the bacterial contamination (improper sewage disposal, animal fecal deris reaching the waterway etc…) could be useful for improving the streams overall health.

Chart 2

sites during 2006 water chemistry sampling events.

Site	Date	Timing	Flow (cfs)	Temp (°C)	DO (mg/L)	% Sat.	Cond (µmhos)	pH	TSS (mg/L)
Rain Creek (1)	7/25/2006	Base	6.9	26.4	7.53	94.1	570	--	2.907
	8/29/2006	Storm	17.06	23.3	5.6	65.8	558	7.4	7.778
Graham Ditch (2)	7/25/2006	Base	2.75	19.3	7.77	84.5	642	--	2.527
	8/29/2006	Storm	3.012	17.7	6.47	67.1	645	7.2	5.600

Chart 3

Site	Date	Timing	NO_3-N (mg/L)	NH_3-N (mg/L)	TKN (mg/L)	SRP (mg/L)	TP (mg/L)	*E. coli* (col/100 mL)
Rain Creek (1)	7/25/2006	Base	0.085	0.086	2.075	0.032	0.161	10
	8/29/2006	Storm	0.860	0.122	0.799	0.101	0.092	100
Graham Ditch (2)	7/25/2006	Base	1.312	0.049	0.405	0.024	0.056	910
	8/29/2006	Storm	0.073	0.233	0.981	0.160	0.170	1420

Chart 4

Macroinvertebrate families and metric scores calculated for Rain Creek

collected July 26, 2006.

mIBI Metric		Metric Score
HBI	4.23	6
No. Taxa (family)	9	2
Total Count (# individuals)	102	2
% Dominant Taxa	75.5	0
EPT Index (# families)	2	0
EPT Count (# individuals)	78	4
EPT Count/Total Count	0.76	8
EPT Abundance/Chironomid Abundance	26.00	8
Chironomid Count	3	8
mIBI Score		**4.2**

Class/Order	Family	#	EPT	# w/t	Tolerance (t)	# x t	%
Amphipoda	Gammaridae	2		2	4	8	1.96
Coleoptera	Hydrophilidae	10				0	9.80
Diptera	Chironomidae	3		3	6	18	2.94
Gastropoda	Physidae	3		3	8	24	2.94
Odonata	Calopterygidae	3		3	5	15	2.94
Platyhelminthes	Turbellaria	2		2	4	8	1.96
Platyhelminthes	Hirudinea	1				0	0.98
Trichoptera	Hydropsychidae	77	77	77	4	308	75.49
Trichoptera	Leptoceridae	1	1	1	4	4	0.98
TOTALS		**102**	**78**	**91**		**385.0**	**100.00**

Chart 5

Macroinvertebrate families and metric scores calculated for Graham Ditch

collected July 26, 2006.

mIBI Metric		Metric Score
HBI	5.24	2
No. Taxa (family)	6	0
Total Count (# individuals)	23	0
% Dominant Taxa	56.5	2
EPT Index (# families)	0	0
EPT Count (# individuals)	0	0
EPT Count/Total Count	0.00	0
EPT Abundance/Chironomid Abundance	0.00	0
Chironomid Count	3	8
mIBI Score		**1.3**

Class/Order	Family	#	EPT	# w/t	Tolerance (t)	# x t	%
Amphipoda	Gammaridae	13		13	4	52	56.52
Diptera	Chironomidae	3		3	6	18	13.04
Gastropoda	Gyraulus	1		1	8	8	4.35
Gastropoda	Physidae	4		4	8	32	17.39
Platyhelminthes	Annelida	1				0	4.35
Platyhelminthes	Hirudinea	1				0	4.35
TOTALS		**23**	**0**	**21**		**110.0**	**100.00**

Chart 6

Nutrient and sediment parameter loading data collected during 2006 sampling events

Site	Date	Timing	NO_3-N Load (kg/d)	NH_3-N Load (kg/d)	TKN Load (kg/d)	SRP Load (kg/d)	TP Load (kg/d)	TSS Load (kg/d)
Rain Creek (1)	7/25/2006	Base	1.43	1.45	35.01	0.54	2.72	49.04
	8/29/2006	Storm	35.87	5.09	33.33	4.21	3.84	324.43
Graham Ditch (2)	7/25/2006	Base	8.82	0.33	2.72	0.16	0.38	16.99
	8/29/2006	Storm	0.54	1.72	7.22	1.18	1.25	41.24

Chart 7

Selected nutrient and sediment parameter areal loading data collected from the Lake Manitou watershed sites during 2006 water chemistry sampling events.

Site	Date	NO_3-N Areal Load (kg/ha-yr)	NH_3-N Areal Load (kg/ha-yr)	TKN Areal Load (kg/ha-yr)	SRP Areal Load (kg/ha-yr)	TP Areal Load (kg/ha-yr)	TSS Areal Load (kg/ha-yr)
Rain Creek (1)	7/25/2006	0.08	0.08	2.05	0.16	0.03	2.87
	8/29/2006	2.10	0.30	1.95	0.22	0.25	18.99
Graham Ditch (2)	7/25/2006	4.12	0.15	1.27	0.18	0.08	7.93
	8/29/2006	0.25	0.80	3.37	0.58	0.55	19.26

3.2 Mount Zion Millpond

Mount Zion Mill Pond has a transparency of 1.6 feet according to the Secchi disk analysis. This is considered poor compared to most Indiana lakes which average approximately 6 feet of transparency. The level of light penetrating the water confirms the Secchi disk result. One percent of light was able to penetrate the water at a depth of four feet. This depth serves as the limit in which aquatic macrophytes and phytoplankton have enough light to photosynthesize. Plankton concentrations were twice as high in the Mt. Zion Mill Pond (71,600/L) compared to the average Indiana lake (35,570/L). Chlorophyll a concentrations were relatively normal (9.7 mg/L compared to 12.9 mg/L as a median for Indiana lakes). This indicates that the majority of plankton in the Mt. Zion Mill Pond is not blue-green algae. Dissolved oxygen analysis indicates a sufficient amount to support fish and other aquatic biota throughout the water column .The total phosphorus concentration in Mt. Zion Mill Pond was over three times the median concentrations for Indiana lakes (0.511 mg/L compared to 0.17 mg/L). Even though the total phosphorus was high in the Mill Pond (see chart 8) the soluble reactive phosphorus (used by plankton and plants) was low (0.039 mg/L). This indicates that the majority of phosphorus present in the Mill Pond is in the particulate form which cannot be used by plankton. The ammonia-nitrogen concentration was less than half the median for Indiana lakes (0.385 mg/L compared to 0.818 mg/L) yet the organic nitrogen concentration was elevated in the Mill Pond (2.37 mg L compared to 1.66 mg/L) relative to the state median. This data suggests that a large amount of organic material is present in the Mill Pond but only a small amount of this material is undergoing decomposition.

The Mount Zion Mill Pond's Indiana Trophic State Index (ITSI) score of 29 is indicative of relatively good water quality and a mesotrophic (moderately productive) environment (see chart 8).

Chart 8

Water quality characteristics of Mt. Zion Mill Pond as sampled July 26, 2006.

Parameter	Epilimnetic Sample	Hypolimnetic Sample	Indiana TSI Points (based on mean values)
pH	7.6	-	-
Alkalinity	254 mg/L	-	-
Conductivity	599 µmhos	-	-
Secchi Depth Transparency	0.5 meters	-	6
Light Transmission @ 3 ft.	4.1 %	-	4
1% Light Level	3.9 feet	-	-
Total Phosphorous	0.511 mg/L	-	4
Soluble Reactive Phosphorous	0.039 mg/L	-	1
Nitrate-Nitrogen	0.057 mg/L	-	0
Ammonia-Nitrogen	0.385 mg/L	-	1
Organic Nitrogen	2.369 mg/L	-	3
Total Suspended Solids	12.56 mg/L	-	-
Oxygen Saturation @ 5ft.	31.3%	-	0
% Water Column Oxic	100%	-	0
Plankton Density	71,612 nu/L	-	10
Blue-Green Dominance	9.69%	-	0
Chlorophyll *a*	9.69 µg/L	-	-
		TSI score	29

3.3 Lake Manitou

The Lake Manitou Secchi disk transparency measured 2.6 feet which indicates poor water clarity compared to most Indiana lakes (6 feet). The measurement of depth at which 1% light is present is 8.2 feet. This depth is considered the littoral zone or the area in which photosynthesis can take place. The plankton concentration in Lake Manitou was low at 10,765/L compared to 35,570/L for a state average. Most of the plankton analyzed was in the form of blue-green algae. In spite of the dominance of blue-green algae in the plankton the chlorophyll a concentration was low measuring only1.04 ug/L. Lake Manitou's dissolved oxygen content suggests that the greatest amount of dissolved oxygen is present at a depth of approximately 5 feet (based on the number of plankton present). Data suggests that the bottom 60% of Lake Manitou does not possess enough dissolved oxygen to support fish or aquatic biota. Total phosphorus concentrations were low in Lake Manitou. The bottom portion of the lake contains slightly higher phosphorus levels than the top portion. This suggests that most of the phosphorus in the lake is in the form of readily usable soluble form (SRP). The soluble reactive phosphorus concentration at the surface of Lake Manitou was below the detection limit. This suggests that the SRP is being consumed by phytoplankton. The SRP was elevated in the deeper waters of Lake Manitou suggesting that dissolved phosphorus is being released from the lakes bottom sediment. This is called internal phosphorus loading.. The greater amount of ammonia-nitrogen in the deeper waters compared to the upper waters confirms that plant decomposition is likely occurring in the hypolimnion (bottom waters).

The lakes Indiana Trophic State Index (ITSI) score of 37 puts lake Manitou in the eutrophic category (see chart 9).The predominance of blue-green algae added 10 points to the score. This may warrant further investigation since the amount of chlorophyll a was low. This seems to be somewhat contradictory data.

Chart 9

Table A. Water quality characteristics of Lake Manitou as sampled July 26, 2006.

Parameter	Epilimnetic Sample	Hypolimnetic Sample	Indiana TSI Points (based on mean values)
pH	8.6	7.4	-
Alkalinity	143 mg/L	219 mg/L	-
Conductivity	400.4 µmhos	394.8 µmhos	-
Secchi Depth Transparency	0.8 meters	-	6
Light Transmission @ 3 ft.	7.5 %	-	4
1% Light Level	8.2 feet	-	-
Total Phosphorous	0.049 mg/L	0.056 mg/L	3
Soluble Reactive Phosphorous	0.010 mg/L	0.173 mg/L	2
Nitrate-Nitrogen	0.015 mg/L	0.066 mg/L	0
Ammonia-Nitrogen	0.047 mg/L	2.444 mg/L	4
Organic Nitrogen	0.848 mg/L	3.372 mg/L	2
Total Suspended Solids	6.725 mg/L	7.087 mg/L	-
Oxygen Saturation @ 5ft.	114.9%	-	1
% Water Column Oxic	38.5%	-	3
Plankton Density	10,764 nu/L	-	2
Blue-Green Dominance	63.2%	-	10
Chlorophyll *a*	1.04 µg/L	-	-
			TSI score 37

3.4 Lake Manitou Survey/Evaluation

The Indiana Department of Natural Resources conducted an aquatic plant survey of Lake Manitou on May 4th 2006 and August 7th 2006. A fish survey was also performed on July 13th to July 19th. Aquatic plants were found at depths of 20.5 feet in May and 16.5 feet in August. Chara was the most prevalent plant in May followed by coontail and eelgrass (see chart 10). The most common plants found in August were eelgrass followed by coontail and chara (see chart 11). The presence of Eurasian watermilfoil decreased significantly in 2006 compared to numbers in 2005. The most notable result of the 2006 aquatic plant survey was the collection of Hydrilla verticillata in Lake Manitou. Hydrilla was collected at three sites along the north shore of the lake. This was the first time hydrilla had been found in Indiana and the Midwest in general. This discovery prompted further testing of the lake for hydrilla. The Indiana Department of Natural Resources chose to treat the entire lake with a herbicide called Fluridone for a period of up to four years and to close the lake to outside use until further notice.

Chart 10

Occurrence and Abundance of Submersed Aquatic Plants - Overall

Lake:	Manitou	Secchi(ft):	20.5	SE Mean species / site:	0.11
Date:	5/4/2006	Littoral sites with plants:	71	Mean natives / site:	1.12
Littoral Depth (ft):	15.0	Number of species:	11	SE Mean natives / site:	0.09
Littoral Sites:	0	Maximum species / site:	4	Species diversity:	0.82
Total Sites:	90	Mean species / site:	1.32	Native diversity:	0.77

Species	Frequency of Occurrence	Score Frequency 0	1	3	5	Dominance
Chara	40.0	60.0	28.9	10.0	1.1	12.9
Coontail	26.7	73.3	16.7	4.4	5.6	11.6
Eelgrass	17.8	82.2	17.8	0.0	0.0	3.6
Northern watermilfoil	14.4	85.6	14.4	0.0	0.0	2.9
Curlyleaf pondweed	10.0	90.0	5.6	2.2	2.2	4.7
Eurasian watermilfoil	10.0	90.0	8.9	1.1	0.0	2.4
Sago pondweed	8.9	91.1	8.9	0.0	0.0	1.8
American Elodea	1.1	98.9	1.1	0.0	0.0	0.2
Flatstem pondweed	1.1	98.9	1.1	0.0	0.0	0.2
Largeleaf Pondweed	1.1	98.9	1.1	0.0	0.0	0.2
Leafy pondweed	1.1	98.9	1.1	0.0	0.0	0.2
Filamentous Algae	92.2					

Chart 11

Occurrence and Abundance of Submersed Aquatic Plants - Overall

Lake:	Manitou	Secchi(ft):	4.5	SE Mean species / site:	0.13
Date:	8/7/2006	Littoral sites with plants:	62	Mean natives / site:	1.24
Littoral Depth (ft):	16.5	Number of species:	9	SE Mean natives / site:	0.12
Littoral Sites:	81	Maximum species / site:	5	Species diversity:	0.77
Total Sites:	90	Mean species / site:	1.29	Native diversity:	0.76

Species	Frequency of Occurrence	Score Frequency 0	1	3	5	Dominance
Eelgrass	48.9	51.1	20.0	21.1	7.8	24.4
Coontail	24.4	75.6	13.3	3.3	7.8	12.4
Chara	22.2	77.8	14.4	4.4	3.3	8.9
Slender Naiad	12.2	87.8	11.1	1.1	0.0	2.9
Sago pondweed	11.1	88.9	10.0	1.1	0.0	2.7
Flatstem pondweed	3.3	96.7	3.3	0.0	0.0	0.7
Hydrilla	3.3	96.7	3.3	0.0	0.0	0.7
Variable-leaved pondweed	1.1	98.9	0.0	1.1	0.0	0.7
Curlyleaf pondweed	1.1	98.9	1.1	0.0	0.0	0.2
Largeleaf pondweed	1.1	98.9	1.1	0.0	0.0	0.2
Filamentous Algae	11.1					

A total of 606 fish were collected in the 2006 fish survey in Lake Manitou. Sixteen species of fish were collected at a cumulative weight of 256.3 lbs. Bluegill was the most abundant fish followed by largemouth bass, yellow perch, and gizzard shad (see chart 12). Carp was the most abundant species collected by weight followed by gizzard shad, largemouth bass, and bluegill .A total of 225 bluegills were collected (see chart 13) at a cumulative weight of 31.6 lbs. The length of blue gill ranged from 2.3 to 8.7 inches. There were 103 largemouth bass collected ranging in size from 1.8 to 14.2 inches.

Chart 12

Lake Manitou Fish Surveys (1970-2006)

Relative abundance of species from 2006 and previous surveys of Lake Manitou.

	2006	2003	1998	1989	1984	1979	1975	1973	1970
Species	Num. (%)	Num. (%)	Num. (%)	Num. (%)	Num. (%)	Num. (%)	Num. (%)	Num. (%)	Num. (%)
Bluegill	42.1	53.4	27.1	40.4	27.0	38.2	30.6	12.3	34.0
Largemouth bass	17.0	6.7	10.8	5.2	6.0	3.1	6.0	0.7	3.8
Yellow perch	12.4	5.4	26.1	3.2	3.5	10.6	9.5	5.5	2.8
Gizzard shad	11.1	17.2	4.4	13.8	11.8	*	21.7	38.7	30.8
Carp	4.6	0.5	0.8	1.0	0.4	*	0.3	-	-
Redear	4.3	6.1	0.4	6.7	2.3	8.0	1.9	1.3	1.9
Warmouth	3.3	-	2.1	1.1	1.4	2.4	1.0	0.3	0.7
Spotted gar	2.8	2.9	3.2	3.8	4.2	1.4	2.2	2.0	1.3
Golden shiner	0.5	0.1	4.0	0.1	2.3	3.3	3.8	1.6	4.2
Brook silverside	0.5	-	-	0.1	**	**	**	1.0	**
Black crappie	0.3	1.7	15.7	15.3	22.3	9.1	7.8	24.4	12.1
Rock bass	0.3	0.9	1.7	0.9	1.2	1.1	0.5	0.1	-
Bowfin	0.3	0.5	-	0.5	0.5	*	0.5	-	0.5
Yellow bullhead	0.2	0.9	0.8	1.3	0.9	5.5	1.3	0.7	2.1
Pumpkinseed	0.2	0.2	-	1.5	1.6	3.9	3.9	1.4	1.0
Black bullhead	0.2	-	-	0.6	-	*	-	-	-
Brown bullhead	-	0.7	1.9	1.7	12.2	9.0	6.4	8.5	2.4
White crappie	-	0.3	0.4	-	-	-	-	-	-
Northern pike	-	*	0.2	2.5	1.5	-	-	-	-
Longnose gar	-	*	-	-	-	*		0.1	-
Smallmouth bass	-	-	0.2	-	-	-	-	-	-
Lake chubsucker	-	-	-	0.1	0.1	1.2	1.7	0.6	1.5
Walleye	-	-	-	0.1	-	-	-	-	-
Redfin pickerel	-	-	-	0.1		*	0.2	-	0.1
Longear sunfish	-	-	-	-	0.3	*	0.1	-	0.2
White sucker	-	-	-	-	0.1	*	0.4	0.8	0.5
Golden redhorse	-	-	-	-	0.1	-	-	-	-
Johnny darter	-	-	-	-	0.1	-	-	-	-
Central mudminnow	-	-	-	-	-	-	0.2	-	-
Hybrid sunfish	-	-	-	-	-	-	0.1	-	0.2
Totals	606 fish	2094 fish	472 fish	1546 fish	737 fish	930 fish	929 fish	706 fish	844 fish

* Represents less than 0.1% of total ** Observed but not collected

Chart 13

Fish Survey Data of Lake Manitou 2006

SPECIES AND RELATIVE ABUNDANCE OF FISHES COLLECTED BY NUMBER AND WEIGHT					
*COMMON NAME OF FISH	NUMBER	PERCENT	LENGTH RANGE (inches)	WEIGHT (pounds)	PERCENT
Bluegill	255	42.1	2.3-8.7	31.59	12.3
Largemouth bass	103	17.0	1.8-14.2	42.49	16.5
Yellow perch	75	12.4	3.5-6.4	3.70	1.4
Gizzard shad	67	11.1	12.8-15.7	61.86	24.1
Carp	28	4.6	13.1-26.0	71.61	27.9
Redear	26	4.3	2.9-9.0	6.08	2.4
Warmouth	20	3.3	2.9-8.4	5.30	2.1
Spotted gar	17	2.8	16.0-33.5	24.76	9.6
Golden shiner	3	0.5	4.7-5.0	0.13	0.1
Brook silverside	3	0.5	3.3-4.1	0.03	0.0
Rock bass	2	0.3	3.6-7.8	0.33	0.1
Bowfin	2	0.3	22.7-23.7	7.25	2.8
Black crappie	2	0.3	4.0-10.3	0.56	0.2
Black bullhead	1	0.2	3.6	0.02	0.0
Yellow bullhead	1	0.2	12.0	1.37	0.5
Pumpkinseed	1	0.2	2.5	0.01	0.0
Total (Species)	606	100.0		257.09	100.0

4.0 Dealing With Watershed Concerns

This section deals with stakeholder concerns within the Lake Manitou watershed as well as the current information regarding each concern. Action plans may be in the form of things already done, things currently being done or things not yet done. In some situations the action needed to adequately come to grips with a problem may not be clear or even possible at this time .These concerns and action plans along with the stakeholder goals are designed to improve the watershed. Chart # 14 reflects stakeholder concerns, existing data regarding these concerns and the actions being taken.

Chart 14

Watershed stakeholders' list of concerns with existing data to develop problem statements: Developed after 22 meetings over the past 3 years starting with conflict resolution of 37 people at Modern Materials and then moving to City Hall after one year of meetings

Concerns	Existing Data	Action plan
	Land Use	
Solid waste concern from the city	**The spreading of solid byproducts on the fields in watershed**	**Meeting with the solid waste department**
Need for more filters in the incoming streams to the lake	**One filter on White Creek is working well and need more**	**Apply for grant to add number of filters**
Increase the number of grass filter strips	**Work with soil and water to educate more farmers**	**Committee formed to work with the local Soil and Water Division**
Sediment reduction from farm land	**Several open ditches to the lake sited**	**Committee formed to work with the survey's office on mapping drains**
Clear cleaning of ditches by the county	**County takes away all vegetation from the banks and erosion occurs**	**Work to educate the Surveyor on a better plan**
	Lake Water Quality	
Sediment in lake from breach of dam in 1989	**Tons of sediment dumped into the lake by the county. Documented by DNR**	**Apply for grants to clean the sediments out of the lake**
Level of the water in the Mt. Zion dam	**Farmers feel it should be lowered for better drainage**	**To contact DNR about the situation**
Problems of invasive	**Milfoil taking over the**	**Apply for grant for**

plants in the lake	**lake**	**plant study**
Geese	**Too many on lake**	**Study ways to control the size of the flock**
Effect of ground water from the county landfill	**No date seems to be available from the county or state**	**Committee working with the IDEM for base data.**
Need of Repair of the Mt. Zion Dam	**Major breach on the east end of the dam resulting in sediment being added to the lake**	**Take pictures of the problem and contact IDNR. Then work on grants to repair the dam**
Set up eco-zone to improve the growth of fish	**Bass Federation concern of the size and quality of the fish**	**Ask DNR to come talk to the group about the process to set aside water area**
City has drains from parking lots into the lake	**Several drains are noted for oil slicks at the entrance into the lake**	**Work with the city to see what could be done to improve the situation and plan for new drains**
	Education	
Develop educational materials	**No program exists at this time**	**Committee to work on some type of booklet to educate the community on the watershed.**
Civic group speakers list available for meetings	**Have not been getting the word out to the community**	**Speakers list developed from the members of the lake association and sent to all the identified civic organizations**

Hydrilla	**DNR identified the first infestation of Hydrilla in Lake Manitou and closed the lake**	**No plan by the state or federal government to handle this situation. Committee stopped all work on the above and helps write the state's plan to close a lake and treat the problem.**
Need to quickly educate the public about the plants in the lake including the finding of the Hydrilla	**Use the three year plant study to make booklet to identify the plants**	**Committee planned and had booklets printed and given to every property owner and boat owner on the lake**

Action plan update

Solid waste concern from the city:

Several meeting were held with the city. The head of the water treatment plant came to the committee and gave a detailed report of what happens to the waste. Does not end up in Fulton County.

Need for more filters in the incoming streams to the lake:

Grant was applied for and we received a small grant. Presentation to the lake association resulted in the association giving money in addition to the grant, and filters were cleaned on White Creek and additional filters were installed

Increase the number of grass filter strips:

This committee has not been able to work with Soil and Water to increase the number of filter strips.

Sediment reduction from farm land:

Worked with the state to present a workshop on a new planting system. Only till up 8 inches for each row crop planted. It was well attended.
Additional articles in the paper and radio shows on the subject.

Clear cleaning of ditches by the county:

Several meeting were held with the county drainage board and the county surveyor's office. They agreed to only clear cut one side of the stream and then plant rye grass as soon as they finish.

Sediment in lake from breach of Mt. Zion dam in 1989:

Grants were applied for from the state. The committee received two grants covering three years of dredging. Total report on CD produced for us by JFNew.

Level of the water in Mt. Zion pond:

The DNR came and gave a presentation and bottom line is the DNR will not allow any change to the water level of the pond. End of this story

Problem of invasive plants in the lake:

Applied and received grant for plant study and treatment for the milfoil. The lake association gave matching money and we completed three years of study and treatment. The state stopped us from the fourth year and resigned the money to the problem of Hydrilla.

Geese:

DNR came to our meeting and presented a program on goose control. After the presentation the committee presented to the lake association the option of applying for a permit from the DNR to oil the eggs on the islands in order to control the population of the geese. The name of "Easter Egg Hunt" was adopted for the project. We have had the Easter egg hunt for the past three years.

Effect of ground water from the county landfill:

We had three meeting in Fulton County with IDEM about the concern. IDEM never has given the community any information about the ground water. The community is very upset with the lack of action by IDEM on this issue. In the past year the county landfill smell has gotten very bad. We have had the congressmen from this area working on the problem. No one in IDEM seems to care about the things going on in Fulton County.

Need to repair of Mt. Zion Dam:

Made presentation to the county council about our concern (covered by two articles in the paper and radio programs). After two years of working with the political system, the county realized the need to aggressive go after grants to repair the dam. The county has a bridge and road going over the dam. The state degraded the inspection report on the bridge and then the county commissioners became concerned. We worked with the county and a consulting group from India polis to raise money for the replacement of the dam. Many meeting with the state representatives and Senator Lugar's office have been held. Funding is in congress to do the repair and it looks like we will finally be able to fix this major problem. Our survey counts this as the number one problem facing the watershed.

Set up eco-zone to improve the growth of fish:

Had four meeting with the state DNR and two public meeting on setting aside 43 acres as an Eco-Zone. This is the forth year of a five year project and the committee wants to renew the agreement with the state for five more years. The area is a no motor zone. The Bass Federation claims the fish are becoming healthier.

City has drains from parking lots into the lake:

Meetings have been held with the City Council on solving this problem. Nothing has happened to develop a new system for filtering this water.

Develop Educational Materials:

Gave out free educational material provided by the state at the boat ramps in past years. On the discovery of Hydrilla in the lake, the committee agreed to put together a booklet based on our three years of plant study with Hydrill being the center plant. We put together the booklet and printed 1000 copies to be given out to all home owners on the lake. Also, when we open the DNR ramp for boats to come into the lake every boat owner received a copy of the booklet. Plans are to give a presentation and a booklet to the Middle School and High School Conservation Clubs.

Along with the materials being given out, we have had at least one article per week in the local paper and one fifteen minute radio show per month. We have covered all of the items identified by the watershed committee over the past three years. All of the articles are being reproduced on CD by the paper for this report. The radio station is certifying the shows presented on the station.

Civic group speakers list available for meetings:

Every civic group in Fulton County has had programs on the watershed programs identified in the past years. Several groups have had more than one program. We have also given four presentations to state groups.

Hydrilla:

"This will be the death of Lake Manitou if not treated now" reads the information from the state and federal experts on the finding of this plant in our lake. The total energy of the watershed committee and the Manitou Lake Association stopped to work on this potential killer. The state did not have a plan for closing a lake or treating this plant, since it was thought it would never be in this area.

A task force was formed with the watershed group, the lake association, IDNR and the University of Florida to plan on how to handle the situation. This task has taken every ounce of time and resources to meet and develop a plan. As a committee, we are very disappointed the IDEM has not given us the next year to put this report together. As with the County Landfill we feel the citizens of Fulton County have been shut out by the big brother in Indianapolis.

We have developed a plan which will be used by the state to close any other lake in Indiana.

Need to quickly educate the public about the plants in the lake including the finding of the Hydrilla:

Articles in the local paper and programs on the radio were used to give the information about the situation. We had two public meetings with the lake association to talk about the problem and our three year plan. Programs were given to all the civic clubs and the Bass Clubs.

4.1 Lake Manitou Sediment Removal Plan

7.0 SUMMARY

The project to dredge areas of accumulated sediment within select areas of Lake Manitou began with the hiring of JFNew in the fall of 2004. JFNew utilized whole lake mapping of sediments by R& R Visual of Rochester and input from lake residents to narrow the scope of the work to six areas around the lake. These six areas included the mouths of the two major drainages: Graham Ditch (also known as White Ditch) on the east, and Rain Creek at the south end of the lake. The other four areas included a bay at the north end of the lake, a natural channel on the northwest side of the lake, a naturally shallow bay in the southwest corner of the main lake, and a natural channel at the outlet of an artificial channel section in the southeast corner of the lake. Permit applications were submitted in January of 2005 to the Indiana Department of Natural Resources –

Division of Water, The US Army Corps of Engineers, and the Indiana Department of Environmental Management. All required permits were received by May 31, 2005 to dredge five of the original six areas selected. JFNew was paid $9,600 to develop the dredge plan and obtain the permits.

The Association applied for a LARE grant in January 2005 requesting $100,000 to dredge two of the five permitted areas. The LARE program awarded $127,575 to the Lake Manitou Association in July 2005 to allow dredging in three areas the first year including the Graham Ditch outlet, the bay on the north end of the lake and the natural channel along the northeast shoreline that inhibited lake access from the public ramp. The Lake Manitou Association selected Dredging Technologies, Inc. to perform the dredging of the three areas in the fall of 2005 for a lump sum of $113,368. EFM Excavating was selected to construct one of the two basins required for the three dredging sites for a lump sum of $24,500 and Morris Excavating was selected to construct the second basin for a lump sum of $19,800. The Lake Manitou Association paid $9,950 to Direct Line communications to bore a 14-inch pipe under State Road 14 for access to the second dredge spoil site. In addition, the Lake Manitou Association contracted with JFNew to administer the project and perform inspections for $12,000. The dredging of six acres of lake bottom in three separate areas and the construction and demolition of two sediment disposal basins was completed under these contracts in April of 2007 for a total cost of $177,218.00 including the cost of the dredge plan.

The Lake Manitou Association applied for an additional LARE grant in January of 2006 and was awarded $100,000 to complete their dredging project. The final area selected for dredging was approximately five acres at the south end of the lake near the outlet of Rain Creek. The contract for dredging and construction of a third sediment spoils basin was awarded to Tennant's Industrial Dredging in August of 2006 for $125,000. JFNew was contracted to administer the project and perform construction inspections on an hourly basis and has invoiced the Lake Manitou Association approximately $10,000 prior to this report. There were additional expenses paid by the Lake Manitou Association to Morris Excavating to modify the basin at the demand of the property owner and to clean up and cap the area of the pipe under State Road 14 from the first dredging phase. The dredging of five acres of lake bottom in phase two, along with the construction of the associated basin and incidental expenses was completed for a total cost of approximately $133,000 including this final report. See Sediment Removal Plan (Appendix B)

Appendix A
QAPP Report

See Attached file