Silver Creek Watershed Management Plan A305-6-172

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PROJECT INTRODUCTION

The Clark County Soil and Water Conservation District (SWCD) successfully submitted an application in 2005 for a Nonpoint Source Section 319 grant from the Indiana Department of Environmental Management (IDEM) to develop a watershed management plan for the Silver Creek Watershed. The Silver Creek Watershed Improvement Project began in January of 2007. The grant enabled the SWCD to conduct a diagnostic study and establish baseline data for water quality within the Silver Creek Watershed. The baseline data will allow a diverse local steering committee to develop a comprehensive watershed management plan that documents the current status of water quality, outlines a vision of the future, and will recommend a clear strategy for implementing watershed/water quality improvements. The grant also provides the SWCD with a device to stimulate community awareness of water quality and lay a foundation of watershed ownership/investment in watershed improvements while laying the groundwork for full implementation of the recommendations and action items of the plan.

A contributing factor that prompted the SWCD to take on this project was the fact that part of Silver Creek and one of its tributaries are on the IDEM 2006, 303 (d) list of impaired waters for nonpoint source pollutants. Impaired waters are defined as those that do not meet federal or state water quality standards. Impaired waters are discussed in greater detail on page 36. The SWCD believes all citizens of the watershed should be made aware of this problem and educated about ways to help eliminate this problem. Steps toward this goal will be made during the project but will need to continue long after the plan is written. That is why the plan is considered a living document intended as a guide to be used by citizens of the watershed to increase their understanding of water quality issues and help with implementation efforts.

Mission Statement

To protect and conserve the natural resources of Silver Creek Watershed through education, monitoring, and planning, thereby creating a healthy watershed.

PART I

INTRODUCTION
AND
BACKGROUND
OF
SILVER CREEK WATERSHED

Study Area

The area covered by this plan is the Silver Creek Watershed. A watershed is the total area of land that drains into a particular waterbody. A Hydrologic Unit Code (HUC) is a unique numerical code created by the U. S. Geological Survey to indicate the size and location of a watershed within the United States. The number is representative of the size of the basin. Larger basins are represented by smaller numbers. Indiana is divided into 39 watersheds at the 8-digit level. Each of these watersheds can also be divided into smaller subwatersheds which are represented by 10-digit numbers, and even smaller units with 12-digit numbers. This project will be based on 10 and 12-digit HUC. Silver Creek Watershed's HUC is 0514010108 (Figure 2). It includes six 12-digit HUC watersheds: 051401010801 - Miller Fork, 051401010802 - Headwaters-Silver Creek, 051401010803 - Blue Lick Creek, 051401010804 - Sinking Fork, 051401010805 - Pleasant Run-Silver Creek, 051401010806 - Jacobs Creek-Silver Creek (Table 2, page 15).

Silver Creek Watershed is in southeastern Indiana (Figure 1) and is a part of the Ohio River basin. Silver Creek Watershed drains from the four counties of Clark, Floyd, Scott, and Washington (Map 1). The total area of the Silver Creek Watershed is 97,442.9 acres, or 152.25 square miles. Eighty-two percent of it lies in Clark County (Table 1 on page 10). The Ohio River forms the southern boundary of the watershed and is also the state line between Indiana and Kentucky. The Ohio River is the defining natural feature of the area. Silver Creek also forms part of the county boundary between Clark and Floyd Counties. The towns of Memphis and Henryville lie completely within the boundaries of the watershed, while only parts of Charlestown, Clarksville, Jeffersonville, New Albany, and Sellersburg are included.

Figure 1: Location of Silver Creek Watershed within the State

Map 1: Location of Silver Creek Watershed within County Boundaries

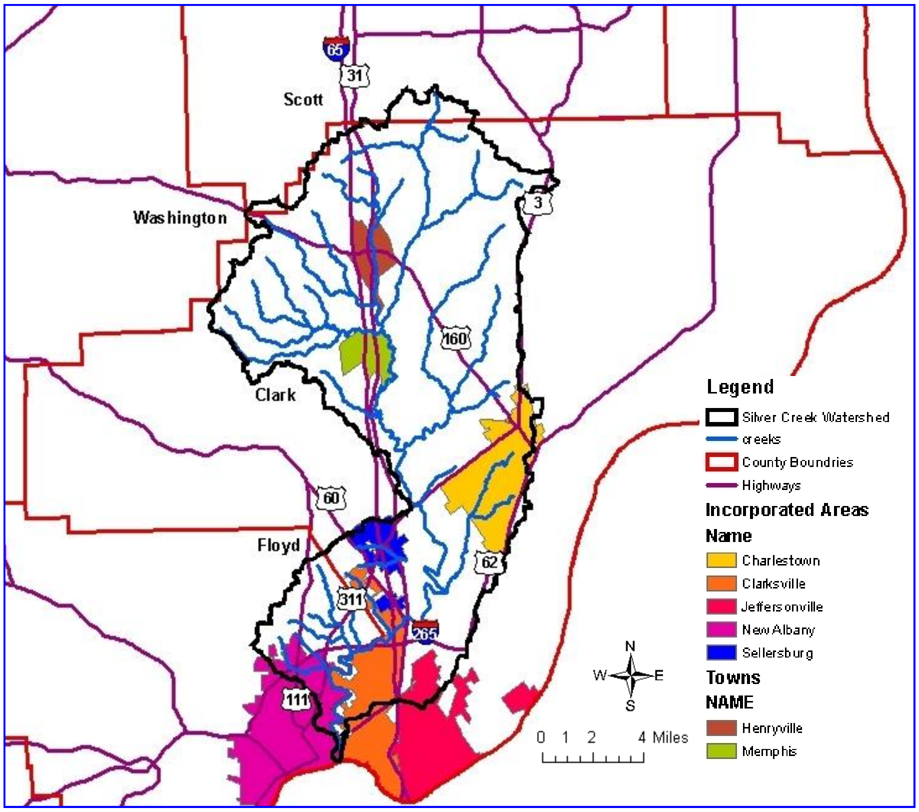


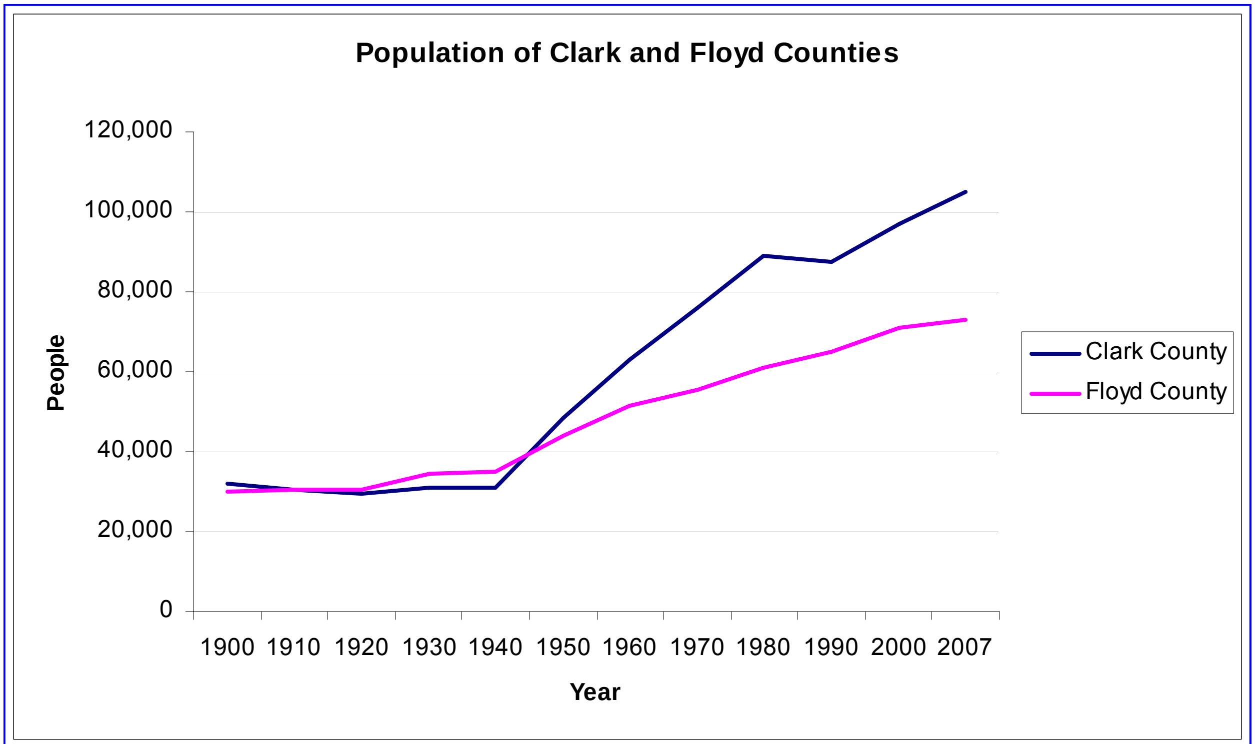
Table 1: County Breakdown of Watershed

County	Total County Area	Area of water-shed in the county	% of county within the wa-tershed	% of watershed in county
Clark	240,000 Acres	80,847 Acres	33.7%	82.9%
Floyd	94,720 Acres	13,860 Acres	14.6%	14.2%
Scott	121,600 Acres	2,485 Acres	2%	2.6%
Washington	328,320 Acres	256 Acres	.2%	.2%

Population Growth

One of the main factors affecting the condition of Silver Creek is the increasing number of residents in Clark and Floyd Counties. The history of area and land use issues are also related to the population growth. Both Clark and Floyd Counties are considered bedroom communities for Louisville, Kentucky. The population grew by 27.1% for Clark County and 27.3% for Floyd County during the last three decades of the 1900's. The population density for Clark and Floyd Counties are 270.9 and 486.5 people per square mile, respectively. As population increases, so does the need for housing and services, which requires building new structures, increasing the impervious area, and causing more runoff. Low impact development has not been embraced by this area of the state so the impervious footprint continues to grow.

Chart 1: Population of Clark and Floyd Counties 1900 through 2007



AREA HISTORY

The area that is now Clark and Floyd Counties was once occupied by prehistoric people. Early cultures considered the area a prime hunting ground. The rapids in the Ohio River, also help contribute to the settlement of the area. Indians were enticed to camp along Silver Creek for two reasons, the clean and abundant water and the numerous beaver dams which made trapping excellent.

Clark County was organized in 1801. In 1784, Clarksville became the first American settlement in the Northwest Territory. Jeffersonville has been the county seat since 1873. Floyd County was organized in 1819, when New Albany became the county seat and the first incorporated town.

There are two theories about how Silver Creek derived its name:

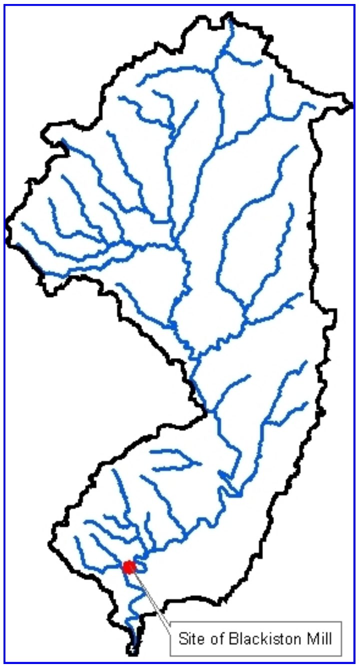
1. In 1775 a band of roving Indians buried a keg of silver by the creek.
2. Early flat-boatmen, while on their way down the Ohio River, were heard to remark that yonder range of hills (knobs) is supposed to be rich in silver ore. No paying quantities have ever been found.

History of the Ohio Falls Cities and their Counties, written in 1882, states that "Silver Creek with its numerous branches, is the finest inland water of this region."

Mills

Silver Creek furnishes sufficient water for running a mill for a portion of the year. Although many mills operated along Silver Creek, one of the most famous mills was Blackiston Mill built in 1853. It was built near the fourth dam on Silver Creek from its mouth. The dam was made of slate and concrete and is still there today. The mill operated as a saw and grist mill as well as a cement mill with a lime kiln. The water mill used old fashioned burrs to grind grain and a sash saw to cut lumber. In 1892, the mill was turned into a dance hall, and the Clark County side was turned into a park. The mill has had many owners over the years, and in 1970 it was closed completely. The mill was destroyed by a flood in 1963 and was demolished around September 6, 1989. Pictures in the June 15, 1983 edition of the Louisville Times show people swimming in Silver Creek at the Blackiston Mill Dam.

Map2: Location of Blackiston Mill



Description: Blackiston Mill Bridge over Silver Creek and Mill (fourth dam) Obtained from New Albany Floyd County Public Library

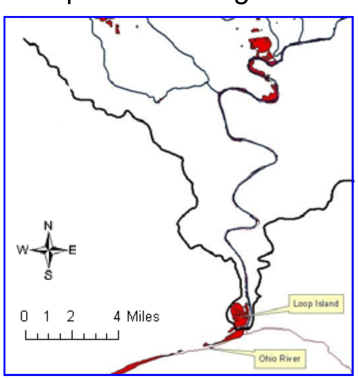
Tannery and Loop Island

In New Albany's east end at the confluence of Silver Creek and the Ohio River is a marshy land. A small island is formed by the water of the creek, which makes a bend in the form of a loop before reaching the Ohio River, this area is referred to as Loop Island. In the 1800's this area was a dueling ground for Kentucky political leader Henry Clay. It is documented by historians that Clay was wounded there in 1809. The importance of this land to the watershed project are the wetlands covering 47 acres of the property. Loop Island became famous in the county because of its use as a wetland (lagoon) to help dilute chemical waste from the leather tanning process at the George Moser Leather Company from the early 1860's through 2002. The company specialized in making leather used in saddles and related items. During the last five years of operation it produced nearly 80 percent of the shoelaces used in the United States. At its peak, the factory employed 75 workers and processed 1,500 cowhides a day using 180,000 gallons of water per day. The lagoon was often called Blood Pond by residents of the area. No animals were ever slaughtered at the tannery. The red color of the pond was due to the ponds' high nutrient content, which nourished red algae to grow. The tanning process at Moser Leather used vegetable products (different kinds of tree bark) instead of harsh chemicals, so the environmental hazards associated with other old tanneries were never a problem here.

Until 1986, the wastewater treatment lagoons overflowed directly into Silver Creek. The discharge pipe was moved from Silver Creek to the Ohio River allowing a more complete usage of the lagoons for treatment by increasing the time in the lagoons. All of these changes significantly reduced the pollutant load on Silver Creek and allowed the tannery to meet IDEM and EPA requirements. The tannery also added $5,000 worth of aquatic plants to further enhance the treatment process, and the name of the area was changed to Loop Island Wetlands. In 2002 the tannery closed all operations.

The next year the wetland area was opened as a nature preserve for the public by its current owner Al Goodman. The towns of Jeffersonville, Clarksville, and New Albany have joined together to form the Ohio River Greenway Development Commission. The mission of Ohio River Greenway is to provide a common linkage between these communities and provide a means for the public to utilize and enjoy this portion of the Ohio River. The Ohio River Greenway project is mentioned here because the trail will go through Loop Island Wetlands. Hopefully, it will help educate the public to the benefits and beauty of a wetland.

The 47 acres of Loop Island Wetlands serves as the last floodplain on Silver Creek, this allows further improvement in water quality of the creek during flood conditions since it moves through the wetlands downstream direction to Ohio River. Water velocity is very slow since it spreads over the 47 acres, allowing sediment of the creek and river to settle during flood conditions. The wetlands gain soil deposited during these floods in the amount one-half to one inch depth per year.

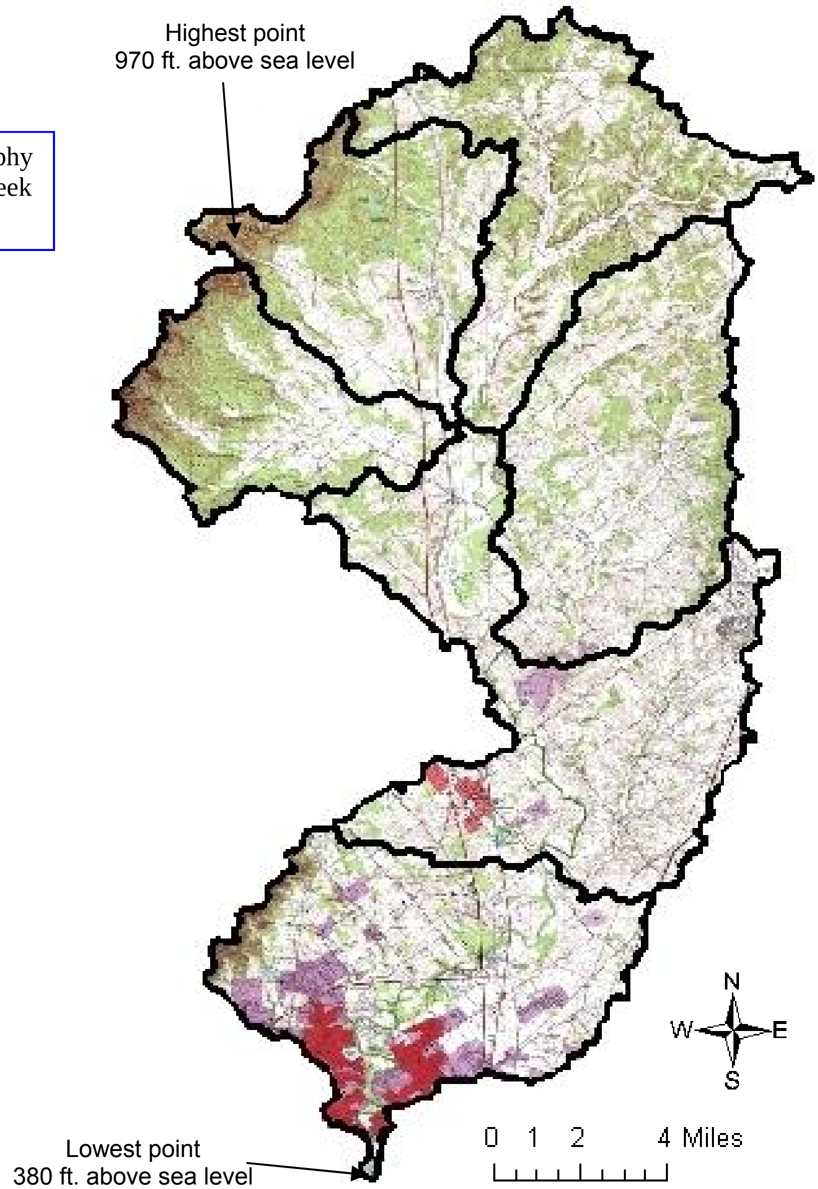


Map 3: Loop Island Wetland Location at the Mouth of Silver Creek

TOPOGRAPHY

The topography of the watershed is nearly level in the southern portion, gently to strongly sloping in the central and northern parts, and steep in the western portion. Ohio River alluvium overlays the southern portion of the watershed. Devonian black shale and limestone underlay the central portion with Devonian black and gray-green shale partially covered with Illinoian glacial till underlying the northern areas. The western portion of the watershed is underlain by Mississippian sandstone, siltstone, and shale. The highest point in the watershed is located in Clark State Forest in the northwestern part of the watershed. The lowest point of the watershed is 380 feet above sea level at the mouth of Silver Creek. Due to the scale of the map that can be included in this report it is difficult to determine the specific elevation of the area but one can get a general idea of the of the area's relief.

Map 4: Topography Map of Silver Creek Watershed



HYDROLOGY
SILVER CREEK WATERSHED
Creeks and 12-digit HUC (subwatersheds)

Silver Creek drains the central part of Clark County and the eastern part of Floyd County. It forms in the rolling uplands in the northern part of the watershed and flows in a southerly direction about 36.4 miles to its outlet in Floyd County where it empties into the Ohio River. Silver Creek is bordered by valleys that range from a half mile to several miles wide. It is surrounded by gently sloping and nearly level terraces. The bottomland areas are well drained to somewhat poorly drained or poorly drained and frequently flooded. The major tributaries of Silver Creek are Sinking Fork and Pleasant Run from the east and Miller Fork, Caney Fork, and Blue Lick Creek from the west. Muddy Fork also contributes to Silver Creek but was not considered in this study, because it is in another 10-digit HUC (05140101130). Six 12- digit watersheds or subwatersheds make up the Silver Creek Watershed. Table 2, Map 3, and Figure 2 on page 15 show the size of each subwatershed as well as the tributaries and their length.

Silver Creek is navigable in Clark County from its junction with the Ohio River for 3.0 river miles.[1] Although people do canoe in Silver Creek, there is no good public access.

1 DNR Division of Water, www.in.gov/nrc/2393htm #c

12-digit Subwatersheds within Silver Creek Watershed

Table 2: Size of 12-digit Watersheds

Name	12-digit HUC	Acres
Miller Fork	051401010801	11,963.30
Headwaters - Silver Creek	051401010802	15,856.88
Blue Lick Creek	051401010803	10,180.24
Sinking Fork	051401010804	17,990.86
Pleasant Run - Silver Creek	051401010805	22,278.74
Jacobs Creek - Silver Creek	051401010806	19,172.50

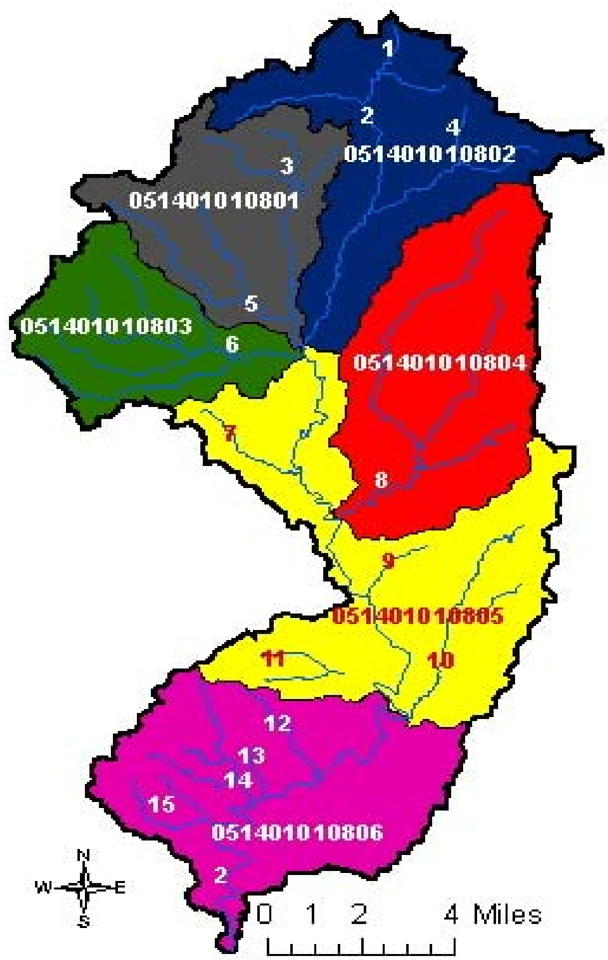
Color scheme will be used throughout this document.

Figure 2: Length of Creeks in Miles

Length of Creeks in Miles

1. Roosting Run - 4.1
2. Silver Creek - 36.4
3. Grain Run - 11.1
4. Clegg Creek - 6.3
5. Lodge Creek - 9.8
6. Blue Lick - 21.8
7. Anson Creek - 2.9
8. Sinking Fork - 19.5
9. Unnamed Tributary - 2.0
10. Pleasant Run - 8.4
11. Camp Run - 3.6
12. Plum Run - 3.1
13. Uphill Run - 1.5
14. Jacobs Creek - 7.6
15. Slate Run - 4.5

Total miles 142.6



Map 5: 12-digit Watersheds and Streams of Silver Creek Watershed

Ecoregions and Climate

An ecoregion is defined as an area with similar ecosystem functions based upon geology, physiography, vegetation, climate, soil, land use, wildlife, and hydrology. The watershed is in Ecoregion 55, Eastern Corn Belt Plains, which is primarily a rolling till plain with local end moraines. A further division places the watershed in the Pre-Wisconsinian Drift Plains (55d) ecoregion and is differentiated from the surrounding ecoregions by its deeply-leached, acidic, pre-Wisconsinian till and thin loess. Widespread areas of nearly flat, very poorly-drained soils with fragipans are also distinctive. Originally, beech forests and elm-ash swamp forests were dominant. Today, soybeans are common and are well adapted to spring wetness. Corn, tobacco, and livestock farming also occurs. Streams often have more sustained runoff and biotic diversity than those of other ecoregions. Stream chemistry and turbidity have been affected by these farming practices.[2]

The climate is continental, humid, and temperate, with warm humid summers and moderately cold winters. The median growing season in the region lasts 182 days, from the last frost in mid-April to the first fall frost in mid-October. Monthly mean temperatures and precipitation values are shown in the Charts 2 and 3 below. Precipitation is well distributed throughout the year, but is slightly greater in the spring and early summer.

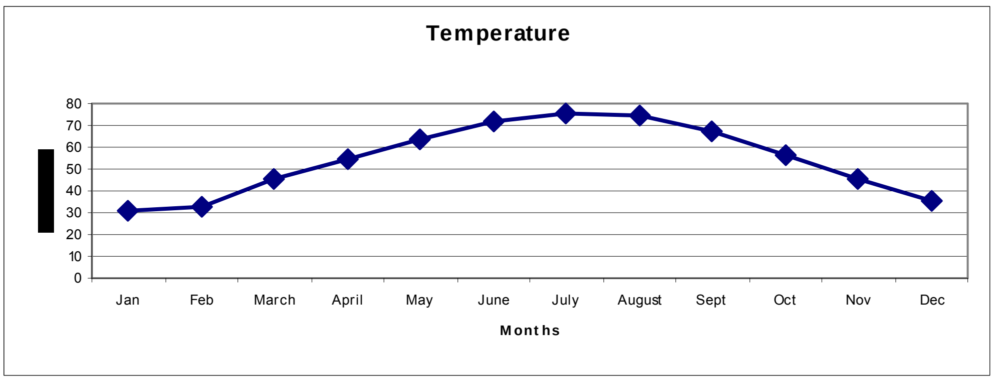


Chart 2: Monthly Mean Temperature for Clark County

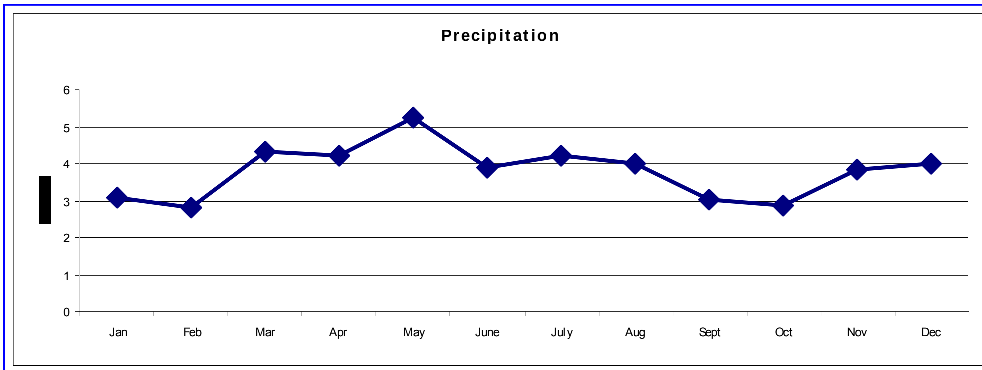


Chart 3: Monthly Mean Precipitation for Clark County

2Ecoregions of Indiana and Ohio, http://wwwepa.gov/bioindicators/html/ecoregions.html

SOILS

Soils are the building blocks of the watershed. They help determine what happens in the watershed and are important to the success of any activities that occur in the watershed. Soil is produced by the action of soil-forming processes on material deposited or accumulated through natural processes. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the processes of soil development have been active.

Parent material is disintegrated and partly weathered rock from which soil has formed. Parent material influences the textural, chemical, and mineralogical properties of soils. Parent material in Clark and Floyd counties is variable, consisting of glacial till and outwash of Illinoian age; lacustrine deposits or lake bed material, Illinoian and Wisconsin age; residuum from limestone, sandstone, and shale; alluvium; and loess (windblown silt). Ice from the Wisconsinan glacier did not reach Clark and Floyd Counties, but the glacier influenced the formation of lacustrine soils near the mouth of Silver Creek.

There are 131 different soil types in the watershed. Appendix I on page 114 gives a detailed description of each soil. The huge number of soil types makes it difficult to assimilate the soil information; therefore, soil associations were examined as a general guide for managing the watershed. Soil associations are useful to people who want a general idea of the soils in a soil survey area or who want to know the location of large tracts that are suitable for a certain kind of land use. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and is it is named for the major soils. The soils in one association may occur in another, but in a different pattern. Map 4 and soil associations descriptions (Figure 3) on page 19 show the soil associations for the watershed.

Other soil characteristics that were considered include soil wetness (referred to as hydric soils, which also a requirement used to determine wetlands) and the suitability of soils for septic systems.

Wetlands are lands where water saturation is the dominant factor in determining the nature of soil development and the types of plant and animal communities. The natural functions of wetlands make them an important element of every ecosystem and very important to a healthy watershed. They provide habitat for fish and wildlife, water quality protection, erosion prevention, flood storage, and recreation. Their cleansing power provides natural pollution control. They filter and collect sediment from runoff water helping to prevent mud from clogging downstream areas. Wetlands help slow water flows, reducing downstream soil erosion. The three essential characteristics of wetlands are hydrophytic vegetation, hydric soils, and wetland hydrology.[3] Criteria for all of the characteristics must be met for areas to be identified as wetlands. Hydric soils are defined by the National Technical Committee for Hydric Soils as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part.[4] The 2008 Natural Resources Conservation Service (NRCS) National Hydric Soils List by State lists four hydric soils found in the watershed. All four of the soils are found in Clark County, totaling 1,533.1 acres or 1.5 per-

3 Cowardin and others, 1979; U.S. Army Corps of Engineers, 1987; National Research Council, 1995; Tiner, 1985
4 Federal Register, 1994

cent of the total watershed. Hydric soils that have been converted to other uses should be capable of being restored to wetlands; which may be important to the improvement of water quality in the Silver Creek Watershed in the future. Map 5 on page 20 shows the wetlands in the watershed based on the 1992 National Wetland Inventory.

The ratings for septic tank absorption fields (Appendix I, page 114) are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health. The ratings for all soils in the watershed are either somewhat limited or very limited for septic system suitability. A somewhat limited rating indicates that the soil has features that are moderately favorable for the specific use. Limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. The very limited rating indicates that the soil has one or more features that are unfavorable for the specific use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected. Eighty percent of the soils in the watershed are rated very limited for septic system suitability and 19 percent are somewhat limited.

In 2001, when the soil survey for Clark and Floyd Counties was updated, a new soil complex called urban soils was created.   Twenty-one percent of the watershed is made up of a combination of urban soils (Ueda, UneC, UngB, UnkB, UnpA, UnrD, and UnsB). The soil complex map units for urban soils are designed for areas in which urban land and soils have been drastically altered by man and are intermixed together. Urban soils are areas that are covered by paved or graveled roads, parking lots and walkways, residential and commercial buildings, and cemetery structures.

Soil Associations

Map 6: Soil Associations

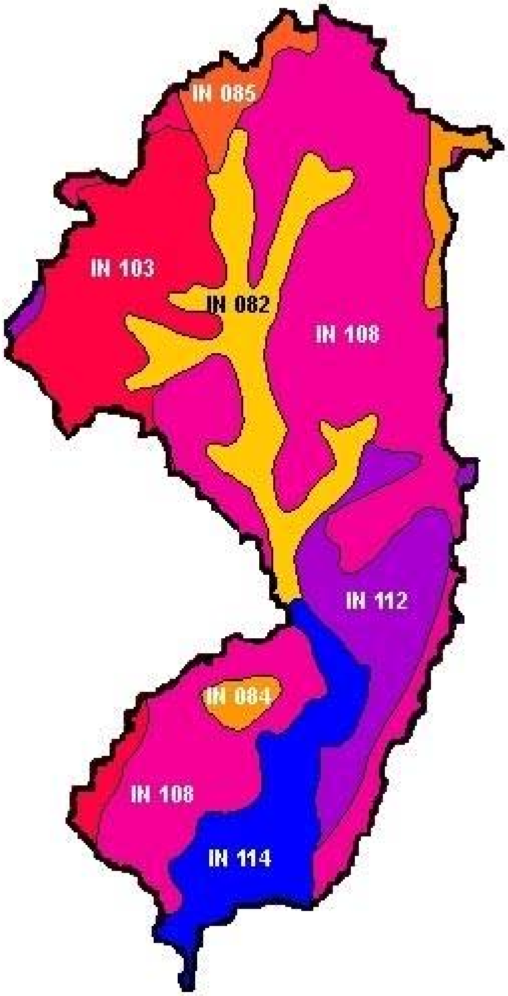


Figure 3: Soil Associations Descriptions

IN082 - Wakeland-Haymond-Wilbur: These soils consist of very deep, somewhat poorly drained to well drained soils that formed in silty alluvium. They are on flood plains and flood-plain steps. Slopes range from 0 to 3 percent.

IN084 - Cobbsfork-Avonburg-Rossmoyne: Deep, somewhat poorly drained and moderately well drained, nearly level and gently sloping soils that have a medium-textured to moderately fine textured subsoil; formed in loess and glacial till on uplands.

IN085 - Cincinnati-Rossmoyne-Hickory: Deep, nearly level to steep, well drained and moderately well drained, medium, textured soils formed in loess and in the underlying silty glacial drift or glacial till; on upland side slopes and ridge tops.

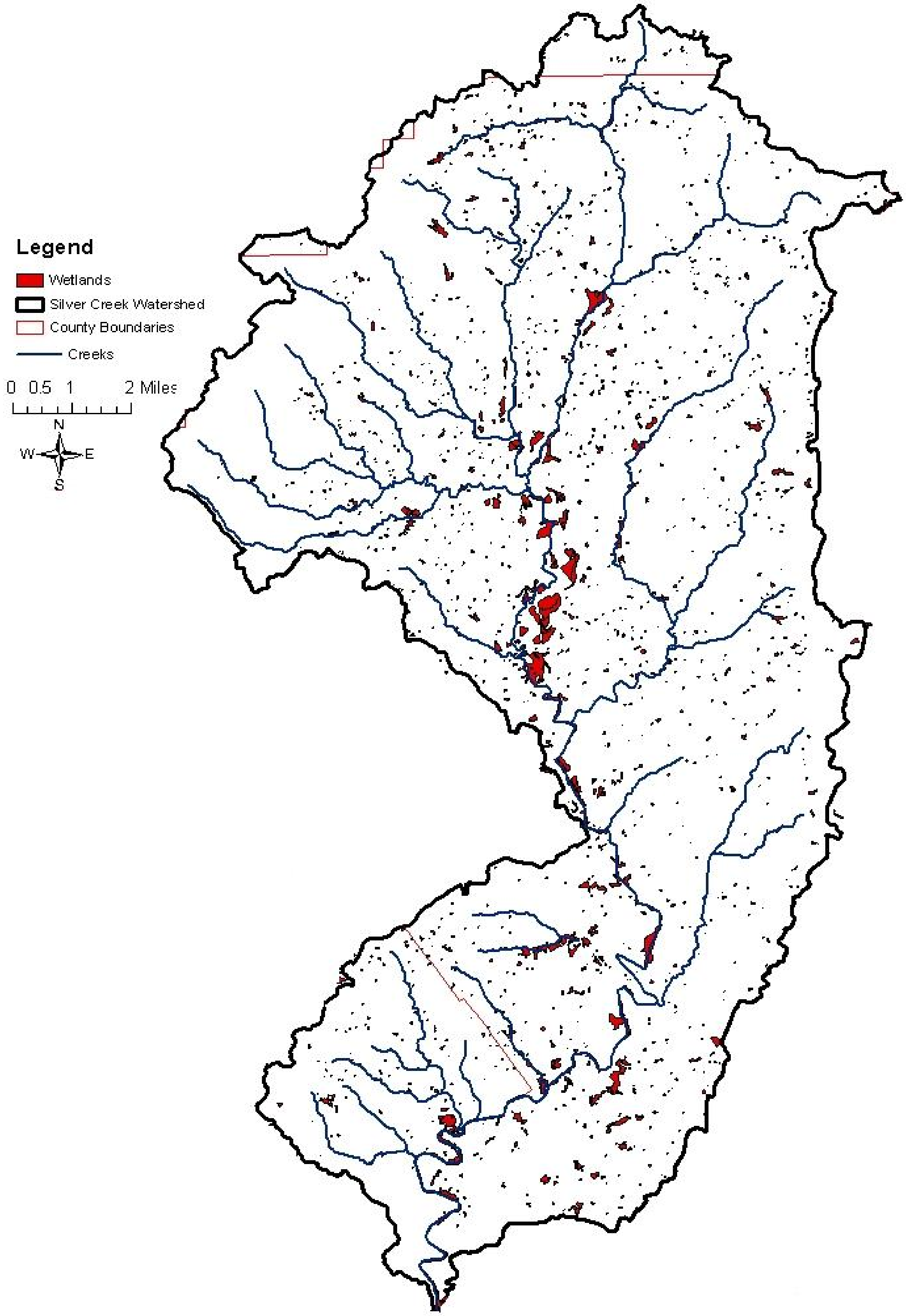
IN 103 - Zanesville-Wellston-Gilpin: Moderately deep and deep, well drained and moderately well drained, gently sloping to steep soils that have a medium textured subsoil; over sandstone, siltstone, and shale on uplands. These soils are on ridgetops and upper side slopes. Slopes range from 0 to 70 percent.

IN108 - Cincinnati-Trappist-Jennings: Deep and moderately deep, well-drained, gently sloping to strongly sloping soils that have a medium-textured to fine-textured subsoil; over shale on uplands. They are on summits, shoulders, backslopes, ridgetops, and benches of dissected till plains considered to be formed during the Illinoian stage. Slopes range from 2 to 60 percent.

IN112 Crider-Baxter-Bedford: Deep, well drained soils on uplands. Slopes range from 0 to 60 percent. Limestone is the main rock in the formation of these soils.

IN 114 Wheeling-Elkinsville-Vincennes: These soils are all found on stream terraces, very deep. Wheeling and Elkinsville are well drained, while Vincennes is poorly drained. Slopes are dominantly 0 to 8 percent but range up to 55 percent. Native vegetation found in these soils was chiefly hardwoods.

Map 7:
Wetlands in Watershed

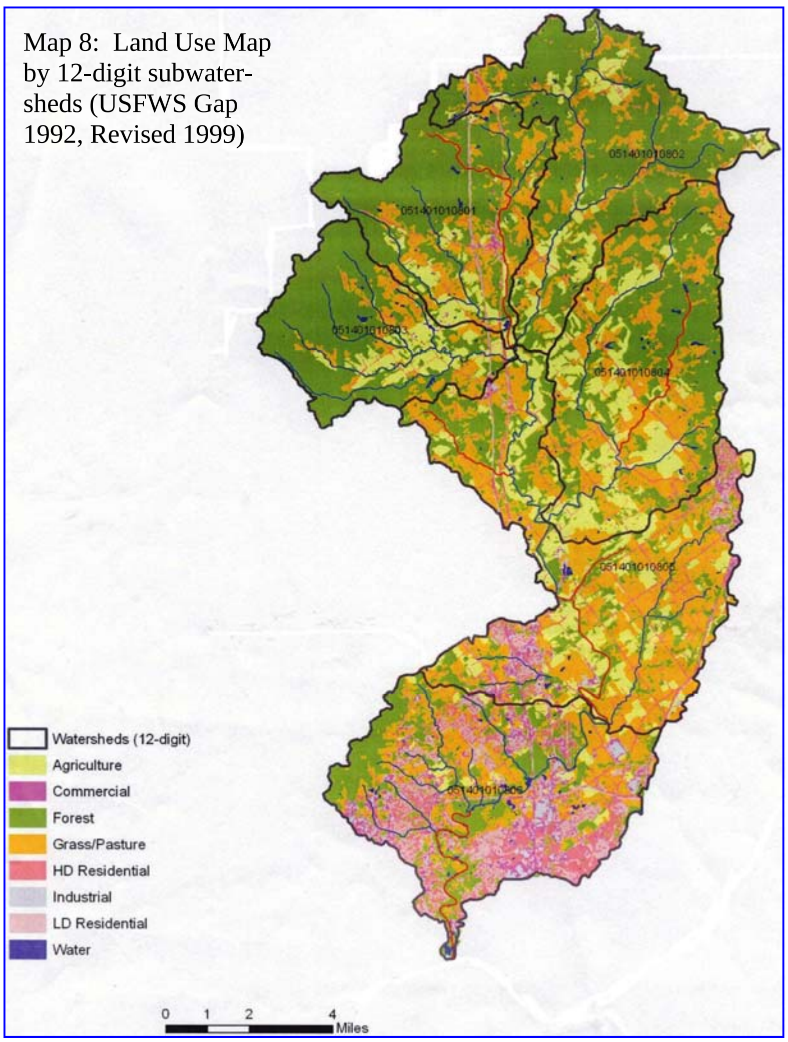


Land Use

(Narrative refers to the whole county. Map 6 is only Silver Creek Watershed.)

The land in Clark and Floyd Counties is primarily used as farmland or for urban development. The primary farm enterprises are cash grain crops and the production of livestock. Corn, soybeans, and winter wheat are the main cash grain crops. Tobacco and other specialty crops are also grown. Hogs and beef cattle are the main livestock raised, and there are a few dairy, poultry, sheep, and goat operations in the counties. Woodland makes up a large part of the area and offers a high potential to wood-using industries.

In Clark County approximately 30 percent of the county is cropland, 10 percent is pasture, and 37 percent is woodland. In Floyd County the breakdown is about 19.5 percent in cropland, 6.8 percent is pasture, and 6.0 percent is woodland. The rest of the land use in both counties is urban and industrial. The areas around cities and towns have been annexed, and the land use is rapidly being changed. Some areas lend themselves to urban development with few limitations, but other areas have so many limitations that nonfarm uses are questionable.[5]



Map 8: Land Use Map by 12-digit subwatersheds (USFWS Gap 1992, Revised 1999)

5 Soil Survey of Clark County, Indiana, 2007

Table 3: Land Use by Subwatershed

(Reference USFWS Gap 1992, Revised 1999)

12 digit HUC	***Sub-watershed Name***	***Ag Pasture***	***Ag Row Crops***	***Forest/ Woodland***	***Shrubland***	***Open Water***	***Urban Impervious***	***Urban High Density***	***Urban Low Density***	***Total acres for sub-watershed***
05140 101801	Miller Fork	1,711.16	2,345.41	7,336.88	130.2	53.22	151.89	38.11	196.43	11,963.30
05140 1010802	Headwaters - Silver Creek	2,564.18	3,346.99	9,532.28	216.1	10.5	107.82	5.92	73.09	15,856.88
05140 1010803	Blue Lick	1,311.64	2,152.55	6,410.27	82.43	39.27	150.41	0	30.34	10,176.91*
05140 1010804	Sinking Fork	4,402.61	6,272.55	6,522.74	228.27	86.79	266.82	20.57	191.32	17,99167
05140 1010805	Pleasant Run - Silver Creek	7,685.37	7,087.62	3,810.78	492.32	30.94	1,171.62	262.81	1,737.28	22,278.74
05140 1010806	Jacobs Creek - Silver Creek	5,105.51	3,849.07	4,929.27	355.28	46.85	934.88	585.21	3,366.10	19,172.17
Total Acres for Watershed		22,780.47	25,054.19	38,542.22	1,504.60	267.57	2,783.44	912.62	5,594.56	97,439.67*
% of Watershed		23.38%	25.71%	39.55%	1.54%	0.27%	2.85%	0.94%	5.74%	99.99%*

* 3.33 Acres in the Blue Lick Subwatershed were not included because of insufficient data. If they had been included, totals would equal 100%.

Agriculture

Land use, which may have been typically agricultural in the past, has given way to urbanization in the last few years. With the increase in population, the number of farms and the acres of farmland have decreased. (Charts 4 and 5 document this trend.)

2002 Census Information

	Clark County	Floyd County
Number of Farms	638	299
Land in Acres	100,602	24,048
Average size in Acres	158	80
Median size in Acres	78	54

Chart 4: Number of Farms in Clark and Floyd Counties 1910 - 2002

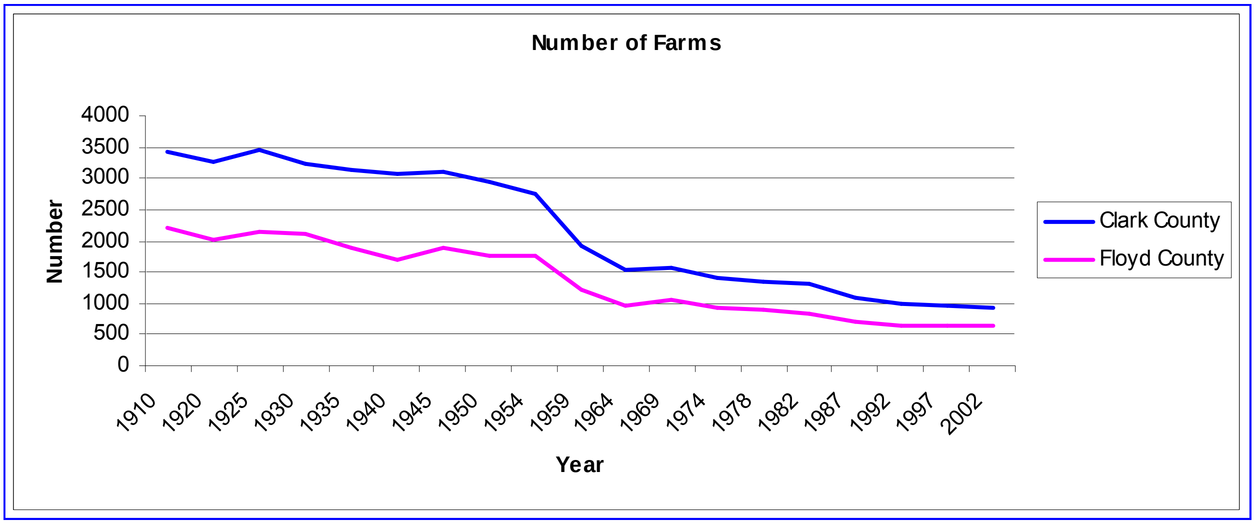
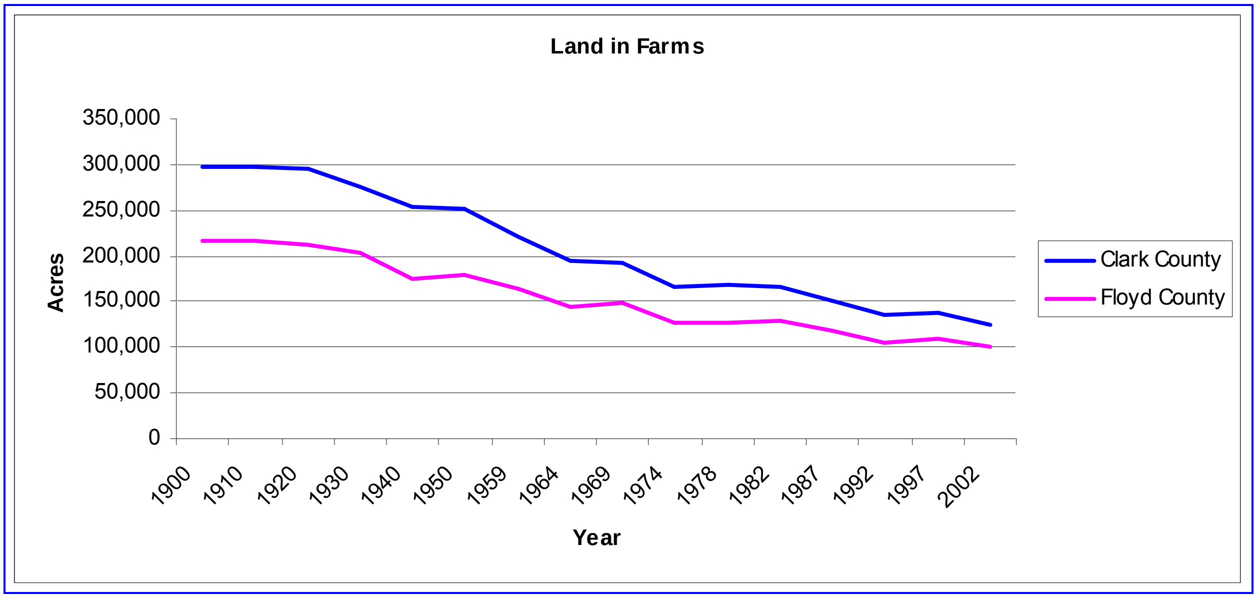


Chart 5: Acres of Farmland in Clark and Floyd Counties 1900 - 2002



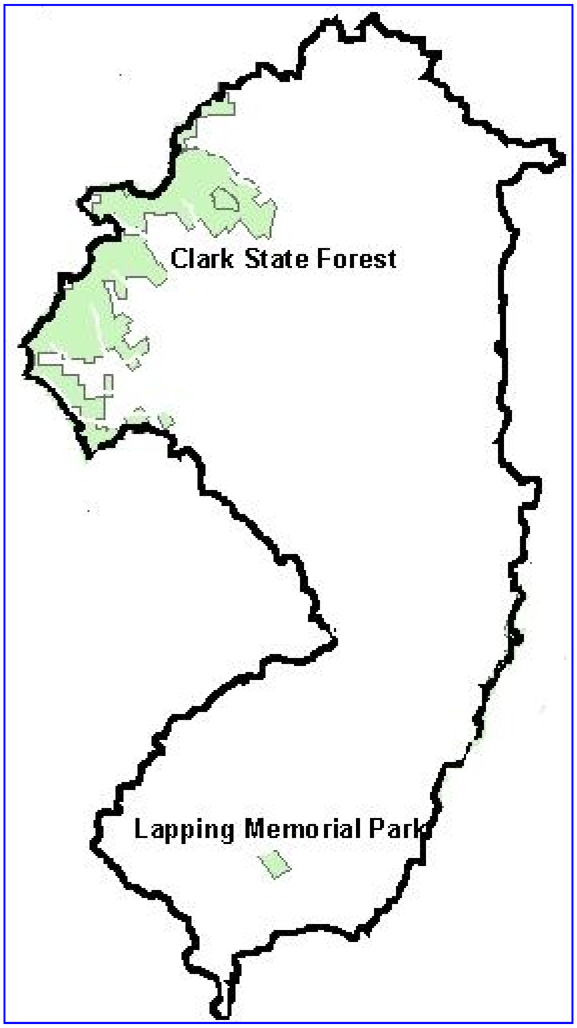
Managed Lands

Managed lands are natural and recreation areas which are owned or managed by federal agencies, state agencies, local agencies, nonprofits organizations, or conservation easements.

Clark State Forest is the oldest state forest in Indiana. It was established in 1903. The original appropriation purchased a two-thousand-acre tract during the administration of Governor Winfield Durbin. It was used as an experimental forest, early in the development of forestry into a science and profession. The forest now consists of 24,434.01 acres. Approximately 10,000 acres of the forest is contained within the Silver Creek Watershed boundaries.

Lapping Memorial Park is a town park located in Clarksville. The park is 332 acres and features play grounds, softball fields, a golf course, tennis courts, basketball courts, volley ball space, horseshoe pits, amphitheater, lodge, shelter house, and three hiking trails immersed in a thick wooded area. The western part of the park runs along the banks of Silver Creek. About one third of the park is left in its "natural" state. The park is a jewel in the most urbanized area of the watershed.

Map 9: Managed Lands in Silver Creek Watershed



Native Vegetation

The native vegetation of the area is mainly deciduous, mixed hardwoods. Differences in natural soil drainage and minor variation in the parent material affected the composition of the forest species. Common trees on well drained soils were yellow-poplar, white oak, red oak, hickory, elm, and sugar maple. Wet soils supported primarily sweetgum, pin oak, beech, and soft maple.[6]

Endangered Species

According to the Natural Resources Conservation Service and U. S. Fish and Wildlife Service (Bloomington Field Office), the following endangered species where reported in the Silver Creek Watershed. Indiana classifies any species whose prospects for survival or recruitment within the state are in immediate jeopardy or are in danger of disappearing from the state as endangered.

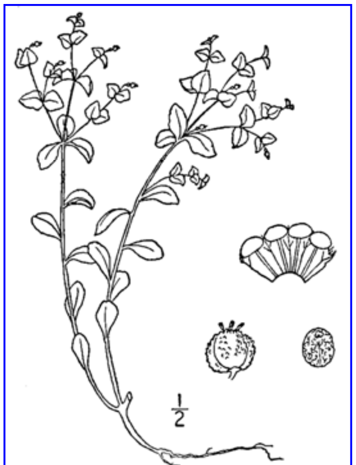
Table 4: Endangered Animal Species of Silver Creek Watershed according to the Natural Resources Conservation Service and U. S. Fish and Wildlife Service.

Common name	Scientific name	Habitat
Barn Owl	Tyto alba	Open country, forest edges and clearings, cultivated areas, and cities.
Black-crowned Night Heron	Nycticoray nycticorax	Marshes, swamps, and wooded streams.
Cabbage Butterfly	Pieris rapae	Gardens, agricultural and abandoned fields, cities, plains, foothills, wandering virtually everywhere except where the most extreme climatic conditions exist.
Cave Isopod	Caecidotea teresae	Caves
Gray Bat	Myotis grisescens	Areas near rivers and streams. Roosts in caves, often containing much water.
Indiana Bat	Myotis sodalis	Wooded or semi-wooded areas along streams in summer. Hibernates in cold caves in winter.
Kirtland's Snake	Clonophis Kirtlandii	Vicinity of marshy meadows, woodland ponds, and open swamplands.
Southeastern Crowned Snake	Tantilla coronata	Pine flatwoods, oak-hickory forests, where soil is moist.

6 Nickell, Allan, Soil Survey of Clark and Floyd Counties, Indiana, 1974

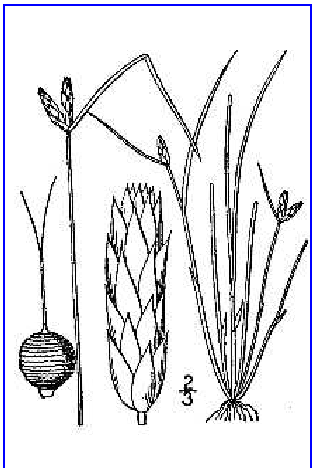
Table 5: Endangered Plants of the Silver Creek Watershed according to the Natural Resources Conservation Service

Common Name	Scientific Name	Habitat
Appalachian quillwort	Isoetes engelmannii	Emergent or in shallow water of lakes, ponds, streams, and ditches.
Bluntleaf Spurge	Euphorbia obtusata	Low woods, thickets, fallow fields, sandy ground, gravel bars.
Hall's Bulrush	Scirpus hallii	Narrow habitat tolerance-found on bare, moist, sandy shores of ponds where water levels fluctuate.
Schreber Aster	Eurhbia schreberi	Found in damp to mesic deciduous mixed woods, most often those with maple, elm, or oak as well as in thickets and shaded roadbanks.
Small Swollen Bladderwort	Utricularia radiate	Inhabits aquatic environments such as lakes, ditches, and swamps from shallow to deep waters at low alti-tudes.
Squarrose Goldenrod	Solidago aquarrosa	Rocky upland woods, thickets, and clearings.
Wild Peavine	Lathyrus ochroleucus	Open woods, thickets, and clear-ings.



Bluntleaf Spurge

Appalachian quillwort



Hall's Bulrush

Water Companies Serving the Watershed

The water companies serving the area are Indiana-American Water Company, Silver Creek Water, Sellersburg Water, Watson Water, and Rural Membership Water Corporation of Clark County. The supply consists of deep wells from the Babb and Hertzach well field located in Jeffersonville. The water is filtered for iron and manganese removal. Current daily pumping capacity is 26 MGD (million gallon per day), and the current daily average demand is 18 MGD.[7] Rural or city water is available to all resdeints of both Clark and Floyd Counties.

Using the Water Well Web Viewer on the Indiana Department of Natural Resources Web Site, 65 wells were found throughout the watershed. Date of completion for these wells ranges from 1960 through 1988. Without contacting each individual owner, it is impossible to know if they are being used today. Most were completed before rural water was available in the area.

Transportation of goods

The area has long been considered a great area for commerce due to its ability to move products. It is rated as having one of the best interstate highway systems in the country. Excellent rail service exists throughout the area as well as excellent commercial and general aviation services. The Ohio River provides barge transportation with full service stevedoring facilities.

7One Southern Indiana Chamber & Economic Development, www.lsi.org/utilities_water.asp

PART II

INVESTIGATION
OF
WATER QUALITY ISSUES

Building Partnerships

(First step in the watershed planning process)

The purpose of this project is to develop a watershed plan using the watershed approach to build a flexible framework for managing water resource quality and quantity for the Silver Creek Watershed. "Watershed plans are a means to resolve and prevent water quality problems that result from both point source and nonpoint source problems. Watershed plans are intended both to provide an analytic framework to restore water quality in impaired waters and to protect water quality in other waters adversely affected or threatened by point source and nonpoint source pollution."[8] This approach includes stakeholder involvement and management actions supported by sound science and appropriate technology.

The first step to achieving a viable plan is to involve a mix of individuals who represent different aspects of the watershed. To help recruit steering committee members individual invitations were mailed to a list of stakeholders developed by the Clark County SWCD to attend an initial meeting in May of 2007. At that meeting, it was decided to hold a public meeting on June 14, 2007. Citizens were encouraged to attend this public meeting through press releases in the local newspapers and newsletters published by the SWCD. The purpose of the public meeting was to introduce the project, solicit members for a steering committee, and to provide a forum for residents to express concerns. A questionnaire was developed asking for individuals to list their top three concerns for Silver Creek Watershed. The backside of the questionnaire gave the individuals an opportunity to volunteer for the cause. The same questionnaire was used at the county fair and outreach activities throughout 2007.

A successful plan is reliant upon a cohesive steering committee. The steering committee must have a foundation of common knowledge, determine the scope of each concern, decide if additional information is needed, and help gather and interpret data and reports to make informed decisions. They are also responsible for ensuring local values are taken into account during plan development, carrying out planning activities, and coordinating plan implementation. The first steering committee meeting was held June 21, 2007. Within a short period of time, the group came together as a team, learning to rely upon each other's assets to complete their task. The members represent diverse interests and backgrounds within the watershed and include government officials, educators, farmers, scientists, industry professionals, and concerned citizens. Appendix II (page136) shows the stakeholder list as well as the list of dedicated steering committee members.

The public concerns gathered during the June public meeting as well as the ones gathered during the Clark County Fair and other outreach activities are listed on page 31. This list contains all the local concerns, perceived and real, within the watershed. After an extended period of discussion, the steering committee decided to remove concern number 3 Water Quality. The reasoning for this decision was based on the fact that the Silver Creek Watershed Improvement Project would not have been initiated if the water quality was not impaired. They concluded that the other items listed are sources (stressors) that are causing the water quality issues. The next step was to combine similar items and then prioritize that list. The finalized list entitled Prioritized Concerns (page 31) is the list the committee used to start development of the plan.

8 **Handbook for Developing Watershed Plans to Restore and Protect Our Waters** United States Environmental Protection Agency, Office of Water, Nonpoint Source Control Branch, Washington, DC, EPA 841-B-08-002, March 2008

As a part of the watershed process, it is vital to determine if the public's concerns are legitimate or perceived problems in the Silver Creek Watershed. For the steering committee to function in a logical progression, clarification of definitions was critical.

Cause/Source: what makes things happen . Causes may include specific pollutants, changes in land use, hydrologic changes, and other factors. Sources may be an activity without a specific location (dog walking), or they may be associated with a material or structure (impervious area), or they could be actions associated with a business or enterprise (poor sediment control in a subdivision).

Concern: the things you are worried about.

Problems: Concerns that have been validated or identified based on information gathered during the planning process.

Stressor is defined by EPA as any physical, chemical, or biological entity or phenomenon that can induce an adverse effect [on aquatic systems] either directly or as on step in a chain of causation. Things that are affecting the environment negatively.

A stressor worksheet (page 32) was completed which gave the committee direction for starting the exploration and examination of the sources. The worksheet was refered to throughout the planning process to be sure all sources were studied. As the committee was completing this task, it became apparent that not all sources were identified by the people who responded to our questionnaire. The committee determined that there were some possible sources that had not been expressed as concerns by the public and that they also needed to be added as sources to be explored. This worksheet went through several revisions and much discussion before the committee was satisfied, it was probably one of the most useful tools, once it was completed, to help the steering committee keep focused on the watershed.

Public Concerns

Gathered at the public meeting on June 14, 2007 and during the
Clark County Fair and other outreach activities during 2007

1. Bank Stabilization
2. Flooding
3. Water Quality
4. Reduction of point and nonpoint source pollution by holding permit holders accountable
5. Educate landowners
6. Preservation of riparian corridor habitat including bank stabilization
7. No loss of wetlands due to filling for development
8. Urban Expansion/Development
   Impervious area
   Variety of problems created – runoff, pet waste, etc.
9. Livestock exclusion from creek
10. Henryville Septic Systems

PRIORITIZED CONCERNS

(The number in parentheses refers to the public concern listed above.)

1. Identify point source and nonpoint source issues
   Septic systems (10)
   Livestock exclusion (9)
   Holding permit holders accountable (4)
2. Development
   Impervious area (8)
   Loss of wetlands (7)
   Problems created – runoff, pet waste, etc. (8)
   Preservation of riparian area (6)
3. Flooding* (2)
4. Bank Stabilization* (1)
5. Education of land owners* (5)

* Concerns 3,4,and 5 were rated equal in the prioritization.

Table 6: Stressor Worksheet

Public Concern Possible Cause/Source	Stressor/Pollutant	What data/info can be used to verify or determine magnitude of the source?
Septic Systems (1)* Livestock and manure management (1) Sewer Overflows (both CSOs & SSOs)	E. coli	Health Department –permits and condemned systems Where is the livestock? IDEM reports Water Quality Data
Bank Stabilization (1) Development (2) Flooding (3) Ag Runoff	Sediment	Visual from committee Input from public Rule 5 and Rule 13 enforcement Loss of wetlands Habitat Evaluation Water Quality Data
Increased Urban Areas (2) Excess runoff (2)	Nonpoint source pollution (oil, grease, runoff)	Increase of impervious area # of building permits Water Quality Data
Over-fertilization of lawns (2) Septic Systems (1) Small animals as well as traditional and nontraditional livestock (1) Runoff from agricultural lands (cropland and pasture)	High nutrient content	Water Quality Data # of building permits
Construction (2) New Development (2) Zoning Plans (2)	Encroachment (for both riparian buffers and wetlands)	Water Quality Data # of Building Permits SWCD Tracking Sheets Visual
Flooding (3) Agriculture (both livestock and grain operations) (4)	Erosion	Visual # of non-compliance letters sent to developers Water Quality Data

*Number in parentheses refers to the prioritized concerns at the bottom of page 31.

Previous Studies Done on Silver Creek Watershed

1972 Preliminary Investigation Report for Public Law 566 (Watershed Protection and Flood Prevention Act)

The driving force for this report was flooding. Research indicates the process for the preliminary investigation report began in 1964 and continued through 1977, with the report being published in 1972. No official document stating why the project was abandoned has been located but from all indications lack, of funding and a decline in public interest killed the project. Some flooding still exists in the area and probably always will due to natural topography and the proximity to the Ohio River. Silver Creek saw some minor flooding in 2007, and again in March of 2008. US Highway 31 was closed for two days due to high water during the 2008 flood. Sellersburg has received a grant to study the stormwater drainage problems in that area (this would be were Muddy Fork empties into Silver Creek).

The reasons listed for the problems in Clark County at that time are some of the same experienced today: (1) rapid population growth due to the proximity to Louisville and (2) the existence of I-65 and US 31 (both of which cross the watershed from north to south).

The complete report can be viewed at the Clark County Soil and Water Conservation District office or at the Jeffersonville Public Library in the Indiana Room.

Watershed Restoration Action Strategy for the Silver-Little Kentucky Watershed, Released in 2002

This strategy broadly covers the entire watershed (8-digit HUC 05140101); therefore, it is intended to be an overall strategy and does not dictate management and activities at the stream site or segment level. The overall goal and purpose of Part 1 of the document is to provide a reference point and map to assist local citizens with improving water quality, and Part 2 is to address the major water quality concerns and recommended management strategies. This document provided useful background information for the Silver Creek Watershed Plan. The complete report can be viewed on line at www.in.gov/idem/progams/water/wsp/05140101part1.pdf or www.in.gov/idem/programs/water/wsp/05140101part2.pdf.

Silver Creek Flood Plain Information Prepared by U.S. Army Corps of Engineers November 1973

This report was prepared in 1973 by the U.S. Army Corps of Engineers at the request of the Clark County Board of Commissioners, the city of Jeffersonville, and the Towns of Clarksville and Sellersburg. It was done because a knowledge of past floods and flood hazards is important in land use planning and for management decisions concerning flood plain utilization. The report includes a history of flooding in Clark County and identifies those areas subject to possible future floods. The report does not provide solutions to the flood problems; however, it does furnish a suitable basis for the adoption of land use controls to guide flood plain development, there by preventing intensification of the loss problems. The report includes a tributary of

Silver Creek - Muddy Fork. Muddy Fork was not included in this project although some flood control measures have been installed on Muddy Fork.

The only stream gage on Silver Creek has been maintained by the U.S. Geological Survey approximately 12.2 miles above the mouth since October 1954. (Still the only stream gage on Silver Creek.) There are three low-flow dams which have negligible effect during high stages.

Major floods on Silver Creek usually occur during the winter and spring months. Floods on Silver Creek are caused by runoff from general, intense rainfall. They can occur during all seasons of the year. Flood stages rise from normal flow levels to flood peak levels in about one day with moderately high velocities in the channel. The stream remains out of its bank for 24 to 48 hours after the end of the rainfall. Silver Creek is subject to backwater flows from the Ohio River, and when high stages occur on both streams, the height and duration of Silver Creek flooding is greatly increased.

Floods causing damage occur frequently in the Silver Creek Basin. Between 1954 and 1973 a gage height of 16 feet had been exceeded 16 times. Overbank flooding begins at a stage of 10.0 feet at the gage. The flood of record for Silver Creek occurred on January 22, 1959, with a reading of 30.89 on the Sellersburg gage. Other large floods occurred in 1960, 1961, and 1964, with elevations of 29.10, 28.17, and 30.40 respectively.

A copy of the report is located in the New Albany-Floyd County Public Library, Indiana Room. It does not circulate.

Water Quality

Background Information and Monitoring Data

Section 303(d) of the Clean Water Act requires states to identify waters, through their 305(b) water quality assessment, that do not or are not expected to meet applicable water quality standards with federal technology based standards alone. States are also required to develop a priority ranking for these waters taking into account the severity of the pollution and the designated uses of the waters. Once this listing and ranking of impaired waters is completed, the states are required to develop Total Maximum Daily Loads (TMDL). A TMDL is the amount of load of a specific pollutant that a waterbody can assimilate and still meet water quality standards. The load is allocated among the current pollutant sources (point, nonpoint and background sources), a margin of safety, and sometimes future growth.

The TMDL approach is an integrated point and nonpoint source pollution control. Under the TMDL approach, waterbodies that do not meet water quality standards are identified. States establish priorities for action and then determine reductions in pollutant loads or other actions needed to meet water quality goals. The approach is flexible and promotes a watershed approach driven by local needs and directed by the State's list of priority waterbodies. The overall goal in developing the TMDL is to establish the management actions on point and nonpoint sources of pollution necessary for a waterbody to meet water quality standards. The IDEM Office of Water Quality has organized its work around a five-year rotating basin schedule. The schedule for implementing the TMDL Strategy is proposed to follow this rotating basin plan to the extent possible.

2006 Listings

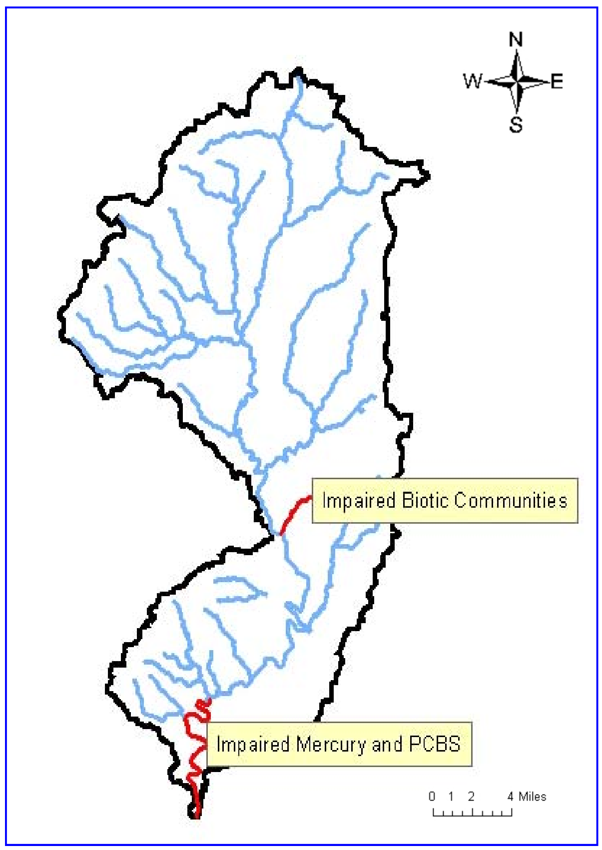
A tributary of Silver Creek is listed on Impaired Waters for 2006. It is unnamed tributary (INN01EB_T1033) 1.9 miles long and impaired for biotic communities. Silver Creek (IINN01EH_ T1003) itself is listed on the impaired list for 4.35 miles at its end for Mercury and PCBs for fish consumption. The tributary is on List 5A and the main stream is on List 5B (lists explained on next below).

Impairment Category 5 was defined by IDEM as follows: (IDEM, 2006).

Category 5 – The water quality standard is not attained. Waterbodies may be listed in both 5A and 5B depending on the parameters causing the impairment.

Category 5A – The waterbodies are impaired or threatened for one or more designated uses by a pollutant(s) and require a TMDL. This category constitutes the Section 303(d) list of waters impaired or threatened by a pollutant(s) for which one or more TMDLs are needed. A waterbody should be listed in this category if it is determined in accordance with the state's assessment and listing methodology that a pollutant has caused, is sus-

Map 10: Impaired Waters of Silver Creek 2006 Waters of Silver Creek



suspected of causing, or is projected to cause impairment. Where more than one pollutant is associated with the impairment of a single waterbody, the waterbody will remain in Category 5 until TMDLs for all pollutants have been completed and approved by U.S. EPA.

Category 5B and 5C - The 5 B list identifies waters that do not meet Fish Consumption Designated Use, and 5C identifies waters for which TMDLs are scheduled to be developed for the next listing cycle. No Silver Creek sites are on the 5C list at this time.

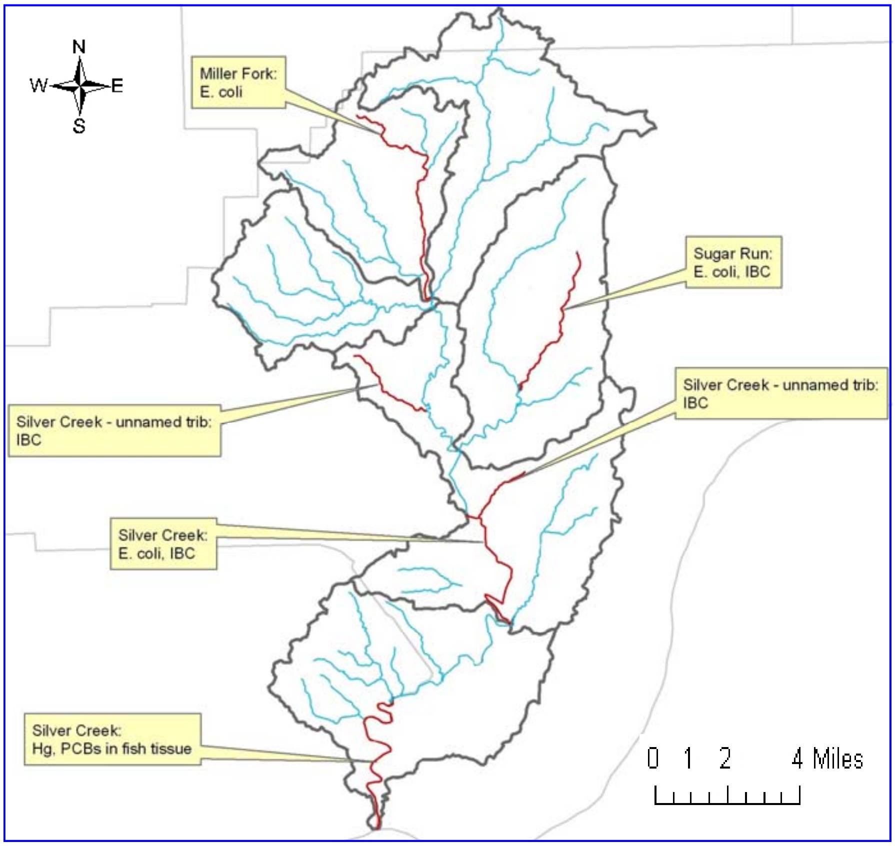
Fish consumption advisories are discussed in Appendix VI, page 168.

The current project was based on 2006 listings, but the 2008 Impaired Waters was released during the project which indicates that there are additional problems in the watershed.

Table 7: Impaired Waters List 2008 for Silver Creek

12-digit HUC	Assessment unit ID	Assessment Unit Name	Cause of Impairment	Category
051401010801	INN01E4_01	Miller Fork	E.Coli	5A
051401010805	INN01E6_T1001	Silver Creek Unnamed Tributary	Impaired Biotic Communties	5A
051401010804	INN01E8_00	Sugar Run	E.Coli	5A
051401010804	INN01E8_00	Sugar Run	Impaired Biotic Communties	5A
051401010805	INN01EB_01	Silver Creek	E.Coli	5A
051401010805	INN01EB_01	Silver Creek	Impaired Biotic Communties	5A
051401010805	INN01EB_T1001	Silver Creek Unnamed Tributary	Impaired Biotic Communties	5A
051401010806	INN01EH_T1003	Silver Creek	Mercury in Fish Tissue	5B
051401010806	INN01EH_T1003	Silver Creek	PCBs in Fish Tissue	5B

Map 11: Impaired Waters of Silver Creek 2008



Previous Testing Results done by IDEM

Five sites along Silver Creek have been sampled by IDEM for E. coli bacteria. One site was sampled in 2000 and four were sampled in 2005. The data collected at all five indicated elevated levels of E. coli. IDEM attributed elevated pathogens to nonpoint sources or unknown sources.

Dissolved oxygen was sampled at 14 sites in Silver Creek. Of those samples, one was collected in 1996, five were collected in 2000, four were collected in 2001, and four were collected in 2005. Five of those sites had levels at or below 4 ppm.[9]

Total phosphorus was measured at eleven sites. Three of the samples were collected in 2000 and four each in 2001 and 2005. The site at the Henryville treatment plant outfall was listed as impaired for phosphorus at 3.00 mg/L.[10]

Miller Fork is a tributary of Silver Creek that flows through the town of Henryville and is the receiving stream for the Henryville Wastewater Treatment Plant final effluent. A low dissolved oxygen concentration below the state stream standard was discovered in Miller Fork downstream of the Henryville plant on May 24, 2000, during the Watershed Monitoring Program probabilistic sampling for the Ohio River Basin. A follow-up Source ID study was conducted on August 28-29, 2001, to determine the source(s) causing the low dissolved oxygen condition. Findings of this study indicated that the Henryville WWTP final effluent was discharging outside of their controlled NPDES permitted stream dilution, which was most likely causing low dissolved oxygen concentration in Miller Fork downstream of the final effluent discharge.[11]

9 Quality Assurance Project Plan prepared by Fuller, Mossbarger, Scott, and May Engineers, Inc. 2007
10 Quality Assurance Project Plan prepared by Fuller, Mossbarger, Scott, and May Engineers, Inc. 2007
11 Beckman T. 2004. *Miller Fork Source Identification Water Quality Study 2001.* Indiana Department of Environmental Management, Office of Water Quality, Assessment Branch, Surveys Section, Indianapolis, Indiana

Current Project Sampling and Sites

Ten monitoring sites were selected by a targeted sampling design in order to meet the monitoring goals of this project, which are as follows:

1. Support development of the Silver Creek Watershed Plan.
2. Evaluate current conditions in waters on the 303(d) List.
3. Identify sources and causes of impairments.
4. Address data gaps.

The monitoring program started on September 26, 2007, and continued monthly until August 27, 2008. The only exception to the monthly monitoring was during March of 2008, when the sampling was postponed a week due to flooding in the area. Therefore, sampling was done on the 2nd and 30th of April 2008.

Sites are located in reaches identified as impaired for biological uses, reaches with known or suspected pollution sources and recently sampled by IDEM or other entities to address data gaps. The chart on page 41 provides more detail about the sampling sites, and the map on page 42 shows the site locations. Pictures of each site are shown in Appendix V on page 163.

Grab samples were analyzed for : Total Kjeldahl Nitrogen (TKN), Total Ammonia (NH3+NH4), Total Phosphorus (TP), Total Solids (TS), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Nitrite-Nitrogen (NO2), Nitrate-Nitrogen (NO3) and E. coli.

Field parameters collected during each sample event were: pH, Dissolved Oxygen (DO), Temperature (T), Specific Conductivity (SC), and Flow.

Benthic macroinvertebrate data was collected 2 times at all 10 sites. The first collection was done on September 10 and 18, 2008, and the second collection is scheduled. During the first collection, site 10 was dry so no macro data was available. The second collection is scheduled for February 2009. Habitat assessment was conducted during the biological collection using the Qualitative Habitat Evaluation Index (QHEI).

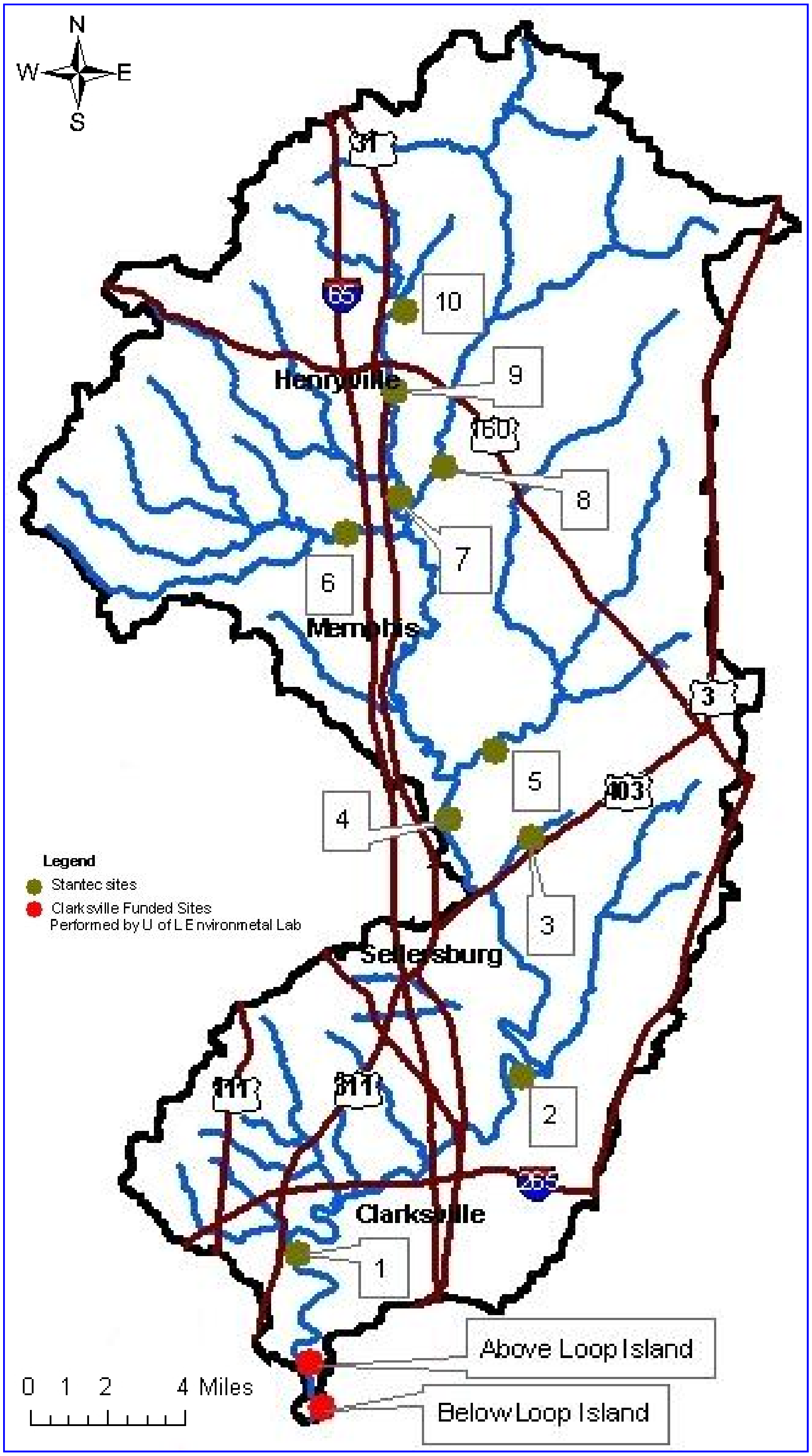
Data collection results are shown in Appendix IV (page 150). Appendix III (page 139) provides background information for the water quality tests performed in this project.

Additional testing

The project received an added benefit when a steering committee member asked the Clarksville Town Council to fund testing at an additional site near the mouth of Silver Creek (actually two additional sites were added). This gave us additional data to help determine the health of Silver Creek. The person that performed the monitoring was Richard Schultz with the University of Louisville's (U of L) Environmental Analysis Lab. One of the additional sites (Loop Island Below) was tested two times on June 21 and October 10, 2008; the other additional site (Loop Island Above) was tested on October 10, 2008. The sites are shown on the map on page 42 along with the sites selected by Stantec. Schultz also used the sites selected in the monitoring program funded by the 319 grant to conduct additional testing. On June 21, 2008, sites 1 through 5 were tested, and all ten sites were tested on October 10, 2008. The following tests were conducted: Nitrogen-Ammonia (NH3-N), Total Nitrogen, Total Phosphorus, Chloride, Temperature, Turbidity, pH, Dissolved Oxygen, Percent Saturation of Oxygen, Specific Conductivity, Total Dissolved Solids, Total Suspended Solids, and Total Solids, Nitrate + Nitrite, soluble Reactive Phosphorus (orthophosphate), Silicon dioxide (SiO_2), Dissolved Organic Carbon, Chlorophyll a, and Pheophytin a. The data collected is shown in Appendix IV (page 150).

Table 8: Sampling Sites Descriptions

Site #	IDEM Site #	Physical Location & Watershed Location	Rationale
1	OSK140 -0007	Bridge on north end of Blackiston Mill Rd. near intersection with Charlestown Rd. Jacobs Creek -Silver Creek 051401010806	303d segment – FCA for PCBs and Mercury, IDEM Site on the main stem, 05140101140070
2	OSK140 -0006	Bridge on Utica Sellersburg Rd., east of Clark Co. airport Pleasant Run - Silver Creek 051401010805	Downstream of inlet from Charlestown watershed (05140101140130), main stem, IDEM site
3	OSK140 -0001	Highway 403, near quarry entrance Pleasant Run - Silver Creek 051401010805	303d segment – IBC, IDEM Site, 05140101140110
4	OSK140 -0008	Bridge on Brick Church Rd. Pleasant Run - Silver Creek 051401010805	Silver Creek main stem, downstream of Sinking Fork watershed (05140101140100) inlet
5		Bridge on Stricker Rd. southeast of Memphis Sinking Fork 051401010804	Tribs from Sinking Fork and Carr-Peyton Branch, previously unassessed 14-digit 05140101140090
6		Bridge on Biggs Rd. west of US 31 Blue Lick Creek 051401010803	Blue Lick Creek inlets into main stem, unassessed 14-digit 05140101140050
7	OSK140 -0002	Bridge on Caney Rd. east of US-31 Headwaters-Silver Creek 051401010802	Below Henryville wastewater treatment plant, IDEM Site, 05140101140040
8		Bridge on Elrod Rd. gravel road off Caney Rd., east of US-31 Headwaters-Silver Creek 051401010802	Silver Creek mainstem and Creek, unassessed 14-digit, 05140101140030
9		Intersection of Prall Hill & Haddox Miller Creek 051401010801	Upstream of Henryville wastewater treatment plant, downstream of inlet from Miller and Caney Fork watershed (05140101140040), near IDEM site OSK 140-0016
10	OSK140 -0033	Hebron Rd. east of US-31 Miller Creek 051401010801	Headwaters of Silver Creek, 14-digit that is listed as partially supporting aquatic life, (05140101140040)



Map 12: Monitoring Site Location Map

Water Quality Monitoring Results Summary

Results of the monitoring program are summarized in Tables 9 and 10 (page 46 and 47). Table 9 includes results of the tests performed by both monitoring sources; Table 10 only includes a summary of the tests performed by U of L's Environmental Analysis Lab; Table 11 (page 49) is a summary of macroinverbrate collection, and Table 12 (page 51) shows the results of the habitat assessment.

Table 9:
Water Quality Standards Used for Silver Creek Project

Water Quality Standards Used for Silver Creek Project		
Test Name	**Criteria or Comparison Value**	**Source of Standard**
Conductivity	1,200 us/cm	Literature - Drinking Water Standard
Dissolved Oxygen	>5 mg/L not <4 mg/L	State Standard
E. Coli	<235 CFU/100mL	State Standard
Flow	----	
Nitrate + Nitrite	1.2 mg/L	Literature
Nitrogen-Ammonia	.01 mg/L	Literature
pH	6.0 - 9.0 su	State Standard
Phosphorus, Total	0.08 mg/L	Literature
Solids, Dissolved	----	
Solids, Suspended	80 mg/L	Literature
Solids, Total	261 mg/L	Literature
Total Kjeldahl Nitrogen	5 mg/L	Literature
Temperature	----	
Turbidity	25	Literature

Discussion

Table # shows the criteria or comparison values used and where the value was obtained. The data indicates that water quality did not meet the criteria or comparison values on a regular basis for Dissolved Oxygen, E coli, Nitrate + Nitrite, and Total Phosphate. Conductivity was considered high at two sites and will also be discussed below. In addition, sampling showed high turbidity readings at two sites (site 1 - 42.1 NTU February 2008 and site 4 - 57.20 NTU July 2008), but it was deemed not to be of concern.

Conductivity

Conductivity is a measure of the ability of water to pass an electrical current. Conductivity is useful as a general measure of stream water quality. Conductivity in streams is affected primarily by the geology of the area through which the water flows. Streams that flow through limestone and clay soils will have higher conductivity values. Data contained in Appendix IV (page 150) shows the majority of test sites tend to have fluctuating values but do not exceed the criteria of 1200 us/cm.

The sites that registered high conductivity readings were Sites 2 and 3. Both of these sites are located near quarries, which might explain these high readings. Site 3 is also located downstream from the Clark County Highway Department Garage where road salt is stored. Road salt raises the conductivity levels of water.

Dissolved Oxygen

Dissolved oxygen (DO) analysis measures the amount of gaseous oxygen (O_2) dissolved in an aqueous solution. Dissolved oxygen is one of the most important parameters in aquatic systems. This gas is an absolute requirement for the metabolism of aerobic organisms and also influences inorganic chemical reactions. Presence of oxygen in water is a positive sign, while absence of oxygen from water often indicates water pollution.

Dissolved oxygen levels below 3 mg/L (milligrams per liter) are stressful to most aquatic life. DO levels below 2 mg/L will not support fish. Levels of 5 to 6 mg/L are usually required for healthy growth and activity of aquatic life. In fresh water, parts per million and milligrams per liter are interchangeable. The state standard for dissolved oxygen is greater than 5 mg/L and not less than 4 mg/L.

Sites 1,9, and 10 did not have any dissolved oxygen impairments. All other sites had at least one reading that would be considered unhealthy for the stream and occupants. Sixteen readings were less than 4 mg/L, and ten readings were less than 5 mg/L but greater than 4mg/L. Most of the low readings took place from June to September. This project was conducted during two years of drought conditions. The drought conditions resulted in low flow (which causes a lack of turbulence or mixing of exposed water to atmospheric oxygen) causing low dissolved oxygen concentrations. Additionally, warm water also holds less oxygen. Until the natural flow is restored, the water quality criteria for dissolved oxygen may not be met without intervention.

E. coli

E. coli, a form of fecal coliform, is generally used as an indicator of harmful bacteria loading, because it is easier and less expensive to monitor than pathogenic organisms, and it is derived solely from the intestinal tract of warm-blooded animals. Fecal coliform bacteria are present in soil as well as in animals.

Indiana water quality standards for total body contact recreation readings require less than 235 CFU per one hundred milliliters. All sites tested except Site 5 (which had none) had at least one result above the standard. Sites 3 and 9 each had five readings above the standard.

The 2006 Impaired Waters list did not have any waters listed for E. coli in the Silver Creek Watershed, but the 2008 Impaired Waters list shows three tributaries of Silver Creek for E. coli (see Map 9 and Table 7 on page 37). The listing indicated that our E. coli results for the project would be unsatisfactory.

Possible sources of elevated bacteria may include human and animal sources. Wastewater treatment plants that are not in compliance with disinfection requirements, failing septic systems, and straight pipes (no septic system) are human sources. Animal sources include pets, wildlife, and livestock.

Nutrients
Nitrogen and Phosphates

The major nutrients of concern for stream systems are phosphorus and nitrogen. These nutrients are found naturally in streams and are required for a healthy aquatic ecosystem. Excess nutrients can lead to eutrophication, which may be indicated by excessive algae growth contributing to decreased levels of dissolved oxygen (which data indicates is a problem).

Phosphorus and nitrogen have several forms in water. The two common phosphorus assays are soluble reactive phosphorus (SRP) and total phosphorus (TP). SRP or orthophosphate is the dissolved form of phosphorus and is the form used by algae. Only the additional monitoring done by U of L's lab tested for SRP. Total phosphorus is a measure of both dissolved and particulate forms of phosphorus.

There are no standards in Indiana for either of these nutrients in streams. Therefore criteria or comparison standards for nitrogen and phosphate must be found elsewhere. After consulting several reliable sources, the committee selected 0.08 mg/L total phosphorus as a threshold. The nitrogen target the committee selected was the nitrate + nitrite reading of 1.2 mg/L.

Phosphorus and nitrogen are found in commercial fertilizers, manure, and other crop production enhancers as well as in human waste.

The high nitrogen reading all came in the months of October through February. Sites 2, 3, and 5 had elevated readings in all of the months. Site 1 had high readings from October through January. Site 4 had high readings from October through December, and Site 8 had its elevated readings in November, January and February. One would expect the nitrogen readings to be high during the growing months when people are adding commercial fertilizers to stimulate plant growth.

The most commonly measured nitrogen forms are nitrate (NO3), nitrite (NO2), nitrogen-ammonia (NH3-N), total Kjeldahl nitrogen (TKN), and total nitrogen. Nitrate is a dissolved form of nitrogen that is commonly found in a rapidly moving stream or anywhere that oxygen is readily available. Nitrogen-ammonia is generally found where oxygen is lacking. Ammonia is a byproduct of decomposition. Ammonia is a dissolved form of nitrogen utilized by algae for growth. TKN is a measure of the total organic nitrogen (particulate) and nitrogen-ammonium in the water sample.

The nitrogen values all came in the months of October through February. Sites 2,3, and 5 had elevated readings in all of the months. Site 1 had high readings from October through January. Site 4 had high readings from October through December, and Site 8 had an elevated value in November, January, and February. Site 7 had one high reading in December. Sites 6, 9, and 10 never had an elevated reading. One would expect the nitrogen readings to be high during the growing months when people are adding commercial fertilizers to stimulate plant growth.

Using 0.08 mg/L as the phosphorus target resulted in 13 readings over the target. The sites with at least one high phosphorus reading were 1, 3, 4, 5, 6, and 7. No pattern is apparent related to the months for high phosphorus values. June and September each had three site above the target. Further investigation may be needed to determine the source (s) of the problem.

Water Quality Data Summary for Project Monitoring

Table 10: Water Quality Monitoring Results Summary Performed by both Monitoring Groups

Water Quality Monitoring Results Summary						
Test Name	**Units**	**# Results**	**Minimum Value**	**Average Value**	**Maximum Value**	**Criteria or Comparison Value**
Conductivity	us/cm	134	56	411.55	2448	1,200
Dissolved Oxygen	mg/L	136	1.2	8.38	15.50	>5 mg/L not <4 mg/L
E. Coli	MPN	118	0	192.3	1011.1	<235 CFU/100mL
Flow	ft/sec	115	0.0	.764	3.0	----
Nitrate + Nitrite	mg/L	136	0.14	0.72	4.834	1.2 mg/L
Nitrogen-Ammonia	mg/L	131	0.018	0.16	1.5	.01 mg/L
pH	su	136	6.00	6.88	7.92	6.0 - 9.0 su
Phosphorus, Total	mg/L	131	0.014	0.064	0.34	0.08 mg/L
Solids, Dissolved	mg/L	126	104	270	1450	----
Solids, Suspended	mg/L	126	<1.0	10.40	63.0	80 mg/L
Solids, Total	mg/L	126	117	302	1580	261 mg/L
Total Kjeldahl Nitrogen	mg/L	131	.1	0.37	1.5	5 mg/L
Temperature	Degrees Centigrade	136	.1	13.23	25.4	----
Turbidity	NTU	124	.60	9.38	57.20	25

Table 11: Water Quality Monitoring Results Summary of Tests Performed by U of L

Water Quality Monitoring Results Summary Additional Tests Performed by U of L Environmental Analysis Lab Not Done by Stantec						
Test Name	**Units**	**# Results**	**Minimum Value**	**Average Value**	**Maximum Value**	**Criteria or Comparison Value**
Chloride	mg/L	18	7.25	42.06	146.09	< 100 mg/L
Chlorophyll a	ug/L	18	0.287	5.236	28.811	<5 ug/L
Dissolved Organic Carbon	mg/L	18	3.16	5.59	8.53	>7 mg/L
Orthophos-phate	mg/L	18	0.009	0.028	0.079	Less than To-tal Phosphate
Pheophytin a	mg/L	18	0.283	1.66	6.601	Less than Chlorophyll a
% Saturation of Oxygen	%	18	39.9	68.58	94.3	----
Silicon Dioxide	mg/L	18	4.65	7.69	10.53	----
Total Nitrogen	mg/L	18	0.326	1.167	1.713	> 2.5 mg/L

Macroinvertebrate Collection Discussion
Provided by Stantec

Initial collection (September 2008)

During September of 2008, nine sites from the Silver Creek drainage area were sampled for aquatic invertebrates. During the sampling, the stream at Site 10 was dry, which precluded macroinvertebrate sampling.

The Silver Creek drainage area was sampled during severe drought conditions. This is the second year in succession that this region of the state has experienced a serious drought. The habitat at all 10 monitoring sites was greatly restricted because of the drought, with flow at all sites restricted to the thalweg. A thalweg is the line defining the lowest point along the length of a stream. Pools and riffles were significantly reduced. Root-wads on the banks, dry and emergent vegetation were often out of the water. Thus, many of the habitats that would normally be inhabited by aquatic invertebrates were not available for colonization.

There was an overall dominance of tolerant and facultative organisms present at all locations. Sites 5, 6, and 7 were the most severely impacted. All of these had reduced TNI, TR, and EPT value and elevated mHBI values. See Table 11 (page 49).

Of particular note is Site 5, from which only 25 organisms were collected in the quantitative sample. This low number of organisms indicates a severe impact, including the possibility that the stream reach may be receiving some type of toxicant.

The MBI rankings were fair at Sites 1, 2, and 4, poor at sites 3,6, 7, 8, and 9, and very poor at Site 5.

Data from this initial sample event indicate that multiple issues may be affecting the drainage. Stressors or factors that may be affecting the biological community, include the continuation of the drought, erosion and sedimentation, and potentially nutrient enrichment. Each of these factors is discussed below.

Drought conditions often decrease dissolved oxygen (DO) levels in the water. DO levels were recorded at all sites during the macroinvertebrate sampling, with values ranging from 1.73 mg/L to 8.18 mg/L and an average of 3.96 mg/L. DO levels under 5 mg/L stress aquatic life, such as fish and macroinvertebrates. Field test data collected during macroinvertebrate sampling is unpublished.

Another condition observed during sampling was loss of riparian habitat and streambank erosion, particularly at Sites 4, 6, 7, 8, and 9. The loss of riparian buffers, stream channelization and increased stormwater volume can contribute to increased erosion and elevated nutrients transported via eroded sediments.

The overall dominance of tolerant and facultative organisms present at all locations is an indicator of moderate to heavy impacts from nutrients. From this initial dataset, Sites 5, 6, and 7 appear to be the most significantly affected.

Second collection (February 2009)

Good quality streams trypically have diverse macroinvertebrate faunas present in late winter and early spring. These faunas are generally dominated by aquatic insects of which the Ephemeroptera, Plecoptera, and Trichoptera (EPT) are major components. A review of the data indicates that none of the ten sites sampled in silver Creek watershed displayed this type of diversity. Conversely, the macroinvertebrate fauna was depauperate at virtually all sites with regard to total numbers of individuals (TNI) and taxa richness (TR). The one exception was TNI at site 3. A summary of this data is included in Table # page #.

The EPT values were very low at all sites, ranging from zero at Sites 1, 2, and 5 to a high of nine at Site 7. even the EPT of nine is from three ot four times lower than would be expected from high quality streams in the Interior Plateau ecoregion. Because of the low TNIs seen at Sites 1, 2, 5, 7, 8, and 9 several metrics could not be accurately calculated, including the percent Ephemeroptera, EPT, clingers, and chironomids plus oligochaets and HBI. The HBI values at Sites 4, 6, and 10 should be viewed with caution: erroneous results are possible when less than 100 organisms are used to calculate this index. This is particularly true of the HBI value of 3.34 calculated for Site 10. The other indices at Site 10 except percent EPT indicate that this is a poor to very poor site rather than a good site as indicated by the HBI.

The MBI values were only calculated at Sites 3, 4, 6, and 10. These sites received a ranking of very poor at Site 4, poor at sites 3 and 6, and fair at Site 10. the MBI can also produce erroneous results when less than 100 organisms are used to calculate the index. The metric scores seen at Sites 3, 4, and 6 seem to indicate that the MBI scores and rankings for those sites are reasonable. The fair ranking at Site 10 is the result of the low value for HBI and the high percent EPT value. These skewed the NMBI value. The percent EPT value at Site 10 was in artifact of the high number of the intolerant winter stonefly Allocapnia sp. The high density of Allocapnia sp. Also skewed the HBI value.

Data for the Fall 2008 and Spring 2009 sample events indicate that biological communities in the Silver Creek Watershed are impaired by multiple issues. Stressors or factors that may be affecting the biological community include drought, erosion and sedimentation and potentially nutrient enrichment.

The Silver Creek drainage was sampled during severe drought conditions in the fall of 2008. this is the second year in succession that this region of the state has experienced a serious drought. The habitat at all ten sites was greatly restricted because of the drought, with flow at all sites restricted to the thalweg. Polls and riffles were significantly reduced, root-wads on the banks were out of the water and dry, and emergent vegetation was often out of the water. Thus, many of the habitats that would normally be inhabited by aquatic invertebrates were not available for colonization.

Drought conditions often decrease dissolved oxygen (DO) levels in the water, as observed during the Fall 2008 sample event. DO levels were recorded at all sites during the macroinvertebrate sampling, with values ranging from 1.73 mg/L to 8.18 mg/L and an average of 3.96 mg/L. DO levels under 5 mg/L stress aquatic life such as fish and macroinvertebrates. During the Spring 2009 sample event, DO and other water quality parameters had improved such that average DO was 9.8 mg/L.

Table 12: Macroinvertebrate Collection # 1 (September 2008) Results Summary

Macroinvertebrate Collection #1 (September 2008) Results Summary* (Numbers in parentheses are the numbers of organisms in the qualitative sample)**									
Metrics	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**
TNI	297 (226)	322 (194)	321 (227)	332 (205)	25 (25)	185 (77)	157 (133)	320 (228)	331 (261)
TR	35 (34)	34 (32)	20 (20)	33 (32)	14 (14)	21 (21)	20 (19)	35 (34)	39 (37)
EPT	8 (8)	9 (8)	2 (2)	9 (9)	0	2 (2)	3 (3)	8 (8)	9 (8)
% Ephem	21	68	2	70	0	37	36	25	15
% EPT	53	73	2	71	0	37	36	27	19
mHBI	6.83	6.1	6.58	4.92	6.8	6.48	6.28	5.18	6.1
% Cling	54	61	17	64	8	7	38	34	22
%Chir + Olig	27	18	71	23	84	59	13	42	65
MBI Score	47.22	53.18	19.37	55.29	12.84	25.36	38.02	39.19	31.29
MBI Ranking	Fair	Fair	Poor	Fair	Very Poor	Poor	Poor	Poor	Poor

* Site 10 was not sampled due to lack of water.
** Qualitative samples were collected from different habitat types found at the site - root wads, overbanks, pools etc.
Quantitative samples were collected from the riffle in a 1 square meter.

TNI - Total number of individuals

TR - taxa richness

EPT - numbers of the generally more sensitive Ephemeroptera-Plecoptera-Trichoptera taxa

% EPT - the percentage of the sample that is made up of the EPT taxa

% Ephem - the percentage of the sample that is made up of the generally sensitive Ephemeroptera.

mHBI - the modified Hilsenhoff Biotic Index

% Cling - the percentage of the sample that is made up of clingers

% Chiro + Olig - the percentage of the sample that is made up of chironomids and oligochaets

MBI - Macroinvertebrate Bioassessment Index

Table 13: Macroinvertebrate Collection #2 (February 2009) Results Summary

Macroinvertebrate Collection # 2 (February 2009) Results Summary (Numbers in parentheses are the numbers of organisms in the qualitative sample)**										
Metrics	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**	**Site 10**
TNI	8 (8)	1 (1)	290 (94)	34 (37)	12 (12)	114 (59)	2 (2)	14 (14)	17 (17)	64 (31)
TR	3 (3)	2 (2)	15 (14)	24 (24)	12 (12)	18 (18)	20 (20)	7 (7)	14 (14)	6 (6)
EPT	0	0	4 (4)	7 (7)	0	5 (5)	9 (9)	2 (2)	4 (4)	2 (2)
% Ephem	ND	ND	0	0	ND	2	ND	ND	ND	2
% EPT	ND	ND	11	0	ND	69	ND	ND	ND	92
mHBI	ND	ND	6.15	8.15	ND	6.24	ND	ND	ND	3.34
% Cling	ND	ND	10	0	ND	1	ND	ND	ND	0
%Chir + Olig	ND	ND	2	81	ND	30	ND	ND	ND	5
MBI Score	ND	ND	29.73	13.93	ND	35.15	ND	ND	ND	43.61
MBI Ranking	ND	ND	Poor	Poor	ND	Poor	ND	ND	ND	Fair

ND - Not Determined

** Qualitative samples were collected from different habitat types found at the site - root wads, overbanks, pools etc.

Quantitative samples were collected from the riffle in a 1 square meter.

TNI - Total number of individuals

TR - taxa richness

EPT - numbers of the generally more sensitive Ephemeroptera-Plecoptera-Trichoptera taxa

% EPT - the percentage of the sample that is made up of the EPT taxa

% Ephem - the percentage of the sample that is made up of the generally sensitive Ephemer-optera.

mHBI - the modified Hilsenhoff Biotic Index

% Cling - the percentage of the sample that is made up of clingers

% Chiro + Olig - the percentage of the sample that is made up of chironomids and oligochaets

MBI - Macroinvertebrate Bioassessment Index

Habitat Assessment Discussion
Provided by Stantec

Habitat data were collected for each site in the Silver Creek drainage according to the Ohio Environmental Protection Agency's (EPA) Qualitative Habitat Evaluation Index (QHEI) as outlined by the Ohio EPA (1989 and 2006). The Indiana Department of Environmental Management (IDEM) uses QHEI scores to evaluate how habitat quality affects aquatic life, such as fish and macroinvertebrate communities. In streams with impaired aquatic communities, QHEI scores are evaluated to determine if habitat is a primary stressor to the aquatic life (IDEM, 2008).

QHEI scores are calculated from six metric scores: substrate, instream cover, channel, morphology, bank erosion and riparian zone, pool-glide and riffle-run quality, and gradient. QHEI scores range from 0 to 100 and correspond with a given habitat rating: Very Poor through Excellent. Each metric is scored out of a maximum of 20, except for the Bank Erosion and Riparian zone and Gradient netrics, which are scored out of 10. the metric scores, QHEI scores, and habitat ratings for each site in the silver Creek Watershed are provided in Table ## Fall 2008 and Table ## Spring 2009 on pages###.

The stream flows through limestone dominated lithology. Generally speaking, this stream system has a moderate to low gradient. The pool areas are dominated by limestone bedrock. The riffle areas consist of limestone bedrock overlain with gravel-cobble substrate, and most of the streams have narrow riparian zones. As the streams increase in size, they tend to spread out laterally because of the abundance of bedrock. This allows the mid- and larger sized streams to be exposed to sunlight for most of the day.

The QHEI ratings were poor at all stations except stations 1, 2, and 9, which were fair during the fall habitat assessment. All sites but two (sites 4 and 5) improved during the spring assessment when water flow was adequate. Many of the habitat metrics are items that occur naturally and would be difficult to impossible to change.

Table 14: Habitat Assessment # 1 (September 2008) Results Summary

Habitat Assessment # 1 (September 2008) Results Summary										
QHEI Metric	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**	**Site 10**
Substrate (20 max points)	1	-2	-3	1	-3	-1	-1	-3	0	0
Instream Cover (20 max points)	8	8	6	10	9	8	7	14	13	10
Channel Morphology (20 max points)	12	17	11	10	5	10	13	11	11	14
Bank Erosion & Riparian Zone (10 max points)	7.5	8	7	3.5	6.5	3.5	3	5.5	5.5	8
Pool/Glide & Riffle/Run Quality (20 max points)	10	11	1	11	9	3	6	8	7	-1
Gradient (10 max points)	6	6	8	4	6	10	10	6	6	10
Headwater** (H) or Large Stream (L)	L	L	H	L	L	H	H	L	H	H
Total	44.5	48	30	39.5	32.5	33.5	38	41.5	42.5	41
Narrative Rating	Fair to Poor	Fair	Poor to Very Poor	Poor	Poor	Poor	Poor	Poor	Fair to Poor	Poor

** Headwaters are defined as less than or equal to 20 square miles

Narrative Rating from QHEI Manual:

	Headwaters	**Larger Streams**
Excellent	70+	75+
Good	55-69	60-74
Fair	43-54	45-59
Poor	30-42	30-44
Very Poor	0-30	0-30

Table 15: Habitat Assessment # 2 (February 2009) Results Summary

Habitat Assessment # 2 (February 2009) Results Summary										
QHEI Metric	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**	**Site 10**
Substrate (20 max points)	12	6	11	4	1	5	14	1	8	10
Instream Cover (20 max points)	15	16	11	11	5	8	13	16	12	15
Channel Morphology (20 max points)	16	16	17	8	8	11	11	16	16	16
Bank Erosion & Riparian Zone (10 max points)	8.5	8.5	7	3	7.5	4.5	3.5	7	7.5	7.5
Pool/Glide & Riffle/Run Quality (20 max points)	1	9	12	8	6	6	10	8	13	13
Gradient (10 max points)	6	6	8	4	6	10	10	6	6	10
Headwater** (H) or Large Stream (L)	L	L	H	L	L	H	H	L	H	H
Total	58.5	61.5	66	38	33.5	44.5	61.5	54	62.5	71.5
Narrative Rating	Fair	Good	Good	Poor	Poor	Fair	Good	Fair	Good	Excel-lent

** Headwaters are defined as less than or equal to 20 square miles

Narrative Rating from QHEI Manual:

	Headwaters	**Larger Streams**
Excellent	70+	75+
Good	55-69	60-74
Fair	43-54	45-59
Poor	30-42	30-44
Very Poor	0-30	0-30

Exploring Sources

Impervious Surfaces

Impervious surfaces are artificial structures such as pavements and building roofs which replace naturally pervious soil with impervious materials. Environmental concerns caused by impervious surfaces are as follows:

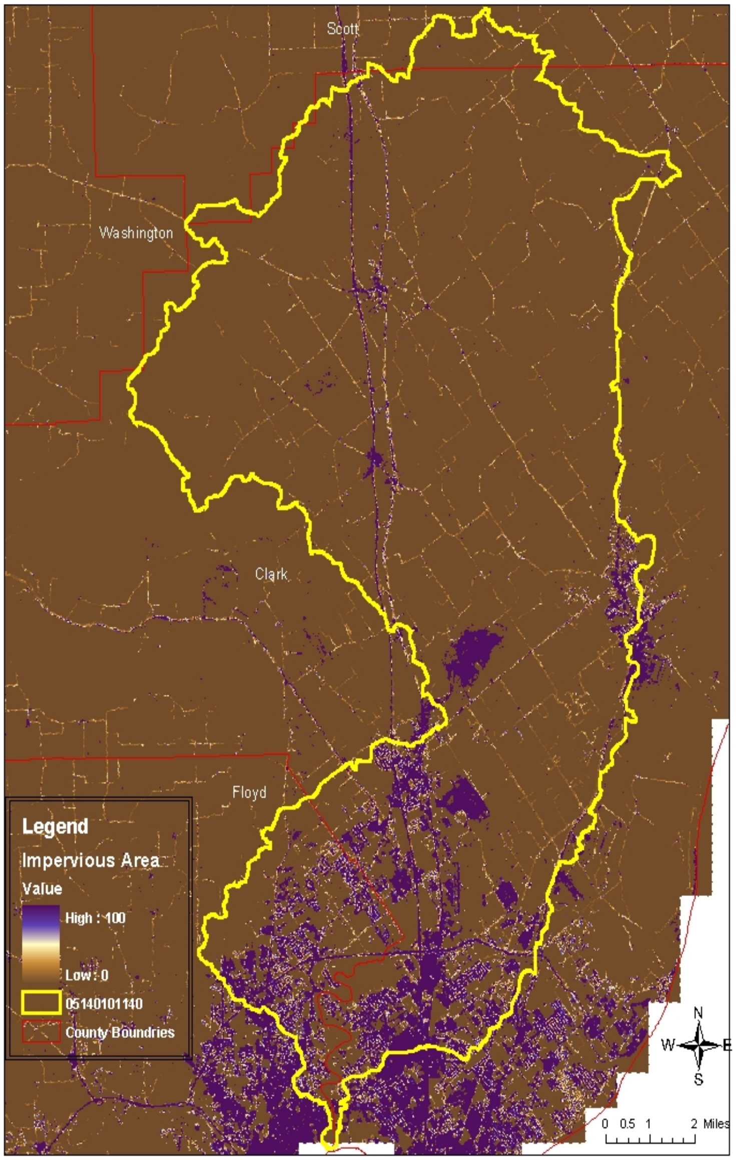
- Sealed soil surfaces eliminate rainwater infiltration and natural groundwater recharge.
- Stream flow declining during dry summers.
- Stormwater runs directly across impervious surfaces raising flood peaks.
- Stream channels erode.
- Sediment loads increase.
- Shifting substrate eliminates aquatic habitats.
- Oil and heavy metals that leak and corrode from automobiles run directly into streams.
- Where combined sewers exist, flood waters cause overflows.
- Impervious construction materials collect solar heat in their dense mass. The warm runoff reduces dissolved oxygen in streams.
- Impervious surfaces displace living vegetation and reduces ecological productivity.

Impervious surface area increases with rising urbanization. Impervious area cover is estimated to be 1 to 2 percent in rural areas, 10 percent in low-density subdivisions, 50 percent in multi-family communities, greater than 70 percent in industrial and commercial areas, and greater than 90 percent in regional shopping centers and dense downtown areas.

The Center for Watershed Protection provides objective and scientifically sound information on effective techniques to protect and restore urban watersheds. They have conducted research that revealed a correlation between the percent of impervious surface in a watershed and stream quality indicators such as channel stability, habitat structure, water quality, and aquatic community diversity. Using the results of this research the Center developed the following classification system. Watersheds with impervious cover below 10 percent are termed “sensitive” and are likely to contain good to excellent stream quality indicators . Watersheds with impervious cover between 10 percent and 25 percent are termed “impacted,” and stream indicators are likely to display signs of degradation. Watersheds with impervious cover above 25 percent are termed “non-supporting” and are likely to display poor stream quality indicators. It is important to note that the model predicts potential rather than actual stream quality.

In EPA’s effort to preserve, protect, and improve the Nation’s water resources from polluted stormwater runoff, they have implemented the Stormwater Phase II Final Rule (in Indiana it is referred to as Rule 13). Phase II is intended to further reduce adverse impacts to water quality and aquatic habitat by instituting the use of controls on the unregulated sources of stormwater discharges that have the greatest likelihood of causing continued environmental degradation. The Municipal Separate Storm Sewer System (MS4s) within the watershed are Clarksville, New Albany, and Sellersburg. Stormwater discharges from MS4s in urbanized areas are a concern because of the high concentration of pollutants found in these discharges. Concentrated development in urbanized areas substantially increases impervious surfaces, such as city streets, driveways, parking lots, and sidewalks, on which pollutants from concentrated human activities settle and remain until a storm event washes them into nearby storm drains. Another concern is the possible illicit connections of sanitary sewers, which can result in fecal coliform bacteria entering the storm sewer system. Stormwater runoff picks up and transports these and other harmful pollutants then discharges them - untreated - to waterways via storm sewer systems. When left uncontrolled, these discharges can result in fish kills, the destruction of spawning and wildlife habitats, a loss in aesthetic value, and contamination of drinking water supplies and recreation waterways that can threaten public health.[12] The MS4 is required to implement stormwater discharge management controls also known as best management practices (BMPs) to help reduce the discharge of pollutants. MS4 communities have instituted Stormwater fees (used to install BMPs) based on impervious area. The average home's fee is based on 2,500 square feet of impervious area.

Map 11 shows the impervious surface in 2001 for the area. Growth in the Clarksville area has exploded since 2004. Veterans Parkway, which is a huge commercial area in Clarksville, is not shown on the map. Since 2002, the impervious area has increased by at least 102 acres in Floyd County alone.



Map 13: Impervious Surface, 2001 USGS

12 Stormwater Phase 11 Final Rule, An Overview Fact Sheet, 1.0 EPA 833-F-00-001, January 2000 (revised December 2005)

Building Permits Issued

The number of building permits issued is an indication of an increase in impervious area. As the impervious area increases so does the amount of run off.

Annual New Residential Permits Reported by US Census Bureau

Clark County	# in Watershed*	Year	Floyd County	# in Watershed*
328	111	2000	353	52
476	160	2001	343	50
792	267	2002	331	48
737	248	2003	468	68
969	327	2004	350	51
968	326	2005	268	39
658	223	2006	233	34

* 33.7% of Clark County is in the watershed, and 14.6% of Floyd County is in the watershed. It is highly unlikely that the percentage would be exactly the same but should be a good indication of building taking place in the watershed.

Table 16: Clark County - Multi-Family Structures

Year	2-Family		3 & 4 Family		5 or More Family	
	Buildings	Units	Buildings	Units	Buildings	Units
2000	2	4	0	0	2	32
2001	4	8	0	0	11	168
2002	9	18	2	7	18	244
2003	9	18	1	4	10	150
2004	11	22	3	12	3	18
2005	2	4	2	18	0	0
2006	0	0	4	16	11	77

Table 17: Floyd County - Multi-Family Structures

Year	2-Family		3 & 4 Family		5 or More Family	
	Buildings	Units	Buildings	Units	Buildings	Units
2000	0	0	0	0	6	72
2001	4	8	0	0	1	23
2002	1	2	0	0	1	8
2003	1	2	0	0	1	6
2004	3	6	3	11	1	6
2005	2	4	0	0	0	0
2006	7	14	4	15	1	8

Septic Permits - Clark County
Repaired and New Construction

Failing or not properly working septic systems is a public concern. There is currently no inspection process of installed septic systems unless there is a complaint. Table 15 shows the number of septic system permits applied for, the number that were actually issued, and the number in the watershed that were condemned. Floyd County was not contacted in regards to the septic permits in their county, because the majority of the county that is in the watershed is either on sewers or package treatment plants.

Table 18: Clark County Septic System Permits 2000-2007

Year	Applications	Final Inspections	Condemned*
2000	353	205	
2001	246	228	1
2002	316	201	2
2003	249	192	0
2004	251	168	0
2005	195	209	1
2006	134	119	4
2007	120	83	8

*Numbers refer to homes located in the watershed that were condemned by the Clark County Health Department for sewage related issues only. The issues may have been corrected and homes since re-occupied.

Unsewered Communities

Results from a 2003 survey conducted by the Indiana State Department of Health and Rural Community Assistance Program to identify communities that need assistance with resolving outstanding sewage disposal problems indicated that within the Silver Creek Watershed there were 5 (Clark - 4 and Floyd - 1). Updated information concerning these communities follows:

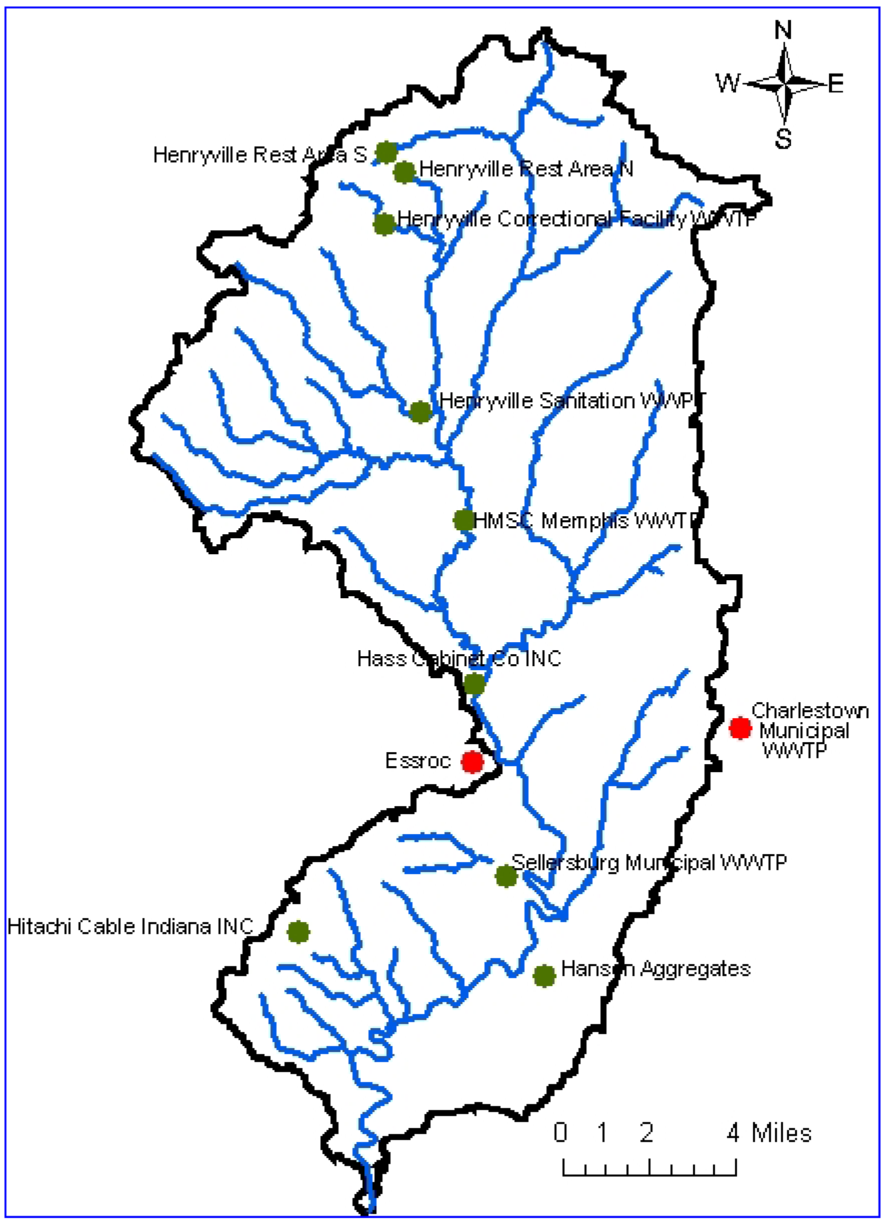
~ Highview and Lakeview have been connected to the Charlestown Sewer System
~ Underwood is in negotiations with the Henryville Membership Sanitation Corporation regarding connections to that system. From all indications it will still be several years before the connection is completed.
~ Sewage treatment does not seem to be a high priority for the unincorporated area of Otisco.
~ Chapel Lane in Floyd county still has a combination of septic and sewers.

National Pollutant Discharge Elimination System (NPDES)

The National Pollutant Discharge Elimination System (NPDES) was established to control the discharge of storm water and/or industrial discharges that could adversely affect the quality of waters of the United States. Map 12 below shows the facilities in the watershed that have effective NPDES permits as of 2007. The two facilities indicated in red are not located in the watershed but their outfall is into Silver Creek. Appendix VII (page 172) provides a summary of the exceedences violation report for these facilities from 2001 through 2007.

Excess E. coli readings were not uncommon at several of the facilities. This may be the reason that Miller Fork was added to the Impaired Waters List for 2008.

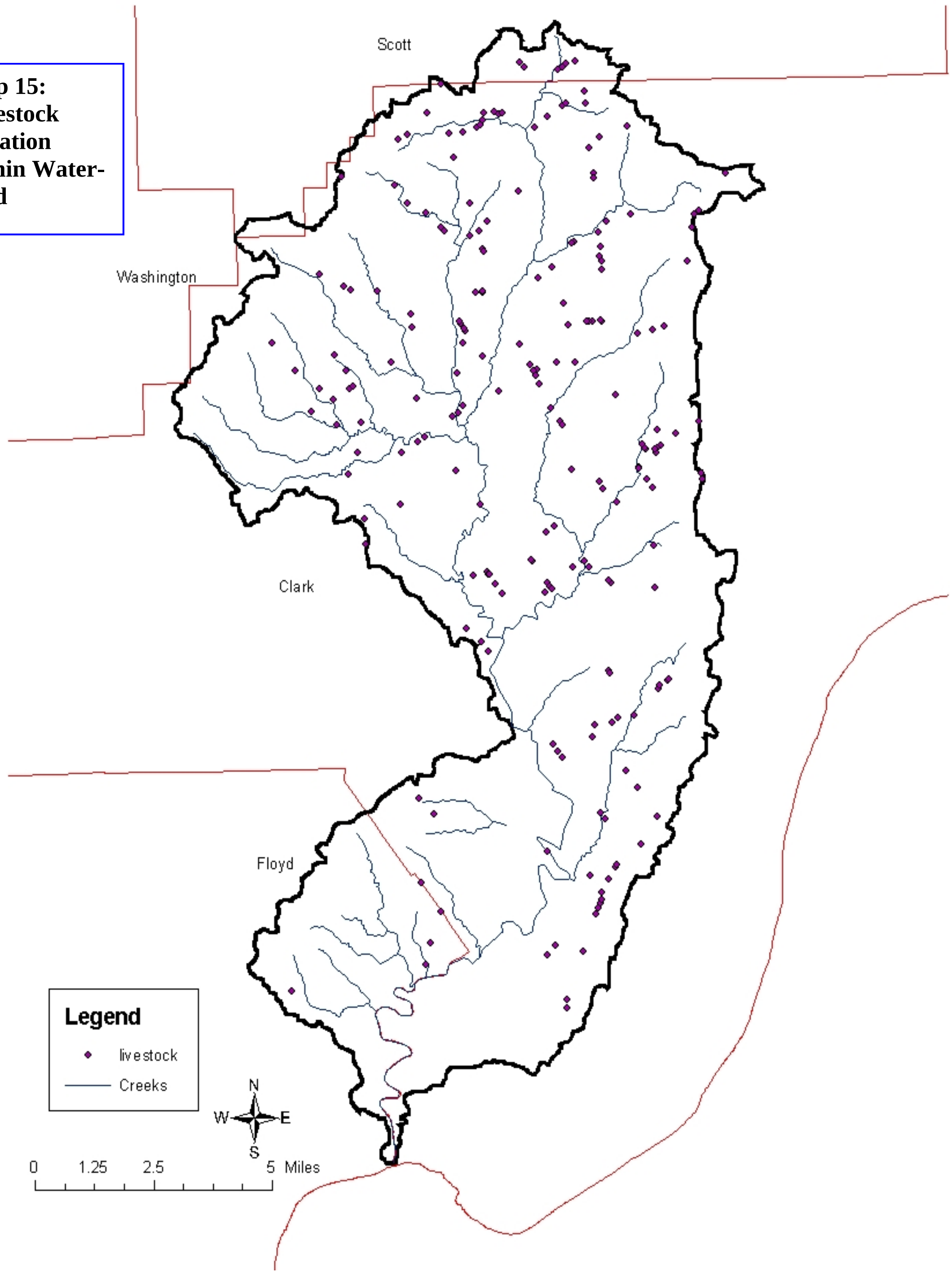
Map 14:
Effective Permitted NPDES Facilities in Silver Creek Watershed



Livestock Location in Watershed

Exclusion of livestock from the creek was a concern, so the following map was created to determine if this concern was founded. The map indicates that lack of exclusion from the creek could be a problem in some areas. The number of animals was not taken into account; only their location was noted. This information was compiled by driving through the watershed. Some animals may have been missed if they could not be seen from the road, but the majority of the livestock operations were noted. The 211 sites consisted of Horses, 113; Beef Cows, 77; Goats, 8; Dairy Cows, 2; Bison, 2; Llama, 1; Alpaca, 1; Combination, 7.

Map 15: Livestock Location within Watershed



Stocking Rates

Besides the location of the animals an additional concern became apparent while driving through the watershed: the stocking rate or number of animals per acre of land. The stocking rate will vary greatly depending on the type of livestock, the fertility of the land, and the climatic conditions. Too many animals living in too small an area produce more manure and urine than soil and plants can process. Too many animals also endanger the farm's productivity, the animals' health, and the natural environment. Excess nitrogen from wastes can drain through the soil and contaminate the groundwater. It can also run directly into the stream. This problem seemed to exist primarily in the suburbanized areas of the watershed.

Buffers

Riparian buffers are defined as strips of grass, shrubs, and/or trees along the banks of rivers and streams which filter polluted runoff and provide a transition zone between water and human land use. They provide several benefits to water quality, including preserving a stream's natural characteristic; improving wildlife and aquatic habitat; cooling water temperature; and catching and filtering sediment, nutrients, and debris. There is no ideal buffer width for all applications in all areas. Many factors, including slope, soil type, adjacent land uses, floodplain, vegetation type, and watershed condition, influence that decision. The NRCS (Natural Resources Conservation Service) Field Office Technical Guide (FOTG) requires that a buffer be 15 feet wide. This is the standard utilized for this plan.

Aerial photos obtained from Farm Service Agency as well as windshield surveys helped to determine the extent of buffers in the watershed. In the agricultural portion of the watershed, there is a total of 33.25 acres (approximately 20 miles) of buffer. The majority of these buffers are in the Pleasant Run - Silver Creek subwatershed (051401010805). About 4 acres, or 2.2 miles, of adequate buffers are in the Sinking Fork subwatershed (051401010804).

The same types of tools were used to determine the buffers in the non-agricultural portions of the watershed; however, the aerial photos used were provided by NRCS. It was rare to find a buffer that met the minimum requirement width of 15 feet. Also in many locations, the buffers on one side of the creek were in great shape, but on the opposite side, the buffer was nonexistent. It was estimated that 0.37 miles (approximately 1,990 feet) of buffers exist in the non-agricultural area.

There are approximately 22.57 miles of buffers in the watershed. Of the 142.6 miles of streams in Silver Creek Watershed, only 14 percent of them are buffered. It was impossible to determined from the aerials the quality of the buffers. The consensus of the steering committee was that any buffer is better than none (if it met the 15-foot width requirement).

Sediment and Erosion

It is well documented that sediment is the number one water pollutant in Indiana. One would expect that sediment would also be a problem in Silver Creek although sediment was not directly monitored. Visual evidence and public comment were used to verify sediment and erosion as a problem in the watershed. Photographs on page 59 are examples of streambank erosion along Silver Creek. The watershed coordinator received several calls from landowners and citizens concerned about streambank stabilization problems.

Streambank Stabilization and Erosion Problems Within the Silver Creek Watershed

High Nutrient Content

Water is consider to have high nutrient content when contaminants in it nourish organisms, especially plants. The contaminates may include nitrogen and phosphorus, either may lead to the harmful growth of algae and other plants when present to excess in a body of water. Both phosphorus and nitrogen are found in commercial fertilizers, manure, and other crop production enhancers as well as human waste. The EPA's 2000 National Water Quality Inventory indicated excessive fertilization of water bodies as one of the most significant causes of water quality impairment in the United States.

Indicators that high nutrient content might be a problem would be the water quality data (nitrogen and phosphorus, E. coli readings), and the type of organisms present in the stream.

The data collected during this project makes it impossible to differentiate between the possible sources, which is the definition of non point source pollution. The water quality results revealed that nitrogen readings was above the target criteria of 1.2 mg/L (nitrate + nitrite) eighteen percent of the time, phosphorus was above the target criteria of 0.08 mg/L nine percent of the time and E. coli results confirm that the streams were over the target of 235 CFU twenty-six percent of the time. During the macroinverbrate collection events in September of 2008 and February 2009 it was observed that the overall dominance of tolerant and facultative organisms present at all locations indicates moderate to heavy impacts from nutrients.

Erosion Control Practices and Construction Sites

Erosion control practices help reduce soil erosion, sedimentation and potential attached pollutants and consequently improve water quality. Indiana has a law referred to as Rule 5 that applies to all "construction activity" that result in the disturbance of (1) acre or more of land. Areas smaller than one acre are also regulated by this Rule if the project is part of a "larger common plan of development or sale". Land disturbance defined by this Rule is any manmade change of the land surface, including removing vegetative cover that exposes the underlying soil, excavating, filling, transporting, and grading. IDEM has also designated several communities referred to as MS4s that are required to develop their own local programs. If the project lies within one of these jurisdictions, plan content will be required to meet local criteria in addition to the items required by Rule 5.

Both Clark and Floyd Soil and Water Conservation Districts have Erosion Control Specialists who are charged with the responsibility of reviewing the preconstruction erosion control plans and site reviews during construction to ensure that the plans are being followed. The enforcement for noncompliance is handled by the local entity or the Indiana Department of Environmental Management (IDEM), Office of Water Quality, Stormwater Program.

The construction and post construction components of the plan review process are very important to water quality and the Silver Creek Watershed. "T*he construction component of the Stormwater Pollution Prevention Plan includes stormwater quality measures to address erosion, sedimentation, and other pollutants associated with land disturbance and construction activities. Proper implementation of the plan and inspections of the construction site are necessary to minimize the discharge of pollutants. The Project Site Owner should be aware that unforeseen construction activities and weather conditions may affect the performance of a* *practice or the effectiveness of the plan. The plan must be a flexible document, with provisions to modify or substitute practices as necessary. The post construction component of the Stormwater Pollution Prevention Plan includes the implementation of stormwater quality measures to address pollutants that will be associated with the final landuse. Post construction stormwater quality measures should be functional upon completion of the measures should be functional upon completion of the project. Long term functionality of the measures are critical to their performance and should be monitored and maintained. "*[13]

According to the Erosion Control Specialists the plan reviews and initial site inspection have improve considerably since the conception of Rule 5 in the early 90s. Once construction begins the problems begin. One specialist said that he had never been on a perfect site once construction had begun. After a site inspection the owner has 2 weeks to repair or correct the problem. This process can be repeated several times. Enforcement is very lax by some of the entities. There have been incidences within both counties where erosion problems continue long after the development is completed. Stop work orders are rarely ever issued.

There are no projects in the watershed violation of Rule 5 at this time. Due to the development potential of the watershed proper erosion control techniques and enforcement of this Rule is critical to the water quality of Silver Creek.

Cropland Tillage Data

In many watersheds throughout the country, runoff from cropland is a major concern. The agricultural community in the four counties making up the Silver Creek Watershed have adopted tillage practices to reduce nutrient, pesticide, and sediment runoff from corn and soybean fields. The following tables give evidence to this fact. The committee feels than any monies spent to promote no-till would be a waste.

Table 19: 2007 Cropland Tillage Data - Corn				
Type of Tillage	**Clark**	**Floyd**	**Scott**	**Washington**
No-Till	86 %	58%	77%	80%
Mulch Till	9%	0%	21%	11%
Conventional	5%	42%	2%	9%

Table 17: 2007 Cropland Tillage Data - Soybeans				
Type of Tillage	**Clark**	**Floyd**	**Scott**	**Washington**
No-Till	87%	88%	89%	85%
Mulch Till	6%	0%	6%	15%
Conventional	7%	12%	5%	0%

No-till - any direct seeding system, including strip preparation, with minimal soil disturbance.

Mulch Till - any tillage system leaving greater than 30% crop residue cover after planting, excluding no-till.

Conventional - Any tillage system leaving less than 30% crop residue cover after planting.

Table #: Summary Verification of Silver Creek Watershed Concerns

Public Concern Possible Cause/ Source	Stressor/ Pollutant	Verified Y - Yes N - No	Conclusion
Septic Systems Livestock and manure management Sewer Overflows (both CSOs & SSOs)	E. coli	Y Y N	E. coli results obtained during the testing cycle of the project verify that there is a problem in the creeks of the watershed. No sewer overflows were reported in the watershed.
Bank Stabilization Development Flooding Ag Runoff	Sediment	Y Y Y N	Visual inspection of the watershed validated the loss of sediment .
Increased Urban Areas Excess runoff	Nonpoint source pollution (oil, grease, runoff)	Y Y	Increased impervious area cause excess runoff which in turn causes more nonpoint source pollution.
Over-fertilization of lawns Septic Systems Small animals as well as traditional and non-traditional livestock Runoff from agricultural lands (cropland and pasture)	High nutrient content	Y Y Y Y	Water quality data and organisms found in the streams indicate that high nutrient content is a problem in Silver Creek and its tributaries.
Construction New Development Zoning Plans	Encroachment (for both riparian buffers and wetlands)	Y Y Y	Construction and new development are encroaching on both riparian buffers and wetlands. Zoning plans encourage buffers along streams but are not mandatory.
Flooding Agriculture (both livestock and grain operations)	Erosion	Y Y/N	Addressing the flooding issues is beyond the scope of this project. Livestock allowed in the streams is causing erosion. Tillage practices are not a major cause of erosion.

Problem Statements

On May 22, 2008, the Steering Committee started the process of developing problem statements for the watershed. These statements were created after data and information concerning sources were analyzed and discussed. The committee also kept the concerns that were expressed by the public (page 31) in mind. This was not an easy task.

E. coli

1. An increase in development will lead to more wastewater, which could result in more sewer overflows during rain events (Pleasant Run-Silver Creek 051401010805 and Jacobs Creek-Silver Creek 051401010806).

2. Improper maintenance of septic systems leads to failure, causing pathogens to enter nearby waterbodies and leads to health problems in humans.

3. Livestock with uncontrolled access to waterbodies may lead to an increase in pathogens from animal waste which can result in digestive and other health problems for humans.

Sediment and Erosion

1. Contractors using inadequate erosion control practices on construction sites and delayed enforcement by local and state governments can lead to excess soil loss entering nearby waterbodies. Sedimentation can lead to increased turbidity which can increase water temperature through heat absorbed particles, thus lowering dissolved oxygen. Sediment may also kill aquatic life by clogging gills or smothering habitats.

2. The lack of proper riparian buffers (in both urban and agricultural areas) is exhibited by increased sedimentation, streambank erosion, general erosion, flooding, algal blooms in summer, increased E. coli contamination, decreased stream habitat (temperature, contaminants, sediment), and decreased aesthetic qualities.

3. Stream bank erosion can lead to excess sedimentation increasing turbidity and water temperature through heat absorbed particles, thus lowering dissolved oxygen. Sediment may also kill aquatic life by clogging gills or smothering habitats.

Nonpoint Source Runoff

1. Lack of education by the general public concerning nonpoint source pollution (pollution generated with no identifiable source) and its effects on water quality.

2. Hazardous runoff from parking lots, roads, junkyards, landfills, and suburban areas enter local waterbodies.

High nutrient content

1. Improper nutrient management on farmland and suburban areas (yards) can lead to nutrient overload in nearby waterbodies, increasing algal blooms, and decreasing dissolved oxygen when the algae dies.

2. Improper stocking rates (number of animals per acre) may cause nutrient overload to nearby waterbodies leading to increased algal blooms, and decreased dissolved oxygen when the algae die.

Impaired biotic communities

1. Erosion, loss of habitat and riparian buffers, and an increase in runoff pollutants can lead to an increase in sedimentation, higher water temperatures, and low dissolved oxygen levels, which in turn may cause death and/or lower numbers and diversity of macroinverbrates.

ESTIMATING POLLUTANT SOURCES AND LOADS

Because no baseline information regarding the pollutant loads in the watershed existed, a model was selected to help with this task. The model selected to estimate pollutant loads was the Long-term Hydrologic Impact Assessment known as L-THIA.[14] It is a "source load" model which helped estimate the load for each land use in the watershed for the pollutants monitored. The information obtained from L-THIA will help support management plan and target restoration resources. The L-THIA model estimates runoff volume and pollutant load concentrations based on soil characteristics, land use, rainfall data, area, impervious surfaces, and long-term climatic data. The land use data is from the 1992 National Land Cover Database derived from Landsat Thematic Mapper data which is the latest available for the L-THIA tool. The fact that the land use data is outdated for some of the project subwatersheds influenced decisions made for the watershed plan. The model uses standard coefficients for runoff for the land uses.

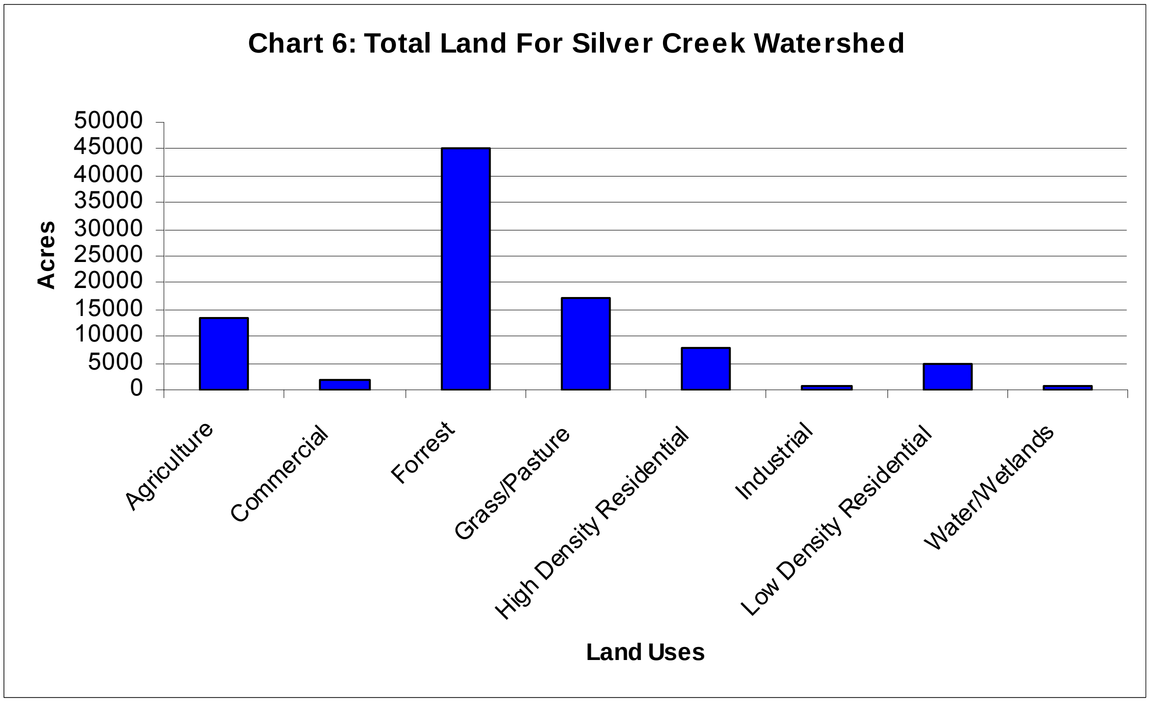
The L-THIA model was run on each of the six 12-digit watersheds that make up Silver Creek. The concentrations predicted by L-THIA are considerably higher than the project's monitoring data, but it is recognized that monitoring is just a snapshot in time. The model uses historical data.

Chart 6 (page 69) shows a breakdown of land use in the total watershed. The pie charts at the bottom of page 69 show the land use by percentage for each subwatershed. The charts at the top of pages 70 through 74 show a comparison of the 12-digit subwatersheds for each pollutant. The pie charts on the bottom of those same pages (70 - 74) indicate the percentage of pollutant coming from each land use for the total watershed. Tables18 through 23 (pages 63 through 68) show the L-THIA load estimates for each 12-digit subwatershed by land use and soil classification. Appendix VIII (page 176) also contains pie charts that depict pollutant estimates by land use for each subwatershed.

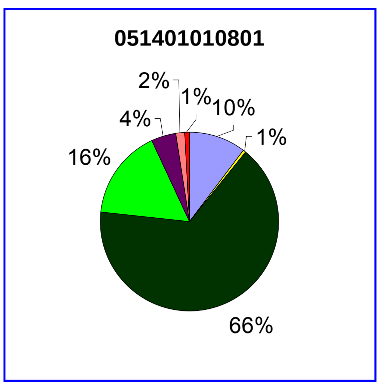
The four maps starting on page 75 also represent results from L-THIA. The darker the color on the maps the greater the pollutant load is in that area.

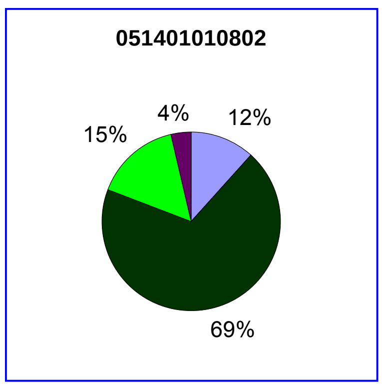
Table 24 (page 79) shows the L-THIA results concerning impervious areas.

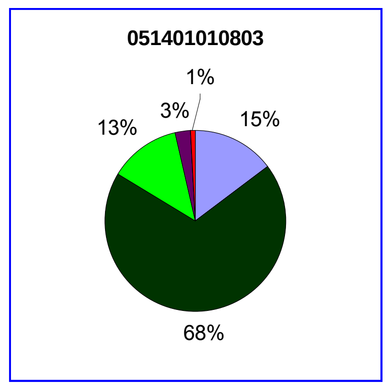
14 Long-term Hydrologic Impact Assessment Model, www.ecn.purdue.edu/runoff/lthianew



Charts 7-12: Percentage of land use for each 12-digit subwatershed.

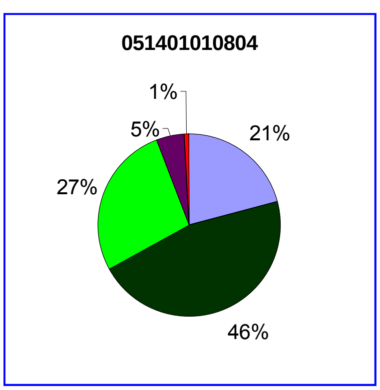


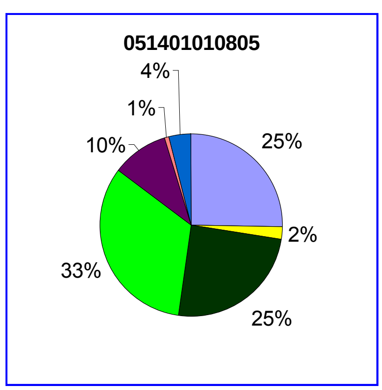


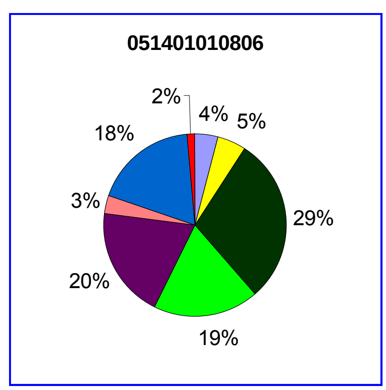


LEGEND

Agricultural | Commercial | Forest | Grass/Pasture
High-density Residential | Industrial | Low-density Residential | Water/Wetlands







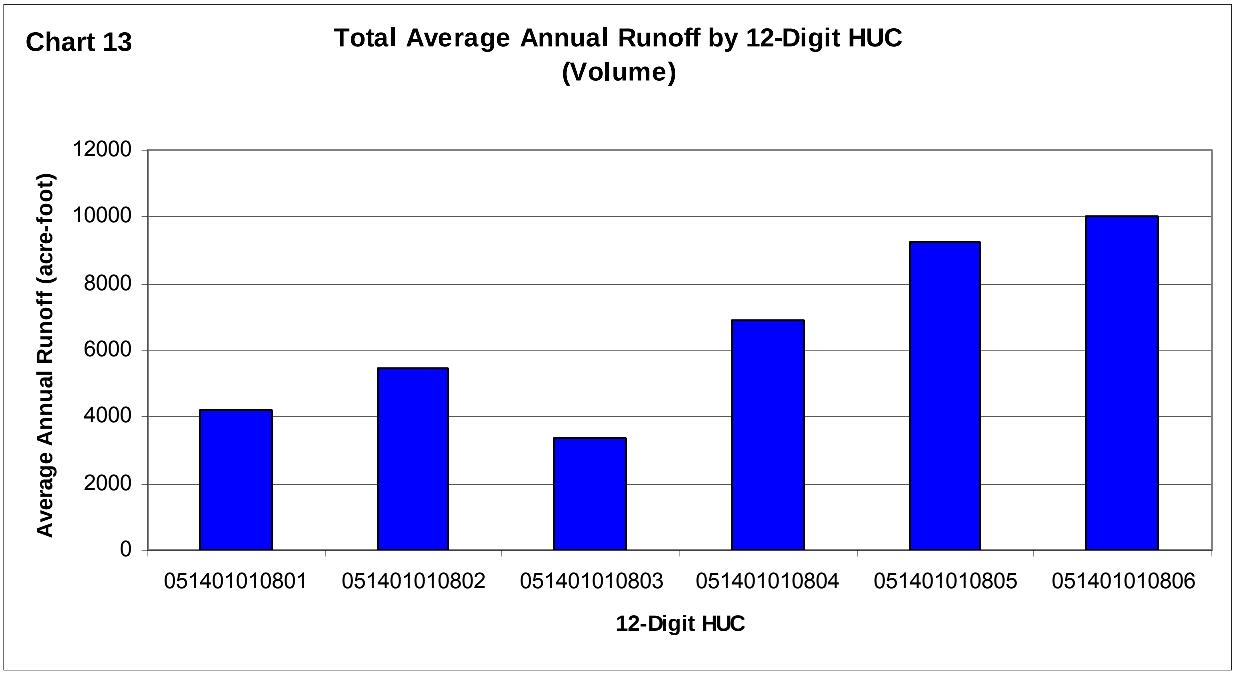


Chart 13
Total Average Annual Runoff by 12-Digit HUC
(Volume)
Average Annual Runoff (acre-foot)
12000
10000
8000
6000
4000
2000
0
051401010801
051401010802
051401010803
051401010804
051401010805
051401010806
12-Digit HUC

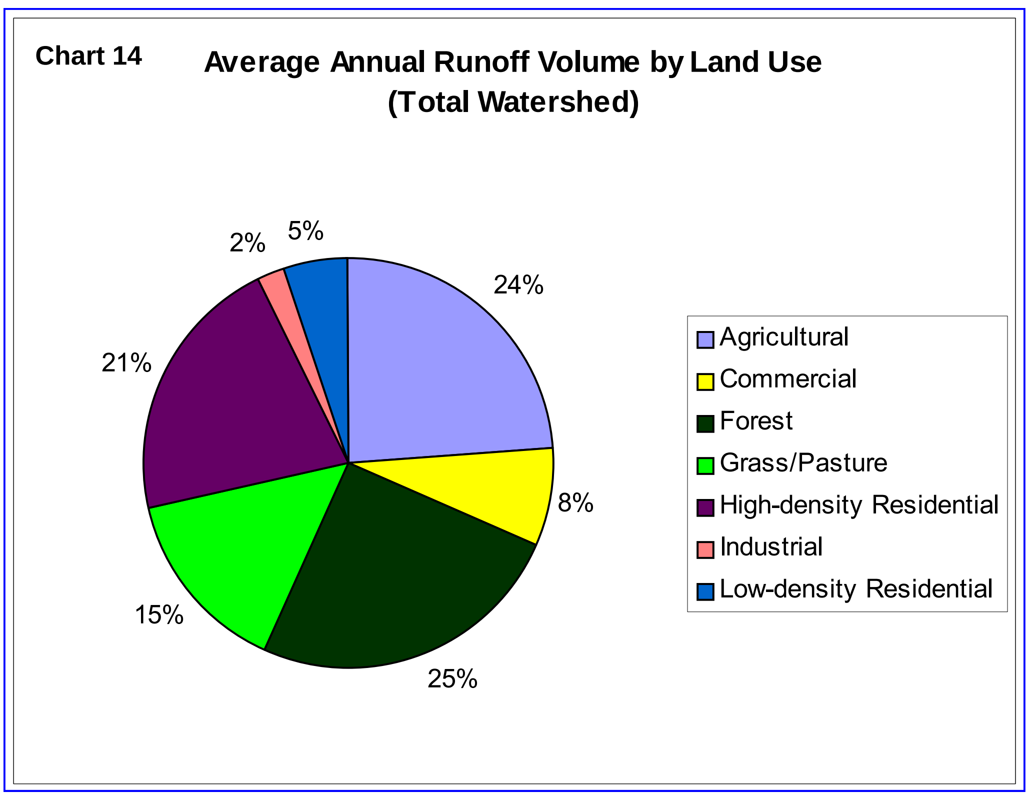


Chart 14
Average Annual Runoff Volume by Land Use
(Total Watershed)
2%
5%
24%
21%
8%
15%
25%
Agricultural
Commercial
Forest
Grass/Pasture
High-density Residential
Industrial
Low-density Residential

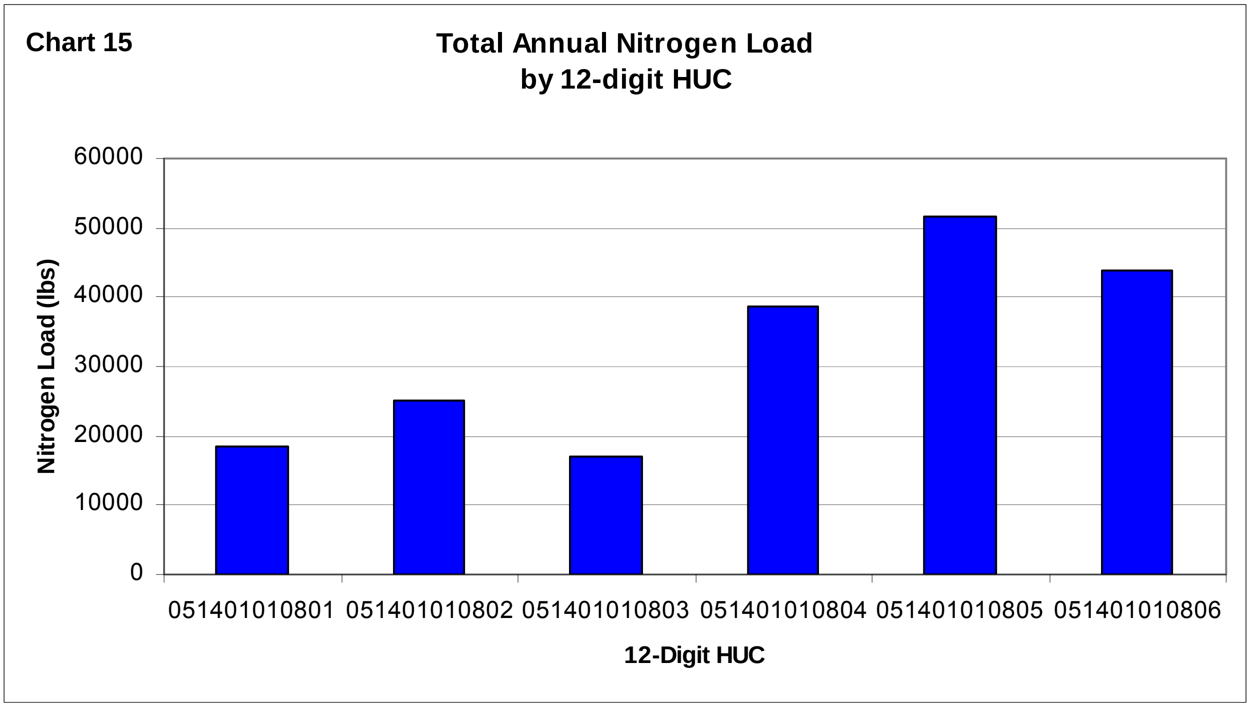


Chart 15
Total Annual Nitrogen Load
by 12-digit HUC
60000
50000
40000
30000
20000
10000
0
Nitrogen Load (lbs)
051401010801
051401010802
051401010803
051401010804
051401010805
051401010806
12-Digit HUC

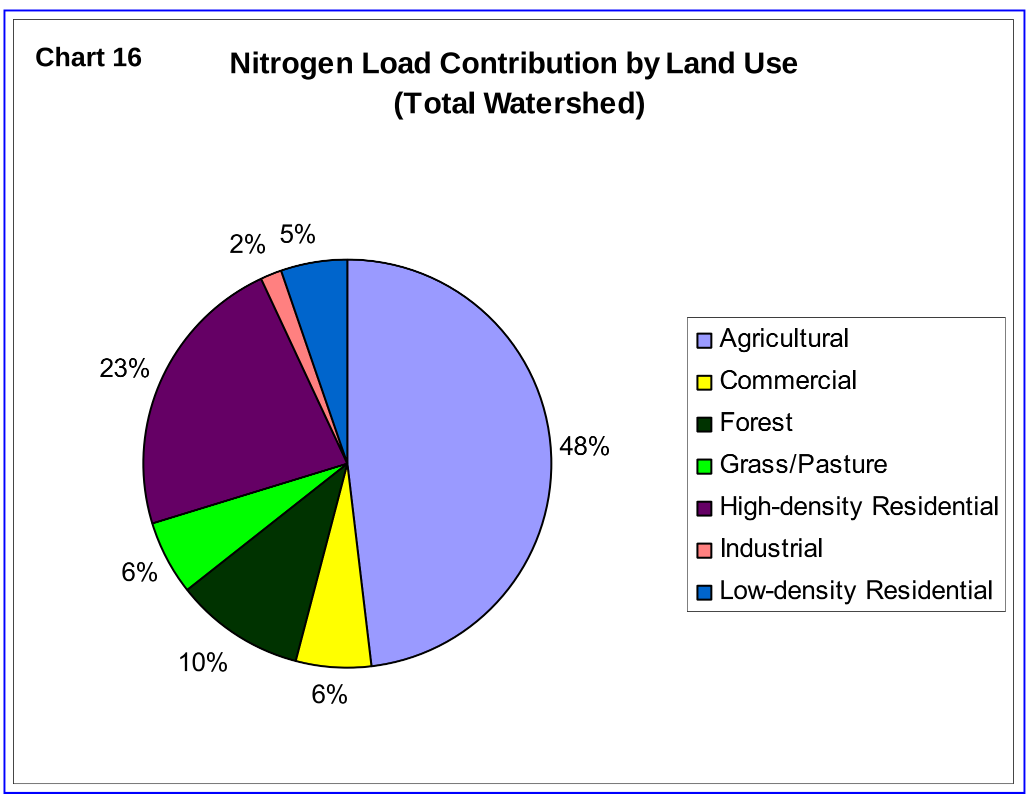


Chart 16
Nitrogen Load Contribution by Land Use
(Total Watershed)
2%
5%
23%
48%
6%
10%
6%
Agricultural
Commercial
Forest
Grass/Pasture
High-density Residential
Industrial
Low-density Residential

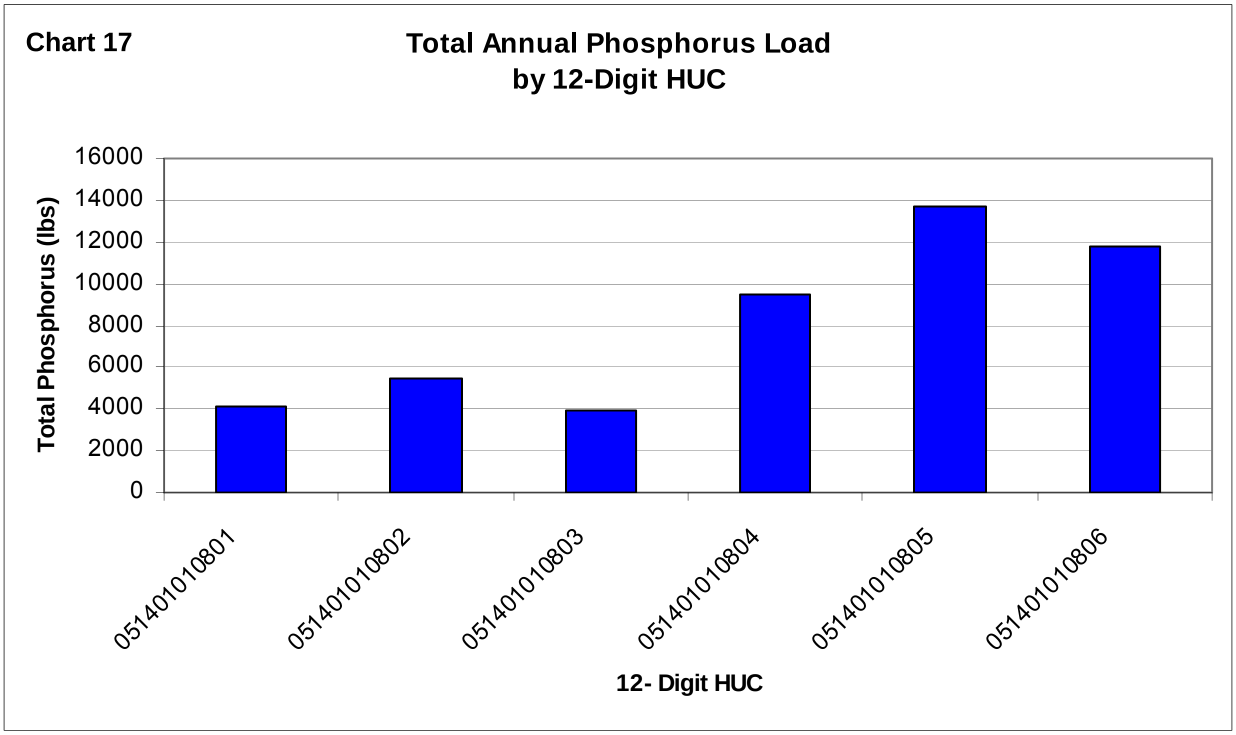


Chart 17
Total Annual Phosphorus Load
by 12-Digit HUC
Total Phosphorus (lbs)
16000
14000
12000
10000
8000
6000
4000
2000
0
051401010801
051401010802
051401010803
051401010804
051401010805
051401010806
12- Digit HUC

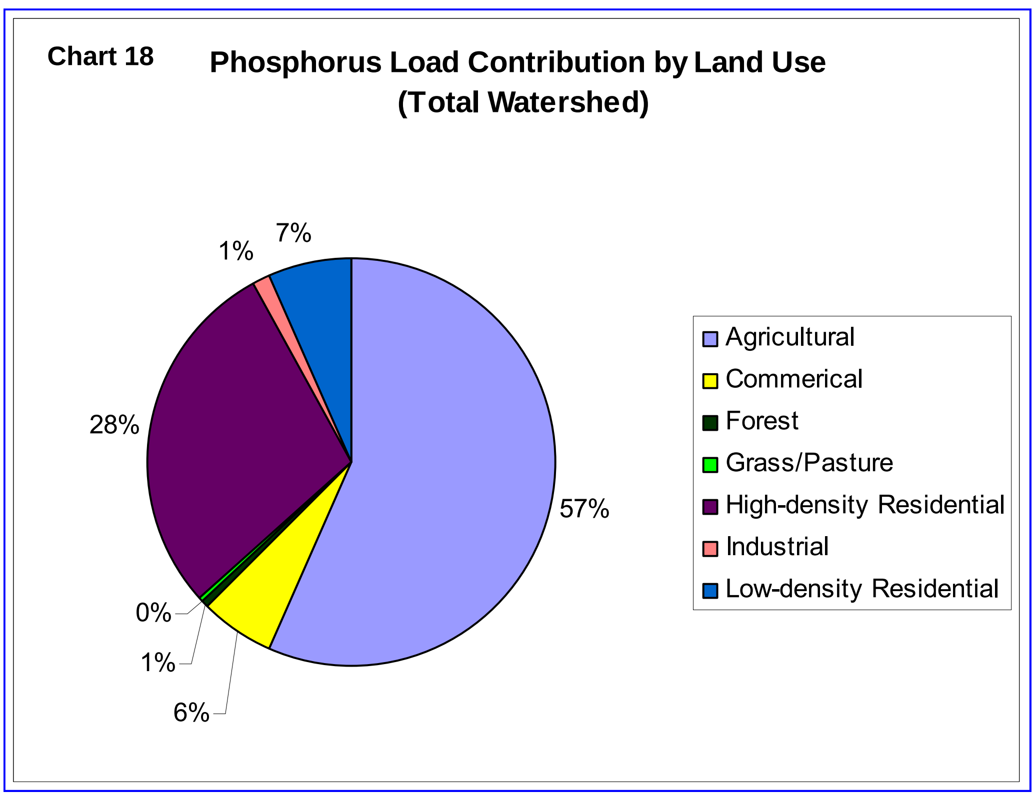


Chart 18
Phosphorus Load Contribution by Land Use
(Total Watershed)
1%
7%
28%
57%
0%
1%
6%
Agricultural
Commerical
Forest
Grass/Pasture
High-density Residential
Industrial
Low-density Residential

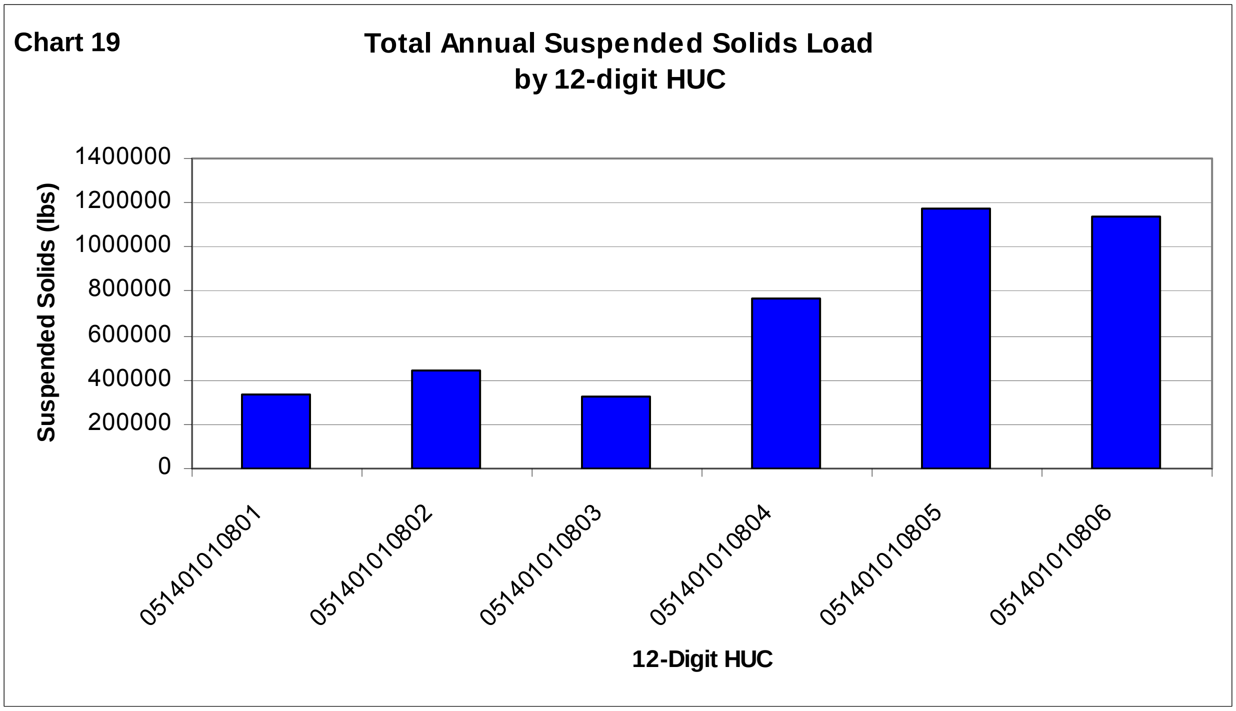


Chart 19
Total Annual Suspended Solids Load
by 12-digit HUC
Suspended Solids (lbs)
1400000
1200000
1000000
800000
600000
400000
200000
0
051401010801
051401010802
051401010803
051401010804
051401010805
051401010806
12-Digit HUC

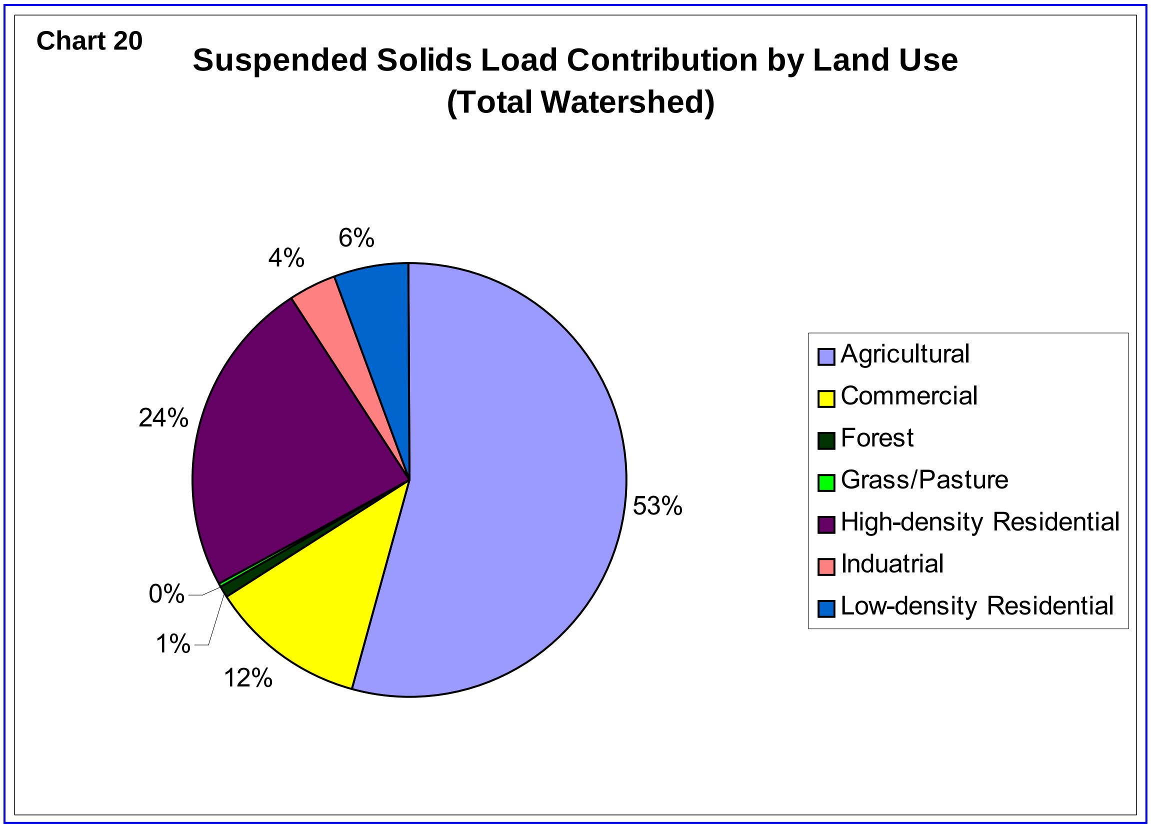


Chart 20
Suspended Solids Load Contribution by Land Use
(Total Watershed)
6%
4%
24%
53%
0%
1%
12%
Agricultural
Commercial
Forest
Grass/Pasture
High-density Residential
Induatrial
Low-density Residential

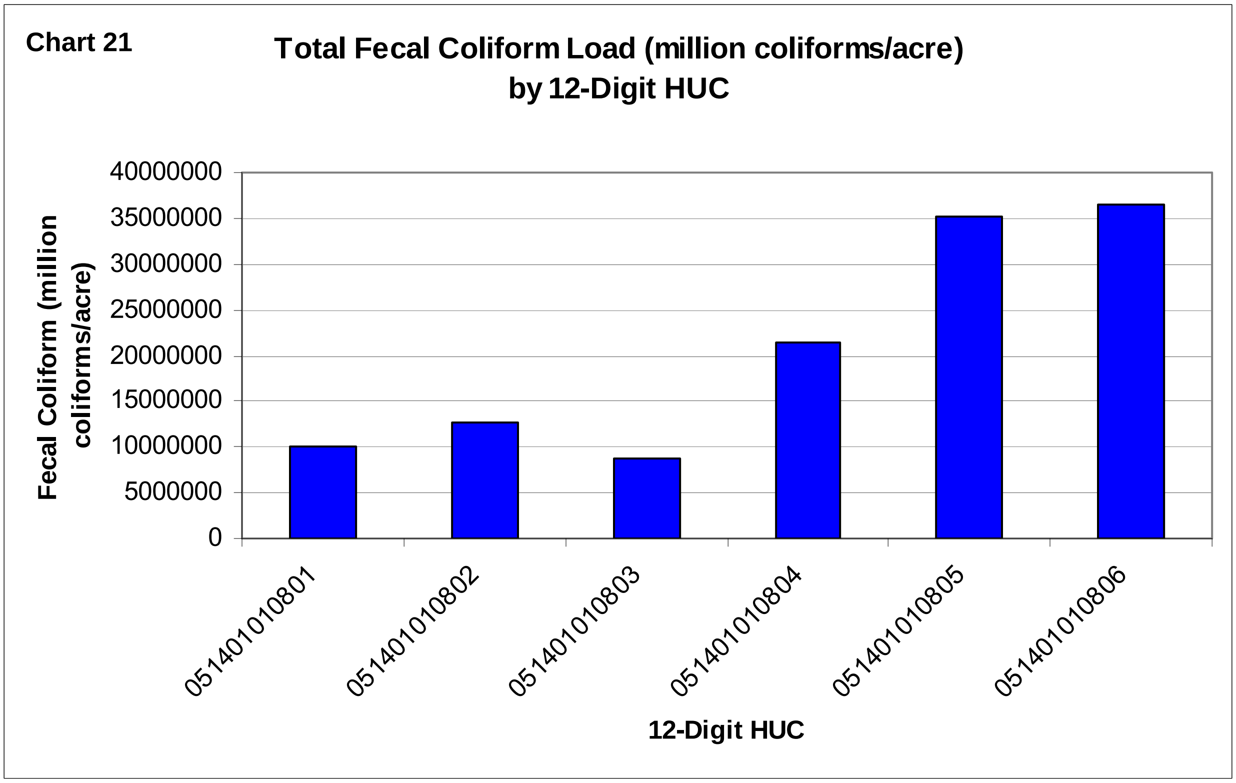


Chart 21
Total Fecal Coliform Load (million coliforms/acre)
by 12-Digit HUC
Fecal Coliform (million coliforms/acre)
40000000
35000000
30000000
25000000
20000000
15000000
10000000
5000000
0
051401010801
051401010802
051401010803
051401010804
051401010805
051401010806
12-Digit HUC

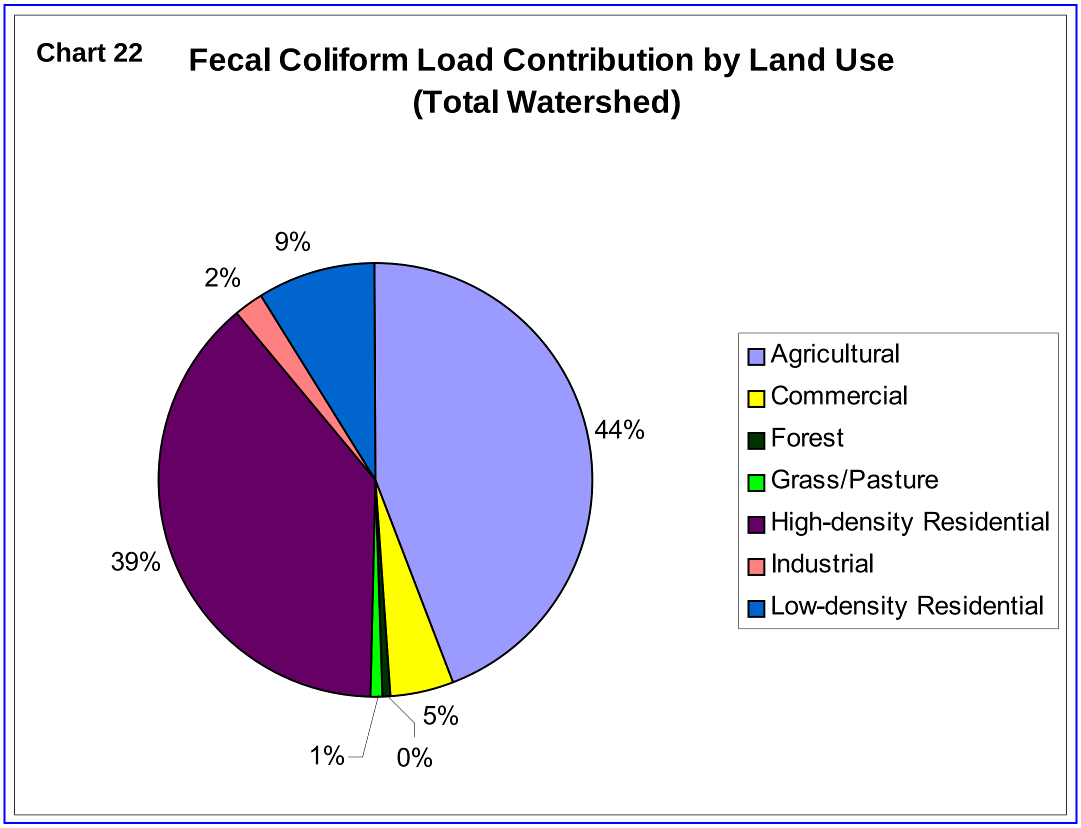
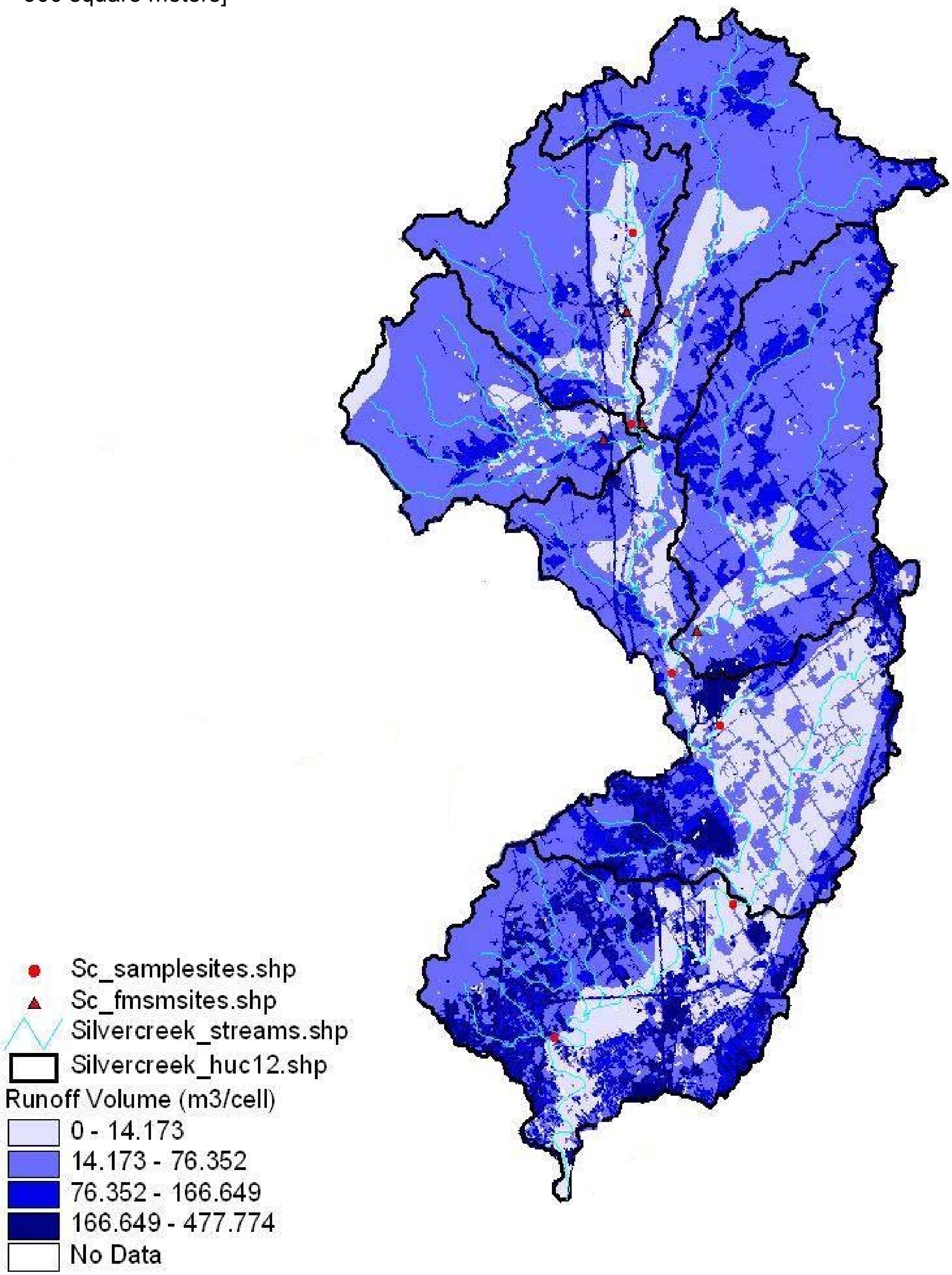


Chart 22
Fecal Coliform Load Contribution by Land Use
(Total Watershed)
9%
2%
44%
39%
5%
1%
0%
Agricultural
Commercial
Forest
Grass/Pasture
High-density Residential
Industrial
Low-density Residential

Map 14

Runoff Volume (m3/cell)

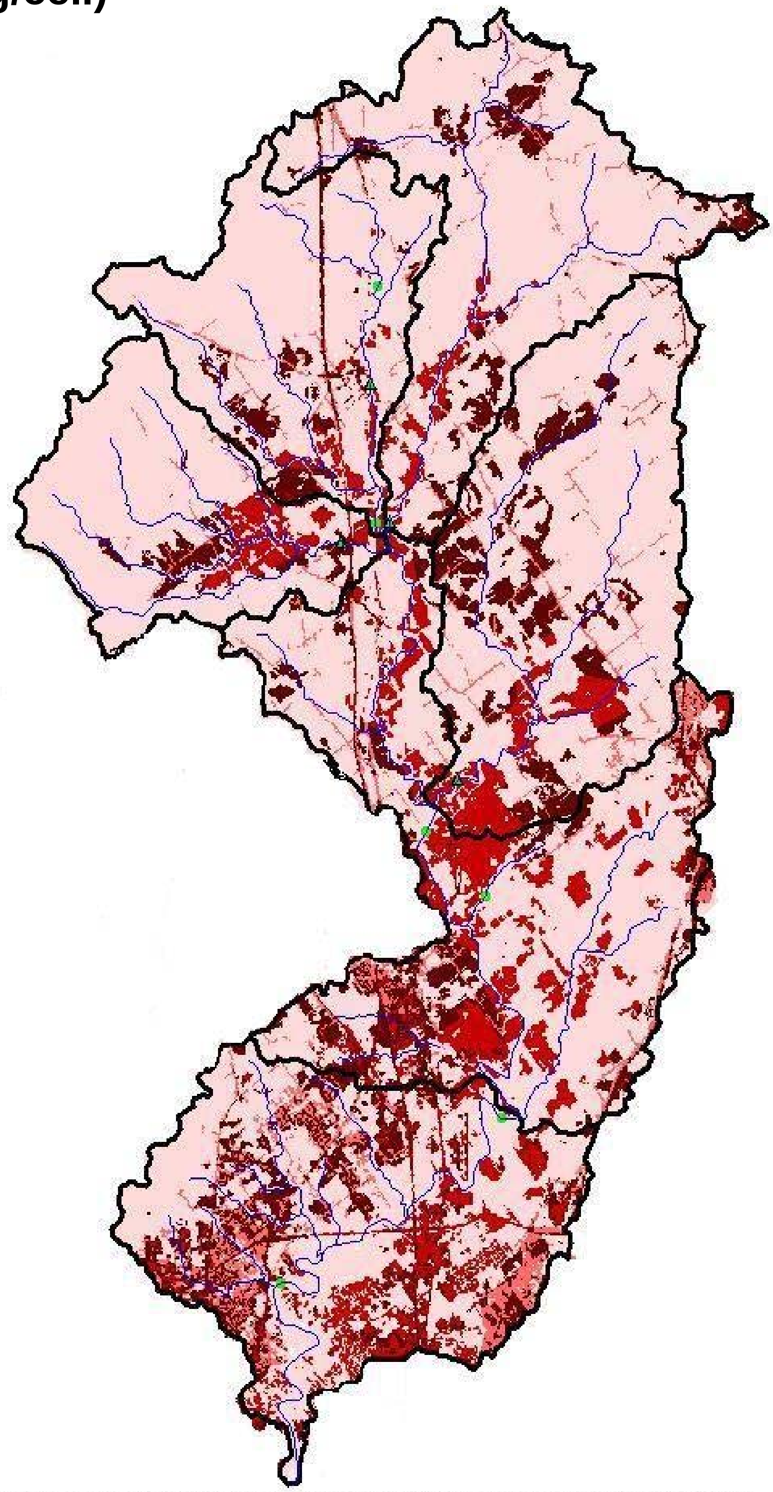
[cell = 900 square meters]

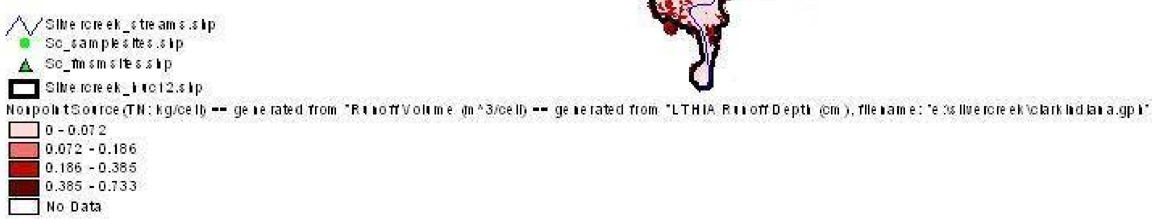


Map 15

Total Nitrogen Loss (kg/cell)

[cell = 900 sq. meters]

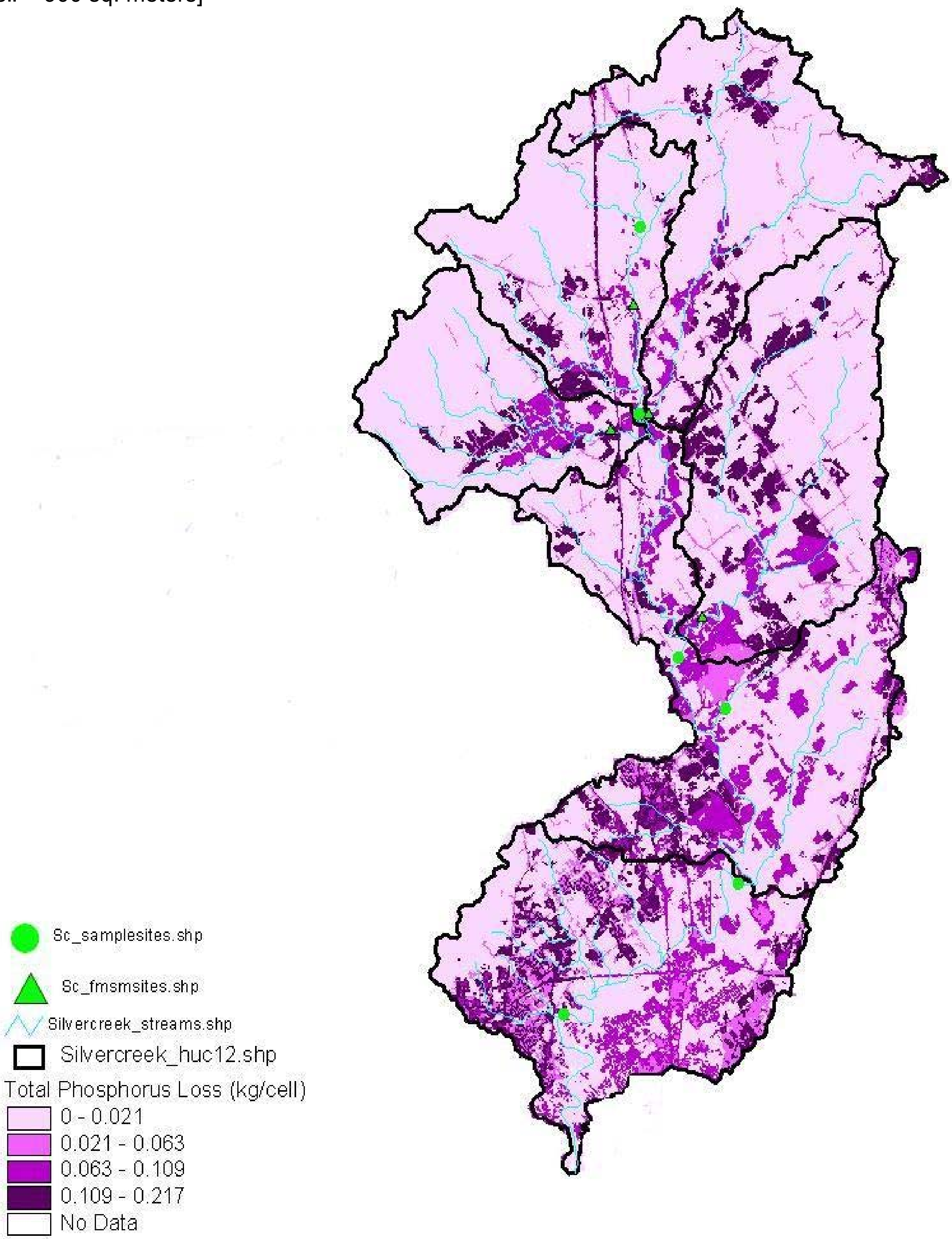




Map 16

Total Phosphorus Loss (kg/cell)

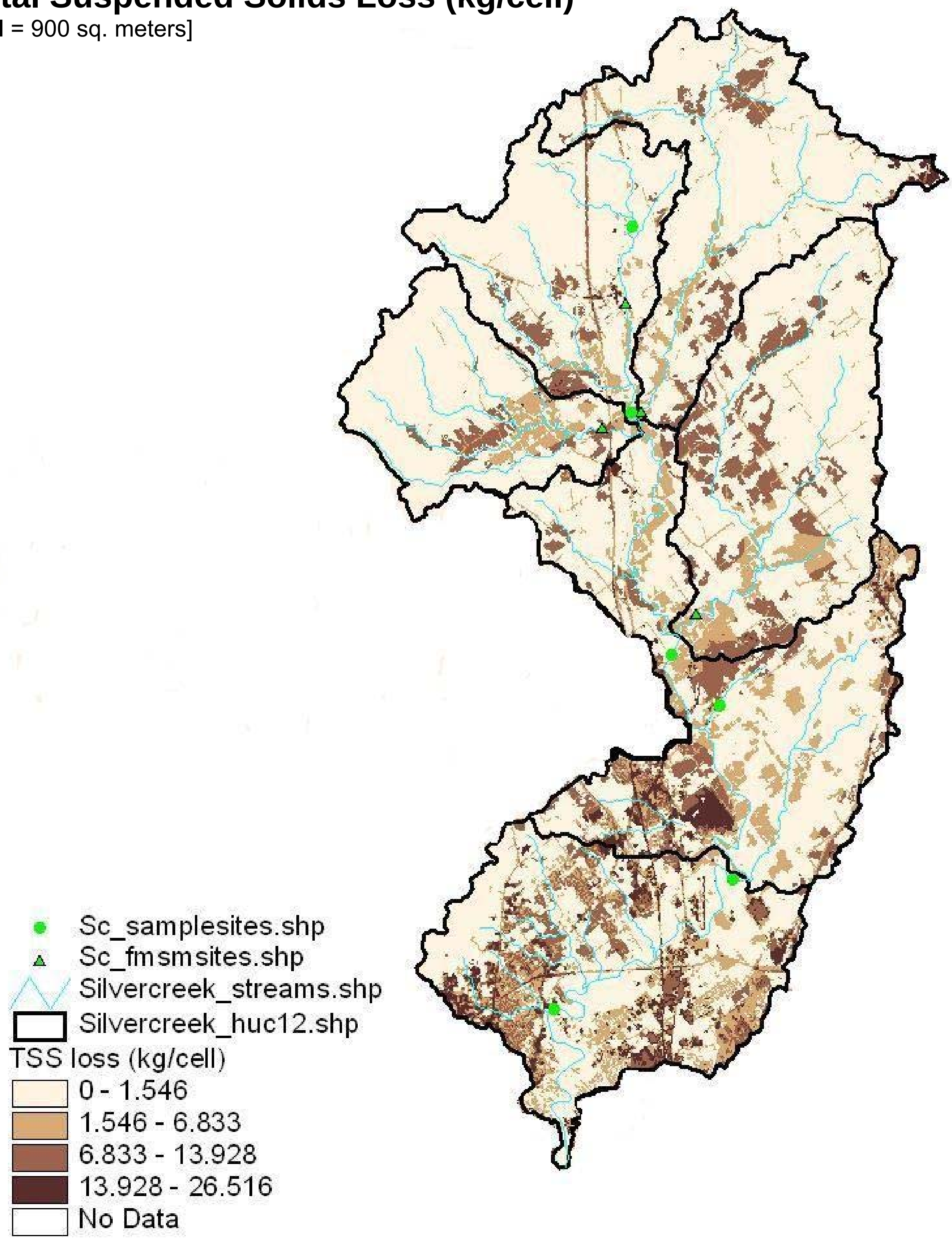
[cell = 900 sq. meters]



Map 17

Total Suspended Solids Loss (kg/cell)

{cell = 900 sq. meters]



Impervious Area of Silver Creek Watershed from L-THIA

Impervious surface has serious impacts on stormwater runoff and water quality as discussed on page 52 of this document. The two subwatersheds (Jacobs Creek-Silver Creek and Pleasant Run-Silver Creek) with the largest impervious area are the two that contribute the most pollutants to the creek according to L-THIA. Literature indicates that at 10 percent imperviousness, water quality impairments are expected. The percentage of imperviousness is greater than estimated by L-THIA, because the data is based on 1992 Landsat Thematic Mapper satellite data. Veteran's Parkway (a commercial explosion) has been developed in the last five years. Prior to development the area was a combination of forest and agricultural land with little if any impervious surface.

Table 24: Impervious Area of Silver Creek Watershed Estimated by L-THIA

Watershed 12-digit HUC and name	Commercial (acres)	High-density Residential (acres)	Industrial (acres)	Low-density Residential (acres)	Total Acres	% of Subwatershed
Miller Creek 051401010801	70.9	532.6	9.0	219.2	831.7	6.9%
Headwaters-Silver Creek 051401010802	11.3	577.0	3.2	42.7	634.2	4.0%
Blue Lick Creek 051401010803	16.5	276.4	8.2	32.5	333.6	3.31%
Sinking Fork 051401010804	6.6	864.6	1.7	29.6	902.5	5.02%
Pleasant Run-Silver Creek 051401010805	475.9	2,386.3	188.7	940.8	3,991.7	17.9%
Jacobs Creek-silver Creek 0514010100806	1,418.5	3,641.0	612.4	3,414.2	9,086.1	47.5%
Total for Silver Creek Watershed	**1,999.7**	**8,277.9**	**823.2**	**4679.0**	**15,779.8**	**16.2%**

Conclusions Drawn from L-THIA Results

The predominant land use in the Silver Creek Watershed is forest (48 percent of the total watershed). Forest land dominates in four of the six subwatersheds and is almost 50 percent in three of the other subwatersheds. Grass and pasture land is the second largest land use at 19 percent . Agricultural land makes up 15 percent of the watershed. High-density residential (9 percent), low-density residential (5 percent), commercial (2 percent), and industrial (1 percent) combine for approximately 16 percent of the watershed. These four land uses make up the impervious area of the watershed, creating the greatest runoff. Only 1% of the watershed is made up of water/wetlands.

RUNOFF
The results indicate the average annual runoff by volume (page 70) is heaviest in the Jacobs Creek-Silver Creek subwatershed (051401010806). This watershed has 47.5 percent impervious area and is being affected heavily by high-density residential and commercial activity. Current land use data would indicate that forest, grass/pasture, and agricultural land is almost nonexistent in that particular subwatershed. Pleasant Run-Silver Creek subwatershed also has high volume runoff. This area is being developed heavily at this time, and the large amount of runoff would not be unexpected. Pleasant Run-Silver Creek has 17 percent impervious area.

NITROGEN
L-THIA estimates that the highest nitrogen loads should be in the Pleasant Run-Silver Creek subwatershed. Agricultural land is the biggest contributor to nitrogen loads in all of the subwatersheds except in the Jacobs Creek-Silver Creek. There, high-density residential and agricultural land are both at 30 percent. The most surprising aspect of the nitrogen load estimate in the Jacobs Creek-Silver Creek subwatershed is that agricultural land is only four percent of the total land use, while high-density residential is 20 percent of the total land use, but they contribute equal amounts of nitrogen.

PHOSPHORUS
Again the subwatershed with the largest total annual phosphorus load estimate according to L-THIA is Pleasant Run-Silver Creek with agricultural land contributing 59 percent of the load. In five of the six subwatersheds making up Silver Creek watershed, agricultural land use is the main contributor. Jacobs Creek-Silver Creek subwatershed's highest contributing land use is high-density residential.

SUSPENDED SOLIDS
Pleasant Run-Silver Creek subwatershed is estimated to be the largest load pollutant of suspended solids. Agriculture is the land use that contributes most to the problem throughout the watershed except in subwatershed Jacobs Creek-Silver Creek where high-density residential is the culprit.

TOTAL FECAL COLIFORM
Jacobs Creek-Silver Creek is the subwatershed estimated by L-THIA to cause the largest pollutant load for total fecal coliform. The land use contributing most to the load is high-density residential in this subwatershed. Agricultural land use is the contributing factor in all of the other subsubwatersheds. Pleasant Run-Silver Creek subwatershed just misses being the top subwatershed for fecal coliform load production. Only E. coli and not total fecal coliform was tested for this project. The comparison between E. coli and fecal coliform is difficult, because

The numbers for total fecal coliforms are of such magnitude. Using L-THIA as a tool for comparison of relative pollutant contributions is emphasized with this example.

Summary

A conclusion that can be drawn from the L-THIA data is that the subwatersheds causing the most runoff and pollutant problems for the watershed are Pleasant Run-Silver Creek, Jacobs Creek-Silver Creek, and Sinking Fork. The land uses that are causing the most problems are agricultural land and high-density residential. The other three subwatersheds, which are in the northern part of the watershed, Miller Creek (051401010801), Headwaters-Silver Creek (051401010802), and Blue Lick Creek (051401010803), are not causing many problems for two reasons: 1) the majority of the land use is forest and 2) although development is on the increase in that part of the watershed, it is not at the level of the rest of the watershed.

Load Reductions

Knowing the load reduction needed to meet the target goals helps in selecting the best management practices required to achieve the goals. Table # show the target load, the estimated current average and maximum loads and reductions needed for both average and maximum current loads for NO3 and Total Phosphorus. The "flow" was taken from L-THIA results (converted acre-ft to liters) and multiplied by the target concentrations (NO3 - 1.2 mg/L; TP - 0.08 mg/L) and then converted to lbs/year. **Note:** The nitrogen target selected by the Steering Committee was 1.2 mg/L using only nitrate plus nitrite not total nitrogen. NO3 is only one part of total nitrogen. The average values obtained from sampling sites within the watershed are almost all below the target value already. These values are consider to be low due to the drought conditions the watershed has experienced over the last two years therefore, the estimated maximum load may be a more realistic target. Additional information about these calculations can be found in Appendix IX on page ##.

Table # NO3 Estimated Reductions Needed

Subwatershed	Target NO3 Load lb/yr)	Estimated Current Average Load (lb/yr)	Estimated Current Maximum Load (lb/yr)	NO3 Reduction Needed (Average Current Load) (lb/yr)	NO3 Reduction Needed (Maximum Current Load) (lb/yr)
051401010801	13781	5512	14011	-8269	230
051401400802	17901	9846	25957	-8056	8056
051401010803	10939	3373	7840	-7566	-2999
051401010804	22427	17194	41116	-5233	18689
051401010805	30102	27844	56942	-2258	26841
051401010806	32650	31017	70741	-1632	38091
Totals	127800	94787	216607		91907

Table # Total Phosphorus Estimated Reductions Needed

Subwatershed	Target TP Load (lb/yr)	Estimated Current Average Load (lb/yr)	Estimated Current Maximum Load (lb/yr)	TP Reduction Needed (Average Current Load) (lb/yr)	TP Reduction Needed (Maximum Current Load) (lb/yr)
051401010801	919	1148	4134	230	3216
051401010802	1193	448	448	-746	-746
051401010803	729	456	1003	-273	273
051401010804	1495	1121	2616	-374	1121
051401010805	2007	1756	7525	-251	5519
051401010806	2177	1632	2449	-544	272
Total	8520	6562	18175		10401

(Yellow) No Reduction Required

Best Management Practices to be Installed

Finding ways to reduce the pollutant loads in Silver Creek Watershed is one of the main goals of this plan. Once again, a model was used to estimate load reductions. Estimation of the load reductions for sediment and nutrients from the implementation of agricultural BMPs was done using the EPA Region 5 model. This model uses the "Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual" (Michigan Department of Environmental Quality, June 1999). The model uses many simplifying assumptions to provide a general estimate of the load reductions caused by implementation of BMPs. The Steering Committee asked for input from both NRCS and ISDA to establish realistic acreage numbers for applying BMPs.

Bank Stabilization

Bank stabilization is a practice that could easily be applied to several miles of Silver Creek, but the practice is very costly at an estimated $10.00 per square foot. Realistically the Steering Committee thinks that a quarter of mile (1320 feet) can be installed. An aspect of the banks that had to be determined before we could run the model was the Lateral Recession Rate (LRR). The LRR is the rate at which bank deterioration has taken place and is measured in feet per year. Using the narrative description provided in the model it was determined that the banks of Silver Creek fall into the severe category on the lower range (0.3).

Estimated Sediment Load Reduction (ton/year) - 158.4

Estimated Phosphorus Load Reduction (lb/year) - 158.4

Estimated Nitrogen Load Reduction (lb/year) - 316.8

Prescribed Grazing

Prescribed grazing is defined as managing the harvest of vegetation with grazing and/or browsing animals by NRCS Field Office Technical Guide. Reasons why this practice is applied are to help improve or maintain surface and /or subsurface water quality and quantity, reduce accelerated soil erosion, and improve or maintain riparian and watershed function. When this practice is applied to five hundred acres in the watershed the

Estimated Sediment Load Reduction (ton/year) - 86.

Estimated Phosphorus Load Reduction (lb/year) - 161.

Estimated Nitrogen Load Reduction (lb/year) - 321.

Cover Crop

Cover crop defined by NRCS is grasses, legumes, forbs, or other herbaceous plants established for seasonal cover and other conservation purposes. Cover crop is important to Silver Creek because it helps reduce erosion and capture and recycle or redistribute nutrients. Implementation of cover crops on 250 acres will reduce the load reduction (estimated) for:

Sediment (ton/year) - 209. Phosphorus (lb/year) - 227. Nitrogen (lb/year) - 453.

Agriculture Buffers

The model does not specifically list buffers as a BMP so filter strips were used instead. The function of both of these practices are essentially the same. There is a notation in the model that states that filer strips may further reduce sediment by 65%, phosphorous by 75%, and nitrogen by 70 % based on Pennsylvania State University (1992). On agricultural lands it s the objective of the implementation grant to install 10 acres of filter strips over the next two years. If all of the buffers get installed the estimated load reductions will be:

Sediment Load Reduction (ton/year) - 4

Phosphorus Load Reduction (lb/year) - 7

Nitrogen Load Reduction (lb/year) - 14

Urban Buffers

The model also includes a worksheet to estimate urban runoff BMP pollutant load reduction. The methodology and efficiency values used in the worksheet were developed by the Illinois Environmental Protection Agency. The worksheet has one select a BMP and enter the land use of the contributing/drainage area in acres according to whether it has storm sewers or not. The model then gives you the estimated load and load reductions. This urban model was ran on subwatersheds Pleasant Run-Silver Creek (051401010805) and Jacobs Creek-Silver Creek (051401010806) because they hold the majority of urban land in the Silver Creek Watershed. The results are shown in Table 25 (page 84) for Subwatershed Pleasant Run-Silver Creek and Table 26 (page 85) for subwatershed Jacobs Creek-Silver Creek.

Table 25:
Urban Runoff BMP Pollutant Load
Estimated Load and Load Reductions
For Pleasant Run-Silver Creek Subwatershed
(051401010805)

Test	Load Before BMP (lbs/yr)	Load After BMP (lbs/yr)	Load Reduction (lbs/yr)
Biological Oxygen Demand (BOD)	293,047	145,058	147,989
Chemical Oxygen Demand (COD)	3,457,247	2,074,348	1,382,899
Total Suspended Solids (TSS)	9,631,483	2,600,500	7,030,983
Lead	8,320	4,576	3,744
Copper	1,772	U	U
Zinc	12,834	5,134	7,701
Total Dissolved Solids (TDS)	20,627,353	U	U
Total Nitrogen (TN)	94,715	56,829	37,886
Total Kjeldahl Nitrogen (TKN)	73,527	U	U
Dissolved Phosphorus (DP)	3,021	U	U
Total Phosphorus (TP)	11,027	6,037	4,990
Cadmium	71	U	U

U = Removal Efficiency for the particular BMP and constituent unavailable.

Table 26
Urban Runoff BMP Pollutant Load
Estimated Load and Load Reductions
For Jacobs Creek-Silver Creek
(051401010806)

Test	Load Before BMP (lbs/yr)	Load After BMP (lbs/yr)	Load Reduction (lbs/yr)
Biological Oxygen Demand (BOD)	315,073	155,961	159,112
Chemical Oxygen Demand (COD)	2,805,033	1,683,020	1,122,013
Total Suspended Solids (TSS)	7,204,920	1,945,328	5,259,592
Lead	6,657	3,661	2,995
Copper	1,324	U	U
Zinc	12,540	5,016	7,524
Total Dissolved Solids (TDS)	14,834,580	U	U
Total Nitrogen (TN)	89,859	53,916	35,944
Total Kjeldahl Nitrogen (TKN)	57,620	U	U
Dissolved Phosphorus (DP)	3,491	U	U
Total Phosphorus (TP)	11,044	6,047	4,997
Cadmium	62	U	U

U = Removal Efficiency for the particular BMP and constituent unavailable.

Conclusions Drawn from Load Reduction Estimates

BMPs Total Estimated Sediment Load Reduction - 457 tons per year

BMPs Total Estimated Phosphorus Load Reduction - 10,540 pounds per year

BMPs Total Estimated Nitrogen Load Reduction - 74,935 pounds per year

The BMPs selected would meet the estimated reductions needed to reach the targets set for the Silver Creek Watershed. If the average loads stay at the levels recorded during the monitoring cycle of this project the reductions would exceed the targets. Even if the maximum load scenario is used the BMPs would meet the total estimate phosphorus load reduction and come close to meeting the target reductions for nitrogen. Two important facts to keep in mind when looking at the reduction results is 1) they are estimates and 2) the target for nitrogen is just NO3 and total nitrogen. A water quality monitoring program must be continued after implementation to ensure that targets are being met.

PART III

STEPS TO THE IMPROVEMENT OF WATER QUAILTY IN SILVER CREEK WATERSHED

Critical Area Identification

Critical areas are targeted areas in the watershed where the stressors/causes are causing the greatest damage and where applying treatment measures will have the greatest effect. The target areas should be:

~ Feasible for the group to address
~ Small enough to be addressed in 3 to 5 years
~ Considered for funding possibilities, willingness of landowners to participate, and whether the impact of treatment can be measured.

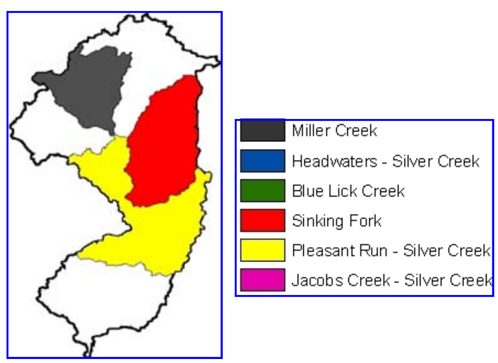
Each pollutant's cause was considered individually. The criteria used to determine the critical areas is discussed below. The committee considered the subwatersheds as a whole and did not try to pinpoint the reaches when determining the critical areas in the watershed. The priority ranking of the critical areas is explained at the end of this section.

E. coli Critical Areas

To determine the critical areas polluted by E. coli the committee looked at monitoring data, livestock location, combined sewer overflows, and septic systems.

Monitoring Data: Every time a site's E. coli reading was over the state standard of 235 CFU/100ml it was given a point. The monitoring sites for each watershed were added together to get a total. If the total was greater than five, it was considered a critical area. The 2008 Impaired Waters List was also consulted since it is based on monitoring data collected by IDEM, which added Sinking Fork (red) (051401010804) because of Sugar Run. Pleasant Run - Silver Creek (yellow) was already considered a critical area but one additional segment within this subwatershed for E. coli was included on the 2008 list. The subwatersheds that are colored below are the critical areas identified using this criteria.

**Figure 4:
Critical Areas determined by monitoring data for E. coli**



Livestock Location: It is difficult to pinpoint where livestock has access to the creek; our windshield survey gave us only the location of the livestock. The subwatersheds that have the largest number of livestock locations where given the highest priority. The two subwatersheds with the highest number of livestock sites are located next to each other, which may increase the E. coli numbers.

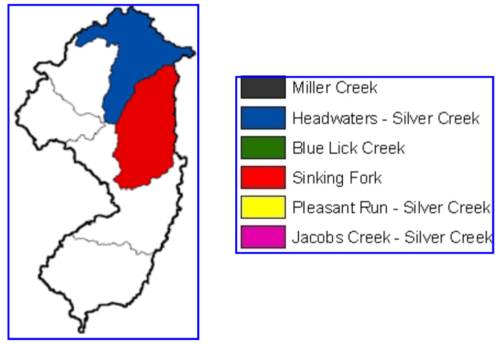


Figure 5: Critical Areas determined by livestock location for E. coli

Combined Sewer Overflows: The effect of combined sewer overflows may be minimal in the watershed area for E coli. When the combined sewer overflow reports were checked at IDEM none were reported in the watershed. According to reports in the newspaper it is a very important issue in some parts of the watershed so the committee decided to designate that portion of the watershed as a critical area until there is substantial evidence to remove it.

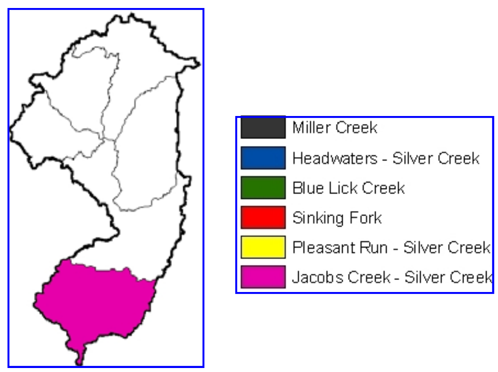


Figure 6: Critical Area for Sewer Overflows for E. coli

Septic Systems: Improperly working septic systems are known to be a source of E. coli. Since there is not an inspection of septic systems once they are installed, the committee used Clark County Health Department list of condemned homes for 2007 to determine the critical area of the watershed for septic systems. Soil types throughout the watershed are either somewhat or very limited for septic system suitability, making the whole watershed unfavorable for traditional absorption septic fields.

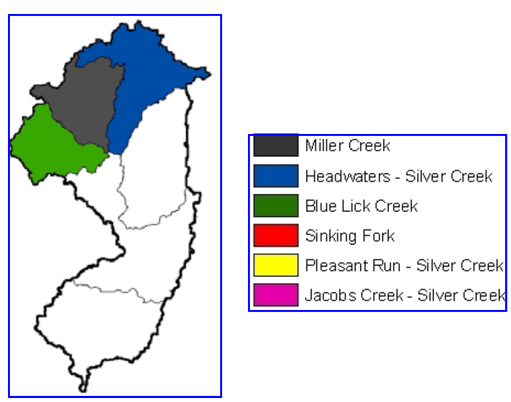


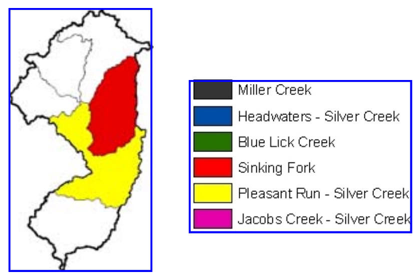
Figure 7: Critical Area for Septic Systems for E. coli

Sediment and Erosion:

The critical areas for sediment and erosion were determined by looking at riparian buffers, livestock location, and streambank erosion (where stabilization of streambank is needed). Sedimentation caused by construction projects is a problem throughout the watershed. In both Clark and Floyd Counties construction project are under the jurisdiction of either MS4 or Rule 5 permits so the steering Committee did not consider using the information when selecting the critical areas for sedimentation and erosion. An outreach and education component in the implementation phase will address this problem.

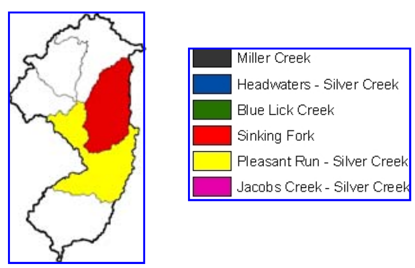
Streambank Erosion: Many factors have combined to cause severe streambank erosion on Silver Creek from just below Blackiston Mill Dam to its outlet into the Ohio River including the natural geology of the area. Funding to correct the problems in that area of Silver Creek would be astronomical. The committee viewed the streambank erosion taking place in the lower reaches of the watershed beyond the scope of this project. The streambank erosion taking place in the upper reaches of the watershed will be the focus of this project. The criteria that was used to identify the critical area was visual inspection, landowners notifying us of problems**,** and percentage of agricultural land.

Figure 8:
Critical Area of watershed for sediment and erosion determined by streambank erosion.



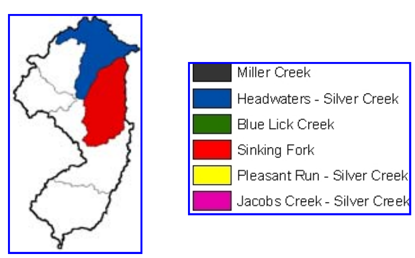
Riparian Buffers: While the public believes the streams throughout the watershed are buffered, the committee understands that many of these are not sufficient. They feel this is a problem throughout the watershed but gave top priority to the two subwatersheds that have the highest percentage of agricultural land.

Figure 9:
Critical Area for buffers for sediment and erosion.



Livestock Location: It is difficult to pinpoint where livestock has access to the creek, our windshield survey gave us only the location of the livestock. The subwatersheds that have the largest number of livestock locations where given the highest priority.

Figure 10:
Critical Areas determined by livestock location for sediment and erosion.

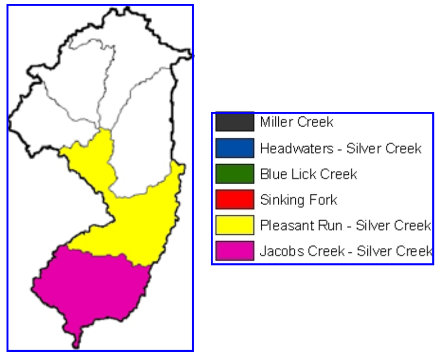


Non- Point Runoff

Critical areas were determined by the committee looking at impervious area and areas of high fertilization (which the committee determined to be agricultural lands and lawns in high and low density residential).

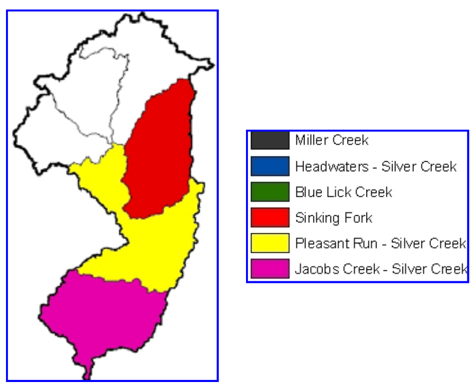
Impervious Areas: Knowing that at 10% impervious area damage is being done to the water quality the committee looked at the chart on page 55 and considered any subwatershed with an impervious area >10% as a critical area.

Figure 11:
Critical areas determined by impervious areas for non-point runoff.



Fertilization: The committee knows that fertilizer is applied not only to agricultural land and grass/pasture lands (may be not as often as recommended) but also to yards (sometimes at rates that exceed recommendations) so all areas where considered when determining critical areas for fertilization. If the land use (agricultural + grass/pasture + high density residential + low density residential) percentages for a subwatershed totaled > 50% it was considered a critical area.

Figure 12:
Critical areas determined by fertilization for non-point runoff.



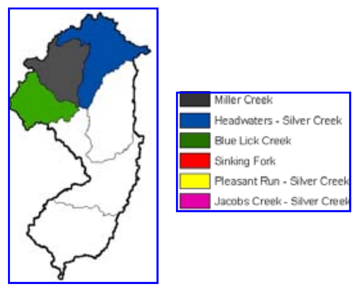
High Nutrient Content

High nutrient content critical areas were determined by looking at the monthly water quality data, septic systems, livestock location, and agricultural lands. Although the committee had considered residential areas when considering fertilization in runoff, they didn't this time.

Water Quality Data: The water quality data was very slow getting to the committee so the data they had when they reached this particular task was not indicating a problem. Thus, no critical area was selected at this time. The parameters that were considered were nitrates, nitrites, nitrogen-ammonia, total Kjedahl nitrogen (TKN) and total phosphorus.

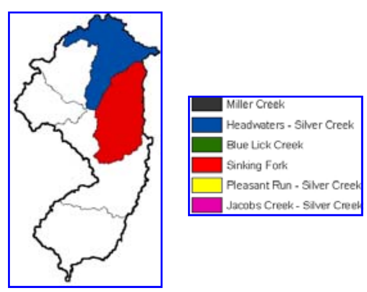
Septic Systems: Here the committee looked at the area where septic systems are most likely to be found in the watershed as well as where condemned systems were located in the past year. The highly urbanized areas were considered low priority because most of those areas are either serviced by sewers or package treatment plants.

Figure 13:
Critical Area determined by septic systems for high nutrient content.



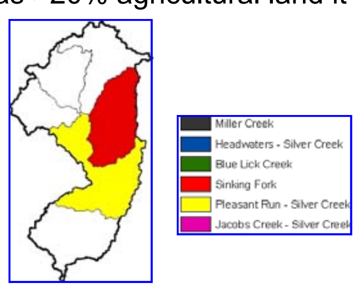
Livestock Location: Again the committee used the livestock location numbers to determine the priority level for high nutrient content although the information that was really needed would have been number of animals per acre.

Figure 14:
Critical Areas determined by livestock location for high nutrient content.



Agricultural Lands: If a subwatershed has >20% agricultural land it was given high priority for nutrients.

Figure 15:
Critical Area determined by agricultural lands for high nutrient content.



Biotic Communities

The committee used the Impaired Waters lists from 2006 and 2008, plus macroinverbrate data to determine the critical areas for biotic communities.

Table # Impaired Biotic Communities from 2006 and 2008 Impaired Waters List

Year of List	Assessment Unit ID	Assessment Unit Name	Subwatershed
2006 & 2008	INN01EB_T1033	Silver Creek Unnamed Tributary	051401010805 Pleasant Run-Silver Creek
2008	INN01E8_00	Sugar Run	051401010804 Sinking Fork
2008	INN01EB_01	Silver Creek	051401010805 Pleasant Run-Silver Creek
2008	INN01EB_T1001	Silver Creek Unnamed Tributary	051401010805 Pleasant Run-Silver Creek

Macroinverbrate data (pages ##) collected during the project was very discouraging throughout the watershed so the committee decided to disregard the data during the selection of the critical areas for biotic communities. The drought conditions of the last two years may have skewed the results.

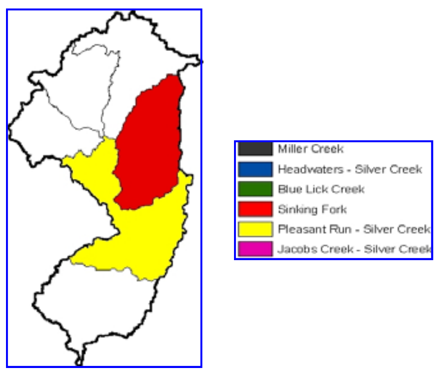
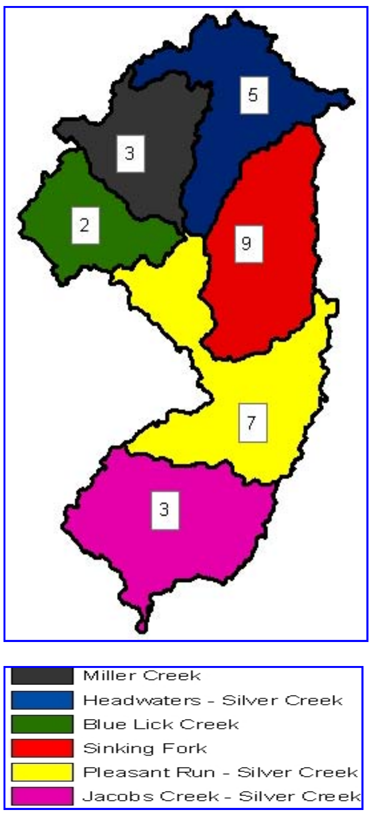


Figure 16:
Critical Areas of watershed for biotic communities.

PRIORITY RANKINGS FOR SILVER CREEK WATERSHED

All subwatersheds within the Silver Creek Watershed have some type of impairment. To help prioritize the subwatersheds the committee gave a subwatershed one point each time it was designated as a critical area. Figure 17 shows the totals for subwatersheds. Based upon these totals the Steering Committee has determined that the implementation grant should concentrate on subwatersheds Sinking Fork (051401010804), and Pleasant Run - Silver Creek (051401010805). After installing BMP in that area the emphasis would be moved to include subwatersheds Miller Fork (051401010801), Headwaters - Silver Creek (051401010802) and Blue Lick Creek (051401010803). Jacobs Creek - Silver Creek (051401010806) will be the last watershed to receive attention because it falls under MS4 jurisdiction, some of its problems are not within the scope of 319 Grants. If the BMPs that are installed work properly they should help improve the water quality downstream also. A concerted education component for this area will be included in the implementation phase.

Figure 17: Priority Point Total for Critical Areas



Priority Rankings

1. Sinking Fork (051401010804)
2. Pleasant Run - Silver Creek (051401010805)
3. Miller - Fork (051401010802
4. Headwaters-Silver Creek (051401010801)
5. Blue Lick Creek (051401010803)
6. Jacobs Creek-Silver Creek (051401010806)

Goals and Objectives

To be able to set goals and objectives for Silver Creek, the Steering Committee completed a step by step process which is described below. The products they produced are on the following pages. Since the plan is a working document, the committee made changes after receiving additional data or information and will continue to make changes. Tables represent the initial framework for action. For water quality restoration and protection to be successful and as the economic environment worsens, it is critical that the public be involved in all aspects of the process.

Stressor Worksheet (page 32)
(What are the pollutants and their sources)
↓
Problem Worksheet
(Identify problems, where they occur in the watershed, what is the cause)
↓
Problem Statement
(Adequately summarizes main concerns within watershed)
↓
Main Goals
(What needs to be done to improve the water quality)
↓
Objectives
(Steps taken to accomplish goal)
↓
Action & Cost
(What we are going to do and how much will it cost)
↓
Target Audience
(Who do we want our actions directed towards)
↓
Performed By
(Who is responsible to get action done)
↓
Time Schedule
(When does it start and how to get accomplished)
↓
Indicator
(What tells us we are accomplishing our goals)

Action Register

An action register lists for each goal what tasks will be performed, when each task will be completed, who is responsible for doing it, and what resources (money and technical assistance) are needed. The one on the following pages (96-106) was created by the committee to simplify the implementation process of the plan.

The organizations listed in the action register are organizations that could potentially provide support, advice or consultation on a particular management measure. These lists are not intended to be comprehensive or to exclude other entities from participating in the development and/or implementation of a management measure. Participation by any and all organizations will be encouraged to participate.

Table 27: Project Cost Estimates Used in Action Register	
$	Less than $1,000
$$	$1,000 to $5,000
$$$	Greater than $5,000

Goals

1. Reduce E. coli loading to reach the EPA standard of 235 colonies/100ml by the year 2015.

2. Reduce sediment loading to meet target goal for Total Suspended Solids (80mg/L) after 1/4 inch rain event.

3. Reduction of non-point source runoff.

4. Reduce anthropogenic nutrient input (Nitrogen target 1.2 mg/L and Phosphorus target 0.08 mg/L) into the stream.

5. Improve beneficial habitat to increase macroinverbrates.

Goal 1: Reduce E. coli loading to reach the EPA standard of 235 colonies/100ml by the year 2015.

Problem 1A: ***An increase in development will lead to more wastewater, which could result in more sewer overflows during rain events in the following subwatersheds (12 digit HUC Pleasant Run - Silver Creek 051401010805 and Jacobs Creek - Silver Creek 0514010108060).***

Objective	Milestones - Cost	Target Audience	Performed By	Time Schedule	Indicator
Increase awareness of public and officials to insure adequate capacity of existing loads and future anticipated loads of wastewater treatment plants.	Workshop for officials emphasizing advantages of proper planning and design versus the ramifications of insufficient wastewater treatment capacity. $	Local Officials	Watershed Coordinator	Workshop to be held in 2010 but may need to be repeated as local officials change.	# of participants attending workshop
			Local officials (sewer boards, city council, town boards)		# of hits on website
					# of overflows
					# of publications distributed
	Map package treatment plants within watershed and place on website. $	General Public		Fall 2011	# of articles in newsletters
	Submit articles to MS4 newsletters. $			Ongoing	# of actions taken using workshop references
	Have informational booth at local fairs and other civic events. $				
	Develop annual brochure on current status of sewer system in conjunction with local officials. $				

Goal 1: Reduce E. coli loading to reach the EPA standard of 235 colonies/100ml by the year 2015.

Problem 1B: ***Improper maintenance of septic systems leads to failure causing pathogens to enter nearby waterbodies and leads to health problems in humans.***

Objective	Milestones - Cost	Target Audience	Performed By	Time Schedule	Indicator
Educate the public about proper maintenance of septic systems.	Develop a publication on proper maintenance of septic systems. $	General Public	Watershed Coordinator	January 2011	Reduction in number of reported failures.
	Set up hot line to report non-working septic system. $$		Local Health Officials		# of hot line reports
	Coordinate a unified tracking system of failed septic systems between agencies. $				# of publications distributed

Goal 1: Reduce E. coli loading to reach the EPA standard of 235 colonies/100ml by the year 2015.

Problem 1C: Livestock with uncontrolled access to waterbodies may lead to an increase in pathogens from animal waste which can result in digestive and other health problems for humans.

Objective	Milestones - Cost	Target Audience	Performed By	Time Schedule	Indicator
Reduce untreated animal waste from entering the creek.	Develop a cost-share program to install buffers. $$$ - $15,000	Livestock owners	Watershed Coordinator	August 2010 develop cost-share criteria then until funds are spent and practices are completed by July 2012	# of feet of buffers installed
			ISDA		# of landowners applying for cost-share programs and # actually installed
			NRCS		
	Develop a cost-share program to fence livestock out of the stream. $$$ - $20,000				# of livestock owners assisted with development and implementation of prescribed grazing plans.
	Assist livestock owners with the development of prescribed grazing plans. $$ - $2,500				

Goal 2: Reduce sediment loading to meet target goal for Total Suspended Solids (80mg/L) after 1/4 inch rain event.

Problem 2A: Contractors using inadequate erosion control practices on construction sites and slow enforcement by local and state governments, can lead to excess soil loss entering nearby waterbodies. Sedimentation can lead to increased turbidity which can increase water temperature through heat absorbed particles, thus lowering dissolved oxygen. Sediment may also kill aquatic life by clogging gills or smothering habitats.

Objective	Milestones - Cost	Target Audience	Performed By	Time Schedule	Indicator
Insure that contractors properly install and maintain erosion control practices.	Make public aware of the impact of improper erosion control measures on the creek through newsletters. $	General Public	Watershed Coordinator	July 2010 Then Ongoing	# of newsletters distributed
		Contractors	Local agencies (plan commission and MS4 regulators)		Meet state benchmark for Total Suspended Solids
			Volunteers		
	Continue water monitoring activities with volunteers and professional of the creek. $$ - $5,000			August 2010 then continuing throughout project on a quartley basis.	# of enforcements
	Work with local agencies to enforce erosion control measures. $			July 2010 Then Ongoing	

Goal 2: Reduce sediment loading to meet the target goal for Total Suspended Solids (80mg/L) after 1/4 inch rain event.

Problem 2B: The lack of proper riparian buffers (in both urban and agricultural areas) is exhibited by increased sedimentation, stream bank erosion, general erosion, flooding, and algal blooms in summer, increased E. coli contamination, decreased stream habitat (temperature, contaminants, sediment), and decreased aesthetic qualities.

Objective	Milestones - Cost	Target Audience	Performed By	Time Schedule	Indicator
Increase the number of adequate buffers in the watershed.	Buffer demonstration sites in both agriculture and urban setting. $$ - $2,000	Homeowners Associations; Developers	Watershed Coordinator; Clark County SWCD	Within 6 months of project start	# of buffers installed; Amount of cost-share spent
	Cost-share funds available to homeowners' associations, developers, agriculture land owners, and public lands (parks, etc.)to install buffers.$$$ - $12,000	Ag Land Owners; General Public; Public Officials	Volunteers; ISDA; NRCS	Ongoing until funds are spent	# of people who purchase buffer plants
	Document status of riparian buffers by ground photography, aerial photography and/or satellite imagery-possible canoe trip down Silver Creek. $			Within 6 months of project start	
	Create opportunities for discounted purchase of buffer plants (i.e. District tree and plant sale). $			Ongoing	

Goal 2: Reduce sediment loading to meet target goal for Total Suspended Solids (80mg/L) after 1/4 inch rain event.

Problem 2C: Streambank erosion can lead to excess sedimentation which increases turbidity causing the water temperature to increase through heat absorbed particles, thus lowering dissolved oxygen. Sediment may also kill aquaitic life by clogging gills or smothering habitats.

Objective	Milestones - Cost	Target Audience	Performed By	Time Schedule	Indicator
Decrease streambank erosion.	Develop a brochure on how to control and lessen the impacts of erosion on the streambank. $	Landowners & General Public	Watershed Coordinator	September 20101	# of brochures distributed
	Develop a cost-share program to help landowners do streambank stablization and protection practies. $$$ - $132,000		Watershed Coordinator ISDA NRCS	August 2010 develop cost-share criteria then until funds are spent or July 2013	# of practices installed Amount of money spent
	Host public fact finding meeting to consider the formation of a conservancy district for Silver Creek. $		Steering Committee	November 2011	# of people that attend the meeting

Goal 3: Reduction of non-point source runoff.

Problem 3A: Lack of education by the general public concerning nonpoint source pollution (pollution generated with no identifiable source) and its effects on water quality.

Objective	Milestones - Cost	Target Audience	Performed By	Time Schedule	Indicator
Education of public about what non-point source pollution is and its impacts on water quality.	Produce a DVD (inconjuction with local high schools) to be distributed to PBS in area highlight Silver Creek and the impacts non-point source pollution has on it. $$ - $2,500.00	General Public	Watershed Coordinator Local students	Start and complete in school year following start of grant. (Complete DVD by spring 2011) Showing on Pubic TV on going	# of times shown on Public TV station
	Develop a partnership with garden centers to hand out brochures about fertilizer recommendations and pesticide applications. $	General Public	Watershed Coordinator	January 2011, then ongoing	# of brochures handed out # of participating garden centers
	Develop a non-point source website. $ - $1000	General Public	Watershed Coordinator Clark SWCD Staff	September 2010	# of hits on website
	Workshop and Demo site on Rain Gardens and Rain Barrels $ - $500			Summer 2011	# of people that attend workshop # of installed rain gardens

Goal 3: Reduction of non-point source runoff.

Problem 3B: Hazardous runoff from parking lots, roads, junkyards, landfills, and suburban areas enter local waterbodies.

Objective	Milestones - Cost	Target Audience		Time Schedule	Indicator
Effective enforcement of existing regulations and to make future regulations are enforceable by local officials.	Research existing regulations. $	Public Officials	Watershed Coordinator MS4 Coordinators	Spring 2011	# of inspections # of corrected infractions # of people attending meeting
	Educational meeting emphasizing enforcement procedures for current regulations and adoption of future enforceable regulations. $				
	Map of required detension/retension ponds in watershed. $	Public Officials General Public	Watershed Coordinator Volunteers	Summer 2011	# of maps requested Baseline data created and # of ponds tested
	Monitor water discharging from detention/retention ponds $$- $1500			Fall 2011 and then ongoing	
Increase public awareness of runoff regulations and enforcement process.	Write newsletter focusing on current regulations and enforcement process. $	General Public	Watershed Coordinator	Spring 2012	# of newsletters sent

Goal 4: Reduce anthropogenic nutrient input (Nitrogen and Phosphorus) into the stream as much as practical according to the baseline data gathered prior to implementation.

Problem 4A: Improper nutrient management on farmland and suburban areas (yards) can lead to nutrient overload in nearby waterbodies which can lead to increase algal blooms, thus decreasing dissolved oxygen when they die.

Objective	Action - Cost	Target Audience	Performed By	Time Schedule	Indicator
Reduce unnecessary amounts of fertilization.	Create a cost share program for proper soil testing. $$ - $5,000	Ag and Suburban Landowners	Watershed Coordinator Jackson-Jennings Co-Op	Winter 2010	# of soil tests
	Educational meeting to interpret soil test results. $		Watershed Coordinator Purdue Cooperative Extension Staff	Late winter/early spring 2011	# of participants
	Develop cost-share program to creat proper buffers for homewoner associations and farm owners. $$$ - $12,000		Watershed Coordinator NRCS Staff SWCD Staff ISDA Staff MS4 Coordinators	August 2010 develop cost-share criteria then ongoing until funds are spent or December 2012	Reduction of Nitrogen and Dissolved Phosphorus in Water
					Increase buffers (ft)
					Amount of money spent

Goal 4: Reduce anthropogenic nutrient input (Nitrogen target 1.2 mg/L and Phosphorus target 0.08 mg/L) into the stream.

Problem 4B: Improper stocking rates may cause nutrient overload to nearby waterbodies leading to increased algal blooms, thus decreasing dissolved oxygen when they die.

Objective	Milestones - Cost	Target Audience	Performed By	Time Schedule	Indicator
Insure that NRCS recommended stocking standards are being followed	Newsletters topics: Overstocking impacts on water quality - benefits of rotational grazing. $	Traditional and non-traditional livestock owners	Watershed Coordinator NRCS Staff Purdue Cooperative Extension Staff ISDA Staff	Summer 2010	# of publications distributed # of rotational grazing systems planned
	Cost share program for alternative water systems $$$ - $20,000			August 2010 develop cost-share criteria then ongoing until funds are spent or December 2013	# of alternative watering systems installed
	Cost share program for interior and exterior fencing. $$$ - $20,000				# of participants in cost share fencing program Improvement of grass in pastures.
	Help producers develop rotational grazing plans. $ - $1,000				Reduction of seasonal adjusted averages of Nitrogen and Phosphorus in the water.

Goal 5: Improve beneficial habitat to increase macroinverbrates.

Problem 5A: Lack of proper buffers can lead to an increase in sedimentation, water temperature, and runoff pollutants causing loss of habitat which in turn causes the death and/or lower numbers of macroinverbrates.

Objective	Milestones - Cost	Target Audience	Performed By	Time Schedule	Indicator
Improve water quality to increase the numbers and diversity of macroinverbrates.	Implementation of this plan. $$$ - $648,658.000	Everybody	Watershed Coordinator plus all partners listed in this plan	Goal is to continue to improve the WQ always. 2015	Increase # of macroinverbrates and diversity of macroinverbrates..
	Develop land trust program to identify potential wetland areas that can be used to create mitigated wetlands. $$	Land Developers Government officals	Watershed Coordinator George Roger Clark Land Trust	Spring 2013	Increased in # of wetland acres

Measuring Progress and Plan Evaluation

The overall success of the watershed management plan is dependent upon the participation of the constituents of the Silver Creek Watershed. To achieve the water quality goals set forth in this plan, it has become apparent to the Committee that a watershed-wide approach with goals that are realistic and measureable are needed for successful implementation. The plan identifies general timeframes and implementation activities that will start as funding becomes available. The watershed plan will be amended if needed to ensure that the strategies identified achieve the goals.

During the development of this plan, the Clark County SWCD applied for a Section 319 grant for implementation of the Silver Creek Watershed improvement plan. Included in the grant for implementation are dollars for cost-share programs for installation of agricultural and urban/suburban Best Management Practices (BMPs), public outreach, educational programming, conservation partnerships, and professional development. Funds required for personnel and administrative costs are also included.

The cost-share program will be developed by a committee consisting of representatives of NRCS, ISDA, Clark County SWCD, and the Steering Committee, as well as the project coordinator. Objective criteria will be established to rank projects designed to maximize dollars spent for improvement of water quality within the Silver Creek Watershed. The cost-share program will be administered through the Clark County SWCD office. Applications will be available in the Clark County SWCD office and on the SWCD web site.

Meetings at least quarterly or as needed, will be conducted by the Steering Committee to ensure that the implementation plan continues to reflect the ideas expressed during the planning process. The action register developed during the planning process and staff reports will be reviewed at these meetings.

In order to document any reductions to contaminant loading identified by the baseline data collected during this project, professional monitoring will continue on a limited basis. A volunteer water quality monitoring network will be developed. Existing sites will be utilized where possible. Collection procedures will be maintained in conjunction with the existing QAPP, but some modifications will be necessary. The water quality monitoring results will be used to refine the necessary loading results and help document the impact of implementation projects. These results will also help to justify any changes in the plan.

Because the Clark County SWCD applied for the implementation grant, they are ultimately responsible for making any changes to the project, keeping all the relative records and documents. Tracking the success of implementation will be accomplished using the indicators developed in the plan. The indicators include number of participants attending workshops; number of hits on the SWCD web site; number of publications distributed; number of articles published in newsletters; number of reports received on the hot line; reductions in the number of reported failures; feet of buffers installed; number of landowners participating in cost-share programs; number of BMPs installed; reduction of pollutant loads for E. coli, total suspended solids, nitrogen, and phosphorus; number of buffer plants purchased through district run programs; number of participating partners; and an increase in the number and diversity of macroinverbrates. The Clark County SWCD will incorporate the review and update process of the plan into their business plan to keep it current.

Glossary of Terms

303(d) List – a list identifying waterbodies that are impaired by one or more water quality elements, thereby limiting the performance of designated beneficial uses.

Aquifer – any geologic formation containing water, especially one that supplies water for wells, springs, etc.

Benthic Community - the community of plants and animals that live on, over, or in the substrate of the surface water.

Best Management Practice (BMP) – are those practices which are determined, after problem assessment and examination of all alternative practices and technological, economic, and institutional considerations, to be the most effective practicable means of preventing or reducing the amount of pollution generated by point or nonpoint sources to a level compatible with water quality goals.

Canopy Cover – the overhanging vegetation over a given area.

Channelization – straightening of a stream; often the result of human activity.

Coliform – intestinal waterborne bacteria that indicates fecal contamination. Exposure may lead to human health risks.

Designated Uses – state established uses that waters should support (e.g., fishing, swimming, aquatic life).

Detention Pond – a basin designed to slow down stormwater runoff by temporarily storing the runoff and releasing it at a specific rate.

Dissolved Oxygen – oxygen dissolved in water that is available for aquatic organisms.

Downstream – in the direction of a stream's current.

Dredge – to clean, deepen, or widen a water body using a scoop, usually done to remove sediment from a streambed.

Easement – a right, such as a right of way, afforded an entity to make limited use of another's real property.

Ecoregion – a community of living organisms and their interrelated physical and chemical environment.

Erosion – the removal of soil particles by the action of water, wind, ice, or other agent.

E. coli (Escherichia coli) – a type of coliform bacteria found in the intestines of warm-blooded organisms, including humans.

Gradient – measure of a degree of incline; the steepness of a slope.

Groundwater - water that flows or seeps downward and saturates soil or rock.

Headwater - the origins of a stream.

Hydrologic Unit Code (HUC) - a unique numerical code created by the U.S. Geological Survey to indicate the size and location of a watershed within the United States.

Impaired Waterway – a waterway which does not meet federal or state water quality standards. Waterways may be impaired for recreational use due to the presence of *E. coli*, for fish consumption due to high levels of PCBs or mercury, for high levels of nutrients, or other causes.

Impervious Surface – any material covering the ground that does not allow water to pass through or infiltrate (e. g., roads, roofs).

Infiltration – downward movement of water through the uppermost layer of soil.

Macroinvertebrates – animals lacking a backbone that are large enough to see without a microscope.

Maximum Contaminant Level (MCL) – the highest level of a contaminant that is allowed in drinking water.

National Pollutant Discharge Elimination System (NPDES) – a national program in which pollutant dischargers, such as factories and treatment plants, are given permits with set limits of discharge allowable.

Nonpoint Source Pollution (NPS) – pollution generated from large areas with no identifiable source (e.g., stormwater runoff from streets, development, and commercial and residential areas).

Permeable – capable of conveying water (e.g., soil, porous materials).

Point Source Pollution – pollution originating from a point, such as a pipe or culvert.

Pollutant – as defined by the Clean Water Act (Section 502(6)): "dredged spoil; solid waste; incinerator residue; sewage; garbage; sewage sludge; munitions; chemical wastes; biological materials; radioactive materials; heat; wrecked or discarded equipment; rock; sand; cellar dirt and industrial; municipal; and agricultural waste discharged into water."

Pool – an area of relatively deep, slow moving water in a stream.

Retention Pond – A basin designed to retain stormwater runoff so that a permanent pool is established.

Riffle – an area of shallow, swift moving water in a stream.

Riparian Zone – an area, adjacent to a water body, which is often vegetated and constitutes a buffer zone between the nearby land and water.

Run - a stretch of fast, smooth current, deeper than a riffle, with little or no turbulence on the

Run-off– water from precipitation, snowmelt, or irrigation that flows over the ground to a waterbody. Run-off can pick up pollutants from the air or land and carry them into streams, lakes, and rivers.

Sediment – soil, sand, and minerals washed from the land into a waterbody.

Sedimentation – the process by which soil particles (sediment) enter, accumulate, and settle to the bottom of a waterbody.

Soil Association – a landscape that has a distinctive pattern of soils in defined proportions. Typically named for the major soils.

Storm Drain – constructed opening in a road system through which run-off from the road surface flows on its way to a waterbody.

Stormwater – the surface water run-off resulting from precipitation falling within a watershed.

Substrate – the material that makes up the bottom layer of a stream.

Suspended Sediment – the fraction of sediment that remains suspended in water and does not settle out or accumulate in the stream bed.

Topographic Map – map that marks variations in elevation across a landscape.

Total Maximum Daily Load (TMDL) – calculation of the maximum amount of a pollutant that a waterbody can receive before becoming unsafe and a plan to lower pollution to that identified safe level.

Tributary – a stream that contributes its water to another stream or waterbody.

Turbidity – presence of sediment or other particles in water, making it unclear, murky, or opaque.

Upstream – against the current.

Water quality – the condition of water with regard to the presence or absence of pollution.

Water quality standard – recommended or enforceable maximum contaminant levels of chemicals or materials in water.

Watershed – the area of land that water flows over or under on its way to a common waterbody.

Wetlands – lands where water saturation is the dominant factor in determining the nature of soil development and the types of plant and animal communities.

Zoning – to designate, by ordinance, areas of land reserved and regulated for specific uses, such as residential, industrial, or open space.

Acronyms

BMP	Best Management Practice
BOD	Biological (or Biochemical) Oxygen Demand
CRP	Conservation Reserve Program
CTIC	Conservation Technology Information Center
CWA	Clean Water Act
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
GAP	Gap Analysis Program
GIS	Geographic Information System
GPS	Global Positioning System
HUC	Hydrologic Unit Code
IAC	Indiana Administrative Code
IBI	Index of Biological Indicators
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
MGD	Million gallons per day
MRCC	Midwestern Regional Climate Center
MS4	Municipal Separate Stormwater Sewer System
NH4	Total Ammonia
NPDES	National Pollutant Discharge Elimination System
NPS	Natural Resources Conservation Service
NWI	National Wetland Inventory
PCB	Polychlorinated Biphenyls
PPM	Part Per Million
QAPP	Quality Assured Project Plan
QHEI	Qualitative Habitat Evaluation Index
SWCD	Soil and Water Conservation District
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TS	Total Solids

USDA	United States Department of Agriculture
USGS	United States Geological Survey
UWA	Unified Watershed Assessment
WHIP	Wildlife Habitat Incentives Program
WMP	Watershed Management Plan
WWTP	Wastewater Treatment Plant

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Appendix I

Soils of the Watershed

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washing-ton	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foun-dations
AddA	Avonburg silt loam, 0 to 2 % slope	3602.6	0	1.9	0	3604.5	3.70 %	None	15	Very Limited	Very Limited
AddB2	Avonburg silt loam, 2 to 4% slopes, eroded	22.6	0	0	0	22.6	0.02	None	15	Very Limited	Very Limited
BbhA	Bartle silt loam, 0 to 2% slopes	1445.8	32.3	4.5	0	1482.6	1.52	None	15	Very Limited	Very Limited
BcrAW	Beanblos-som silt loam, 1 to 3 % slopes	1168.2	162.9	56.1	0	1387.2	1.42	Occasional, duration brief	102	Very Limited	Very Limited
BdoA	Bedford silt loam, 0 to 2% slopes	81.0	0	0	0	81.0	0.08	None	54	Very Limited	Somewhat Limited
BdoB	Bedford silt loam, 2 to 6 % slopes	95.8	0	0	0	95.8	0.10	None	18 to 30	Very Limited	Somewhat Limited
BfbC2	Blocher, soft bed-rock-Weddel silt loams, 6 to 12 % slopes, eroded	1924.8	0	134.6	0	2095.4	2.11	None	76	Very Limited	Somewhat Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washing-ton	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foun-dations
BfcC3	Blocher, soft bed-rock-Weddel silt loams, 6 to 12% slopes, severely eroded	673.2	0	109.6	0	782.8	0.80	None	76	Very Limited	Somewhat Limited
BnyD3	Bonnell clay loam, 12 to 22% slopes, severely eroded	566.1	0	37.8	0	603.9	0.62	None	>200	Very Limited	Very Limited
BobE5	Bonnell-Hickory clay loams, 15 to 30 % slopes, gullied	4.6	0	5.4	0	10.0	0.01	None	>200	Very Limited	Very Limited
BodAW	Bonnie silt loam, 0 to 1% slopes	281.9	0	0	0	281.9	0.29	Occasional	0 to 30.48	Very Limited	Very Limited
BvoG	Browns-town-Gilwood silt loams, 25 to 75% slopes	436.2	0	254.3	0	690.5	0.71	None		Very Limited	Very Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washing-ton	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foun-dations
CcaG	Caneyville-rock out-crop com-plex 25 to 60% slopes	84.2	0	0	0	84.2	0.09	None		Very Limited	Very Limited
CkkB2	Cincinnati silt loam, 2 to 6% slopes, eroded	2384.2	451.4	68.4	0	2904	2.98	None	79	Very Limited	Somewhat Limited
CldC2	Cincinnati-Blocher silt loams, 6 to 12% slopes, eroded	838.8	90.8	327.1	0	1256.7	1.29	None	61	Very Limited	Somewhat Limited
CldC3	Cincinnati-Blocher silt loams, 6 to 12% slopes, severely eroded	305.4	0	34.5	0	339.9	0.35	None	36	Very Limited	Very Limited
ClfA	Cobbsfork silt loam, 0 to 1% slopes	1053.2	0	0	0	1053.2	1.08	None		Very Limited	Very Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washington	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foundations
CspB2	Crider silt loam, 2 to 6% slopes eroded	3890.3	0	0	0	3890.3	3.99	None		Somewhat Limited	Somewhat Limited
CtrB2	Crider silt loam, Karst, undulation, eroded	762.8	0	0	0	762.8	0.78	None		Somewhat Limited	Somewhat Limited
CtwB	Crider-Bedford-Navilleton silt loams, 2 to 6% slopes	108.9	365.4	0	0	474.3	0.49	None	>200	Very Limited	Somewhat Limited
CwaAQ	Cuba silt loam, 0 to 2% slopes	12.8	30.5	0	0	43.3	0.04	Rarely		Very Limited	Very Limited
CxgC3	Crider-Haggatt silt loam, 6 to 12% slopes, severely eroded	338.4	0	0	0	338.4	0.35	None		Somewhat Limited	Somewhat Limited

SOILS											
Soil Name	**Map Unit Name**	**Clark**	**Floyd**	**Scott**	**Washing-ton**	**Total Acres**	**% of Watershed**	**Flooding**	**Depth to Water Ta-ble in cm**	**Suitable for septic systems**	**Suitable for foun-dations**
ComC	Coolville silt loams 6 to 12% slopes	2125.6	0	72.3	0	2197.9	2.26	None	30	Very Limited	Very Limited
ComC3	Coolville silt loam, 6 to 12% slopes, severely eroded	0	0	22.8	0	22.8	0.02	None	30	Very Limited	Very Limited
ConC3	Coolville-Rarden complex, 6 to 12% slopes, severely eroded	427.3	0	112.3	0	539.6	0.55	None	30	Very Limited	Very Limited
ConD	Coolville-Rarden complex, 12 to 18% slopes	3168.1	0	167.1	0	3335.2	3.42	None	30	Very Limited	Very Limited
CspA	Crider silt loam, 0 to 2% slopes	164.8	0	0	0	164.8	0.17	None		Somewhat Limited	Somewhat Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washington	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foundations
CxhC2	Crider-Haggatt silt loam, 6 to 12% slopes, eroded	1125.8	0	0	0	1125.8	1.16	None		Somewhat Limited	Somewhat Limited
CxmC2	Crider-Haggatt silt loam, Karst,Rolling , Eroded	1769.5	0	0	0	1769.5	1.82	None		Somewhat Limited	Somewhat Limited
CxnC3	Crider-Haggat complex, 2 to 12% slopes, karst, rolling, severely eroded	616.8	0	0	0	616.8	0.63	None		Somewhat Limited	Somewhat Limited
DbrG	Dam silty clay loam, 20 to 55% slopes	1733.7	0	350.8	0	2084.5	2.14	None	>200	Very Limited	Very Limited
DfnA	Dubois slit loam, 0 to 2 % slopes	116.8	0	4.7	0	121.5	0.12	None	30	Very Limited	Very Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washing-ton	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foun-dations
DfnB2	Dubois silt loam, 2 to 6% slopes, eroded	0	0	3.1	0	3.1	0.00	None	30	Very Limited	Very Limited
DtvC2	Deputy-Trappist silt loams, 6 to 12% slopes, eroded	2616.9	0	0	0	2616.9	2.69	None	46	Very Limited	Somewhat Limited
EepB	Elkinsville silt loam, 2 to 6% slopes	0	0	1.9	0	1.9	0.00	None	>200	Somewhat Limited	Somewhat Limited
EepF	Elkinsville, silt loam, 18 to 35% slopes	0	0	5.4	0	5.4	0.01	None	>200	Very Limited	Very Limited
EesA	Elkinsville-Millstone silt loam, 0 to 2% slopes	2.3	0	0	0	2.3	0.00	None		Somewhat Limited	Somewhat Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washing-ton	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foun-dations
EesB	Elkinsville, -Millstone silt loam, 2 to 6% slopes	40.1	0	0	0	40.1	0.04	None		Somewhat Limited	Somewhat Limited
GgbG	Gilwood-Browns-town silt loams, 25 to 75% slopes	3609.7	1019.0	0	0	4628.7	4.75	None	>200	Very Limited	Very Limited
GgfD	Gilwood-wraps silt loams, 6 to 18% slopes	352.2	0	67.4	0	419.6	0.43	None	>200	Very Limited	Somewhat Limited
GID2	Gilpin silt loam, 12 to 18% slopes, eroded	0	0	0	12.4	12.4	0.01	None	>200	Very Limited	Very Limited
GmaG	Gnawbone-Kurtz silt loams, 20 to 60% slopes	4812.2	908.2	93.7	0	5814.1	5.97	None	>200	Very Limited	Very Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washing-ton	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foun-dations
GnF	Gilpin-Berks loams, 18 to 50% slopes	0	0	0	218.9	218.9	0.22	None	>200	Very Limited	Very Limited
GyaD2	Grayford silt loam, 12 to 25% slopes, eroded	6.1	0	0	0	6.1	0.01	None		Very Limited	Very Limited
GyaD3	Grayford silt loam, 12 to 25% slopes se-verely eroded	14.4	0	0	0	14.4	0.01	None		Very Limited	Very Limited
GykD3	Grayford silt loam, karst, hilly, severely eroded	41.9	0	0	0	41.9	0.04	None		Very Limited	Very Limited
HcaA	Hatfield silt loam, 0 to 2% slopes	15.8	0	0	0	15.8	0.02	None	15.24 to 60.98	Very Limited	Very Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washing-ton	Total Acres	% of Water-shed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foun-dations
HcbAQ	Hatfield silty clay loam, 0 to 2% slopes	34.1	0	0	0	34.1	0.03	Rarely	15.24 to 60.96	Very Limited	Very Limited
HccA	Haubstadt silt loam, 0 to 2% slopes	0	0	29.0	0	29.0	0.03	None	46	Very Limited	Somewhat Limited
HccB2	Haubstadt silt loam 2 to 6% slopes, eroded	169.9	0	158.0	0	327.9	0.34	None	46	Very Limited	Somewhat Limited
HcdC2	Haubstadt-Shircliff silt loams, 6 to 15% slopes, eroded	2.5	0	4.5	0	7.0	0.01	None	46	Very Limited	Somewhat Limited
HceC3	Haubstadt-Shircliff complex 6 to 15% slopes, severely eroded	0	0	3.3	0	3.3	0.00	Occa-sional, duration brief	30.48 to 45.72	Very Limited	Very Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washing-ton	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foun-dations
HcgAH	Haymond silt loam, o to 2% slopes	140.5	124.2	0	0	264.7	0.27	Occasional, duration brief	>200	Very Limited	Very Limited
HcgAV	Haymond silt loam, 0 to 2%	789.7	0	0	0	789.7	0.81	Frequent, brief duration	>200	Very Limited	Very Limited
HcgAW	Haymond silt loam, 0 to 2% slopes	1847.1	57.0	0	0	1904.1	1.95	Occasional, duration brief	>200	Very Limited	Very Limited
HerE	Hickory-Bonnell complex, 12 to 25% slopes	786.3	0	201.4	0	987.7	1.01	None	>200	Very Limited	Very Limited
HtwD2	Haggatt-Caneyville silt loam 12 to 25% slopes, eroded	672.1	0	0	0	672.1	0.69	None		Very Limited	Very Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washing-ton	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foundations
MhyC3	Medora silt loam, 6 to 12% slopes, severely eroded	0	0	32.6	0	32.6	0.03	None	30	Very Limited	Very Limited
MsvA	Montgom-ery silty clay loam, 0 to 1% slopes	54.0	0	0	0	54.0	0.06	None	0 to 30.48	Very Limited	Very Limited
NaaA	Nabb silt loam, 0 to 2%	501.6	68.7	0.8	0	571.1	0.59	None	46	Very Limited	Somewhat Limited
NaaB2	Nabb silt loam, 2 to 6%, eroded	2000.8	140.1	31.5	0	2172.4	2.23	None	46	Very Limited	Somewhat Limited
NamF	Negley clay loam, 12 to 22% slopes, severely eroded	0	0	39.2	0	39.2	0.04	None	>200	Very Limited	Very Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washing-ton	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foun-dations
NanD3	Negley clay loam, 12 to 22% slopes, severely eroded	0	0	14.6	0	14.6	0.01	None	>200	Very Limited	Very Limited
PcrA	Pekin silt loam 0 to 2 % slopes	0	179.1	3.4	0	182.5	0.19	None	46	Very Limited	Somewhat Limited
PcrB2	Pekin silt loam, 2 to 6% slopes, eroded	2925.3	252.0	24.8	0	3202.1	3.29	None	46	Very Limited	Somewhat Limited
PcrC2	Pekin silt loam, 6 to 12% slopes, eroded	550.8	0	0	0	550.8	0.57	None	46	Very Limited	Somewhat Limited
PcrC3	Pekin silt loam, 6 to 12% slopes, severely eroded	213.1	0	3.5	0	216.6	0.22	None	30	Very Limited	Very Limited

SOILS											
Soil Name	**Map Unit Name**	**Clark**	**Floyd**	**Scott**	**Washing-ton**	**Total Acres**	**% of Watershed**	**Flooding**	**Depth to Water Table in cm**	**Suitable for septic systems**	**Suitable for foun-dations**
PeB	Pekin silt loam, 2 to 6% slopes	0	0	0	9.7	9.7	0.01	None	46	Very Limited	Somewhat Limited
PhaA	Peoga silt loam 0 to 1% slopes	144.0	0	0	0	144.0	0.15	None	0 to 30.48	Very Limited	Very Limited
Pml	Pits quarry	1145.1	0	0	0	1145.1	1.18	None		Not rated	Not Rated
RblC3	Rarden silty clay loam, 6 to 12% slopes, severely eroded	0	0	30.5	0	30.5	0.03	None	30	Very Limited	Very Limited
RblD3	Rarden, silty clay loam, 12 to 18% slopes, severely eroded	310.6	0	57.4	0	368.0	0.38	None	30	Very Limited	Very Limited

SOILS											
Soil Name	**Map Unit Name**	**Clark**	**Floyd**	**Scott**	**Washing-ton**	**Total Acres**	**% of Watershed**	**Flooding**	**Depth to Water Table in cm**	**Suitable for septic systems**	**Suitable for foun-dations**
RbmD5	Rarden silty clay, 6 to 18% slopes, gullied	33.5	0	5.8	0	39.3	0.04	None	30	Very Limited	Very Limited
RctD3	Rarden-Coolville complex, 12 to 22% slopes, severely eroded	0	276.7	0	0	276.7	0.28	None	30	Very Limited	Very Limited
RptG	Rohan-Jessietown complex 25 to 60% slopes, rocky	2415.2	0	43.0	0	2458.2	2.52	None	>200	Very Limited	Very Limited
RtcA	Ryker silt loam 0 to 2% slopes	6.5	0	0	0	6.5	0.01	None		Somewhat Limited	Somewhat Limited
RtcB2	Ryker silt loam 2 to 6% slopes	3.1	0	0	0	3.1	0.00	None		Somewhat Limited	Somewhat Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washington	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foundations
RzrB2	Ryker silt loam, karst, undulating, eroded	35.9	0	0	0	35.9	0.04	None		Somewhat Limited	Somewhat Limited
RztC2	Ryker-Gryford silt loams, 6 to 12% slopes, eroded	10.2	0	0	0	10.2	0.01	None		Somewhat Limited	Somewhat Limited
RzvC2	Ryker-Grayford silt loam, karst, rolling, severely eroded	5.3	0	0	0	5.3	0.01	None		Somewhat Limited	Somewhat Limited
RzvC3	Ryker-Grayford silt loam, karst, rolling severely eroded	8.5	0	0	0	8.5	0.01	None		Somewhat Limited	Somewhat Limited
SceB2	Scottsburg silt loam, 2 to 4% slopes, eroded	2403.0	27.7	0	0	2430.7	2.49	None	46	Very Limited	Somewhat Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washing-ton	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foun-dations
SfyB	Shircliff silt loam, 2 to 6% slopes	937.6	106.6	0	0	1044.2	1.07	None	46	Very Limited	Very Limited
SoaB	Spickert silt loam, 2 to 6% slopes	37.5	0	3.2	0	40.7	0.04	None	46	Very Limited	Somewhat Limited
SoaC2	Spicker silt loam 6 to 12% slopes eroded	0	0	47.9	0	47.9	0.05	None	45.72 to 76.2	Somewhat Limited	Somewhat Limited
SolC2	SolC2 Spickert-Wrays silt loams, 6 to 12% slopes, eroded	48.2	0	0	0	48.2	0.05	None	46	Very Limited	Somewhat Limited
StaAQ	Steff silt loam, 0 to 2% slopes	198.6	61.5	12.0	0	272.1	0.28	Rarely	46	Very Limited	Very Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washing-ton	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foun-dations
UngB	Urban land Udarents, fragipan substratum, complex, till plain, 0 to 12% slopes	6080.3	3637.8	0	0	9718.1	9.97	None	>200	Not Rated	Not Rated
UnkB	Urban land Udarents, silty sub-stratum, complex terrance, 0 to 6% slopes	190.3	1326.9	0	0	1517.2	1.56	None	>200	Not Rated	Not Rated
UnpA	Urban land Udarents, loamy sub-stratum,co mplex terrance, 0 to 3% slopes	1165.3	1278.6	0	0	2443.9	2.51	Not Rated	>200	Not Rated	Not Rated

SOILS											
Soil Name	**Map Unit Name**	**Clark**	**Floyd**	**Scott**	**Washing-ton**	**Total Acres**	**% of Watershed**	**Flooding**	**Depth to Water Table in cm**	**Suitable for septic systems**	**Suitable for foun-dations**
UnrD	Urban land Udarents, soft bed-rock sub-stratum, complex, hills 6 to 20% slopes	0	259.9	0	0	259.9	0.27	None		Not Rated	Not Rated
UnsB	Urban land Udarents, clayey, substratum, complex, hills 2 to 10% slopes	2860.3	0	0	0	2860.3	2.94	None		Not Rated	Not Rated
WaaAV	Wakeland silt loam, 0 to 2% slopes	837.6	13.6	0	0	851.2	0.87	Frequent, brief dura-tion	15	Very Limited	Very Limited
WaaAW	Wakeland silt loam, 0 to 2% slopes	850.0	113.0	0	0	963.0	0.99	Occasional, duration brief	15	Very Limited	Very Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washing-ton	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foun-dations
WeC2	Wellston silt loam, 6 to 12% slopes , eroded	0	0	0	11.0	11.0	0.01	None	>200	Somewhat Limited	Somewhat Limited
WeD	Wellston silt loam, 12 to 18% slopes	0	0	0	4.2	4.2	0.00	None	>200	Very Limited	Very Limited
WedB2	Weddel silt loam, 2 to 6% slopes, eroded	2103.7	0	38.3	0	2142.0	2.20	None	46	Very Limited	Somewhat Limited
WhdD2	Wellrock-Gnawbone-Spickert, soft bed-rock sub-stratum, silt loams 6 to 18% slopes, eroded	0	14.2	0	0	14.2	0.01	None	46	Somewhat Limited	Very Limited

SOILS

Soil Name	Map Unit Name	Clark	Floyd	Scott	Washington	Total Acres	% of Watershed	Flooding	Depth to Water Table in cm	Suitable for septic systems	Suitable for foundations
WnmA	Whitcomb, silt loam, 0 to 2% slopes	327.2	0	0	0	327.2	0.34	None	15.24 to 60.96	Very Limited	Very Limited
WokAV	Wilbur silt loam, 0 to 2% slopes	1069.4	17.9	0	0	1087.3	1.12	Frequent, brief duration	46	Very Limited	Very Limited
WokAW	Wilbur silt loam, 0 to 2% slopes	2254.4	36.4	0	0	2290.8	2.35	Occasional, duration brief	46	Very Limited	Very Limited

Appendix II

Partnerships

Stakeholders				
Name	**Address**	**City**	**Zip Code**	**Affiliation**
Judy Popp	1417 Hwy 160	Charlestown	47111	Clark Co. Farm Bureau
Mike Meyer	1216 Akers Ave.	Jeffersonville	47130	Clark Co. Health Dept.
John Hardin	656 S. Boatman Rd. Suite 3	Scottsburg	47170	Scott Co. SWCD
Maurice Stilger	5126 Old George-town Rd.	Georgetown	47122	Floyd Co. SWCD
Ann Cristiani	815 E. St. Joe Rd.	Sellersburg	47172	Clark County 4-H Horse and Pony Club
Walt Zak	P.O. Box 119	Henryville	47126	Clark State Forest
Karen Schaffer	350 Missouri Ave. Suite 101	Jeffersonville	47130	Stantec
Steve Hall	350 Missouri Ave. Suite 101	Jeffersonville	47130	Stantec
Paul Kraft	2000 Broadway	Clarksville	47129	Clarksville Town Board
Sharon Marra	9208 Hwy 62	Charlestown	47111	Clark Co. Solid Waste
Dave Trotter	9608 Hwy 62 Suite 1	Charlestown	47111	Purdue Extension Clark Co.
Doug Reiter	316 E. Utica Street	Sellersburg	47172	Sellersburg Town Board
Bryan Wallace	4230 Portage Place	Jeffersonville	47130	Oak Park Conservancy
Ron Mattingly	4332 Payne Koehler	New Albany	47150	Farmer
Kerry Krininger	1737 Millerwood	New Albany	47150	Citizen
Pat Little	7800 Hwy 403	Charlestown	47111	Citizen
Tim Deatrick	521 Navajo Drive	New Albany	47105	New Albany Stormwater Board
Becky Seals	10220 Stony Point	Charlestown	47111	Farmer
David Hitt	301 Hwy 31	Sellersburg	47172	Essroc Cement Co.
Kenny Rush	1019 E. Utica	Sellersburg	47172	Sellersburg Stone
Ed Meyer	501 E. Court Av.	Jeffersonville	47130	Clark Co. Commissioner
Sam Hagest	722 Deam Lake Rd.	Borden	47106	Clark Co. SWCD
Dana Coots	7475 Bethany Rd.	Charlestown	47111	Clark Co. SWCD

Stakeholders				
Name	**Address**	**City**	**Zip Code**	**Affiliation**
Amil Kleinert	6921 Stacy Road	Charlestown	47111	Clark Co. SWCD
Peg Wright	3029 Seminole	Jeffersonville	47130	Clark Co. SWCD
Cindi White	11407 Charlestown - Memphis Rd.	Memphis	47143	Citizen
Mark Burgin	1309 Sticker Road	Memphis	47143	Farmer

STEERING COMMITTEE

The following Steering Committee members served faithfully throughout the project, providing excellent input and guidance to complete the task. Their service is greatly appreciated.

Bryan Wallace, Chairman
Karl Eve
David Hitt
Jane Sarles
Richard Schultz
Maurice Stilger

Others who also contributed to the success of the project were:

Al Goodman, Owner of Loop Island Wetlands
Doug Dunlevey, Superintendent of Henryville Membership Sanitation Corporation
Mike Johnson, Indiana State Department of Agriculture
Tami Kruer, Clark County SWCD staff
Melanie Davis, Clark County SWCD staff
Pat Larr, District Conservationist, NRCS
Clark County Health Department - Mike Meyer and Doug Benefield
Indiana American Water Company - Joanna Wood
Oak Park Wastewater Treatment Plant
Indiana State Department of Health - Bharat Patel

APPENDIX III

Water Quality Tests Background Information

Water Quality Tests
Background Information

This section gives background information about water quality tests that were performed during the project by Stantec and by Richard Schultz of the University of Louisville Environmental Analysis Lab. This information allows better interpretation of the data collected.

CHLORIDE

Chloride is a material that is both a natural component of water and a very common industrial material. It enters water from industrial processes, domestic sewage, and surface runoff. It is often termed a conservative pollutant or conservative ion, because it is not taken up by plants or algae as a nutrient. It does not react as readily as many other materials in the water nor does it settle out readily. Therefore, it is a good indicator of human impacts.

Causes:

- Road salts
- Industrial processes
- Failing septic systems
- Feed lots
- Surface runoff

State standards: None

CHLOROPHYLL A

Chlorophyll a is the primary plant pigment. It allows plants (including algae) to conduct photosynthesis. Algae, or phytoplankton, is the base of the aquatic food chain and important to sustaining life in the river. However, too much phytoplankton could cause degradation of water quality. Scientists have found a strong correlation between phytoplankton biomass and chlorophyll a concentration in water, offering a general idea of how much planktonic algae are in the stream.

State standards: None [In smaller streams, this value should be less than 5 micrograms per liter (ug/L), anything higher may indicate excess nutrient inputs (nitrogen and/or phosphorus).]

CONDUCTIVITY

Conductivity is a measure of the ability of water to pass an electrical current. It is also useful as a general measure of stream water quality. Each stream tends to have a relatively constant range. Conductivity in streams is affected primarily by the geology of the area through which the water flows. Streams that flow through limestone and clay soils will have higher conductivity values. Conductivity is also affected by temperature. The warmer the water, the higher the conductivity.

Causes:

- Conductivity of rainwater
- Road Salt application
- Fertilizer application
- Failing septic systems

State standards: None

DISSOLVED ORGANIC CARBON (DOC)

Dissolved organic carbon is the organic carbon present in the water in a dissolved form which is an indicator of organic matter in the water.

State standards: None [Generally, high DOC values greater than seven milligrams per liter are indicative of organic pollution. Seven milligrams per liter is considered to be a ball-park figure.]

DISSOLVED OXYGEN (DO) & % SATURATION

Dissolved oxygen analysis measures the amount of gaseous oxygen (O2) dissolved in an aqueous solution. Dissolved oxygen is one of the most important parameters in aquatic systems. This gas is an absolute requirement for the metabolism of aerobic organisms and also influences inorganic chemical reactions. Presence of oxygen in water is a positive sign, while absence of oxygen from water often indicates water pollution.

Some factors affecting DO are:

~ Temperature (cold water holds more DO)
~ Altitude/atmospheric pressure
~ Turbulence
~ Plant growth/photosynthesis (oxygen levels rise during the day and fall at night)
~ Amount of decaying organic material

Dissolved oxygen levels below three ppm are stressful to most aquatic life. DO levels below two ppm will not support fish. Levels of five to six ppm are usually required for healthy growth and activity of aquatic life.

Causes:

Rapid decomposition of organic materials, such as dead algae, and shoreline vegeta tion. Manure wastewater decreases oxygen.

High ammonia concentrations in the stream use up oxygen in the process of oxidizing ammonia (NH40 to nitrate (NO3) through nitrification.

Less oxygen can dissolve in water at higher temperature.

Lack of turbulence or mixing of exposed water to atmospheric oxygen results in low dissolved oxygen concentrations.

State standards: Avg. > 5mg/L, not <4mg/L. Typical range for DO - 5.4 to 14.2 mg/L. Indiana Average 9.8 mg/L.

% Saturation - Percent saturation is the percent of milligrams of oxygen gas dissolved in one liter of water at a given temperature compared with the maximum milligrams of oxygen gas that can remain dissolved in one liter of water at the same temperature and pressure. To determine the percent saturation, the DO concentration and the water temperature are necessary. Daily and seasonal temperature changes. Thermal pollution greatly impacts oxygen levels and aquatic life in the stream.

State standards: None

E. coli

E. coli (Escherichia coli) is a specific species of fecal coliform bacteria used in Indiana's state water quality standards. Fecal coliform bacteria are found in the feces of warm-blooded animals, including humans, livestock, and waterfowl. These bacteria are naturally present in the digestive tracts of animals but are rare or absent in unpolluted waters. Some strains of E. coli can lead to illness in humans. The bacteria can enter the body through the mouth, nose, eyes, ears, or cuts in the skin.

Causes:

Human waste from poorly functioning septic systems, wastewater treatment systems, or combined sewer overflows.
Pet and wildlife (including waterfowl) waste.
Livestock or manure runoff from fields.

State Standards: For total body contact recreation, E. coli shall not exceed 235 CFU/100 mL. CFU (Most Probable Number). Typical range for E. coli is 133 to 1,157 colonies/100 mL. Indiana Average is 645 colonies/100 mL.

Nitrogen
(Total Nitrogen, Nitrate, Nitrite, Nitrogen-Ammonia, Total Kjeldahl Nitrogen)

Nitrogen is one of the most abundant elements and is found in all living things. Nitrogen-containing compounds act as nutrients in streams.

Nitrate (NO3) and Nitrite (NO2) - Bacteria in water quickly convert nitrites (NO2) to nitrates (NO3), and this process uses up oxygen. Excessive concentration of nitrites can produce a serious condition in fish called "brown blood disease". Nitrites also can react directly with hemoglobin in the blood of humans and other warm-blooded animals to produce methemoglobin. It causes a condition known as "blue baby" disease.

Causes:

Municipal and industrial wastewater
Septic tanks - Sewage is the number one source of nitrates in Indiana's surface water
Fertilized agricultural field and lawns
Discharges from car exhausts

State Standard: None [Combined concentration of nitrate and nitrite shall not exceed 10 mg/L. Typical range for Nitrate (NO3) = 0 to 36.08 mg/L. Indiana average is 12.32 mg/L.

Nitrogen-ammonia (NH3-N) - Ammonia is the most reduced inorganic form of nitrogen in water. Although ammonia is only a small component of the nitrogen cycle, excess ammonia contributes to eutrophication of water bodies. At high levels, it is toxic to aquatic life. About three-fourths of the ammonia produced in the United States is used in fertilizers either as the compound itself or as ammonium salts such as sulfate and nitrate. Large quantities of ammonia are used in the production of nitric acid, urea, and nitrogen compounds. Since ammonia is a decomposition product from urea and protein, it is found in domestic wastewater. Aquatic life and fish also contribute to ammonia levels in a stream. Plants are more tolerant of ammonia than animals, and invertebrates are more tolerant than fish.

Causes of ammonia:

Agricultural runoff
Sewage treatment plant effluents
Urban runoff
Industrial effluent
Animal waste

State Standards: State standard exists, but is temperature and pH dependent.

Total Kjeldahl Nitrogen (TKN) is a measure of both the ammonia and the organic forms of nitrogen. Ammonia and nitrogen affects have been discussed above. Organic nitrogen is not immediately available for biological activity therefore, it does not contribute to furthering plant proliferation until decomposition occurs.

Total Nitrogen is the sum of the concentrations of all forms of nitrogen present in water, including those that are not immediately available for biological uptake.

State Standards: None for either Total Kjeldahl Nitrogen or Total Nitrogen.

pH

pH is a term used to indicate the alkalinity or acidity of a substance as ranked on a scale from zero (most acidic to 14 (most basic). Seven on the scale is neutral. Each change in pH unit represents a tenfold change in acidity. The pH level is an important measure of water quality, because aquatic organisms are sensitive to pH, especially during reproduction. A ph range of 6.5 to 8.2 is optimal for organisms. Due to a high concentration of limestone in this area, the water is often slightly more basic. High pH values tend to facilitate the solubilization of ammonia, heavy metals, and salts. Low ph levels tend to increase carbon dioxide and carbonic acid concentrations.

Causes:

Mining
Agriculture
Industrial effluents
Acidic precipitation - acid rain
Natural processes - Higher temperatures result in slightly lower pH values. Algae blooms may raise the pH to nine or more.

State Standards: Between 6 - 9. Typical range for pH is 7.2 - 8.8. Indiana average is 8.0

Pheophytin a

Pheophytin a is a degradation pigment. It is a general indication of the health of the plankton community. Generally values are less than those of chlorophyll a. If a pheo-a is greater than chl a on a given day, it suggests the algal community is dying off.

State Standards: None

Phosphorus
(Total Phosphorus and Orthophosphate)

Total Phosphorus occurs naturally in the environment and is essential to plant and animal life. Total phosphorus is a measure of inorganic and organic forms of phosphorus. It is the most limiting nutrient to plant growth in fresh water. Phosphates are not toxic to people or animals unless they are present in very high levels. Once it is in an aquatic system, it remains there and cycles through different forms unless physically removed. Phosphates exist in three forms: orthophosphate, metaphosphate (or polyphosphate), and organically bound phosphate. The addition of phosphates to detergents is illegal in Indiana. It contributes to the conditions hypoxia and eutrophication. Naturally low phosphate levels in most fresh water limits algal growth. Excess phosphates support rapid algal growth. Decomposition of algae uses up oxygen and may produce odors and algal toxins.

Causes:

Phosphorus occurs naturally in soil; therefore, soil erosion and runoff are a significant source.

Manure sources, such as treatment lagoons, over-fertilized agricultural fields, or water fowl.

Urban sources, such as storm drains, parking lots and road runoff, and construction sites.

Municipal wastewater and septic tank effluent.

Lawn fertilizer.

State Standards: None [Draft nutrient benchmark is 0.3 mg/L. Typical range is 0 to 0.85 mg/L. Indiana average is 0.05 mg/L.]

Orthophosphates are one form of phosphates. They are dissolved in water (mostly inorganic) and are readily available for plant uptake. Thus, the orthophosphate concentration is useful as an indicator of current potential for algae blooms and eutrophication.

State Standards: None [Generally orthophosphate values are expected to be less than total phosphate, since orthophosphate is but on e component of total phosphate.]

Silica
(Measure as Silicon Dioxide (SiO2))

Silica is a nutrient of interest for a specific group of algae, the diatoms, which are a dominant form in many streams, especially headwater streams. This group of algae has been used extensively in water quality assessment, and several states have developed biotic indices. Indiana is currently working on development of a system.

Solids
(Total Solids, Total Suspended Solids, and Total Dissolved Solids)

Total Suspended Solids (TSS) is the measure of the particulate matter that is suspended within the water column. Suspended solids are any particles/substances that are neither dissolved nor settled in the water. They will not pass through a two-micron filter.

Total Dissolved Solids (TDS) is the total weight of all solids that are dissolved in a given volume of water. Dissolved solids refer to any minerals, salts, metals, cations, or anions dissolved in the water. The most common chemical constituents are calcium, phosphates, nitrates, sodium, potassium, and chloride. These particles that will pass through a two-micron filter.

Total Solids is the combination of total suspended solids, total dissolved solids, and the “settleable solids”. “Settleable solids” are any material of any size that will not remain suspended or dissolved in a holding tank not subject to motion and excludes both TDS and TSS.

The terms sediment and silt are often used to refer to suspended solids. Sediment is the number one pollutant in Indiana. Suspended solids consist of an inorganic fraction (silts, clays, etc.) and an organic fraction (algae, zooplankton, bacteria, and detritus) that are carried along by water as it runs off the land. The geology and vegetation of a watershed affect the amount of suspended solids.

Generally, solids do not pose health affects; however, too much dissolved solids in the water can affect humans by inducing a laxative effect and giving the water a mineral taste. Aesthetic characteristics of water are indicated by solids. Solids affect turbidity which can cause temperature to rise and oxygen levels to fall as a result of less photosynthesis. Solids can bind to toxic compounds and heavy metals. Suspended solids can clog fish gills, either killing the fish or reducing their growth rate. When suspended sediment settles out and drops to the bottom, it may smother bottom-dwelling organisms, cover breeding areas and smother eggs.

Causes:

Accelerated erosion from agricultural land, logging, surface mining, and construction sites.
Road salts.
Industrial effluent.
Sewage treatment.
Agricultural runoff.
Leaching of soil contamination.

State Standards: None [Total Suspended Solids - Target of 80 mg/L; Total Dissolved Solids - no state standard for streams, but not to exceed 750 mg/L in Lake Michigan.]

Temperature

Water temperature varies naturally over the course of a day, with the change of seasons, the amount of rainfall, and flow rates. The maximum daily temperature is usually several hours after noon, and the minimum is around day break.

Water temperature is very important to overall water and stream quality. Temperature affects:

~ Dissolved Oxygen Levels - Colder water can hold more dissolved oxygen than warmer water. Lower oxygen levels weaken fish and aquatic insects, making them more susceptible to illness and disease.
~ Rate of Photosynthesis by algae and aquatic plants increases with increased temperature.
~ Metabolic Rates of Aquatic Organisms - Many animals require specific temperatures to survive.

Causes:

Loss of shading by trees in the riparian zone and the watershed.
Runoff from roads and parking lots.

State Standards: None [State Water Quality Standard is for Temperature Change: <5º F change downstream and < 2º F change for trout streams.]

Turbidity

Turbidity is the relative clarity of the water. Turbidity should not be confused with color. Darkly colored water can still be clear and not turbid.

Turbid waters become warmer as suspended particles absorb heat from sunlight, causing oxygen levels to fall. Photosynthesis decreases with lesser light. Suspended solids in turbid water can clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development.

Causes:

Soil erosion.
Urban runoff.
Algae and organic matter.

State Standard: None [Typical range is 0 to 173 NTU. Indiana Average is 36 NTU]

Water Flow

Flow is the volume of water flowing through a point in the stream per second. Flow is also called discharge. Knowing the flow is critical in calculating the amount of a contaminant in a stream. Base flow is the amount of water that would drain absent any rain inputs and is usually from groundwater.

Flow influences the ability of a stream to dilute pollution. Flow and velocity affect the available oxygen level in water. Higher velocities and flows generate higher levels of turbulence which, in turn, cause more air to be mixed within the flow.

The flow rate of the water body is also a primary factor in Total Suspended Solid concentrations. Fast running water can carry more particles and larger-sized sediment. Heavy rains can pick up sand, silt, clay, and organic particles (such as leaves, soil, tire particles) from the land and carry it to surface water. A change in flow rate can also affect TSS; if the speed or direction of the water current increases, particulate matter from bottom sediments may be resuspended.

State Standards: None [Flow is completely dependent on the site.]

Macroinvertebrates
Biological Monitoring

Benthic macroinvertebrates are animals that lack backbones (invertebrate), are big enough to be seen with the naked eye (macro), and live at least part of their lives in or on the bottom (benthos) of a body of water. They make good indicators of watershed health, because they are relatively easy to sample and identify, are relatively immobile, differ in their tolerance to amount and types of pollution, are continuous indicators of environmental quality, and are a critical part of the aquatic food web. Biological monitoring is based on the fact that different species react to pollution in different ways. Pollution-sensitive organisms, such as mayflies, are more susceptible to the effects of physical or chemical changes in a stream than other organisms. The presence or absence of such indicator organisms is an indirect measure of pollution.

The benthic community in the streams was evaluated using IDEM's macroinvertebrate Index of Biotic Integrity (mIBI). The mIBI is a multi-metric index that combines several aspects of the benthic community composition to provide a complete assessment of a creek's biological integrity. IDEM defines biological integrity as the ability to support and maintain a balanced, integrated, and adaptive community of organisms having a species composition, diversity, and functional organization comparable to those of natural habitats within a region. Biological integrity is equated with pristine conditions or those conditions with no or minimal disturbance, and it is used as the baseline for the IBI.

Each macro sample in the project was analyzed using the following metrics: taxa richness (TR), ephemeroptera-Trichoptera-Plecoptera index (EPT), percent EPT (EPT %), Hilsenhoff Biotic index (HBI), and percent clingers (CL%).

Habitat Assessment

The physical habitat at the sampling sites for each of the streams was evaluated using the Qualitative Habitat Evaluation Index (QHEI). The index was developed by the Ohio Environmental Protection Agency to provide a measure of the stream habitat and riparian health that generally corresponds to physical factors affecting fish and other aquatic life. The six metrics considered for the QHEI are substrate (bottom type), fish cover (hiding places), stream shape and human alterations, riparian areas and erosion, pool/glide and riffle-run quality, and map gradient. The QHEI evaluates the characteristics of a 200-foot stream segment as opposed to the characteristics of the entire stream. Each metric is scored individually then summed to provide the total QHEI score, which generally ranges from 20 to 100. Following is a brief discussion of the 6 metrics used to calculate the QHEI.

Substrate - is the bottom sediment material in a natural water system. The quality of substrate refers to the embeddedness of the benthic zone. The rocks, gravel, cobble, and boulders that comprise a stream's substrate do not fit together perfectly like pieces in a jigsaw puzzle. Small pores and crevices exist between the rocks in the stream's substrate. Many stream organisms can colonize these pores and crevices, or microhabitats. In streams that carry high silt loads, the pores and crevices between rock substrate become clogged over time. This clogging, or "embedding", of the stream's substrate eliminates habitat for the stream's biota. Thus, sites with heavy embeddedness and siltation receive lower QHEI scores for the substrate metric. Sites that have greater substrate diversity receive higher scores as they can provide greater habitat diversity for benthic organisms.

Fish cover, or in-stream cover refers to the type(s) and quantity of habitat provided within the stream itself. Examples of in-stream cover include woody logs and debris, aquatic and overhanging vegetation, and root wads extending from the stream banks.

Stream shape and human alterations evaluates the stream's physical development with respect to habitat diversity. Pool and riffle development within the stream reach, the channel sinuosity, and other factors that represent the stability and direct modification of the site comprise this metric score.

Riparian areas and erosion - A stream's buffer area for the QHEI consists of the riparian zone (the area immediately adjacent to the stream) and the floodplain zone (the area beyond the riparian zone that may influence the stream through runoff). The buffer zone is instrumental in the dentention, removal, and assimilation of nutrients. For the purpose of the QHEI, a riparian zone consist only of forest, shrub, swamp, or woody vegetation. Weedy, herbaceous vegetation has higher runoff potential than wood components and does not represent an acceptable riparian zone type for the QHEI. Streams with grass or herbaceous vegetation growing in the riparian zone receive low QHEI scores. The extent of erosion is critical to the stabilization of stream banks, which may result from insufficient vegetation.

Pool/glide and Riffle-run Quality - For clarification, following are the definitions for these terms:

Pool is an area of the stream with slow current velocity and a depth greater than riffle and run areas. The stream bed is often concave and stream width frequently is the greatest the water surface slope is nearly zero.

Glide is an area common to most modified stream channels that do not have distinguishable pool run and riffle habitats. The current and flow are similar to that of a canal. The water surface gradient is nearly zero.

Riffle are areas of the stream with fast current velocity and shallow depth. The water surface is visibly broken.

Runs are areas of the stream that have a rapid non-turbulent flow. Runs are deeper than riffles with a faster current velocity than pools and are generally located down stream from riffles with a faster current velocity than pools and are generally located down stream from riffles where the stream narrows. The stream bed is often flat beneath a run, and the water surface is not visibly broken.

These zones in a stream, when present, provide diverse habitat and, in turn, can increase habitat quality. The depth of pools within a reach and the stability of riffle substrate are some factors that affect the QHEI score.

Map Gradient is calculated using topographic data. The score for this metric is based on the premise that both very low and very high gradient streams will have negative effects on habitat quality. Moderate gradient streams receive the highest score of 10. The gradient ranges for scoring take into account the varying influence of gradient with stream size.

The QHEI for this project was calculated at each of the ten monitoring sites described on page 41 during the macroinverbrate collection on September 10 or 18, 2008. The QHEI evaluates only a 200-foot stream segment. Scores greater than 60 are considered to be conducive to the existence of warm water faunas. Scores greater than 75 typify habitat conditions that have the ability to support exceptional warm water faunas. Scores below 51 suggest that poor habitat may be limiting biota within the stream. The higher the QHEI score, the more diverse the habitat for colonization by macroinvertebrates.

APPENDIX IV

Water Quality Data

Site 1 Blackiston Mill at Dam												
Date	**9/26/07**	**10/30/07**	**11/28/07**	**12/18/07**	**1/28/08**	**2/27/08**	**4/2/08**	**4/30/08**	**5/28/08**	**6/24/08**	**7/30/08**	**8/27/08**
E. coli	37.9 MPN	116.2 MPN	913.9 MPN	4.0 MPN	1.0 MPN	88.8 MPN	142.1 MPN	93.3 MPN	116.2 MPN	50.4 MPN	18.9 MPN	15.6 MPN
Nitrate	0.06mg/L	2.60mg/L	1.98mg/L	2.04mg/L	2.09mg/L	1.18mg/L	0.81mg/L	0.82mg/L	0.91 mg/L	1.03mg/L	0.01 mg/L	.16 mg/L
Nitrite	ND	0.031 mg/L	0.008 mg/L	0.005 mg/L	0.006 mg/L	ND	ND	0.0006 mg/L	0.006 mg/L	0.004 mg/L	0.004 mg/L	0.008 mg/L
Solids, Sus-pended	10mg/L	13mg/L	25mg/L	15mg/L	4.0mg/L	NA	35.0mg/L	7.0mg/L	13 mg/L	9 mg/L	7 mg/L	9 mg/L
Solids, Total	384mg/L	492mg/L	315mg/L	230mg/L	291mg/L	NA	209mg/L	308mg/L	234 mg/L	370 mg/L	283 mg/L	545 mg/L
Solids, Dissolved	360mg/L	446mg/L	274mg/L	200mg/L	270mg/L	NA	156mg/L	277mg/L	207 mg/L	345 mg/L	259 mg/L	519 mg/L
Nitrogen-Ammonia	0.1mg/L	<0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1 mg/L	NA	0.1 mg/L	0.1 mg/L
TKN	0.6mg/L	0.5mg/L	0.8mg/L	0.4mg/L	0.2mg/L	0.5mg/L	0.4mg/L	0.3mg/L	0.4 mg/L	NA	0.7 mg/L	0.6 mg/L
Phospho-rus, Total	0.04mg/L	0.07mg/L	0.09mg/L	0.04mg/L	0.08mg/L	0.07mg/L	0.06mg/L	0.06mg/L	0.07 mg/L	NA	0.06 mg/L	0.05 mg/L
Conduc-tivity	625 us/cm	686 us/cm	423 us/cm	320 us/cm	395 us/cm	247 us/cm	187 us/cm	485 us/cm	331 us/cm	567 us/cm	525 us/cm	830 us/cm
Dissolved Oxygen	6.01 mg/L	10.27 mg/L	11.84 mg/L	13.25 mg/L	15.50 mg/L	13.56 mg/L	10.50 mg/L	8.98 mg/L	6.16 mg/L	5.65 mg/L	5.79 mg/L	5.72 mg/L
Flow	0.15 ft/sec	0.4ft/sec	1.2ft/sec	0.882 ft/sec	0.7ft/sec	3.0ft/sec	0.5ft/sec	1.5ft/sec	1.5 ft/sec	0.5 ft/sec	0.3 ft/sec	1.0 ft/sec
pH	7.92 su	7.26 su	7.50 su	7.45 su	7.78 su	7.12 su	6.50 su	7.44 su	7.41 su	7.89 su	7.31 su	7.06 su
TDS (Done in Field)	310ppm	346ppm	213ppm	170ppm	220ppm	124ppm						
Tempera-ture	23.8 C	11.7 C	7.9 C	4.5 C	0.9 C	3.5 C	11.7 C	15.3 C	20.3 C	24.4 C	27.1 C	21.6 C
Turbidity	5.93NTU	10.50NTU	23.00NTU	13.70NTU	4.11NTU	42.1NTU	30.00NTU	4.91NTU	8.80 NTU	5.82 NTU	4.22 NTU	6.04NTU

Site 2 Bridge on Utica/Sellersburg Road												
Date	**9/26/07**	**10/30/07**	**11/28/07**	**12/18/07**	**1/28/08**	**2/27/08**	**4/2/08**	**4/30/08**	**5/28/08**	**6/24/08**	**7/30/08**	**8/27/08**
E. coli	93.3 MPN	73.3 MPN	251.2 MPN	13.5 MPN	18.9 MPN	113.7 MPN	88.6 MPN	141.4 MPN	613.1 MPN	344.1 MPN	689.3 MPN	88.2 MPN
Nitrate	0.11 mg/L	2.27mg/L	2.27mg/L	2.10mg/L	1.75mg/L	1.27mg/L	0.89mg/L	0.48mg/L	0.92 mg/L	0.74 mg/L	0.44 mg/L	0.1 mg/L
Nitrite	ND	0.021 mg/L	0.004 mg/L	0.005 mg/L	0.005 mg/L	ND	ND	0.004 mg/L	0.008 mg/L	0.01 mg/L	0.011 mg/L	0.004 mg/L
Solids, Sus-pended	5.0mg/L	12mg/L	15mg/L	18mg/L	5.0mg/L	NA	35.0mg/L	10.0mg/L	12.0 mg/L	11.0 mg/L	8.0 mg/L	9 mg/L
Solids, Total	1580mg/L	528mg/L	330mg/L	224mg/L	252mg/L	NA	208mg/L	215mg/L	288 mg/L	271 mg/L	884 mg/L	325 mg/L
Solids, Dissolved	1450mg/L	479mg/L	297mg/L	198mg/L	229mg/L	NA	152mg/L	190mg/L	258 mg/L	297 mg/L	822 mg/L	304 mg/L
Nitrogen-Ammonia	0.1mg/L	<0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1 mg/L	NA	0.1 mg/L	0.1 mg/L
TKN	0.6mg/L	0.6mg/L	0.6mg/L	0.4mg/L	0.2mg/L	0.5mg/L	0.4mg/L	0.2mg/L	0.4 mg/L	NA	0.5 mg/L	0.4 mg/L
Phospho-rus, Total	0.06mg/L	0.04mg/L	0.06mg/L	0.04mg/L	0.03mg/L	0.05mg/L	0.1mg/L	0.03mg/L	0.04 mg/L	NA	0.03 mg/L	0.04 mg/L
Conduc-tivity	2448 us/cm	751 us/cm	500 us/cm	310 us/cm	327 us/cm	270 us/cm	169 us/cm	326 us/cm	426 us/cm	454 us/cm	1379 us/cm	494 us/cm
Dissolved Oxygen	4.46 mg/L	8.65 mg/L	10.86 mg/L	12.81 mg/L	14.98 mg/L	13.49 mg/L	10.28 mg/L	7.78 mg/L	5.91 mg/L	3.53 mg/L	4.3 mg/L	3.4 mg/L
Flow	No report	0.3ft/sec	1.2ft/sec	2.087 ft/sec	0.5ft/sec	0.8ft/sec	4.0ft/sec	1.5ft/sec	1.0 ft/sec	1 ft/sec	0.3 ft/sec	0.3 ft/sec
pH	7.52 su	7.14 su	7.20 su	7.79 su	7.80 su	6.97 su	6.70 su	7.18 su	7.51 su	7.28 su	6.99 su	6.78 su
TDS (Done in Field)	1222ppm	375ppm	343ppm	155ppm	180ppm	134ppm						
Tempera-ture	22.2 C	11.4 C	8.5 C	4.8 C	1.9 C	3.0 C	10.8 C	14.1 C	19.5 C	22.9 C	25.4 C	21.2 C
Turbidity	5.93NTU	10.44NTU	13.00NTU	12.70NTU	6.81NTU	32.7NTU	25.7NTU	7.06NTU	9.20 NTU	8.54 NTU	7.93NTU	5.53NTU

Site 3 SR 403, entrance road to quarry

Date	9/26/07	10/30/07	11/28/07	12/18/07	1/28/08	2/27/08	4/2/08	4/30/08	5/28/08	6/24/08	7/30/08	8/27/08
E. coli	870.4 MPN	343.6 MPN	328.2 MPN	0 MPN	1 MPN	44.1 MPN	32.7 MPN	70.3 MPN	137.6 MPN	238.2 MPN	658.6 MPN	Did not sample
Nitrate	ND	2.81mg/L	4.83mg/L	4.18mg/L	3.15mg/L	3.55mg/L	0.72mg/L	0.36mg/L	0.65 mg/L	NA	0.4 mg/L	
Nitrite	ND	ND	0.004 mg/L	ND	ND	ND	ND	ND	0.006 mg/L	NA	0.011 mg/L	
Solids, Sus-pended	35mg/L	4.0mg/L	5.0mg/L	10.0mg/L	4.0mg/L	NA	42.0mg/L	7.0mg/L	20.0 mg/L	9 mg/L	63.0 mg/L	
Solids, Total	495mg/L	691mg/L	478mg/L	423mg/L	591mg/L	NA	194mg/L	184mg/L	189 mg/L	192 mg/L	988 mg/L	
Solids, Dissolved	443mg/L	350mg/L	443mg/L	394mg/L	549mg/L	NA	138mg/L	158mg/L	158 mg/L	209 mg/L	861 mg/L	
Nitrogen-Ammonia	0.1mg/L	<0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1 mg/L	NA	0.1 mg/L	
TKN	1.1mg/L	0.3mg/L	0.3mg/L	0.3mg/L	0.2mg/L	0.2mg/L	0.4mg/L	0.2mg/L	0.4 mg/L	NA	0.6 mg/L	
Phospho-rus, Total	0.22mg/L	0.07mg/L	0.05mg/L	0.03mg/L	0.03mg/L	0.03mg/L	0.05mg/L	0.03mg/L	0.04 mg/L	NA	0.11 mg/L	
Conduc-tivity	780 us/cm	988 us/cm	822 us/cm	632 us/cm	865 us/cm	648 us/cm	155 us/cm	271 us/cm	246 us/cm	319 us/cm	1290 us/cm	
Dissolved Oxygen	4.24 mg/L	9.09 mg/L	9.76 mg/L	10.84 mg/L	12.94 mg/L	12.51 mg/L	10.58 mg/L	8.40 mg/L	6.80 mg/L	5.17 mg/L	5.53 mg/L	
Flow	0 ft/sec	0.1ft/sec	0.2ft/sec	0.191 ft/sec	1.1ft/sec	0.3ft/sec	2.0ft/sec	1.0ft/sec	0.5 ft/sec	1.0 ft/sec	0.3 ft/sec	
pH	7.81 su	7.31 su	7.19 su	7.45 su	7.30 su	7.34 su	6.40 su	7.42 su	7.49 su	7.27 su	7.30 su	
TDS (Done in Field)	369ppm	489ppm	369ppm	318ppm	430ppm	325ppm						
Tempera-ture	23.7 C	11.4 C	11.2 C	7.3 C	6.9 C	6.9 C	9.9 C	13.3 C	18.0 C	23.0 C	23.1 C	
Turbidity	14.6NTU	2.84NTU	4.75NTU	6.15NTU	2.89NTU	4.46NTU	29.00NTU	6.56NTU	14.00NTU	6.16 NTU	57.20NTU	

Site 4 Brick Church Road Bridge at junction with Weber Road and Bud Prather												
Date	**9/26/07**	**10/30/07**	**11/28/07**	**12/18/07**	**1/28/08**	**2/27/08**	**4/2/08**	**4/30/08**	**5/28/08**	**6/24/08**	**7/30/08**	**8/27/08**
E. coli	133.1 MPN	396.8 MPN	328.2 MPN	0 MPN	1 MPN	120.1 MPN	88.2 MPN	99.0 MPN	1011.1 MPN	139.6 MPN	34.4 MPN	51.2 MPN
Nitrate	ND	1.85mg/L	2.16mg/L	1.98mg/L	0.01mg/L	1.18mg/L	0.78mg/L	0.07mg/L	0.74 mg/L	0.74 mg/L	0.05 mg/L	0.01 mg/L
Nitrite	ND	0.01 mg/L	0.006 mg/L	ND	0.004 mg/L	ND	ND	ND	0.006 mg/L	0.011 mg/L	0.004 mg/L	0.004 mg/L
Solids, Sus-pended	12mg/L	9mg/L	8.0mg/L	9.0mg/L	4.0mg/L	NA	15.0mg/L	12.0mg/L	25.0 mg/L	8.0 mg/L	5.0 mg/L	8.0 mg/L
Solids, Total	283mg/L	290mg/L	220mg/L	169mg/L	220mg/L	NA	161mg/L	240mg/L	178 mg/L	207 mg/L	212 mg/L	232 mg/L
Solids, Dissolved	260mg/L	263mg/L	201mg/L	150mg/L	197mg/L	NA	128mg/L	214mg/L	145 mg/L	220 mg/L	197 mg/L	220 mg/L
Nitrogen-Ammonia	0.1mg/L	<0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.04mg/L	0.1 mg/L	NA	0.1 mg/L	0.1 mg/L
TKN	0.6mg/L	0.4mg/L	0.5mg/L	0.4mg/L	0.4mg/L	0.4mg/L	0.3mg/L	0.6mg/L	0.5 mg/L	NA	0.4 mg/L	0.5mg/L
Phospho-rus, Total	0.04mg/L	0.04mg/L	0.04mg/L	0.04mg/L	0.04mg/L	0.04mg/L	0.03mg/L	0.04mg/L	0.05 mg/L	NA	0.03 mg/L	0.04 mg/L
Conduc-tivity	457 us/cm	407 us/cm	320 us/cm	228 us/cm	314 us/cm	216 us/cm	178 us/cm	273 us/cm	248 us/cm	332 us/cm	334 us/cm	382 us/cm
Dissolved Oxygen	2.45 mg/L	8.31 mg/L	10.88 mg/L	12.74 mg/L	14.43 mg/L	13.69 mg/L	9.85 mg/L	7.99 mg/L	5.80 mg/L	3.49 mg/L	4.41 mg/L	4.34 mg/L
Flow	0.5 ft/sec	0.1ft/sec	0.2ft/sec	0.884 ft/sec	0.1ft/sec	0.9ft/sec	1.0ft/sec	0.0ft/sec	0.5 ft/sec	1.0 ft/sec	0.3 ft/sec	0.3 ft/sec
pH	7.36 su	6.80 su	6.96 su	7.36 su	7.60 su	6.68 su	6.49 su	7.14 su	7.49 su	7.12 su	7.07 su	6.75 su
TDS (Done in Field)	229ppm	201ppm	220ppm	11ppm	153ppm	109ppm						
Tempera-ture	23.1 C	10.4 C	7.6 C	3.2 C	12.0 C	1.5 C	9.2 C	13.9 C	18.1 C	21.6 C	25.1 C	20.7C
Turbidity	10.07NTU	8.41NTU	8.05NTU	9.75NTU	4.04NTU	23.3NTU	16.00NTU	7.33NTU	15.00NTU	8.29NTU	4.39NTU	5.05NTU

Site 5 Bridge on Stricker Road

Date	9/26/07	10/30/07	11/28/07	12/18/07	1/28/08	2/27/08	4/2/08	4/30/08	5/28/08	6/24/08	7/30/08	8/27/08
E. coli	63.1 MPN	65.7 MPN	119.8 MPN	0 MPN	8.6 MPN	172.3 MPN	149.7 MPN	17.3 MPN	178.2 MPN	148.3 MPN	77.1 MPN	15.0 MPN
Nitrate	ND	1.31mg/L	1.26mg/L	2.20mg/L	1.92mg/L	1.57mg/L	0.91mg/L	0.23mg/L	0.55 mg/L	0.09 mg/L	0.05 mg/L	0.02 mg/L
Nitrite	ND	0.089 mg/L	0.020 mg/L	0.006 mg/L	0.006 mg/L	ND	ND	0.044 mg/L	0.011 mg/L	0.015 mg/L	0.004 mg/L	0.004 mg/L
Solids, Suspended	26mg/L	18mg/L	12mg/L	7.0mg/L	8.0mg/L	NA	18.0mg/L	4.0mg/L	13.0 mg/L	12.0 mg/L	16.0 mg/L	24.0 mg/L
Solids, Total	292mg/L	266mg/L	286mg/L	184mg/L	310mg/L	NA	183mg/L	136mg/L	244 mg/L	261 mg/L	258 mg/L	208 mg/L
Solids, Dissolved	254mg/L	235mg/L	267mg/L	169mg/L	280mg/L	NA	148mg/L	120mg/L	217 mg/L	241 mg/L	232 mg/L	179 mg/L
Nitrogen-Ammonia	0.1mg/L	0.3mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.04mg/L	0.1 mg/L	0.1 mg/L	0.1 mg/l	0.1 mg/L
TKN	1.5mg/L	1.1mg/L	0.6mg/L	0.5mg/L	0.4mg/L	0.4mg/L	0.4mg/L	0.1mg/L	0.6 mg/L	0.7 mg/L	0.7 mg/L	1.2 mg/L
Phosphorus, Total	0.14mg/L	0.06mg/L	0.04mg/L	0.06mg/L	0.04mg/L	0.05mg/L	0.05mg/L	0.03mg/L	0.05 mg/L	0.04 mg/L	0.06 mg/L	0.09 mg/L
Conductivity	433 us/cm	373 us/cm	433 us/cm	56 us/cm	473 us/cm	234 us/cm	185 us/cm	205 us/cm	358 us/cm	415 us/cm	404 us/cm	297 us/cm
Dissolved Oxygen	2.2 mg/L	3.24 mg/L	6.39 mg/L	9.05 mg/L	13.39 mg/L	12.13 mg/L	7.83 mg/L	9.43 mg/L	7.68 mg/L	2.97 mg/L	3.71 mg/L	1.32 mg/L
Flow	0 ft/sec	0.2ft/sec	0.1ft/sec	0.293 ft/sec	frozen	NA	0.0ft/sec	0.0ft/sec	0.5 ft/sec	1.0 ft/sec	0.3 ft/sec	0.3 ft/sec
pH	7.38 su	6.94 su	7.27 su	7.06 su	7.16 su	7.08 su	6.89 su	6.70 su	7.40 su	7.20 su	7.25 su	6.68 su
TDS (Done in Field)	216ppm	185ppm	216ppm	128ppm	236ppm	130ppm						
Temperature	22.9 C	9.7 C	6.8 C	5.0 C	5.0 C	2.0 C	10.6 C	10.3 C	18.8 C	22.4 C	25.4 C	21.0 C
Turbidity	16.5NTU	15.10NTU	8.97NTU	11.70NTU	5.94NTU	17.9NTU	15.30NTU	2.05NTU	7.60NTU	8.96NTU	11.30NTU	11.80NTU

Site 6 Bridge on Biggs Road

Date	9/26/07	10/30/07	11/28/07	12/18/07	1/28/08	2/27/08	4/2/08	4/30/08	5/28/08	6/24/08	7/30/08	8/27/08
E. coli	156.5 MPN	8.6 MPN	95.7 MPN	198.9 MPN	21.1 MPN	57.8 MPN	66.9 MPN	285.1 MPN	601.5 MPN	248.9 MPN	45.0 MPN	49.6 MPN
Nitrate	ND	0.34mg/L	0.67mg/L	0.86mg/L	0.79mg/L	0.01mg/L	0.34mg/L	0.31mg/L	0.41 mg/L	0.14 mg/L	0.05 mg/L	0.11 mg/L
Nitrite	ND	ND	ND	ND	ND	0.004 mg/L	ND	0.008 mg/L	0.006 mg/L	0.004 mg/L	0.004 mg/L	0.01 mg/L
Solids, Suspended	6.0mg/L	4.0mg/L	4.0mg/L	5.0mg/L	4.0mg/L	NA	8.0mg/L	4.0mg/L	4.0 mg/L	7.0 mg/L	5.0 mg/L	24.0 mg/L
Solids, Total	235mg/L	150mg/L	156mg/L	119mg/L	148mg/L	NA	117mg/L	211mg/L	135 mg/L	142 mg/L	155 mg/L	254 mg/L
Solids, Dissolved	217mg/L	138mg/L	144mg/L	111mg/L	137mg/L	NA	117mg/L	188mg/L	119 mg/L	131 mg/L	139 mg/L	221 mg/L
Nitrogen-Ammonia	0.1mg/L	<0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.01mg/L	0.2 mg/L	0.1 mg/L	0.1 mg/L	0.2 mg/L
TKN	1.0mg/L	0.2mg/L	0.3mg/L	0.4mg/L	0.1mg/L	0.4mg/L	0.3mg/L	0.7mg/L	1.2 mg/L	0.2mg/L	0.5 mg/L	0.9 mg/L
Phosphorus, Total	0.10mg/L	0.03mg/L	0.03mg/L	0.03mg/L	0.03mg/L	0.03mg/L	0.03mg/L	0.11mg/L	0.03 mg/L	0.03 mg/L	0.03 mg/L	0.06 mg/L
Conductivity	347 us/cm	218 us/cm	219 us/cm	160 us/cm	216 us/cm	145 us/cm	98 us/cm	342 us/cm	188 us/cm	214 us/cm	232 us/cm	379 us/cm
Dissolved Oxygen	1.27 mg/L	8.54 mg/L	12.51 mg/L	14.05 mg/L	14.71 mg/L	14.6 mg/L	11.23 mg/L	7.85 mg/L	6.05 mg/L	4.42 mg/L	4.53 mg/L	2.86 mg/L
Flow	0 ft/sec	0.0ft/sec	0.2ft/sec	0.792 ft/sec	frozen	2.3ft/sec	1.5ft/sec	0.0ft/sec	0.5 ft/sec	1.0 ft/sec	0.3 ft/sec	0.3 ft/sec
pH	7.17 su	6.60 su	6.92 su	7.27 su	6.81 su	6.78 su	6.34 su	6.90 su	7.17 su	6.89 su	6.48 su	6.46 su
TDS (Done in Field)	173ppm	109ppm	111ppm	80ppm	109ppm	78ppm						
Temperature	21.6 C	7.5 C	3.8 C	1.5 C	0.2 C	1.0 C	8.1 C	10.0 C	16.7 C	20.7 C	23.5 C	20.1 C
Turbidity	6.11NTU	1.91NTU	4.20NTU	7.20NTU	3.18NTU	22.2NTU	12.90NTU	2.04NTU	3.9NTU	4.91NTU	4.46NTU	12.30NTU

Site 7 Bridge on Caney Road												
Date	**9/26/07**	**10/30/07**	**11/28/07**	**12/18/07**	**1/28/08**	**2/27/08**	**4/2/08**	**4/30/08**	**5/28/08**	**6/24/08**	**7/30/08**	**8/27/08**
E. coli	42.6 MPN	<1 MPN	298.7 MPN	172.3 MPN	90.7 MPN	7.2 MPN	101.4 MPN	27.2 MPN	1011.1 MPN	913.9 MPN	549.2 MPN	1.0 MPN
Nitrate	ND	0.37mg/L	1.09mg/L	1.22mg/L	0.81mg/L	0.71mg/L	0.45mg/L	0.39mg/L	0.34 mg/L	0.18 mg/L	0.08 mg/L	0.11 mg/L
Nitrite	ND	ND	0.004 mg/L	ND	0.006 mg/L	ND	ND	ND	0.008 mg/L	0.066 mg/L	0.008 mg/L	0.01 mg/L
Solids, Sus-pended	8.0mg/L	4.0mg/L	7.0mg/L	6.0mg/L	5.0mg/L	NA	7.0mg/L	4.0mg/L	8.0 mg/L	7.0 mg/L	5.0 mg/L	24.0 mg/L
Solids, Total	240mg/L	321mg/L	251mg/L	170mg/L	282mg/L	NA	151mg/L	132mg/L	186 mg/L	287 mg/L	220 mg/L	254 mg/L
Solids, Dissolved	220mg/L	298mg/L	229mg/L	157mg/L	254mg/L	NA	126mg/L	115mg/L	164 mg/L	267 mg/L	201 mg/L	221 mg/L
Nitrogen-Ammonia	0.3mg/L	<0.1mg/L	0.1mg/L	0.1mg/L	1.5mg/L	0.1mg/L	0.1mg/L	0.01mg/L	0.1 mg/L	0.1 mg/L	0.3 mg/L	0.2 mg/L
TKN	1.0mg/L	0.2mg/L	0.6mg/L	0.3mg/L	2.9mg/L	0.3mg/L	0.3mg/L	0.1mg/L	0.4 mg/L	1.3 mg/L	0.8 mg/L	0.9 mg/L
Phospho-rus, Total	0.06mg/L	0.03mg/L	0.03mg/L	0.03mg/L	0.34mg/L	0.03mg/L	0.03mg/L	0.03mg/L	0.05 mg/L	0.36 mg/L	0.12 mg/L	0.06 mg/L
Conduc-tivity	383 us/cm	477 us/cm	361 us/cm	262 us/cm	412 us/cm	222 us/cm	141 us/cm	201 us/cm	NA	455 us/cm	369 us/cm	379 us/cm
Dissolved Oxygen	2.54 mg/L	9.02 mg/L	12.15 mg/L	13.93 mg/L	14.70 mg/L	14.78 mg/L	11.18 mg/L	8.78 mg/L	6.52 mg/L	3.11 mg/L	2.70 mg/L	2.86 mg/L
Flow	0 ft/sec	0.1ft/sec	0.5ft/sec	2.963 ft/sec	1.2ft/sec	1.4ft/sec	2.5ft/sec	1.0ft/sec	0.5 ft/sec	0.0 ft/sec	0.3 ft/sec	0.3 ft/.sec
pH	7.12 su	6.48 su	6.86 su	7.05 su	7.25 su	6.63 su	6.73 su	6.68 su	7.14 su	6.88 su	6.62 su	6.46 su
TDS (Done in Field)	196ppm	236ppm	182ppm	125ppm	207ppm	110ppm						
Tempera-ture	21.9C	7.2C	3.4C	1.2C	0.9C	0.3C	7.8C	10.2C	16.9 C	20.9 C	23.0 C	20.1 C
Turbidity	3.99NTU	1.60NTU	12.60NTU	6.70NTU	3.46NTU	15.2NTU	12.60NTU	1.60NTU	6.80NTU	5.78NTU	4.70NTU	12.3NTU

Site 8 Bridge on Elrod Road

Date	9/26/07	10/30/07	11/28/07	12/18/07	1/28/08	2/27/08	4/2/08	4/30/08	5/28/08	6/24/08	7/30/08	8/27/08
E. coli	No Water due to drought	<1 MPN	115.3 MPN	117.8 MPN	14.6 MPN	90.6 MPN	42.8 MPN	23.1 MPN	549.2 MPN	131.3 MPN	272.3 MPN	15.1 MPN
Nitrate		0.78 mg/L	1.74 mg/L	0.01 mg/L	1.58 mg/L	1.26 mg/L	0.81 mg/L	0.08 mg/L	0.61 mg/L	0.29 mg/L	0.08 mg/L	0.02 mg/l
Nitrite		0.005 mg/L	ND	0.00 mg/L	ND	ND	ND	ND	0.004 mg/L	0.004 mg/L	0.004 mg/L	0.004 mg/L
Solids, Sus-pended		4.0 mg/L	4.0 mg/L	4.0mg/L	4.0mg/L	NA	8.0mg/L	4.0mg/L	5.0 mg/L	4.0 mg/L	4.0 mg/L	9.0 mg/L
Solids, Total		146mg/L	182mg/L	132mg/L	177mg/L	NA	125mg/L	202mg/L	128 mg/L	147 mg/L	152 mg/L	163 mg/L
Solids, Dissolved		187 mg/L	167 mg/L	123 mg/L	161 mg/L	NA	104 mg/L	178 mg/L	116 mg/L	142 mg/L	140 mg/L	151 mg/L
Nitrogen-Ammonia		<0.1 mg/L	0.1 mg/L	0.1 mg/L	0.1 mg/L	0.1 mg/L	0.1 mg/L	0.1 mg/L	0.1 mg/L	0.1 mg/L	0.1 mg/L	0.1 mg/L
TKN		0.2 mg/L	0.3 mg/L	0.2 mg/L	0.1 mg/L	0.3 mg/L	0.2 mg/L	0.1 mg/L	0.2 mg/L	0.2 mg/L	0.2 mg/L	0.4 mg/L
Phospho-rus, Total		0.03 mg/L	0.03 mg/L	0.03 mg/L	0.03 mg/L	0.03 mg/L	0.03 mg/L	0.03 mg/L	0.03 mg/L	0.03 mg/L	0.03 mg/L	0.03 mg/L
Conduc-tivity		294 us/cm	288 us/cm	183 us/cm	221 us/cm	162 us/cm	109 us/cm	321 us/cm	186 us/cm	218 us/cm	225 us/cm	239 us/cm
Dissolved Oxygen		10.24 mg/L	12.38 mg/L	13.90 mg/L	14.99 mg/L	14.54 mg/L	11.09 mg/L	9.70 mg/L	6.48 mg/L	4.93 mg/L	4.52 mg/L	3.99 mg/L
Flow		0.2ft/sec	0.7ft/sec	2.449 ft/sec	0.9ft/sec	1.6ft/sec	1.5ft/sec	1.0ft/sec	0.5ft/sec	1.0ft/sec	0.3ft/sec	0.3 ft/sec
pH		6.58 su	6.28 su	7.05 su	6.68 su	6.43 su	6.48 su	6.50 su	6.89 su	6.76 su	6.57 su	6.42 su
TDS (Done in Field)		146ppm	136ppm	96ppm	111ppm	81ppm						
Tempera-ture		6.9C	3.4C	2.0C	0.1C	0.7C	8.1C	8.0C	16.4 C	19.9 C	22.9 C	20.8 C
Turbidity		2.75NTU	2.95NTU	5.10NTU	4.23NTU	13.6NTU	11.80NTU	1.69NTU	3.30NTU	2.32NTU	4.33NTU	2.86NTU

Site 9 Intersection of Prall Hill & Haddox (Henryville)												
Date	**9/26/07**	**10/30/07**	**11/28/07**	**12/18/07**	**1/28/08**	**2/27/08**	**4/2/08**	**4/30/08**	**5/28/08**	**6/24/08**	**7/30/08**	**8/27/08**
E. coli	456.9 MPN	11.3 MPN	436.0 MPN	193.5 MPN	157.6 MPN	14.5 MPN	14.8 MPN	74.9 MPN	437.4 MPN	298.7 MPN	913.9 MPN	10.0 MPN
Nitrate	0.04mg/L	0.50mg/L	1.06mg/L	0.84mg/L	0.80mg/L	0.58mg/L	0.31mg/L	0.08mg/L	0.41 mg/L	0.15 mg/L	0.08mg/L	0.01 mg/L
Nitrite	ND	ND	ND	ND	ND	ND	ND	0.004 mg/L	0.006 mg/L	0.004 mg/L	0.004 mg/L	0.004 mg/L
Solids, Sus-pended	4.0mg/L	4.0mg/L	6.0mg/L	4.0mg/L	4.0mg/L	NA	5.0mg/L	4.0mg/L	13.0mg/L	4.0mg/L	4.0mg/L	4.0 mg/L
Solids, Total	334mg/L	322mg/L	236mg/L	156mg/L	264mg/L	NA	140mg/L	202mg/L	181mg/L	274mg/L	285mg/L	291 mg/L
Solids, Dissolved	309mg/L	300mg/L	217mg/L	145mg/L	257mg/L	NA	122mg/L	178mg/L	161mg/L	274mg/L	267mg/L	282 mg/L
Nitrogen-Ammonia	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	NA	0.2mg/L	0.1 mg/L
TKN	0.3mg/L	0.2mg/L	0.4mg/L	0.3mg/L	0.1mg/L	0.4mg/L	0.2mg/L	0.1mg/L	0.5mg/L	NA	0.5mg/L	0.3 mg/L
Phospho-rus, Total	0.03mg/L	0.03mg/L	0.03mg/L	0.03mg/L	0.03mg/L	0.04mg/L	0.03mg/L	0.03mg/L	0.04mg/L	NA	0.03mg/L	0.03 mg/l
Conduc-tivity	512 us/cm	465 us/cm	365 us/cm	229 us/cm	370 us/cm	217 us/cm	131 us/cm	321 us/cm	255 us/cm	448 us/cm	462 us/cm	449 us/cm
Dissolved Oxygen	2.54 mg/L	8.46 mg/L	12.80 mg/L	14.40 mg/L	14.45 mg/L	15.32 mg/L	11.06 mg/L	9.70 mg/L	7.96 mg/L	3.04 mg/L	3.89 mg/L	4.32 mg/L
Flow	0.5 ft/sec	0.1ft/sec	0.3ft/sec	1.525 ft/sec	0.3ft/sec	1.6ft/sec	2.5ft/sec	1.0ft/sec	1.0 mg/L	1.0 mg/L	0.6 mg/L	0.1 ft/sec
pH	7.1 su	6.77 su	6.39 su	6.86 su	6.51 su	6.69 su	6.70 su	6.50su	7.02 su	6.52 su	6.88 su	6.57 su
TDS (Done in Field)	256ppm	233ppm	178ppm	114ppm	197ppm	108ppm						
Tempera-ture	21.6C	6.8C	3.2C	0.4C	0.3C	0.2C	7.5C	8.0C	15.6 C	19.9 C	23.3 C	20.4 C
Turbidity	3.99NTU	2.00NTU	10.51NTU	6.10NTU	1.19NTU	13.5NTU	13.70NTU	1.69NTU	14.8NTU	0.93NTU	2.88NTU	0.60NTU

Site 10 Hebron Church Road East of State Road 31

Date	9/26/07	10/30/07	11/28/07	12/18/07	1/28/08	2/27/08	4/2/08	4/30/08	5/28/08	6/24/08	7/30/08	8/27/08
E. coli	330 MPN	<1 MPN	316.9 MPN	601.5 MPN	151.0 MPN	90.6 MPN	24.9 MPN	91.0 MPN	1011.1 MPN	178.9 MPN	172.5 MPN	7.1 MPN
Nitrate	0.13mg/L	0.62mg/L	1.08mg/L	0.63mg/L	1.10mg/L	0.49mg/L	0.22mg/L	ND	0.22 mg/L	0.02 mg/L	0.03 mg/L	0.06 mg/L
Nitrite	0.031 mg/L	ND	ND	ND	0.015 mg/L	ND	ND	ND	0.004 mg/L	0.004 mg/L	0.004 mg/L	0.004 mg/L
Solids, Suspended	9.0mg/L	4.0mg/L	4.0mg/L	4.0mg/L	4.0mg/L	NA	5.0mg/L	5.0mg/L	24.0mg/L	5 mg/L	7 mg/L	9 mg/L
Solids, Total	287mg/L	247mg/L	226mg/L	138mg/L	242mg/L	NA	132mg/L	200mg/L	209mg/L	199mg/L	231 mg/L	244 mg/L
Solids, Dissolved	259mg/L	229mg/L	211mg/L	130mg/L	235mg/L	NA	115mg/L	178mg/L	171mg/L	186mg/L	209mg/L	220 mg/L
Nitrogen-Ammonia	0.04mg/L	<0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1mg/L	0.1 mg/L
TKN	1.1mg/L	0.2mg/L	0.3mg/L	0.3mg/L	0.1mg/L	0.3mg/L	0.3mg/L	0.2mg/L	0.6mg/L	0.4mg/L	0.5mg/L	0.6 mg/L
Phosphorus, Total	0.05mg/L	0.03mg/L	0.04mg/L	0.03mg/L	0.03mg/L	0.03mg/L	0.03mg/L	0.03mg/L	0.08mg/L	0.03mg/L	0.03mg/L	0.04 mg/L
Conductivity	625 us/cm	381 us/cm	No reading	228 us/cm	330 us/cm	193 us/cm	128 us/cm	321 us/cm	275 us/cm	336 us/cm	554 us/cm	394 us/cm
Dissolved Oxygen	6.01 mg/L	10.92 mg/L	13.49 mg/L	14.46 mg/L	14.59 mg/L	15.33 mg/L	11.68 mg/L	9.97 mg/L	7.60 mg/L	3.91 mg/L	4.12 mg/L	3.35 mg/L
Flow	0.0 ft/sec	0.2ft/sec	0.3ft/sec	0.47 ft/sec	1.0ft/sec	0.9ft/sec	3.0ft/sec	0.0ft/sec	1.0ft/sec	0.0ft/sec	0.3ft/sec	0.3 ft/sec
pH	7.92 su	6.64 su	7.14 su	6.38 su	6.39 su	6.86 su	6.70 su	6.52 su	6.14 su	6.00 su	6.33 su	6.17 su
TDS (Done in Field)	310ppm	191ppm	192ppm	103ppm	170ppm	96ppm						
Temperature	23.8C	6.5C	3.5C	0.8C	0.2C	0.7C	7.3C	7.3C	14.8 C	19.3 C	24.4 C	19.0 C
Turbidity	5.93NTU	0.85NTU	4.13NTU	5.15NTU	1.59NTU	17.0NTU	11.60NTU	2.37NTU	33.00NTU	3.02NTU	4.95NTU	2.49NTU

Data from WQ test performed by Richard Schultz with the University of Louisville Environmental Analysis Lab June 21, 2008						
	Loop Island Below	**Stantec Site 1**	**Stantec Site 2**	**Stantec Site 3**	**Stantec Site 4**	**Stantec Site 5**
Nitrate + Nitrite NO3 + NO2 (mg/L)	1.066	1.211	1.112	1.192	1.108	0.117
Nitrogen-Ammonia NH3 (mg/L)	0.151.	0.056	0.088	0.022	0.104	0.361
Total Nitrogen TN (mg/L)	1.642	1.691.	1.576	1.584	1.504	1.479
Orthophosphate SRP (mg/L)	0.019	0.051	0.012	0.017	0.008	0.007
Total Phosphate TP (mg/L)	0.096	0.105	0.046	0.059	0.31	0.054
Silicon Dioxide SiO2 (mg/L)	7.17	7.22	7.49	8.76	8.09	4.74
Chloride Cl (mg/L)	36.18	28.17	72.61	90.53	16.14	9.68
Dissolved Organic Carbon DOC (mg/L)	4.18	4.69	4.27	3.16	4.41	6.09
Chlorophyll a (ug/L)	1.428	3.436	0.955	0.403	0.748	5.082
Pheophytin a (ug/L)	1.271	1.66	0.576	0.326	0.29	1.113
Temperature (degrees Centigrade)	20.7	22.4	22.4	18.1	22.6	23.4
Turbidity (NTU)	15.2	9.8	10.3	12.4	8.6	9.2
pH (su)	6.67	7.13	6.65	6.56	6.62	6.81
Dissolved Oxygen (mg/L)	7.89	8.21	4.79	7.65	5.27	4.28
% Saturation of Oxygen (%)	88.2	94.3	54.9	81.7	60.8	50.5
Specific Conductivity (us/cm)	483	441	684	1042	334	419
Total Dissolved Solids TDS (mg/L)	317	277	410	769	212	275
Total Suspended Solids TSS (mg/L)	34.2	15.9	17.2	31.8	9.1	9.9
Total Solids TS (mg/L)	353	294	429	773	222	285

Data from WQ test performed by Richard Schultz with the University of Louisville Environmental Analysis Lab October 10, 2008												
	Loop Island Above	**Loop Island Below**	**Stantec Site 1**	**Stantec Site 2**	**Stantec Site 3**	**Stantec Site 4**	**Stantec Site 5**	**Stantec Site 6**	**Stantec Site 7**	**Stantec Site 8**	**Stantec Site 9**	**Stantec Site 10**
Nitrate + Nitrite NO3 + NO2 (mg/L)	0.024	0.101	0.146	0.256	0.457	0.021	0.032	<0.015	0.037	<0.015	0.028	0.248
Nitrogen-Ammonia NH3 (mg/L)	0.066	0.041	0.061	0.074	0.018	0.141	0.318	0.238	0.068	0.048	0.019	0.069
Total Nitrogen TN (mg/L)	0.542	0.864	1.058	0.976	0.742	1.713	1.635	1.428	0.642	0.585	0.326	1.018
Orthophosphate SRP (mg/L)	0.026	0.025	0.079	0.009	0.012	0.011	0.012	0.012	0.011	0.006	0.009	0.009
Total Phosphate TP (mg/L)	0.051	0.049	0.158	0.014	0.021	0.071	0.045	0.053	0.017	0.008	0.019	0.033
Silicon Dioxide SiO2 (mg/L)	4.65	4.72	6.48	7.11	10.53	9.04	7.88	9.28	7.43	8.46	8.01	8.27
Chloride Cl (mg/L)	44.98	45.81	58.66	146.09	86.42	17.66	7.25	8.02	20.59	10.84	37.62	19.83
Dissolved Organic Carbon DOC (mg/L)	6.61	6.01	6.93	5.62	4.99	8.24	8.53	7.89	4.59	3.74	5.26	5.37
Chlorophyll a (ug/L)	0.425	2.193	17.875	6.645	0.287	28.811	3.844	7.435	0.681	0.475	2.164	11.369
Pheophytin a (ug/L)	0.889	1.071	6.601	1.967	0.342	4.083	2.897	2.98	0.438	0.283	0.386	2.788
Temperature (degrees Centigrade)	18.3	17.2	18.3	17.8	16.8	18.2	20.4	18.5	17.4	19.6	18.1	17.1
Turbidity (NTU)	3.4	4.5	8.6	3.6	3.2	5.1	16.3	6.8	3.9	3.4	3.9	2.6
pH (su)	7.13	7.22	7.33	6.78	7.11	6.54	6.94	6.68	6.41	6.46	6.89	6.31
Dissolved Oxygen (mg/L)	7.36	8.46	8.81	5.65	5.52	3.75	5.43	6.39	5.65	6.75	7.49	4.81
% Saturation of Oxygen (%)	78.3	87.1	92.9	58.8	56.5	39.9	59.4	68.8	59.1	73.2	79.8	50.2
Specific Conductivity (us/cm)	505	508	598	1117	1107	349	351	283	366	252	525	405
Total Dissolved Solids TDS (mg/L)	353	354	368	659	689	226	236	198	224	154	321	257
Total Suspended Solids TSS (mg/L)	4.1	5.8	10.2	4.1	3.1	5.6	19.7	10.2	2.5	<1.0	1.9	1.4
Total Solids TS (mg/L)	359	363	380	664	694	232	257	209	228	155	323	258

Appendix V

Monitoring Site Photos

Site 1

Upstream **Downstream**

Site 2

Upstream **Downstream**

Upstream

Site 3

Downstream

Site 4

Up Stream **Down Stream**

Site 5

Upstream **Downstream**

Site 6

Upstream **Downstream**

Site 7

Up Stream

Down Stream

Site 8

Upstream

Downstream

Site 9

Upstream

Downstream


Site 10

Up Stream **Down Stream**


Below Loop Island

Upstream **Downstream**

APPENDIX VI

Fish Advisories

Fish Consumption Advisories

The fish consumption advisory is a very important document for people who consume fish from Silver Creek and the Ohio River. The advisory for both waterbodies are included, because there is the potential of fish from the Ohio entering Silver Creek at its mouth.

The Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the Indiana State Department of Health have come together to create the Indiana Fish Advisory since 1972. Fish may take in contaminants from the water they live in and the food they eat. These contaminants may build up in fish over time. Eating the contaminated fish could harm humans. The advisory should be used as a guide to reduce the risk of eating contaminated fish. The advisory is based on levels of Polychlorinated Biphenyls (PCBs) and Mercury found in fish tissue. Criteria for placing fish on the Indiana Fish Consumption Advisory are developed using the Great Lakes Task Force risk-based approach. Fish are tested regularly only in areas where there is suspected contamination. In each area, samples were taken of bottom-feeding fish, top-feeding fish, and fish feeding in between.

Advisories are issued to protect the most sensitive populations from adverse health effects. At-risk populations include children under 15, pregnant or nursing women, and those women planning to have children within six years.

Polychlorinated Biphenyls (PCBs)

PCBs are a group of 200 man-made chemicals. They are oily liquids or solids, clear to yellow in color, with no smell or taste. Due to the health effects associated with PCBs, the EPA banned all uses in 1979. Because these contaminants were used so widely and take a long time to break down, they can be found everywhere. PCBs have been released into the environment through spills, leaks from electrical and other equipment, and improper disposal and storage. After PCBs enter the environment, they are persistent and can travel long distances. PCBs bind tightly to sediments, thereby contaminating water bodies. Fish get them into their bodies from living in water with contaminated sediment and by eating contaminated food, including smaller fish. PCBs build up in the fatty tissues of fish.

PCBs are easily absorbed by the body and are stored in fatty tissue. They are eliminated slowly from the body, and it can take many years for them to be completely eliminated after exposure. They can build up in the body over time since they are not eliminated well.

Removing the skin and fat from fish filets will help reduce PCB intake. Grilling, broiling or baking the fish on an elevated rack that allows the fat to drip away (instead of frying) also helps.

Swimming in water where PCBs are found will result in minimal exposure, because they are not very soluble in water and tend to bind tightly to the sediment.

Mercury

Mercury is found in the environment because of natural and human activities. Mercury gets into water bodies in several ways, including rain and runoff. It stays in the environment for a long time. When moving through the environment, mercury goes through a series of complex changes. Through these changes in lake and river sediments, an organic form of mercury – methyl mercury – is created. Methyl mercury is very persistent in the environment and moves up the food chain to predator species. It can accumulate in people who eat these predator species.

If methyl mercury is ingested, most of it is absorbed through the gastrointestinal tract into the bloodstream where it is rapidly carried to other parts of the body. It takes about 70 days for half of the mercury that entered the body to be removed. The remaining mercury is slowly removed from the body over several months.

Methyl mercury is stored in the muscle of the fish, the part of the fish people eat. Removing the skin and the fat from the fish will not reduce the mercury intake.

Swimming or accidental swallowing of the water will result in only minimal exposure to methyl mercury.

2007 FISH CONSUMPTION ADVISORY

Group 1 = Unlimited meals (at risk population – limit to 1 meal per week)*
Group 2 = 1 meal per week (at risk population – limit to 1 meal per month)*
Group 3 = 1 meal per month (at risk population - **DO NO EAT)***
Group 4 = 1 meal every 2 months (at risk population - **DO NOT EAT)***
Group 5 = DO NOT EAT

*At risk populations include children under 15, pregnant or nursing women, and those women planning to have children within six years.

All Indiana Rivers and Streams (unless otherwise specified) due to PCBs
Carp 15-20 inches are group 3
Carp 20-25 inches are group 4
Carp 25+ inches are group 5

Silver Creek

Species	Fish Size	Contaminant	Group
Carp	21-25	PCB	3
Carp	25+	PCB	4
Channel Catfish	Up to 10	PCB	1
Freshwater Drum	18+	PCB	3
Longear Sunfish	Up to 5	PCB	1

Ohio River

Species	Fish Size (inches)	Contaminant	Group
Carp	Up to 33	PCB	3
Carp	33+	PCB	4
Channel Catfish	14-19	PCB	3
Channel Catfish	19-26	PCB	4
Channel Catfish	26+	PCB	5
Flathead Catfish	17-23	PCB	3
Flathead Catfish	23+	PCB	4
Freshwater Drum	>13	PCB	3
Largemouth Bass	13+	PCB	3
Paddlefish*	ALL	PCB	3
Sauger/Walleye/Saugeye	13-17	PCB	3
Sauger/Walleye/Saugeye	>17	PCB	4
Smallmouth Bass	13-15	PCB	4
Smallmouth Bass	15+	PCB	5
Spotted Bass	13+	PCB	3
White/Striped/Hybrid Bass	10-20	PCB	3
White/Striped/Hybrid Bass	20+	PCB	4

*Paddlefish has been added as a precaution due to elevated levels of PCBs that have been noted in preliminary tissue and egg samples.

APPENDIX VII

NPDES Report

NPDES Violation Report Summary

The following data is a summary of the violation report for the NPDES facilities in the Silver Creek Watershed from 2001 through 2007. Only the exceedences have been listed in this summary.

HENRYVILLE REST AREA SOUTH I65 – IN0059439
(Effective)

BOD, carbonaceous, 05 day, 20C - August 2005

E. coli - April 2003 through May 2006

Oxygen, dissolved (DO) – April through August of 2003

Solids, total suspended – January 2002 through November 2005

HENRYVILLE REST AREA NORTH I65 – IN0038555
(Effective)

E. coli – April 2003 through July 2007

Nitrogen, ammonia total (as N) – May 2007 through November 2007

Oxygen, dissolved (DO) – April 2003 through August 2003
March 2006 through May 2006

Solids, total suspended – March 2002 through December 2005

HENRYVILLE CORRECTIONAL UNIT – IN0030155
(Effective)

E. coli - May, August, September 2007

Nitrogen, ammonia total (as N) – May 2001 through November 2006
August 2007

Solids, total suspended – July 2001 through September\ 2004
November 2005
August 2006
February through November 2007

Oxygen, dissolved (DO) – July 2001 though May 2002
October 2006

Chlorine, total residual – July 2201 through August 2002
August 2005
BOD, carbonaceous, 05 day, 20C – June 2001 through May 2002
September 2005

HENRYVILLE MEMBERSHIP SAN CORP – IN0035521
(Effective)

BOD, carbonaceous, 05 day, 20C – December 2002

Dilution factor – June 2004

HMSC-MEMPHIS WWTP – IN0061671
(Effective)

Nitrogen, ammonia total (as N) – January 2004 through June 2004

HAAS CABINET COMPANY – IN0051454
(Effective)

E. coli – June 2007

HITACHI CABLE INDIANA, IINC. – ING250040
(Effective)

pH – January 2001 through December 2002
September 2007

Temperature, water degrees Fahrenheit – May 2001
February 2002
January and April 2005

The following two facilities are not located in the watershed but they discharge to it.

CHARLESTOWN MUNICIPAL WWTP
(Effective)

BOD, carbonaceous, 05 day, 20C – January 2001 through August 2002

E. coli, colony forming units (CFU) – September & November 2004
November 2005
October 2007

Solids, suspended percent removal – January 2001 through August 2002

Solids, total suspended – January 2001 through August 2002
January 2007

ESSROC CEMENT CORP
(Effective)

pH – February, March, July, December 2001
April, July, December 2002
February, March, September 2003
January, February, December 2004
November 2005
February, March 2006
October 2007

Solids, total suspended – January 2001 through September 2003
January, May, August, October 2004
January, August, November 2005
June 2006 and February, June, & December 2007

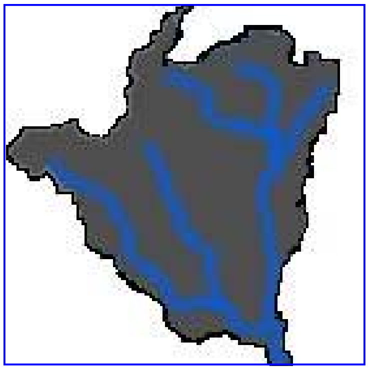
Flow, in conduit or thru treatment plant – January 2001
April 2002
January, May 2003
October 2007

Flow, total – December 2001
April 2002
January, May 2003
October 2007

Appendix VIII

Tables and Charts Depicting L-THIA Results

Table 18:   L-THIA Results for Subwatershed Miller Creek 051401010801

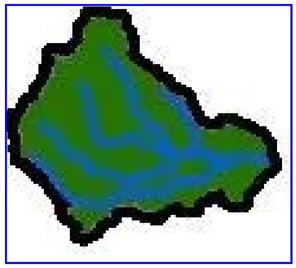


Land Use	Hydrologic Soil Group	Area (Acres)	Average Annual Runoff Volume (acre-ft)	Nitrogen (lbs/acres)	Phosphorus (lbs/acres)	Total Suspended Solids (lbs/acres)	Fecal coli-form (millions of coliform/ acres)
Agriculture	C	1228.4	761.63	9243	2730	224786	5462120
Commercial	C	70.9	121.32	448	107	18574	230925
Forest	C	7903.0	1941.62	3749	53	5355	107112
Grass/ Pasture	C	1962.8	641.87	1238	17	1770	35409
High-density Residential	C	532.6	628.17	3154	987	71040	3465406
Industrial	C	9.1	11.56	39.	8	1928	30928
Low-density Residential	C	219.2	116.98	586	184	13230	645352
Water/ Wetlands	C	95.6	0	0	0	0	0
Total Annual Volume (acre -ft) or Total (lbs)		12021.7	4223.15	18457.3	4086	336684	9977252

Table 19:
L-THIA Results for Subwatershed Headwaters-Silver Creek 051401010802

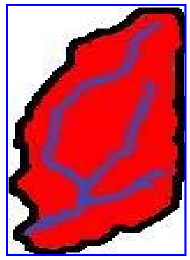
Land Use	Hydrologic Soil Group	Area (Acres)	Average Annual Runoff Volume (acre-ft)	Nitrogen (lbs/acre)	Phosphorus (lbs/acre)	Total Suspended Solids (lbs/acre)	Fecal coli-form (millions of coliform/ acres)
Agriculture	C	1701.1	1054.71	12800	3781	311286	7563979
Agriculture	D	175.3	133.82	1623	479	39498	959776
Commercial	C	11.3	19.33	71	16	2960	36801
Forest	C	10326.2	2536.94	4898	69	6997	139953
Forest	D	511.2	213.44	411	5	588	11775
Grass/ Pasture	C	2302.4	752.95	1453	20	2076	41537
Grass/ Pasture	D	103.0	55.00	106	1	151	3034
High-density Residential	C	529.7	624.79	3136	982	70658	3446742
High-density Residential	D	47.3	66.82	334	105	7558	368659
Industrial	C	3.2	4.02	13	3	671	10768
Low-density Residential	C	37.7	20.12	100	31	2275	111028
Low-density Residential	D	5.0	3.87	19	6	437	21356
Water/ Wetlands	C	64.5	0	0	0	0	0
Water/ Wetlands	D	0.9	0	0	0	0	0
Total Annual Volume (acre -ft) or Total (lbs)		15818.9	5485.8	24966	5499	445156	12715409

Table 20:
LTHIA Results for Subwatershed Blue Lick Creek 051401010803



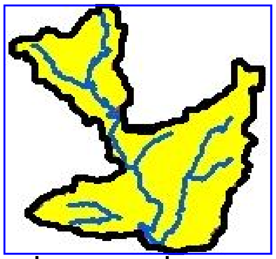
Land Use	Hydrologic Soil Group	Area (Acres)	Average Annual Runoff Volume (acre-ft)	Nitrogen (lbs/acres)	Phosphorus (lbs/acres)	Total Suspended Solids (lbs/acres)	Fecal coli-form (millions of coliform/ acres)
Agriculture	C	1490.3	923.71	11210	3312	272623	6624510
Commercial	C	16.5	28.19	103	24	4316	53665
Forest	B	369.1	24.81	48	1	68	1368
Forest	C	6521.0	1602.07	3093	44	4419	88380
Grass/ Pasture	B	6.3	0.74	1.2	0	1	41
Grass/ Pasture	C	1282.8	419.50	809	11	1156	23142
High-density Residential	B	1.01	0.79	3	1	89	4380
High-density Residential	C	275.4	324.77	1630	510	36728	1791653
Industrial	C	8.2	10.40	35	7	1733	27806
Low-density Residential	C	32.5	17.35	87	27	1963	95775
Water/ Wetlands	C	81.8	0	0	0	0	0
Total Annual Volume (acre -ft) or Total (lbs)		10085.0	3352.33	17020	3937	323097	8710720

Table 21:
L-THIA Results for Subwatershed Sinking Fork 051401010804



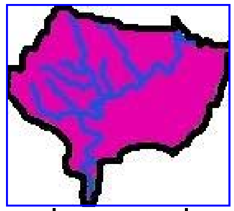
Land Use	Hydrologic Soil Group	Area (Acres)	Average Annual Runoff Volume (acre-ft)	Nitrogen (lbs/acre)	Phosphorus (lbs/acre)	Total Suspended Solids (lbs/acre)	Fecal coli-form (millions of coliform/ acre)
Agriculture	B	615.6	222.27	2697.	797	65603	1594104
Agriculture	C	3101.7	1923.05	23339	6895	567571	13791450
Agriculture	D	27.9	21.30	258	76	6289	152816
Commercial	C	4.9	8.37	31	7	1282	15946
Commercial	D	1.7	3.10	11	2	476	5926
Forest	B	180.0	12.09	23	0.3	33	667
Forest	C	7595.0	1865.93	3603	51	5146	102936
Forest	D	495.9	207.01	400	5	570	11420
Grass/Pasture	B	454.2	53.91	103	1	148	2974
Grass/Pasture	C	4136.1	1352.58	2611	37	3730	74617
Grass/Pasture	D	309.4	165.14	318	4	455	9110
High-density Residential	B	45.6	34.83	174	54	3939	192134
High-density Residential	C	740.8	873.61	4384	1373	98797	4819422
High-density Residential	D	78.2	110.34	553	173	12479	608774
Industrial	C	1.7	2.12	7	1	353	5680
Low-density Residential	B	1.2	0.30	1	0.5	34	1690
Low-density Residential	C	21.6	11.49	57	17	1300	63416
Low-density Residential	D	6.8	5.16	26	7	584	28518
Water/Wetlands	B	10.4	0	0	0	0	0
Water/Wetlands	C	127.4	0	0	0	0	0
Water/Wetlands	D	5.3	0	0	0	0	0
Total Annual Volume (acre-ft) or Total (lbs)		17961.3	6872.6	38596	9502	768789	21481600

Table 22:
L-THIA Results for Subwatershed Pleasant Run-Silver Creek 051401010805



Land Use	Hydro-logic Soil Group	Area (Acres)	Average Annual Runoff Volume (acre-ft)	Nitrogen (lbs/acre)	Phosphorus (lbs/acre)	Total Suspended Solids (lbs/acre)	Fecal coli-form (millions of coliform/ acre)
Agriculture	B	1779.7	642.55	7798	2303	189641	4608129
Agriculture	C	2459.1	1524.64	18504	5467	449984	10934186
Agriculture	D	73.2	55.85	677	200	16483	400538
Commercial	B	47.7	67.38	249	59	10316	128244
Commercial	C	317.1	542.66	2005	479	83074	1032817
Commercial	D	111.1	206.30	762	182	31582	392638
Forest	B	1965.0	132.09	254	3	364	7287
Forest	C	3758.1	923.28	1782	25	2547	50933
Forest	D	203.0	84.76	163	2	233	4675
Grass/Pasture	B	4269.1	506.70	978	13	1397	27953
Grass/Pasture	C	3536.2	1156.42	2232	31	3189	63795
Grass/Pasture	D	167.2	89.22	172	2	245	4921
High-density Residential	B	779.2	595.02	2987	935	67291	3282519
High-density Residential	C	1375.6	1622.41	8144	2550	183480	8950264
High-density Residential	D	231.5	326.96	1640	513	36976	1803717
Industrial	B	24.8	24.66	86	18	4115	65988
Industrial	C	124.1	156.57	544	120	26128	418927
Industrial	D	39.8	60.40	210	46	10080	161623
Low-density Residential	B	135.2	33.20	166	51	3755	183181
Low-density Residential	C	617.2	329.37	1653	518	37249	1817029
Low-density Residential	D	188.6	144.06	723	226	16292	794753
Water/Wetlands	B	34.4	0	0	0	0	0
Water/Wetlands	C	60.3	0	0	0	0	0
Water/Wetlands	D	3.6	0	0	0	0	0
Total Annual Volume (acre-ft) or Total (lbs)		22300.7	9224.50	51728	13744	1174421	35134116

Table 23:
L-THIA Results for Subwatershed Jacobs Creek-Silver Creek 051401010806



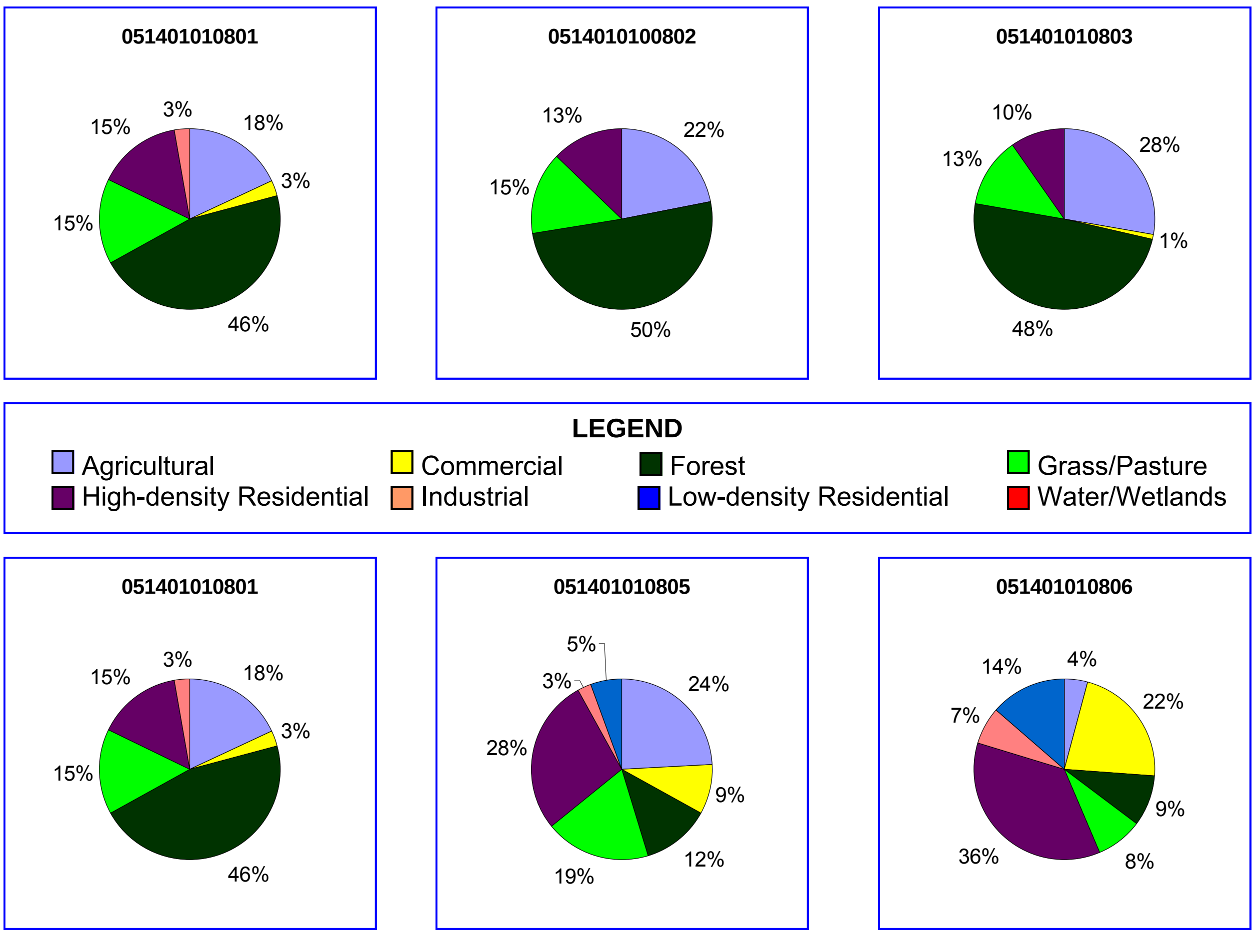
Land Use	Hydro-logic Soil Group	Area (Acres)	Average Annual Runoff Volume (acre-ft)	Nitrogen (lbs/acre)	Phosphorus (lbs/acre)	Total Suspended Solids (lbs/acre)	Fecal coli-form (millions of coliform/ acre)
Agriculture	B	318.7	115.06	1396	412	33960	825195
Agriculture	C	439.3	272.37	3305	976	80388	1953373
Agriculture	D	34.4	26.23	318	94	7744	188191
Commercial	B	804.6	1135.91	4198	1002	173894	2161931
Commercial	C	609.1	1042.46	3853	920	159587	1984057
Commercial	D	4.8	8.86	32	8	1357	16881
Forest	B	2313.4	155.52	300	4	428	8580
Forest	C	3166.6	777.96	1502	21	2145	42917
Forest	D	21.0	8.78	17	0.2	24	484
Grass/Pasture	B	1466.6	174.06	335	4	480	9602
Grass/Pasture	C	1992.3	651.53	1257	17	1797	35943
Grass/Pasture	D	12.3	6.55	12	0.2	17	361
High-density Residential	B	1689.3	1289.91	6475	2027	145877	7116005
High-density Residential	C	1933.4	2280.26	11447	3584	257877	12579406
High-density Residential	D	18.3	25.84	120	40	2922	142556
Industrial	B	411.9	409.91	1424	316	68407	1096773
Industrial	C	200.4	252.92	879	195	42207	676703
Industrial	D	0.1	0.10	0.3	0.1	17	275
Low-density Residential	B	1577.1	387.46	1945	608	43818	2137476
Low-density Residential	C	1823.2	973.00	4884	1529	110038	5367739
Low-density Residential	D	13.9	10.67	530	16	1205	58844
Water/Wetlands	B	237.8	0	0	0	0	0
Water/Wetlands	C	44.5	0	0	0	0	0
Total Annual Volume (acre-ft) or Total (lbs)		19133.0	10005.35	43761	11776	1134189	36403291

Runoff

The pie charts below illustrate the amount of runoff contributed by each land use in the individual subwatersheds.

Example: Subwatershed 051401010801 - 46% of the total runoff comes from forest land, 18% of total runoff comes from agricultural land, 15 % of the total runoff comes from grass/ pasture land, 15% of the total runoff comes from high-density residential, and 3% of the total runoff comes from both commercial and industrial land use.

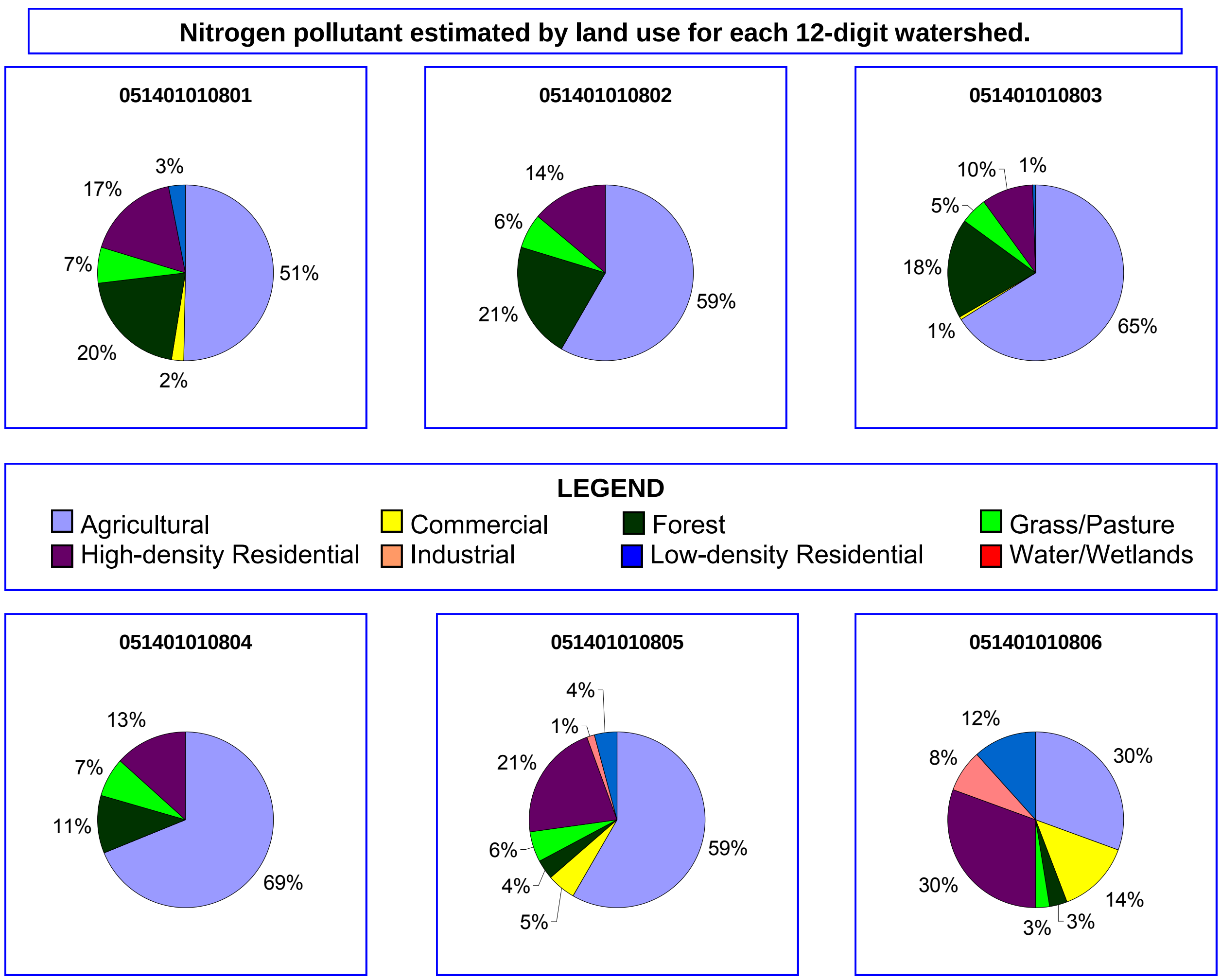
Runoff estimated by land use for each 12-digit watershed.



Nitrogen Load

The pie charts below illustrate the nitrogen load contributed by each land use in the individual subwatersheds.

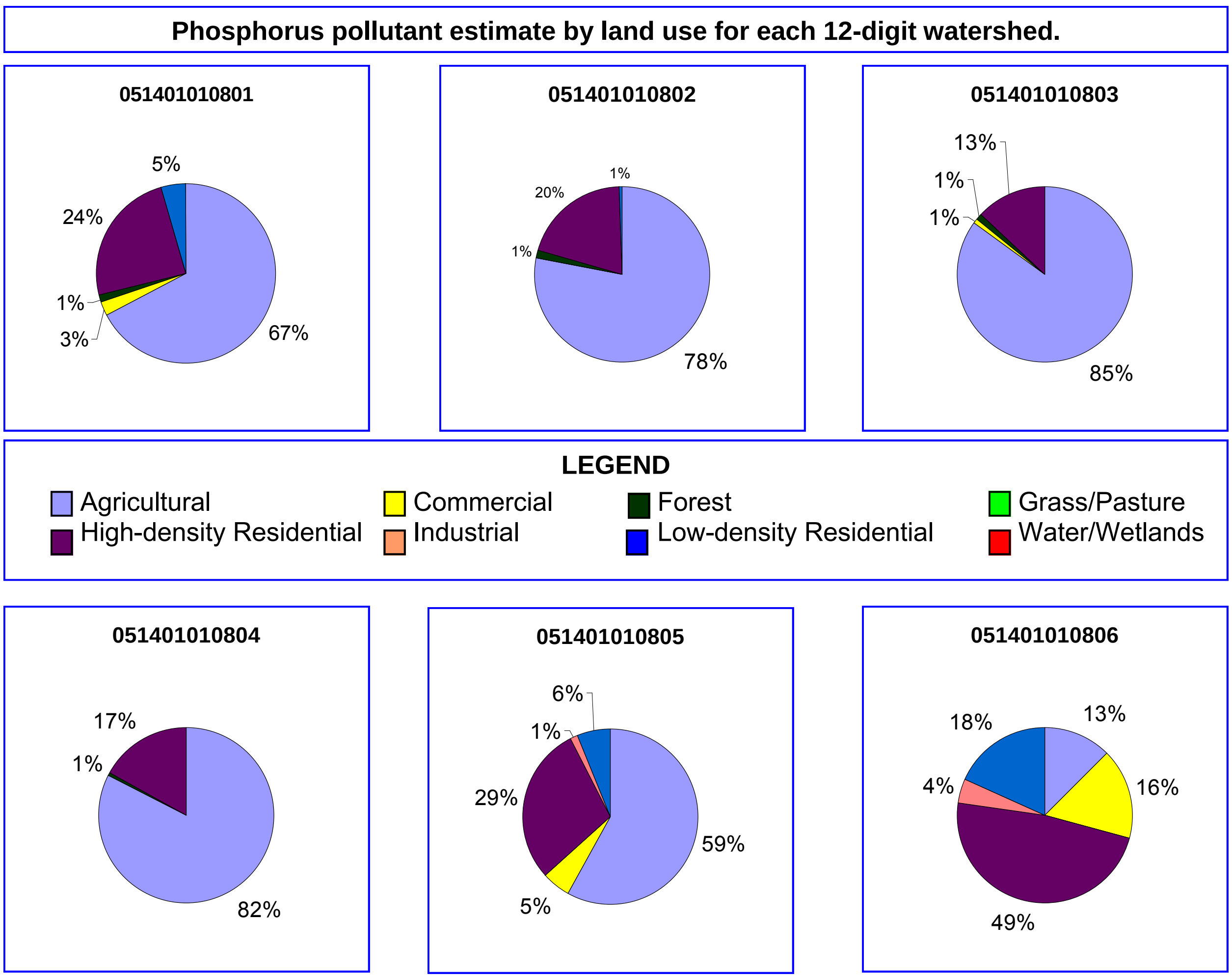
Example: Subwatershed 051401010801 - 51% of the total nitrogen load is contributed by agricultural land, 20% is contributed by forest land, 17% comes from high-density residential land, grass/pasture land contributes 7% of the total nitrogen load, 3% comes from low density residential land, and 2% of the total nitrogen load is produced by commercial land.



Phosphorus Load

The pie charts below illustrate the phosphorus load contributed by each land use in the individual subwatersheds.

Example: Subwatershed 051401010801 - The largest land use contributor to the phosphorus load is agricultural at 67%, high-density residential land contributes 24% of the total phosphorus load in this watershed, 5% of the total phosphorus load comes from low-density residential, commercial land contributes 3 % of the phosphorus load, while only 1% is contributed by forest land.



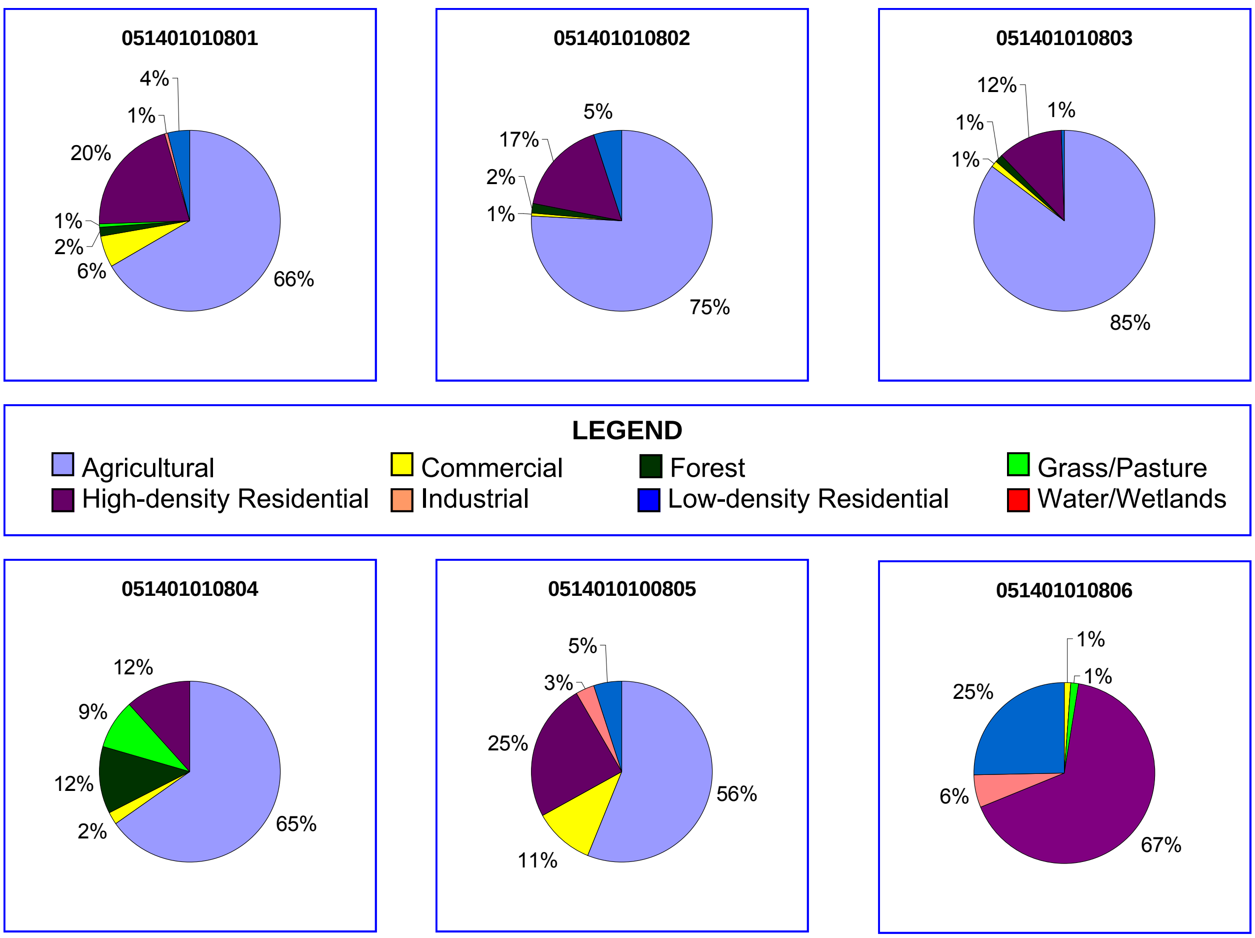
Suspended Solids Load

The pie charts below illustrate the suspended solids load contributed by each land use in the individual subwatersheds.

Example: In Subwatershed 051401010801 -

Agricultural contributes 66% of the total suspended solids load.
High Density Residential contributes 20% of the total suspended solids load.
Commercial contributes 6% of the total suspended solids load.
Low Density Residential contributes 4% of the total suspended solids load.
Forest contributes 2% of the total suspended solids load.
Industrial contributes 1% of the total suspended solids load.
Grass/Pasture contributes 1% of the total suspended solids load.

Suspended solid pollutant estimated by land use for each 12-digit watershed.

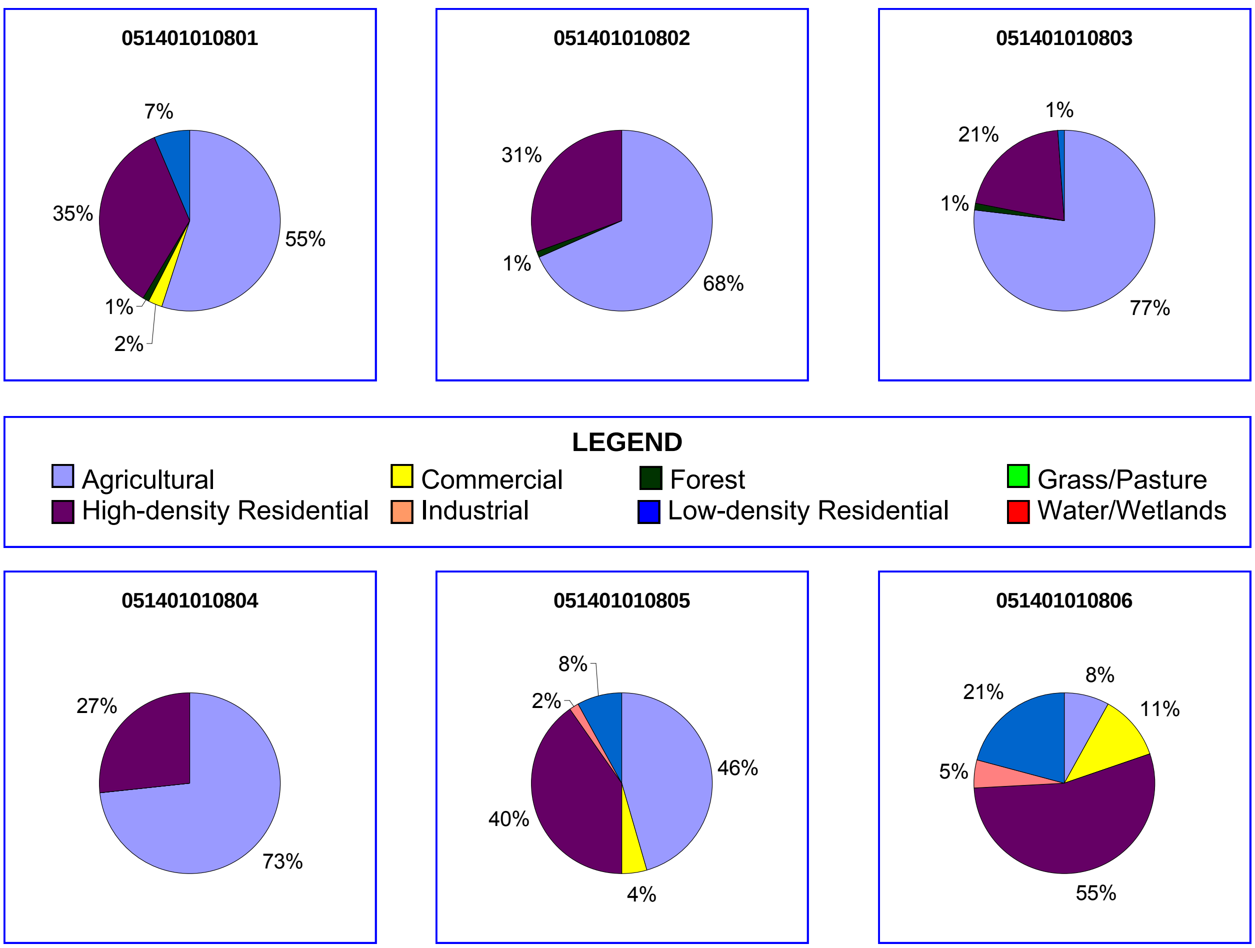


Fecal Coliform Loads

The pie charts below illustrate the fecal coliform load contributed by each land use in the individual subwatersheds. E. coli was the only type of fecal coliform that was collected during the monitoring phase of this project.

Example: In Subwatershed 051401010801, the largest contributor according to land use is agricultural at 55 % of the total fecal coliform load, 35% of the total fecal coliform load is contributed by high-density residential land use, 7 % is contributed by low-density residential land use, 2 % is contributed by commercial land, and 1% of the total fecal coliform load comes from forest land.

Fecal Coliform pollutant estimate by land use for each 12-digit watershed.



Appendix IX

Load Reduction Interpertations

Tables Used to Estimate Load Reductions

Table # contains the target loads for each subwatershed and the watershed as a whole. The "flow" was taken from L-THIA (converted acre-ft to liters) and multiplied by the target concentrations (NO3 - 1.2 mg/L; Total Phosphorus - 0.08 mg/L) and converted to lbs/year.

Conversion factors
1 acre foot = 1233481.8553 liters
1 lb. = 453592.37 milligrams
1 milligram = 0.0000022046226218 lbs.

Table # Target Loads

Subwatershed	Average Annual Runoff (acre-ft)	Average Annual Runoff (lbs)	Target NO3 Load (lb/yr)	Target Total Phosphorus (lb/yr)
051401010801	4223.15	5209178897	13781	919
051401010802	5485.8	6766634762	17901	1193
051401010803	3352.33	4135038228	10939	729
051401010804	6872.6	8477227399	22427	1495
051401010805	9224.5	11378253374	30102	2007
051401010806	10005.35	12341417681	32650	2177
Total	39163.73	48307750341	127800	8520

Table # contains the average and maximum concentrations for the sampling sites indicated. See Water Quality Data in Appendix IV page ##.

Table # Average and Maximum Loads for N)3 and Total Phosphorus (using data collected during project)

Subwatershed	Characterized by Sample site	NO3 Average (mg/L)	NO3 Maximum (mg/L)	Total Phosphorus Average (mg/L)	Total Phosphorus Maximum (mg/L)
051401010801	7	0.48	1.22	0.1	0.36
051401010802	8	0.66	1.74	0.03	0.03
051401010803	6	0.37	0.86	0.05	0.11
051401010804	5	0.92	2.2	0.06	0.14
051401010805	2	1.11	2.27	0.07	0.3
051401010806	1	1.14	2.6	0.06	0.09

Table # contains the estimated current load based on the average value and maximum value obtained from current water quality data.

Table # Current Load Based on Average Value and Maximum Value					
Subwatershed	**Average Annual Runoff (lbs/yr)**	**NO3 Average Load (lb/yr)**	**NO3 Maximum Load (lb/yr)**	**Total Phosphorus Average Load (lb/yr)**	**Total Phosphorus Maximum Load (lb/yr)**
051401010801	5209178897	5512	14011	1148	4134
051401010802	6766634762	9846	25957	448	448
051401010803	4135038228	3373	7840	456	1003
051401010804	8477227399	17194	41116	1121	2616
051401010805	11378253374	27844	56942	1756	7525
051401010806	12341417681	31017	70741	1632	2449
Total	48307750341	94787	216607	6562	18175

Table # contains the estimated load reductions needed to meet the target load. Reductions are calculated for the average and maximum scenarios, but almost no reductions are required when the average values are used.

Table # Reductions Needed to meet Target Load							
Sub-watershed	**Average Annual Runoff (lb/yr)**	**Target NO3 Load (lb/yr)**	**NO3 Reduction Needed (Average Load)**	**NO3 Reduction Needed (Maximum Load)**	**Target Total Phosphorus (lb/yr)**	**Total Phosphorus Reduction Needed (Average Load)**	**Total Phosphorus Reduction Needed (Maximum Load)**
051401010801	5209178897	13781	-8269	230	919	230	3216
051401010802	6766634762	17901	-8056	8056	1193	-746	-746
051401010803	4135038228	10939	-7566	-2999	729	-273	273
051401010804	8477227399	22427	-5233	18689	1495	-374	1121
051401010805	11378253374	30102	-2258	26841	2007	-251	5519
051401010806	12341417681	32650	-1632	38091	2177	-544	272
Total	48307750341	127800		91907	8520		10401

No reduction needed

References

"Facts about Illinois' (PCB) Advisory" Illinois fish Advisory – Illinois Department of Public Health. www.idph.state.il.us.

"Mercury Contamination in Fish" Natural Resources Defense Council. www.nrdc.org.

Chesapeake Bay and Mid-Atlantic from Space. >http://Chesapeake.townson.edu//andscape/ impervious>.

Clarksville Parks. http://wwclarksvilleparks.com/.

Deam, Charles C. M.A., DSC., LLD, Trees of Indiana. 1999.

Frankenberger,J., S.McLoud, and A. Faulkenburg. 2002 . Watershed Inventory Workbook for Indiana: A guide for watershed partnerships.

Friends of Five Creeks. >www.fivecreeks.org>.

Hoosier Riverwatch Volunteer Stream Monitoring Training Manual 2007

Indiana Agricultural Statistics Service. http://www.nass.usda.gov/in/.

Indiana Business Bulletin, Bureau of Business Research Ball State University. www.bsu.edu.

Indiana Department of Health. www.in.gov/isdh.

Interpreting Water Quality Data, British Columbia, Integrated Land Management Bureau. grande.nal.usda.gov/wqic/cig_bin/retrieve_wq_record.pl?rec_id=713.

Ipswich-Parker Suburban Watershed Channel. www.ipswatch.sr.unh.edu/index.html.

Kentucky Water. www.KYwater.org.

McLoud, Susan. Indiana Watershed Planning Guide. Mishawaka, IN: D.J. Case & Associates, 2003

Nagel, Byron G. and Marshall, Dena L. , Soil Survey of Clark County, Indiana, 2007.

Nickell, Allan, Soil Survey of Clark and Floyd Counties, Indiana 1974.

One Southern Indiana Chamber and Economic Development. www.lsi.org/utilties_water.asp.

South Central Indiana Economic Development. southcentralcape.org.

Stats-Indiana. www.stats.indiana.edu/population.

Target Science. www.lalc.k12ca.us/target.

References Continued

Tetra Tech, Inc., 1998. Getting In Step, A Guide for Conducting Watershed Outreach Campaigns.

Tetra Tech, Inc., Getting in Step, Engaging and Involving Stakeholders in Your Watershed.

"The Impervious Cover Model." Center for Watershed Protection. www.cwp.org.

United States, Environmental Protection Agency. Handbook for Developing Watershed Plans to Restore and Protect Our Waters. 2008

Ventura Stream Team. www.stream-team.org.

Wikipedia - free encyclopedia. http://enwikipedia.org.

Indiana Agricultural Statistics Service, U. S. Census of Agriculture, February 1999, http://www.nassiusda.gov.in

Water Well Web Viewer, www.in.gov/dnr/water/7062.htm.

www.answers.com

Conservation Partnership for Grazing, New England Small Farm Institute, Protect Water Quality in the Chicopee Basin www.smallfarm.org

Division of Agricultural Sciences and Natural Resources, Oklahoma State University/Stocking Rate: The Key to Successful Livestock Production - F- 2871. http://www.osuextra.com

New Hampshire Code of Administrative Rules Surface Water Regulations, www.des.nh.gov/factsheets/ws/ws-1-6 html

BASIN: General Information, http://bcn.boulder.co.us/basin/data/BACT/info/TSS.html

Colorado River Watch Network, http://www.lcra.org/water/quality/crwn/indicators.html

Environmental Protection Agency State of Ohio, “Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)”, June 2006

The Journal for Surface Water Quality Professionals; *Stormwater,* www.stormh2o.com/january-february-2002/evaluating-nitrogen-phosphorus-2.aspx.