Little Duck/Lilly Creek
Watershed Management Plan

EPA Clean Water Act Section 319 grant
ARN: A305-5-112
April 4, 2005 to December 3, 2007

Sponsored by the
Madison County Soil & Water Conservation District

Submitted to the
Indiana Department of Environmental Management
December 2007

Watershed Management Plan Prepared by:

Crist Blassaras
Watershed Coordinator
182 W. 300 N. Suite D
Anderson, IN 46012
crist.blassaras@in.nacdnet.net

TABLE OF CONTENTS

DOCUMENTATION FOLDERS SUPPORTING WMP:

1.0 INTRODUCTION

1.1 Mission Statement

The Lilly Creek and Little Duck Creek watershed community is a coalition of existing conservation groups, municipalities, agricultural communities, and concerned citizens dedicated to developing and implementing a successful watershed plan to protect, maintain, and enhance the ecosystems of the Lilly Creek, Pipe Creek, Little Duck Creek, and Big Duck Creeks.

1.2 Watershed Location

The Lilly Creek and Little Duck Creek watersheds include the two 14 digit hydrologic unit code (HUC) watersheds that drain Lilly Creek and Little Duck Creek. The Lilly Creek and Little Duck Creek watersheds encompass all of the two 14 digit watersheds including the Pipe Creek – Lilly Creek watershed (HUC 05120201050060) and the Duck Creek – Little Duck Creek watershed (HUC 05120201060020) within the Upper West Fork White River basin (HUC 05120201). The watersheds include nearly 22,672 acres or 35 square miles. Drainage from the Lilly Creek watershed flows into Lilly and Pipe Creeks, which combine at the downstream edge of the 14-digit watershed. Likewise, the Little Duck Creek watershed contains the entirety of the Little Duck Creek drainage; however, only a portion of the Big Duck Creek drainage is contained within this 14-digit watershed. Water drains from Lilly Creek to Pipe Creek and from Little Duck Creek to Big Duck Creek. Pipe Creek and Big Duck Creek both flow into the West Fork White River near Perkinsville and Strawtown respectively.

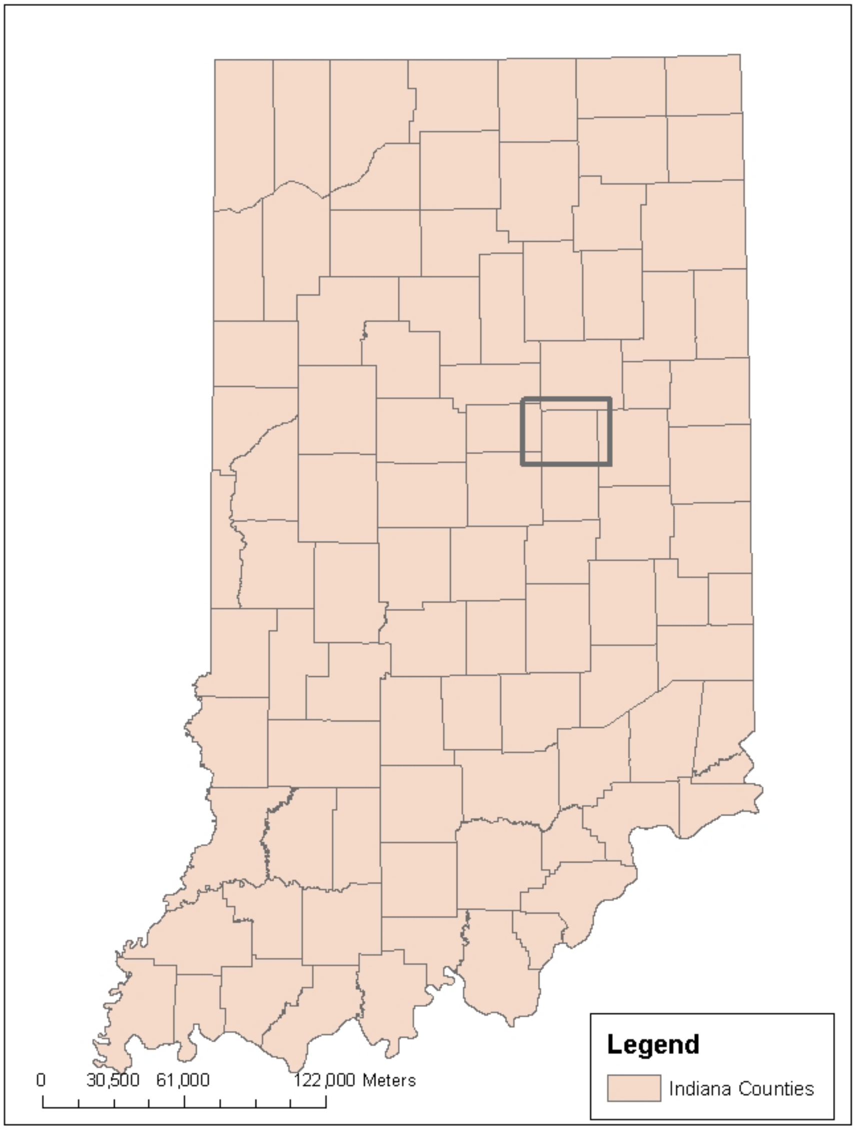


Figure 1 - Location of watersheds within Madison County.

The Lilly Creek and Little Duck Creek watersheds are located in primarily rural areas of Madison County. The City of Elwood (2000 population: 9,737) and the town of Orestes (2000 population: 334) are included in these watersheds. Overall population of both watersheds is approximately 12,278.

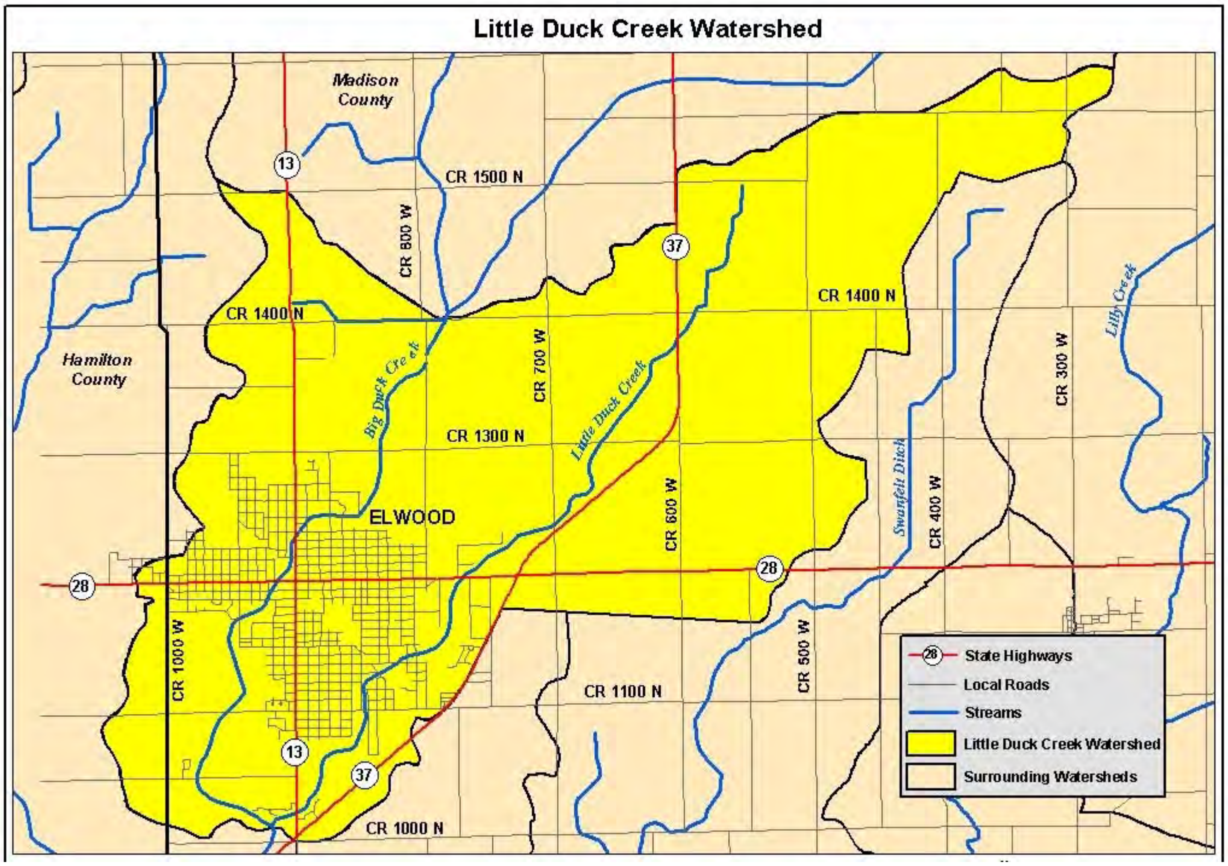


Figure 2 – Little Duck Creek Watershed.

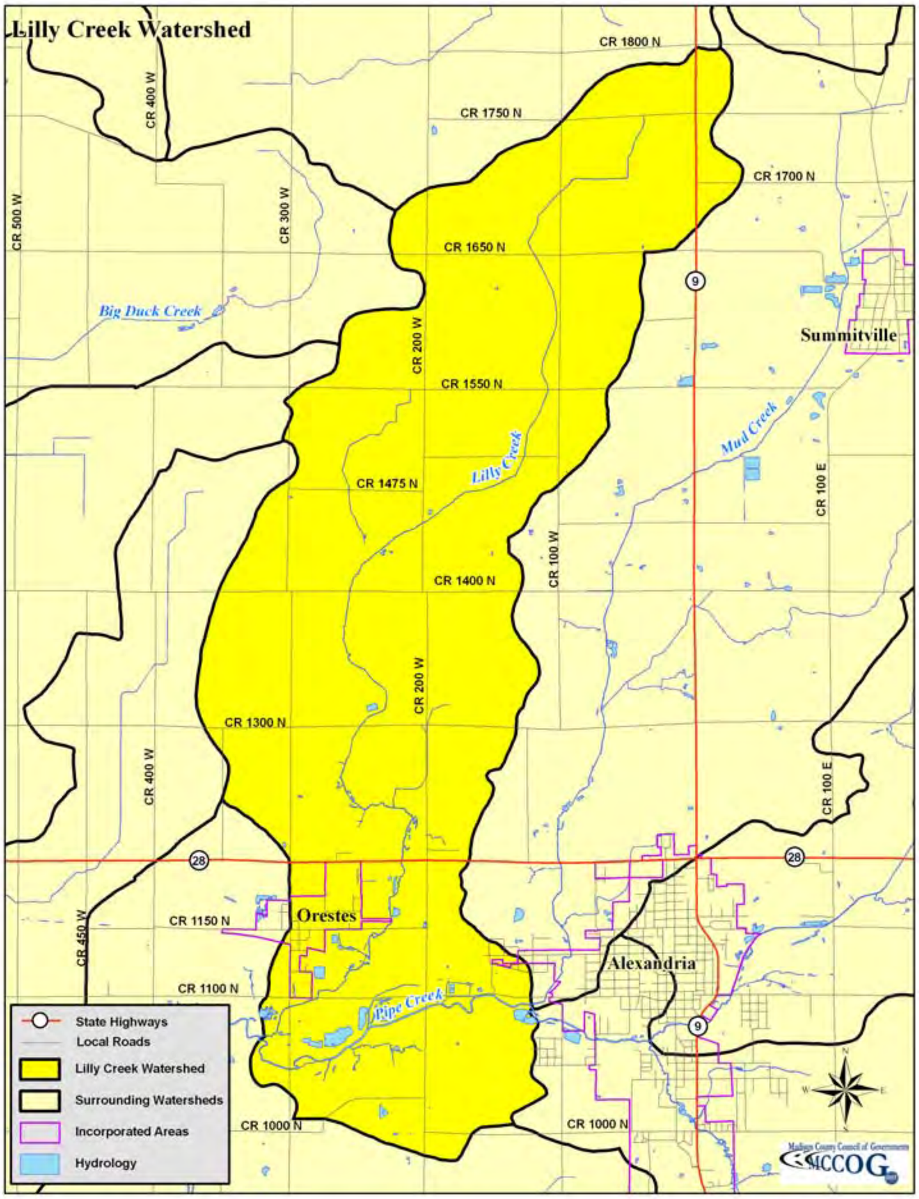


Figure 3 – Lilly Creek Watershed.

This project arose out of a desire by the Madison County Soil & Water Conservation District (SWCD) Board of Supervisors, SWCD staff, and the Swanfelt Watershed Steering Committee to undertake a targeted approach to improving water quality with the help of watershed stakeholders. The Lilly Creek and Little Duck Creek watersheds were chosen based on the following criteria:

- Watershed contains the headwaters of Little Duck Creek and Lilly Creek
- Watershed contains public wellheads
- Watershed contains 303 (d) listed streams
- Watershed is small in size but contains both urban and rural geography

This WMP documents the concerns watershed stakeholders have for the Lilly Creek and Little Duck Creek watersheds and describes the stakeholders' vision for these watersheds. It also outlines the goals, strategies, and action items watershed stakeholders have selected to achieve this vision. The plan concludes with methods for measuring progress toward goals and objectives outlined throughout the plan and time frames for periodic refinement of the plan.

1.3 Watershed Partnerships

To be effective, the preparation of any WMP should include full community participation. Support, direction, and insight from individuals, groups, and/or government agencies within the planning impact areas are essential for successful short-term and long-term watershed management planning and implementation. The Lilly Creek and Little Duck Creek WMP encouraged and provided opportunity for full community participation.

The planning process included meetings of the Steering Committee, public meetings, and availability of draft documents for review. Meeting and activity dates and notes were posted on the Madison County SWCD website. (www.madisonswcd.org)

NAME	AFFILIATION	SUBCOMMITTEE
Garland Antrim	SWCD Board Chairman/Farmer	
Crist Blassaras	SWCD Watershed Coordinator	BMP, Sampling
Greg Bohlander	IN Farm Bureau/Resident	BMP, Sampling
Jerry Bridges	Council of Governments	
Brandon Clidence	County Health Dept.	
Judy DeLury	White River Watchers	Inventory, Outreach, BMP, Editing, Sampling
Tammy Doty	City of Anderson – Urban Forester	
Vickie Griffin	Landowner	
Mary Harless	Resident – Elwood Schools	Outreach, Editing
Dan Ippolito	Anderson University	Inventory, Outreach, Sampling
Angie Martin	RQAW	Inventory, Editing
Glen Murray	Elwood Water Dept.	
Brad Newman	Madison County Surveyor	Inventory, BMP, Sampling
Janelle Parke	SWCD Executive Director	Outreach
Chad Pigg	City of Anderson Engineering	
Bill Savage	Elwood Economic Dev. Dir.	
John Shettle	Town of Orestes	Inventory, Sampling
Mike Shuter	Farmer/Landowner	
Curt Utterback	Resident/Red Gold	
Mike Washburn	Elwood Wastewater Treatment	
Shane Wingler	Red Gold	
Don Zalokar	Phillippe Water	Outreach
Rick Durham	Durham Engineering	
Rob Shumowsky	Council of Governments - GIS	

Table 1 – Steering Committee Members.

The Madison County SWCD was the sponsor for the WMP process. The SWCD applied for an Environmental Protection Agency Section 319 Clean Water Act grant in 2003. The SWCD was awarded the grant and received $96,150. A total of $32,050 was required as in-kind services or cash match.

The SWCD developed a list of key stakeholders for the planning area based on the previous Swanfelt Ditch Steering Committee. Additional members joined the committee based on recommendations and personal acquaintances.

The public was invited to participate in all aspects of this project. Public meetings were held throughout the plan development. Steering committee meetings were also open to the public. The meeting information and updates were sent in the form of press releases to local newspapers, watershed newsletters, targeted mailings, personal conversations, and posting on the Madison County SWCD website. All meetings were held in locations accessible to the public including Anderson Public Library, Elwood Public Library, Elwood YMCA, Orestes Town Hall, and Elwood Municipal Building.

The goal of the first public meeting was to obtain stakeholder input on the watershed, water quality, and land use concerns related to the WMP. Over the course of several months interviews with residents in the area were conducted and surveys were mailed to the residents to develop a sense of community objectives specific to the Lilly Creek & Little Duck Creek watershed. The SWCD conducted a first quarter mail-out survey to assess perceptions about recreation, pollution, water quality, drinking water, and wildlife habitat from the stakeholders. This information is found in Appendix G. An eighth quarter final survey was mailed out to assess stakeholders changes in perception, behavior, meeting participation, and future direction they would like to see taken if implementation money is made available. This information is found in Appendix H.

1.4 Concerns

The community was continually asked for their watershed quality concerns over the course of the project. This discussion came up at formal meetings as well as during informal conversations. Concerns and suggestions were noted during these discussions and later lumped into general categories. These categories are listed below. Neither the category nor the order is intended to confer any prioritization, and many of the issues are closely interrelated. The community prioritized the concerns later in the process.

1.41 Plan Development, Education, & Outreach

- Public needs to be educated about water quality issues
- Educate community leaders who influence relevant ordinances
- Identify & accentuate farms practicing conservation tillage
- Identify & accentuate eco-friendly lawn care professionals and cleaners

1.42 E-Coli

- Combined Sewer Overflows
- Poorly installed and/or maintained septic systems
- Cattle access to Lilly Creek and both horse and cattle to Little Duck
- Wildlife impact in waterways
- Restricted recreational use (fishing, swimming, boating)
- Need to identify source of E. coli

1.43 Sedimentation

- Stream bank erosion
- Impaired drainage

1.44 Agricultural Practices

- Manure management
- Proper application of pesticides and fertilizers
- Use of conservation practices (no-till, buffer strips, grassed waterways)
- Livestock impact on water quality

1.5 Vision for the Future

As the stakeholders listed concerns regarding the current state of water quality in the Lilly Creek and Little Duck Creek watershed, they also described their vision for the watershed in the future. Several common themes began to surface during the public meetings. Nearly all stakeholders envisioned clean streams that supported multiple uses. Stakeholders unanimously voiced support for a future in which the water was clean and safe for recreation and consumption. Stakeholders also envisioned a future where more individuals have a better understanding of actions they could take to protect water quality. The following vision statement was developed using stakeholder input:

> *Our vision for the Lilly Creek and Little Duck Creek watershed is a healthy ecosystem that supports species diversity, protects water quality, and improves quality of life, flora, and fauna in northern Madison County while maintaining the important social, economic, recreational, agricultural, and drainage uses of the watershed.*

Watershed stakeholders selected goals and strategies that will enable them to make this vision a reality.

2.0 DESCRIPTION OF WATERSHED

2.1 Location

The Lilly Creek & Little Duck Creek watersheds are two 14 digit HUC watersheds that encompass nearly 22,672 acres in northwest Madison County, Indiana (Figure 1). Lilly Creek (05120201050060) is approximately 9,751 acres and Little Duck Creek (05120201060020) contains approximately 12,921 acres. The Lilly & Little Duck Creek watershed consists of 7 streams and/or ditches. Their names and lengths are as follows:

Lilly Creek	10.2 miles
Pipe Creek	3.7 miles
Little Duck Creek	9.4 miles
Big Duck Creek	5.5 miles
Noble Ditch	1.3 miles
Dong Run	0.7 miles
Carver Run	1.8 miles

Table 2 - Streams & Mileage.

2.2 Physical Setting

2.21 Geology

The geology of the watershed is a direct result of the Wisconsinan glacier activity. This gave the Lilly and Little Duck Creek Watershed loamy, high lime, late-Wisconsinan glacial till, glacial outwash and scattered loess overlie Paleozoic carbonates and shale. Its bedrock group is primarily Silurian rocks.

2.22 Soils & Topography

The soils and topography of the Lilly Creek and Little Duck Creek watershed are typical of the Eastern Corn Belt Plains Ecoregion. This region contains glaciated, level to rolling glacial till plain, with end moraines and glacial outwash landforms. Common soil series include Fincastle, Treaty, Cyclone, Xenia, Ockley and Shoals. Common soil types within the watershed consist of Brookston, Crosby, Miami, and Mahalasville. These soils grew Beech forests, oak-sugar maple forests, white oak forests, pin oak swamps, elm-ash swamps grew on nearly level terrain. At present, corn, soybeans, tomatoes, small grains, hay, and livestock are grown agriculturally on these soils. These soils are typified by Brookston – Crosby soil associations. This association is made up of nearly level to gently sloping rises and knobs that are interspersed with level and slightly depressional areas. The Brookston soils are dark colored, very poorly drained and have a silty or clayey surface layer and a dark gray clayey subsoil. They are underlain by grayish-brown to yellowish-brown, calcareous loamy till. The Crosby soils are lighter colored than the Brookston soils and have less clay in the surface layer. They are somewhat poorly drained and have dark yellowish-brown clayey subsoil underlain by yellowish-brown, calcareous loamy till. Both soils typically require artificial drainage for commodity crop production (United States Department of Agriculture, 1969).

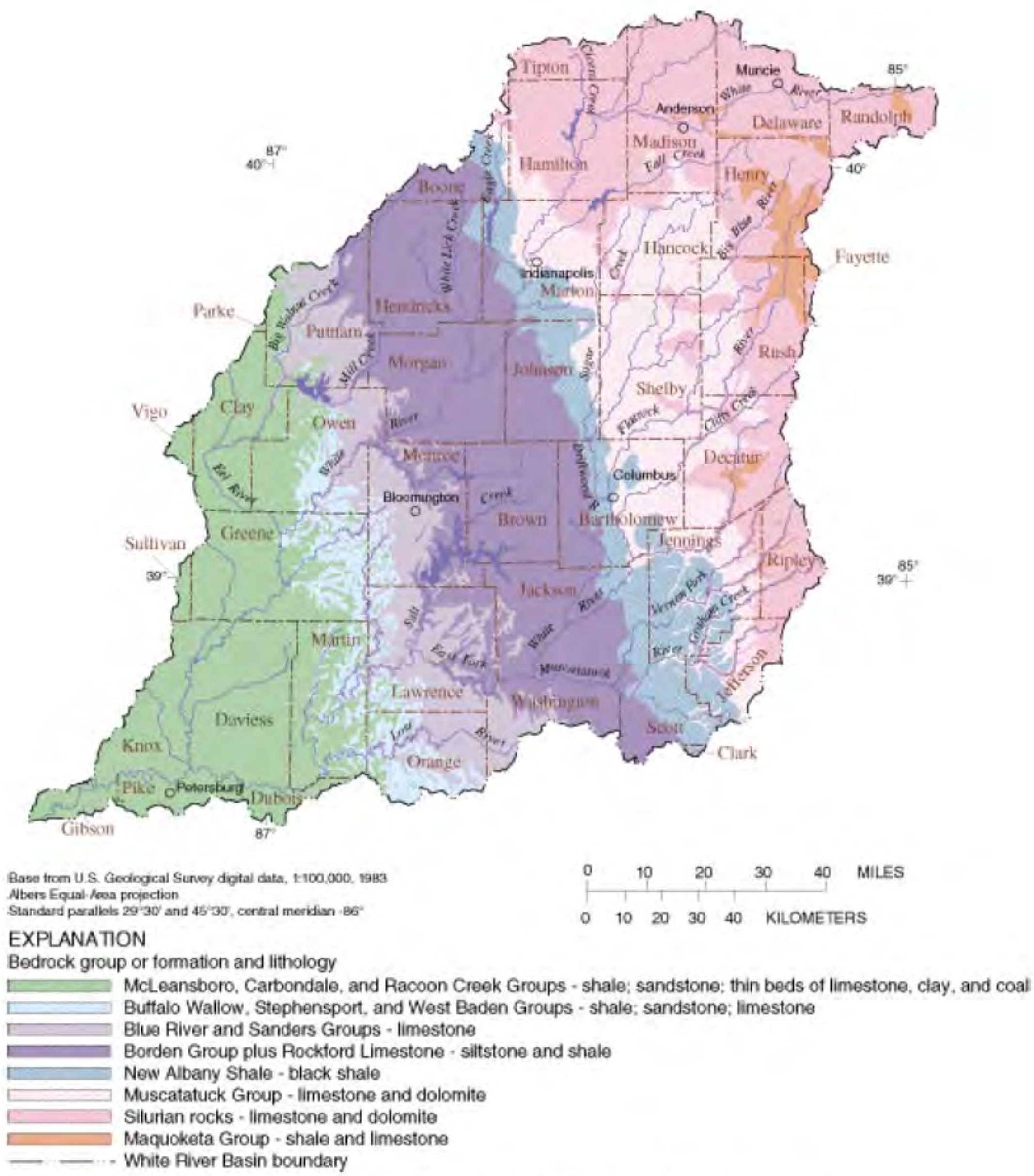


Figure 4 – Bedrock Geology.

2.23 Climate

Madison County, including the Lilly Creek and Little Duck Creek Watershed, has a typical Midwest North American climate. The watershed receives average rainfall amounts of 38 inches. Average low temperature for the watershed is 18.3 ^{o}F. Average high temperature for the watershed is 83.8 ^{o}F. (City-data.com, 2005a).

2.24 Natural History

Before settlement of the area during the early 1800's the entire Lilly Creek and Little Duck Creek watershed was dominated by hardwood forests, streams, and wetlands. At the time of settlement, the new residents cleared most all of the forested areas and began installing subsurface tiles to drain the land for agricultural production. In addition to the tile installation, the residents also constructed new, open ditches to assist draining areas that were not easily serviced by existing streams and/or areas. Current conditions on the streams include some areas of vegetation and some have little or no vegetation buffering the stream from adjacent land uses.

2.25 Endangered Species

There are nine species of vascular plants, two species of mussels, one species of insect, four species of birds, one species of mammal, and three types of high quality natural areas that are endangered at a federal, state or both the federal and state level. These species mentioned are for the area of Madison County. A complete listing specific to Madison County may be accessed via Indiana Department of Natural Resources, Division of Nature preserves. (Indiana Department of Natural Resources, 1999). No listing of endangered species specific to the Lilly and Little Duck Creek Watershed was found.

2.3 Land Use

In the Lilly Creek watershed the land use is dominated by agricultural production. Agricultural producers plant the majority of the farm acreage to corn and soybeans. However, wheat, alfalfa, and tomatoes are also planted. There are a few small livestock operations in the watershed. A confined animal feeding operation was recently permitted. It is to be located at the intersection of 700W & 1300N and will contain 4000 hogs.

Outside of the urban area of the town of Orestes, the watershed is dotted by small hobby farms, larger full-time farm operations, and rural, residential home plots. Both within the urban and outlying areas, ownership of land is private in nature. Within the watershed, there are no significant public lands or public natural areas that exist.

Of note is the existence of the corporate headquarters for Red Gold, located in the town of Orestes. Red Gold is the nation's largest tomato product supplier outside of California.
According to MCCOG interpolation, the total acreage of the Lilly Creek watershed is 9,751. Of this total acreage, 68% of the Lilly Creek watershed is cropland (approximately 6,652 acres).

Land Use	***Acreage***
Commercial	36.39
Farmsteads	1,276.89
Fields	6,652.62
Heavy Industrial	31.94
High Density Residential	126.29
Institutional	9.38
Light Industrial	50.67
Parks/Open Space	95.44
Single Family Residential	490.69
Wooded	782.98

Table 3 - Lilly Creek Land Use.

Land use in the Little Duck watershed is primarily row crops and the city of Elwood. Within the city of Elwood, land use is primarily Low Intensity Residential. Land uses of Industrial/ Commercial/ Transportation and Urban/ Recreational Grasses are also common within Elwood. The land uses overall for the watershed are below.

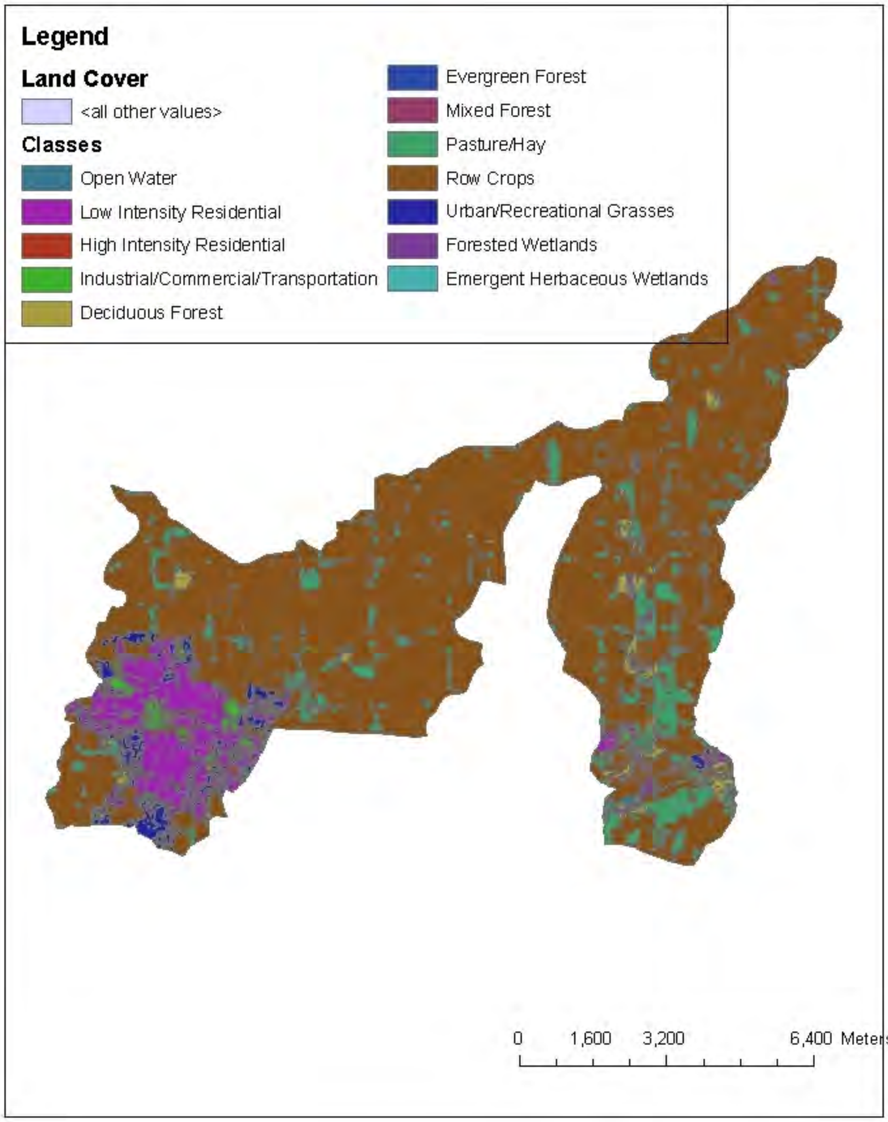


Figure 5 – Land Use.

3.0 BASELINE WATER QUALITY AND WATERSHED CONDITIONS

3.1 Introduction

Data Contained in this section documents current water quality conditions in the Lilly Creek and Little Duck Creek and its tributaries. Understanding the creeks' current conditions will help watershed stakeholders set realistic goals for future water quality conditions. This data will also serve as the benchmark against which future water quality conditions can be compared to measure stakeholder success in achieving their vision for the future of these creeks.

3.2 Existing Data

3.21 United States Geological Survey

"The mission of the U.S. Geological Survey (USGS) is to assess the quantity and quality of the earth resources of the Nation and to provide information that will assist resource managers and policymakers at Federal, State, and local levels in making sound decisions. Assessment of water-quality conditions and trends is an important part of this overall mission. The long term goals of the National Water Quality Assessment Program (NAWQA) are to describe the status and trends in the quality of a large, representative part of the Nation's surface- and ground-water resources, and to provide a sound, scientific understanding of the primary factors affecting the quality of these resources. The White River Basin in Indiana is one of many large river basins being studied throughout the United States."

The NAWQA report specifically points out that within agricultural areas of the White River basin, nutrient concentrations, ammonia, pesticides, and herbicide concentrations were present and exceeded water quality targets. They also mention that land use, differing types of agricultural practices and seasonal changes in nutrient uptake and runoff from varying levels of precipitation affect the quantity of the pollutants that are found through their water quality monitoring in the White River Basin.
The report also states that ammonia and nitrites levels were 2 times and 5 times greater, respectively, in an agricultural watershed affected by farm animals.

3.22 IDEM

State and regional reports provide benchmarks for water quality in Indiana lakes and streams by identifying how the watershed fits into the overall state and regional picture. A variety of sources were reviewed to assist in establishing baseline water quality conditions in the waterbodies of the Lilly Creek & Little Duck Creek watershed. Every two years, the United States Environmental Protection Agency (USEPA) requires the state to submit an Indiana Water Quality 305(b) report on the status of waters in the state. The current and historical Indiana Water Quality 305(b) reports were studied (IDEM, 1989-1990; IDEM, 1992-1993; IDEM, 1995-1996; IDEM, 2002; IDEM, 2004; and IDEM, 2006). Additionally, the USEPA requires that Indiana submit a Section 303(d) List of Impaired Water Bodies for Indiana, which is named after enabling legislation in the federal Clean Water Act. This list provides a listing of waters that do not or are not expected to meet applicable water quality standards. This list was examined to determine if any portion of the Lilly Creek & Little Duck Creek watershed was listed as impaired.

In the Indiana Water Quality 305(b) reports for the years 1989-1990, 1992-1993, and 1995-1996, Lilly Creek & Little Duck Creek were assessed and given a rating of fully supporting of aquatic life (IDEM, 1991; IDEM, 1994; and IDEM, 1997). In 1998, Duck Creek in Elwood to Little Duck Creek and Pipe Creek were placed on the 303(d) list for E. coli. Pipe Creek was also cited for impaired biotic communities in 1998. In 2004, the Little Duck Creek Basin and Big Duck Creek were placed on the 303(d) list for E. coli. Pipe Creek was also cited for fish consumption for PCBs and mercury. The 2006 303(d) lists Pipe Creek, Little Duck Creek Basin, Duck Creek from Elwood to Little Duck

Creek, and Big Duck Creek for E. coli. Pipe Creek is still listed as a fish consumption advisory for PCBs and mercury. Duck Creek and Pipe Creek have a draft TMDL report on file at IDEM. A TMDL (Total Maximum Daily Load)**,** established under section 303(d) of the federal Clean Water Act, is a calculation of the maximum amount of pollutant that a waterbody can receive and still meet water quality standards, and allocates pollutant loadings among point and non-point sources. No segments of these watersheds are listed as impaired for aquatic life on the 2006 303d list.

3.23 Madison County Tillage Transect

The Tillage Transect is generally completed every two years by Indiana Conservation Partnership employees stationed in Madison County (SWCD, ISDA, & NRCS). The purpose is to give a summary of trends associated with the adoption of no-till and/or conservation tillage with relation to crop residue and soil loss within Madison County. The surveys are completed each spring after crops have emerged but while the soil residue conditions are still visible. Data is recorded and compiled statewide by most all counties and viewed on a state level as well.

The Madison County Tillage Transect from the spring of 2004 showed that 81% of the corn crop is conventional till, with the remaining 11% and 8% being no-till and mulch till. The soybean crop showed that 16% was conventional till, 68% was no-till, and 16% mulch till. Madison County ranked 62nd out of 89 counties surveyed in percent of corn planted using a no-till system. No-till corn acreage has decreased from 14% in 2000 to 11% in 2004. Madison County ranked 5th out of 89 counties in 2000 by planting 83% of its soybeans utilizing no-till. Soybean no-till has decreased from 83% to 68% in 4 years. A tillage transect was conducted in May of 2007, but the state has not released the results.

3.24 US Fish & Wildlife Service Study

In 2002, Thomas Simon conducted an assessment of the fish assemblages of major tributaries of the West Fork White River at 77 stream reaches from Indianapolis to Muncie, Indiana. The survey was conducted in the fish kill zone to document the species present including basic biological data. In addition, habitat and water quality was assessed during two time periods between July and October 2002. Characteristics of the fish assemblage of each tributary were compared to habitat, ammonia, and nitrate concentrations measured during the fall sampling period. Big Duck Creek study sites were #42, #43, and #45. Little Duck Creek study sites were #46 and #47. Pipe Creeks study site was #54. Lilly Creek study sites were #55 and #56. Six of these sample sites were also utilized in our chemical and biological assessments. (This study can be accessed at: http://www.in.gov/idem/your_environment/wrcac/index.html)

Overall results indicate that nitrate levels are acutely (10mg/L) to chronically (12mg/L) toxic and further investigation is needed. Ohio-EPA has established a nitrate target for TMDL's at 1.5mg/L. The habitat assessment shows that the majority of fish species are pollution tolerant. Channelization, removal of riparian corridors, sedimentation, and loss of in stream cover were cited as primary reasons for the loss of habitat quality. (Simon, 2004)

3.25 JFNew Watershed Stream Sampling

To supplement the base of existing data, JFNew completed water chemistry sampling and physical habitat assessments at 12 locations within the Lilly Creek & Little Duck Creek watershed. Three sampling sites were located on Big Duck Creek with an additional three sampling sites on Little Duck Creek. Five sampling sites were located on Lilly Creek and one sampling site on Pipe Creek at the road crossing closest to its convergence with Lilly Creek.

2005	2006
8/3 – base flow	5/9 – base flow
9/6 – base flow	6/15 –base flow
9/26 – storm flow	7/12 – storm flow
10/19 – base flow	8/2 – base flow

Table 4 – JFNew Sampling Schedule.

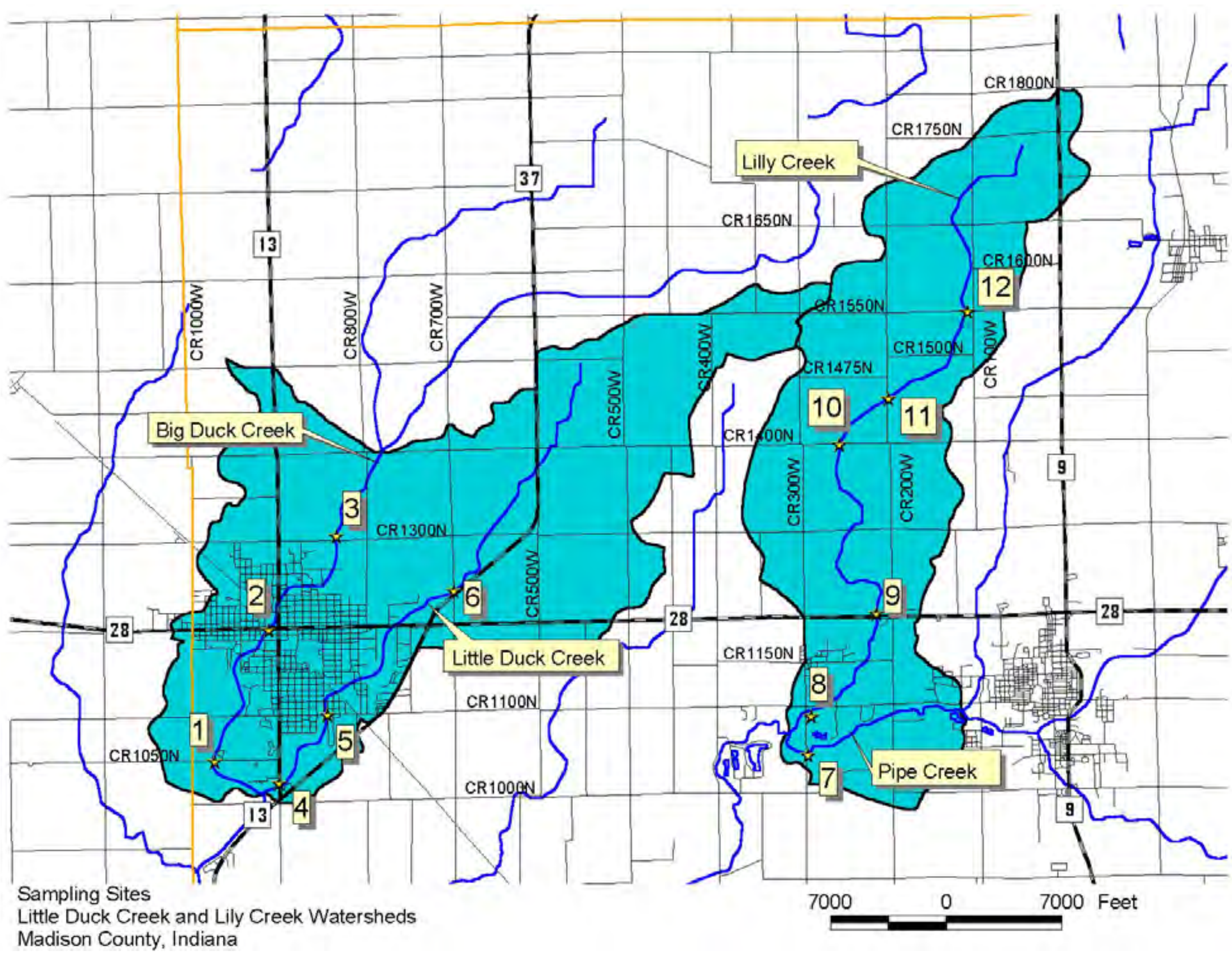


Figure 6 – Sampling Sites.

3.251 Water Quality Parameters

JFNew measured various chemical parameters over a two year period. Descriptions of the parameters measured are listed below.

Temperature

Temperature can determine the form, solubility, and toxicity of a broad range of aqueous compounds. Likewise, water temperature regulates the species composition and activity of life associated with the aquatic environment. As essentially all aquatic organisms are cold-blooded, the temperature of the water regulates their metabolism and ability to survive and reproduce effectively (USEPA, 1976). The Indiana Administrative Code (IAC) (327 IAC 2-1-6) sets maximum temperature limits to protect aquatic life for Indiana streams. For example, temperatures during the months of June and July should not exceed 90°F by more than 3°F. The code also states that the "maximum temperature rise at any time or place…shall not exceed 5°F in streams…"

Dissolved Oxygen (DO)

DO is the dissolved gaseous form of oxygen. It is essential for respiration of fish and other aquatic organisms. Fish require a DO concentration of at least three to five mg/l of DO. Cold water fish such as trout generally require higher concentrations of DO than warm water fish such as bass or bluegill. The IAC sets minimum DO concentrations at five mg/l for warm water fish. DO enters water by diffusion from the atmosphere and as a byproduct of photosynthesis from algae and plants. Excessive algae growth can over-saturate (greater than 100 percent saturation) the water with DO. Waterbodies with large populations of algae and macrophytes often exhibit supersaturation due to the high levels of photosynthesis. Dissolved oxygen is consumed by respiration of aquatic organisms, such as fish, and during bacterial decomposition of plant and animal matter.

Conductivity

Conductivity is a measure of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions: on their total concentration, mobility, and valence (APHA, 1998). In lower flow conditions, conductivity is higher than it is following a storm because the water moves more slowly across or through ion containing soils and substrates during base flow. Carbonates and other charged particles (ions) dissolve into the slow-moving water, thereby increasing conductivity levels.

pH

The pH of stream water describes the concentration of acidic ions (specifically H^+) present in the water. The pH also determines the form, solubility, and toxicity of a wide range of other aqueous compounds. The IAC establishes a range of six to nine pH units for the protection of aquatic life.

Turbidity

Turbidity (measured in Nephelometric Turbidity Units or NTUs) is a measure of water coloration and particles suspended in the water itself. It is generally related to suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, plankton, and other microscopic organisms. According to the Hoosier Riverwatch, the average turbidity of an Indiana stream is 11 NTU with a typical range of 4.5-17.5 NTU (White, unpublished data). Turbidity measurements 〉20 NTU have been found to cause undesirable changes in aquatic life (Walker, 1978). The USEPA developed recommended water quality criteria as part of the work to establish numeric criteria for nutrients on an ecoregional basis. Recommended turbidity concentrations for the Central Corn Belt Plains, in which the Lilly Creek and Little Duck Creek watersheds lie are 9.89 NTUs (USEPA, 2000).

Nitrogen
Nitrogen is an essential plant nutrient found in fertilizers, human and animal wastes, yard waste, and the air. About 80 percent of the air we breathe is nitrogen gas. Nitrogen gas diffuses into water where it can be "fixed", or converted by blue-green algae to ammonia for their use. Nitrogen can also enter lakes and streams as inorganic nitrogen and ammonia. Because of this, there is an abundant supply of available nitrogen to aquatic systems. The two common forms of nitrogen are:

- *Nitrate-nitrogen*

Nitrate is an oxidized form of dissolved nitrogen that is converted to ammonia by algae. It is found in streams and runoff when dissolved oxygen is present, usually in the surface waters. Ammonia applied to farmland is rapidly oxidized or converted to nitrate and usually enters surface and groundwater as nitrate. The Ohio EPA (1999) found that the median nitrate-nitrogen concentration in wadeable streams classified as modified warm water habitat (MWH) was 1.6 mg/l. MWH was defined as: the aquatic life use assigned to streams that have irretrievable, extensive, man-induced modification that precludes attainment of the warm water habitat use designation; such stream are characterized by species that are tolerant of poor chemical quality (fluctuating dissolved oxygen) and habitat conditions (siltation, habitat amplification) that often occur in modified streams (Ohio EPA, 1999). The target or concentration breakpoint we used for load reduction calculations was 1.5mg/L.

- *Ammonia-nitrogen*

Ammonia-nitrogen is a form of dissolved nitrogen that is the preferred form for algae use. Bacteria produce ammonia as they decompose dead plant and animal matter. Ammonia is the reduced form of nitrogen and is found in water where dissolved oxygen is lacking. Important sources of ammonia include fertilizers and animal manure. Both temperature and pH govern the toxicity of ammonia for aquatic life. According to the IAC, maximum ionized ammonia concentrations for the study streams should not exceed approximately 1.94 to 7.12 mg/l, depending on the water's pH and temperature. The target or concentration breakpoint we used for load reduction calculations was 0.5mg/L.

Phosphorus
Phosphorus is an essential plant nutrient and the one that most often controls aquatic plant (algae and macrophyte) growth. It is found in fertilizers, human and animal wastes, and yard waste. There are few natural sources of phosphorus to streams other than that which is attached to soil particles; there is no atmospheric (vapor) form of phosphorus. For this reason, phosphorus is often a limiting nutrient in aquatic systems. This means

that the relative scarcity of phosphorus may limit the ultimate growth and production of algae and rooted aquatic plants. Management efforts often focus on reducing phosphorus inputs to receiving waterways because: (a) it can be managed and (b) reducing phosphorus can reduce algae production. The target or concentration breakpoint we used for load reduction calculations was 0.17mg/L. This is the same breakpoint used for the Wabash River Nutrient and Pathogen TMDL.

Total Suspended Solids (TSS)
A TSS measurement quantifies all particles suspended in stream water. Closely related to turbidity, this parameter quantifies sediment particles and other solid compounds typically found in stream water. In general, the concentration of suspended solids is greater during high flow events due to increased overland flow. The increased overland flow erodes and carries more soil and other particulates to the stream. The state of Indiana does not have a TSS standard. In general, TSS concentrations greater than 80 mg/l have been found to be harmful to aquatic life (Waters, 1995). The target or concentration breakpoint we used for load reduction calculations was 50mg/L. This is the same breakpoint used for the Wabash River Nutrient and Pathogen TMDL.

E. coli Bacteria
E. coli is one member of a group of bacteria that comprises the fecal coliform bacteria and is used as an indicator organism to identify the potential presence of pathogenic organisms in a water sample. Pathogenic organisms can present a threat to human health by causing a variety of serious diseases, including infectious hepatitis, typhoid, gastroenteritis, and other gastrointestinal illnesses. E. coli can come from the feces of any warm-blooded animal. Wildlife, livestock, and/or domestic animal defecation, manure fertilizers, previously contaminated sediments, and failing or improperly sited septic systems are common sources of the bacteria. The IAC sets the maximum standard at 235 colonies/100 ml in any one sample within a 30 day period.

Macroinvertebrates
The benthic community at each sample site was evaluated using two biological indices: the Hilsenhoff Family Level Biotic Index (HBI) (Hilsenhoff, 1988) and IDEM's macroinvertebrate Index of Biotic Integrity (mIBI) (IDEM, unpublished). The HBI uses the macroinvertebrate community to assess the level of organic pollution in a stream. The HBI is based on the premise that different families of aquatic insects possess different tolerance levels to organic pollution. Hilsenhoff assigned each aquatic insect family a tolerance value from 1 to 9; those families with lower tolerances to organic pollution were assigned lower values, while families that were more tolerant to organic pollution were assigned higher values. The HBI is calculated by multiplying the number of organisms from each family collected at a given site by the family tolerance value, summing these products, and dividing by the total number of organisms in the sample:

$$HBI = \frac{x_i t_i}{n}$$

where x_i is the number of species in a given family, t_i is the tolerance values of that family, and n is the total number of organisms in the sample. Benthic communities dominated by organisms that are tolerant of organic pollution will exhibit higher HBI scores compared to benthic communities dominated by intolerant organisms. Table 5 correlates the HBI score with the level of organic pollution.

Hilsenhoff Family Level Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.75	Excellent	Organic pollution unlikely
3.76-4.25	Very good	Possible slight organic pollution
4.26-5.00	Good	Some organic pollution probable
5.01-5.75	Fair	Fairly substantial pollution likely
5.76-6.50	Fairly poor	Substantial pollution likely
6.51-7.25	Poor	Very substantial pollution likely
7.26-10.00	Very poor	Severe organic pollution likely

Table 5 - Water quality correlation to Hilsenhoff Biotic Index score.

IDEM's mIBI is a multi-metric index designed to provide a complete assessment of a creek's biological integrity. Karr and Dudley (1981) define biological integrity as "the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the best natural habitats within a region". It is likely that this definition of biological integrity is what IDEM means by biological integrity as well. The mIBI consists of ten metrics which measure the species richness, evenness, composition, and density of the benthic community at a given site. The metrics include family-level HBI (Hilsenhoff's FBI), number of taxa, number of individuals, percent dominant taxa, EPT Index, EPT count, EPT count to total number of individuals, EPT count to chironomid count, chironomid count, and total number of individuals to number of squares sorted. (EPT stands for the Ephemeroptera, Plecoptera, and Trichoptera orders.) A classification score of 0, 2, 4, 6, or 8 is assigned to specific ranges for metric values. For example, if the benthic community being assessed supports nine different families, that community would receive a classification score of 2 for the "Number of Taxa" metric. The mIBI is calculated by averaging the classification scores for the ten metrics. mIBI scores of 0-2 indicate the sampling site is severely impaired; scores of 2-4 indicate the site is moderately impaired; scores of 4-6 indicate the site is slightly impaired; and scores of 6-8 indicate that the site is non-impaired.

JFNew collected six sets of water chemistry samples during normal or baseline conditions and two sets of water chemistry samples during a period of more than one inch of rain in a 24-hour period. Benthic macroinvertebrates were assessed twice a year in early and late summer along with each stream's physical habitat. To ensure comparability to data collected previously by IDEM, JFNew followed similar stream sampling protocols. The stream sampling and the appropriate quality assurance/quality control procedures are referenced in the project's Quality Assurance Project Plan (QAPP). Appendix A contains the project QAPP and Appendix E contains tables of the results of field sampling performed at twelve sample sites by JFNew.

In addition to water sampling, a Qualitative Habitat Evaluation Index (QHEI) was assessed for these sties. Photos taken for the QHEI are located in Appendix F and QHEI data sheets are provided in Appendix B. This assessment quantifies six metrics: substrate, instream cover, channel morphology, riparian zone and bank erosion, pool/glide quality and riffle/run quality, and gradient. Numbers are assigned based on these metrics for a final QHEI score. IDEM considers scores above 64 to be fully supporting of a balanced warm water community, while scores below 51 are considered to be non-supporting for the stream's aquatic life use designation.

3.252 Water Quality Sampling Results

Temperature
Water temperature varied with season. In general, there was no consistent difference between water temperatures in Little Duck Creek and Lilly Creek. Sites located in the lower portion of the watershed typically exhibited slightly lower water temperatures compared to sites located in the upper watershed during all sampling events. The cooler water temperatures in the lower watershed may be the result of greater groundwater influence on the streams but is likely due to larger portions of canopy cover in the lower portion of the watershed compared to streams and sties in the upper portion of the watershed.

DO
DO in all streams exceeded the Indiana state minimum warmwater standard of 5 mg/l at all sites in the Little Duck Creek watershed indicating that oxygen was sufficient to support aquatic life. Low DO levels in headwaters of Lilly Creek (Sites 10 to 12) limit the use of these ditches by fish as refuges. Lilly Creek at CR 1400N and CR 1550N possessed DO concentrations below the state minimum standard. Lilly Creek at CR 1550N contained a dissolved oxygen concentration as low as 0.71 mg/l. All other sites possessed sufficient dissolved oxygen to support warmwater biotic communities.

All of the sampling sites, with the exception of the two headwater sites within Little Duck and Big Duck Creeks, possessed saturation levels (84-95%) within the typical range for streams the size of Little Duck and Lilly Creeks. However, Big Duck Creek at CR 1050N (Site 1), Little Duck Creek at South P Street, and the sites along the length of Lilly Creek routinely exhibited dissolved oxygen saturation levels less than 60%. All three headwater sites along Lilly Creek (Sites 10 to 12) contained less than 30% dissolved oxygen during the August 2006 assessment.

Within Lilly Creek (Sites 10-12), the low dissolved oxygen saturation accompanied high (relative to other sites in the watershed) BOD concentrations. Decomposition processes likely played a role in lowering the DO content of the water at these three sites.

Conductivity
Conductivity concentrations generally fell within acceptable ranges. However, conductivity levels measured in some of the watershed streams are of concern. Big Duck

Creek at CR 1050N exceeded the state standard during three of the four sampling events in 2005 and one of the four sampling events in 2006. Within the Lilly Creek watershed, Lilly Creek at CR 300W and Pipe Creek both exceeded the state standard for conductivity. Lilly Creek exceeded the standard during all four of the sampling events in 2005.

pH

In general, pH values fell within acceptable ranges as determined by the Indiana Administrative Code for the protection of aquatic biota. The pH measurements for stream sites in both the Little Duck Creek and Lilly Creek watersheds fell within the state standards of 6 and 9.

Turbidity

Streams in both the Duck Creek and Lilly Creek watersheds possessed elevated turbidity levels. Recommended turbidity concentrations for the Central Corn Belt Plains, in which the Lilly Creek and Little Duck Creek watershed lies are 9.89 NTUs (USEPA, 2000). All sites exceeded USEPA recommended nutrient criteria turbidity levels at least once during the 2005 sampling events. The highest turbidity was recorded at most sites during the August 2005 storm event. In 2006, none of the Big Duck Creek sampling sites exhibited turbidity levels above the recommended criteria, while the Little Duck Creek at CR 1100N and 700W sampling sites both possessed turbidity levels in excess of the recommended criteria at least once during the 2006 sampling events.

Lilly Creek watershed sites recorded greater numbers of exceedances than Little Duck Creek watershed sites especially during 2006. Pipe Creek exceeded the recommended criteria during five of the eight sampling events. This is not surprising based on the large watershed draining to Pipe Creek at its sampling location.

Nitrate-Nitrogen

Nitrate-nitrogen concentrations during base and storm flow conditions were elevated throughout the watersheds. Pipe Creek possessed nitrate-nitrogen concentrations in excess of the Indiana state drinking water standard during two of the four 2005 sampling events. In 2006, all of the sites within the Little Duck Creek watershed exceeded the state standard during the June base flow sampling event as did Lilly Creek at CR 1550N. Additionally, all sites exceeded the USEPA recommended criteria for nitrate-nitrogen, while many sites exceeded the concentrations at which the Ohio EPA determined that biotic impairment occurs.

Ammonia-Nitrogen

Ammonia-nitrogen concentrations were elevated at all sites during the eight sampling events. However, only one site (Lilly Creek at SR 28; September 2005) exceeded the Indiana state standard for drinking water during all of the sampling events which is 1mg/L. Little Duck Creek watershed streams typically possessed lower ammonia-nitrogen concentrations than those present in Lilly Creek watershed streams.

Phosphorus

Under both base and storm flow conditions, total phosphorus concentrations were generally high in the Little Duck Creek and Lilly Creek watersheds. At all of these sampling sites total phosphorus concentrations exceeded the Ohio EPA's numeric total phosphorus criteria set to protect aquatic life. (Indiana does not have numeric nutrient criteria). The high total phosphorus concentrations and resultant productivity in these tributaries may be altering the tributaries' biotic community structure and impairing aquatic life in the tributaries. The habitat assessment and the four macroinvertebrate samplings support this concern.

Total Suspended Solids (TSS)

Streams throughout the Little Duck Creek and Lilly Creek watersheds possessed elevated total suspended solids concentrations on several occasions after rain events; however, none of the samples exceeded the level determined by Waters (1998) to be deleterious for aquatic life.

E. coli

E. coli concentrations exceeded the Indiana state standard for state waters at least once at every sampling site during each sampling season (2005 and 2006). Little Duck Creek at SR 13 and Lilly Creek at CR 1550N exceeded the state standard during all eight sampling events, while Pipe Creek at CR 300W and Big Duck Creek at CR 1050N exceeded the state standard during seven of the eight sampling events. Only Big Duck Creek at CR 1300N exceeded the state standard during less than half of the sampling events. All the samples collected under storm flow conditions were in excess of the state standard. Storm flow E. coli concentrations were of special concern in Big Duck Creek at CR 1050N where E. coli concentrations measured 141,360 colonies/100mL and 241,920 colonies/100mL during the 2005 and 2006 storm sampling events, respectively. Throughout the two watersheds, E. coli concentrations in excess of the standard measured 1.1 to 1030 times the state standard. High E. coli concentrations suggest the presence of other pathogens. These other pathogens may impair the tributaries biota and limit human use of the creeks.

Site #	Stream	Location	Exceeds State Standard* **		Doesn't exceed std, but value of concern*	
			2005	2006	2005	2006
1	Big Duck Creek	CR 1050 N.	--	1	3	3
2	Big Duck Creek	SR 13	--	1	1	2
3	Big Duck Creek	CR 1300 N.	--	1	1	2
4	Little Duck Creek	SR 13	--	1	2	2
5	Little Duck Creek	CR 1100 N.	--	1	2	2
6	Little Duck Creek	CR 700 W.	--	1	2	2
7	Pipe Creek	CR 300 W.	2	--	2	3
8	Lilly Creek	CR 300 W.	--	--	1	3
9	Lilly Creek	SR 28	--	--	1	4
10	Lilly Creek	CR 1400 N.	--	--	1	3
11	Lilly Creek	CR 200 W.	--	--	1	3
12	Lilly Creek	CR 1550 N.	--	1	2	2

* The number represents the number of times that the site exceeded the standard.
** IAC standard < 10 mg/L; Ohio EPA state 2 mg/L = impaired biotic communities; Ohio EPA recommended criteria < 1 mg/L. USEPA recommended criteria < 0.63 mg/L.

Table 6 - Water quality standard summary of stream nitrate concentrations sampled during 2005 and 2006 in the Duck Creek and Lilly Creek watersheds.

Site #	Stream	Location	Exceeds USEPA recommended nutrient criteria* **	
			2005	2006
1	Big Duck Creek	CR 1050 N.	4	3
2	Big Duck Creek	SR 13	2	1
3	Big Duck Creek	CR 1300 N.	--	1
4	Little Duck Creek	SR 13	3	2
5	Little Duck Creek	CR 1100 N.	3	2
6	Little Duck Creek	CR 700 W.	2	1
7	Pipe Creek	CR 300 W.	3	4
8	Lilly Creek	CR 300 W.	3	3
9	Lilly Creek	SR 28	--	3
10	Lilly Creek	CR 1400 N.	--	3
11	Lilly Creek	CR 200 W.	1	3
12	Lilly Creek	CR 1550 N.	2	3

* The number represents the number of times that the site exceeded the standard.
** USEPA recommended nutrient criteria, Dodd et al. (1998) level at which eutrophication occurs, and the Ohio EPA recommended level < 0.075mg/L.

Table 7 - Water quality standard summary of stream total phosphorus concentrations sampled during 2005 and 2006 in the Duck Creek and Lilly Creek watersheds.

Site #	Stream	Location	Exceeds State Standards* **	
			2005	2006
1	Big Duck Creek	CR 1050 N	4	3
2	Big Duck Creek	South B Street	1	3
3	Big Duck Creek	CR 1300 N	1	2
4	Little Duck Creek	SR 13	4	4
5	Little Duck Creek	CR 1100 N	2	4
6	Little Duck Creek	CR 700 N	3	2
7	Pipe Creek	CR 300 W	3	4
8	Lilly Creek	CR 300 W	2	3
9	Lilly Creek	SR 28	2	4
10	Lilly Creek	CR 1400 N	2	4
11	Lilly Creek	CR 200 W	2	3
12	Lilly Creek	CR 1550 N	4	4

* The number represents the number of times that the site exceeded the standard.
** IAC standards = <235 colonies/100 ml in any one sample in 30 days

Table 8 - Water quality standard summary of stream E. coli concentrations sampled during 2005 and 2006 in the Duck Creek and Lilly Creek watersheds.

Macroinvertebrates

The results of the macroinvertebrate survey assist with directing watershed management decisions. On average, Big Duck Creek at CR 1050N (Site 1), Little Duck Creek at SR13 (Site 4), and Pipe Creek at CR 300W (Site 7) possessed the highest quality macroinvertebrate community average scores of 3.06, 3.00, and 3.31, respectively. All of these average scores rate as moderately impaired. Big Duck Creek at CR 1050N (Site 1) possessed the highest calculated score (4.5) during the initial assessment (August 2005) while Lilly Creek at CR 300W (Site 8) possessed the lowest calculated score (1.0) during the October 2005 assessment. All of the watershed streams contained communities dominated by moderate to very tolerant species.

Macroinvertebrate communities in only three of the stream reaches during a total of five assessments rated as slightly impaired. These ratings occurred in Big Duck Creek at CR 1050N (Site 1) during the August and October 2005 assessments, in Little Duck Creek at SR 13 (site 4) during August 2005 and May 2006 assessments, and in Pipe Creek at CR 300W (Site 7) during the October 2005 assessment. All other sites rated as moderately or severely impaired during the four assessments. Although these streams' scores differ slightly from assessment to assessment, streams typically fell into the same biotic integrity class. Karr and Chu (1999) indicate that differences between scores *within* an integrity class are not statistically significant; these differences within integrity classes often reflect the large variability associated with sampling natural biological communities rather than true differences in community quality.

3.3 Watershed Tours

Watershed tours were conducted in order to record observations of potential water quality impacts. Various members of the steering committee took part in the watershed tours. The tours were conducted at different times of the year. Additionally, the group viewed aerial photography and pictometry to determine where vegetative buffers were needed.

In general, there were lots of field tiles flowing into the creeks. A large amount of heavily tilled land was also noted. At three sites, livestock and horses had direct access to the creek. Most bridges had pipes on the roadway that directly dropped down to the creek. Litter was a problem primarily in urban areas, although trash was common throughout the creeks. Storm drains were not marked and were heavily clogged with debris.

3.4 Watershed Interviews

In order to gauge general perceptions of water quality issues in the Lilly Creek & Little Duck Creek watershed, the SWCD conducted interviews as well as mailed initial surveys to stakeholders who live and/or work in the area. Information gathered during the interview process was considered during the decision-making process of this WMP.

Results of the initial survey are summarized in Appendix G. The general consensus of the public survey was that poor drainage (19%) and flooding (13%) were issues of concern. Stakeholders also cited restricted recreational use (67%) as a concern. Many stakeholders mentioned foul odors in the creeks, especially after heavy rain events. The City of Elwood's 14 Combined Sewer Overflows were specifically referenced. 19% of stakeholders surveyed were concerned about pollutants from agricultural runoff. A final survey was conducted and that information can be found in Appendix H. The general consensus of the final survey showed that (67%) of the respondents were more aware of water quality issues that before this project began and (97%) said they would modify their behavior if it would lead to improved water quality.

3.5 Water Quality Concerns

Water quality conditions were generally poor throughout the Little Duck Creek and Lilly Creek watersheds. With respect to water chemistry, nutrient concentrations were higher than the Ohio EPA's standards to protect aquatic life (Indiana does not possess numeric nutrient criteria). Additionally, high conductivity levels and low dissolved oxygen concentrations were of concern throughout the two watersheds. *E. coli* concentrations exceeded the state standard at sites throughout both watersheds during all four sampling events. Habitat scores were generally poor throughout the two watersheds. QHEI scores ranged from 33 (Little Duck Creek at CR 700W, Big Duck Creek at SR 13, Lilly Creek at CR 1550N) to 54 (Big Duck Creek at CR 1050N and Lilly Creek at CR 300W). mIBI scores reflected the poor habitat and water quality conditions present throughout the watersheds. Scores ranged from low of 1 (Little Duck Creek at South P Street) to a high of 4.5 (Big Duck Creek at CR 1050N). These scores suggest that stream reaches throughout both the Little Duck Creek and Lilly Creek watersheds are not capable of fully supporting their aquatic life use designation. These results do not correspond with the IDEM 2006 303d list. However, because of our sampling results this management plan will address that concern.

3.6 Results Analysis

In order to interpret the sampling results and set water quality goals for the implementation of this WMP, the data had to be converted into a useable format. Therefore, the concentrations calculated in the lab were converted into loading rates. For example, phosphorus, nitrate, and total suspended solid concentrations were converted into kg/day of total load into the watershed system. Appendix D shows the loading rates of the various water quality parameters that were measured in the sampling series.

For the purpose of this watershed plan and setting load reduction goals, annual load was calculated for sediment and nutrient concentrations measured during JFNew's sampling events.

The final calculations for target loads, reductions needed, average reductions needed/site, average current loads, average target loads, and average % reductions/site are found in Appendix I using the target breakpoints listed in the above sections.

4.0 CLARIFYING OUR PROBLEMS

4.1 Linking Concerns to Existing Data

Throughout the planning process, watershed stakeholders were invited to share their concerns for the Lilly Creek and Little Duck Creek watershed. All of the stakeholders' concerns identified during the planning process were detailed in the Concerns Section of the Introduction (Section 1.4). The watershed coordinator developed a group of broad categories to utilize within the planning process to develop problem statements, identify priority areas, and set goals for watershed and water quality improvement. The process of developing problem statements began with an investigation of stakeholder concerns and data collected during the watershed inventory process.

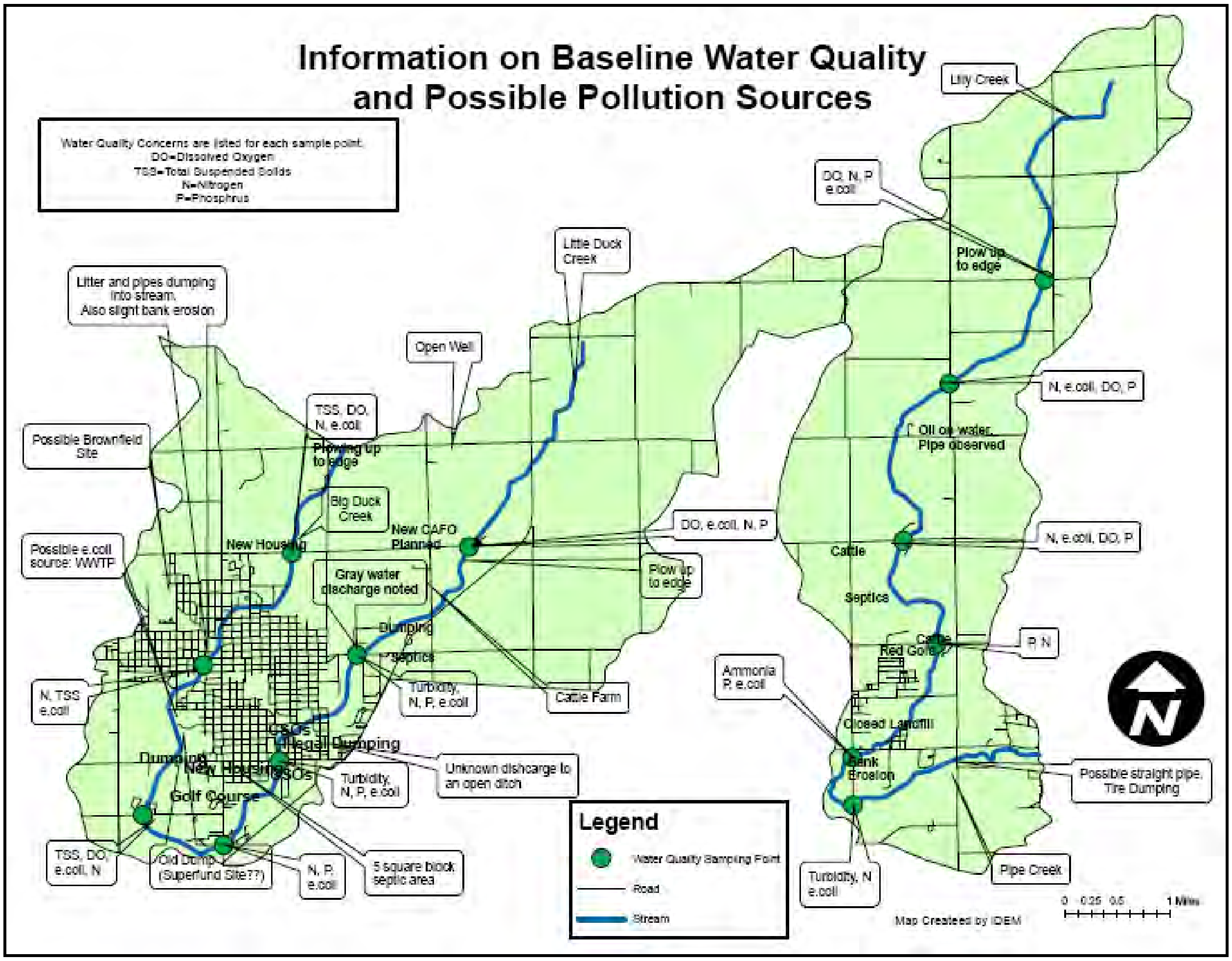


Figure 7 - Baseline Water Quality & Possible Pollution Sources.

4.11 Developing Problem Statements

Problem statement development occurred throughout the planning process in an effort to tie watershed stakeholders' concerns with existing data and develop a clear pathway for future work in the Lilly Creek and Little Duck Creek watershed. Once the problem statements were approved, the stakeholders were surveyed and asked to rank the problem statements in order from most important to least important. The problem statements below are presented in order of importance.

Problem Statement 1:

Pathogen levels in the watershed regularly exceed the state standard of 235 colonies/100mL, and often exceed safety standards for partial human contact with the water (1,000 colonies/100mL)

Stressor:	E. coli
Potential Sources:	Failing septic systems
	Agricultural fields where manure surface application are used
	Livestock and horse access to creeks-three sites

Natural wildlife, waterfowl, and pets
City of Elwood's 14 combined sewer overflows – Big Duck Creek

Problem Statement 2:
Sediment carried through the watershed is degrading and filling creeks and limiting their use for drainage, wildlife habitat, recreational, and aesthetic purposes.

Stressor: Silt/Sediment
Potential Sources: Lack of soil conservation practices in agricultural fields
Livestock and horse access to streams
Bank erosion
Construction activities

Problem Statement 3:
Elevated nitrate levels, documented in historic and recent water quality sampling, are negatively affecting the quality of downstream surface waters.

Stressor: Nutrients
Potential Sources: Soil Erosion
Agricultural fertilizers (both manure & synthetic)
Residential lawn fertilizers
Livestock and horse access to streams
Industrial waste
Household waste

Problem Statement 4:
Elevated phosphorus levels, documented in historic and recent water quality sampling, are negatively affecting the quality of downstream surface waters.

Stressor: Nutrients
Potential Sources: Soil Erosion
Agricultural fertilizers (both manure & synthetic)
Residential lawn fertilizers
Livestock and horse access to streams
Industrial waste
Household waste

Problem Statement 5:
Residents in the watershed are not knowledgeable about their daily impact on the watershed and how it impacts to water quality

Stressor: Lack of public education
Potential Sources: Improper or no septic maintenance
Residential lawn care – application of fertilizers and herbicides
Improper disposal of pet waste
Storm sewer recognition

4.12 Linking Problem Statements to Concerns

The following reflects the stakeholders' concerns and identifies the corresponding problem statement.

Concerns	*Problem Statement #*
Public needs to be educated about water quality issues	1,2,3,4
Educate community leaders who influence relevant ordinances	1,2,3,4
Identify and accentuate farms practicing conservation tillage	1,2,3,4
Identify and accentuate eco-friendly lawn care professionals and cleaners	4
Database management	4
Combined sewer overflows	1,3
Poorly installed and/or maintained septic systems	1,4
Livestock impact in creeks	1,2,3
Wildlife impact in creeks	1,2,3
Restricted recreational use (fishing, swimming, boating)	1,2,3,4
Need to identify source of e. coli	1,2,3
Stream bank erosion	1,2,3
Impaired drainage	2
Manure management	1,2,3
Proper application of pesticides and fertilizers	1,3,4
Use of agricultural conservation practices	1,2,3,4

Table 9 – Linking Problem Statements to Concerns.

5.0 CRITICAL AREAS

Taking into consideration all of the data collected throughout the planning process, the following critical areas were developed.

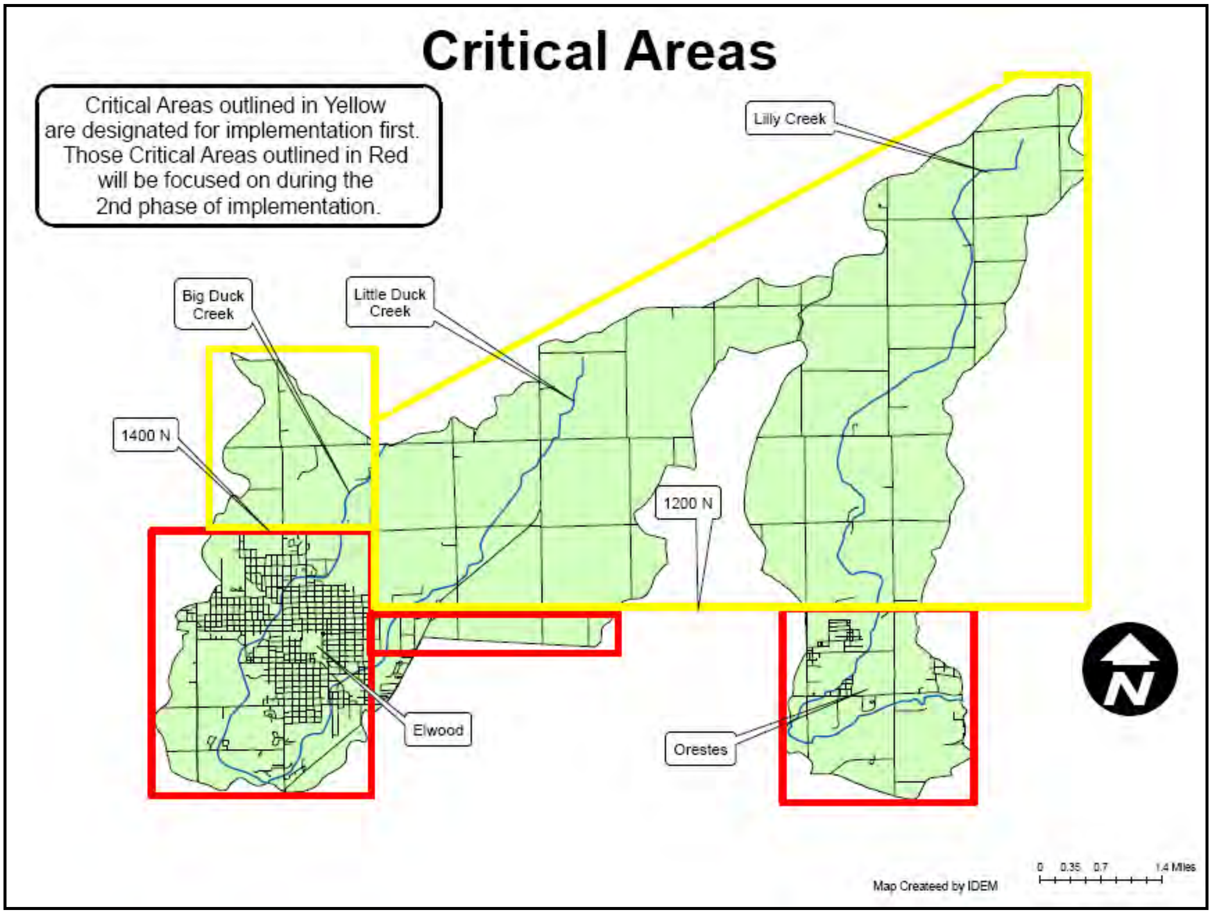


Figure 8 – Critical Areas – Agriculture and Urban

Critical Area #1

Agricultural areas that are conventionally tilled and/or lacking buffers

Through the planning process it was determined that inadequate levels of conservation tillage or no-till practices are occurring and there are large stream segments lacking buffers. (See Figures 10 and 11 below) The figures illustrate the locations of areas with adequate buffers. They also point out areas of concern or where riparian buffer areas can be improved. This can cause erosion and surface runoff of nutrients, chemicals, and sediment. All six sample sites in the agricultural areas had Qualitative Habitat Evaluation Index (QHEI) scores considered to be non-supporting for the stream's aquatic life use designation. These results do not correspond with the IDEM 2006 303d list. Due to the results of the chemical and biological assessments along with the location of headwaters the following is critical area #1. The following critical areas are prioritized for when implementation monies become available.

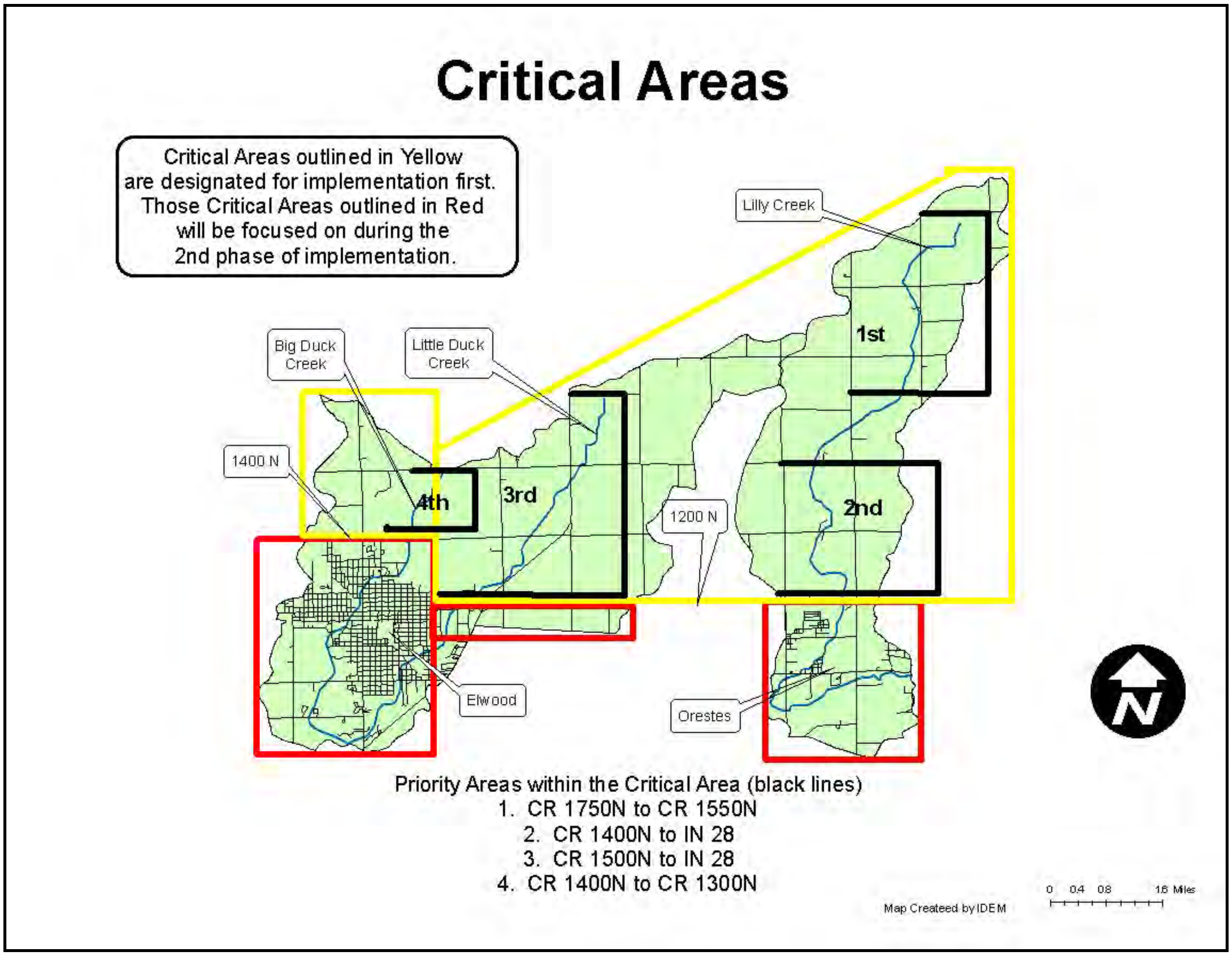


Figure 9 – Critical Areas by priority

Lilly Creek: CR 1750N to 1200N (5.5 miles)

1. **CR1550N** to **CR1750N** is the first priority area on Lilly Creek needing BMP's. This **headwater** area is lacking adequate buffers and there is heavy muck/silt deposition that is extensive. Channelization, canopy removal, and one of the lowest QHEI scores affects this stream segment. This area needs nitrate and E. coli reductions.

2. **CR1400N** to **SR28 (CR1200N)** is the second priority area on Lilly Creek needing BMP's. This area has the highest E. coli reductions needed and cattle have access to the stream at SR28. There are also five ten-apartment buildings on septic fields located west of Lilly Creek on CR1400N that house migrant workers. This area is lacking adequate buffers and there is heavy muck/silt deposition that is extensive. Channelization, canopy removal, and low QHEI scores affect this stream segment. Nitrates need to be reduced and this was the only area needing a TSS (total suspended solid) load reduction.

Little Duck: CR 1500N to 1200N (3 miles)

3. **CR700W** heading north-east to **CR1500N** is the third priority area needing BMP's. This **headwater** area is lacking adequate buffers and there is heavy muck/silt deposition that is extensive. Channelization, canopy removal, and a low QHEI score effect this stream segment. This area needs nitrate and E. coli reductions. Horses have access on the west side where Little Duck Creek goes under IN37 just south of CR1400N. During a windshield survey it was noted that surface applied manure was present on the east side of CR700W west of the creek. Cattle also have access on the west side where the creek passes under 700W just north of IN37.

Big Duck: CR 1400N to 1300N (1 mile)

4. **CR1300N to CR1400N** is the fourth priority area needing attention BMP's. This area is lacking adequate buffers and there is heavy muck/silt deposition that is extensive. Channelization, canopy removal, and one of the lowest QHEI scores affects this stream segment. This area needs nitrate and E. coli reductions.

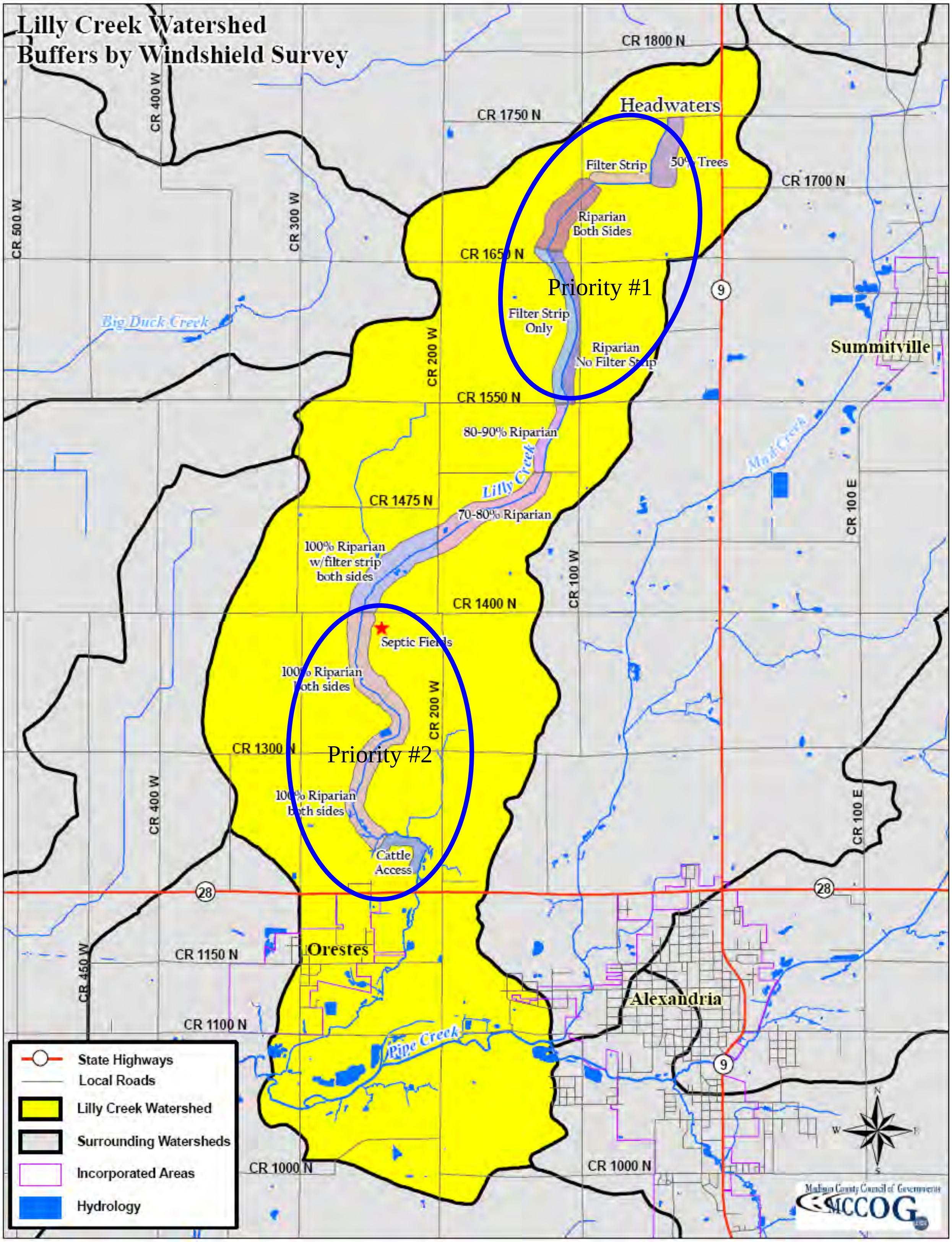


Figure 10 – Lilly Creek Buffers

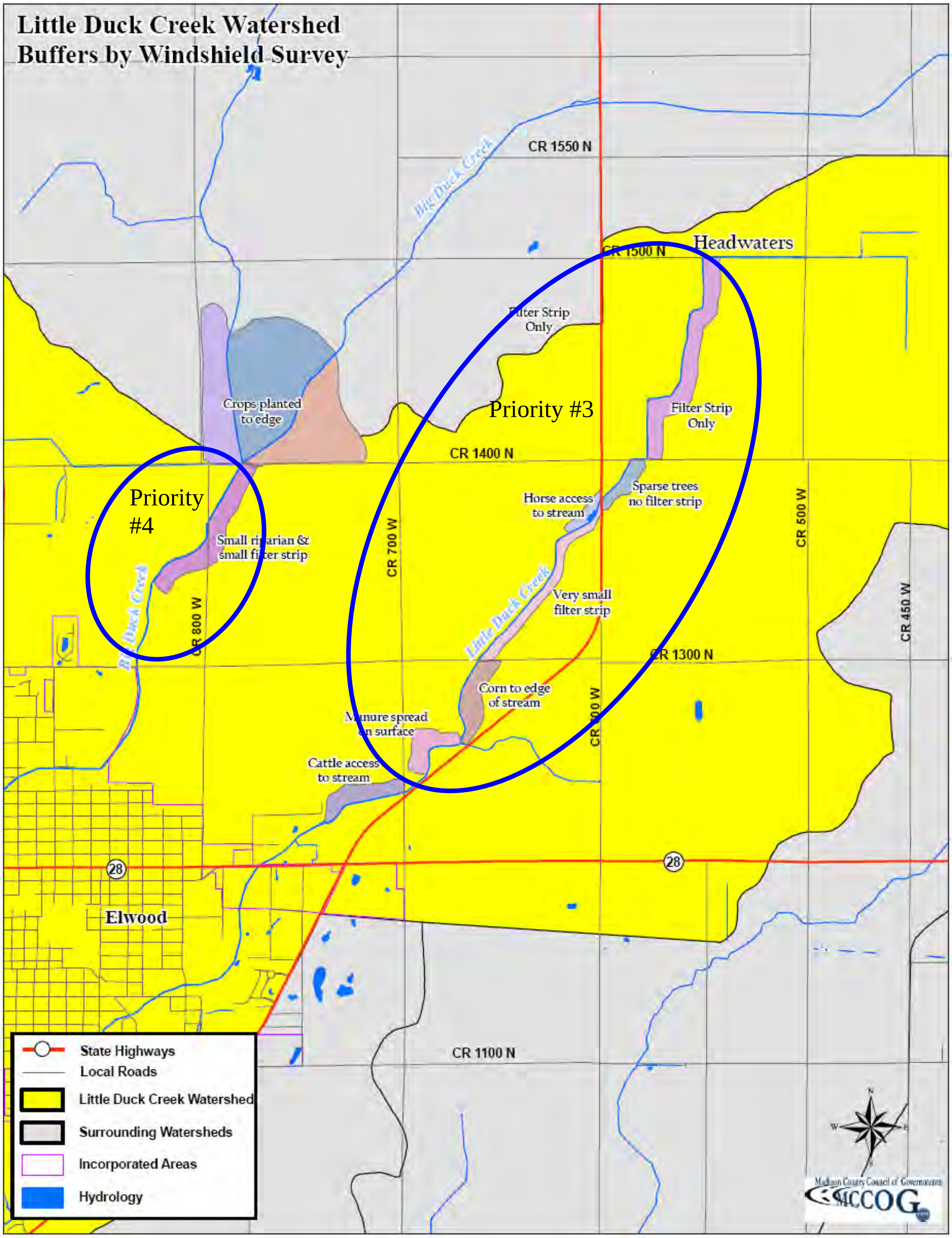


Figure 11 - Little Duck Buffers

Critical Area #2

Urbanized areas (specifically the Town of Orestes and the City of Elwood)

Throughout the planning process E. coli was cited as a major issue of concern. The chemical assessments show extremely high levels of E. coli at sampling site #1 (CR 1050N). The City of Elwood has 14 combined sewer overflows. Storm sewers shorten the transport of storm water runoff and can increase the quantity of sediment and other pollutants in the streams. Four of the seven sample sites in the urban areas had Qualitative Habitat Evaluation Index (QHEI) scores considered to be non-supporting for the stream's aquatic life use designation. These results do not correspond with IDEM 2006 303d list. The stream segments in the urban areas all need to have trash and debris removed. Citizens need to be educated about proper disposal of pet wastes, petroleum products, paints, and proper use of yard fertilizers and herbicides. Citizens need to be aware of what urban BMP practices they can utilize to reduce runoff from their residential sites.

Critical area # 2 is the following locations:

Lilly Creek: CR 1200N to 1050N (1.5 miles)
Little Duck: CR 1200N to 1025N (1.75 miles)
Big Duck: CR 1300N to 1025N (2.75 miles)

These three stream segments have the highest QHEI scores at the farthest reach from the headwaters. This may be due to increased flow rates. Five of the sixth highest E. coli reductions needed occurred in these urban stream segments. Big Duck Creek at CR1050N is below the Elwood Waste Water Treatment Plant and recorded the highest E. coli reduction needed at 99.72%. Little Duck Creek at SR13 was second at 98.90%.

6.0 SETTING GOALS

6.1 Potential Goals and Techniques

To address the problem statements, goals were developed and techniques identified for accomplishing the goals. Initial goals were derived from the stakeholder concerns and resulting problem statements. During the July, 2006 stakeholder meeting, steering committee members reviewed and refined the potential goals, and then prioritized them according to the problem statements to which they applied. The potential goals and techniques listed below were developed.

Potential Goal 1

Reduce the concentrations of E. coli in the watershed to meet the state standard of 235 colonies/100mL by 2030.

Potential Techniques:

- Determine specific sources of E. coli
- Replace failing septic systems and encourage routine maintenance
- Restrict livestock and horse access to creeks in Lilly and Little Duck creeks

- Promote conservation practices to agricultural and residential stakeholders
- City of Elwood reduces 14 CSO's as funding becomes available

Potential Goal 2
Reduce the sediment load during storm events to Lilly Creek & Little Duck Creek watershed by 25% over the next ten years.

Potential Techniques:
- Promote conservation tillage
- Riparian buffers, filter strips, grassed waterways
- Enforcement of erosion control ordinances
- Restrict horse and cattle access to streams
- Place the watershed on a regulated drain maintenance program

Potential Goal 3
Reduce the nitrate loads in Lilly Creek & Little Duck Creek watershed by 15% over the next five years.

Potential Techniques:
- Promote conservation tillage
- Riparian buffers, filter strips, grassed waterways
- Restrict horse and cattle access to streams
- Replace failing septic systems and encourage routine maintenance
- Proper residential lawn care and storm sewer awareness
- Manure management practices program

Potential Goal 4
Reduce the phosphorus loads in Lilly Creek & Little Duck Creek watershed by 15% over the next five years.

Potential Techniques:
- Promote conservation tillage
- Riparian buffers, filter strips, grassed waterways
- Restrict horse and cattle access to streams
- Replace failing septic systems and encourage routine maintenance
- Proper residential lawn care and storm sewer awareness
- Manure management practices program

Potential Goal 5
Increase stakeholder participation in implementation of the Lilly Creek & Little Duck Creek WMP.

Potential Techniques:
- Outreach (newsletters, press releases, SWCD website)
- Coordination with local community groups or units of local government

- Public education (field days, BMP tours)
- Promote other governmental agency conservation programs (CREP, CRP, EQIP, Hoosier Heartland RC&D)

6.2 Final Goals and Objectives

The following goals and action plan are a result of several public and steering committee meetings. The plan is designed to address critical area # 1 during the first five years of the cost-share implementation phase. The urban component of the implementation cost-share program focusing on critical area #2 will occur during years 5 through 10 and involve another funding source.

To achieve these goals the Farm Service Agency, Indiana State Department of Agriculture and Natural Resources Conservation Service will assist the Madison County Soil & Water Conservation District in the execution of a cost-share program marketing agricultural BMPs. The agricultural BMPs could include but are not limited to conservation tillage, riparian buffers, filter strips, grassed waterways, field borders, and livestock exclusion fencing. The primary focus will be to develop and implement a cost-share program for equipment modifications for no-till and reduced till. Estimated costs of equipment modifications are $500 - $600 per planter row. The steering committee strives to convert 1/3 of the cropland to no-till within five years and 2/3 of the cropland within 10 years. One third of the cropland changing from conventional tillage to conservation tillage practices will allow for target sedimentation, nitrate and phosphorus load reductions to be achieved. Another goal of the steering committee is to have 30 acres of filter strips installed within 10 years. The estimated cost per acre of filter strip is $65-150.

The sedimentation reductions found below in Table 10 and Table 12 were calculated using the USLE (Universal Soil Loss Equation) for cropland with less than 3% slope. 30% residue was used for the conservation tillage calculations. The actual reductions in sedimentation and nutrients will be greater because some of the ground is strip-tilled which leaves at least an 85% residue cover.

The nutrient reductions found in Table 11 and Table 12 were calculated using IDEM's Region V model. The data generated for Tables 10 through 12 are located at the Madison County SWCD.

**Table 10 - Plan for Best Management Practices Implementation
Sedimentation Reduction Table**

Priority Ranking	Creek	Location of BMP	Best Management Practice	Number of Acres	Sediment Reduction in tons/year	Responsible Party
1	Lilly	CR1550N to CR1750N	Conservation Tillage	1,280	4,736	SWCD
2	Lilly	SR 28 to CR1400N	Conservation Tillage	1,280	4,736	SWCD
3	Little Duck	CR700W to CR1500N	Conservation Tillage	1,920	7,104	SWCD
4	Big Duck	CR1300N to CR1400N	Conservation Tillage	640	2,368	SWCD
TOTALS				5,120	18,944	

Implementation will start during the first quarter and continue throughout the contract time period until the implementation monies are exhausted. All BMP's will be ranked and implemented by proximity to the waterway and with regard to the load reductions that can be attained. The Madison County SWCD will be the responsible party for all conservation tillage rankings and equipment modifications. The NRCS, ISDA, Hoosier Heartland RC & D, and CREP will be the responsible parties for the installation of filter strips, riparian wildlife habitat areas, and grassed waterways.

Table 11 - Nutrient Reduction Table

Priority Ranking	Creek	Location of BMP	Best Management Practice	Number of Acres	Nitrogen Reduction pounds/year	Phosphorus Reduction pounds/year
1	Lilly	CR1550N to CR1750N	Conservation Tillage	1,280	5,133	2,568
2	Lilly	SR 28 to CR1400N	Conservation Tillage	1,280	5,133	2,568
3	Little Duck	CR700W to CR1500N	Conservation Tillage	1,920	7,394	3,699
4	Big Duck	CR1300N to CR1400N	Conservation Tillage	640	2,751	1,376
TOTALS				5,120	17,872	8,944

Table 12 – Long Range Estimated Load Reductions in Critical Areas 1-4 Combined

Year	Post BMP-years	Sediment Reduction-Tons	Nitrogen Reduction-Tons	Phosphorus Reduction-Tons
2010	2	37,888	35,744	17,888
2015	7	132,608	125,104	62,608
2020	12	227,328	214,464	107,328
2025	17	322,048	303,824	152,048

Once implemented, this watershed management plan will exceed the goals for sediment, nitrogen, and phosphorus reductions by the year 2015 . The E. coli loads will be reduced due to conservation tillage practices and other best management practices listed in this plan. The

In focusing on critical area # 2, cooperation from the town and city officials will be needed. The Orestes town council president serves as the steering committee president and the mayor of Elwood has also been involved throughout the planning process as well as other city of Elwood employees. Storm drains prevent flooding of roads and neighborhoods by carrying rain and snowmelt away from streets and sidewalks. Unlike water from our taps and tub, water flowing into storm drains is not treated. Storm drains connect directly into our streams. Trash, pet waste, motor oil, paint, and other materials dump or wash into storm drains into Lilly, Little Duck, and Big Duck Creeks. Markers on each storm drain will remind the citizens to keep storm drains and our streams clean. The Cattails Country Club in Elwood could help by installing buffer strips along the southern edge of the property close to Big Duck Creek.

The following are the prioritized goals and respective action plans for the Lilly Creek & Little Duck Creek watershed.

Goal 1: The watershed group aspires to reduce E. coli to the state standard of 235 colonies/100mL by 2030 and educate stakeholders on BMPs available to reduce pathogenic contamination of the Lilly Creek & Little Duck Creek watershed.

Implementation Items:

- Elwood reduces the current 14 CSO’s as funding becomes available.
- Develop and distribute residential flyers to help with individual lot reductions in stormwater run off.
- Develop and distribute a summary of BMPs available to reduce the risk of pathogenic contamination of waterbodies in the Lilly Creek and Little Duck Creek watershed. The list should include management techniques to address contamination from all potential sources. In addition, the list should be written to target a non-technical audience.
- Conduct a conservation tillage marketing program.
- Develop and implement a cost-share program for Best Management Practices (BMPs). BMPs could include but are not limited to conservation tillage, riparian

buffers, filter strips, grassed waterways, field borders, and horse and livestock exclusion fencing.

Education Items: Education will take place during the first two years.

- Mail septic system repair and maintenance brochures to residents of the watershed
- Conduct a tour of city sewage treatment plant.
- Conduct a field day to educate the public on agricultural BMPs.
- Develop and distribute nonpoint source pollution education newsletters and press releases.
- Maintain watershed website and advertise it at outreach events.
- Conduct a conservation tillage marketing program.

Goal 2: By the year 2015, reduce the nitrate load during storm events to Lilly Creek and Little Duck Creek watersheds by 15%.

Implementation Items:

- Develop and implement a cost-share program for Best Management Practices (BMPs). BMPs could include but are not limited to conservation tillage, riparian buffers, filter strips, grassed waterways, field borders, and livestock exclusion fencing.

Education Items:

- Conduct a field day to educate the public on agricultural BMPs.
- Develop and distribute nonpoint source pollution education newsletters and press releases.
- Maintain watershed website and advertise it at outreach events.

Goal 3: By the year 2015, reduce the phosphorus loads to Lilly Creek and Little Duck Creek watersheds by 15%

Implementation Items:

Conduct a conservation tillage marketing program.

- Develop and implement a cost-share program for Best Management Practices (BMPs). BMPs could include but are not limited to conservation tillage, riparian buffers, filter strips, grassed waterways, field borders, and livestock exclusion fencing.

Education Items:

- Conduct a field day to educate the public on agricultural BMPs.
- Develop and distribute nonpoint source pollution education newsletters and press releases.
- Maintain watershed website and advertise it at outreach events.

Goal 4: Increase stakeholder participation in implementation of the Lilly Creek and Little Duck Creek WMP.

Implementation Items:

- Promote other governmental agency conservation programs (CREP, CRP, EQIP, Hoosier Heartland RC&D)
- Coordinate with local community groups or units of local government to conduct creek clean-ups, label storm drains, promote soil & water conservation 4H projects, etc.
- Utilize city, county, and state politicians to leverage involvement.
- Conduct a conservation tillage marketing program.

Education Items:

- Develop and distribute nonpoint source pollution education newsletters and press releases.
- Maintain watershed website and advertise it at outreach events.

7.0 MEASURING SUCCESS

Measuring the success at achieving the stakeholders' goals and assessing the progress towards realizing their vision for the Lilly Creek and Little Duck Creek watershed is an important component of this plan. Success will be measured by the following:

- Reversing the negative trend for no-till corn and beans in Madison County utilizing the 2007 & 2009 Madison County Tillage Transect. We would like to increase no-till corn by 10% by the 2009 Tillage Transect.
- Increase public attendance at conservation tillage field days, BMP tours, public meetings, steering committee meetings, creek clean-ups, etc.
- Counting the number of new CRP, CREP, EQIP, etc. applications.
- Geolocating newly installed BMPs.
- Improvement of chemical and biological assessments as determined by future testing.
- Reduction in sediment and nutrient loading as determined by future testing.
- Pre and post implementation surveys to stakeholders.

8.0 CONCLUSION

The successful implementation of the WMP in the Lilly Creek and Little Duck Creek watersheds will have allowed producers to participate in a cost-share program that directly benefits all stakeholders by improving water quality. Conservation tillage in this 35 mile square headwater area is the single best management practice that can help reduce E. coli, sedimentation, nitrates, and phosphorus. This practice used in combination with riparian buffers, filter strips, grassed waterways, with horse and cattle exclusion fencing will help improve the water quality of these streams while also improving wildlife habitat and recreation opportunities. This watershed management plan will exceed the goals for nitrogen, and phosphorus reductions by the year 2105. With the expected implementation to begin in 2008, the initial outcome is expected to take us to at or over our goals for the first critical area. Further improvements to be implemented in a subsequent phase to address the second downstream critical priority area.

9.0 REFERENCES CITED

APHA-AWWA-WPCF, 1998. Standard Methods for the Examination of Water and Wastewater. 15th edition, APHA, Washington, USA.

City-data.com, 2005a. Anderson, Indiana. Accessed August 29, 2005 from http://www.city-data.com/city/Anderson-Indiana.html

Correll, D.L., 1998. The Role of Phosphorus in the Eutrophication of Receiving Waters: A Review. J. Environ. Qual. 27:261-266.

Hilsenhoff, W.L., 1988. Rapid field assessment of organic pollution with a family-level biotic index. Journal of North American Benthological Society. 7(1):65-68.

Hoosier Riverwatch Training Manual, 2004.

Indiana Department of Environmental Management (IDEM), 1998. Indiana Water Quality Report. Annual Report: IDEM/34/02/002/1998.

Indiana Department of Environmental Management (IDEM), 2006. Indiana Water Quality 305(b) Reports. http://www.in.gov/idem/owm/planbr/wqs/quality.html. Accessed July, 15 2006.

Indiana Department of Environmental Management (IDEM), 2006. Section 303(d) List of Impaired Water Bodies for Indiana. http://www.in.gov/idem/owm/planbr/wqs/303d.html. Accessed July 15, 2006.

Indiana Department of Natural Resources, 1999. Endangered, threatened and rare species documented from Madison County, Indiana. http://www.state.in.us/dnr/naturepr/species/madison.pdf Accessed September 20, 2005.

Karr, J.R. and D.R. Dudley, 1981. Ecological perspective on water quality goals. Environmental Management. 5:55-68.

Karr, J.R. and E.W. Chu, 1999. Restoring life in running waters. Island Press, Washington D.C.

McCafferty, W.P., 1981. Aquatic Entomology. Jones and Bartlett Publishers, Sudbury, Massachusetts p.447.

Ohio Environmental Protection Act (OEPA), 1999.

Simon, Thomas, 2004. Assessing the Fish Communities and Habitat Quality of the Upper White River Tributaries from Indianapolis to Muncie, Indiana. US Fish & Wildlife Service, Bloomington, IN.

U.S. EPA, 1976. Quality criteria for water. EPA-440/9-76-023 or PB-263943. National Technical Information Service, Springfield, VA.

U.S. EPA, 2000. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health. EPA-822-B-00-004. Office of Science and Technology Office of Water U.S. Environmental Protection Agency. Washington D.C.

U.S. Department of Agriculture, 1967. Soil Survey Madison County Indiana. Washington D.C.

Walker, R.G., 1978. Deep-water Sandstone Facies and Ancient Submarine fans: Models for Exploration for Stratigraphic Traps. American Association of Petroleum Geologists Bulletin 62:932-966.

Waters, TE., 1995. Sediment in Streams: Sources, Biological Effects and Control. American Fisheries Society: Bethesda, MD

Special Thanks for Support, Leadership, and Technical Assistance

I would like to thank the stakeholders who live in the Lilly and Little Duck watersheds for their participation in this project.

I would like to thank the Madison County Soil and Water Conservation District and their Supervisors for sponsoring this 319 grant. I would like to acknowledge Laura Fribley, who was the Watershed Coordinator for the first year. Janelle Parke provided assistance with the production of the watershed newsletters and coordination of the steering committee meetings. Shannon Adams provided administrative assistance.

The Steering Committee and the sub-committees provided invaluable assistance throughout this entire project.

Sara Peel from JF New provided technical assistance with the QAPP, QHEI, and all of the biological and chemical assessments.

The Madison County surveyor, Brad Newman served as a steering committee member and also helped with aerial pictometry assessment of stream buffers.

The Madison County Council of Governments provided assistance with the generation of the watershed maps. Thanks to Trent Pell and Rob Shumowski.

The Indiana State Department of Agriculture (ISDA) provided technical planning for conservation practices installed through the Conservation Reserve Enhancement Program (CREP). Thanks to Doug Walker.

The Natural Resources Conservation Services (NRCS) also provided technical assistance. Thanks to Mike Hughes and Told Herrli who were the District Conservationists.

Judy Delury is an Associate Supervisor at the Madison County SWCD and a steering committee member. Judy assisted Brad Newman in gathering buffer information from aerial pictometry and completed all of the GIS requirements for this project.

Trinka Mount from the Ohio-EPA-TMDL section helped with establishing nutrient targets and provided reference materials.

The following people from the Indiana Department of Environmental Management (IDEM) helped during this two and a half year process: Bonny Elifritz, Sky Schelle, Pam Brown, Tim Kroeker, Joanna Land, Kathleen Hagan, Steve West, Nathan Rice, and Ernie Johnson.

Mayor Merrill Taylor and Bill Savage provided assistance from the City of Elwood.

John Shettle provided assistance from the Town of Orestes.

Thank you for all of your help in making this watershed management plan.

Crist Blassaras-Watershed Coordinator

Quality Assurance Project Plan
for
Lilly Creek and Little Duck Creek Watersheds
Watershed Management Plan
in
Madison County, Indiana

A305-5-112

Prepared by:

JFNew
Madison County Soil and Water Conservation District

Prepared for:

Indiana Department of Environmental Management
Office of Water Management
Watershed Management Section

Final Draft
July 12, 2005

Approved By:

Project Manager: ______________________________ __________
Sara Peel Date

WMS QA Manager: ______________________________ __________
Betty Ratcliff Date

WMS Section Chief: ______________________________ __________
Linda Schmidt Date

Planning Branch Chief: ______________________________ __________
Martha Clark Mettler Date

TABLE OF CONTENTS

PAGE

List of Appendices

List of Figures

List of Tables

Distribution List

Betty Ratcliff, IDEM Quality Assurance Manager
Watershed Management Section
Indiana Department of Environmental Management
100 North Senate Avenue
P.O. Box 6015
Indianapolis, Indiana 46206-6015

Pamela Brown, IDEM Project Manager
Watershed Management Section
100 North Senate Avenue
Mail Code 65-40
Indianapolis, Indiana 46206-6015

Sara Peel, Project Manager, JFNew
708 Roosevelt Road
Walkerton, IN 46574

Laura Fribley, Madison County SWCD
182 W. 300 N., Suite D
Anderson, IN 46012

Joe Exl, Project Technician, JFNew
708 Roosevelt Road
Walkerton, IN 46574

Section 1: Study Description

Historical Information

The Lilly Creek and Little Duck Creek watersheds include the two 14-digit watersheds that drain Lilly Creek and Little Duck Creek. The Lilly Creek and Little Duck Creek watersheds encompasses all of two 14-digit watersheds including the Pipe Creek-Lilly Creek watershed (HUC 05120201050060) and the Duck Creek-Little Duck Creek watershed (HUC 05120201060020) within the larger West Fork White River basin (HUC 05120201). The watersheds include nearly 22,672 acres or 35 square miles. Drainage from the Lilly Creek watershed flows into Lilly and Pipe Creeks, which combine at the downstream edge of the 14-digit watershed. Likewise, the Little Duck Creek watershed contains the entirety of the Little Duck Creek drainage; however, only a portion of the Big Duck Creek drainage is contained within this 14-digit watershed (Figure 1). Water drains from Lilly Creek to Pipe Creek and from Little Duck Creek to Big Duck Creek. Pipe Creek and Big Duck Creek both flow into the West Fork White River near Perkinsville and Strawtown, respectively.

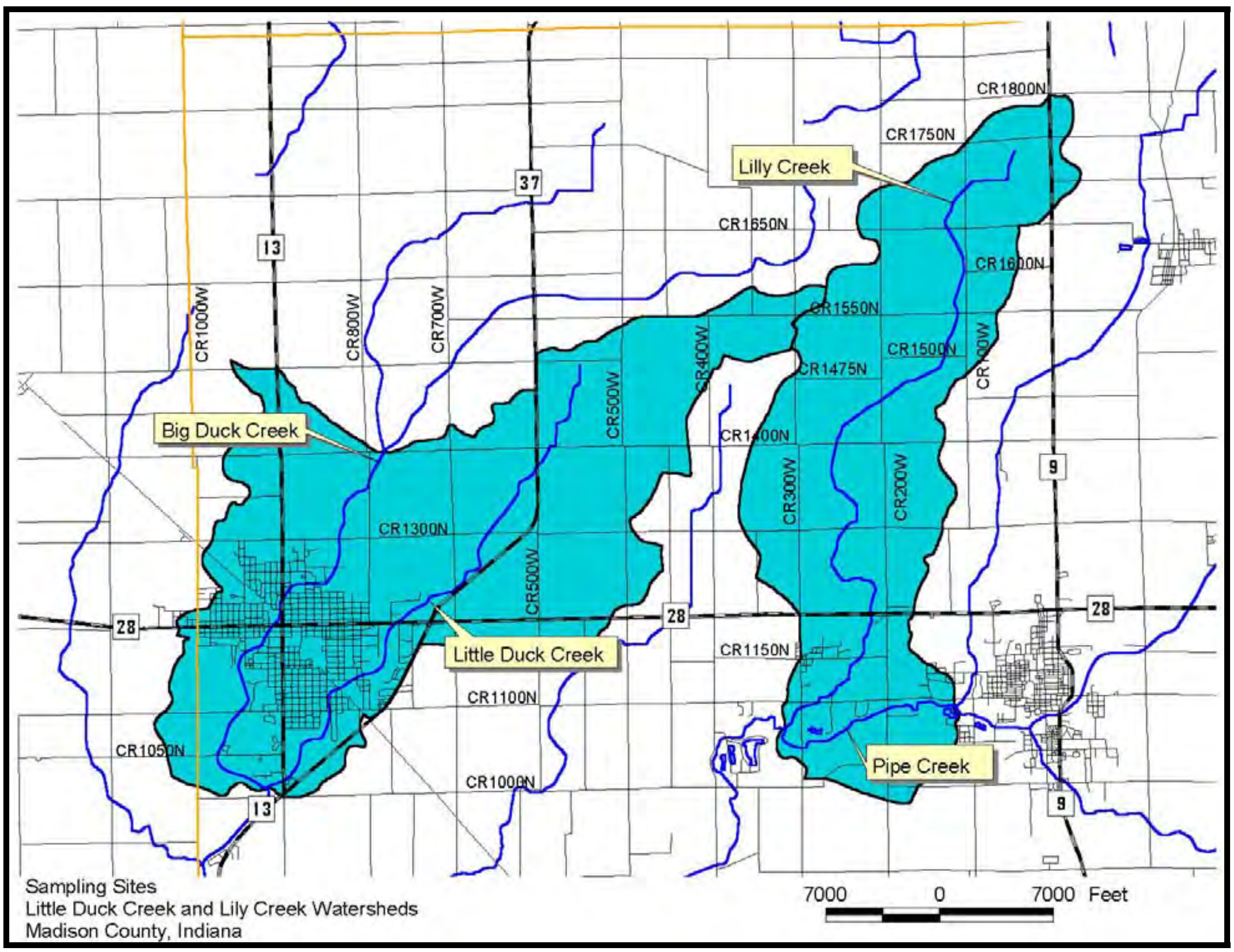


Figure 1. 14-Digit watersheds within the Lilly Creek and Little Duck Creek watersheds.

State and local agencies have conducted a number of water quality studies that focus on waterbodies in the Lilly Creek and Little Duck Creek watersheds. In the 1992-93 305(b) report, IDEM indicated that Lilly Creek was fully supporting for its aquatic life use designation, but was non-supporting for recreational usage due to high *E. coli* concentrations. During the same assessment period, Duck Creek was found to be non-supporting for both is recreational and aquatic life use due to high E. coli concentrations, combined sewer overflows, and wastewater treatment plan by-passes. The 1994-95 305(b) report reported similar results. Sampling completed by IDEM in 2001 indicate that pathogen concentration remain high in both the Lilly Creek and Little Duck Creek watersheds. *E. coli* concentrations greater than the state standard were observed at multiple sample sites throughout both watersheds. Additionally, total phosphorus concentrations were elevated within the Lilly Creek watershed during one sample collection and in the Little Duck Creek watershed on multiple occasions. Pipe Creek, Little Duck Creek, and Big Duck Creek are on the 2004 303(d) list of impaired waterbodies for high pathogen levels. Additionally, Pipe Creek is included on the 303(d) list of impaired waterbodies for impaired biotic communities, PCBs, and mercury.

Recognizing the need to include the entire Lilly Creek and Little Duck Creek watersheds in their ecological restoration efforts, the Madison County SWCD plans to work throughout the entire Lilly Creek and Little Duck Creek watersheds. To this end, the Madison County SWCD, along with watershed stakeholders, will develop a watershed management plan for the Lilly Creek and Little Duck Creek watersheds. Once completed, the plan will help prevent further ecological degradation of the watershed and guide future watershed management efforts to ensure the area's ecological health.

Study Goals

The goal of the sampling/water quality collection portion of this study is to determine the quality of water in the streams of the Lilly Creek and Little Duck Creek watersheds. Chemical, biological, and physical conditions of the selected inlet streams will be documented. The collection of this data will allow for the identification of problem areas, characterization of the watershed, and implementation of broad management decision making for the development of a watershed management plan for the Lilly Creek and Little Duck Creek watersheds. This information will be supplemented with historical data documenting the conditions of the watersheds such as land use, soils, and cultural resources and stakeholder concerns and issues discussed through watershed meetings. Data collected during this sampling will be combined with previously collected data to determine changes in the watersheds and will serve as baseline data for the tracking of water quality improvement success.

In summary, the goal of the sampling/water quality collection portion of this study is to determine the quality of water in the Lilly Creek and Little Duck Creek watersheds. This goal will be achieved with the following actions:

Action 1: Field and laboratory water chemistry data collection at each of the twelve sites four times annually for a two-year sampling period will include dissolved oxygen, temperature, pH, nitrate+nitrite, ammonia, total phosphorus, biological oxygen demand, total suspended solids, and *E. coli*.

Action 2: Collect discharge measurements at each sampling site for each of the four annual sampling events for the two-year sampling period to use in the calculation of pollutant loading.

Action 3: Conduct macroinvertebrate collection twice annually at each of the twelve sample sites over the two-year sampling period to assess the biological community.

Action 4: Conduct habitat assessment at each of the twelve sample sites once during the sampling period to assess physical stream conditions.

Action 5: Analyze chemical, biological, and physical data to allow for comparison with historical data and to provide baseline water quality information.

Action 6: Use chemical, biological, and physical data to evaluate and rank priority areas in the watershed and to develop recommendations for appropriate Best Management Practices to improve watershed water quality.

To achieve the goal of evaluating and ranking priority areas within the watersheds, standardized data collection methodology and analysis will be used for each of the sampling stations. Consistencies in methodology will ensure sampling stations can be compared to one another, enabling the Project Manager to determine which sites are most degraded relative to others in the watershed. Methodologies will follow those established and accepted by the scientific community and regulatory agencies (Indiana Department of Environmental Management (IDEM), Ohio Environmental Protection Agency (OEPA), and U.S. Environmental Protection Agency (USEPA)). For example, macroinvertebrates will be collected to assess the biological community using protocol developed by IDEM for rapid bioassessment. Macroinvertebrate data will then be analyzed using IDEM's macroinvertebrate Index of Biotic Integrity (mIBI). Standardized methodology and analysis will also allow comparisons to be made to past studies within and outside of the Lilly Creek and Little Duck Creek watersheds that have used these methodologies.

Study Site

The project site is the Lilly Creek and Little Duck Creek watersheds encompassing 35 square miles in northwestern Madison County, Indiana (Figure 1). Because the project's goal is to document the ecological conditions in the Lilly Creek and Little Duck Creek watersheds, the study will examine and/or identify the following parameters: 1.Water chemistry (pH, temperature, dissolved oxygen, nitrate+nitrite, ammonia, total phosphorus, total suspended solids, biological oxygen demand, and *E. coli*), 2. Riparian/stream habitat quality, and 3. Biological (aquatic macroinvertebrate) populations in the watershed.

Sampling Design

All parameters (water chemistry, macroinvertebrates, and habitat) will be collected and analyzed at each of the twelve sample sites. Sample sites were selected to achieve an accurate representation of the variety of stream habitat types found within the watershed. Preliminary site selection was based on map analysis. The map analysis consisted of locating tributaries with relatively large watersheds and accessible sampling points (road crossings). This approach was also taken in an attempt to have sampling stations that may be able to indicate which subwatersheds are contributing the most pollutants to the Lilly Creek and Little Duck Creek watersheds. The sampling stations selected based on this map analysis were then field checked by the Madison County SWCD for confirmation of site accessibility and appropriateness for the biological and physical assessment protocols (mIBI and QHEI). Following the field inspection, twelve sampling stations (six per 14-digit watershed) were selected for water chemistry, macroinvertebrate, and habitat assessment. Approximate locations of these sites are shown in Figure 2 and will be georeferenced during the course of the study. Appendix A provides additional details on the site locations. Landowners at these sampling stations will be contacted to obtain permission to conduct sampling in those areas. Should permission be denied, acceptable substitute stations will be selected using the same criteria outlined above. Any changes in sampling locations will be submitted as an addendum to this QAPP.

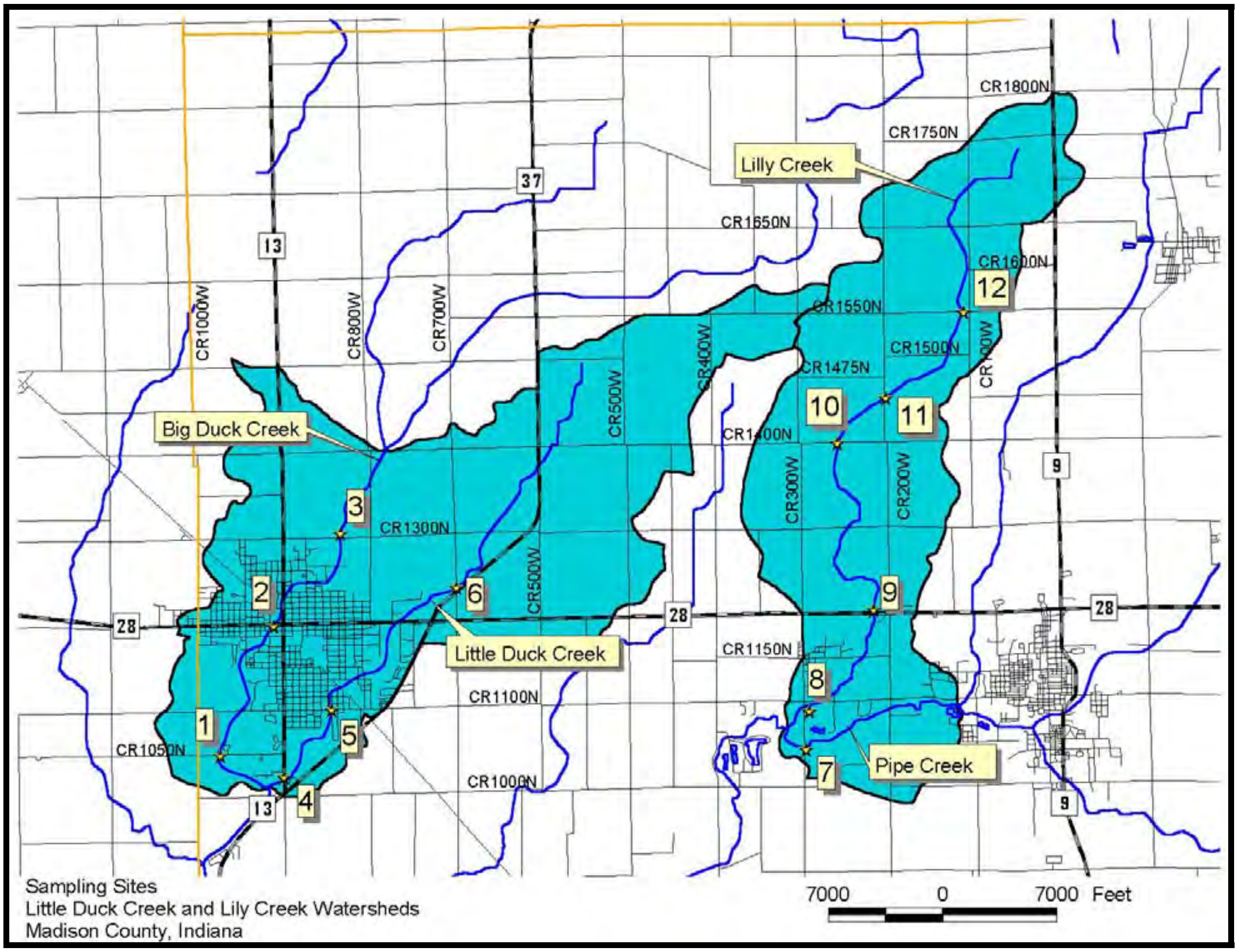


Figure 2. Sampling locations. Appendix A contains detailed sample site information.

JFNew will collect baseline stream water chemistry data at twelve sites within the Lilly Creek and Little Duck Creek watersheds (Figure 2). Specifics detailing sample site selection are included in Section 3. Details about each sample site including location and stream name is included in Appendix A. Water chemistry parameters to be sampled include nitrate+nitrite, ammonia, total suspended solids, total phosphorus, pH, dissolved oxygen, biological oxygen demand, *E. coli*, and temperature. Temperature, pH, and dissolved oxygen will be analyzed *in situ* with field equipment. Discharge will be measured at each site to allow loading calculations and comparison of relative contributions of each of the tributaries.

Water chemistry samples will be collected four times annually during the two-year study period for a total of eight sampling events. Samples will be taken three times during the growing season under base flow conditionas and once during a storm (peak) flow event on an annual basis. Water chemistry sampling events will be timed to capture samples from base flow and peak flow (1" or more of rain in a 24-hour period) events. If soils are saturated by previous storm events, a storm event releasing 0.75" of rain may be sufficient to produce runoff and will be used as a storm event sample. JFNew will use best professional judgment to determine if a rain event of less than 1" qualifies as a storm event. This timing allows collection during a wide range of temporal and seasonal factors that may impact water quality. The water chemistry sampling schedule is flexible to prevent sampling during inappropriate weather or when equipment is not working. Following each sampling event, water chemistry samples will be delivered to the appropriate, contracted laboratory. JFNew will deliver *E. coli* and BOD samples to ESG Laboratories in Indianapolis, Indiana. The remaining samples (nitrate+nitrite, ammonia, total phosphorus, and total suspended solids) will be sent to the Clean Lakes Program (CLP) Laboratory in Bloomington, Indiana for analysis of the remaining parameters. Water chemistry data gathered during this study will be compared to state and USEPA recommended criteria.

Macroinvertebrate sampling will occur twice annually during the two-year study period for a total of four sampling events. The biological sampling event will take place during low flow conditions in the summer, typically the greatest period of environmental stress for aquatic macroinvertebrate communities and in the all, typically the period of lowest stress for the aquatic macroinvertebrate community. Macroinvertebrates will be identified to family level to satisfy the project goal of surveying the entire watershed while staying within the project budget. Several researchers (Hilsenhoff, 1988, USEPA, 1989, and IDEM, Unpublished) have confirmed the appropriateness of using family level identification (vs. species level) to make broad scale management decisions as is the goal with this project. The aquatic macroinvertebrate community will be assessed using the Indiana Department of Environmental Management (IDEM) Rapid Bioassessment protocol (IDEM, unpublished).

Habitat sampling will occur once during the study period unless any of the sites undergo significant alterations. Habitat quality will be assessed using Ohio Environmental Protection Agency (OEPA) Qualitative Habitat Evaluation Index (QHEI) protocol (OEPA, 1989).

This sampling design reflects our sampling goals. Furthermore, the design allows JFNew to meet the goals to determine the quality of water in the Lilly Creek and Little Duck Creek watersheds and to evaluate and rank the conditions of the streams for subwatershed prioritization.

Study Schedule

Sampling station specific chemical, biological, and physical parameters will be sampled periodically throughout the project's two year sampling period (Table 1). Biological sampling will occur once during the summer and once during the fall during each year of the project. Habitat sampling will occur once during the first summer of the project. Chemical sampling will occur four times annually during the two year project. Chemical samples will be collected three times during base flow and once under storm flow conditions on an annual basis. Geolocation of sample sites will occur once during the sampling period.

Table 1. Parameters studied.

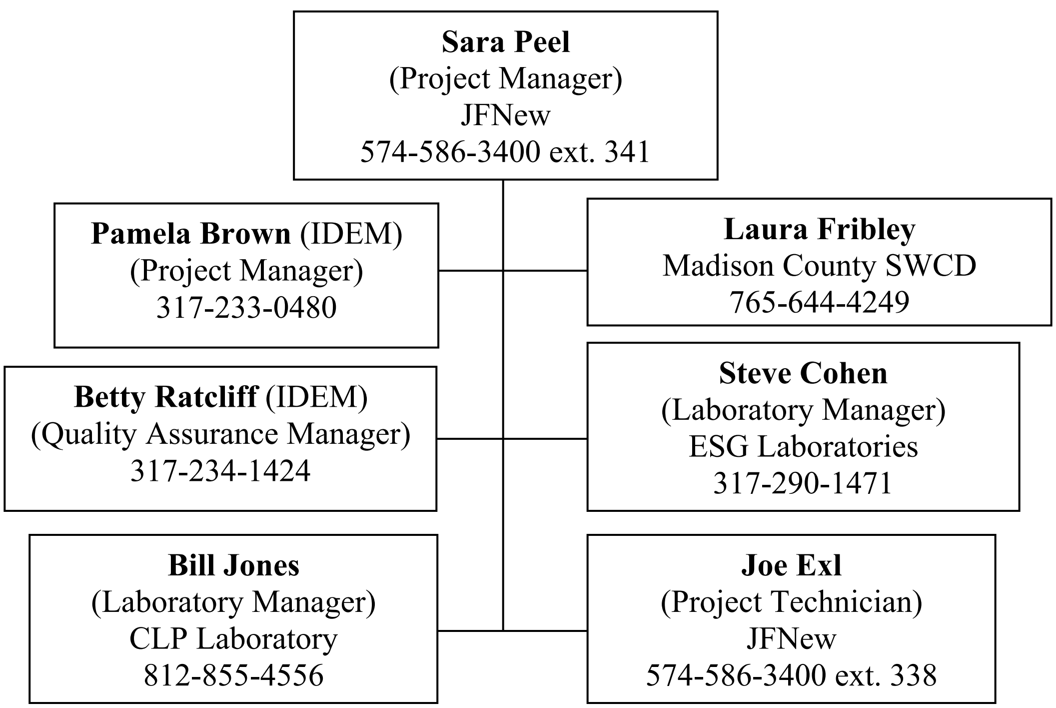
	Type of Sample/ Parameter	Number of Sampling Stations	Sampling Event Frequency	Sampling Period
Biological	Macroinvertebrate	12	4	Summer 2005-Fall 2006
Physical	Habitat	12	1	Summer 2005
Chemical	Water Chemistry*	12	8	Summer 2005-Fall 2006
	Discharge	12	8	Summer 2005-Fall 2006
Geolocation	GPS	8	1	Summer 2005

*Water chemistry samples will be analyzed for temperature, dissolved oxygen, pH, nitrate+nitrite, ammonia, total phosphorus, BOD, total suspended solids, and *E. coli*.

Section 2: Study Organization and Responsibility

Key Personnel

In general, JFNew will be responsible for the design, planning, execution, analysis and documentation of technical aspects of the project. The water-testing laboratories (Indiana Clean Lakes Program Laboratory and ESG Laboratires) will be responsible for chemical water quality analysis. The Madison County SWCD will be responsible for providing forums for public input and documenting the public's concerns and goals. Indiana Department of Environmental Management (IDEM) will provide the overall project guidance and assistance. Specific duties and responsibilities are outlined below.



In general, the Project Technician reports to the Project Manager and Project Manager coordinates with the CLP Laboratory, ESG Laboratories, IDEM Quality Assurance Manager, IDEM Project Manager, and Madison County SWCD.

Project Organization

Project Technician is responsible for:

- QAPP development
- Collection of general watershed parameters
- Collection of historical water quality data
- Geolocation of sampling sites
- Water chemistry sampling
- Macroinvertebrate sampling
- Macroinvertebrate identification
- Habitat sampling
- Data entry for water chemistry, macroinvertebrate, and habitat samples
- Analysis of collected information

Project Manager is responsible for:

- Oversight of Project Technician's duties listed above
- Selection of sampling site locations
- Review water chemistry and habitat field data sheets prior to leaving sampling site
- Implementation of QAPP
- Water chemistry sampling
- Macroinvertebrate sampling
- Macroinvertebrate QA/QC
- Review of water chemistry, macroinvertebrate, and habitat data entry for completeness and accuracy
- Analysis of collected information

Section 3: Data Quality Objectives for Measurement of Data

The project goal is to obtain an overview of water quality in the Lilly Creek and Little Duck Creek watersheds from which a watershed management plan can be developed. Like many projects, this project has financial, temporal, and other constraints. For examples, we will collect physical, biological, and chemical data from each of the streams in the Lilly Creek and Little Duck Creek watersheds. Sites sampled on each of the streams will provide information on the relative pollutant inputs of each subwatershed. This information will prioritize one subwatershed over another subwatershed when evaluating where to spend limited funding. The sampling design will not; however, provide representative data for the whole watershed. Specificity will be sacrificed in order to obtain a greater quantity of general information on of the entire watershed, rather than specific information on a portion of it. For example, family level identification will be used rather than species level of the macroinvertebrate communities. This will allow for the collection of more data per level of effort. Researchers have already confirmed the acceptable use of family level identification to make broad management decisions and prioritize areas for future specific work (USEPA, 1989; IDEM, Unpublished; Hilsenhoff, 1988). Collecting information on this larger scale will allow for the collection of more data for the same cost as the collection of a lesser quantity of data at a small scale. Based on this, the general data quality objectives are to gather representative information on the ecosystem's health at a watershed scale, collect broad, watershed scale data to make broad conclusions, and perform collection by accepted protocols to ensure the effort can be repeated in the future.

Like any project, this project has financial and temporal constraints. The project goal is to document the ecological conditions of the watershed with special emphasis on water quality from which a watershed management plan can be developed. The project's data quality goals are based on this overall project goal. Based on this, the general data quality objectives for measurement of data are to gather representative information on the ecosystem to make broad conclusions, and perform collection by accepted protocols to ensure the effort can be repeated in the future. The data quality objectives for measurement of data are precision, accuracy, representativeness, comparability, and completeness.

DQO: Precision and Accuracy

Field Water Chemistry Parameters

Field equipment will be calibrated in accordance with manufacturer's specifications as detailed in Section 6. Replicate field measurements will be taken with the following field equipment: the Hanna Instruments HI 98129 pH, EC/TDS and temperature meter; the YSI Model 55 dissolved oxygen/temperature meter; and Marsh McBirney model 2000 portable flow meter. One replicate will be taken in every twelve measurements or once per sampling event. Precision will be calculated using the Relative Percent Difference equation:

$$RPD = \frac{(C - C') \times 100\%}{(C + C')/2}$$

Where:
C = the larger of the two values
C' = the smaller of the two values

The acceptable relative percent difference for field water chemistry parameters is detailed in Table 2. Regular, schedule maintenance in accordance with manufacturer's instructions will be used to insure equipment precision and accuracy.

Field equipment will be calibrated following manufacturers specifications on the day of sample collection. Field equipment use will follow recommended usage by the equipment manufacturer. Expected accuracy measurements for field equipment measurements are those listed by the equipment manufacturers and are displayed in Table 2.

Laboratory Water Chemistry Parameters

The Project Manager and Project Technician (or two Project Technicians if the Project Manager is not available) will collect samples in accordance with the contracted laboratories' Quality Assurance/Quality Control (QA/QC) requirements. For all parameters analyzed by ESG Laboratories and the Indiana CLP Laboratory, this will include the collection of one duplicate sample in every twelve samples collected, or one duplicate sample per sampling event. One set of field blank samples (one sample per parameter) will be collected during each sampling trip. Duplicate and field blank sample analysis will occur following the laboratory procedure detailed in the laboratory QA/QC plans (Appendices B and C). The contracted laboratories will implement QA/QC measures to ensure data quality as detailed in the laboratories' QA/QC documents (Appendices B and C). Section 3 of the CLP Laboratory QAPP provides information on the procedures followed for these DQO's. The laboratory standards are sufficient to meet the stated goals of this project. Table 2 summarizes the data quality objectives for measurement of data for the water chemistry parameters. Data not meeting laboratory standards for duplicates or field blanks will be removed from the sample set and will not be used for watershed prioritization.

Biological and Habitat Parameters
To ensure precision, all sampling protocols will be carried out as required in the procedural documentation by qualified individuals. The same field crew, consisting of the Project Manager and a Project Technician (or two Project Technicians if the Project Manager is not present) will sample each site using the same procedure to maintain consistency among sites. The consistency of field personnel and procedural organization will enhance precision by minimizing sampling variability.

Macroinvertebrates will be identified by an experienced and trained Project Technician. The Project Manger will check identification accuracy of at least 10% of the macroinvertebrate specimens identified by the Project Technician. Based on IDEM's sampling and subsampling methodology, each sample will consist of 100 organisms; 10% of each subsample, or 10 organisms, will be checked for accuracy. Any discrepancies between identification will be noted and discussed in order to obtain the correct identification through collaboration on the specific specimen in question. This level of quality control will allow for making broad management decisions. The accuracy and precision in identification is expected to be high given the limited number of technicians involved, their technical expertise, and the level of oversight they receive in the collection and identification of macroinvertebrates. Table 2 outlines the parameters, measurement range, accuracy, and precision of macroinvertebrates evaluation.

Habitat evaluation will be conducted by an experienced/trained Project Manager and a Project Technician (or two Project Technicians if the Project Manager is unavailable). Habitat will be evaluated on an individual basis then compared. Any discrepancies in habitat scoring will be noted and discussed in order to obtain an accurate and precise habitat score through collaboration. If a score can not be determined through collaboration, then the Project Manager's (or Lead Technician if the Project Manger is not present) will be used for scoring purposes. Table 2 outlines the parameters, measurement range, accuracy, and precision of habitat evaluation.

Global Positioning System Parameters
Location coordinate data precision is expected to be high, while accuracy is submeter. Table 2 lists detailed precision and accuracy information for the Trimble Pro XRS GPS.

Table 2. Data quality objectives for measurement of data for field and laboratory methods.

Parameter	Precision	Accuracy	Completeness
pH	RPD<5%	± 0.1	75%
Temperature	RPD<5%	± 2%	75%
Dissolved Oxygen	RPD<5%	± 0.3 mg/l	75%
Flow	RPD <5%	±2% + zero stability zs=±0.03 ft/sec	75%
E. coli	See Appendix C.	See Appendix C.	75%
Ammonia	See Appendix B.	See Appendix B.	75%
Nitrate+nitrite	See Appendix B.	See Appendix B.	75%
Total Phosphorus	See Appendix B.	See Appendix B.	75%
Total Suspended Solids	See Appendix B.	See Appendix B.	75%
Biological Oxygen Demand	See Appendix C.	See Appendix C.	
GPS	High	50 cm ± 1 ppm	100%
Habitat Analysis	High	High	100%
Macroinvertebrates	High	High	100%

DQO: Completeness

In the event that some catastrophic event (i.e. weather anomaly, chemical spill, or other event that would prohibit access to sampling sites) were to take place, the first action taken would be to delay the sampling to a later time that year, in hopes that sampling would occur under more representative conditions. There is flexibility built into the project schedule to allow sampling to occur during favorable conditions, preserving data quality.

Field and Laboratory Water Chemistry Parameters

One hundred percent (100%) collection of field and laboratory water chemistry samples is expected. Sampling locations have been field checked to ensure sampling access and proper sampling hydrology is present at each site. However, climatic or other changes beyond the project's control may alter conditions in the watershed. Refusal of landowners to grant access to the property may also limit the sample collection. Equipment malfunction or problems during sample collection and analysis could also limit the amount of water chemistry data over the term of the project. For the Little Duck Creek watershed, Sites 2 and 5 provide information about the developed portion of the watershed; however, Sites 1 and 4 will also provide information on the developed portion of the Little Duck Creek watershed. Therefore, the loss of Sites 2 and 5 will still enable watershed stakeholders to prioritize work in the developed portion of the watershed. Furthermore, the loss of these sample sites would still enable watershed stakeholders to prioritize work in these subwatersheds. Likewise, Sites 10 and 11 in the Lilly Creek watershed provide similar data information on the agricultural area of the watershed. If samples could not be collected at Site 11 watershed stakeholders would not be prevented from prioritizing work in this area. Therefore, loss of three sample sites would not prevent the project from attaining its goal of developing a watershed management plan. Based on this 75% completeness (see equation below) for water chemistry samples will be acceptable for completion of the project.

$$\%\ \text{completeness} = \frac{(\text{number of valid measurements}) \times 100\%}{(\text{number of valid measurements expected})} = \frac{72 \times 100\%}{96} = 75\ \%$$

Macroinvertebrate and Habitat Parameters
Again, one hundred percent (100%) collection of macroinvertebrate and habitat samples is expected. Sampling will occur at the same sites as those utilized for water chemistry sample collected. Sample locations have been field checked to ensure sampling access and proper sampling hydrology is present at each site. Climatic or other changes beyond the project's control may alter the condition of the watershed; however, since macroinvertebrate and habitat data is being collected once over the lifetime of the project sample collection could be rescheduled to allow for data collection. Still, the refusal of landowners to grant access to the property may also limit the sample collection at the selected sites. Again, the loss of Sites 2, 5, or 11 would not prevent the project from attaining its goal of developing a watershed management plan. Based on this 75% completeness (see equation below) will be acceptable for completion of the project.

$$\% \text{ completeness} = \frac{(\text{number of valid measurements}) \times 100\%}{(\text{number of valid measurements expected})} = \frac{32 \times 100\%}{48} = 75\ \%$$

Global Positioning System Parameters
The geolocation of the sample sites is not dependent upon the weather or other climatic situations (barring the loss of satellites). Since GPS data can be collected over the length of the project, 100% completeness should be achieved.

DQO: Representativeness
Representativeness is the most important data quality metric in the project since the project objective is to provide watershed scale data. Representativeness of sampling sites was achieved by performing a desktop review of potential sampling sites. Because the number of stream and road crossings within the Lilly Creek and Little Duck Creek watersheds exceeds the number of sites that can be sampled by this project given the limited resources, not all tributaries could be samples. The following criteria were used to narrow the set of potential sites. Potential sites were selected based on accessibility (proximity to a road) and location in the watershed. Potential sites were then field checked by the Madison County SWCD to ensure accessibility to sampling stations and that the variety of physical, riparian, and in-stream habitats in the watershed were all represented in the sampling stations. Landowner permission will confirm potential sampling locations usability as sampling sites. An additional criterion for choosing sites is whether it has been used in historical studies to which this project's data may be compared.

DQO: Comparability
Water chemistry parameters are expected to be comparable to other studies if sampling and laboratory protocols and data quality objectives for measurement of data are similar. Results of this study can be compared to other studies that use this protocol and similar data quality objectives. All laboratory water chemistry analysis will be conducted using common, EPA-approved methods. All chemical data to be used for direct comparison with the data collected during the present study will be reviewed prior to its use to ensure comparability. As noted in the Sampling Design section, any non-analogous historical data (data collected under a different protocol with different data quality objectives) used in the study will be cited as such in the final product.

The macroinvertebrate and habitat samples are expected to be comparable because the project will follow macroinvertebrate sampling and habitat assessment procedures set forth by IDEM's Rapid Bioassessment protocol for macroinvertebrates, using the macroinvertebrate Index of Biotic Integrity (IDEM, unpublished) and OEPA's Quality Habitat Evaluation Index (QHEI). Results of this study can be compared to other studies using these protocols. All macroinvertebrate and habitat data to be used for direct comparison with the data collected during the present study will be reviewed prior to its use to ensure comparability.

Section 4: Sampling Procedures

The sampling methods and equipment are summarized in Table 2.

Water Chemistry Sampling

Water chemistry samples will be taken at each station to test the parameters listed in Table 2. Temperature, dissolved oxygen, pH, and flow measurements will be made in the field using the following instruments: YSI Model 55 dissolved oxygen/temperature meter; Hanna Instruments HI 98129 pH, EC/TDS and temperatures meter; and the Marsh McBirney Model 2000 portable flow meter. All measurements will be taken according to the standard operating procedures provided by the manufacturer of the equipment. Project biologists will record water chemistry field measurements on standardized field log data sheets (Appendix D). Sampling location, sample number/field ID, date, time, weather, Universal Transverse Mercantor (UTM) coordinates (North American Descent 1983, Zone 16), and any additional field notes will also be recorded on the field sheet.

Flow measurements will be taken utilizing protocols outlined in Marsh-McBirney (1990). A tape measure will be staked across the width of the channel prior to any measurements being taken. If the stream is less than two inches (2") deep, then multiple point velocity measurements will be taken throughout the width of the channel. Channel depths will be measured at a minimum of five points across the channel. Discharge will be calculated using the following formula:

$$\text{Discharge} = \frac{\left(\sum d_i\right)}{(n+1)}\, w*v$$

where d equals stream depth, n equals the number of streams depths measured, w equals the width of the stream, and v equals the velocity of the stream (0.9 times the fastest velocity recorded). This equation has been modified from EPA (1997).

If the stream is greater than two inches in depth, then the trapezoid channel method will be utilized to calculate stream discharge. The interval width, thus the number of flow measurements recorded across the channel, is determined by the channel width. If the channel width is less than fifteen feet, then the interval width will be equal to the stream width divided by five. If the channel is greater than fifteen feet wide, then the interval width will be equal to the channel width multiplied by 0.1. Stream depths will be recorded at the right and left edges of the predetermined trapezoid (SI_o and SI_1). Flow measurements will be recorded at the midpoint of each trapezoid ($SI_{1/2}$). All data will be recorded on the data sheet included in Appendix D. Discharge will be calculated using a calibrated Excel spreadsheet to minimize data errors involved in performing hand calculations.

Grab samples will be collected for the remaining water chemistry parameters (nitrate+nitrite, ammonia, total phosphorus, total suspended solids, BOD, and *E. coli)*. Samples will be placed in prepared containers supplied by the Indiana CLP laboratory in Bloomington, Indiana and ESG Laboratories in Indianapolis, Indiana (Table 3). The laboratories will provide the appropriate preservative in the pre-packaged containers as necessary. Sample collection will proceed in a manner similar to that outlined in *EPA Volunteer Stream Monitoring: A Methods Manual* (1997). One member of the field crew will wade to the center of the stream's thalweg to collect the water sample. The crewmember will invert a clean sample bottle (an extra one, not one used for sample storage) from the laboratory into the stream's thalweg. At a depth of approximately 8 to 12 inches below the water surface, the crewmember will turn the bottle into the current to allow for collection of water. (If the stream at the sampling station is shallower than 16 inches, water collection will occur mid-way between the water's surface and the stream bottom.) Once the bottle is full, the crewmember will scoop the bottle up toward the surface. Water in this bottle will be poured into the sample containers provided by the analytical laboratories.

The sample containers will be labeled as outlined in the proceeding section, stored on ice and transported to the appropriate laboratory for analysis. *E. coli* and BOD samples will be stored on ice and transported to ESG Laboratories in Indianapolis. Required chain of custody procedures as outlined in ESG Laboratories' QA/QC plan (Appendix C) will be followed. All other samples (nitrate+nitrite, ammonia, total phosphorus, and total suspended solids) will be stored on ice and shipped to the CLP Laboratory in Bloomington, Indiana. Required chain of custody procedures as outlined in the laboratory's QA/QC plan (Appendix B) will be followed. Water chemistry samples will be processed at both labs using the laboratory's standard operating protocol (see Table 3). All eight water chemistry samples collection events will follow this protocol for each of the twelve sample sites, duplicates, and field blanks. Analytical results from the water quality labs will be based on their schedule, but are anticipated within 2-3 weeks of sample collection.

Table 3. Sampling procedures.

Parameter	Sample Frequency	Sample Container*	Sample Volume	Holding Time
pH	8	N/A	N/A	N/A
Temperature	8	N/A	N/A	N/A
Dissolved Oxygen	8	N/A	N/A	N/A
Flow	8	N/A	N/A	N/A
E. coli	8	HDPE Nalgene	100 ml	6 hours†
Ammonia	8	HDPE Nalgene	125 ml	28 days
Nitrate+nitrite	8	HDPE Nalgene	125 ml	28 days
Total Phosphorus	8	Glass Media	125 ml	48 hours
BOD	8	HDPE Nalgene	500 ml	7 days
Total Suspended Solids	8	HDPE Nalgene	1000 ml	7 days
GPS	1	N/A	N/A	N/A
Macroinvertebrates	4	Clean, wide-mouth plastic collection jugs containing 70-80% alcohol	N/A	7 days
Habitat Analysis	1	N/A	N/A	N/A

*Sample containers will be provided and preserved by the contracted laboratory. ESG Laboratories will provide and preserve containers for *E. coli* and BOD sampling. The CLP Laboratory will provide and preserve sample bottles for all remaining laboratory parameters.
†This value refers to the maximum time between sample collection and analysis, not the holding time from the time the sample arrives at the lab. That holding time is 2 hours.

Macroinvertebrate Sampling

Methods for sampling macroinvertebrates will follow standard methods established by IDEM's Rapid Bioassessment protocol. Two samples using a 1 × 1 meter, 600 μm kick net will be performed at each of the sample stations. Since the water is no more than chest deep at any one site, each site lends itself to the use of a kick net. Organisms collected in the net will be placed in clean, wide-mouth plastic collection jugs containing 70-80% alcohol and stored on ice. Macroinvertebrate samples will be transported on ice to the JFNew laboratory immediately following collection of the samples. Macroinvertebrate samples will be identified and checked within one week of collection to limit any potential deterioration of the identifying features of the organisms. During the identification and confirmation time period, macroinvertebrate samples will be stored on ice or in a refrigerated cooler. Macroinvertebrate identification results will be recorded on data sheets (Appendix E).

Habitat Evaluation

Habitat evaluation will be conducted at each station using Ohio EPA's Quality Habitat Evaluation Index (QHEI). The field crew will adhere to OEPA QHEI standard procedures. Assessments will be made by the field crew and noted on QHEI data sheets (Appendix F).

Section 5: Custody Procedures

Field sampling data and data sheets used for water chemistry field sampling will remain in JFNew's custody; therefore, chain of custody does not apply to these measurements.

The field crew consisting of the Project Manager and Project Technician (or two Project Technicians if the Project Manager is not present) will collect the water chemistry samples using the procedure outlined in Section 4. Samples will be labeled with the sampling location, sample number (same as "Field ID" on the laboratory Chain of Custody Record), date and time of collection, sample parameters, and sampler name(s). This information along with the project name and project number will be recorded on the laboratories' Chain of Custody Records (Appendices B and C). Appendices B and C contain blank Chain of Custody Records for the CLP laboratory and ESG Laboratories, respectively.

E. coli samples will be stored on ice and transported within 6 hours to the ESG Laboratories. The Project Manager (or Project Technician if the Project Manager is not a member of the field crew) will sign the Chain of Custody Record in the presence of the laboratory technician when samples are released to the laboratory. ESG Laboratories will review sample labels and remove any samples from the dataset that cannot be attributed to specific samplers, have not been properly preserved, or that exceed the maximum holding time. The laboratory manager will also sign-off on laboratory bench sheets after all checks have been completed. A copy of the chain of custody form will accompany sample result documents from ESG Laboratories. The report from ESG Laboratories is expected within 2-3 weeks of sampling.

All other water chemistry samples will be analyzed by the CLP laboratory. These samples will be stored on ice and transported to the laboratory within 24 hours of sample collection. The Project Manager or Lead Project Technician will sign the Chain of Custody form prior to shipping the samples to the CLP laboratory. Clean Lakes Program staff will review sample labels and remove any samples from the data set that cannot be attributed to specific samples, have not been properly preserved, or that exceed the maximum holding time. The report from the CLP laboratory is expected within one month of sampling. A copy of the chain of custody form will accompany sample results.

The field crew consisting of the Project Manager and Project Technician (or two Project Technicians if the Project Manager is not present) will use IDEM's Rapid Bioassessment protocol to collect macroinvertebrates samples. All macroinvertebrates removed from the sites will be placed in wide-mouth plastic containers with a preservative and labeled with the sample location, sample number, date and time of collection, sample parameter, and sampler(s) name(s). Sample bottles will be stored on ice. Samples will be transported to the JFNew laboratory and stored in a cooler until identification is completed. Identification will be completed within one week of sampling. Identifications will be made by a Project Technician and checked for accuracy by the Project Manager using the following taxonomic references: Merritt and Cummins (1996), McCafferty (1981), Thorp and Covich (1991) and Pennak (1978). Appendix E contains the data sheet to be used for macroinvertebrate identification. Macroinvertebrates and data sheets used during identification will remain in JFNew's custody; therefore, chain of custody does not apply to these measurements.

Habitat measurements will be noted on the QHEI data sheet like those located in Appendix F. Samples are not collected as part of this procedure. Habitat assessment data sheets will remain in JFNew's custody; therefore, chain of custody does not apply to these measurements.

Section 6: Calibration Procedures and Frequency

Calibration measures will be performed on all field equipment to be used (where appropriate) based upon the manufacturers recommendations as outlined in the users manual for each individual piece of equipment. Field equipment that cannot be calibrated, such as a tape measure, will not be calibrated. Field equipment calibration will be performed the day of sampling prior to its use in the field. The YSI Model 55 oxygen and temperature probe is auto-calibrated based on the altitude and salinity of the sample prior to time of use. The Hanna Instruments HI 98129 ph, EC/TDS and temperature meter is calibrated using Fisher calibration buffer (pH 4.0 and 7.0). The Marsh McBirney Model 2000 flow meter is calibrated by the manufacturer prior to shipping. If equipment cannot be properly calibrated, then sampling will be rescheduled. If the GPS can not be properly calibrated, then GPS measurements will be recorded at a later date following proper calibration and all other sampling will proceed as scheduled. See Appendix B for Indiana CLP laboratory and Appendix C for ESG Laboratories calibration procedures and frequency.

Section 7: Sample Analysis Procedures

Table 4 summarizes the analytical procedures for each water chemistry parameter. Each laboratory has the capability, as shown in their respective Quality Assurance documents (Appendices B and C), to analyze the water samples according to the procedures listed in Table 4.

Table 4. Analytical procedures.

Matrix	Parameter	Method	Detection Limits
Water	pH	Hach pH meter	0.1
Water	Temperature	YSI Model 55	1°C
Water	Dissolved Oxygen	YSI Model 55	0.1 mg/l
Water	Flow	Marsh McBirney Model 2000 portable flow meter	0.1 ft/s
Water	*E. coli*	Standard Method 9223B	N/A
Water	Ammonia	Alkaline phenol and hypochlorite method	0.03 mg/l
Water	Nitrate+nitrite	Cadmium reduction method	0.10 mg/l
Water	Total Phosphorus	Standard Method 4500-P F	0.01 mg/l
Water	Total Suspended Solids	Standard Method 2540 D	1 mg/l
Water	Biological Oxygen Demand	EPA 405.1	1 mg/L
Geolocation	GPS	Trimble Pathfinder Pro XRS	submeter
Substrate	Macroinvertebrates	IDEM	N/A
Habitat	Habitat Analysis	OEPA QHEI	N/A

All procedures that will be used to analyze the macroinvertebrate samples and QHEI assessments will strictly adhere to the IDEM Rapid Bioassessment protocol or the OEPA QHEI protocol, respectively. Because these tools were designed to make rapid assessments at large scales, the use of these tools will enable the achievement of project goals. In general, detection limits are not applicable to the biological and physical habitat assessment used in this project. However, small organisms (smaller than 600 µm) may not be collected due to mesh size of the sampling net. Similarly, the field picker may overlook small organisms caught in the net. Nets will be double checked to prevent this. Table 4 provides an overview of the analytical procedures.

Section 8: Quality Control Procedures

Quality control will be achieved by strict adherence to written protocol. To achieve precision in field measurements, replicate measurements will be taken. Replicate measurements for each field parameter will be taken at one of the twelve sampling sites for each sampling event. To achieve accuracy in field measurements, equipment will be properly maintained and equipment calibration will occur as detailed in Section 6. To achieve precision in laboratory measurements, duplicate samples will be collected one time in twelve samples or once per sampling trip. The contracted laboratories have established control limits for all quality control checks established by their protocols (Appendices B and C). To achieve accuracy in laboratory measurements, field blanks collected concurrently with sample collection will be analyzed. Field blank collection will ensure that no outside contamination occurs during the process of sample bottle preparation or sample collection. Additional laboratory QA/QC checks for accuracy and precision will be implemented by ESG Laboratories and the CLP Laboratory (Appendices B and C). Field work will be performed by the same crew at each site. The Project Manger or Lead Technician will ensure consistency in sample collection and field work. This quality control procedure will allow for comparison to be made among sampling sites, and thus, achieve the project's goals of identifying hot spots within the watershed for more targeted intensive management.

Quality control in the field will be obtained by adherence to procedures detailed in Sections 3 and 4. This quality control includes replicate samples, equipment calibration, and adherence to procedures as detailed in Section 3. Quality control of laboratory water chemistry analysis will be performed as outlined in the respective laboratories' QA/QC plans (Appendices B and C). This quality control includes use of field replicates, lab duplicates, split samples, field blanks, reference standards, and method blanks where appropriate. This level of quality control is sufficient to achieve project goals.

Quality control of macroinvertebrate identification will be achieved by having a single initial identifier of each sample with 10% of each sample being checked by the Project Manager. Inaccuracies greater than 25% of the checked portion will trigger reevaluation of the entire sample unless deemed unnecessary. (For example, technician is consistently misidentifying one family; in that case, only the individuals of that family will be reevaluated.) Consistency in protocol will allow for comparisons to be made among sample sites and thus achieve the project goals of identifying priority areas within the watershed for targeted intensive management.

Independent QHEI assessments will be made by each member of the field crew to ensure precision and accuracy of habitat assessment. Any differences in assessments will be averaged, if possible, based on the metric. Where averaging of a metric is not possible, the value given by the Project Manager will be accepted. Fieldwork will be performed by the same crew at each site. The Project Manager will ensure consistency in sample collection and fieldwork.

Section 9: Data Reduction, Analysis, Review, and Reporting

Data Reduction

Field data sheets will be inspected for completeness and signed by the Project Manager or Lead Project Technician before leaving the site. The Project Manager or Lead Project Technician will calculate the RPD before leaving the site to ensure the precision data quality objectives for measurement of data for the field measurements are met. It will be assumed that accuracy data quality objective of field measurements are met if there is no problem with equipment calibration. The field data sheet contains fields showing whether the RPD met the data quality objective, if calibration was completed, if the measurement was taken (completeness), and if protocol was followed (comparability). Data from the field data sheets and macroinvertebrate identification data sheets will be used to calculate both a macroinvertebrate Index of Biotic Integrity (mIBI) and QHEI to indicate the biological integrity or habitat quality of the aquatic system at the specific sites studied. The Project Manager will review macroinvertebrate identification. Field measurements using electronic instrumentation need no further reduction. Data reduction in the laboratory will be done in accordance with Indiana CLP laboratory and ESG Laboratories QA/QC protocol (Appendices B and C).

Data Analysis

Discharge and loadings will be calculated using an electronic spreadsheet/database program designed for this project and compatible with software used by JFNew, IDEM, and the Madison County SWCD to minimize errors involved with performing hand calculations. Once the raw data has been reviewed by the Project Manger, discharge will be calculated using methodology detailed in Section 4 (Marsh McBirney, 1990). Once discharge has been calculated, the pollutant load will be calculated by multiplying the specific site discharge by the concentration of a pollutant found at that site. Pollutant loads among sites will be compared to identify which sites provide the greatest load of pollutant to the Lilly Creek and Little Duck Creek watersheds.

Data Review

The Project Technician will enter all data into a computerized spreadsheet/database program designed for this project and compatible with software used by JFNew, IDEM, and the Madison County SWCD. The Project Manager will review data entry for completeness and errors.

Data Reporting

ESG Laboratories and the CLP laboratory will provide sample results with qualifying information for any results which fall outside of the control limits. A copy of the chain of custody form will accompany laboratory results.

The Project Manager will be responsible for report production and distribution. The Project Technicians will provide assistance in these tasks. The report will contain the data results, interpretation of the data, Best Management Practice proposals for existing watershed conditions, a compilation of watershed stakeholders' concerns and goals, and proposals for future development in the watershed.

Section 10: Performance and System Audits

Specific audits such as those conducted on the contracting laboratories by outside auditors are not applicable to this type of project. Such audits are not necessary to achieve the project goals given the scope of this study and the intended use of the data. However, the following checks and oversight will be utilized to ensure data quality:

- The Project Manager will provide oversight to all technical staff ensuring strict adherence to all protocols.
- Field data sheets will be reviewed for completeness prior to leaving the field.
- Two individuals will make QHEI assessments at each site.

Both the CLP laboratory and ESG Laboratories has built in audits (Appendices B and C). The Project staff is open to IDEM's audits upon IDEM's request. The Project Manager will conduct a system audit following the first sampling event and at the end of the project to ensure data quality objectives for measurement of data are met.

Section 11: Preventative Maintenance

JFNew will utilize a dissolved oxygen meter/thermometer (YSI Model 55), pH meter (Hanna Instruments HI 98129), flow meter (Marsh McBirney Model 2000 portable flow meter), global positioning system (Trimble Pathfinder Pro XRS), tape measure, and kicknet for water quality sampling. To keep these instruments and equipment in proper working order, all maintenance will be performed as outlined in the users manuals provided with the equipment where appropriate. Additional batteries for the dissolved oxygen meter and GPS, a separate thermometer, and replacement dissolved oxygen membranes will be present in the field for any necessary field repairs. An additional set of collection bottles and nets will be taken along on each sampling trip (where applicable). Preventative maintenance in each respective laboratory is covered in Appendices B and C.

Section 12: Data Quality Assessment

DQO: Precision and Accuracy

As stated in the Study Goals in Section 1, the goal of the project is to document the physical, biological, and chemical condition of the Lilly Creek and Little Duck Creek watersheds. Collected data will be utilized to identify priority areas in the watershed that may be contributing more non-point source pollutants to the Lilly Creek and Little Duck Creek watersheds. Data quality controls outlined in the sections above will be sufficient to meet the objectives of the study. Data quality assessments conducted by the contracting laboratories will be sufficient to meet the objectives of the project (Appendices B and C). Laboratory analysis of precision and accuracy checks, including control levels for duplicate and replicate samples and field and laboratory blanks, will be kept on file in the contract laboratories. All laboratory data will be assessed by ESG Laboratories and the CLP Laboratory to determine if data quality falls within the required precision and accuracy levels specified by each laboratory (Appendices B and C). The laboratories will follow established protocols to determine if data is valid. Any data that is determined to not meet laboratory quality control guidelines will not be reported or used for subwatershed prioritization. All QA/QC measures for each run of the samples will be included with the lab's final data analysis and will be included as an appendix in the final report.

Field measurements and biological and habitat data will be accepted as valid provided no significant problems occur during calibration and sampling. Field water chemistry measurements will be repeated if precision failures are observed (RPD>5%). Data that does not meet precision goals will not be included in sample analysis and subwatershed prioritization. The accuracy of field measurements and biological and habitat data will not be quantified. However, the data will be acceptable provided that no significant problems occurred during equipment calibration or sampling. Sampling will be rescheduled if problems occur during equipment calibration. Field measurements will be repeated if difficulties occur during sampling.

DQO: Completeness
All data determined to be accurate and precise will be considered valid and will be reported even if completeness objectives are not met. Due to flexibility in scheduling of sampling events, 75-100% completeness is anticipated. If for some reason (such as ones outlined in previous sections) 100% collection of samples is not possible, the data will be evaluated to determine whether the watershed has been sufficiently represented in the data collection to date.

DQO: Representativeness
Meeting the goal of representation is of primary importance since it is one of the study's goals. Data will be evaluated for representativeness based primarily on the following criteria: all sampling stations have been sampled at least once and water chemistry samples have been collected during storm and base flow events. Those criteria are listed in order of importance. The first one listed will have more importance in deciding whether the project is complete despite not having collected 100% of the samples. Any decisions to deem the project complete without 100% collection of data will be made by the Project Manager. The IDEM Project Manager will be included in all such decisions.

DQO: Comparability
Data collected during this study will meet comparability requirements if standard operating procedures as outlined in Section 4 are followed. Water chemistry data will be comparable with other data collected using the same protocol. Likewise, macroinvertebrate and habitat data will be comparable to IDEM data only if the standard operating procedures are followed. If problems occur during sample collection that requires the use of non-standardized operating procedures, then that data will be evaluated for comparability. This will likely result in the removal of this data from the data set.

Section 13: Corrective Action

Should extraordinary events occur that could adversely affect the collection of accurate, representative data (extreme climatic conditions, chemical spill, etc.) testing shall be rescheduled during the same year when conditions are more favorable. The data can then be analyzed so that reports can be written. Since water chemistry sampling is to be done eight times, macroinvertebrate sampling conducted four times, and habitat one time during the study period, it is feasible to schedule sampling at a time when conditions permit within the project's timeframe. If, for reasons beyond the project's control, samples cannot be collected during the project's timeframe, the prohibitive conditions will be noted and discussed with the IDEM Project Manager.

The CLP laboratory and ESG Laboratories corrective actions that will be taken for the chemical water quality analysis are noted in Appendices B and C. Although it is not anticipated, should data received from the CLP laboratory or ESG Laboratories be unusable given the project's data goals, another sampling event will occur to replace effected data. Assurance from the CLP laboratory and/or ESG Laboratories that similar problems in data quality will not be repeated will be obtained prior to submission of any samplings.

Less than 75% accuracy of the checked portion (10%) of the macroinvertebrate sample will trigger corrective actions for the macroinvertebrate identification. Such corrective actions could include discussion with sampler and identifier to determine the source of error, re-identification of part of or the entire sample, and/or discarding an unusable sample where appropriate. Any habitat data collected according to standard operating protocols will meet the data collection objectives. Corrective actions are not applicable to this form of assessment.

Section 14: Quality Assurance Reports

Quality Assurance reports will be submitted to IDEM's Watershed Management Section every three months as part of the Quarterly Progress Report and/or Final Report. Any problems that are found with the data will be documented in the quarterly reports. Quality assurance issues that may be addressed in the quarterly report include, but are not limited to the following:

- Assessment of such items as data accuracy and completeness
- Results of performance and/or systems audit
- Significant QA/QC problems and recommended solutions
- Discussion of whether the QA objectives were met and the resulting impact on decision making
- Limitations on use of the measurement data

If no QA/QC problems arise, this will be noted in the report.

References

APHA et al. 1995. Standard Methods for the Examination of Water and Wastewater, 19th edition. American Public Health Association, Washington, D.C.

Hilsenholf, W.L. 1988. Rapid field assessment of organic pollution with a family-level biotic index. J.N. Am. Benthol. Soc. 7(1): 65-68.

Indiana Department of Environmental Management. Unpublished. Macroinvertebrate Index of Biological Integrity.

Indiana Department of Environmental Management. 1996. 1994-1995 305(b) Report. Indianapolis, Indiana.

Marsh-McBirney. 1990. Model 2000 Installation and Operations Manual.

McCafferty, W.P. 1981. Aquatic Entomology. Jones and Bartlett Publishers, Sudbury, Massachusetts 447 pp.

Merritt, R.W., and K.W. Cummins. 1996. Aquatic Insects of North America. Kendall/Hunt Publishing Company, Berkeley 862 pp.

Ohio Environmental Protection Agency. 1989. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Water Quality Monitoring and Assessment, Columbus, Ohio.

OI Analytical. 2000. The FLOW solution operations manual for segmented flow analysis. College Station, Texas.

Pennak, R.W. 1978. Fresh Water Invertebrates of the United States. John Wiley & Sons, Inc. New York 803 pp.

Thorp, J.H. and A.P. Covich. 1991. Ecology and Classification of North American Freshwater Invertebrates. Academic Press, Inc. San Diego, California 911 pp.

U.S. Environmental Protection Agency. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79/020.

U.S. Environmental Protection Agency. 1989. Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish. Revised ed. EPA/440/4-89-001.

U.S. Environmental Protection Agency. 1997. Volunteer Stream Monitoring: A Methods Manual. EPA-841-B-97-003.

APPENDIX A

Sampling Station Locations

WATER QUALITY SAMPLING FIELD LOG SHEET

SITE NUMBER AND LOCATION: ____

DATE: ____________________ PROJECT NAME: ______________________________

TIME: _____________

FIELD CREW: __________________________________

WEATHER CONDITIONS: ____

OTHER OBSERVATIONS: ____

EQUIPMENT CALIBRATION (Date): _____________________

FIELD PARAMETERS	REPLICATE (if taken)	
pH: ____________	pH: ___________	RPD = _______
Temperature: _______________	Temperature: ___________	RPD = _______
Dissolved Oxygen: ___________	Dissolved Oxygen: _______	RPD = _______
DO % Saturation: ____________	DO % Saturation: _______	RPD = _______
Total Dissolved Solids: _________	TDS: ______	RPD= _______
Calculated Flow: _____________		

$$\text{Relative Percent Difference (RPD)} = \frac{(sample_1 - sample_2)}{((sample_1 + sample_2)/2)}$$

LAB PARAMETERS

E. coli: ____

Ammonia: ____

Nitrate: ____

Total Suspended Solids: ____

Total Phosphorus: ____

BOD: ____

Field Crew Leader Signature: _____________________

Site	Watershed	Creek	Location	Observed Flora	General Land Use	Creek bottom	Approx Width (ft) (4/19/05)	Approx Depth (in) (4/19/05)
1	Little Duck Creek	Big Duck Creek	1050 N. Approximately 1/2 mile W of SR 13.	Wooded	Suburban	Rocky	15-20	12-24
2	Little Duck Creek	Big Duck Creek	S B Street. Just W. oF S 13th. Bridge #606	S. woody. N. grassy	Urban/ Residential	Rip rap	(5/13/05) 10	(5/13/05) 12
3	Little Duck Creek	Big Duck Creek	1300 N. ½ mile W. of 800 W.	N. shrubby/grassy. S. wooded		muddy with scattered rocks	12	9-15
4	Little Duck Creek	Little Duck Creek	900 W (SR 13) just N. of SR 37	Woody vegetation	Urban	Rock	10-15	12
5	Little Duck Creek	Little Duck Creek	1100 N. Bridge #55	Woody vegetation	Urban	Rock	10	8
6	Little Duck Creek	Little Duck Creek	700 N. and SR 37	N. woody vegetation. S. grass and fenced	Agricultural	Mud. Some rocks	(5/31/05) 10	(5/31/05) 12
7	Lilly Creek	Pipe Creek	300 W 1/2 mile S of 1100 N. Bridge.	Mostly wooded on sides.	Suburban/ Agricultural. Residential on one side, ag. on other.	Gravelly/ rocky/ sandy bottom	15 - 25	24
8	Lilly Creek	Lilly Creek	300 W. Just S of 1100 N. Bridge.	Wooded along sides.	Agricultural	Rocky	15	12
9	Lilly Creek	Lilly Creek	Hwy 28, 1/4 mile west of 200 W. Bridge.	Grassy sides of bank.	Pasture	Muddy with large rocks.	10 - 12.	
10	Lilly Creek	Lilly Creek	1400 N, 1/2 mile E of 300 W. Bridge # 11.	Wooded along stream, but grassy on northeast side of creek.	Agricultural	Muddy/ some big rocks.	10 - 22	24 -36
11	Lilly Creek	Lilly Creek	200 N. 1/4 mile S of 1475 N.	Mostly wooded.	Agriculture	Sandy/ clay bottom	15-20	12-15
12	Lilly Creek	Lilly Creek	1550 N and 100 W. Bridge.	All grass up to edge (north of field). South of bridge: grassy/ woody vegetation.	Agriculture	Rock	(5/31/05) 36	(5/31/05) 6

LC1	Lilly Creek	Lilly Creek Alternate	1150 N. East of Orestes. Bridge # 43. W of 200 W.	Woody area	Semi-rural	Muddy/rocky	22	24-36
LDC1	Little Duck Creek	Little Duck Creek Alternate	1300 N just W. of SR 37	N. woody on one side, mostly grass. S. grassed	Agricultural	gravelly-S	(5/31/05) 4-10	(5/31/05) 10
BDC1	Little Duck Creek	Big Duck Creek Alternate	1400 N west of 700	grassy above bridge, tree lined below banks	Agricultural	lots of rip rap	12	12-24

APPENDIX B

ESG Laboratories
Laboratory QA/QC Plan and Chain of Custody Form

APPENDIX C

Indiana Clean Lakes Program QAPP
Laboratory QA/QC Plan and Chain of Custody Form

APPENDIX D

Water Quality Sampling Data Sheets

WATER QUALITY SAMPLING FIELD LOG SHEET

SITE NUMBER AND LOCATION: ____

DATE: ______________________ PROJECT NAME: ________________________________

TIME: ______________

FIELD CREW: ____________________________________

WEATHER CONDITIONS: ____

OTHER OBSERVATIONS: ____

EQUIPMENT CALIBRATION (Date): ______________________

FIELD PARAMETERS	REPLICATE (if taken)	
pH: ____________	pH: ___________	RPD = _______
Temperature: _______________	Temperature: ___________	RPD = _______
Dissolved Oxygen: ___________	Dissolved Oxygen: _______	RPD = _______
DO % Saturation: ____________	DO % Saturation: _______	RPD = _______
Total Dissolved Solids: _________	TDS: ______	RPD= _______
Calculated Flow: _____________		

Relative Percent Difference (RPD)= $\frac{(sample_1 - sample_2)}{((sample_1 + sample_2)/2)}$

LAB PARAMETERS

E. coli: ____

Ammonia: ____

Nitrate: ____

Total Suspended Solids: ____

Total Phosphorus: ____

BOD: ____

Field Crew Leader Signature: ______________________

Discharge Measurement

Site:______________________________ Date:____________ Time:___________
Project #:__________________________ Project Name:____________________
Crew Members:____________________ Equipment:_______________________
Physical Site Description:____
GPS Coordinates:______________________________

If the stream is <2" deep:
Stream Width:_____feet
Stream Depths: _____, _____, _____, _____, _____, _____, _____, _____, _____, _____feet
U: _____, _____, _____, _____, _____, _____, _____, _____, _____, _____ft/s
U_{max}:_____ft/s

If the stream is >2" deep:
Stream Width (W):_____feet
Interval Width (IW) (If W<15', then IW=W/5. If W>15, then IW=W*0.1):_____feet

Segment	SI_0		SI_1		½ IW		$U_{0.4}$	
	Location	Depth (ft)	Location	Depth (ft)	Location	Depth (ft)	Set Depth	Rate (ft/s)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

Field Crew Leader Signature: ______________________

APPENDIX E

Qualitative Habitat Evaluation Index (QHEI) Data Sheets

STREAM: ____________ **RIVER MILE:** ________ **DATE:** ________ **QHEI SCORE** [ ]

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present) **SUBSTRATE SCORE** [ ]

TYPE			POOL	RIFFLE				POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)	___	___	[ ]	[ ]	GRAVEL(7)	___	___
[ ]	[ ]	BOULDER(9)	___	___	[ ]	[ ]	SAND(6)	___	___
[ ]	[ ]	COBBLE(8)	___	___	[ ]	[ ]	BEDROCK(5)	___	___
[ ]	[ ]	HARDPAN(4)	___	___	[ ]	[ ]	DETRITUS(3)	___	___
[ ]	[ ]	MUCK/SILT(2)	___	___	[ ]	[ ]	ARTIFIC(0)	___	___

SUBSTRATE ORIGIN (all)
- [ ] LIMESTONE(1)
- [ ] TILLS(1)
- [ ] SANDSTONE(0)
- [ ] SHALE(-1)
- [ ] COAL FINES(-2)
- [ ] RIP/RAP(0)
- [ ] HARDPAN(0)

SILT COVER (one)
- [ ] SILT-HEAVY(-2)
- [ ] SILT-MOD(-1)
- [ ] SILT-NORM(0)
- [ ] SILT-FREE(1)

Extent of Embeddedness (check one)
- [ ] EXTENSIVE(-2)
- [ ] MODERATE(-1)
- [ ] LOW(0)
- [ ] NONE(1)

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [ ] <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrates)

COMMENTS: ____________

2) INSTREAM COVER: **COVER SCORE** [ ]

TYPE (Check all that apply)
- [ ] UNDERCUT BANKS(1)
- [ ] OVERHANGING VEGETATION(1)
- [ ] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [ ] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- [ ] AQUATIC MACROPHYTES(1)
- [ ] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)
- [ ] EXTENSIVE >75%(11)
- [ ] MODERATE 25-75%(7)
- [ ] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS: ____________

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE) **CHANNEL SCORE** [ ]

SINUOSITY
- [ ] HIGH(4)
- [ ] MODERATE(3)
- [ ] LOW(2)
- [ ] NONE(1)

DEVELOPMENT
- [ ] EXCELLENT(7)
- [ ] GOOD(5)
- [ ] FAIR(3)
- [ ] POOR(1)

CHANNELIZATION
- [ ] NONE(6)
- [ ] RECOVERED(4)
- [ ] RECOVERING(3)
- [ ] RECENT OR NO RECOVERY(1)

STABILITY
- [ ] HIGH(3)
- [ ] MODERATE(2)
- [ ] LOW(1)

MODIFICATION/OTHER
- [ ] SNAGGING
- [ ] RELOCATION
- [ ] CANOPY REMOVAL
- [ ] DREDGING
- [ ] ONE SIDE CHANNEL MODIFICATION
- [ ] IMPOUND
- [ ] ISLAND
- [ ] LEVEED
- [ ] BANK SHAPING

COMMENTS: ____________

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank) **RIPARIAN SCORE** [ ]

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
[ ]	[ ]	WIDE >150 ft.(4)
[ ]	[ ]	MODERATE 30-150 ft.(3)
[ ]	[ ]	NARROW 15-30 ft.(2)
[ ]	[ ]	VERY NARROW 3-15 ft.(1)
[ ]	[ ]	NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
[ ]	[ ]	FOREST, SWAMP(3)	[ ]	[ ]	URBAN OR INDUSTRIAL(0)
[ ]	[ ]	OPEN PASTURE/ROW CROP(0)	[ ]	[ ]	SHRUB OR OLD FIELD(2)
[ ]	[ ]	RESID.,PARK,NEW FIELD(1)	[ ]	[ ]	CONSERV. TILLAGE(1)
[ ]	[ ]	FENCED PASTURE(1)	[ ]	[ ]	MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
[ ]	[ ]	NONE OR LITTLE(3)
[ ]	[ ]	MODERATE(2)
[ ]	[ ]	HEAVY OR SEVERE(1)

COMMENTS: ____________

5) POOL/GLIDE AND RIFFLE/RUN QUALITY **NO POOL = 0** **POOL SCORE** [ ]

MAX.DEPTH (Check 1)
- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [ ] 1.2-2.4 ft.(2)
- [ ] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)
- [ ] POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)
- [ ] TORRENTIAL(-1)
- [ ] FAST(1)
- [ ] MODERATE(1)
- [ ] SLOW(1)
- [ ] EDDIES(1)
- [ ] INTERSTITIAL(-1)
- [ ] INTERMITTENT(-2)

COMMENTS: ____________

RIFFLE SCORE [ ]

RIFFLE/RUN DEPTH
- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [ ] GENERALLY 2-4 in.(1)
- [ ] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE
- [ ] STABLE (e.g., Cobble,Boulder)(2)
- [ ] MOD.STABLE (e.g., Pea Gravel)(1)
- [ ] UNSTABLE (Gravel, Sand)(0)
- [ ] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS
- [ ] EXTENSIVE(-1)
- [ ] MODERATE(0)
- [ ] LOW(1)
- [ ] NONE(2)
- [ ] NO RIFFLE(0)

COMMENTS: ____________

6) GRADIENT (FEET/MILE): ______ **% POOL** ______ **% RIFFLE** ______ **% RUN** ______ **GRADIENT SCORE** [ ]

STREAM: Site 1 - Big Duck Creek **RIVER MILE:** CR 1050 N **DATE:** 8/4/2005 **QHEI SCORE** 54

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)

SUBSTRATE SCORE 15

TYPE			POOL	RIFFLE				POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)			[ ]	[ ]	GRAVEL(7)		
[ ]	[ ]	BOULDER(9)			[ ]	[X]	SAND(6)		
[ ]	[X]	COBBLE(8)			[ ]	[ ]	BEDROCK(5)		
[ ]	[ ]	HARDPAN(4)			[ ]	[ ]	DETRITUS(3)		
[ ]	[ ]	MUCK/SILT(2)			[ ]	[ ]	ARTIFIC(0)		

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

SUBSTRATE ORIGIN (all)

- [ ] LIMESTONE(1)
- [ ] RIP/RAP(0)
- [X] TILLS(1)
- [ ] HARDPAN(0)
- [ ] SANDSTONE(0)
- [ ] SHALE(-1)
- [ ] COAL FINES(-2)

SILT COVER (one)

- [ ] SILT-HEAVY(-2)
- [ ] SILT-MOD(-1)
- [X] SILT-NORM(0)
- [ ] SILT-FREE(1)

Extent of Embeddedness (check one)

- [ ] EXTENSIVE(-2)
- [ ] MODERATE(-1)
- [X] LOW(0)
- [ ] NONE(1)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrat

COMMENTS:

2) INSTREAM COVER:

COVER SCORE 8

TYPE (Check all that apply)

- [X] UNDERCUT BANKS(1)
- [X] OVERHANGING VEGETATION(1)
- [X] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [X] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- [ ] AQUATIC MACROPHYTES(1)
- [X] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

- [ ] EXTENSIVE >75%(11)
- [ ] MODERATE 25-75%(7)
- [X] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS:

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)

CHANNEL SCORE 9

SINUOSITY

- [ ] HIGH(4)
- [ ] MODERATE(3)
- [X] LOW(2)
- [ ] NONE(1)

DEVELOPMENT

- [ ] EXCELLENT(7)
- [ ] GOOD(5)
- [ ] FAIR(3)
- [X] POOR(1)

CHANNELIZATION

- [ ] NONE(6)
- [ ] RECOVERED(4)
- [X] RECOVERING(3)
- [ ] RECENT OR NO RECOVERY(1)

STABILITY

- [X] HIGH(3)
- [ ] MODERATE(2)
- [ ] LOW(1)

MODIFICATION/OTHER

- [ ] SNAGGING
- [ ] RELOCATION
- [ ] CANOPY REMOVAL
- [ ] DREDGING
- [ ] ONE SIDE CHANNEL MODIFICATION
- [ ] IMPOUND
- [ ] ISLAND
- [ ] LEVEED
- [ ] BANK SHAPING

COMMENTS:

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)

RIPARIAN SCORE 8

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
[ ]	[ ]	WIDE >150 ft.(4)
[X]	[X]	MODERATE 30-150 ft.(3)
[ ]	[ ]	NARROW 15-30 ft.(2)
[ ]	[ ]	VERY NARROW 3-15 ft.(1)
[ ]	[ ]	NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
[ ]	[X]	FOREST, SWAMP(3)	[ ]	[ ]	URBAN OR INDUSTRIAL(0)
[ ]	[ ]	OPEN PASTURE/ROW CROP(0)	[ ]	[ ]	SHRUB OR OLD FIELD(2)
[X]	[ ]	RESID.,PARK,NEW FIELD(1)	[ ]	[ ]	CONSERV. TILLAGE(1)
[ ]	[ ]	FENCED PASTURE(1)	[ ]	[ ]	MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
[X]	[X]	NONE OR LITTLE(3)
[ ]	[ ]	MODERATE(2)
[ ]	[ ]	HEAVY OR SEVERE(1)

COMMENTS:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

NO POOL = 0 **POOL SCORE** 4

MAX.DEPTH (Check 1)

- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [ ] 1.2-2.4 ft.(2)
- [X] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)

- [X] POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)

- [ ] TORRENTIAL(-1)
- [ ] FAST(1)
- [ ] MODERATE(1)
- [X] SLOW(1)
- [ ] EDDIES(1)
- [ ] INTERSTITIAL(-1)
- [ ] INTERMITTENT(-2)

COMMENTS:

RIFFLE SCORE 0

RIFFLE/RUN DEPTH

- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [ ] GENERALLY 2-4 in.(1)
- [X] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE

- [ ] STABLE (e.g., Cobble,Boulder)(2)
- [ ] MOD.STABLE (e.g., Pea Gravel)(1)
- [ ] UNSTABLE (Gravel, Sand)(0)
- [X] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS

- [ ] EXTENSIVE(-1)
- [ ] MODERATE(0)
- [ ] LOW(1)
- [ ] NONE(2)
- [X] NO RIFFLE(0)

COMMENTS:

6) GRADIENT (FEET/MILE): 12 **% POOL** 10% **% RIFFLE** 0 **% RUN** 90% **GRADIENT SCORE** 10

Conducted by: JFNew
Project Number: 05-04-109

STREAM: Site 2 - Big Duck Creek **RIVER MILE:** South B Street **DATE:** 8/4/2005 **QHEI SCORE** 40

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)

SUBSTRATE SCORE -1

TYPE (Pool)	TYPE (Riffle)		POOL	RIFFLE	TYPE (Pool)	TYPE (Riffle)		POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)			[ ]	[ ]	GRAVEL(7)		
[ ]	[ ]	BOULDER(9)			[ ]	[ ]	SAND(6)		
[ ]	[ ]	COBBLE(8)			[ ]	[ ]	BEDROCK(5)		
[ ]	[ ]	HARDPAN(4)			[ ]	[ ]	DETRITUS(3)		
[ ]	X	MUCK/SILT(2)			[ ]	X	ARTIFIC(0)		

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) X <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrat

SUBSTRATE ORIGIN (all)

- [ ] LIMESTONE(1)
- [ ] RIP/RAP(0)
- X TILLS(1)
- [ ] HARDPAN(0)
- [ ] SANDSTONE(0)
- [ ] SHALE(-1)
- [ ] COAL FINES(-2)

SILT COVER (one)

- X SILT-HEAVY(-2)
- [ ] SILT-MOD(-1)
- [ ] SILT-NORM(0)
- [ ] SILT-FREE(1)

Extent of Embeddedness (check one)

- X EXTENSIVE(-2)
- [ ] MODERATE(-1)
- [ ] LOW(0)
- [ ] NONE(1)

COMMENTS:

2) INSTREAM COVER:

COVER SCORE 15

TYPE (Check all that apply)

- [ ] UNDERCUT BANKS(1)
- X OVERHANGING VEGETATION(1)
- X SHALLOWS (IN SLOW WATER)(1)
- X DEEP POOLS(2)
- X ROOTWADS(1)
- X BOULDERS(1)
- [ ] OXBOWS(1)
- X AQUATIC MACROPHYTES(1)
- X LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

- [ ] EXTENSIVE >75%(11)
- X MODERATE 25-75%(7)
- [ ] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS:

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)

CHANNEL SCORE 6

SINUOSITY

- [ ] HIGH(4)
- [ ] MODERATE(3)
- [ ] LOW(2)
- X NONE(1)

DEVELOPMENT

- [ ] EXCELLENT(7)
- [ ] GOOD(5)
- [ ] FAIR(3)
- X POOR(1)

CHANNELIZATION

- [ ] NONE(6)
- [ ] RECOVERED(4)
- [ ] RECOVERING(3)
- X RECENT OR NO RECOVERY(1)

STABILITY

- X HIGH(3)
- [ ] MODERATE(2)
- [ ] LOW(1)

MODIFICATION/OTHER

- [ ] SNAGGING
- [ ] IMPOUND
- [ ] RELOCATION
- [ ] ISLAND
- X CANOPY REMOVAL
- [ ] LEVEED
- [ ] DREDGING
- [ ] BANK SHAPING
- [ ] ONE SIDE CHANNEL MODIFICATION

COMMENTS:

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)

RIPARIAN SCORE 5

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
[ ]	[ ]	WIDE >150 ft.(4)
[ ]	[ ]	MODERATE 30-150 ft.(3)
[ ]	X	NARROW 15-30 ft.(2)
X	X	VERY NARROW 3-15 ft.(1)
X	[ ]	NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
[ ]	[ ]	FOREST, SWAMP(3)	[ ]	[ ]	URBAN OR INDUSTRIAL(0)
[ ]	[ ]	OPEN PASTURE/ROW CROP(0)	[ ]	[ ]	SHRUB OR OLD FIELD(2)
X	X	RESID.,PARK,NEW FIELD(1)	[ ]	[ ]	CONSERV. TILLAGE(1)
[ ]	[ ]	FENCED PASTURE(1)	[ ]	[ ]	MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
X	X	NONE OR LITTLE(3)
[ ]	[ ]	MODERATE(2)
[ ]	[ ]	HEAVY OR SEVERE(1)

COMMENTS:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

NO POOL = 0 POOL SCORE 9

MAX.DEPTH (Check 1)

- X >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [ ] 1.2-2.4 ft.(2)
- [ ] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)

- X POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)

- [ ] TORRENTIAL(-1)
- [ ] EDDIES(1)
- [ ] FAST(1)
- [ ] INTERSTITIAL(-1)
- [ ] MODERATE(1)
- [ ] INTERMITTENT(-2)
- X SLOW(1)

COMMENTS:

RIFFLE SCORE 0

RIFFLE/RUN DEPTH

- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [ ] GENERALLY 2-4 in.(1)
- X GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE

- [ ] STABLE (e.g., Cobble,Boulder)(2)
- [ ] MOD.STABLE (e.g., Pea Gravel)(1)
- [ ] UNSTABLE (Gravel, Sand)(0)
- X NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS

- [ ] EXTENSIVE(-1)
- [ ] NONE(2)
- [ ] MODERATE(0)
- X NO RIFFLE(0)
- [ ] LOW(1)

COMMENTS:

6) GRADIENT (FEET/MILE): 6

% POOL 30% % RIFFLE 0 % RUN 70% GRADIENT SCORE 6

Conducted by: JFNew
Project Number: 05-04-109

STREAM: Site 3 - Big Duck Creek **RIVER MILE:** CR 1300 N **DATE:** 8/4/2005 **QHEI SCORE** 32.5

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)

SUBSTRATE SCORE 10

TYPE			POOL	RIFFLE				POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)	___	___	[ ]	[X]	GRAVEL(7)	___	___
[ ]	[ ]	BOULDER(9)	___	___	[ ]	[X]	SAND(6)	___	___
[ ]	[ ]	COBBLE(8)	___	___	[ ]	[ ]	BEDROCK(5)	___	___
[ ]	[ ]	HARDPAN(4)	___	___	[ ]	[ ]	DETRITUS(3)	___	___
[ ]	[ ]	MUCK/SILT(2)	___	___	[ ]	[ ]	ARTIFIC(0)	___	___

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

SUBSTRATE ORIGIN (all)

[ ] LIMESTONE(1)	[ ] RIP/RAP(0)
[X] TILLS(1)	[ ] HARDPAN(0)
[ ] SANDSTONE(0)	
[ ] SHALE(-1)	
[ ] COAL FINES(-2)	

SILT COVER (one)

[X] SILT-HEAVY(-2)	[ ] SILT-MOD(-1)
[ ] SILT-NORM(0)	[ ] SILT-FREE(1)

Extent of Embeddedness (check one)

[X] EXTENSIVE(-2)	[ ] MODERATE(-1)
[ ] LOW(0)	[ ] NONE(1)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrat

COMMENTS: ____

2) INSTREAM COVER:

COVER SCORE 7

TYPE (Check all that apply)

[X] UNDERCUT BANKS(1)	[ ] DEEP POOLS(2)	[ ] OXBOWS(1)
[X] OVERHANGING VEGETATION(1)	[ ] ROOTWADS(1)	[X] AQUATIC MACROPHYTES(1)
[X] SHALLOWS (IN SLOW WATER)(1)	[ ] BOULDERS(1)	[ ] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

- [ ] EXTENSIVE >75%(11)
- [ ] MODERATE 25-75%(7)
- [X] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS: ____

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)

CHANNEL SCORE 6

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY	MODIFICATION/OTHER	
[ ] HIGH(4)	[ ] EXCELLENT(7)	[ ] NONE(6)	[ ] HIGH(3)	[ ] SNAGGING	[ ] IMPOUND
[ ] MODERATE(3)	[ ] GOOD(5)	[ ] RECOVERED(4)	[X] MODERATE(2)	[ ] RELOCATION	[ ] ISLAND
[X] LOW(2)	[ ] FAIR(3)	[ ] RECOVERING(3)	[ ] LOW(1)	[X] CANOPY REMOVAL	[ ] LEVEED
[ ] NONE(1)	[X] POOR(1)	[X] RECENT OR NO RECOVERY(1)		[ ] DREDGING	[X] BANK SHAPING
				[ ] ONE SIDE CHANNEL MODIFICATION	

COMMENTS: ____

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)

RIPARIAN SCORE 3.5

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
[ ]	[ ]	WIDE >150 ft.(4)
[ ]	[ ]	MODERATE 30-150 ft.(3)
[ ]	[ ]	NARROW 15-30 ft.(2)
[X]	[X]	VERY NARROW 3-15 ft.(1)
[X]	[X]	NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
[ ]	[ ]	FOREST, SWAMP(3)	[ ]	[ ]	URBAN OR INDUSTRIAL(0)
[X]	[X]	OPEN PASTURE/ROW CROP(0)	[ ]	[ ]	SHRUB OR OLD FIELD(2)
[ ]	[ ]	RESID.,PARK,NEW FIELD(1)	[ ]	[ ]	CONSERV. TILLAGE(1)
[ ]	[ ]	FENCED PASTURE(1)	[ ]	[ ]	MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
[X]	[X]	NONE OR LITTLE(3)
[ ]	[ ]	MODERATE(2)
[ ]	[ ]	HEAVY OR SEVERE(1)

COMMENTS: ____

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

NO POOL = 0 POOL SCORE 0

MAX.DEPTH (Check 1)

- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [ ] 1.2-2.4 ft.(2)
- [ ] <1.2 ft.(1)
- [X] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)

- [ ] POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)

[ ] TORRENTIAL(-1)	[ ] EDDIES(1)
[ ] FAST(1)	[ ] INTERSTITIAL(-1)
[ ] MODERATE(1)	[ ] INTERMITTENT(-2)
[ ] SLOW(1)	

COMMENTS: ____

RIFFLE SCORE 0

RIFFLE/RUN DEPTH	RIFFLE/RUN SUBSTRATE	RIFFLE/RUN EMBEDDEDNESS	
[ ] GENERALLY >4 in. MAX.>20 in.(4)	[ ] STABLE (e.g., Cobble,Boulder)(2)	[ ] EXTENSIVE(-1)	[ ] NONE(2)
[ ] GENERALLY >4 in. MAX.<20 in.(3)	[ ] MOD.STABLE (e.g., Pea Gravel)(1)	[ ] MODERATE(0)	[ ] NO RIFFLE(0)
[ ] GENERALLY 2-4 in.(1)	[ ] UNSTABLE (Gravel, Sand)(0)	[ ] LOW(1)	
[X] GENERALLY <2 in.(Riffle=0)(0)	[X] NO RIFFLE(0)		

COMMENTS: ____

6) GRADIENT (FEET/MILE): 6

% POOL 0 % RIFFLE 0 % RUN 100% GRADIENT SCORE 6

Conducted by: JFNew
Project Number: 05-04-109

STREAM: Site 4 - Little Duck Creek **RIVER MILE:** SR 13 **DATE:** 8/4/2005 **QHEI SCORE** 53.5

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)

SUBSTRATE SCORE 18

TYPE			POOL	RIFFLE	TYPE			POOL	RIFFLE
		BLDER/SLAB(10)			X		GRAVEL(7)	X	X
		BOULDER(9)					SAND(6)	X	X
	X	COBBLE(8)	X	X			BEDROCK(5)		
		HARDPAN(4)					DETRITUS(3)		
		MUCK/SILT(2)	X	X			ARTIFIC(0)	X	X

SUBSTRATE ORIGIN (all)

	LIMESTONE(1)		RIP/RAP(0)
X	TILLS(1)		HARDPAN(0)
	SANDSTONE(0)		
	SHALE(-1)		
	COAL FINES(-2)		

SILT COVER (one)

	SILT-HEAVY(-2)		SILT-MOD(-1)
X	SILT-NORM(0)		SILT-FREE(1)

Extent of Embeddedness (check one)

	EXTENSIVE(-2)		MODERATE(-1)
X	LOW(0)		NONE(1)

TOTAL NUMBER OF SUBSTRATE TYPES: [X] >4(2) [ ] <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrat

COMMENTS:

2) INSTREAM COVER:

COVER SCORE 7

TYPE (Check all that apply)

	UNDERCUT BANKS(1)		DEEP POOLS(2)		OXBOWS(1)
	OVERHANGING VEGETATION(1)	X	ROOTWADS(1)	X	AQUATIC MACROPHYTES(1)
X	SHALLOWS (IN SLOW WATER)(1)		BOULDERS(1)	X	LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

	EXTENSIVE >75%(11)
	MODERATE 25-75%(7)
X	SPARSE 5-25%(3)
	NEARLY ABSENT <5%(1)

COMMENTS:

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)

CHANNEL SCORE 8

SINUOSITY		DEVELOPMENT		CHANNELIZATION		STABILITY	
	HIGH(4)		EXCELLENT(7)		NONE(6)	X	HIGH(3)
	MODERATE(3)		GOOD(5)		RECOVERED(4)		MODERATE(2)
	LOW(2)		FAIR(3)	X	RECOVERING(3)		LOW(1)
X	NONE(1)	X	POOR(1)		RECENT OR NO RECOVERY(1)		

MODIFICATION/OTHER

	SNAGGING		IMPOUND
	RELOCATION		ISLAND
	CANOPY REMOVAL		LEVEED
	DREDGING		BANK SHAPING
	ONE SIDE CHANNEL MODIFICATION		

COMMENTS:

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)

RIPARIAN SCORE 8.5

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
X	X	WIDE >150 ft.(4)
X		MODERATE 30-150 ft.(3)
		NARROW 15-30 ft.(2)
	X	VERY NARROW 3-15 ft.(1)
		NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
X	X	FOREST, SWAMP(3)			URBAN OR INDUSTRIAL(0)
		OPEN PASTURE/ROW CROP(0)			SHRUB OR OLD FIELD(2)
	X	RESID.,PARK,NEW FIELD(1)			CONSERV. TILLAGE(1)
		FENCED PASTURE(1)			MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
X	X	NONE OR LITTLE(3)
		MODERATE(2)
		HEAVY OR SEVERE(1)

COMMENTS:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

NO POOL = 0 **POOL SCORE** 0

MAX.DEPTH (Check 1)

	>4 ft.(6)
	2.4-4 ft.(4)
	1.2-2.4 ft.(2)
	<1.2 ft.(1)
X	<0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)

	POOL WIDTH>RIFFLE WIDTH(2)
	POOL WIDTH=RIFFLE WIDTH(1)
X	POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)

	TORRENTIAL(-1)		EDDIES(1)
	FAST(1)		INTERSTITIAL(-1)
	MODERATE(1)		INTERMITTENT(-2)
	SLOW(1)		

COMMENTS:

RIFFLE SCORE 4

RIFFLE/RUN DEPTH

	GENERALLY >4 in. MAX.>20 in.(4)
	GENERALLY >4 in. MAX.<20 in.(3)
X	GENERALLY 2-4 in.(1)
	GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE

X	STABLE (e.g., Cobble,Boulder)(2)
	MOD.STABLE (e.g., Pea Gravel)(1)
	UNSTABLE (Gravel, Sand)(0)
	NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS

	EXTENSIVE(-1)		NONE(2)
	MODERATE(0)		NO RIFFLE(0)
X	LOW(1)		

COMMENTS:

6) GRADIENT (FEET/MILE): 6 **% POOL** 0 **% RIFFLE** 15% **% RUN** 85% **GRADIENT SCORE** 6

Conducted by: JFNew
Project Number: 05-04-109

STREAM: Site 5 - Little Duck Creek **RIVER MILE:** CR 1100 N **DATE:** 8/4/2005 **QHEI SCORE** 32.5

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)

SUBSTRATE SCORE -1

TYPE (POOL / RIFFLE)

- [ ] [ ] BLDER/SLAB(10)
- [ ] [ ] BOULDER(9)
- [ ] [ ] COBBLE(8)
- [ ] [ ] HARDPAN(4)
- [ ] [X] MUCK/SILT(2)
- [ ] [ ] GRAVEL(7)
- [ ] [ ] SAND(6)
- [ ] [ ] BEDROCK(5)
- [ ] [ ] DETRITUS(3)
- [ ] [X] ARTIFIC(0)

SUBSTRATE ORIGIN (all)

- [ ] LIMESTONE(1)
- [X] TILLS(1)
- [ ] SANDSTONE(0)
- [ ] SHALE(-1)
- [ ] COAL FINES(-2)
- [ ] RIP/RAP(0)
- [ ] HARDPAN(0)

SILT COVER (one)

- [X] SILT-HEAVY(-2)
- [ ] SILT-MOD(-1)
- [ ] SILT-NORM(0)
- [ ] SILT-FREE(1)

Extent of Embeddedness (check one)

- [X] EXTENSIVE(-2)
- [ ] MODERATE(-1)
- [ ] LOW(0)
- [ ] NONE(1)

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrat

COMMENTS:

2) INSTREAM COVER:

COVER SCORE 6

TYPE (Check all that apply)

- [ ] UNDERCUT BANKS(1)
- [X] OVERHANGING VEGETATION(1)
- [X] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [X] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- [ ] AQUATIC MACROPHYTES(1)
- [ ] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

- [ ] EXTENSIVE >75%(11)
- [ ] MODERATE 25-75%(7)
- [X] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS:

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)

CHANNEL SCORE 7

SINUOSITY

- [ ] HIGH(4)
- [ ] MODERATE(3)
- [ ] LOW(2)
- [X] NONE(1)

DEVELOPMENT

- [ ] EXCELLENT(7)
- [ ] GOOD(5)
- [X] FAIR(3)
- [X] POOR(1)

CHANNELIZATION

- [ ] NONE(6)
- [ ] RECOVERED(4)
- [ ] RECOVERING(3)
- [X] RECENT OR NO RECOVERY(1)

STABILITY

- [X] HIGH(3)
- [ ] MODERATE(2)
- [ ] LOW(1)

MODIFICATION/OTHER

- [ ] SNAGGING
- [ ] RELOCATION
- [X] CANOPY REMOVAL
- [ ] DREDGING
- [ ] ONE SIDE CHANNEL MODIFICATION
- [ ] IMPOUND
- [ ] ISLAND
- [ ] LEVEED
- [X] BANK SHAPING

COMMENTS:

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)

RIPARIAN SCORE 5.5

River Right Looking Downstream

RIPARIAN WIDTH (per bank) — L R (per bank)

- [ ] [ ] WIDE >150 ft.(4)
- [X] [ ] MODERATE 30-150 ft.(3)
- [ ] [X] NARROW 15-30 ft.(2)
- [ ] [X] VERY NARROW 3-15 ft.(1)
- [X] [ ] NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY — L R (most predominant per bank)

- [ ] [ ] FOREST, SWAMP(3)
- [ ] [ ] OPEN PASTURE/ROW CROP(0)
- [X] [ ] RESID.,PARK,NEW FIELD(1)
- [ ] [ ] FENCED PASTURE(1)

L R (per bank)

- [ ] [X] URBAN OR INDUSTRIAL(0)
- [ ] [ ] SHRUB OR OLD FIELD(2)
- [ ] [ ] CONSERV. TILLAGE(1)
- [ ] [ ] MINING/CONSTRUCTION(0)

BANK EROSION — L R (per bank)

- [X] [X] NONE OR LITTLE(3)
- [ ] [ ] MODERATE(2)
- [ ] [ ] HEAVY OR SEVERE(1)

COMMENTS:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

NO POOL = 0 **POOL SCORE** 5

MAX.DEPTH (Check 1)

- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [X] 1.2-2.4 ft.(2)
- [ ] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)

- [X] POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)

- [ ] TORRENTIAL(-1)
- [ ] FAST(1)
- [ ] MODERATE(1)
- [X] SLOW(1)
- [ ] EDDIES(1)
- [ ] INTERSTITIAL(-1)
- [ ] INTERMITTENT(-2)

COMMENTS:

RIFFLE SCORE 4

RIFFLE/RUN DEPTH

- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [X] GENERALLY 2-4 in.(1)
- [ ] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE

- [X] STABLE (e.g., Cobble,Boulder)(2)
- [ ] MOD.STABLE (e.g., Pea Gravel)(1)
- [ ] UNSTABLE (Gravel, Sand)(0)
- [ ] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS

- [ ] EXTENSIVE(-1)
- [ ] MODERATE(0)
- [X] LOW(1)
- [ ] NONE(2)
- [ ] NO RIFFLE(0)

COMMENTS:

6) GRADIENT (FEET/MILE): 6 **% POOL** 20% **% RIFFLE** 30% **% RUN** 50% **GRADIENT SCORE** 6

Conducted by: JFNew
Project Number: 05-04-109

STREAM: Site 6 - Little Duck Creek **RIVER MILE:** CR 700 N **DATE:** 8/4/2005 **QHEI SCORE** 36

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)

SUBSTRATE SCORE 12

TYPE	POOL	RIFFLE	TYPE	POOL	RIFFLE
BLDER/SLAB(10)			X GRAVEL(7)		
BOULDER(9)			X SAND(6)		
COBBLE(8)		X	BEDROCK(5)		
HARDPAN(4)			DETRITUS(3)		
MUCK/SILT(2)			ARTIFIC(0)		

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

SUBSTRATE ORIGIN (all)
- [ ] LIMESTONE(1)
- [ ] RIP/RAP(0)
- [X] TILLS(1)
- [ ] HARDPAN(0)
- [ ] SANDSTONE(0)
- [ ] SHALE(-1)
- [ ] COAL FINES(-2)

SILT COVER (one)
- [ ] SILT-HEAVY(-2)
- [X] SILT-MOD(-1)
- [ ] SILT-NORM(0)
- [ ] SILT-FREE(1)

Extent of Embeddedness (check one)
- [ ] EXTENSIVE(-2)
- [X] MODERATE(-1)
- [ ] LOW(0)
- [ ] NONE(1)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrat

COMMENTS:

2) INSTREAM COVER:

COVER SCORE 3

TYPE (Check all that apply)
- [ ] UNDERCUT BANKS(1)
- [ ] OVERHANGING VEGETATION(1)
- [X] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [ ] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- [X] AQUATIC MACROPHYTES(1)
- [ ] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)
- [ ] EXTENSIVE >75%(11)
- [ ] MODERATE 25-75%(7)
- [ ] SPARSE 5-25%(3)
- [X] NEARLY ABSENT <5%(1)

COMMENTS:

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)

CHANNEL SCORE 5

SINUOSITY
- [ ] HIGH(4)
- [ ] MODERATE(3)
- [ ] LOW(2)
- [X] NONE(1)

DEVELOPMENT
- [ ] EXCELLENT(7)
- [ ] GOOD(5)
- [ ] FAIR(3)
- [X] POOR(1)

CHANNELIZATION
- [ ] NONE(6)
- [ ] RECOVERED(4)
- [ ] RECOVERING(3)
- [X] RECENT OR NO RECOVERY(1)

STABILITY
- [ ] HIGH(3)
- [X] MODERATE(2)
- [ ] LOW(1)

MODIFICATION/OTHER
- [ ] SNAGGING
- [ ] RELOCATION
- [X] CANOPY REMOVAL
- [ ] DREDGING
- [ ] ONE SIDE CHANNEL MODIFICATION
- [ ] IMPOUND
- [ ] ISLAND
- [ ] LEVEED
- [ ] BANK SHAPING

COMMENTS:

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)

RIPARIAN SCORE 3

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
		WIDE >150 ft.(4)
		MODERATE 30-150 ft.(3)
		NARROW 15-30 ft.(2)
		VERY NARROW 3-15 ft.(1)
X	X	NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
		FOREST, SWAMP(3)			URBAN OR INDUSTRIAL(0)
X	X	OPEN PASTURE/ROW CROP(0)			SHRUB OR OLD FIELD(2)
		RESID.,PARK,NEW FIELD(1)			CONSERV. TILLAGE(1)
		FENCED PASTURE(1)			MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
X	X	NONE OR LITTLE(3)
		MODERATE(2)
		HEAVY OR SEVERE(1)

COMMENTS:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

NO POOL = 0 **POOL SCORE** 4

MAX.DEPTH (Check 1)
- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [ ] 1.2-2.4 ft.(2)
- [X] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)
- [X] POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)
- [ ] TORRENTIAL(-1)
- [ ] FAST(1)
- [ ] MODERATE(1)
- [X] SLOW(1)
- [ ] EDDIES(1)
- [ ] INTERSTITIAL(-1)
- [ ] INTERMITTENT(-2)

COMMENTS:

RIFFLE SCORE 3

RIFFLE/RUN DEPTH
- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [X] GENERALLY 2-4 in.(1)
- [ ] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE
- [ ] STABLE (e.g., Cobble,Boulder)(2)
- [X] MOD.STABLE (e.g., Pea Gravel)(1)
- [ ] UNSTABLE (Gravel, Sand)(0)
- [ ] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS
- [ ] EXTENSIVE(-1)
- [ ] MODERATE(0)
- [X] LOW(1)
- [ ] NONE(2)
- [ ] NO RIFFLE(0)

COMMENTS:

6) GRADIENT (FEET/MILE): 6 **% POOL** 15% **% RIFFLE** 25% **% RUN** 60% **GRADIENT SCORE** 6

Conducted by: JFNew
Project Number: 05-04-109

STREAM: Site 7 - Pipe Creek **RIVER MILE:** CR 300 W **DATE:** 8/4/2005 **QHEI SCORE** 45

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)

SUBSTRATE SCORE 13

TYPE			POOL	RIFFLE				POOL	RIFFLE
		BLDER/SLAB(10)			X		GRAVEL(7)	X	X
		BOULDER(9)				X	SAND(6)	X	X
		COBBLE(8)					BEDROCK(5)		
		HARDPAN(4)					DETRITUS(3)		
		MUCK/SILT(2)	X	X			ARTIFIC(0)	X	X

SUBSTRATE ORIGIN (all)

	LIMESTONE(1)		RIP/RAP(0)
X	TILLS(1)		HARDPAN(0)
	SANDSTONE(0)		
	SHALE(-1)		
	COAL FINES(-2)		

SILT COVER (one)

	SILT-HEAVY(-2)		SILT-MOD(-1)
X	SILT-NORM(0)		SILT-FREE(1)

Extent of Embeddedness (check one)

	EXTENSIVE(-2)	X	MODERATE(-1)
	LOW(0)		NONE(1)

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrat

COMMENTS:

2) INSTREAM COVER:

COVER SCORE 8

TYPE (Check all that apply)

X	UNDERCUT BANKS(1)		DEEP POOLS(2)		OXBOWS(1)
	OVERHANGING VEGETATION(1)	X	ROOTWADS(1)		AQUATIC MACROPHYTES(1)
X	SHALLOWS (IN SLOW WATER)(1)	X	BOULDERS(1)	X	LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

	EXTENSIVE >75%(11)
	MODERATE 25-75%(7)
X	SPARSE 5-25%(3)
	NEARLY ABSENT <5%(1)

COMMENTS:

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)

CHANNEL SCORE 6

SINUOSITY		DEVELOPMENT		CHANNELIZATION		STABILITY	
	HIGH(4)		EXCELLENT(7)		NONE(6)	X	HIGH(3)
	MODERATE(3)		GOOD(5)		RECOVERED(4)		MODERATE(2)
	LOW(2)		FAIR(3)		RECOVERING(3)		LOW(1)
X	NONE(1)	X	POOR(1)	X	RECENT OR NO RECOVERY(1)		

MODIFICATION/OTHER

	SNAGGING		IMPOUND
	RELOCATION		ISLAND
	CANOPY REMOVAL		LEVEED
	DREDGING		BANK SHAPING
	ONE SIDE CHANNEL MODIFICATION		

COMMENTS:

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)

RIPARIAN SCORE 7

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
X		WIDE >150 ft.(4)
	X	MODERATE 30-150 ft.(3)
		NARROW 15-30 ft.(2)
X	X	VERY NARROW 3-15 ft.(1)
		NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
X	X	FOREST, SWAMP(3)			URBAN OR INDUSTRIAL(0)
X		OPEN PASTURE/ROW CROP(0)			SHRUB OR OLD FIELD(2)
	X	RESID.,PARK,NEW FIELD(1)			CONSERV. TILLAGE(1)
		FENCED PASTURE(1)			MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
X	X	NONE OR LITTLE(3)
		MODERATE(2)
		HEAVY OR SEVERE(1)

COMMENTS:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

NO POOL = 0 **POOL SCORE** 5

MAX.DEPTH (Check 1)

	>4 ft.(6)
	2.4-4 ft.(4)
X	1.2-2.4 ft.(2)
	<1.2 ft.(1)
	<0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)

X	POOL WIDTH>RIFFLE WIDTH(2)
	POOL WIDTH=RIFFLE WIDTH(1)
	POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)

	TORRENTIAL(-1)		EDDIES(1)
	FAST(1)		INTERSTITIAL(-1)
X	MODERATE(1)		INTERMITTENT(-2)
	SLOW(1)		

COMMENTS:

RIFFLE SCORE 0

RIFFLE/RUN DEPTH

	GENERALLY >4 in. MAX.>20 in.(4)
	GENERALLY >4 in. MAX.<20 in.(3)
	GENERALLY 2-4 in.(1)
X	GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE

	STABLE (e.g., Cobble,Boulder)(2)
	MOD.STABLE (e.g., Pea Gravel)(1)
	UNSTABLE (Gravel, Sand)(0)
X	NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS

	EXTENSIVE(-1)		NONE(2)
	MODERATE(0)	X	NO RIFFLE(0)
	LOW(1)		

COMMENTS:

6) GRADIENT (FEET/MILE): 5

% POOL 5% **% RIFFLE** 0 **% RUN** 95% **GRADIENT SCORE** 6

Conducted by: JFNew
Project Number: 05-04-109

STREAM: Site 8 - Lilly Creek **RIVER MILE:** CR 300 W **DATE:** 8/4/2005 **QHEI SCORE** 53.5

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)

SUBSTRATE SCORE 15

TYPE			POOL	RIFFLE				POOL	RIFFLE
		BLDER/SLAB(10)			X		GRAVEL(7)	X	X
		BOULDER(9)				X	SAND(6)	X	X
		COBBLE(8)		X			BEDROCK(5)		
		HARDPAN(4)					DETRITUS(3)		
		MUCK/SILT(2)	X				ARTIFIC(0)	X	X

TOTAL NUMBER OF SUBSTRATE TYPES: [X] >4(2) [ ] <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrat

SUBSTRATE ORIGIN (all)

- [ ] LIMESTONE(1)
- [X] TILLS(1)
- [ ] SANDSTONE(0)
- [ ] SHALE(-1)
- [ ] COAL FINES(-2)
- [ ] RIP/RAP(0)
- [ ] HARDPAN(0)

SILT COVER (one)

- [ ] SILT-HEAVY(-2)
- [X] SILT-NORM(0)
- [X] SILT-MOD(-1)
- [ ] SILT-FREE(1)

Extent of Embeddedness (check one)

- [ ] EXTENSIVE(-2)
- [X] LOW(0)
- [X] MODERATE(-1)
- [ ] NONE(1)

COMMENTS:

2) INSTREAM COVER:

COVER SCORE 13

TYPE (Check all that apply)

- [X] UNDERCUT BANKS(1)
- [X] OVERHANGING VEGETATION(1)
- [X] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [X] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- [X] AQUATIC MACROPHYTES(1)
- [X] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

- [ ] EXTENSIVE >75%(11)
- [X] MODERATE 25-75%(7)
- [ ] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS:

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)

CHANNEL SCORE 8

SINUOSITY

- [ ] HIGH(4)
- [ ] MODERATE(3)
- [ ] LOW(2)
- [X] NONE(1)

DEVELOPMENT

- [ ] EXCELLENT(7)
- [ ] GOOD(5)
- [ ] FAIR(3)
- [X] POOR(1)

CHANNELIZATION

- [ ] NONE(6)
- [ ] RECOVERED(4)
- [X] RECOVERING(3)
- [ ] RECENT OR NO RECOVERY(1)

STABILITY

- [X] HIGH(3)
- [ ] MODERATE(2)
- [ ] LOW(1)

MODIFICATION/OTHER

- [ ] SNAGGING
- [ ] RELOCATION
- [ ] CANOPY REMOVAL
- [ ] DREDGING
- [ ] ONE SIDE CHANNEL MODIFICATION
- [ ] IMPOUND
- [ ] ISLAND
- [ ] LEVEED
- [ ] BANK SHAPING

COMMENTS:

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)

RIPARIAN SCORE 4.5

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
		WIDE >150 ft.(4)
		MODERATE 30-150 ft.(3)
X		NARROW 15-30 ft.(2)
	X	VERY NARROW 3-15 ft.(1)
		NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
		FOREST, SWAMP(3)			URBAN OR INDUSTRIAL(0)
X	X	OPEN PASTURE/ROW CROP(0)			SHRUB OR OLD FIELD(2)
		RESID.,PARK,NEW FIELD(1)			CONSERV. TILLAGE(1)
		FENCED PASTURE(1)			MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
X	X	NONE OR LITTLE(3)
		MODERATE(2)
		HEAVY OR SEVERE(1)

COMMENTS:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

NO POOL = 0 POOL SCORE 5

MAX.DEPTH (Check 1)

- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [X] 1.2-2.4 ft.(2)
- [ ] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)

- [X] POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)

- [ ] TORRENTIAL(-1)
- [ ] FAST(1)
- [ ] MODERATE(1)
- [X] SLOW(1)
- [ ] EDDIES(1)
- [ ] INTERSTITIAL(-1)
- [ ] INTERMITTENT(-2)

COMMENTS:

RIFFLE SCORE 0

RIFFLE/RUN DEPTH

- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [ ] GENERALLY 2-4 in.(1)
- [X] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE

- [ ] STABLE (e.g., Cobble,Boulder)(2)
- [ ] MOD.STABLE (e.g., Pea Gravel)(1)
- [X] UNSTABLE (Gravel, Sand)(0)
- [ ] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS

- [ ] EXTENSIVE(-1)
- [X] MODERATE(0)
- [ ] LOW(1)
- [ ] NONE(2)
- [ ] NO RIFFLE(0)

COMMENTS:

6) GRADIENT (FEET/MILE): 19 **% POOL** 10% **% RIFFLE** 5% **% RUN** 85% **GRADIENT SCORE** 8

Conducted by: JFNew
Project Number: 05-04-109

STREAM: Site 9 - Lilly Creek **RIVER MILE:** SR 28 **DATE:** 8/4/2005 **QHEI SCORE** 49

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)

SUBSTRATE SCORE 12

TYPE			POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)		
[ ]	[ ]	BOULDER(9)		
[ ]	[ ]	COBBLE(8)		
[ ]	[ ]	HARDPAN(4)		
[ ]	[ ]	MUCK/SILT(2)	X	
[ ]	[X]	GRAVEL(7)	X	
[ ]	[X]	SAND(6)	X	
[ ]	[ ]	BEDROCK(5)		
[ ]	[ ]	DETRITUS(3)	X	
[ ]	[ ]	ARTIFIC(0)	X	

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

SUBSTRATE ORIGIN (all)

[ ] LIMESTONE(1) [ ] RIP/RAP(0)
[X] TILLS(1) [ ] HARDPAN(0)
[ ] SANDSTONE(0)
[ ] SHALE(-1)
[ ] COAL FINES(-2)

SILT COVER (one)

[X] SILT-HEAVY(-2) [ ] SILT-MOD(-1)
[ ] SILT-NORM(0) [ ] SILT-FREE(1)

Extent of Embeddedness (check one)

[ ] EXTENSIVE(-2) [ ] MODERATE(-1)
[X] LOW(0) [ ] NONE(1)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrat

COMMENTS:

2) INSTREAM COVER:

COVER SCORE 11

TYPE (Check all that apply)

[ ] UNDERCUT BANKS(1) [ ] DEEP POOLS(2) [ ] OXBOWS(1)
[X] OVERHANGING VEGETATION(1) [ ] ROOTWADS(1) [X] AQUATIC MACROPHYTES(1)
[X] SHALLOWS (IN SLOW WATER)(1) [ ] BOULDERS(1) [X] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

[ ] EXTENSIVE >75%(11)
[X] MODERATE 25-75%(7)
[ ] SPARSE 5-25%(3)
[ ] NEARLY ABSENT <5%(1)

COMMENTS:

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)

CHANNEL SCORE 9

SINUOSITY: [ ] HIGH(4) [ ] MODERATE(3) [X] LOW(2) [ ] NONE(1)

DEVELOPMENT: [ ] EXCELLENT(7) [ ] GOOD(5) [ ] FAIR(3) [X] POOR(1)

CHANNELIZATION: [ ] NONE(6) [ ] RECOVERED(4) [X] RECOVERING(3) [ ] RECENT OR NO RECOVERY(1)

STABILITY: [X] HIGH(3) [ ] MODERATE(2) [ ] LOW(1)

MODIFICATION/OTHER: [ ] SNAGGING [ ] RELOCATION [X] CANOPY REMOVAL [ ] DREDGING [ ] ONE SIDE CHANNEL MODIFICATION [ ] IMPOUND [ ] ISLAND [ ] LEVEED [X] BANK SHAPING

COMMENTS:

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)

RIPARIAN SCORE 4

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
[ ]	[ ]	WIDE >150 ft.(4)
[ ]	[ ]	MODERATE 30-150 ft.(3)
[ ]	[ ]	NARROW 15-30 ft.(2)
[X]	[X]	VERY NARROW 3-15 ft.(1)
[ ]	[ ]	NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
[ ]	[ ]	FOREST, SWAMP(3)	[ ]	[ ]	URBAN OR INDUSTRIAL(0)
[X]	[X]	OPEN PASTURE/ROW CROP(0)	[ ]	[ ]	SHRUB OR OLD FIELD(2)
[ ]	[ ]	RESID.,PARK,NEW FIELD(1)	[ ]	[ ]	CONSERV. TILLAGE(1)
[ ]	[ ]	FENCED PASTURE(1)	[ ]	[ ]	MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
[X]	[X]	NONE OR LITTLE(3)
[ ]	[ ]	MODERATE(2)
[ ]	[ ]	HEAVY OR SEVERE(1)

COMMENTS:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

NO POOL = 0 **POOL SCORE** 5

MAX.DEPTH (Check 1): [ ] >4 ft.(6) [ ] 2.4-4 ft.(4) [X] 1.2-2.4 ft.(2) [ ] <1.2 ft.(1) [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1): [X] POOL WIDTH>RIFFLE WIDTH(2) [ ] POOL WIDTH=RIFFLE WIDTH(1) [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply): [ ] TORRENTIAL(-1) [ ] FAST(1) [ ] MODERATE(1) [X] SLOW(1) [ ] EDDIES(1) [ ] INTERSTITIAL(-1) [ ] INTERMITTENT(-2)

COMMENTS:

RIFFLE SCORE 0

RIFFLE/RUN DEPTH: [ ] GENERALLY >4 in. MAX.>20 in.(4) [ ] GENERALLY >4 in. MAX.<20 in.(3) [ ] GENERALLY 2-4 in.(1) [X] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE: [ ] STABLE (e.g., Cobble,Boulder)(2) [ ] MOD.STABLE (e.g., Pea Gravel)(1) [ ] UNSTABLE (Gravel, Sand)(0) [X] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS: [ ] EXTENSIVE(-1) [ ] MODERATE(0) [ ] LOW(1) [ ] NONE(2) [X] NO RIFFLE(0)

COMMENTS:

6) GRADIENT (FEET/MILE): 10

% POOL 10% % RIFFLE 0 % RUN 90% **GRADIENT SCORE** 8

Conducted by: JFNew
Project Number: 05-04-109

STREAM: Site 10 - Lilly Creek **RIVER MILE:** CR 1400 N **DATE:** 8/4/2005 **QHEI SCORE** 38.5

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)

SUBSTRATE SCORE 7

TYPE — POOL / RIFFLE

- [ ] [ ] BLDER/SLAB(10)
- [ ] [ ] BOULDER(9)
- [ ] [ ] COBBLE(8)
- [ ] [ ] HARDPAN(4)
- [X] [ ] MUCK/SILT(2)
- [ ] [ ] GRAVEL(7)
- [ ] [X] SAND(6)
- [ ] [ ] BEDROCK(5)
- [ ] [ ] DETRITUS(3)
- [ ] [ ] ARTIFIC(0)

SUBSTRATE ORIGIN (all)

- [ ] LIMESTONE(1)
- [X] TILLS(1)
- [ ] SANDSTONE(0)
- [ ] SHALE(-1)
- [ ] COAL FINES(-2)
- [ ] RIP/RAP(0)
- [ ] HARDPAN(0)

SILT COVER (one)

- [X] SILT-HEAVY(-2)
- [X] SILT-NORM(0)
- [ ] SILT-MOD(-1)
- [ ] SILT-FREE(1)

Extent of Embeddedness (check one)

- [X] EXTENSIVE(-2)
- [X] LOW(0)
- [ ] MODERATE(-1)
- [ ] NONE(1)

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrat

COMMENTS:

2) INSTREAM COVER:

COVER SCORE 9

TYPE (Check all that apply)

- [X] UNDERCUT BANKS(1)
- [X] OVERHANGING VEGETATION(1)
- [X] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [X] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- [X] AQUATIC MACROPHYTES(1)
- [X] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

- [ ] EXTENSIVE >75%(11)
- [ ] MODERATE 25-75%(7)
- [X] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS:

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)

CHANNEL SCORE 8

SINUOSITY

- [ ] HIGH(4)
- [ ] MODERATE(3)
- [ ] LOW(2)
- [X] NONE(1)

DEVELOPMENT

- [ ] EXCELLENT(7)
- [ ] GOOD(5)
- [X] FAIR(3)
- [ ] POOR(1)

CHANNELIZATION

- [ ] NONE(6)
- [ ] RECOVERED(4)
- [ ] RECOVERING(3)
- [X] RECENT OR NO RECOVERY(1)

STABILITY

- [X] HIGH(3)
- [ ] MODERATE(2)
- [ ] LOW(1)

MODIFICATION/OTHER

- [X] SNAGGING
- [ ] RELOCATION
- [X] CANOPY REMOVAL
- [ ] DREDGING
- [ ] ONE SIDE CHANNEL MODIFICATION
- [ ] IMPOUND
- [ ] ISLAND
- [ ] LEVEED
- [X] BANK SHAPING

COMMENTS:

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)

RIPARIAN SCORE 3.5

River Right Looking Downstream

RIPARIAN WIDTH (per bank) — L R (per bank)

- L [ ] R [ ] WIDE >150 ft.(4)
- L [ ] R [ ] MODERATE 30-150 ft.(3)
- L [ ] R [ ] NARROW 15-30 ft.(2)
- L [X] R [ ] VERY NARROW 3-15 ft.(1)
- L [ ] R [X] NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY — L R (most predominant per bank)

- L [ ] R [ ] FOREST, SWAMP(3)
- L [X] R [X] OPEN PASTURE/ROW CROP(0)
- L [ ] R [ ] RESID.,PARK,NEW FIELD(1)
- L [ ] R [ ] FENCED PASTURE(1)

L R (per bank)

- L [ ] R [ ] URBAN OR INDUSTRIAL(0)
- L [ ] R [ ] SHRUB OR OLD FIELD(2)
- L [ ] R [ ] CONSERV. TILLAGE(1)
- L [ ] R [ ] MINING/CONSTRUCTION(0)

BANK EROSION — L R (per bank)

- L [X] R [X] NONE OR LITTLE(3)
- L [ ] R [ ] MODERATE(2)
- L [ ] R [ ] HEAVY OR SEVERE(1)

COMMENTS:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

NO POOL = 0 **POOL SCORE** 5

MAX.DEPTH (Check 1)

- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [X] 1.2-2.4 ft.(2)
- [ ] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)

- [ ] POOL WIDTH>RIFFLE WIDTH(2)
- [X] POOL WIDTH=RIFFLE WIDTH(1)
- [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)

- [ ] TORRENTIAL(-1)
- [ ] FAST(1)
- [ ] MODERATE(1)
- [X] SLOW(1)
- [X] EDDIES(1)
- [ ] INTERSTITIAL(-1)
- [ ] INTERMITTENT(-2)

COMMENTS:

RIFFLE SCORE 0

RIFFLE/RUN DEPTH

- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [ ] GENERALLY 2-4 in.(1)
- [X] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE

- [ ] STABLE (e.g., Cobble,Boulder)(2)
- [ ] MOD.STABLE (e.g., Pea Gravel)(1)
- [ ] UNSTABLE (Gravel, Sand)(0)
- [X] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS

- [ ] EXTENSIVE(-1)
- [ ] MODERATE(0)
- [ ] LOW(1)
- [ ] NONE(2)
- [X] NO RIFFLE(0)

COMMENTS:

6) GRADIENT (FEET/MILE): 5

% POOL 10% % RIFFLE 0 % RUN 90% **GRADIENT SCORE** 6

Conducted by: JFNew
Project Number: 05-04-109

STREAM: Site 11 - Lilly Creek **RIVER MILE:** CR 200 W **DATE:** 8/4/2005 **QHEI SCORE** 44

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)

SUBSTRATE SCORE 6

TYPE			POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)		
[ ]	[ ]	BOULDER(9)		
[ ]	[ ]	COBBLE(8)		
[ ]	[ ]	HARDPAN(4)		
[ ]	[X]	MUCK/SILT(2)	X	X
[ ]	[ ]	GRAVEL(7)	X	X
[X]	[ ]	SAND(6)	X	X
[ ]	[ ]	BEDROCK(5)		
[ ]	[ ]	DETRITUS(3)		
[ ]	[ ]	ARTIFIC(0)	X	X

SUBSTRATE ORIGIN (all)
- [ ] LIMESTONE(1)
- [X] TILLS(1)
- [ ] SANDSTONE(0)
- [ ] SHALE(-1)
- [ ] COAL FINES(-2)
- [ ] RIP/RAP(0)
- [ ] HARDPAN(0)

SILT COVER (one)
- [X] SILT-HEAVY(-2)
- [ ] SILT-MOD(-1)
- [ ] SILT-NORM(0)
- [ ] SILT-FREE(1)

Extent of Embeddedness (check one)
- [ ] EXTENSIVE(-2)
- [X] MODERATE(-1)
- [ ] LOW(0)
- [ ] NONE(1)

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrat

COMMENTS:

2) INSTREAM COVER:

COVER SCORE 11

TYPE (Check all that apply)
- [X] UNDERCUT BANKS(1)
- [ ] OVERHANGING VEGETATION(1)
- [X] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [X] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- [ ] AQUATIC MACROPHYTES(1)
- [X] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)
- [ ] EXTENSIVE >75%(11)
- [X] MODERATE 25-75%(7)
- [ ] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS:

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)

CHANNEL SCORE 11

SINUOSITY
- [ ] HIGH(4)
- [ ] MODERATE(3)
- [X] LOW(2)
- [ ] NONE(1)

DEVELOPMENT
- [ ] EXCELLENT(7)
- [ ] GOOD(5)
- [X] FAIR(3)
- [ ] POOR(1)

CHANNELIZATION
- [ ] NONE(6)
- [ ] RECOVERED(4)
- [X] RECOVERING(3)
- [ ] RECENT OR NO RECOVERY(1)

STABILITY
- [X] HIGH(3)
- [ ] MODERATE(2)
- [ ] LOW(1)

MODIFICATION/OTHER
- [ ] SNAGGING
- [ ] RELOCATION
- [X] CANOPY REMOVAL
- [ ] DREDGING
- [ ] ONE SIDE CHANNEL MODIFICATION
- [ ] IMPOUND
- [ ] ISLAND
- [ ] LEVEED
- [X] BANK SHAPING

COMMENTS:

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)

RIPARIAN SCORE 5

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
[ ]	[ ]	WIDE >150 ft.(4)
[ ]	[ ]	MODERATE 30-150 ft.(3)
[X]	[X]	NARROW 15-30 ft.(2)
[ ]	[ ]	VERY NARROW 3-15 ft.(1)
[ ]	[ ]	NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
[ ]	[ ]	FOREST, SWAMP(3)	[ ]	[ ]	URBAN OR INDUSTRIAL(0)
[X]	[X]	OPEN PASTURE/ROW CROP(0)	[ ]	[ ]	SHRUB OR OLD FIELD(2)
[ ]	[ ]	RESID.,PARK,NEW FIELD(1)	[ ]	[ ]	CONSERV. TILLAGE(1)
[ ]	[ ]	FENCED PASTURE(1)	[ ]	[ ]	MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
[X]	[X]	NONE OR LITTLE(3)
[ ]	[ ]	MODERATE(2)
[ ]	[ ]	HEAVY OR SEVERE(1)

COMMENTS:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

NO POOL = 0 **POOL SCORE** 5

MAX.DEPTH (Check 1)
- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [X] 1.2-2.4 ft.(2)
- [ ] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)
- [X] POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)
- [ ] TORRENTIAL(-1)
- [ ] FAST(1)
- [ ] MODERATE(1)
- [X] SLOW(1)
- [ ] EDDIES(1)
- [ ] INTERSTITIAL(-1)
- [ ] INTERMITTENT(-2)

COMMENTS:

RIFFLE SCORE 0

RIFFLE/RUN DEPTH
- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [ ] GENERALLY 2-4 in.(1)
- [X] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE
- [ ] STABLE (e.g., Cobble,Boulder)(2)
- [ ] MOD.STABLE (e.g., Pea Gravel)(1)
- [ ] UNSTABLE (Gravel, Sand)(0)
- [X] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS
- [ ] EXTENSIVE(-1)
- [ ] MODERATE(0)
- [ ] LOW(1)
- [ ] NONE(2)
- [X] NO RIFFLE(0)

COMMENTS:

6) GRADIENT (FEET/MILE): 5 **% POOL** 5% **% RIFFLE** 10% **% RUN** 85% **GRADIENT SCORE** 6

Conducted by: JFNew
Project Number: 05-04-109

STREAM: Site 12 - Lilly Creek **RIVER MILE:** CR 1550 N **DATE:** 8/4/2005 **QHEI SCORE** 32.5

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)

SUBSTRATE SCORE 5

TYPE			POOL	RIFFLE				POOL	RIFFLE
		BLDER/SLAB(10)					GRAVEL(7)		
		BOULDER(9)			X		SAND(6)	X	X
		COBBLE(8)					BEDROCK(5)		
		HARDPAN(4)					DETRITUS(3)		
	X	MUCK/SILT(2)	X	X			ARTIFIC(0)	X	X

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

SUBSTRATE ORIGIN (all)

[ ]	LIMESTONE(1)	[ ]	RIP/RAP(0)
[X]	TILLS(1)	[ ]	HARDPAN(0)
[ ]	SANDSTONE(0)		
[ ]	SHALE(-1)		
[ ]	COAL FINES(-2)		

SILT COVER (one)

[X]	SILT-HEAVY(-2)	[ ]	SILT-MOD(-1)
[ ]	SILT-NORM(0)	[ ]	SILT-FREE(1)

Extent of Embeddedness (check one)

[X]	EXTENSIVE(-2)	[ ]	MODERATE(-1)
[ ]	LOW(0)	[ ]	NONE(1)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrat

COMMENTS:

2) INSTREAM COVER:

COVER SCORE 6

TYPE (Check all that apply)

[X]	UNDERCUT BANKS(1)	[ ]	DEEP POOLS(2)	[ ]	OXBOWS(1)
[X]	OVERHANGING VEGETATION(1)	[ ]	ROOTWADS(1)	[ ]	AQUATIC MACROPHYTES(1)
[X]	SHALLOWS (IN SLOW WATER)(1)	[ ]	BOULDERS(1)	[ ]	LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

- [ ] EXTENSIVE >75%(11)
- [ ] MODERATE 25-75%(7)
- [X] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS:

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)

CHANNEL SCORE 6

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY	MODIFICATION/OTHER	
[ ] HIGH(4)	[ ] EXCELLENT(7)	[ ] NONE(6)	[X] HIGH(3)	[ ] SNAGGING	[ ] IMPOUND
[ ] MODERATE(3)	[ ] GOOD(5)	[ ] RECOVERED(4)	[ ] MODERATE(2)	[ ] RELOCATION	[ ] ISLAND
[ ] LOW(2)	[ ] FAIR(3)	[ ] RECOVERING(3)	[ ] LOW(1)	[X] CANOPY REMOVAL	[ ] LEVEED
[X] NONE(1)	[X] POOR(1)	[X] RECENT OR NO RECOVERY(1)		[ ] DREDGING	[X] BANK SHAPING
				[ ] ONE SIDE CHANNEL MODIFICATION	

COMMENTS:

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)

RIPARIAN SCORE 5.5

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
		WIDE >150 ft.(4)
		MODERATE 30-150 ft.(3)
		NARROW 15-30 ft.(2)
X	X	VERY NARROW 3-15 ft.(1)
		NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
X	X	FOREST, SWAMP(3)			URBAN OR INDUSTRIAL(0)
X	X	OPEN PASTURE/ROW CROP(0)			SHRUB OR OLD FIELD(2)
		RESID.,PARK,NEW FIELD(1)			CONSERV. TILLAGE(1)
		FENCED PASTURE(1)			MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
X	X	NONE OR LITTLE(3)
		MODERATE(2)
		HEAVY OR SEVERE(1)

COMMENTS:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

NO POOL = 0 POOL SCORE 4

MAX.DEPTH (Check 1)

- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [ ] 1.2-2.4 ft.(2)
- [X] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)

- [X] POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)

[ ]	TORRENTIAL(-1)	[ ]	EDDIES(1)
[ ]	FAST(1)	[ ]	INTERSTITIAL(-1)
[ ]	MODERATE(1)	[ ]	INTERMITTENT(-2)
[X]	SLOW(1)		

COMMENTS:

RIFFLE SCORE 0

RIFFLE/RUN DEPTH

- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [ ] GENERALLY 2-4 in.(1)
- [X] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE

- [ ] STABLE (e.g., Cobble,Boulder)(2)
- [ ] MOD.STABLE (e.g., Pea Gravel)(1)
- [ ] UNSTABLE (Gravel, Sand)(0)
- [X] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS

[ ]	EXTENSIVE(-1)	[ ]	NONE(2)
[ ]	MODERATE(0)	[X]	NO RIFFLE(0)
[ ]	LOW(1)		

COMMENTS:

6) GRADIENT (FEET/MILE): 5

% POOL 5% % RIFFLE 5% % RUN 90% GRADIENT SCORE 6

Conducted by: JFNew
Project Number: 05-04-109

Appendix C. Physical, chemical, and pathogenic concentration graphics.

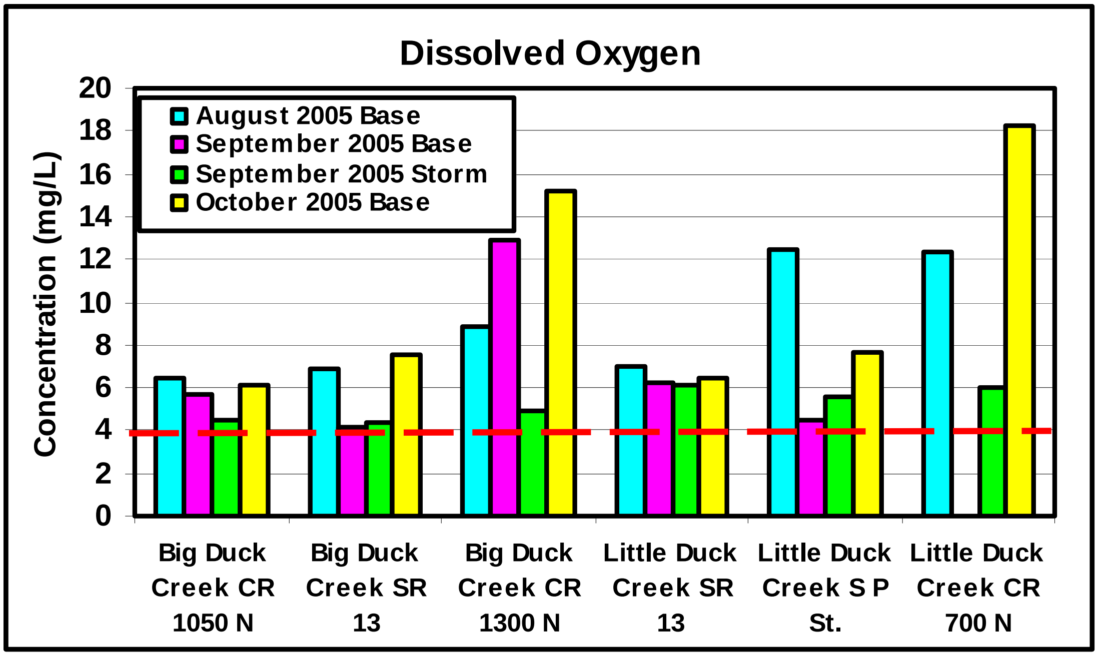


Figure 1. Dissolved oxygen concentrations for the Little Duck Creek Watershed stream sites for 2005. The minimum IAC state standard for DO is 4 mg/L which represents the dashed line.

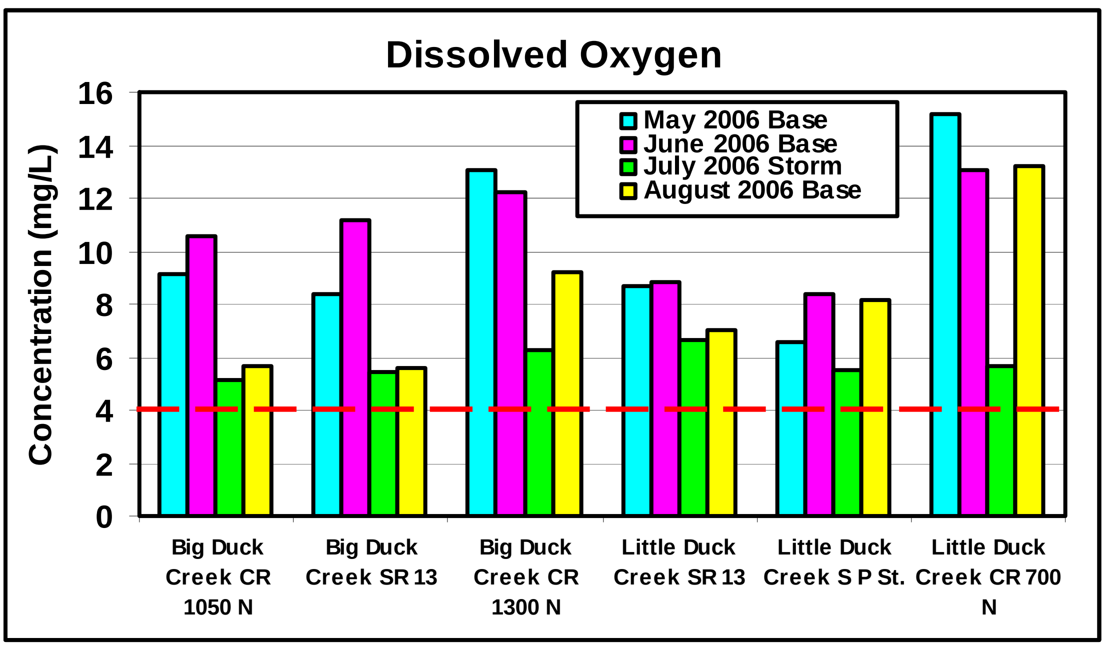


Figure 2. Dissolved oxygen concentrations for the Little Duck Creek Watershed stream sites for 2006. The minimum IAC state standard for DO is 4 mg/L which represents the dashed line.

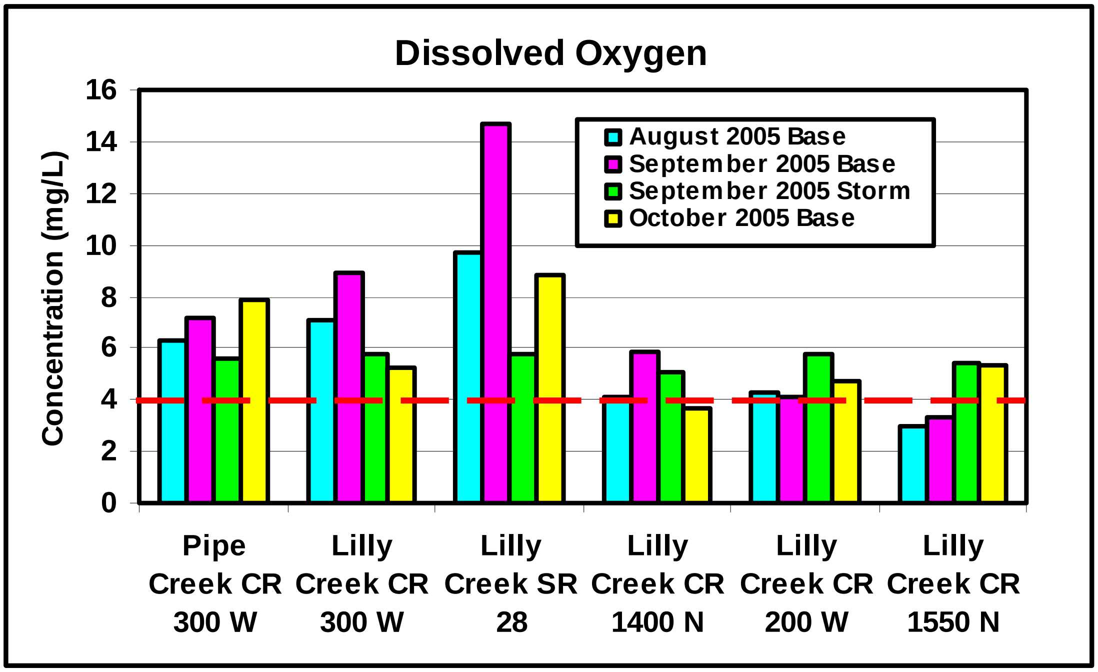


Figure 3. Dissolved oxygen concentrations for the Lilly Creek Watershed stream sites for 2005. The minimum IAC state standard for DO is 4 mg/L which represents the dashed line.

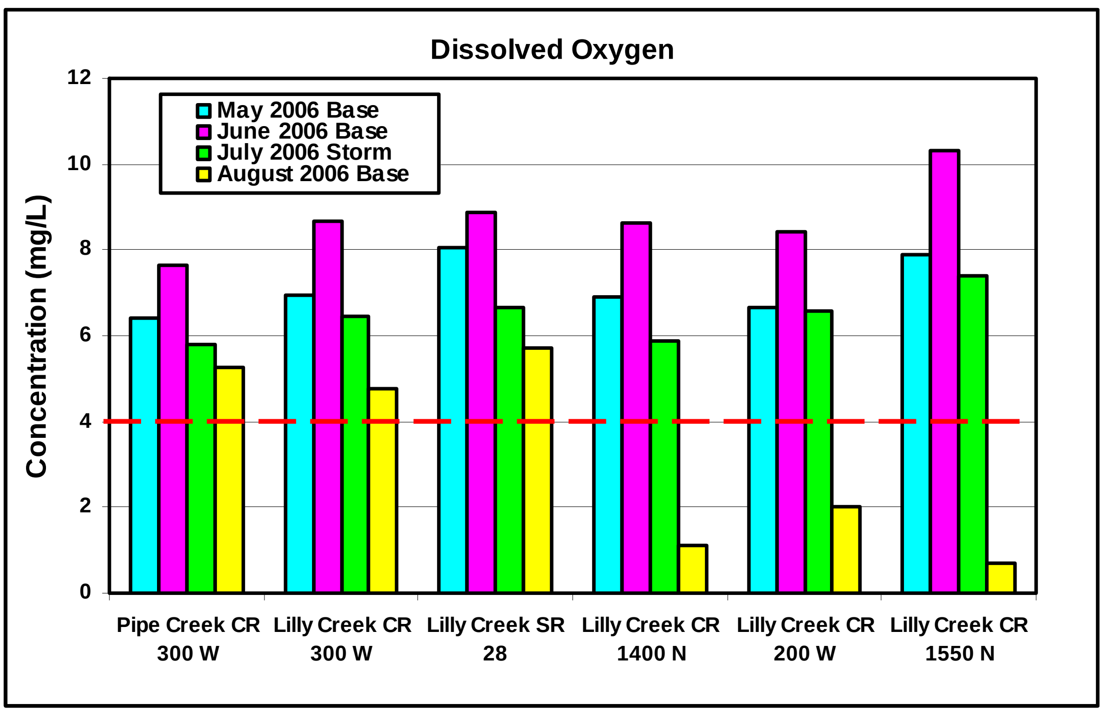


Figure 4. Dissolved oxygen concentrations for the Lilly Creek Watershed stream sites for 2006. The minimum IAC state standard for DO is 4 mg/L which represents the dashed line.

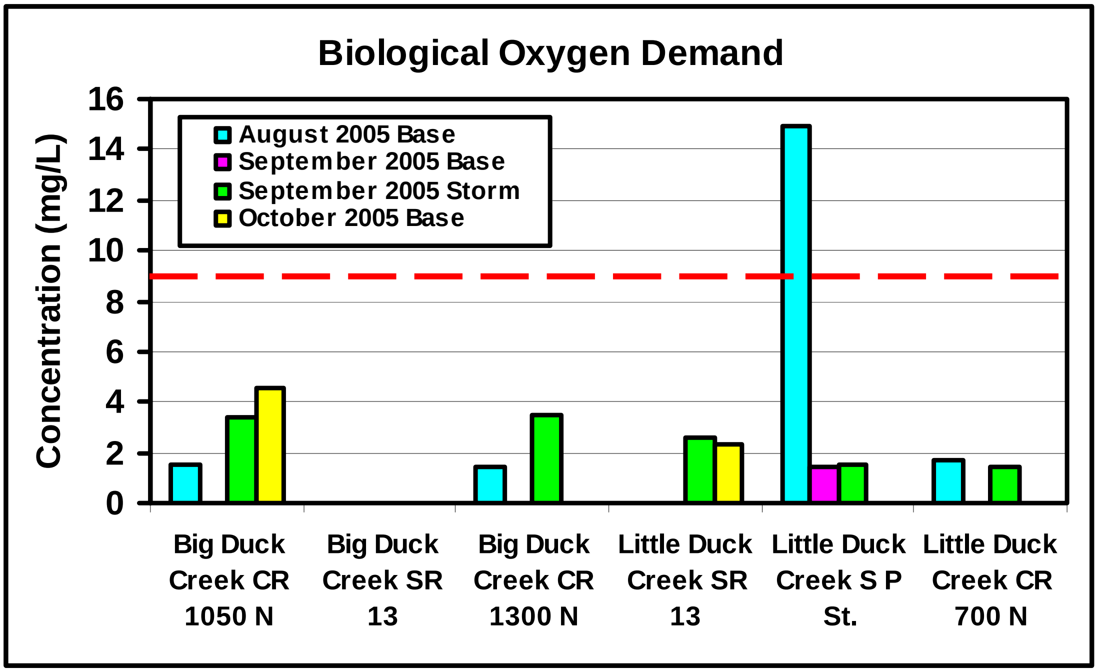


Figure 5. Biochemical oxygen demand concentrations for the Little Duck Creek Watershed stream sites for 2005.

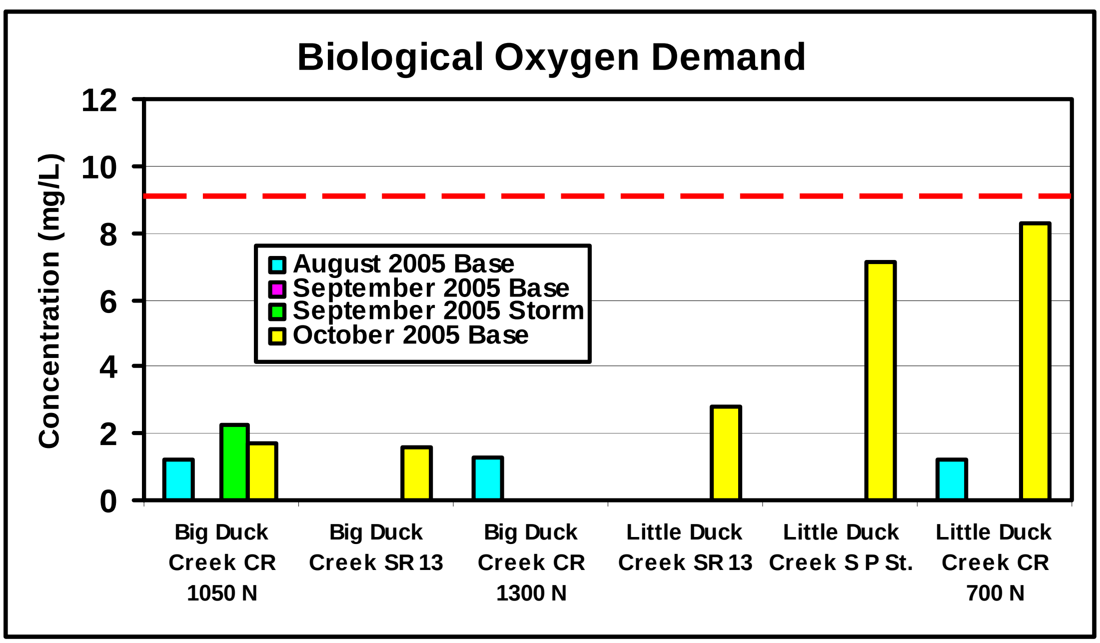


Figure 6. Biochemical oxygen demand concentrations for the Little Duck Creek Watershed stream sites for 2006.

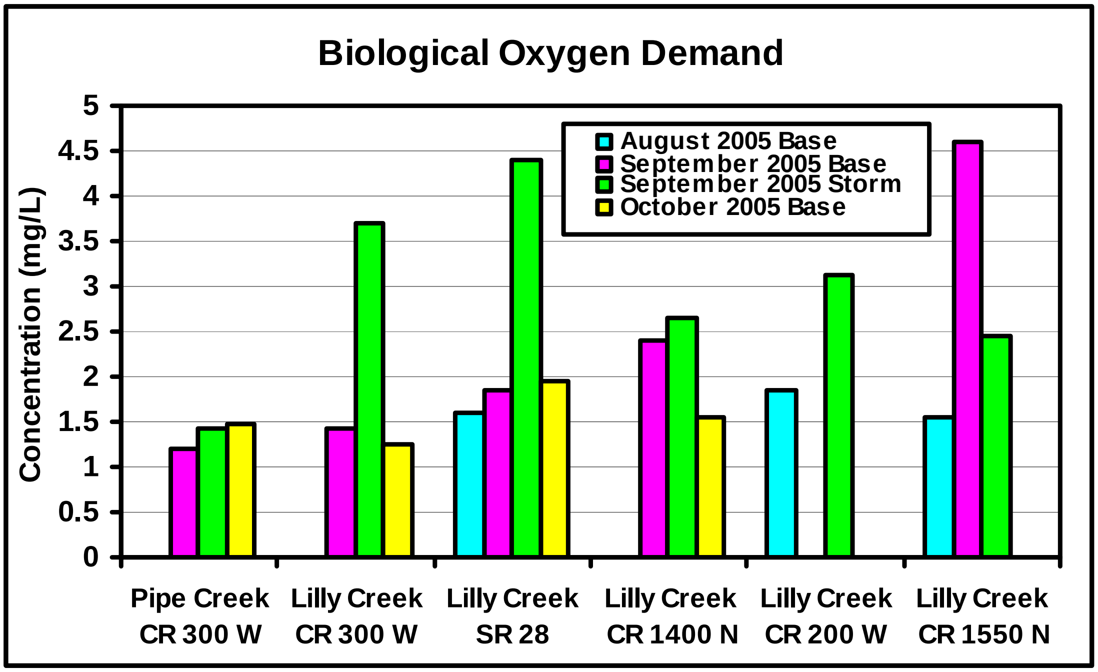


Figure 7. Biochemical oxygen demand concentrations for the Lilly Creek Watershed stream sites for 2005.

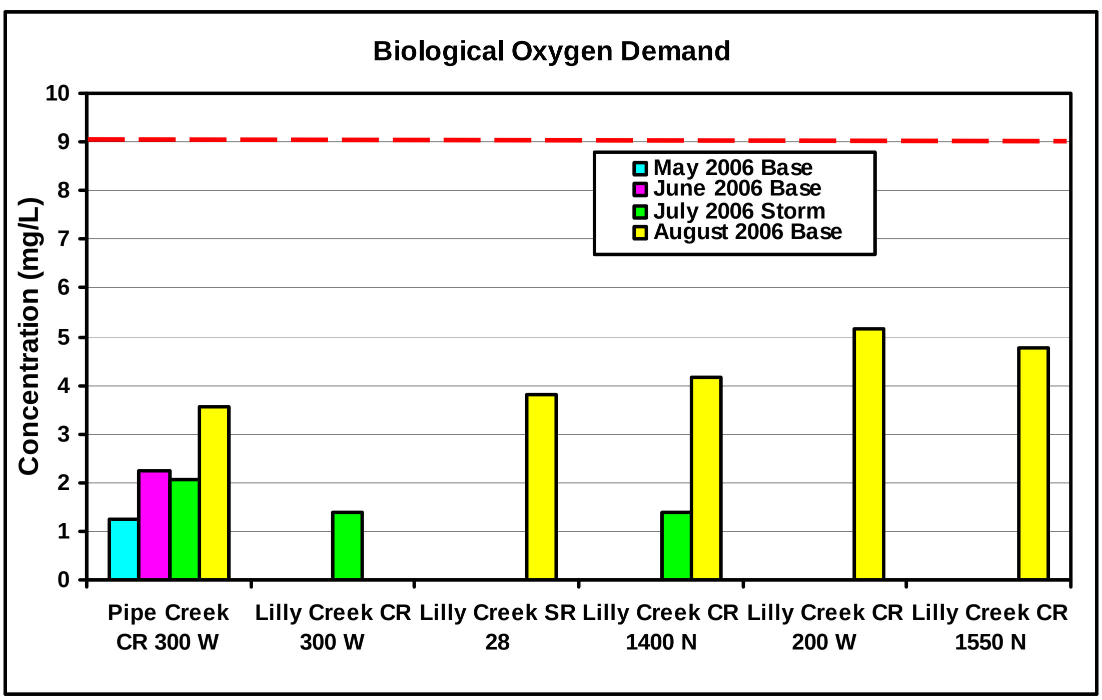


Figure 8. Biochemical oxygen demand concentrations for the Lilly Creek Watershed stream sites for 2006.

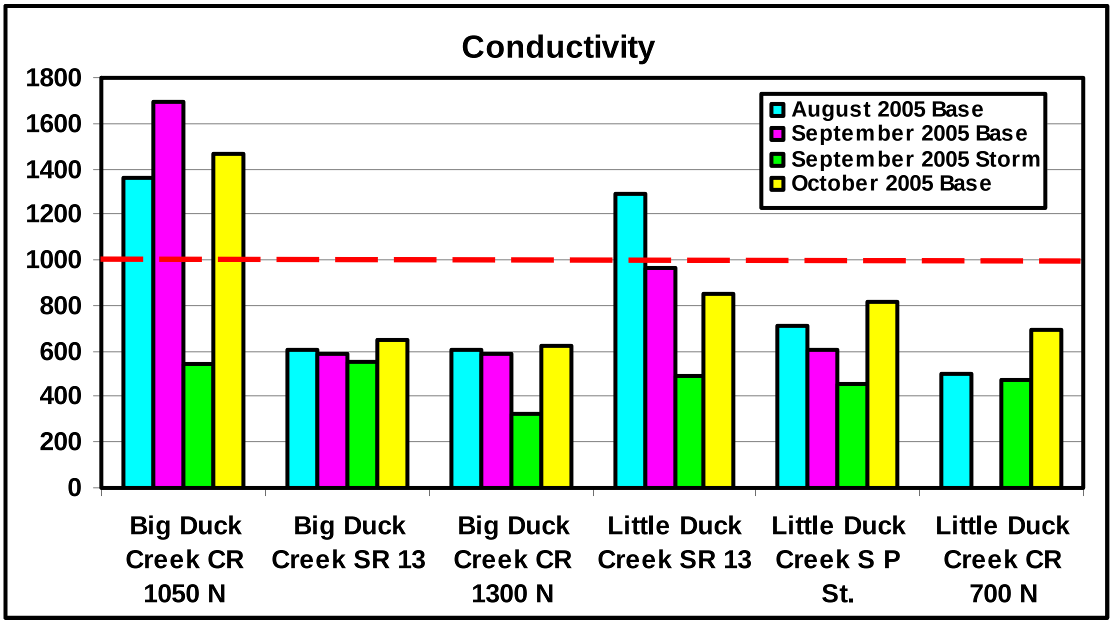


Figure 9. Conductivity measurements for the Little Duck Creek Watershed stream sites for 2005. The low end of the state standard maximum for conductivity is 1000 µmhos, which is represented by the dashed line.

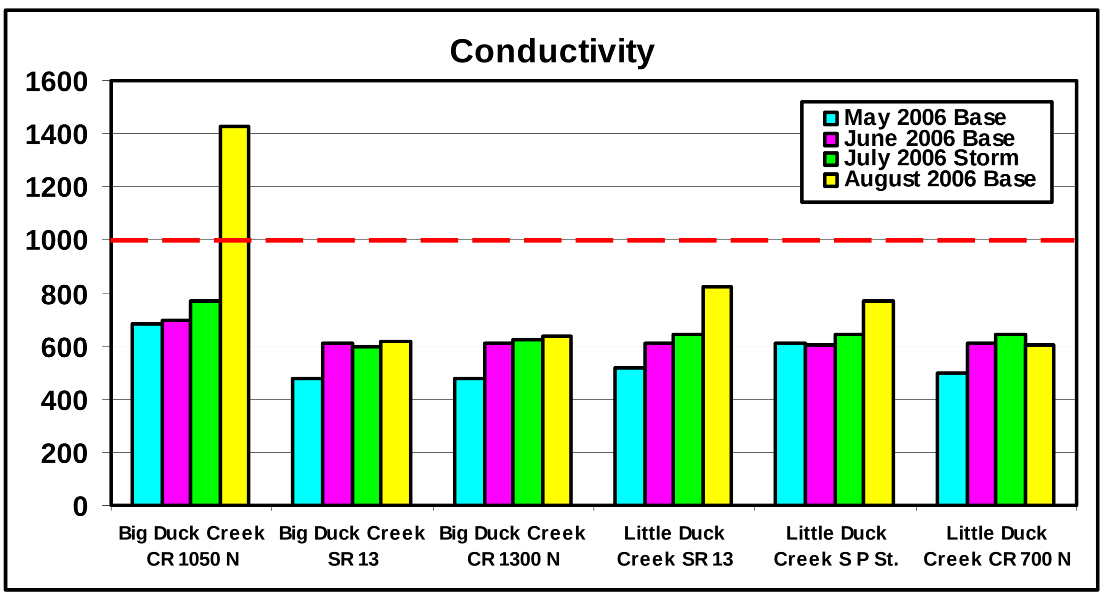


Figure 10. Conductivity measurements for the Little Duck Creek Watershed stream sites for 2006. The low end of the state standard maximum for conductivity is 1000 µmhos, which is represented by the dashed line.

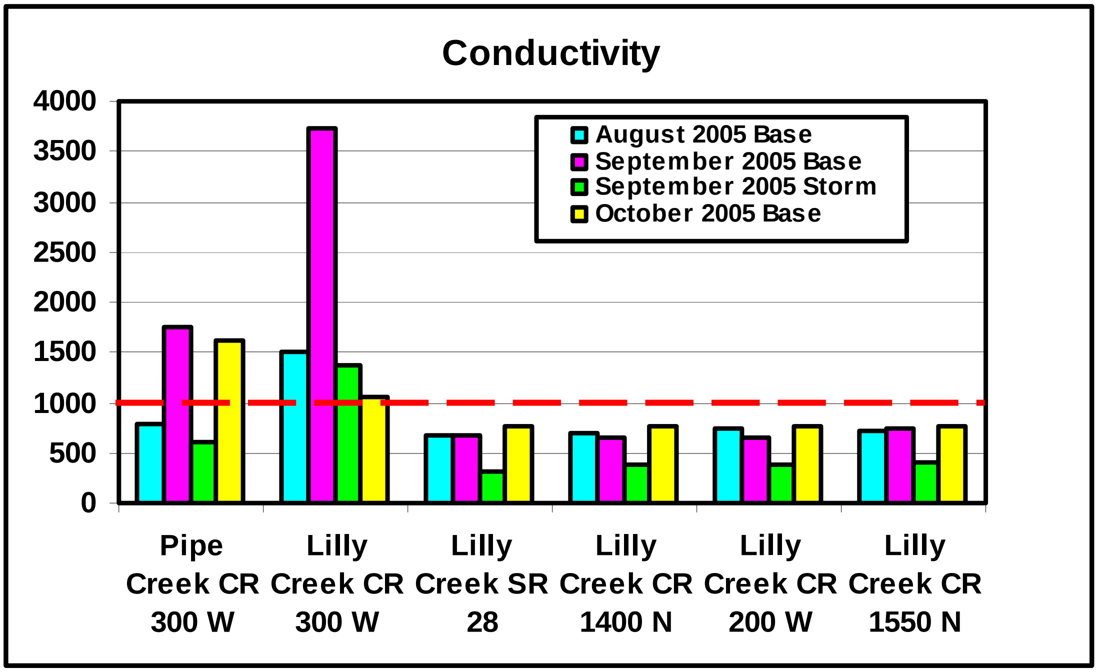


Figure 11. Conductivity measurements for the Lilly Creek Watershed stream sites for 2005. The low end of the state standard maximum for conductivity is 1000 μmhos, which is represented by the dashed line.

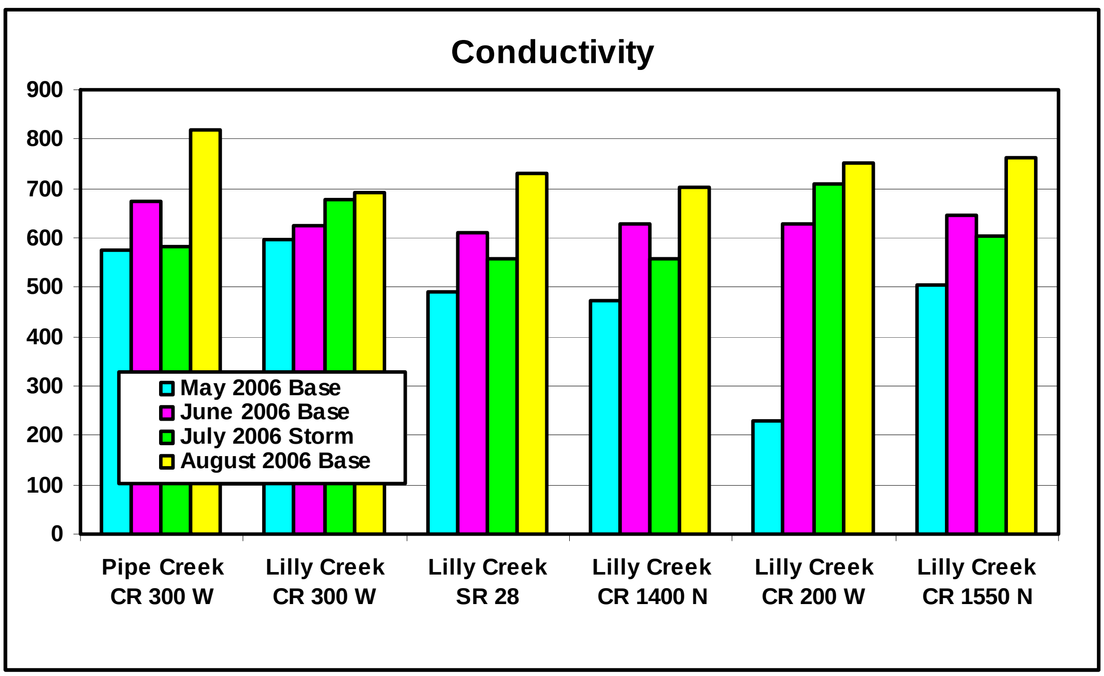


Figure 12. Conductivity measurements for the Lilly Creek Watershed stream sites for 2006. The low end of the state standard maximum for conductivity is 1000 μmhos, which is represented by the dashed line.

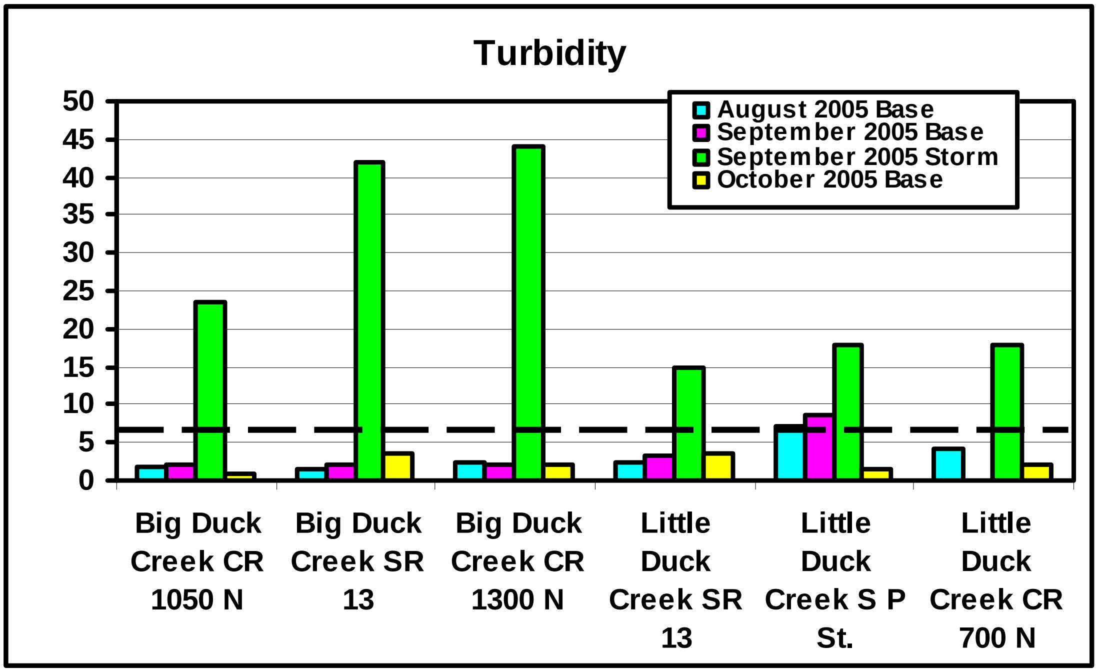


Figure 13. Turbidity measurements for the Little Duck Creek Watershed stream sites for 2005. The maximum recommended turbidity measurement is 6.3 NTU, according to the USEPA nutrient criteria, which is represented by the dashed line (USEPA, 2000).

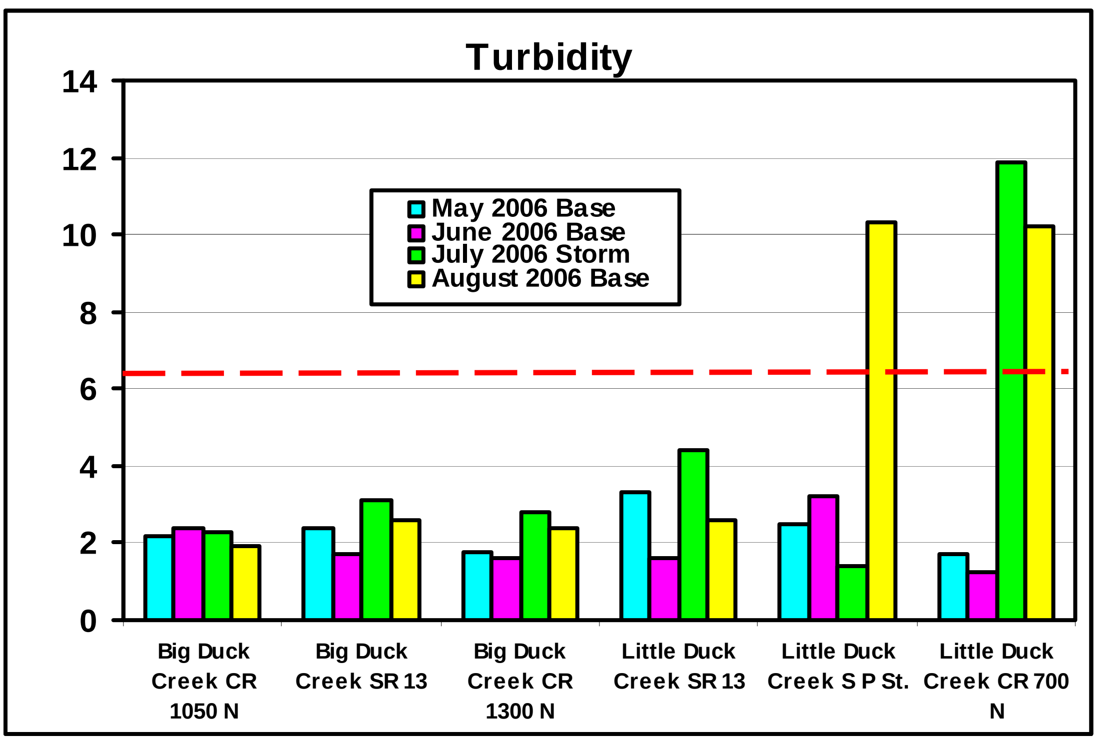


Figure 14. Turbidity measurements for the Little Duck Creek Watershed stream sites for 2006. The maximum recommended turbidity measurement is 6.3 NTU, according to the USEPA nutrient criteria, which is represented by the dashed line (USEPA, 2000).

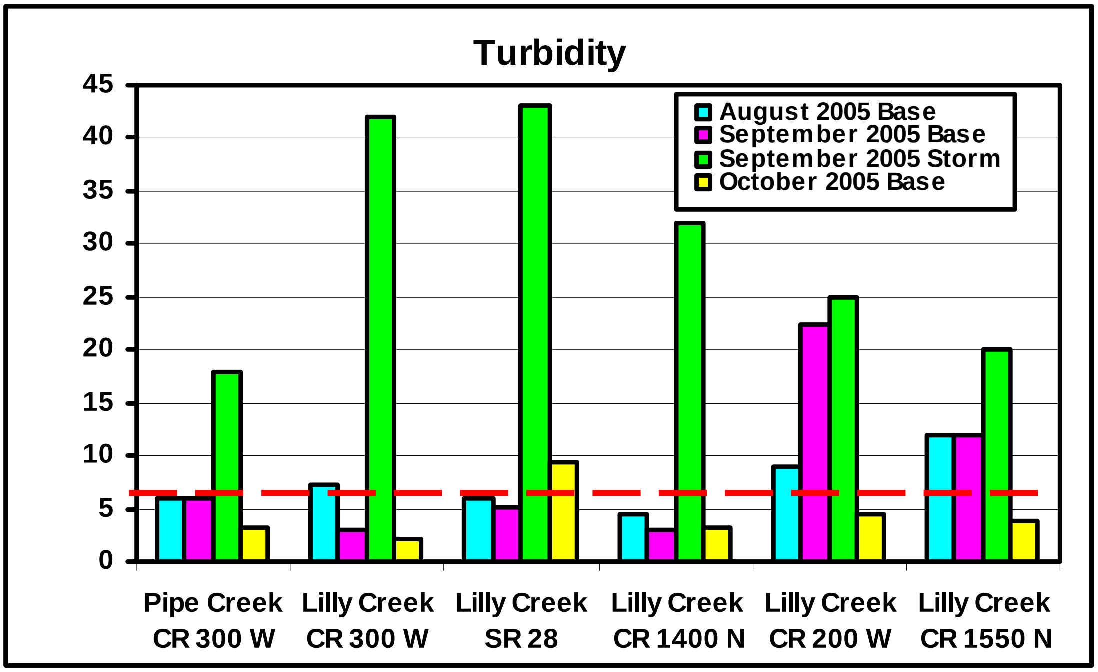


Figure 15. Turbidity measurements for the Lilly Creek Watershed stream sites for 2005. The maximum recommended turbidity measurement is 6.3 NTU, according to the USEPA nutrient criteria, which is represented by the dashed line (USEPA, 2000).

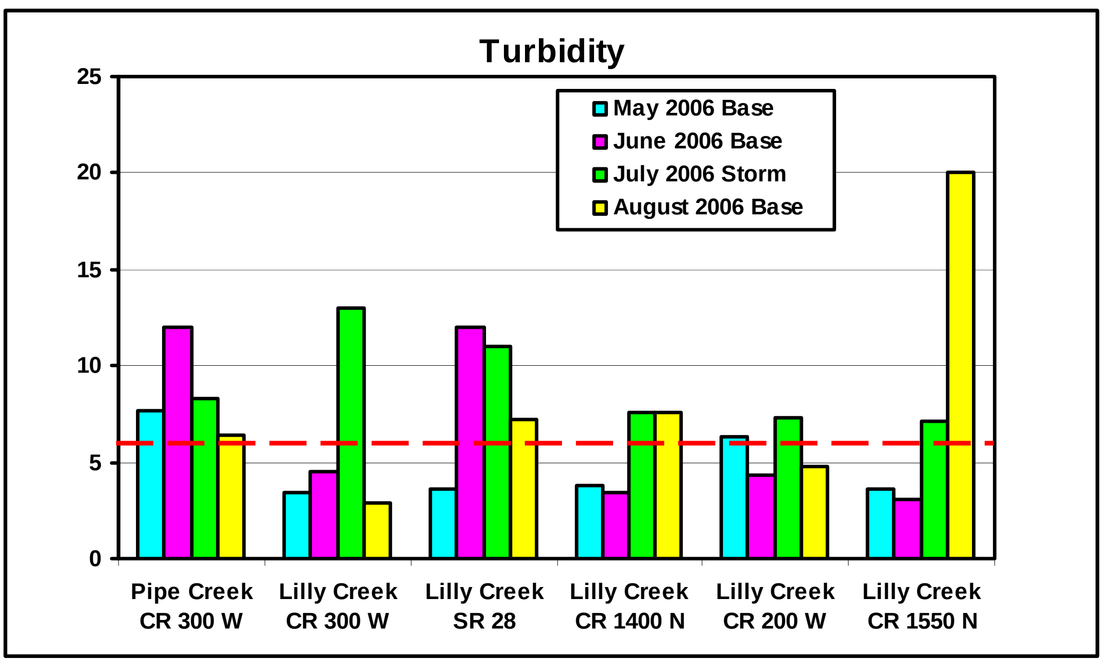


Figure 16. Turbidity measurements for the Lilly Creek Watershed stream sites for 2006. The maximum recommended turbidity measurement is 6.3 NTU, according to the USEPA nutrient criteria, which is represented by the dashed line (USEPA, 2000).

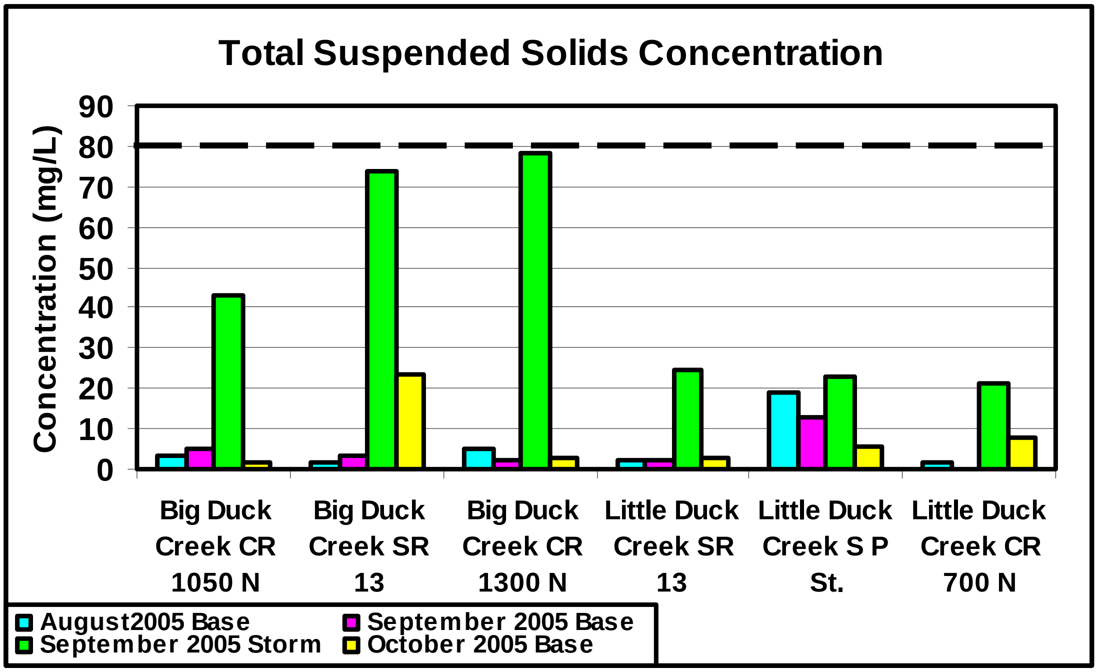


Figure 17. Total suspended solids concentrations for the Little Duck Creek Watershed stream sites for 2005. The dashed line at 80 mg/L represents concentrations deleterious for aquatic biota (Waters, 1998).

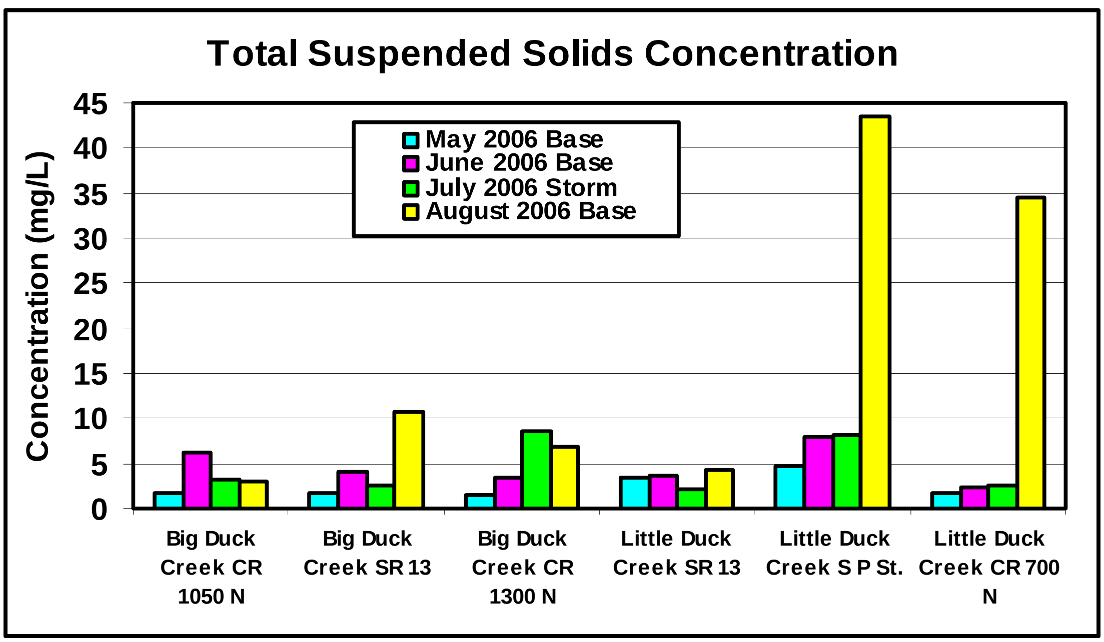


Figure 18. Total suspended solids concentrations for the Little Duck Creek Watershed stream sites for 2006.

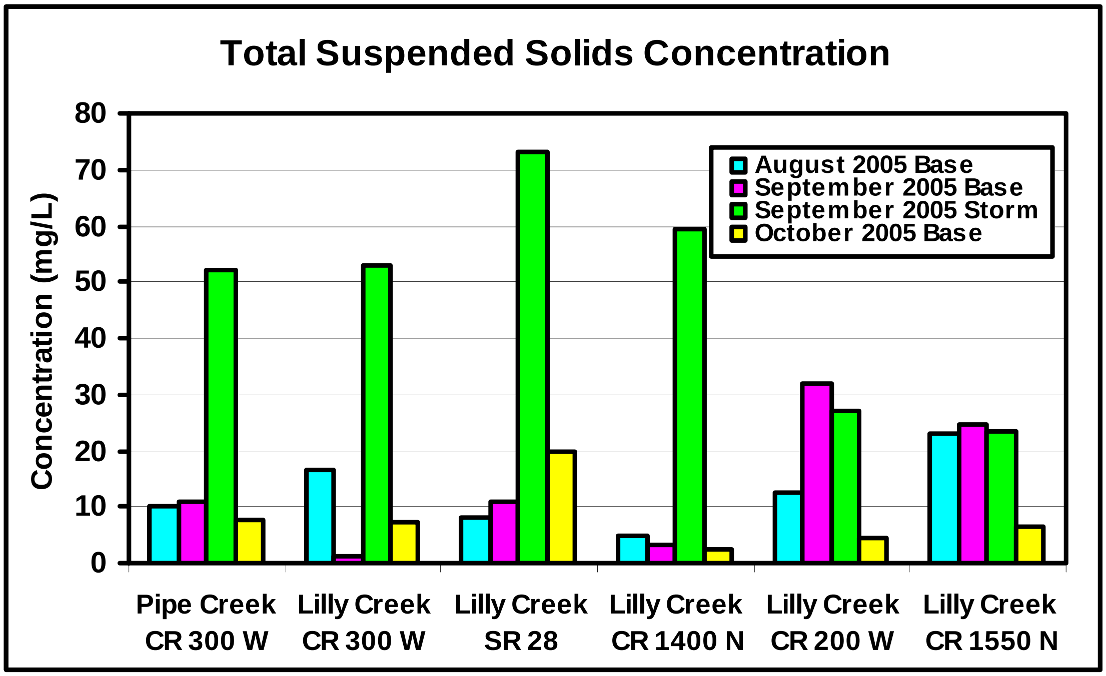


Figure 19. Total suspended solids concentrations for the Lilly Creek Watershed stream sites for 2005. The dashed line at 80 mg/L represents concentrations deleterious for aquatic biota (Waters, 1998).

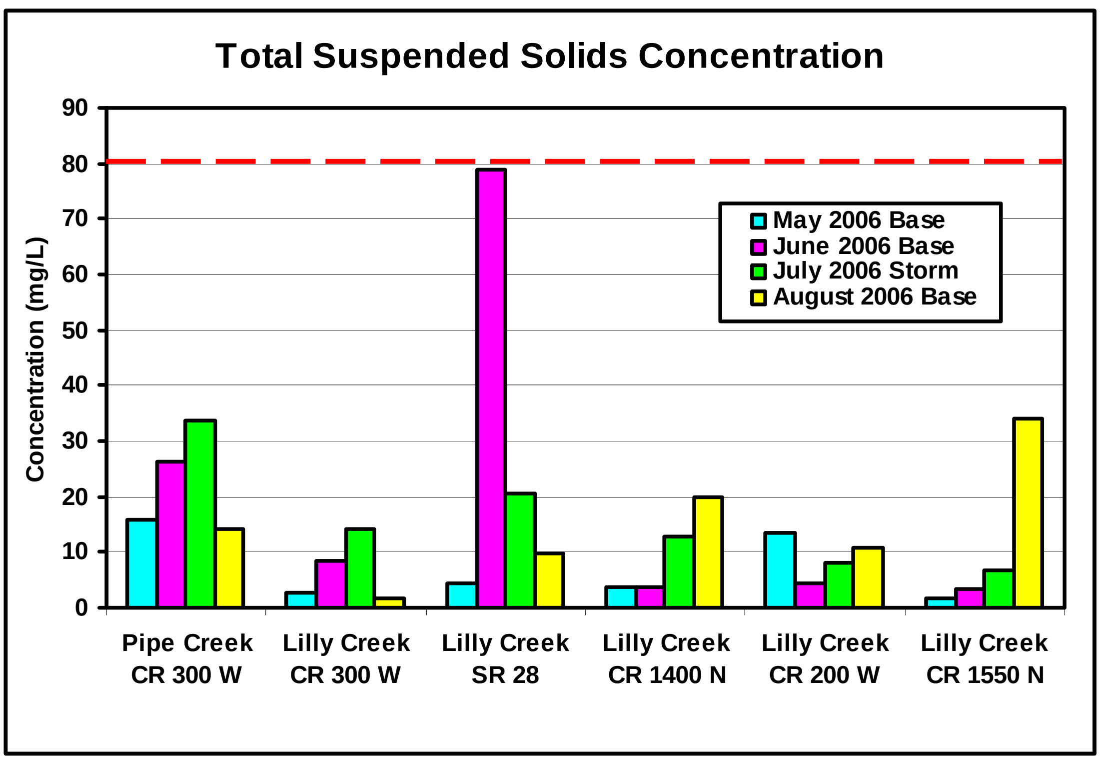


Figure 20. Total suspended solids concentrations for the Lilly Creek Watershed stream sites for 2006. The dashed line at 80 mg/L represents concentrations deleterious for aquatic biota (Waters, 1998).

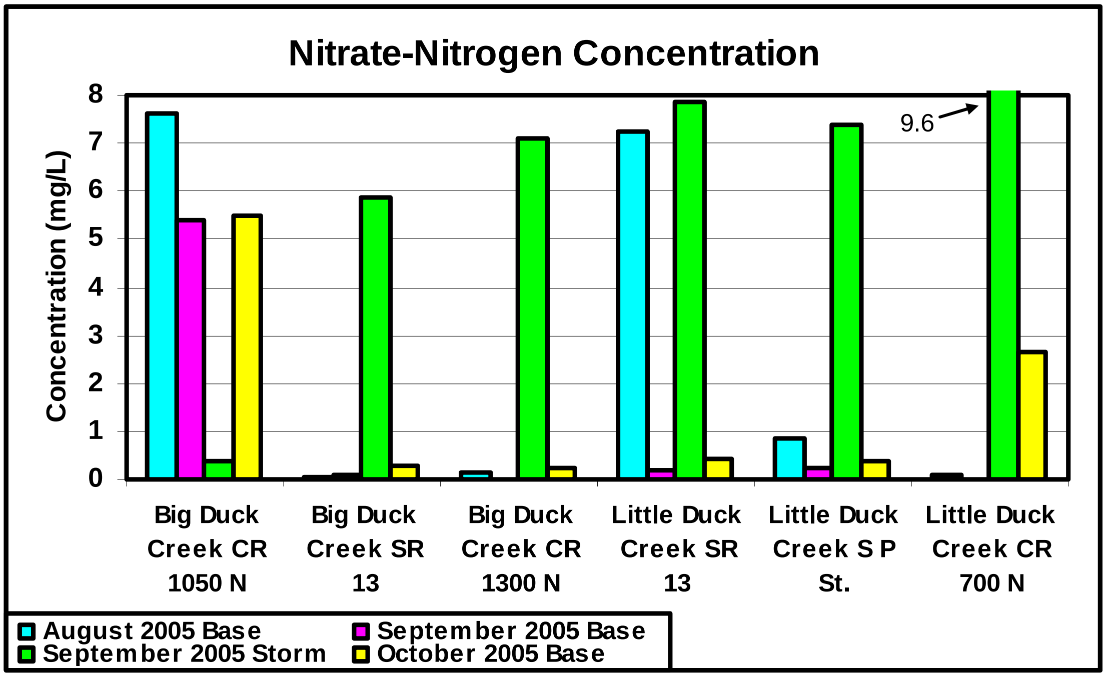


Figure 21. Nitrate concentrations for the Little Duck Creek Watershed stream sites for 2005. The maximum IAC state standard for nitrate-nitrogen is 10mg/L, which is represented by the dashed line.

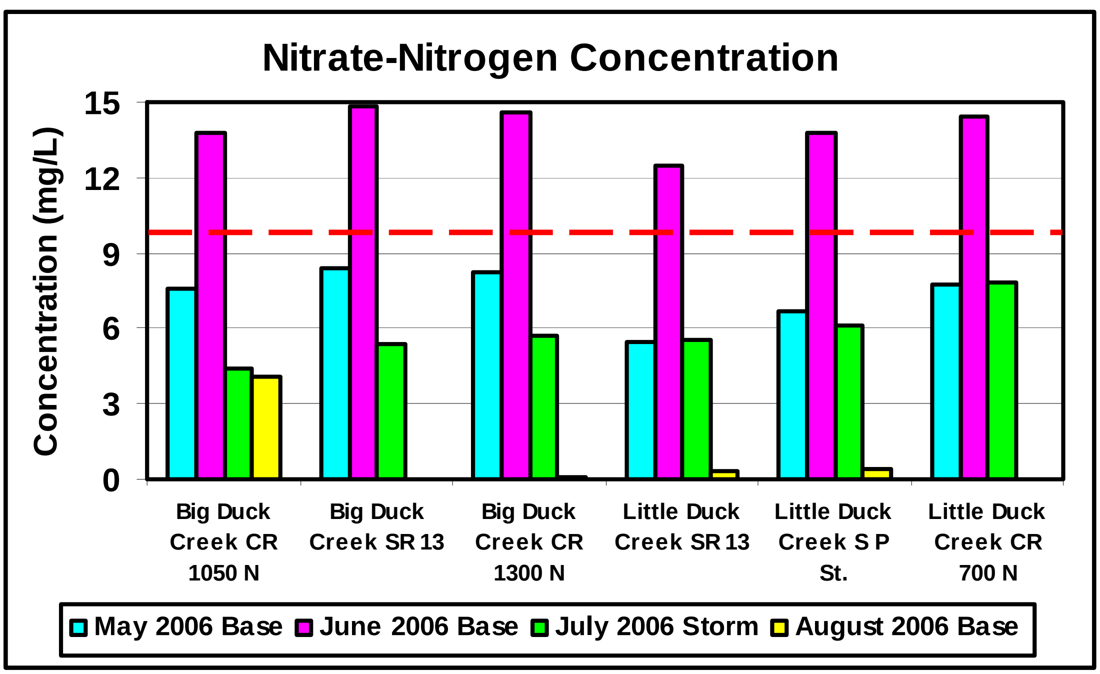


Figure 22. Nitrate concentrations for the Little Duck Creek Watershed stream sites for 2006. The maximum IAC state standard for nitrate-nitrogen is 10mg/L, which is represented by the dashed line.

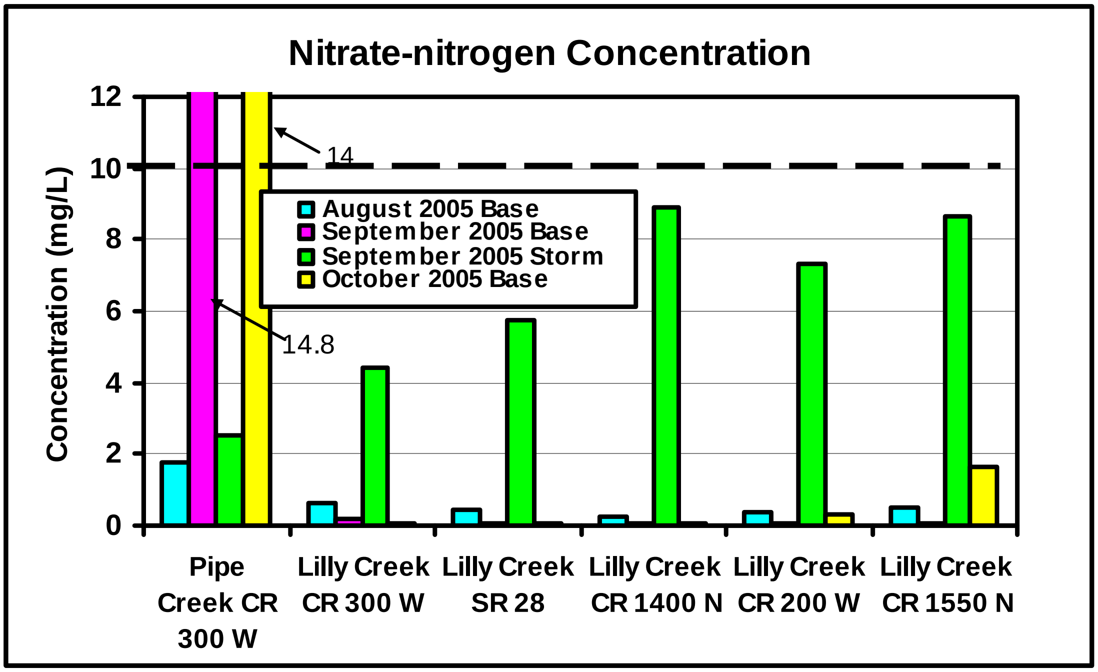


Figure 23. Nitrate concentrations for the Lilly Creek Watershed stream sites for 2005. The maximum IAC state standard for nitrate-nitrogen is 10mg/L, which is represented by the dashed line.

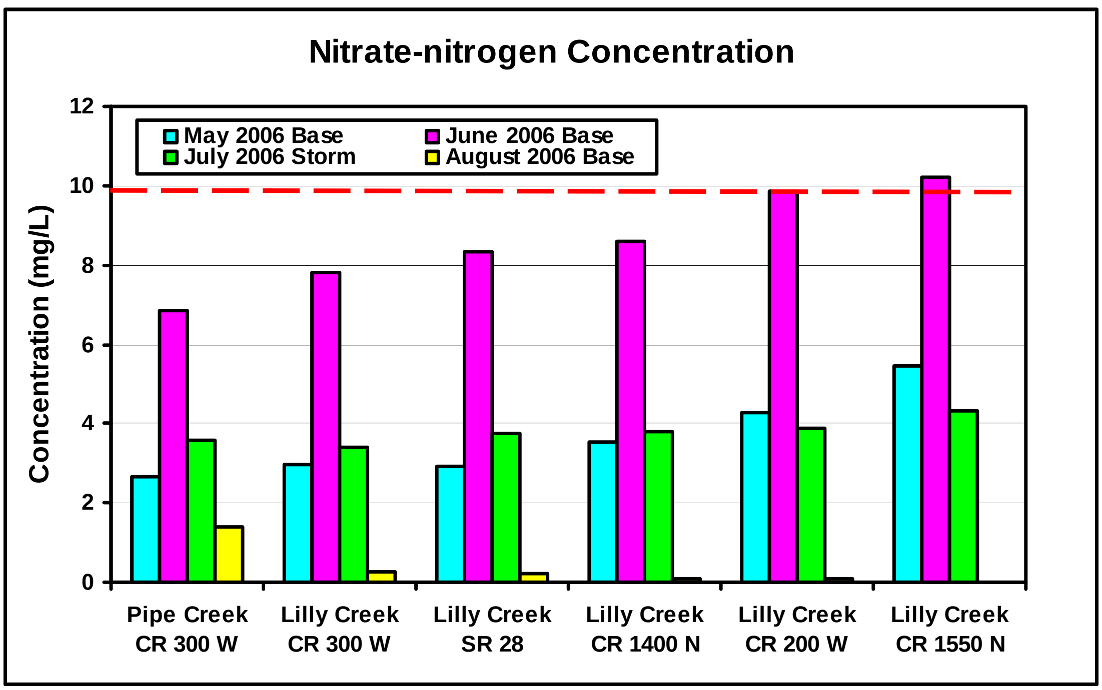


Figure 24. Nitrate concentrations for the Lilly Creek Watershed stream sites for 2006. The maximum IAC state standard for nitrate-nitrogen is 10mg/L, which is represented by the dashed line.

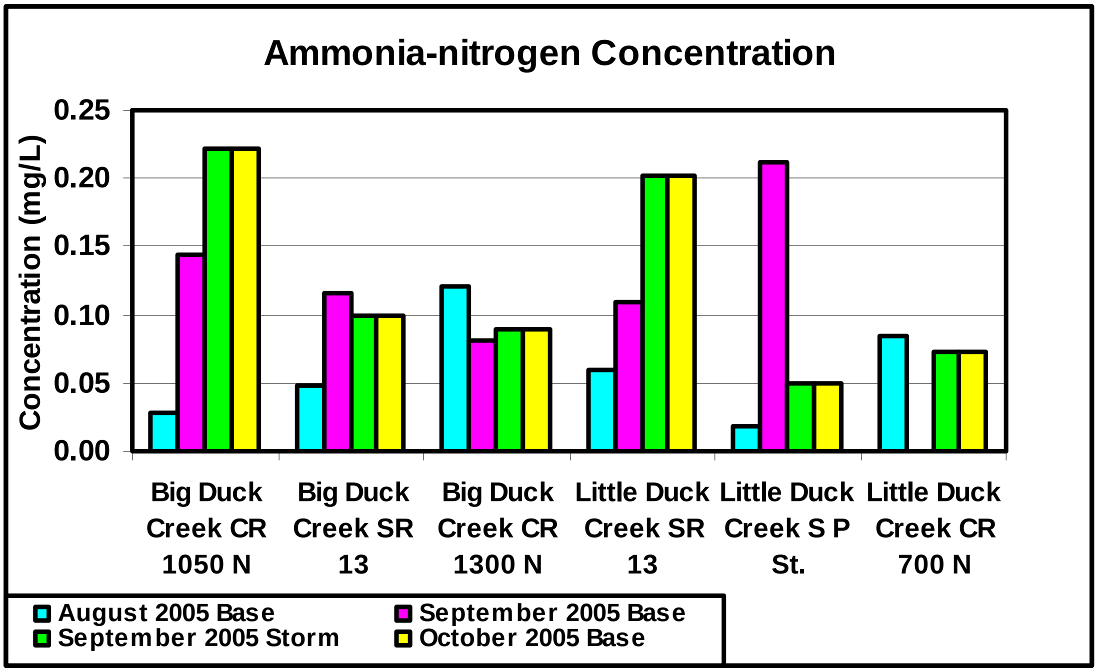


Figure 25. Ammonia concentrations for the Little Duck Creek Watershed stream sites for 2005.

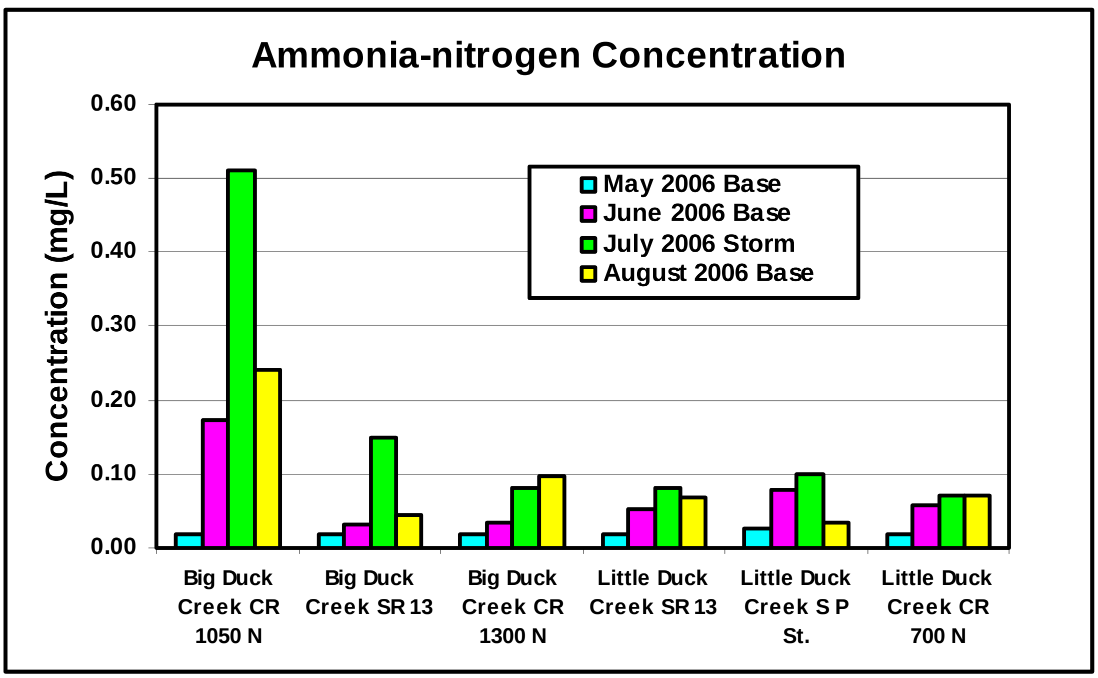


Figure 26. Ammonia concentrations for the Little Duck Creek Watershed stream sites for 2006.

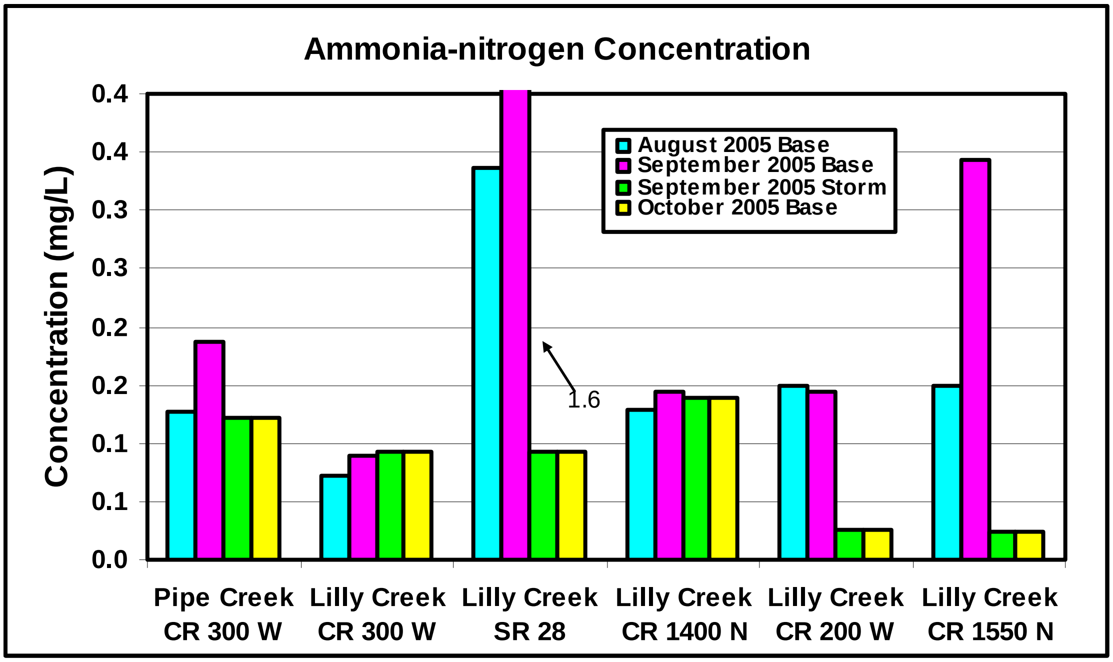


Figure 27. Ammonia concentrations for the Lilly Creek Watershed stream sites for 2005.

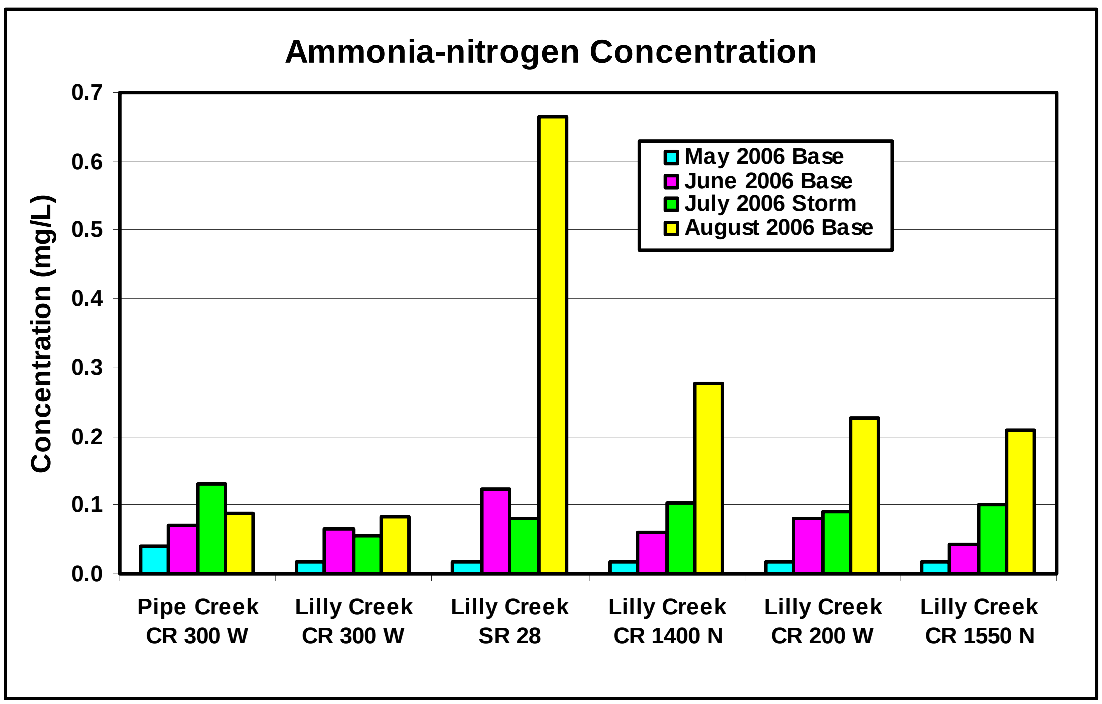


Figure 28. Ammonia concentrations for the Lilly Creek Watershed stream sites for 2006.

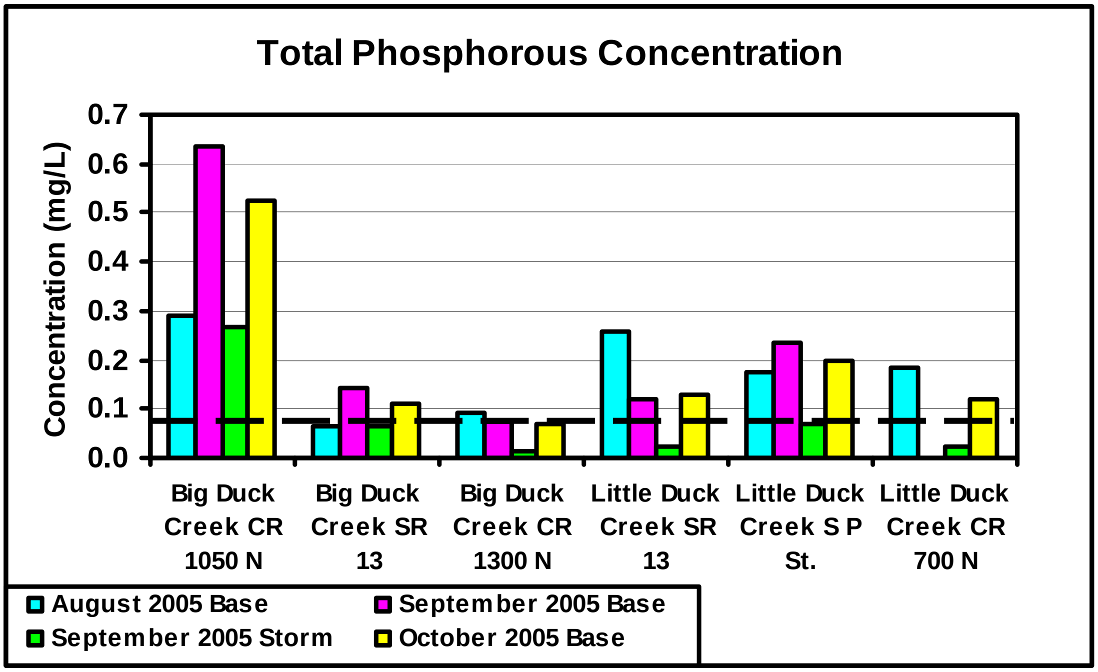


Figure 29. Total phosphorus concentrations for the Little Duck Creek Watershed stream sites for 2005. The dashed line at 0.075mg/L represents the USEPA's recommended nutrient criteria for streams in this area and streams that would demonstrate eutrophic conditions (Dodds et al., 1998).

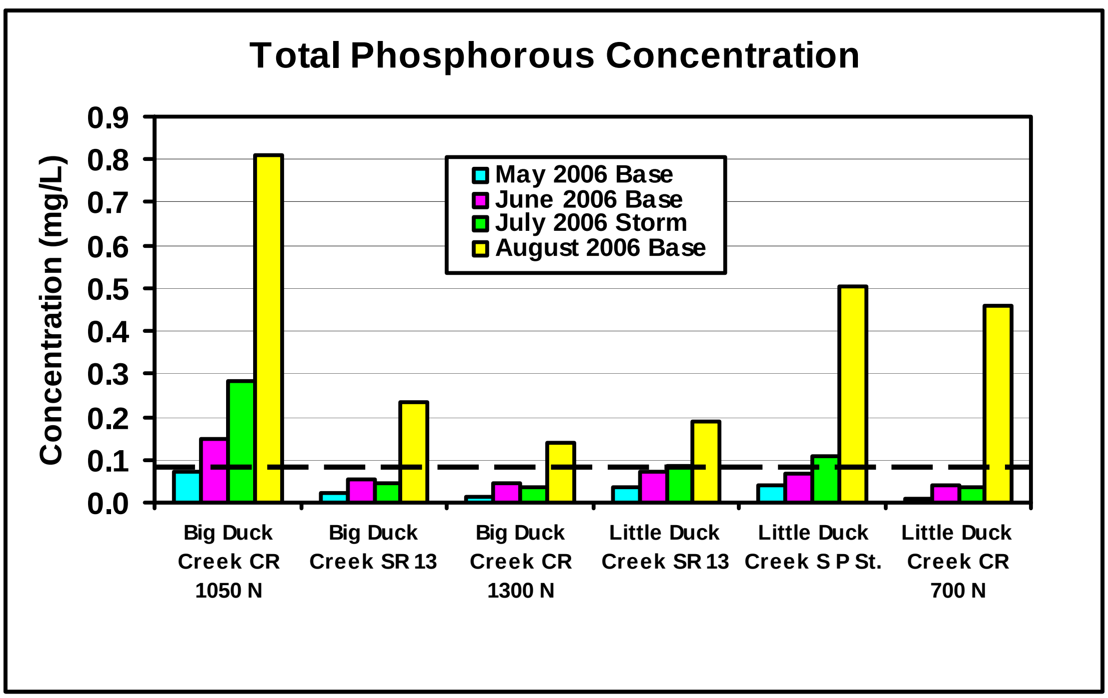


Figure 30. Total phosphorus concentrations for the Little Duck Creek Watershed stream sites for 2006. The dashed line at 0.075mg/L represents the USEPA's recommended nutrient criteria for streams in this area and streams that would demonstrate eutrophic conditions (Dodds et al., 1998).

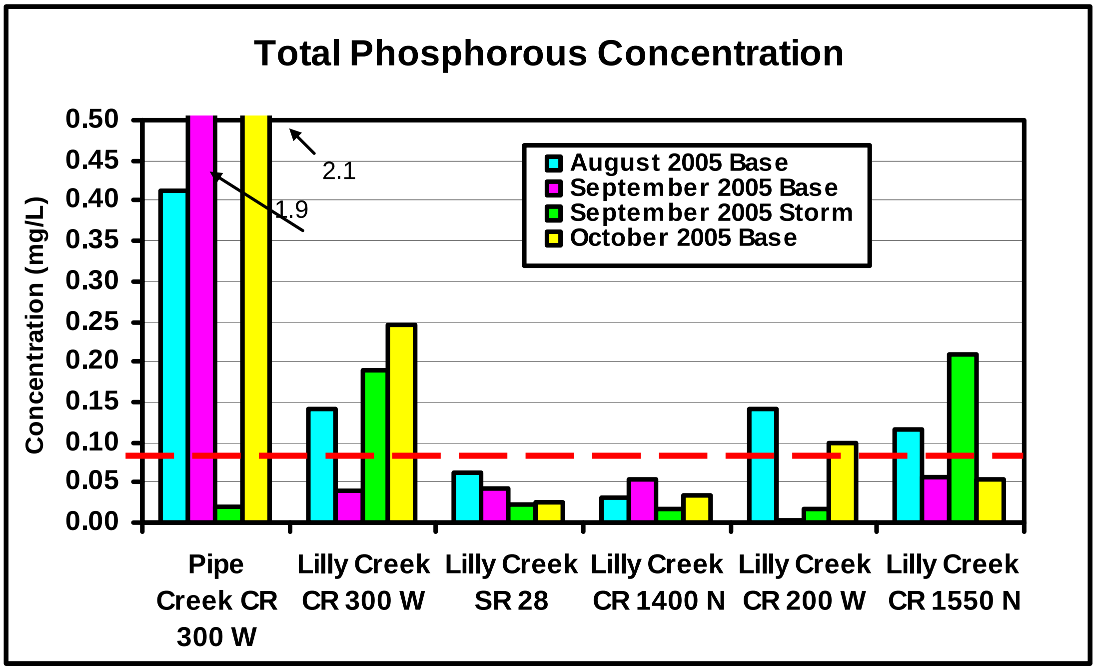


Figure 31. Total phosphorus concentrations for the Lilly Creek Watershed stream sites for 2005. The dashed line at 0.075mg/L represents the USEPA's recommended nutrient criteria for streams in this area and streams that would demonstrate eutrophic conditions (Dodds et al., 1998).

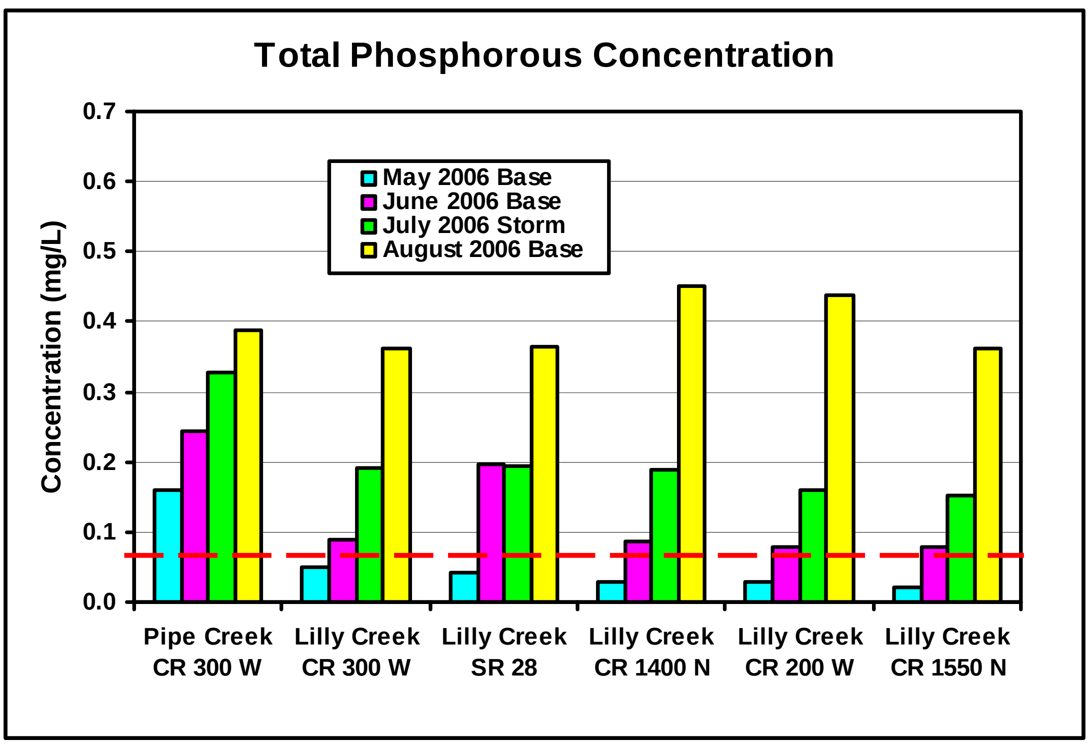


Figure 32. Total phosphorus concentrations for the Lilly Creek Watershed stream sites for 2006. See above for details on line.

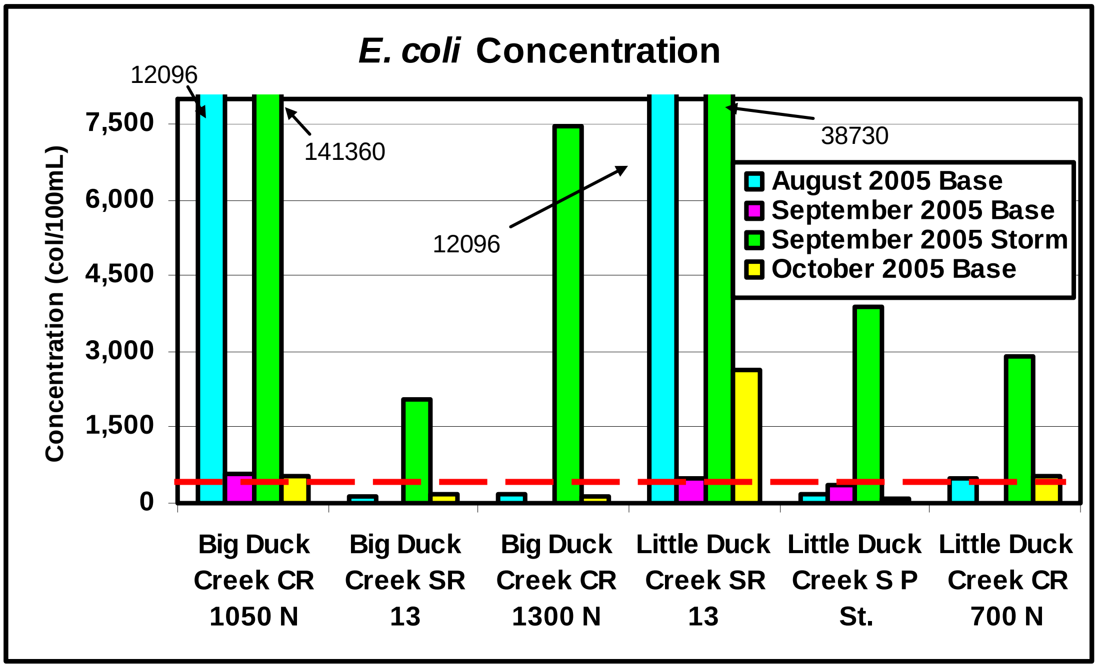


Figure 33. *E. coli* concentrations for the Little Duck Creek Watershed stream sites for 2005. The IAC standard is 235 colonies/100 mL in any one sample in 30 days as indicated by the dashed line.

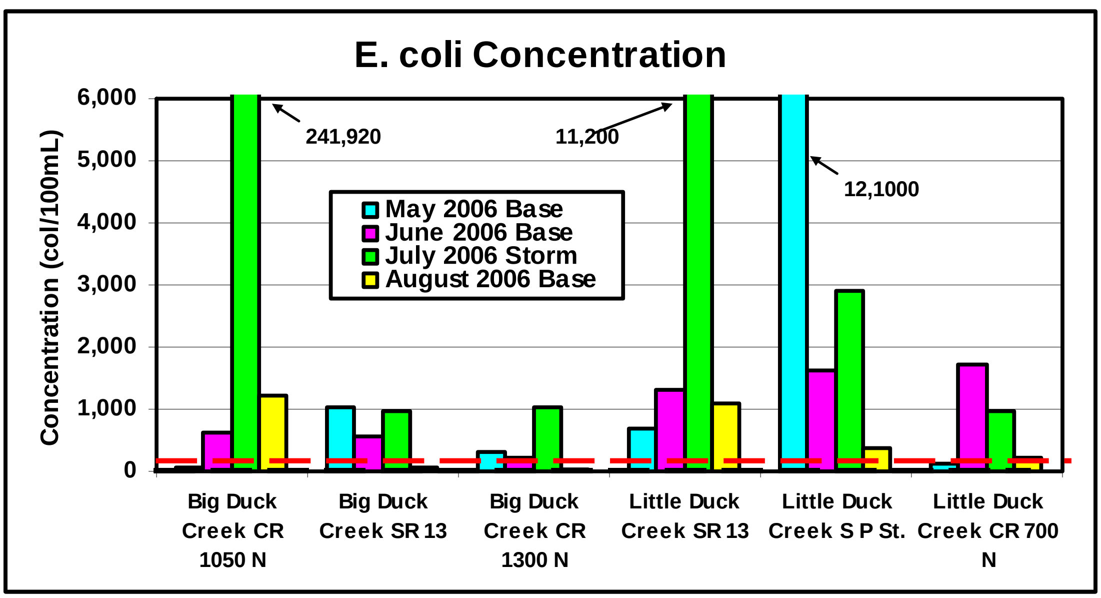


Figure 34. *E. coli* concentrations for the Little Duck Creek Watershed stream sites for 2006. The IAC standard is 235 colonies/100 mL in any one sample in 30 days as indicated by the dashed line.

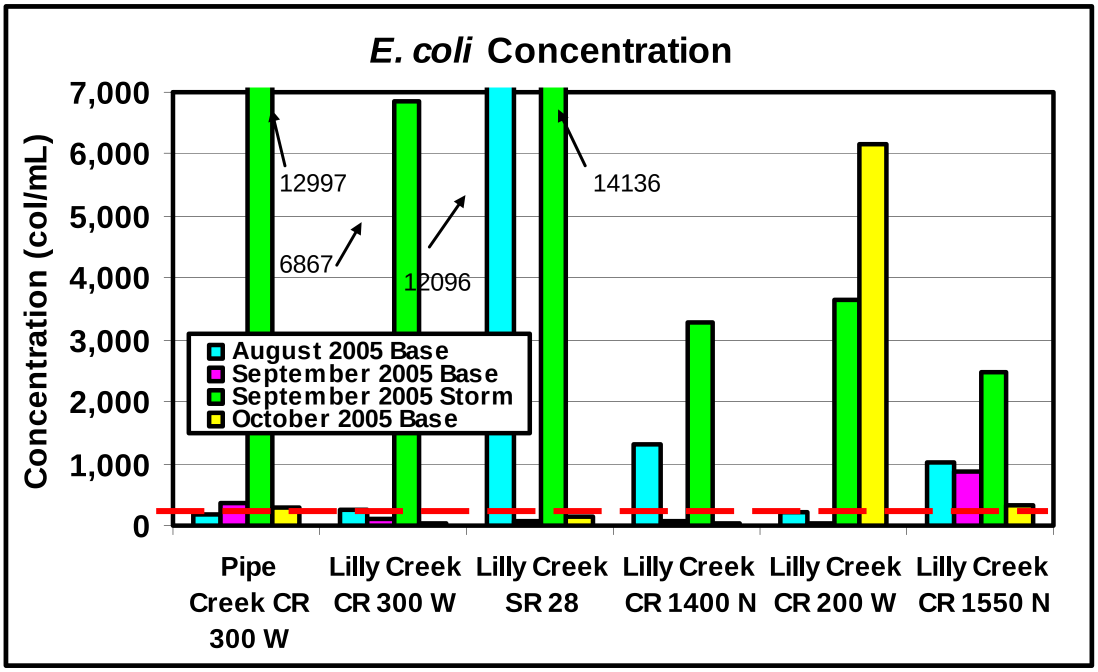


Figure 35. *E. coli* concentrations for the Lilly Creek Watershed stream sites for 2005. The IAC standard is 235 colonies/100 mL in any one sample in 30 days as indicated by the dashed line.

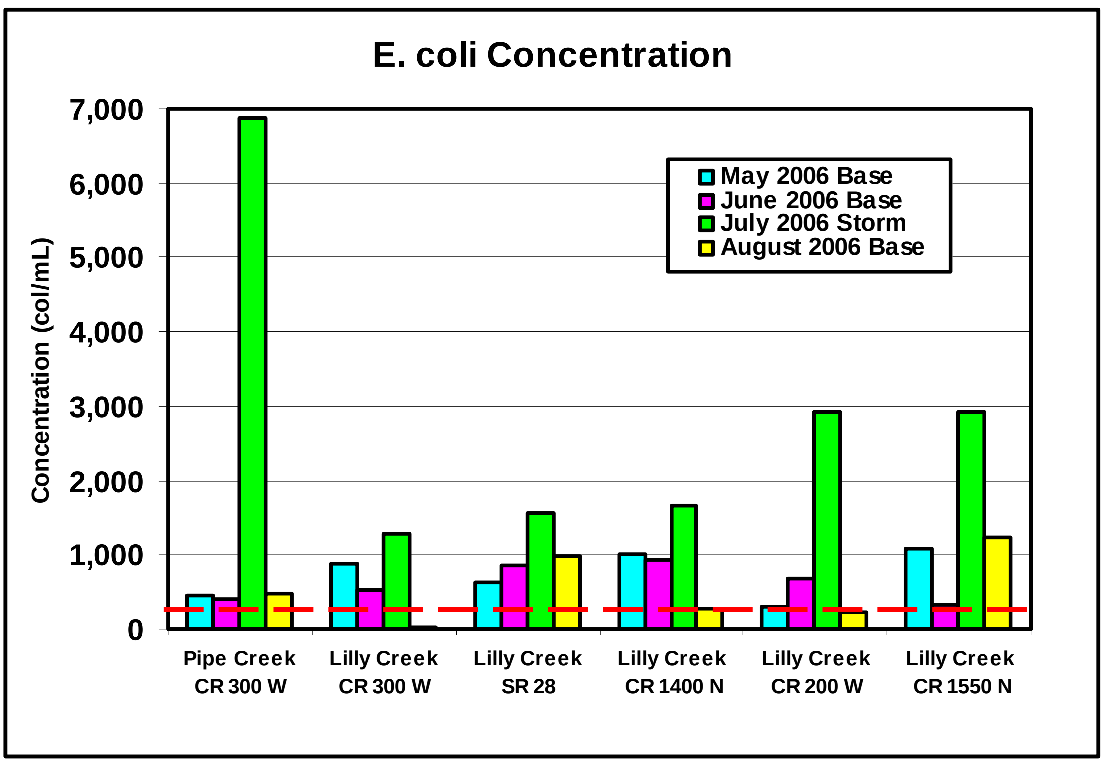


Figure 36. *E. coli* concentrations for the Lilly Creek Watershed stream sites for 2006. The IAC standard is 235 colonies/100 mL in any one sample in 30 days as indicated by the dashed line.

Appendix D. Chemical, and pathogenic loading rate graphics.

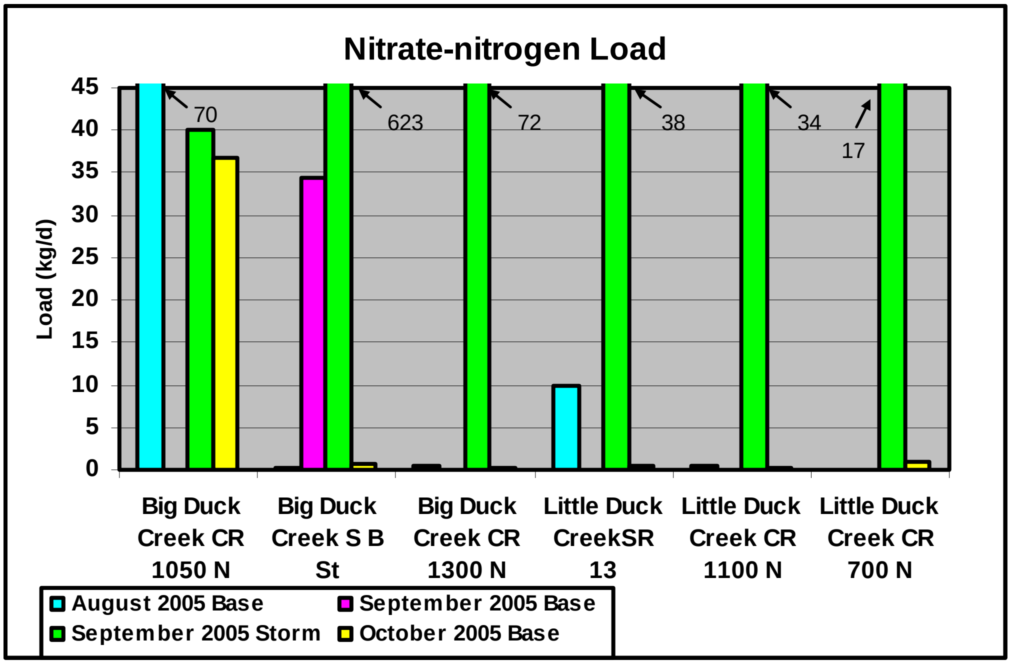


Figure 1. Nitrate loading rates for the Little Duck Creek Watershed stream sites for 2005.

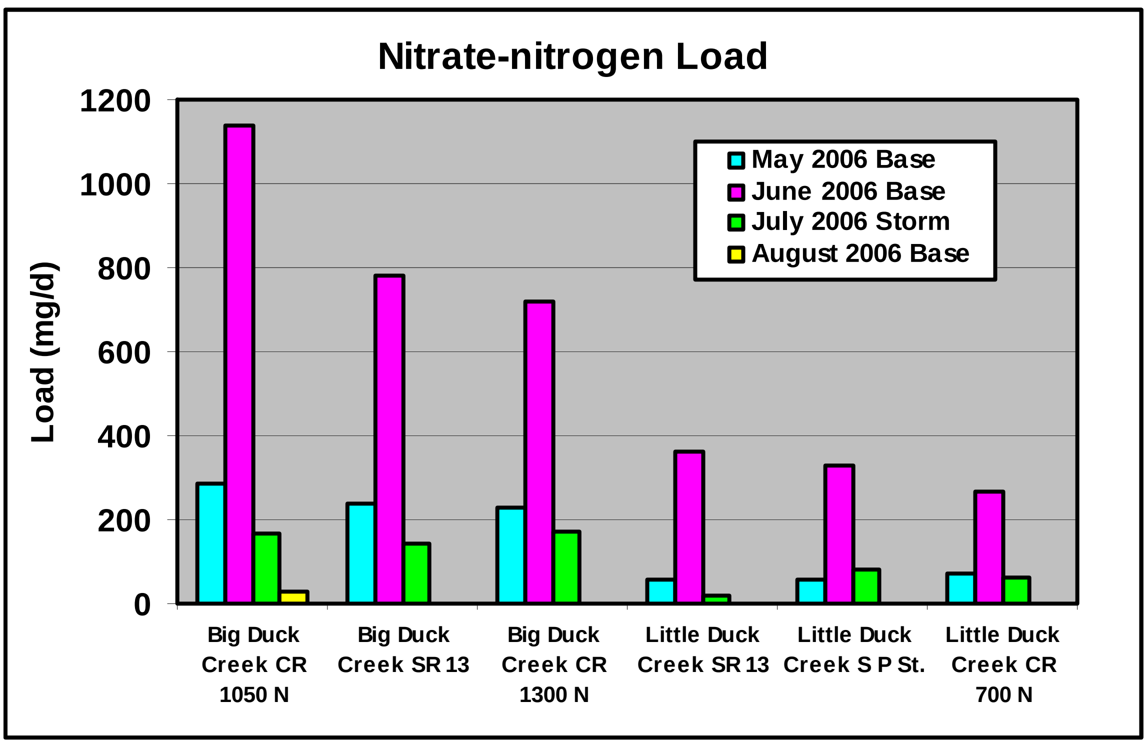


Figure 2. Nitrate loading rates for the Little Duck Creek Watershed stream sites for 2006.

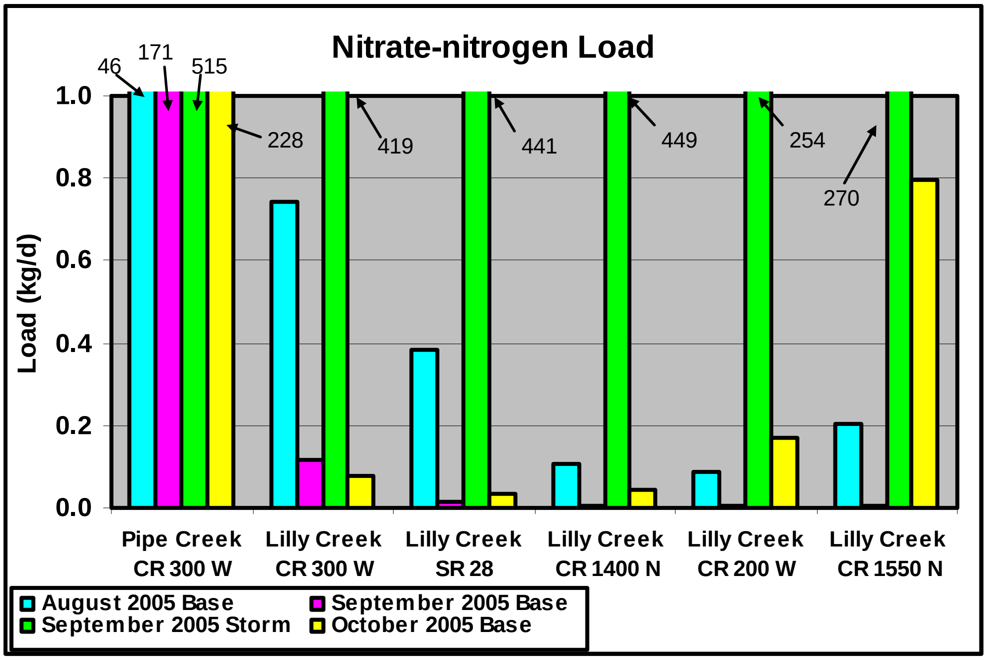


Figure 3. Nitrate loading rates for the Lilly Creek Watershed stream sites for 2005.

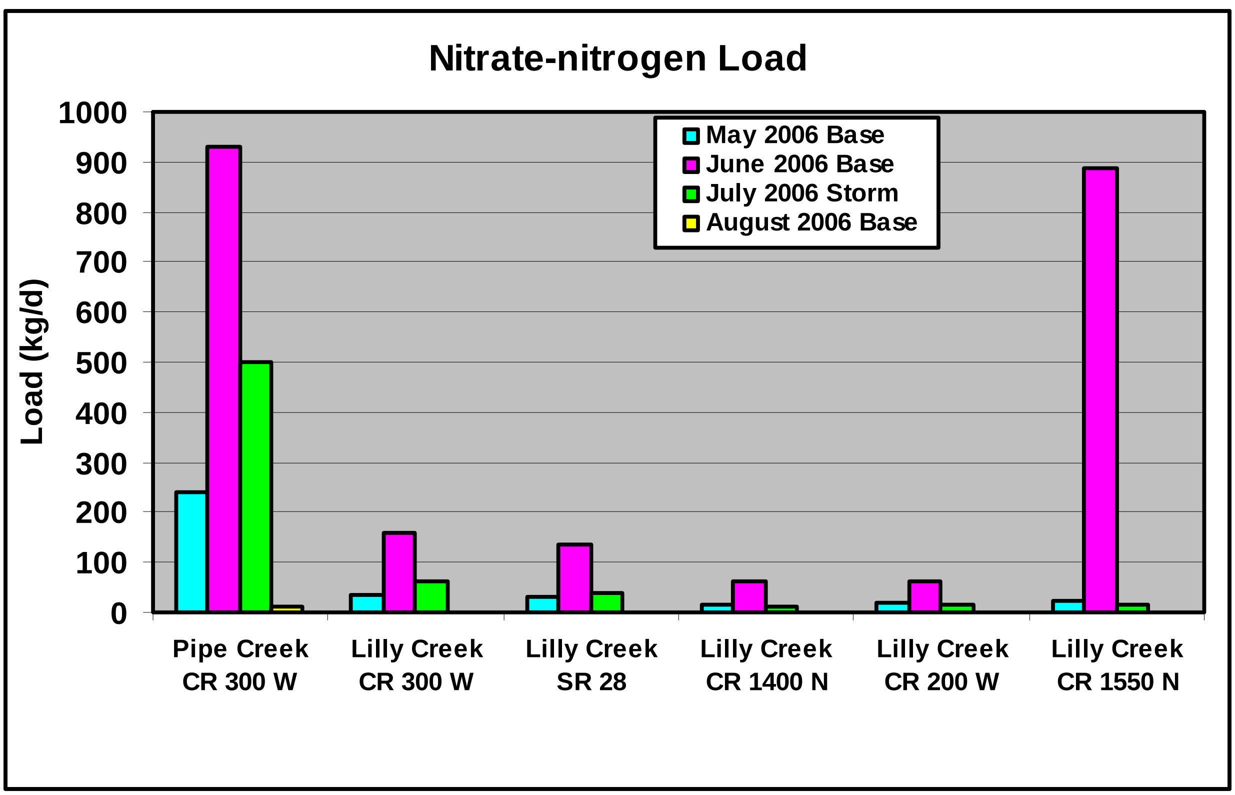


Figure 4. Nitrate loading rates for the Lilly Creek Watershed stream sites for 2006.

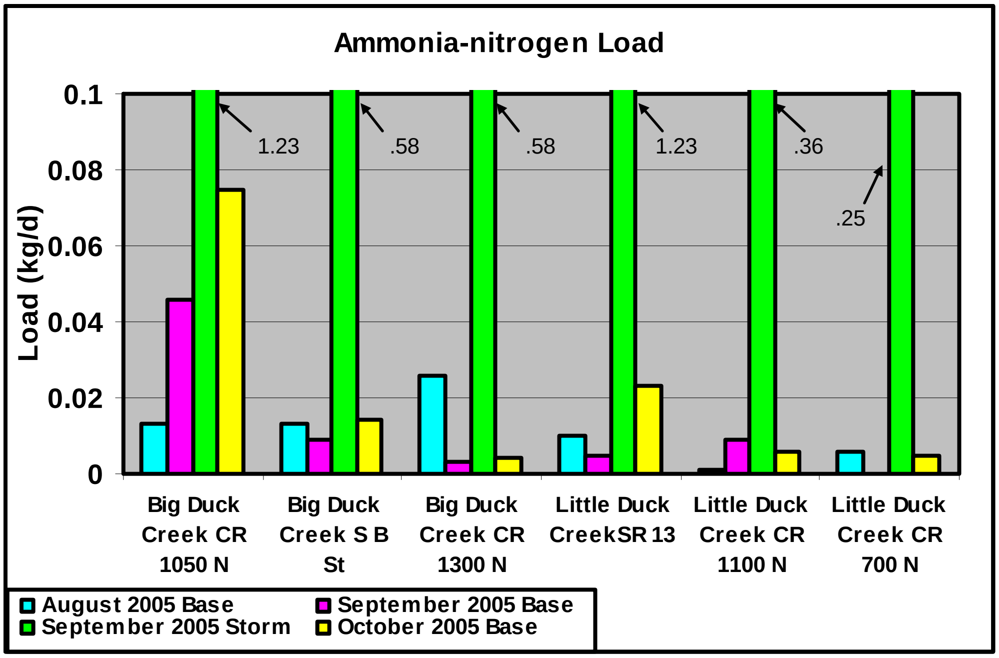


Figure 5. Ammonia loading rates for the Little Duck Creek Watershed stream sites for 2005.

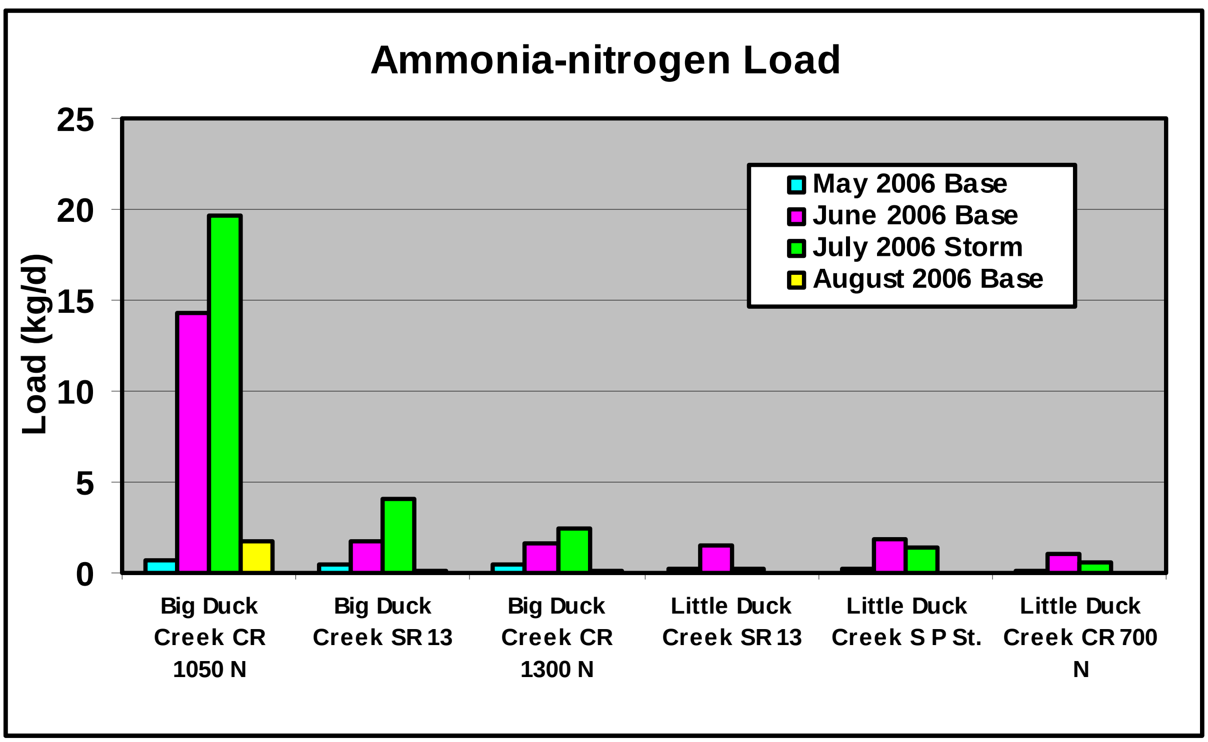


Figure 6. Ammonia loading rates for the Little Duck Creek Watershed stream sites for 2006.

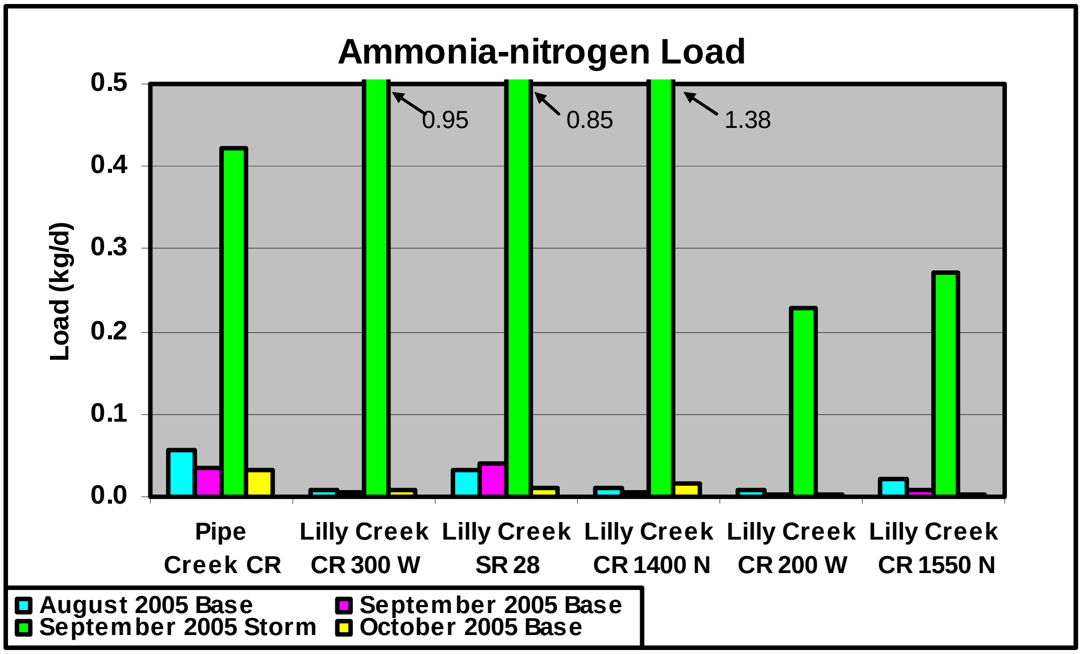


Figure 7. Ammonia loading rates for the Lilly Creek Watershed stream sites for 2005.

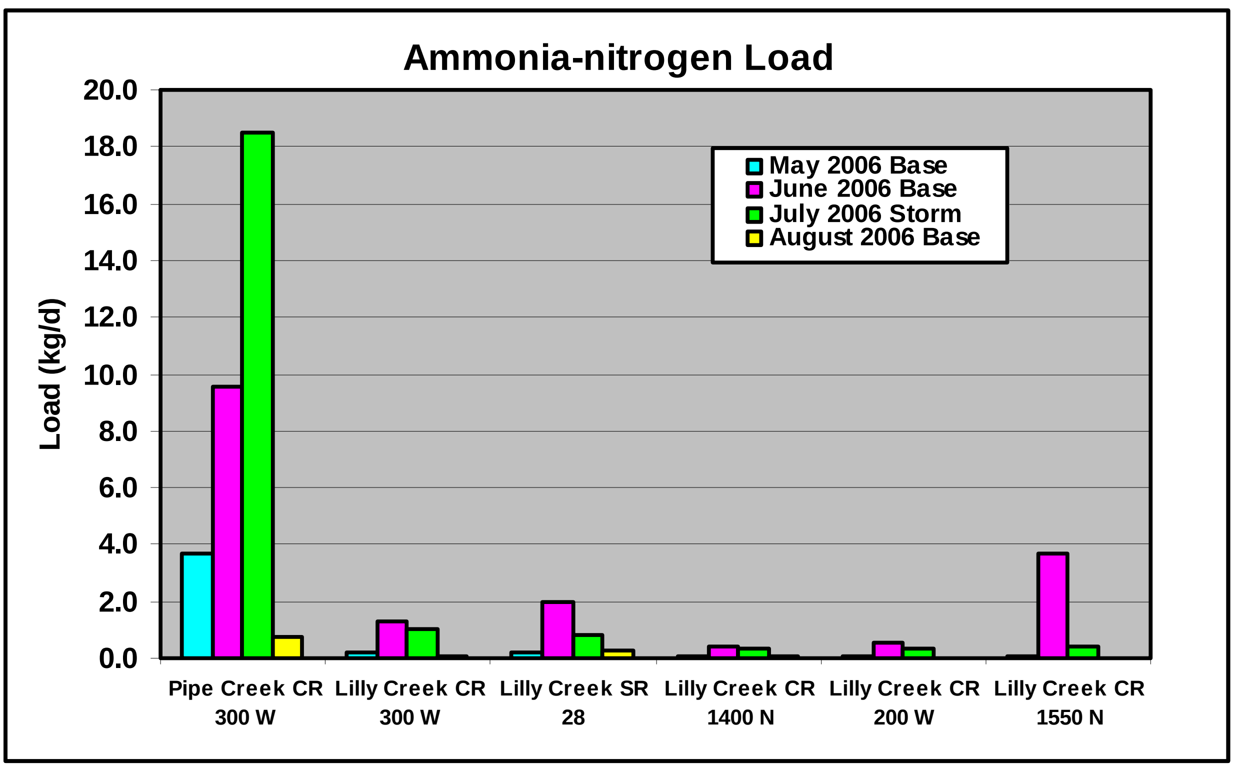


Figure 8. Ammonia loading rates for the Lilly Creek Watershed stream sites for 2006.

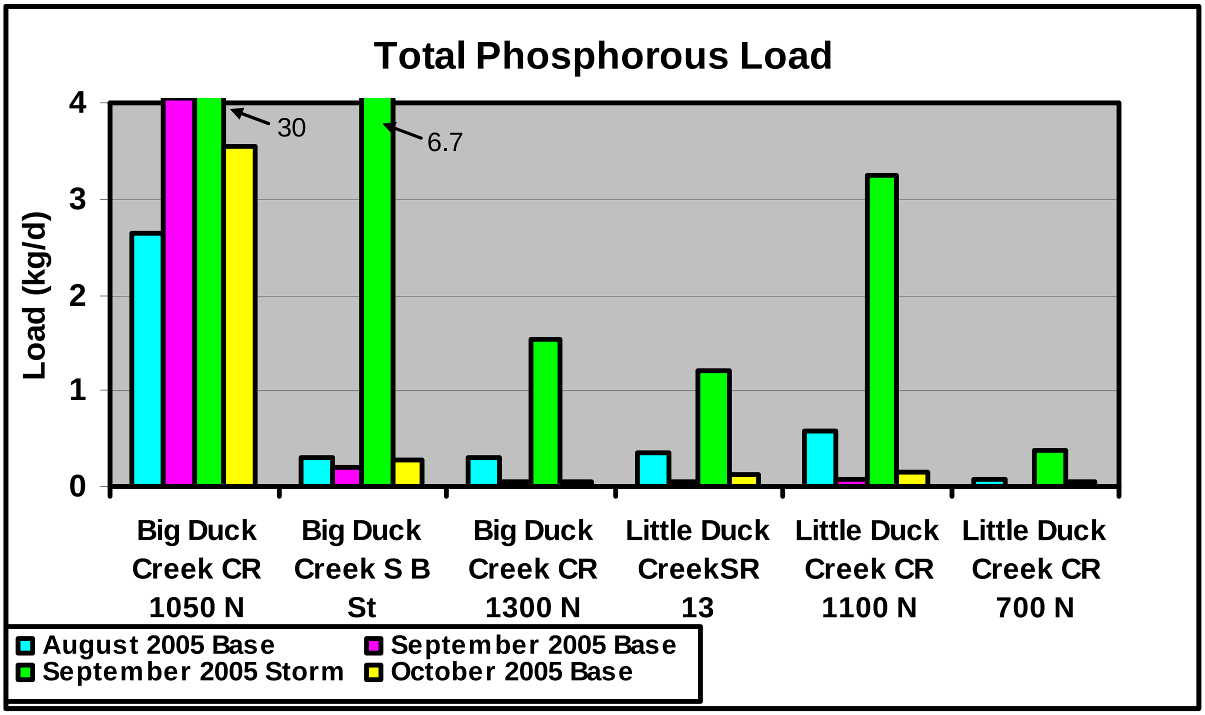


Figure 9. Total phosphorus loading rates for the Little Duck Creek Watershed stream sites for 2005.

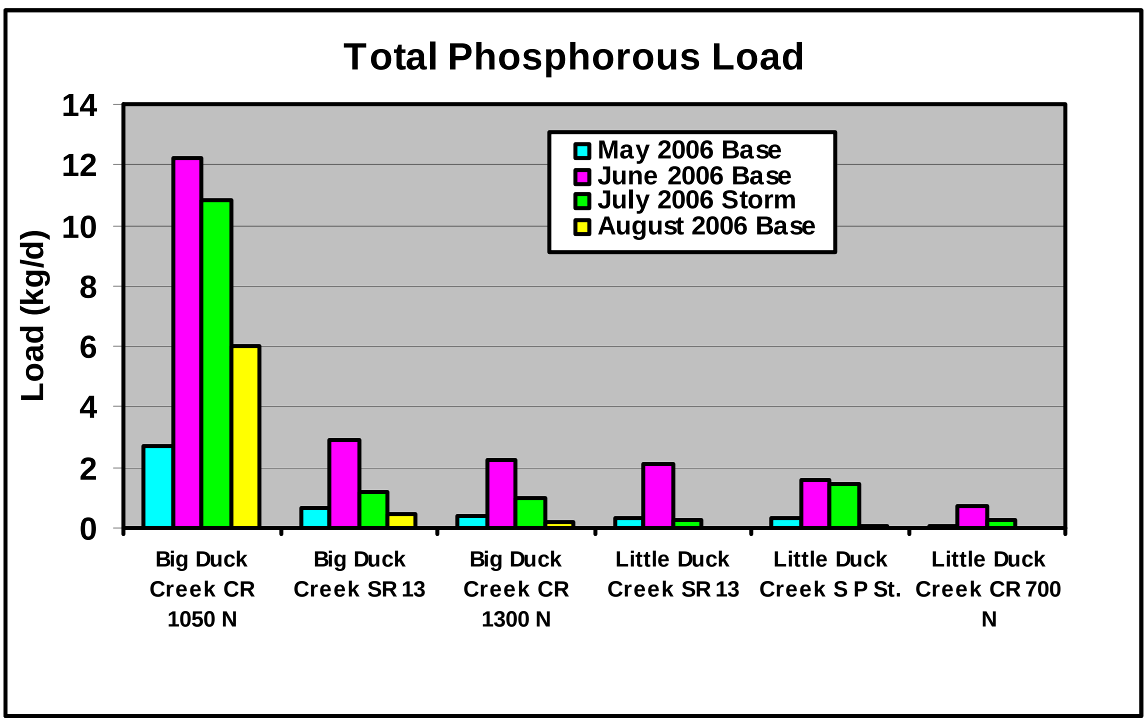


Figure 10. Total phosphorus loading rates for the Little Duck Creek Watershed stream sites for 2006.

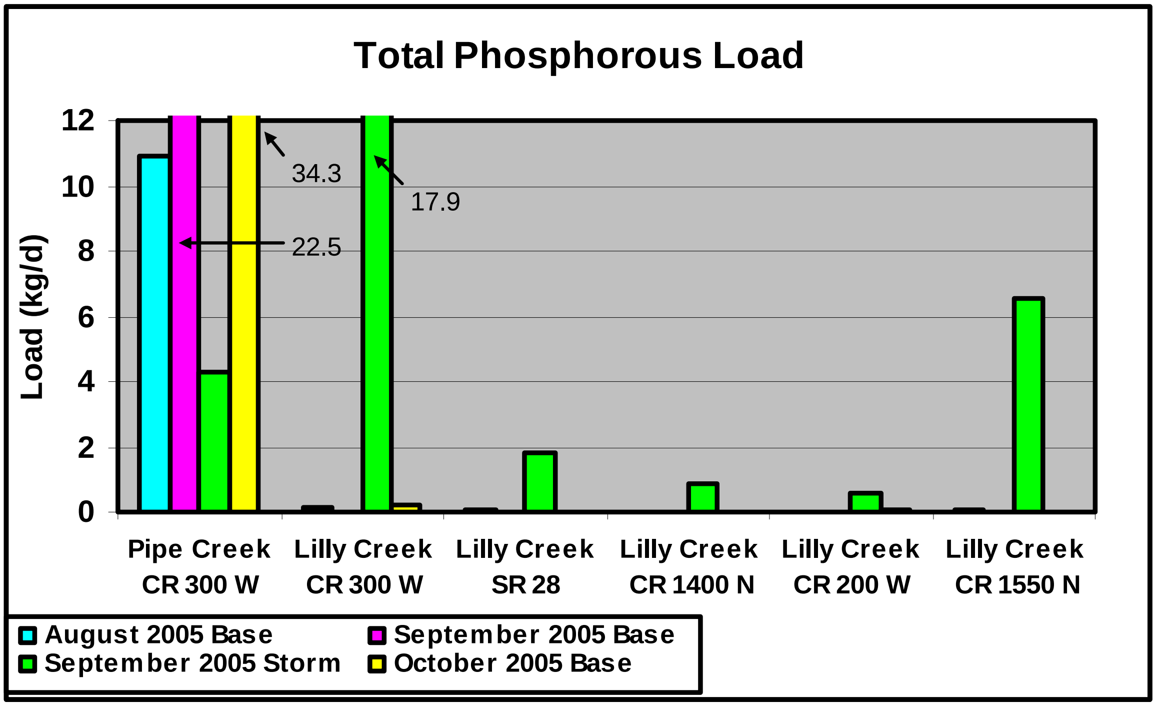


Figure 11. Total phosphorus loading rates for the Lilly Creek Watershed stream sites for 2005.

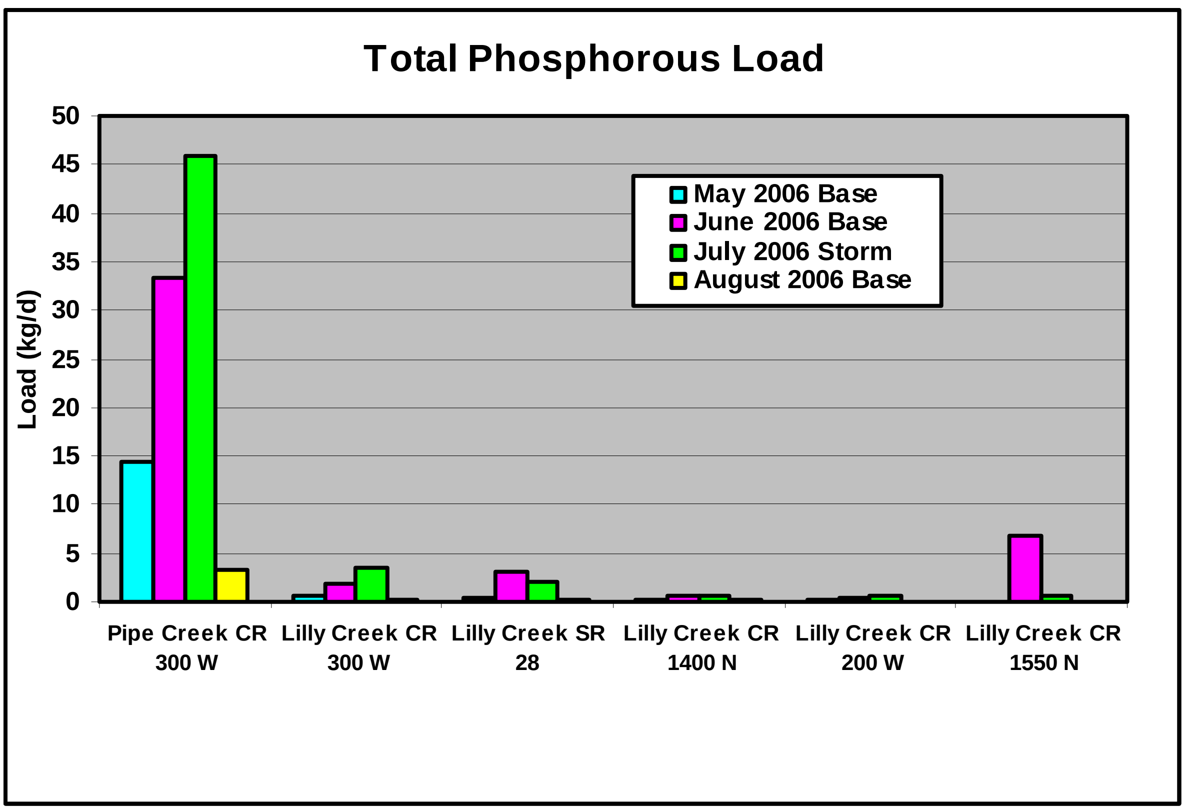


Figure 12. Total phosphorus loading rates for the Lilly Creek Watershed stream sites for 2006.

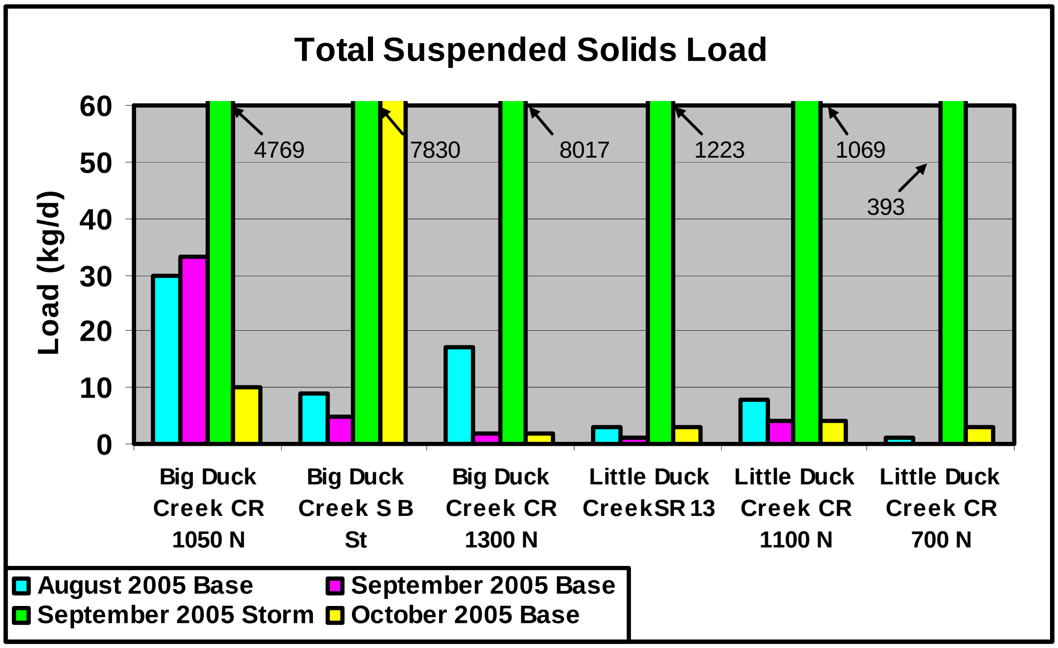


Figure 13. Total suspended solids loading rates for the Little Duck Creek Watershed stream sites for 2005

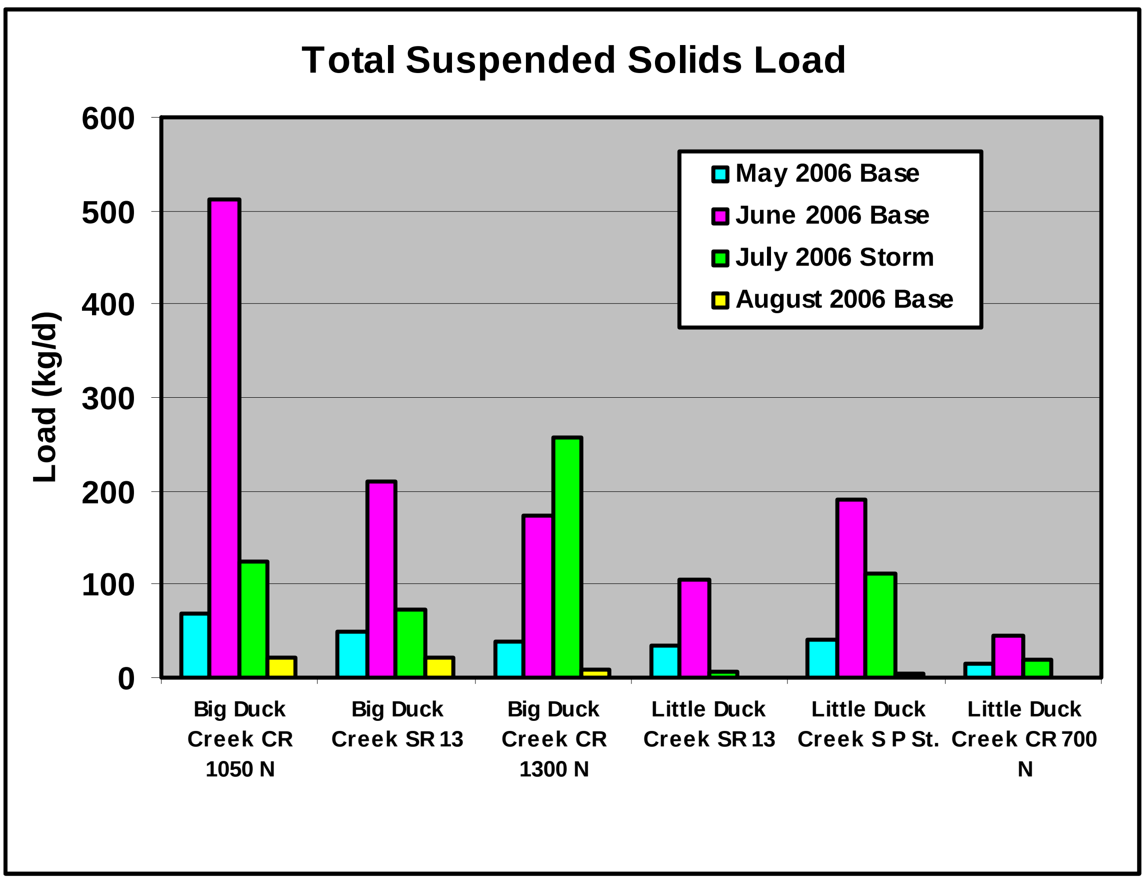


Figure 14. Total suspended solids loading rates for the Little Duck Creek Watershed stream sites for 2006.

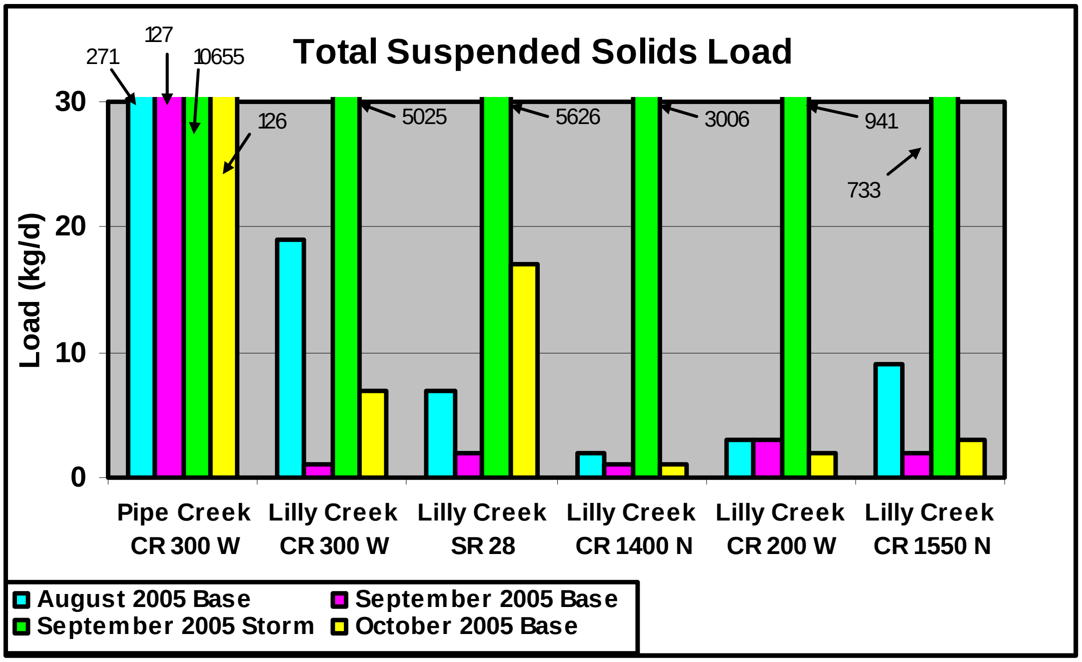


Figure 15. Total suspended solids loading rates for the Lilly Creek Watershed stream sites for 2005.

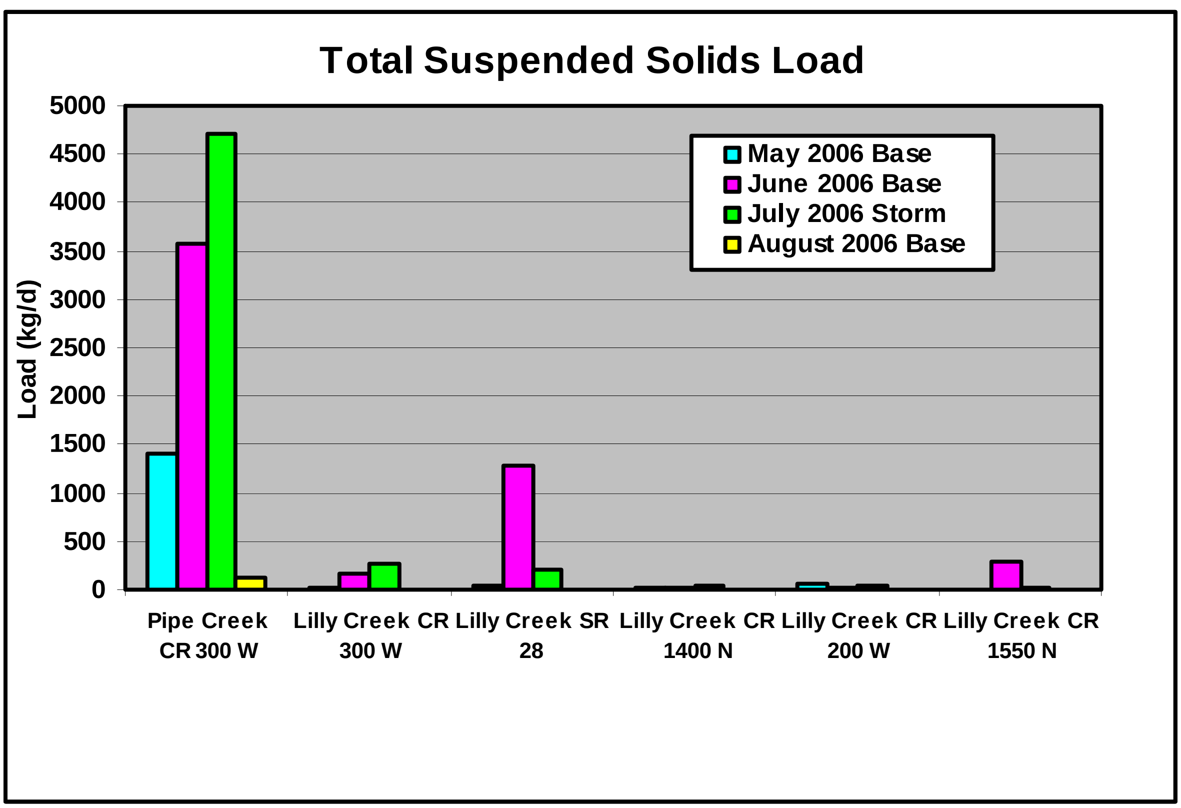


Figure 16. Total suspended solids loading rates for the Lilly Creek Watershed stream sites for 2006.

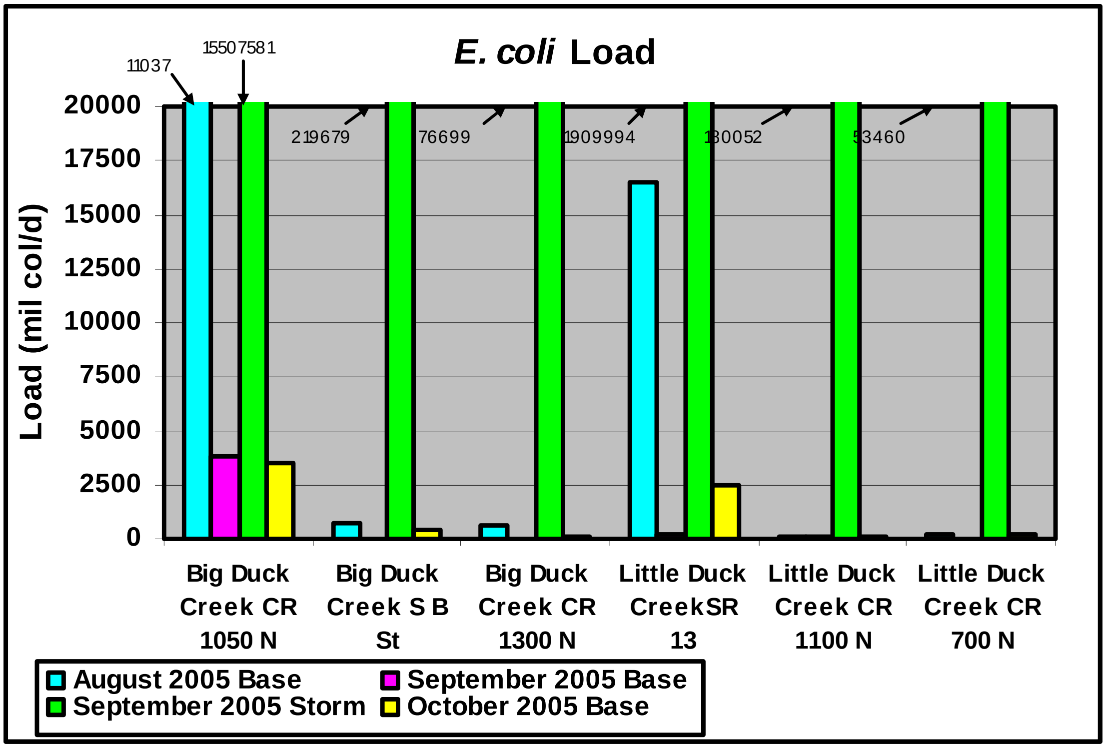


Figure 17. *E. coli* loading rates for the Little Duck Creek Watershed stream sites for 2005.

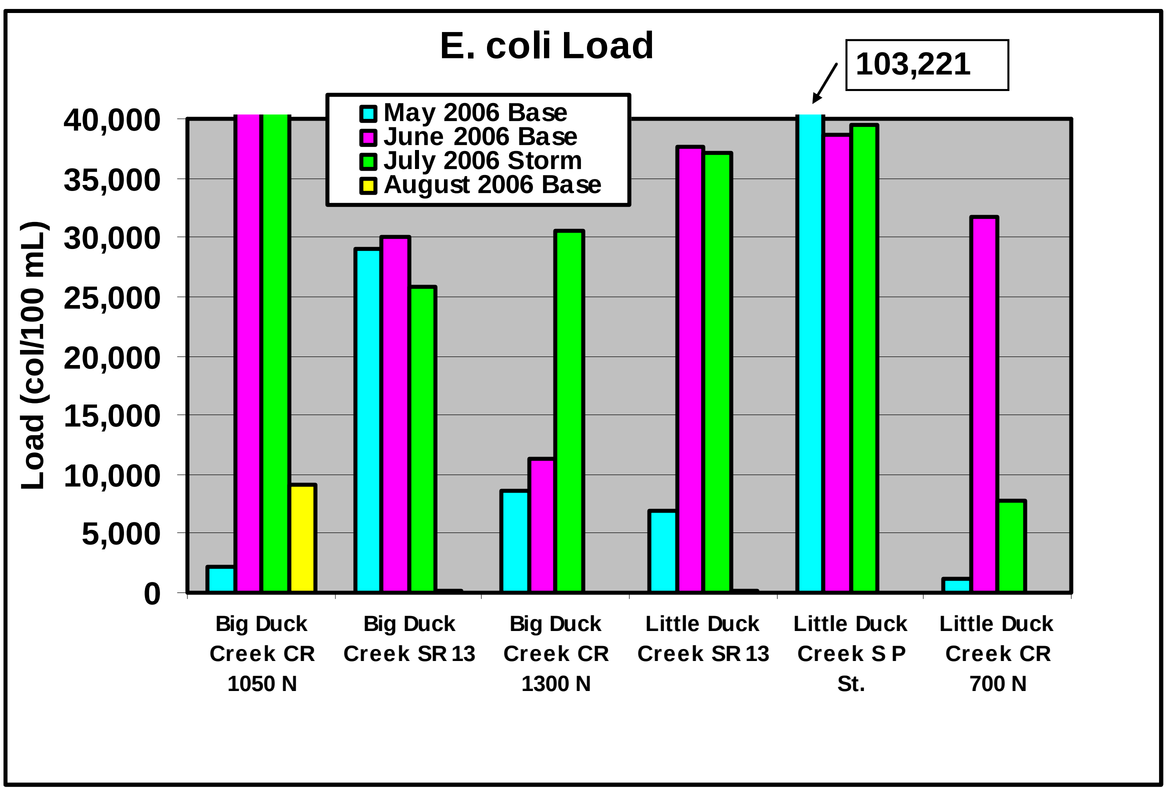


Figure 18. *E. coli* loading rates for the Little Duck Creek Watershed stream sites for 2006.

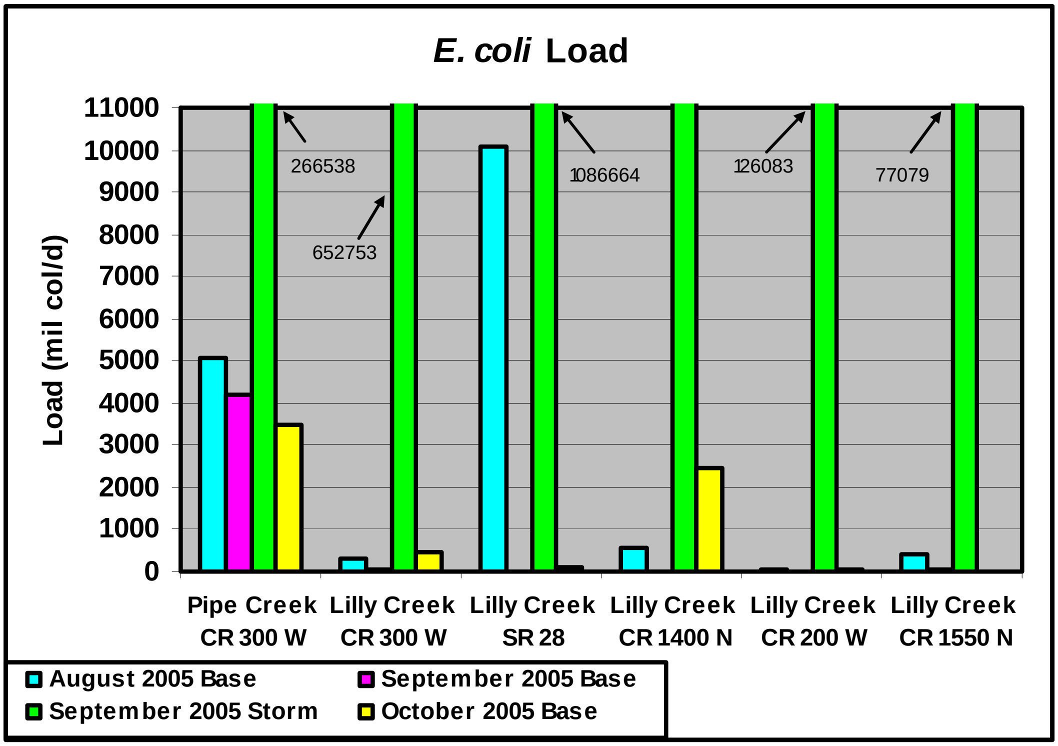


Figure 19. *E. coli* loading rates for the Lilly Creek Watershed stream sites for 2005.

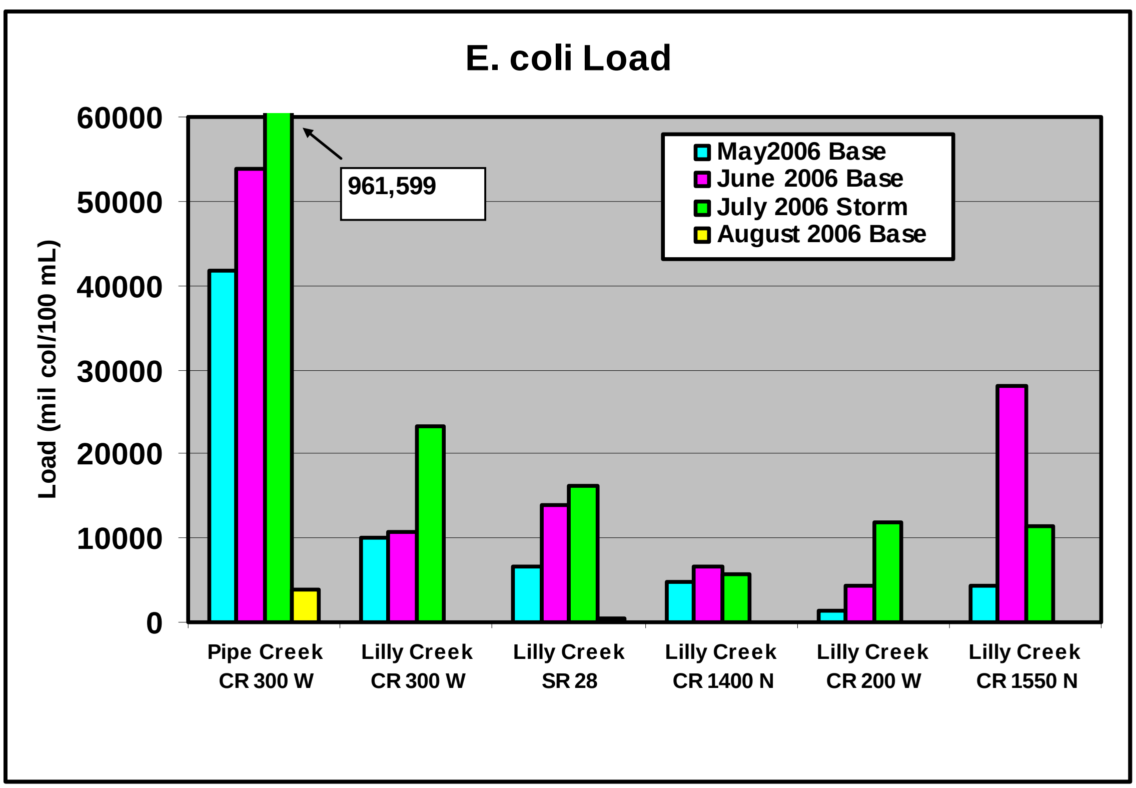


Figure 20. *E. coli* loading rates for the Lilly Creek Watershed stream sites for 2006.

Table 1. Macroinvertebrate taxa identified at each site as collected during sampling on August 3-4, 2005.

Order	**Family**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**	**Site 10**	**Site 11**	**Site 12**
Amphipoda													
	Haustoriidae	--	2	--	--	--	--	--	--	--	--	--	--
	Talitridae	--	--	--	--	--	--	--	--	2	9	5	48
Bivalvia													
	Sphaeriidae	--	1	4	--	--	--	--	4	--	--	2	--
Colepotera													
	Dytiscidae	--	6		1		1		3	--	1	--	--
	Elmidae	1	2	10	15	1	3	3	9	2	18	32	37
	Gyrinidae	--	--	1	--	--	--	--	--	--	--	--	--
	Haliplidae	--	1	--	--	--	8	--	4	7	2	1	4
	Hydrophilidae	--	--	1	--	--	13	--	1	6	--	--	--
	Staphylinidae	--	--	--	--	--	--	--	--	--	--	1	--
Diptera													
	Chironomidae	3	17	2	6	--	--	3	10	6	1	8	1
	Ptychopteridae	--	31	--	--	--	--	--	--	--	--	--	--
	Tipulidae	1	--	1	1	--	--	--	3	--	--	--	1
Ephemeroptera													
	Baetidae	1	--	--	1	1	--	--	--	1	3	--	--
	Caenidae	--	--	--	--	--	--	4	2	--	--	--	--
	Ephemerellidae	--	--	--	4	--	--	--	--	--	--	--	--
	Heptageniidae	--	1	--	--	--	--	4	--	--	--	9	--
	Siphlonuridae	4	--	--	--	--	--	--	--	--	--	--	--
Gastropoda													
	Lymnaeidae	--	--	--	--	--	4	--	--	--	--	--	--
	Physidae	--	10	16	--	16	17	--	10	8	38	8	20
	Planorbidae	--	--	3	--	--	5	--	2	--	--	1	2
Hempitera													
	Belostomatidae	--	--	--	--	--	2	--	--	--	1	--	--
	Corixidae	--	--	--	--	--	--	6	1	45	33	8	1
	Gerridae	--	1	1	--	1	--	9	3	1	--	4	--
	Mesoveliidae	--	--	--	--	1	--	--	--	--	--	--	--
	Veliidae	--	--	--	--	--	--	--	3	--	--	2	3
Hirudinea		--	--	--	1	2	--	2	3	--	--	2	
	Glossiphoniidae	1	5	4	--	--	--	--	--	--	--	--	--
	Nematomorpha	--	--	--	--	--	--	--	--	--	--	1	--
Odonata													
	Aeshnidae	--	--	1	--	--	--	--	2	--	1	11	--
	Corduliidae	2	--	--	--	--	--	--	--	--	--	--	--
	Lestidae	2	40	--	--	6	16	--	--	16	17	2	2
Trichoptera													
	Hydropsychidae	96	1	--	83	--	--	3	24	--	--	1	4
	Total	**111**	**118**	**44**	**112**	**28**	**71**	**34**	**84**	**94**	**124**	**98**	**123**

Table 2. Macroinvertebrate taxa found at each site found as collected during sampling on October 3-4, 2005.

Order	Family	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12
Amphipoda													
	Gammaridae	--	--	--	--	--	--	--	--	--	--	2	1
	Talitridae	--	1	--	--	--	--	1	5	12	32	--	46
Bivalvia													
	Sphaeriidae	--	1	3	1	--	--	4	14	--	25	4	--
Colepotera													
	Elmidae	8	--	8	12	1	1	5	1	1	1	--	7
	Haliplidae	--	3	1	--	--	8	--	--	--	--	1	3
	Hydrophilidae	--	1	5	--	--	5	1	--	2	--	--	--
Diptera													
	Chironomidae	4	10	9	36	27	15	6	9	3	6	3	5
	Simuliidae	--	8	--	--	--	1	--	--	--	--	--	--
	Syrphidae	--	--	--	1	--	--	--	--	--	--	--	--
	Tipulidae	1	--	--	4	3	--	1	--	--	--	--	--
Ephemeroptera													
	Baetidae	--	--	1	--	--	--	--	--	--	--	--	3
	Caenidae	--	3	1	--	1	--	--	--	--	--	--	--
	Heptageniidae	--	--	1	2	--	--	3	1	--	--	--	--
Gastropoda													
	Ancylidae				3								
	Physidae	1	8	3	25	2	20	12	38	10	4	9	5
	Planorbidae		3	27	7		6		8		32	1	2
Hempitera													
	Belostomatidae	--	--	--	--	--	1	--	1	--	--	--	--
	Corixidae	--	--	--	--	--	2	5	7	5	59	2	1
	Gerridae	--	1	--	1	--	--	--	4	--	--	3	--
	Notonectidae	--	--	--	--	--	--	--	1	1	--	--	--
	Veliidae	--	--	--	--	--	--	9	--	3	--	1	3
Hirudinea													
	Glossiphoniidae	3	--	15	6	1	16	2	--	6	4	--	--
Nematomorpha		--	--	--	--	--	--	--	1	--	--	--	--
Odonata													
	Aeshnidae	--	--	--	--	--	--	--	--	1	--	--	1
	Agrionidae	--	--	4	3	--	--	5	9	--	1	3	2
	Coenagrionidae	7	51	5	3	--	29	8	5	55	2	1	16
	Corduliidae	--	--	--	--	--	--	--	--	--	3	--	--
	Libellulidae	--	3	--	--	--	8	--	--	2	--	--	--
Oligochaeta		2	--	--	--	--	--	--	--	--	--	--	--
Trichoptera													
	Hydropsychidae	67	2	2	--	2	--	33	1	--	--	--	2
	Polycentropodidae	--	--	--	--	--	--	2	--	--	--	--	--
	Total	**93**	**95**	**85**	**104**	**37**	**112**	**97**	**105**	**101**	**169**	**30**	**97**

Table 3. Macroinvertebrate taxa found at each site found as collected during sampling on May 9, 2006.

Order	Family	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12
Amphipoda													
	Gammaridae	--	--	--	--	--	--	--	--	--	--	8	1
	Talitridae	--	--	--	--	--	--	--	--	2	2	--	--
Bivalvia													
	Corbicula fluminea	--	--	1	--	--	--	3	--	--	--	--	--
	Sphaeriidae	--	3	5	2	6	4	1	16	--	2	1	--
Coleoptera													
	Dytiscidae	--	--	--	--	3	2	--	3	9	2	5	1
	Elmidae	3	1	4	17	--	--	5	1	--	--	4	2
	Haliplidae	--	--	--	--	--	--	--	--	2	--	--	--
Decopoda													
	Palaemonidae	--	--	--	--	--	--	--	--	8	--	1	--
Diptera													
	Chironomidae	76	14	34	16	23	67	42	40	15	2	10	9
	Culicidae	5	--	--	--	--	--	--	--	--	--	--	5
	Simuliidae	--	49	5	9	--	2	2	--	1	--	2	--
	Tipulidae	--	--	--	1	--	--	--	--	--	--	3	1
Ephemeroptera													
	Baetidae	--	--	--	8	--	--	4	2	--	--	--	--
	Caenidae	--	2	12	--	--	1	3	--	--	--	--	--
	Heptageniidae	--	1	--	--	--	--	--	--	--	--	--	--
Gastropoda													
	Lymnaeidae	--	4	--	--	--	4	3	8	--	--	--	--
	Physidae	1	--	3	1	1	8	--	6	3	7	2	6
	Planorbidae	1	--	8	--	2	15	1	2	--	3	6	--
Hemiptera													
	Belostomatidae	--	--	--	--	--	--	--	--	1	--	--	--
	Corixidae	--	--	--	--	--	--	--	--	4	46	--	--
	Veliidae	--	--	--	2	1	--	--	--	--	--	1	--
Hirudinea	Glossiphoniidae	1	1	3	4	--	1	3	1	5	2	3	--
Nematomorpha		--	--	--	--	1	--	--	--	--	--	--	--
Odonata													
	Aeshnidae	--	--	--	--	--	--	--	--	--	1	2	--
	Agrionidae	--	--	--	--	--	--	2	2	--	--	1	--
	Coenagrionidae	47	4	1	3	3	3	5	5	8	--	--	--
	Gomphidae	--	--	--	--	--	--	1	--	--	--	--	--
	Libellulidae	--	1	--	--	--	--	--	--	--	--	--	--
Oligochaeta		--	--	--	--	2	1	--	2	--	2	1	1
Plecoptera													
	Chloroperlidae	--	--	--	--	--	--	--	--	--	--	2	2
	Perlodidae	--	--	--	--	--	--	--	--	2	--	--	--

Order	Family	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12
Trichoptera													
	Helicopsychidae	--	--	29	52	--	--	--	--	--	--	--	--
	Hydropsychidae	1	--	--	--	--	--	14	--	5	--	--	1
	Limnephilidae	--	--	--	1	--	--	--	--	--	--	--	--
	Polycentropodidae	--	--	--	--	--	--	--	1	--	--	--	--
	Total	**135**	**80**	**105**	**116**	**42**	**108**	**89**	**89**	**65**	**69**	**52**	**29**

Table 4. Macroinvertebrate taxa found at each site as collected during sampling on August 2, 2006.

Order	Family	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12
Amphipoda													
	Gammaridae	--	--	--	--	--	--	--	--	--	--	--	3
Bivalvia													
	Corbicula	1	--	1	--	1	1	3	4	--	--	--	--
Bivalvia	Sphaeriidae	--	1	2	--	2	1	--	1	1	2	1	1
Coleoptera													
	Curculionidae	--	--	--	--	--	--	--	--	3	--	--	--
	Dryopidae	--	--	--	--	--	--	--	--	1	--	--	--
	Dytiscidae	--	--	--	--	--	--	--	--	--	--	--	--
	Elmidae	--	--	1	--	--	1	4	--	--	--	2	1
	Gyrinidae	--	--	--	--	--	--	--	--	--	--	--	--
	Haliplidae	--	1	2	1		2	--	--	1	--	3	--
	Helodidae	--	--	--	--	--	--	--	--	1	--	2	--
	Hydrophilidae	--	--	1	--	--	--	--	--	--	--	--	1
Collembola													
	Poduridae	--	--	--	--	--	--	--	--	--	1	--	--
Diptera													
	Chironomidae	3	19	4	41	7	29	12	7	8	25	9	2
	Empididae	--	--	--	2	--	--	--	--	--	--	--	--
	Nematocera	--	1	--	--	--	--	--	--	--	--	--	--
	Nymphomyiidae	--	--	--	--	--	--	1	--	--	--	--	--
	Sciomyzidae	--	--	--	--	--	--	--	--	1	--	--	4
	Simuliidae	--	--	--	--	--	--	--	--	--	--	--	1
Ephemeroptera													
	Baetidae	--	--	--	--	--	--	7	--	4	--	--	--
	Caenidae	--	28	3	--	3	15	--	1	--	--	--	--
	Ephemerellidae	--	--	--	--	--	--	--	--	--	--	--	--
	Heptageniidae	1	7	--	1	2	--	1	--	--	--	--	--
Gastropoda													
	Ancylidae	--	--	--	2	--	--	4	--	--	--	--	--
	Physidae	2	7	16	7	--	17	1	2	11	10	4	10
	Planorbidae	--	--	10	--	--	7	--	11	--	--	1	--
	Viviparidae	--	--	--	--	--	1	10	--	--	6	--	--
Hemiptera													
	Corixidae	--	2	--	--	--	--	3	6	38	--	7	--
	Gerridae	--	--	--	--	--	--	--	--	--	--	--	1
	Notonectidae	--	--	1	--	--	--	--	--	--	--	--	--
	Veliidae	--	--	--	--	--	--	--	1	--	1	--	--
Hirudinea													
	Glossiphoniidae	3	1	8	--	--	1	1	--	17	58	--	1
Isopoda													
	Asillidae	--	--	--	--	--	1	--	--	--	--	--	--

Order	**Family**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**	**Site 10**	**Site 11**	**Site 12**
Odonata													
	Coenagrionidae	--	3	2	--	--	4	--	--	3	3	--	--
	Libellulidae	--	4	--	--	--	--	--	--	--	--	--	--
Oligochaeta		1	--	--	--	--	--	1	--	--	2	--	4
Platyhelminthes	Planaria	--	--	6	2	--	--	--	--	--	--	--	1
Trichoptera													
	Helicopsychidae	--	--	11	19	--	--	--	--	--	--	--	--
	Hydropsychidae	7	--	--	--	2	--	7	--	--	--	--	1
Total		**18**	**74**	**68**	**75**	**17**	**80**	**55**	**33**	**89**	**108**	**29**	**31**

Table 5. Macroinvertebrate scores calculated for Site 1: Big Duck Creek at CR 1050 N.

Date	August-05		October-05		May-06		August-06	
HBI	4.30	6	4.43	6	6.01	0	5.46	2
No. Taxa (family)	9	2	8	2	7	0	7	0
Total Count (# individuals)	111	2	93	2	130	4	18	0
% Dominant Taxa	86.5	0	72	0	58.46	2	38.9	4
EPT Index (# families)	3	2	1	0	1	0	2	0
EPT Count (# individuals)	101	6	67	4	1	0	8	0
EPT Count/Total Count	0.91	8	0.72	8	0.01	0	0.44	4
EPT Abun./Chir. Abun.	33.67	8	16.75	8	0.01	0	2.67	4
Chironomid Count	3	8	4	8	76	4	3	8
mIBI score		**4.67**		**4.22**		**1.10**		**2.40**

Table 6. Macroinvertebrate scores calculated for Site 2: Big Duck Creek at State Road 13.

Date	August-05		October-05		May-06		August-06	
HBI	7.40	0	6.39	0	6.16	0	6.73	0
No. Taxa (family)	13	4	13	4	10	2	11	4
Total Count (# individuals)	118	2	95	2	80	2	74	0
% Dominant Taxa	33.9	4	54	2	61.25	2	37.8	4
EPT Index (# families)	2	0	2	0	2	0	2	0
EPT Count (# individuals)	2	0	5	0	3	0	35	2
EPT Count/Total Count	0.02	0	0.05	0	0.04	0	0.47	6
EPT Abun./Chir. Abun.	0.12	0	0.50	0	0.21	0	1.84	2
Chironomid Count	17	8	10	8	14	8	19	8
mIBI score		**2.00**		**1.78**		**1.60**		**2.90**

Table 7. Macroinvertebrate scores calculated for Site 3: Big Duck Creek at CR 1300 N.

Date	August-05		October-05		May-06		August-06	
HBI	6.50	0	6.45	0	5.47	2	5.98	0
No. Taxa (family)	11	4	14	4	11	4	14	4
Total Count (# individuals)	44	0	85	2	105	2	68	0
% Dominant Taxa	36.4	4	32	4	32.38	4	23.5	6
EPT Index (# families)	0	0	4	4	2	0	2	0
EPT Count (# individuals)	0	0	5	0	41	2	14	0
EPT Count/Total Count	0.00	0	0.06	0	0.39	4	0.21	2
EPT Abun./Chir. Abun.	0.00	0	0.56	0	1.21	2	3.50	4
Chironomid Count	2	8	9	8	34	6	4	8
mIBI score		**1.78**		**2.44**		**2.90**		**2.70**

Table 8. Macroinvertebrate scores calculated for Site 4: Little Duck Creek at SR 13.

Date	August-05		October-05		May-06		August-06	
HBI	4.05	8	6.30	0	4.27	6	5.28	2
No. Taxa (family)	8	2	13	4	12	4	8	2
Total Count (# individuals)	112	2	104	2	116	2	75	0
% Dominant Taxa	74.1	0	35	4	44.83	2	54.7	2
EPT Index (# families)	3	2	1	0	3	2	2	0
EPT Count (# individuals)	88	4	2	0	61	4	20	2
EPT Count/Total Count	0.79	8	0.02	0	0.53	6	0.27	2
EPT Abun./Chir. Abun.	14.67	8	0.06	0	3.81	4	0.49	0
Chironomid Count	6	8	36	6	16	8	41	6
mIBI score		**4.67**		**1.78**		**4.20**		**1.8**

Table 9. Macroinvertebrate scores calculated for Site 5: Little Duck Creek at CR 1100 N (South P Street).

Date	August-05		October-05		May-06		August-06	
HBI	7.96	0	5.78	0	6.28	0	5.78	0
No. Taxa (family)	7	0	7	0	9	2	6	0
Total Count (# individuals)	28	0	37	0	42	0	17	0
% Dominant Taxa	57.1	2	73	0	54.76	2	41.2	4
EPT Index (# families)	1	0	2	0	0	0	3	2
EPT Count (# individuals)	1	0	3	0	0	0	7	0
EPT Count/Total Count	0.04	0	0.08	0	0.00	0	0.41	4
EPT Abun./Chir. Abun.	--	8	0.11	0	0.00	0	1.00	2
Chironomid Count	0	8	27	8	23	8	7	8
mIBI score		**2.00**		**0.89**		**1.30**		**2.20**

Table 10. Macroinvertebrate scores calculated for Site 6: Little Duck Creek at CR 700 W.

Date	August-05		October-05		May-06		August-06	
HBI	7.17	0	7.03	0	6.40	0	6.75	0
No. Taxa (family)	10	2	12	4	11	4	12	4
Total Count (# individuals)	71	0	112	2	108	2	80	2
% Dominant Taxa	23.9	6	26	6	62.04	0	36.3	4
EPT Index (# families)	1	0	0	0	1	0	1	0
EPT Count (# individuals)	2	0	0	0	1	0	15	0
EPT Count/Total Count	0.03	0	0.00	0	0.01	0	0.19	2
EPT Abun./Chir. Abun.	--	8	0.00	0	0.01	0	0.52	0
Chironomid Count	0	8	15	8	67	6	29	8
mIBI score		**2.67**		**2.22**		**1.30**		**2.20**

Table 11. Macroinvertebrate scores calculated for Site 7: Pipe Creek at CR 300 W.

Date	**August-05**		**October-05**		**May-06**		**August-06**	
HBI	6.21	0	5.63	2	5.48	2	5.42	2
No. Taxa (family)	8	2	15	6	14	4	13	4
Total Count (# individuals)	34	0	97	2	89	2	55	0
% Dominant Taxa	26.5	6	34	4	47.19	2	21.8	8
EPT Index (# families)	3	2	3	2	3	2	3	2
EPT Count (# individuals)	11	0	38	2	21	2	15	0
EPT Count/Total Count	0.32	4	0.39	4	0.24	2	0.27	2
EPT Abun./Chir. Abun.	3.67	4	6.33	6	0.50	0	1.25	2
Chironomid Count	3	8	6	8	42	6	12	8
mIBI score		**2.89**		**4.00**		**2.40**		**3.10**

Table 12. Macroinvertebrate scores calculated for Site 8: Lilly Creek at CR 300W.

Date	**August-05**		**October-05**		**May-06**		**August-06**	
HBI	5.56	2	7.29	0	6.41	0	6.96	0
No. Taxa (family)	16	6	15	6	13	4	8	2
Total Count (# individuals)	84	2	105	2	89	2	33	0
% Dominant Taxa	28.6	6	36	4	44.94	2	33.3	4
EPT Index (# families)	2	0	2	0	2	0	1	0
EPT Count (# individuals)	26	2	2	0	3	0	1	0
EPT Count/Total Count	0.31	4	0.02	0	0.03	0	0.03	0
EPT Abun./Chir. Abun.	2.60	4	0.22	0	0.08	0	0.14	0
Chironomid Count	10	8	9	8	40	6	7	8
mIBI score		**3.78**		**2.22**		**1.60**		**1.60**

Table 13. Macroinvertebrate scores calculated for Site 9: Lilly Creek at SR 28.

Date	August-05		October-05		May-06		August-06	
HBI	8.57	0	6.83	0	6.21	0	8.41	0
No. Taxa (family)	10	2	12	4	13	4	12	4
Total Count (# individuals)	94	2	101	2	65	0	89	2
% Dominant Taxa	47.9	2	54	2	23.08	6	42.7	4
EPT Index (# families)	1	0	0	0	2	0	1	0
EPT Count (# individuals)	1	0	0	0	7	0	4	0
EPT Count/Total Count	0.01	0	0.00	0	0.11	0	0.04	0
EPT Abun./Chir. Abun.	0.17	0	0.00	0	0.47	0	0.50	0
Chironomid Count	6	8	3	8	15	8	8	8
mIBI score		**1.56**		**1.78**		**1.10**		**2.00**

Table 14. Macroinvertebrate scores calculated for Site 10: Lilly Creek at 1400 N.

Date	August-05		October-05		May-06		August-06	
HBI	7.89	0	8.32	0	8.99	0	7.30	0
No. Taxa (family)	11	4	11	4	10	2	9	2
Total Count (# individuals)	124	2	169	4	69	0	108	2
% Dominant Taxa	30.6	6	35	4	66.67	0	53.7	2
EPT Index (# families)	1	0	0	0	0	0	0	0
EPT Count (# individuals)	3	0	0	0	0	0	0	0
EPT Count/Total Count	0.02	0	0.00	0	0.00	0	0.00	0
EPT Abun./Chir. Abun.	3.00	4	0.00	0	0.00	0	0.00	0
Chironomid Count	1	8	6	8	2	8	25	8
mIBI score		**2.67**		**2.22**		**2.70**		**1.60**

Table 15. Macroinvertebrate scores calculated for Site 11: Lilly Creek at CR 200W.

Date	August-05		October-05		May-06		August-06	
HBI	5.57	2	6.78	0	5.42	2	7.41	0
No. Taxa (family)	17	6	12	4	16	6	8	2
Total Count (# individuals)	98	2	32	0	52	0	29	0
% Dominant Taxa	32.7	4	28	6	19.23	8	31.0	6
EPT Index (# families)	2	0	0	0	1	0	0	0
EPT Count (# individuals)	10	0	0	0	2	0	0	0
EPT Count/Total Count	0.10	0	0.00	0	0.04	0	0.00	0
EPT Abun./Chir. Abun.	1.25	2	0.00	0	0.20	0	0.00	0
Chironomid Count	8	8	3	8	10	8	9	8
mIBI score		**2.67**		**2.00**		**2.70**		**1.80**

Table 16. Macroinvertebrate scores calculated for Site 12: Lilly Creek at 1550 N.

Date	August-05		October-05		May-06		August-06	
HBI	6.56	0	6.85	0	6.33	0	6.11	0
No. Taxa (family)	11	4	15	6	10	2	13	4
Total Count (# individuals)	123	2	98	2	29	0	31	0
% Dominant Taxa	39.0	4	47	2	31.03	6	32.3	4
EPT Index (# families)	1	0	2	0	2	0	1	0
EPT Count (# individuals)	4	0	5	0	3	0	1	0
EPT Count/Total Count	0.03	0	0.05	0	0.10	0	0.03	0
EPT Abun./Chir. Abun.	4.00	4	1.00	2	0.33	0	0.50	0
Chironomid Count	1	8	5	8	9	8	2	8
mIBI score		**2.44**		**2.22**		**1.80**		**1.80**

Site 1 Downstream, 08/03/05, Base Flow

Site 1 Downstream, 09/26/05, Storm Flow

Site 1 Photographs
Big Duck Creek
County Road 1050 North
Madison County, Indiana

Site 2 Downstream, 09/06/05, Base Flow

Site 2 Downstream, 09/26/05, Storm Flow

Site 2 Photographs
Big Duck Creek
State Road 13
Madison County, Indiana

Site 3 Upstream, 08/02/06, Base Flow

Site 3 Upstream, 07/12/06, Storm Flow

Site 3 Photographs
Big Duck Creek
County Road 1300 North
Madison County, Indiana

Site 4 Upstream, 09/06/05, Base Flow

Site 4 Upstream, 09/26/05, Storm Flow

Site 4 Photographs
Little Duck Creek
State Road 13
Madison County, Indiana

Site 5 Downstream 08/03/05, Base Flow

Site 5 Downstream, 09/26/05, Storm Flow

Site 5 Photographs
Little Duck Creek
County Road 1100 North (South P Street)
Madison County, Indiana

Site 6 Downstream 08/03/05, Base Flow

Site 6 Downstream 09/26/05, Storm Flow

Site 6 Photographs
Little Duck Creek
County Road 700 West
Madison County, Indiana

Site 7 Downstream 08/03/05, Base Flow

Site 7 Downstream 09/26/05, Storm Flow

Site 7 Photographs
Pipe Creek
County Road 300 West
Madison County, Indiana

Site 8 Upstream, 09/06/05, Base Flow

Site 8 Upstream, 09/26/05, Storm Flow

Site 8 Photographs
Lilly Creek
County Road 300 West
Madison County, Indiana

Site 9 Upstream, 05/09/06, Base Flow

Site 9 Downstream, 07/12/06, Storm

Site 9 Photographs
Lilly Creek
State Road 28
Madison County, Indiana

Site 10 Upstream, 05/09/06, Base Flow

Site 10 Upstream, 07/12/06, Storm Flow

Site 10 Photographs
Lilly Creek
County Road 1400 North
Madison County, Indiana

Site 11 Downstream, 09/06/05, Base Flow

Site 11 Downstream, 09/26/05, Storm Flow

Site11 Photographs
Lilly Creek
County Road 200 West
Madison County, Indiana

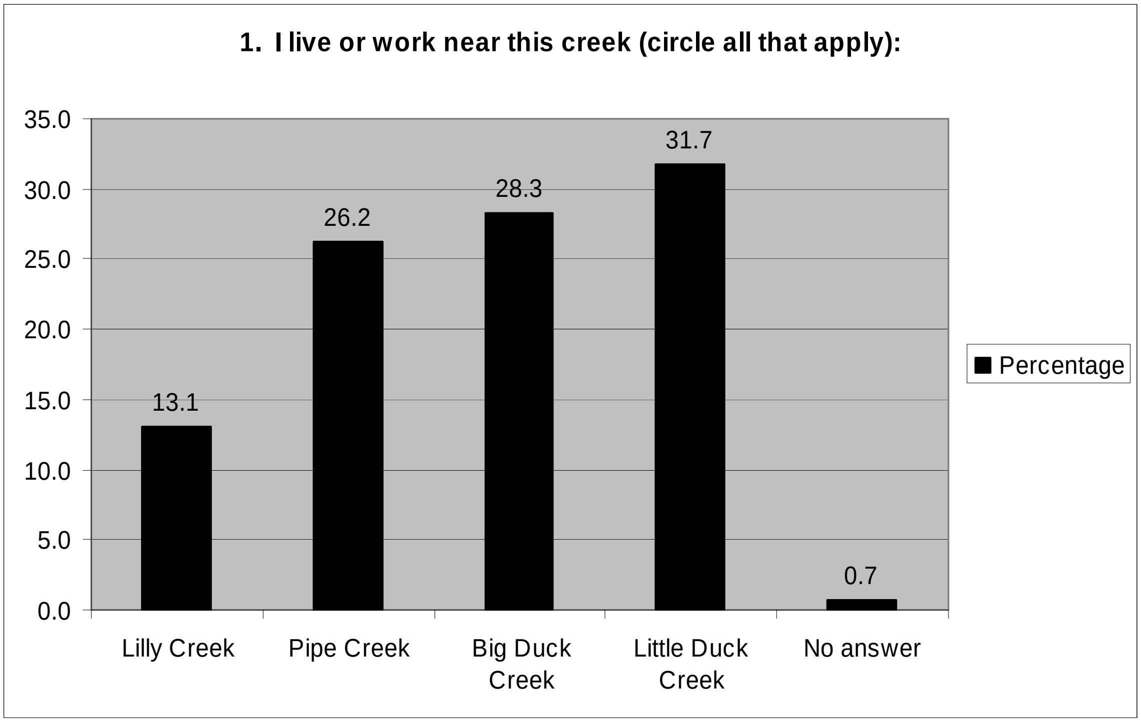
Site 12 Upstream, 08/04/05, Base Flow

Site 12 Upstream, 07/12/06, Storm Flow

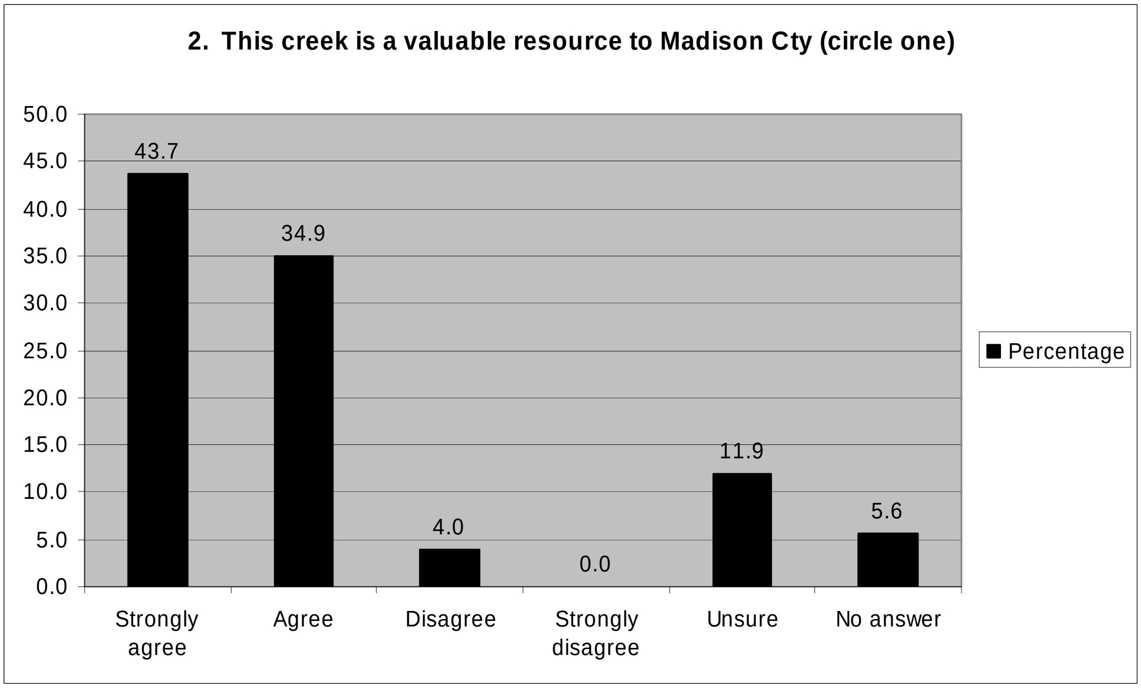
Site 12 Photographs
Lilly Creek
County Road 1550 North
Madison County, Indiana

Appendix G – SWCD Initial Survey Results

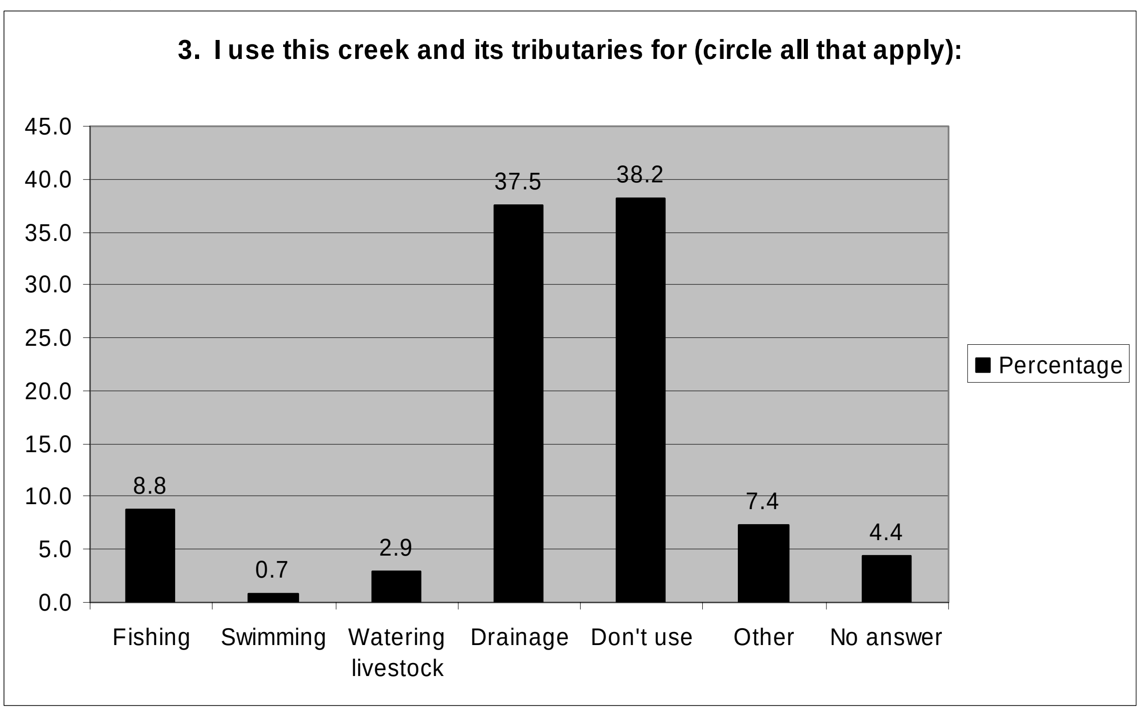
1. I live or work near this creek: Lilly Creek, Pipe Creek, Big Duck Creek, Little Duck Creek



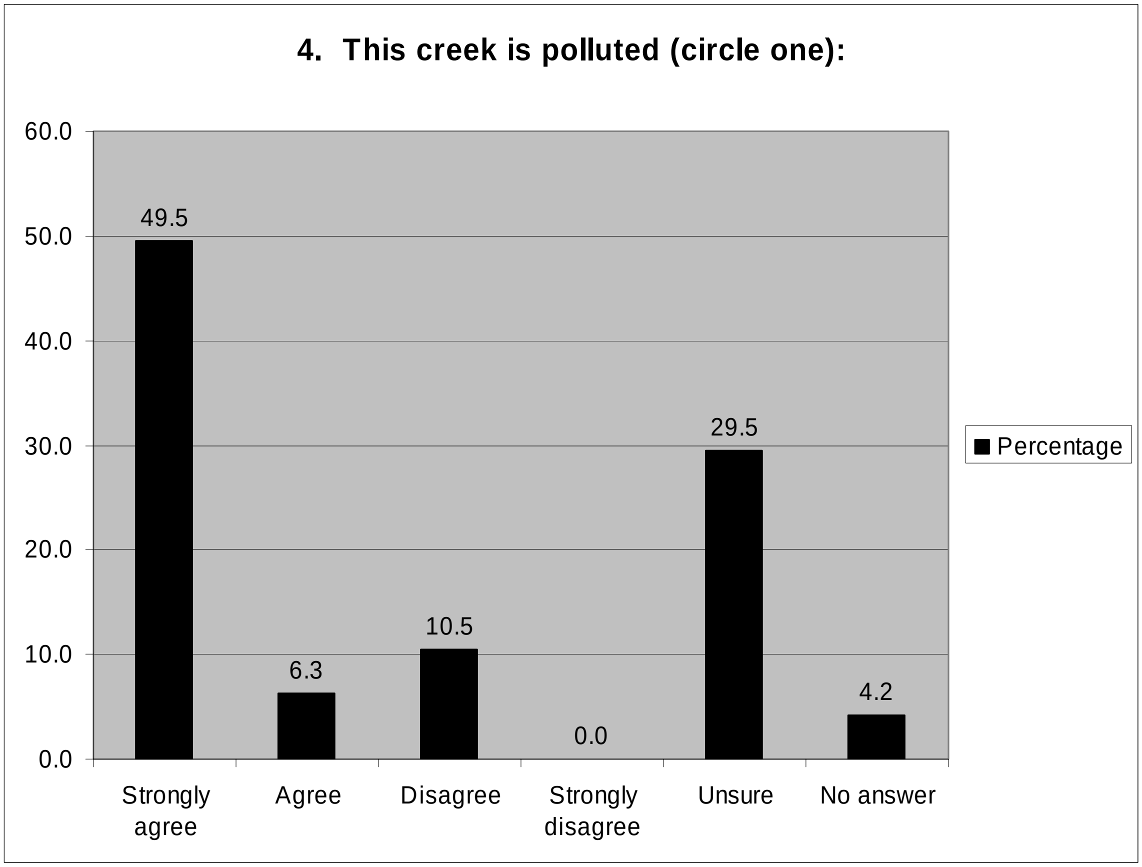
2. This creek is a valuable resource to Madison County: strongly agree, agree, disagree, strongly agree, unsure



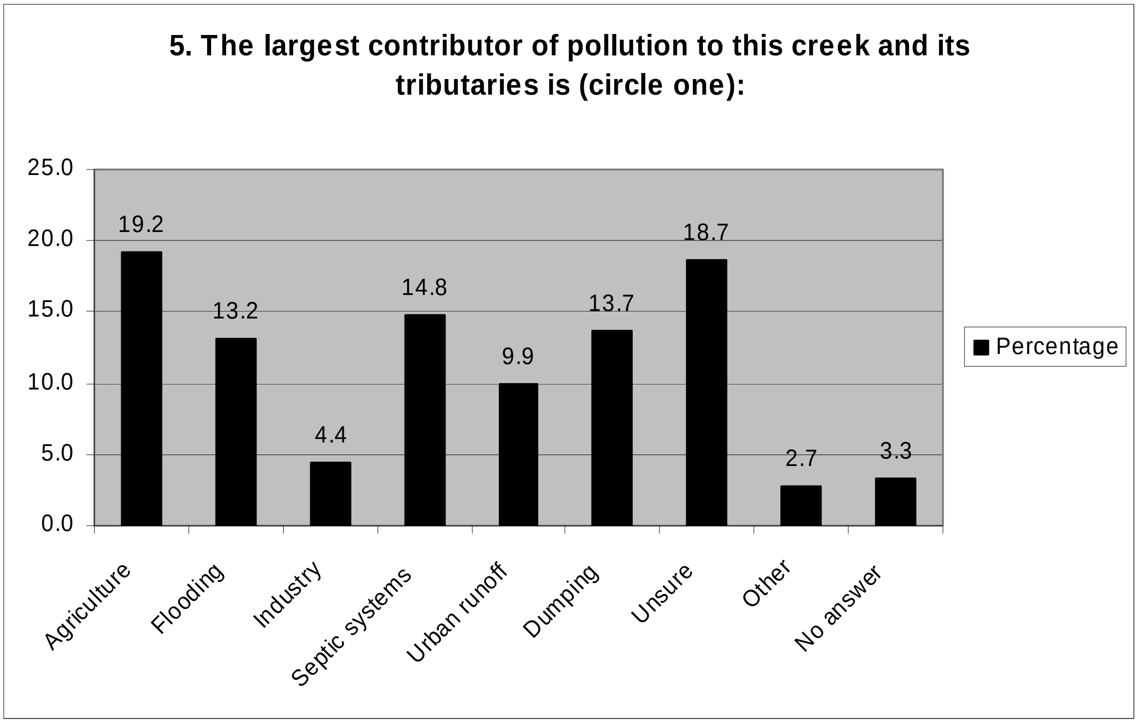
3. I use this creek and its tributaries for: fishing, swimming, watering livestock, drainage, don't use, other:



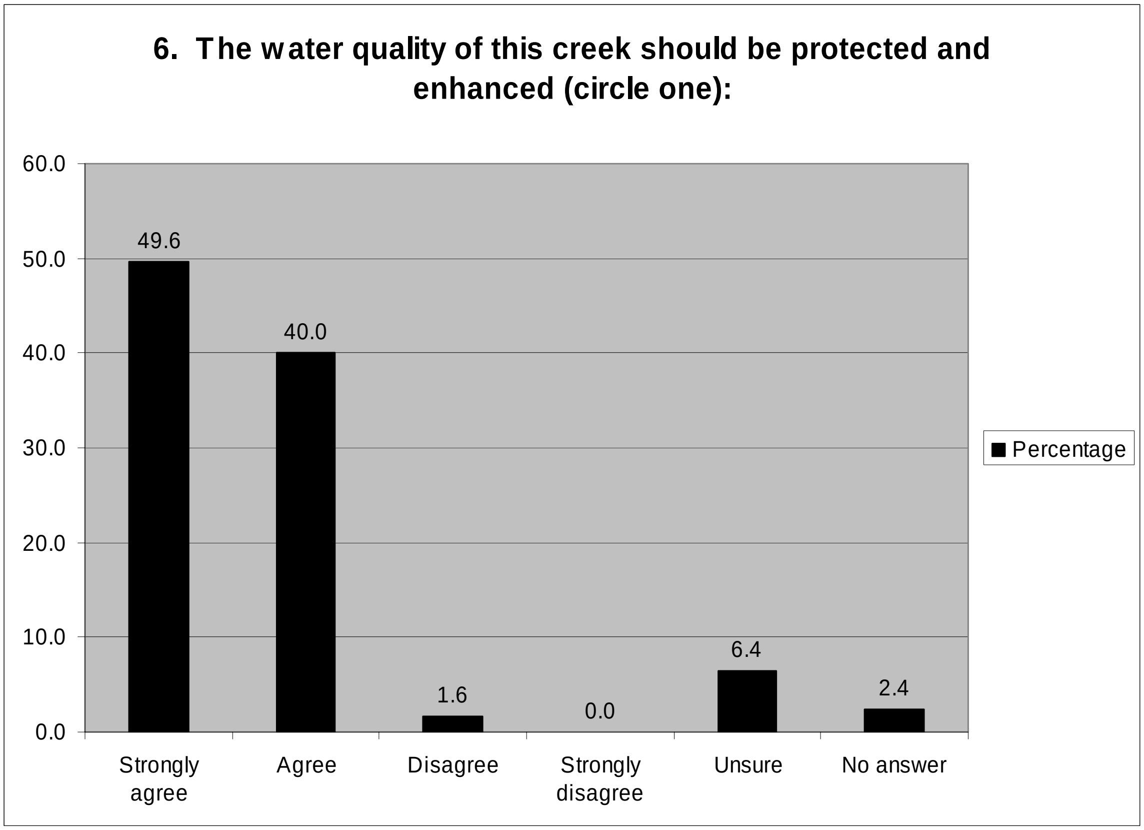
4. This creek is polluted: strongly agree, agree, disagree, strongly disagree, unsure



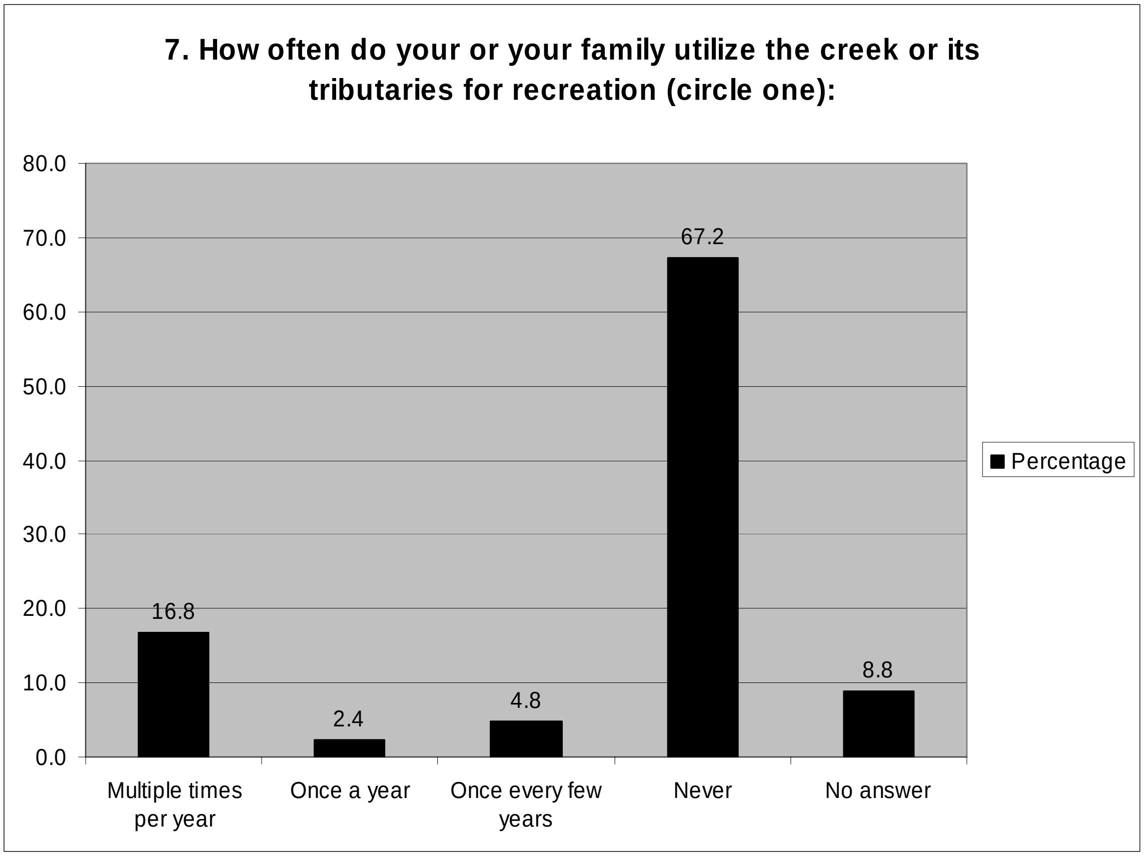
5. The largest contributor of pollution to this creek and its tributaries is: agriculture, flooding, industry, septic systems, urban runoff, dumping, unsure, other:



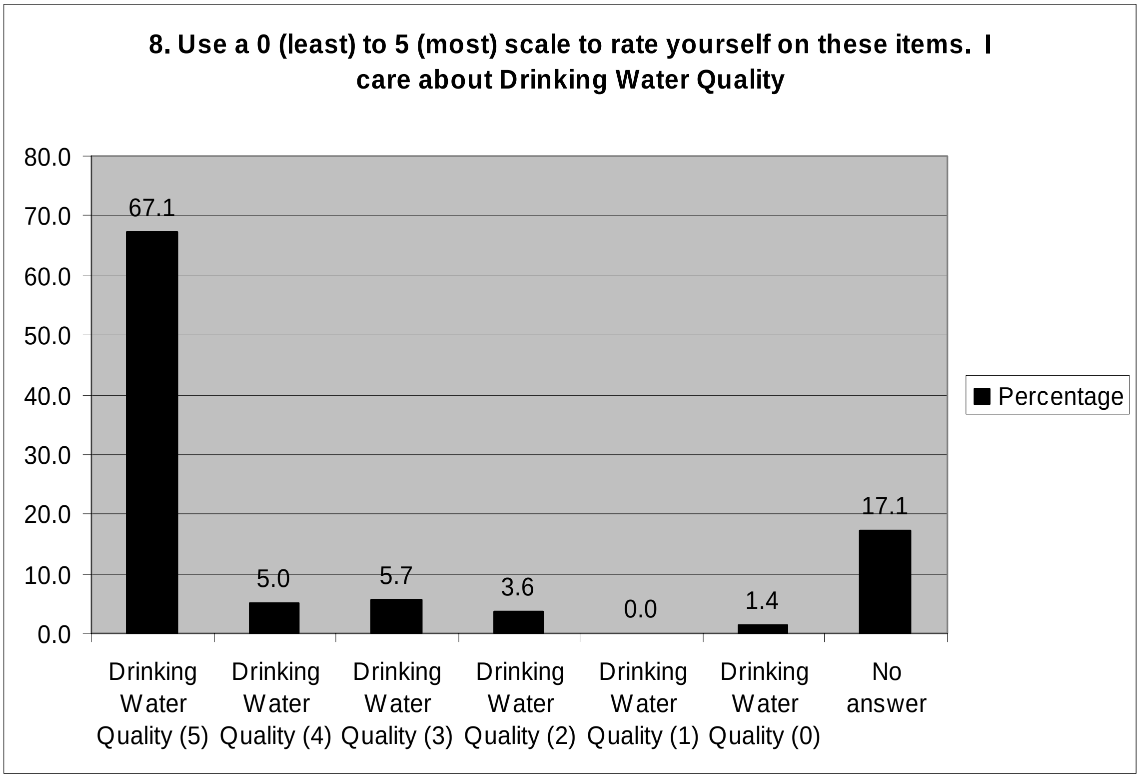
6. The water quality of this creek should be protected and enhanced: strongly agree, agree, disagree, strongly disagree, unsure

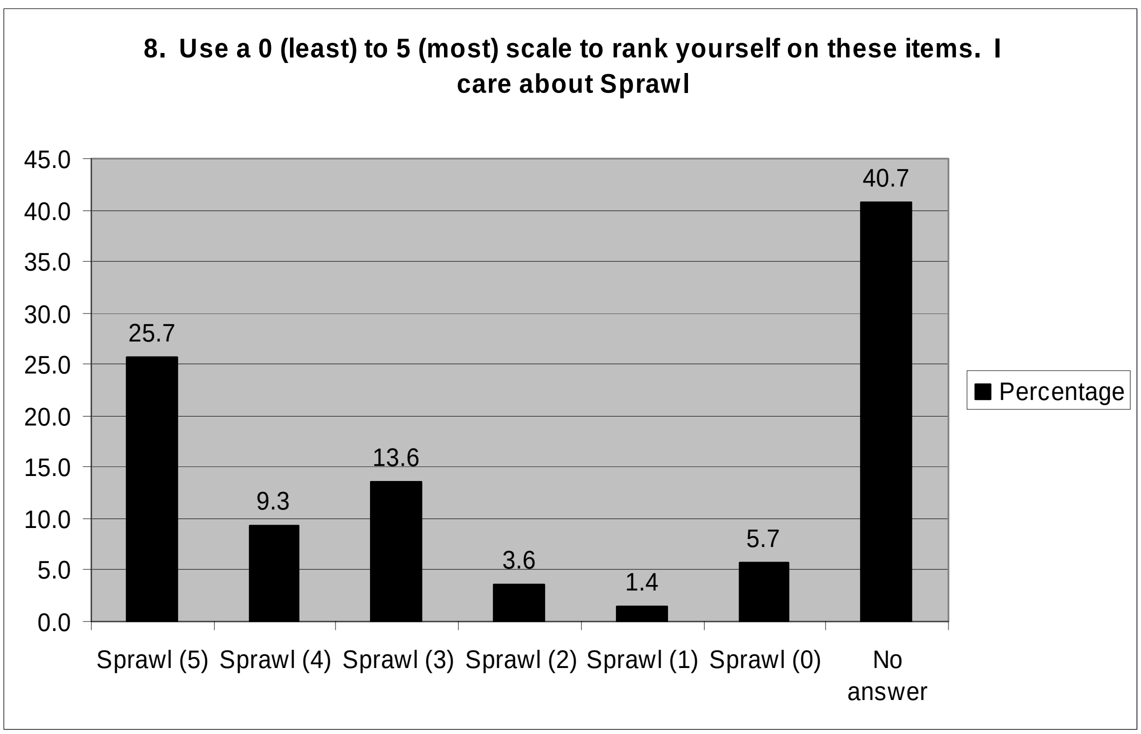


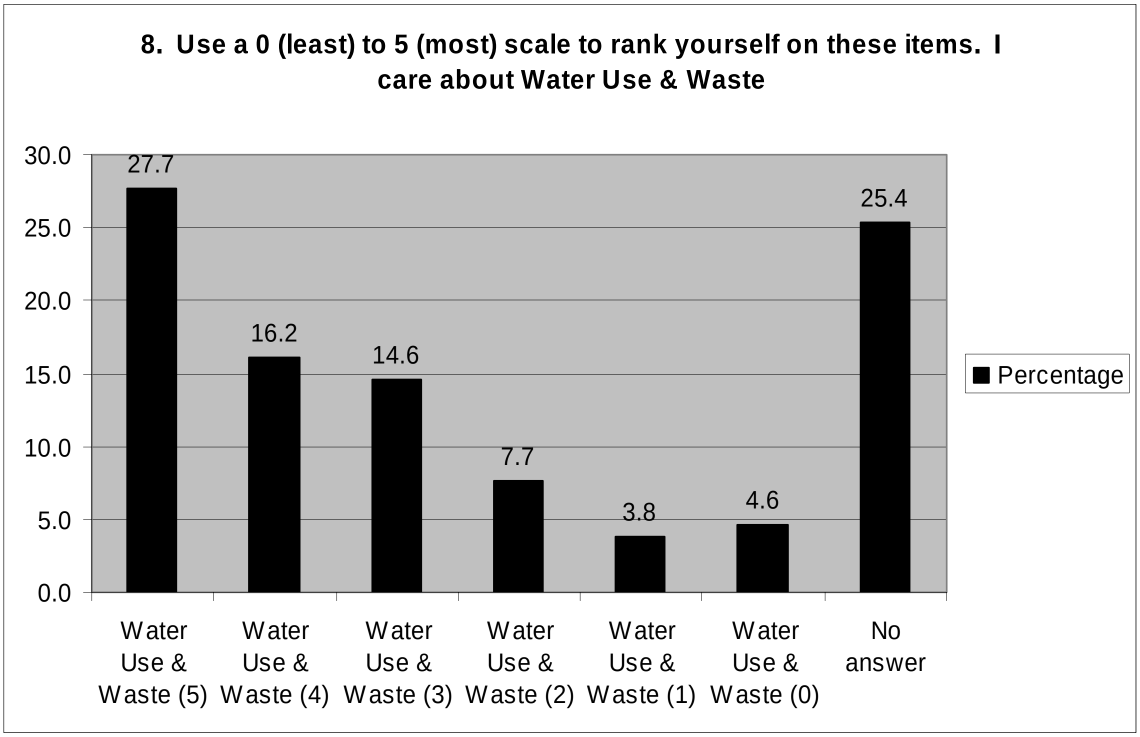
7. How often do you or your family utilize the creek or its tributaries for recreation:

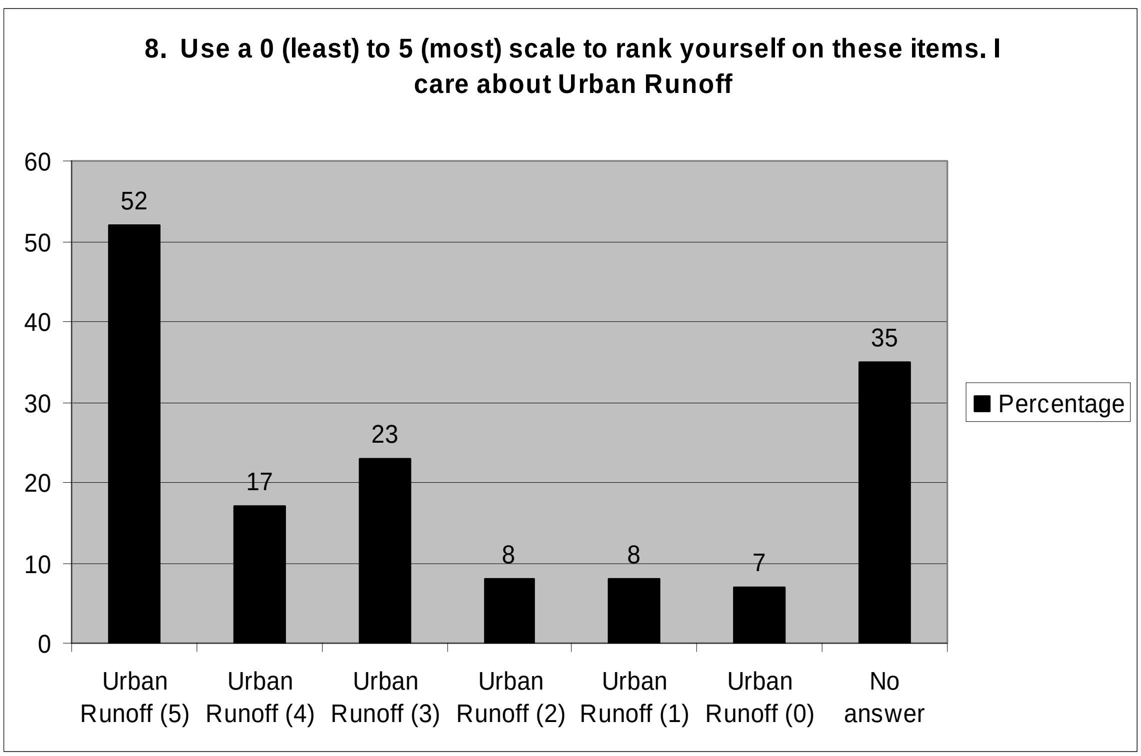


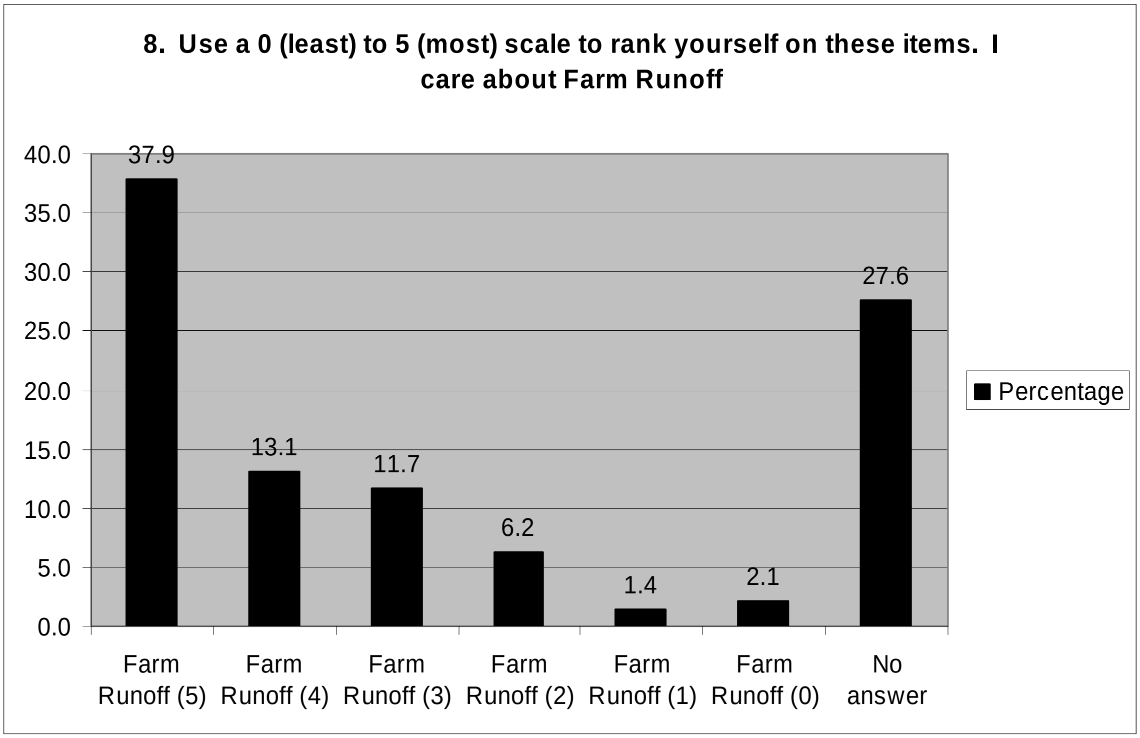
8. Use a 0 (least) to 5 (most) scale to rate yourself on these items. I care about Drinking Water Quality, Sprawl, Water Use & Waste, Urban Runoff, Farm Runoff, Waste Water Treatment, Wildlife Habitat, Drainage

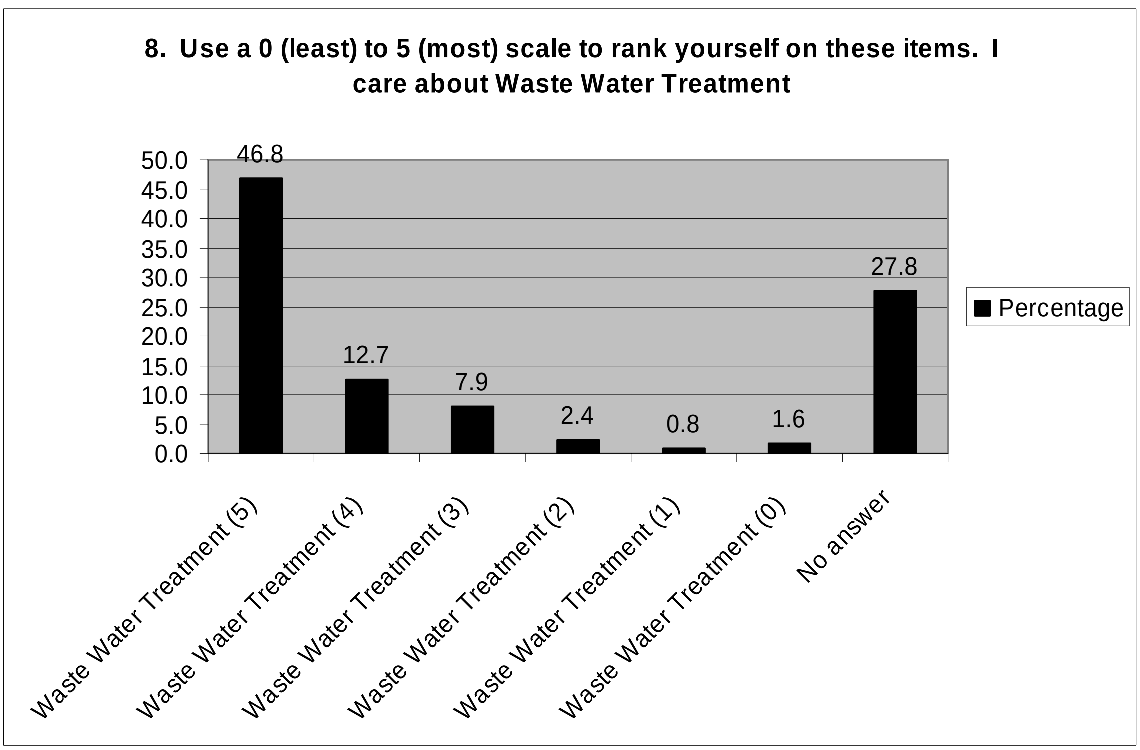

8. Use a 0 (least) to 5 (most) scale to rate yourself on these items. I care about Drinking Water Quality
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
67.1
5.0
5.7
3.6
0.0
1.4
17.1
Drinking Water Quality (5)
Drinking Water Quality (4)
Drinking Water Quality (3)
Drinking Water Quality (2)
Drinking Water Quality (1)
Drinking Water Quality (0)
No answer
Percentage

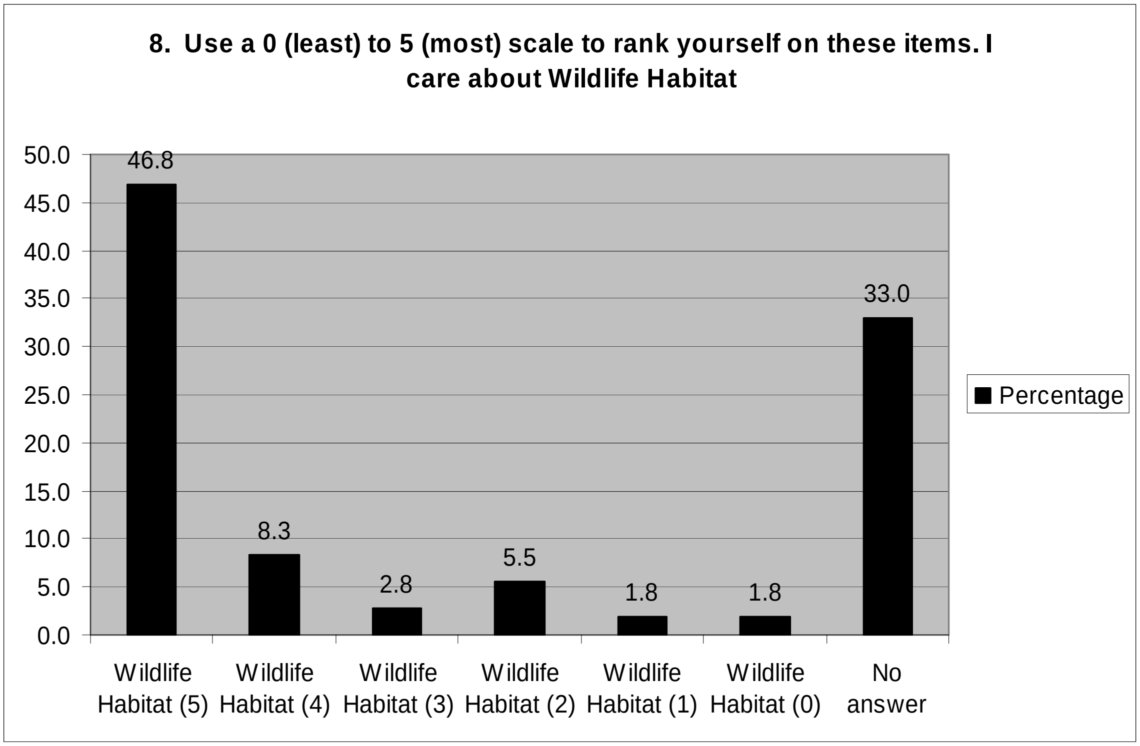

8. Use a 0 (least) to 5 (most) scale to rank yourself on these items. I care about Sprawl
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
25.7
9.3
13.6
3.6
1.4
5.7
40.7
Sprawl (5)
Sprawl (4)
Sprawl (3)
Sprawl (2)
Sprawl (1)
Sprawl (0)
No answer
Percentage

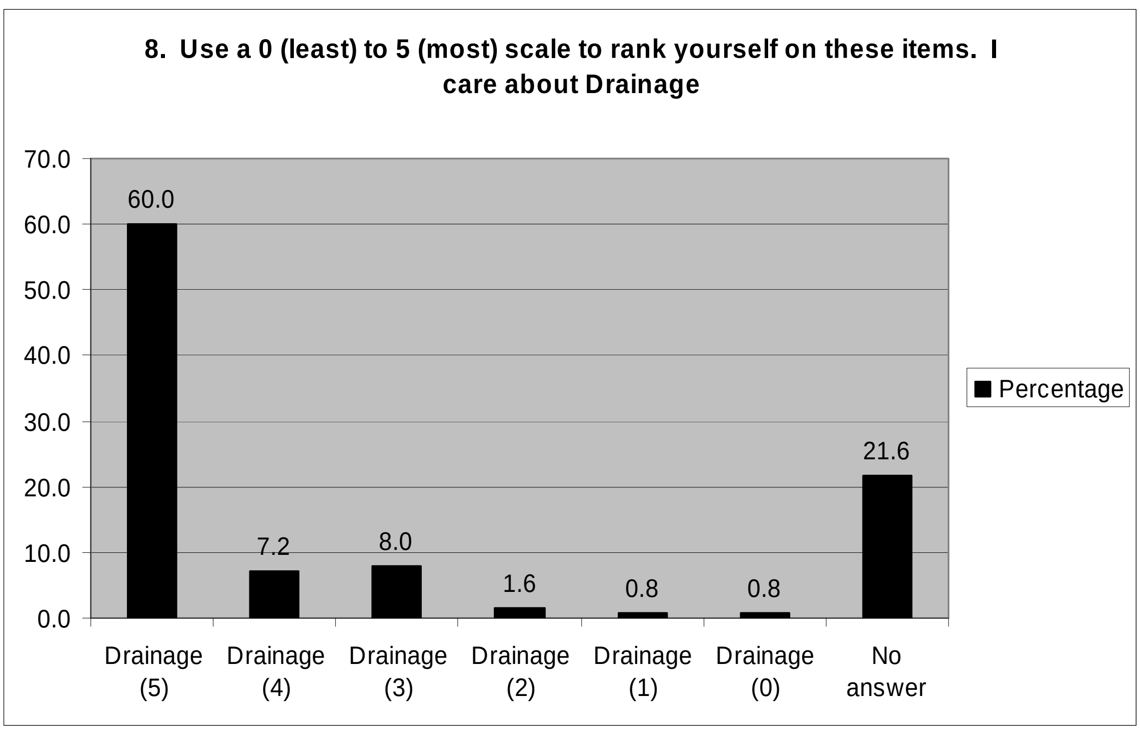

8. Use a 0 (least) to 5 (most) scale to rank yourself on these items. I care about Water Use & Waste
30.0
25.0
20.0
15.0
10.0
5.0
0.0
27.7
16.2
14.6
7.7
3.8
4.6
25.4
Water Use & Waste (5)
Water Use & Waste (4)
Water Use & Waste (3)
Water Use & Waste (2)
Water Use & Waste (1)
Water Use & Waste (0)
No answer
Percentage


8. Use a 0 (least) to 5 (most) scale to rank yourself on these items. I care about Urban Runoff
60
50
40
30
20
10
0
52
17
23
8
8
7
35
Urban Runoff (5)
Urban Runoff (4)
Urban Runoff (3)
Urban Runoff (2)
Urban Runoff (1)
Urban Runoff (0)
No answer
Percentage


8. Use a 0 (least) to 5 (most) scale to rank yourself on these items. I care about Farm Runoff
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
37.9
13.1
11.7
6.2
1.4
2.1
27.6
Farm Runoff (5)
Farm Runoff (4)
Farm Runoff (3)
Farm Runoff (2)
Farm Runoff (1)
Farm Runoff (0)
No answer
Percentage

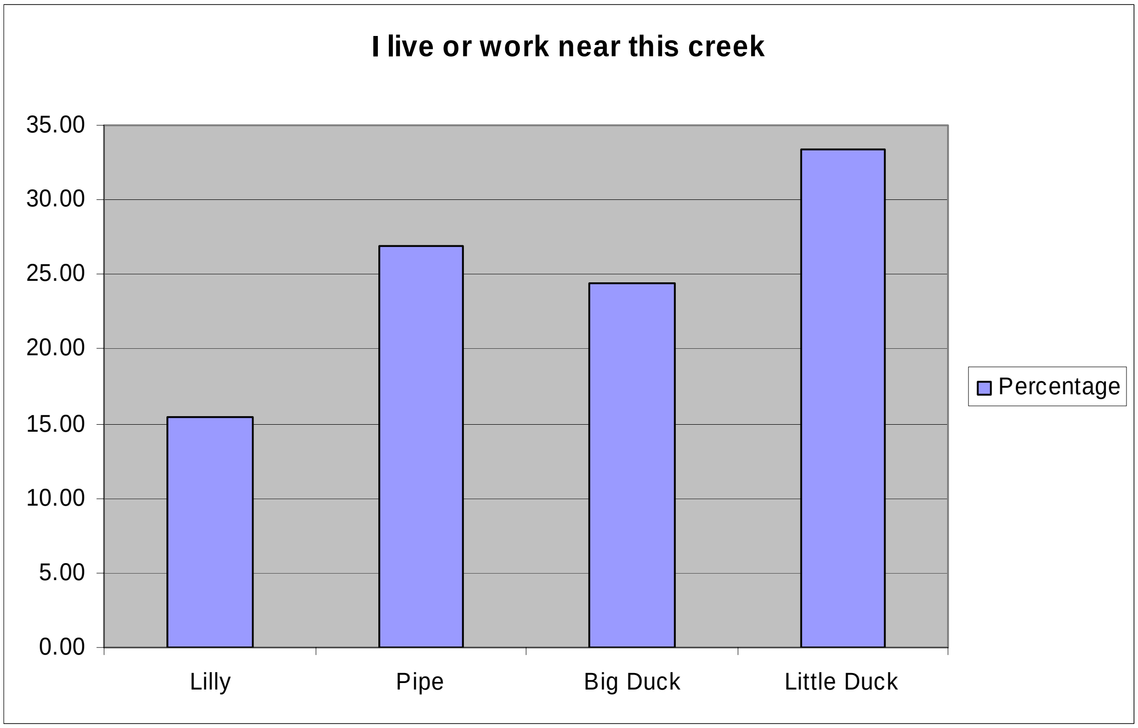

8. Use a 0 (least) to 5 (most) scale to rank yourself on these items. I care about Waste Water Treatment
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
46.8
12.7
7.9
2.4
0.8
1.6
27.8
Waste Water Treatment (5)
Waste Water Treatment (4)
Waste Water Treatment (3)
Waste Water Treatment (2)
Waste Water Treatment (1)
Waste Water Treatment (0)
No answer
Percentage


8. Use a 0 (least) to 5 (most) scale to rank yourself on these items. I care about Wildlife Habitat
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
46.8
8.3
2.8
5.5
1.8
1.8
33.0
Wildlife Habitat (5)
Wildlife Habitat (4)
Wildlife Habitat (3)
Wildlife Habitat (2)
Wildlife Habitat (1)
Wildlife Habitat (0)
No answer
Percentage

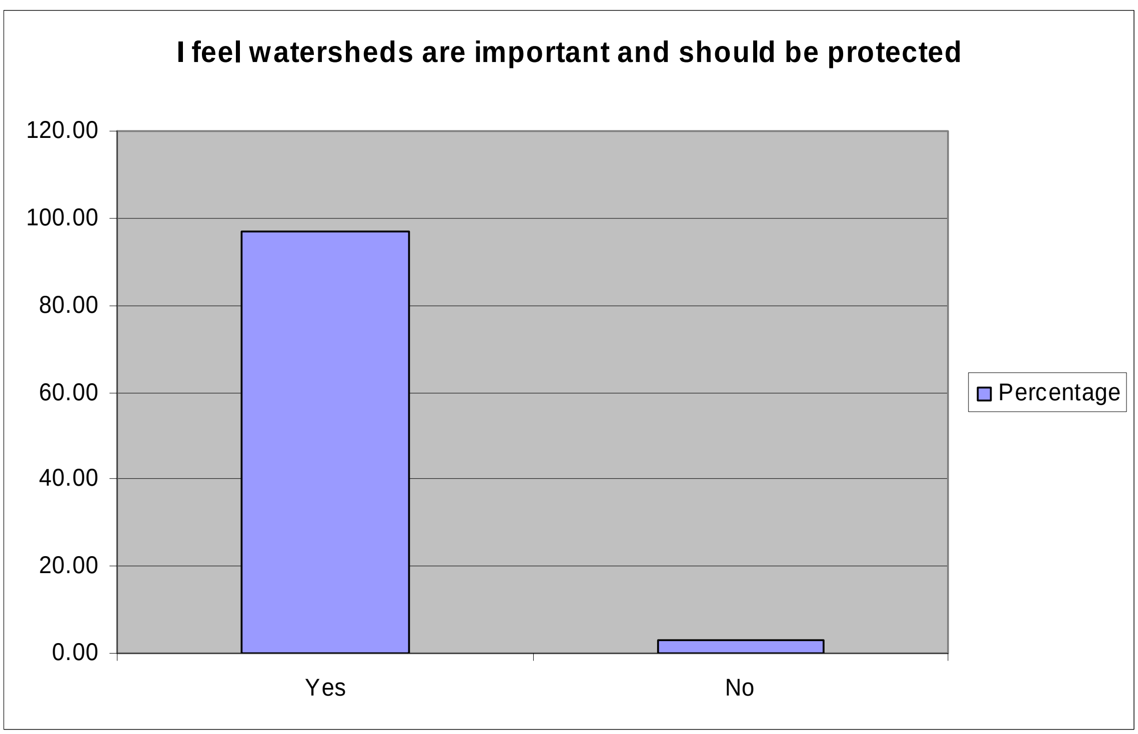

8. Use a 0 (least) to 5 (most) scale to rank yourself on these items. I care about Drainage
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
60.0
7.2
8.0
1.6
0.8
0.8
21.6
Drainage (5)
Drainage (4)
Drainage (3)
Drainage (2)
Drainage (1)
Drainage (0)
No answer
Percentage

Appendix H - SWCD Final Survey Results

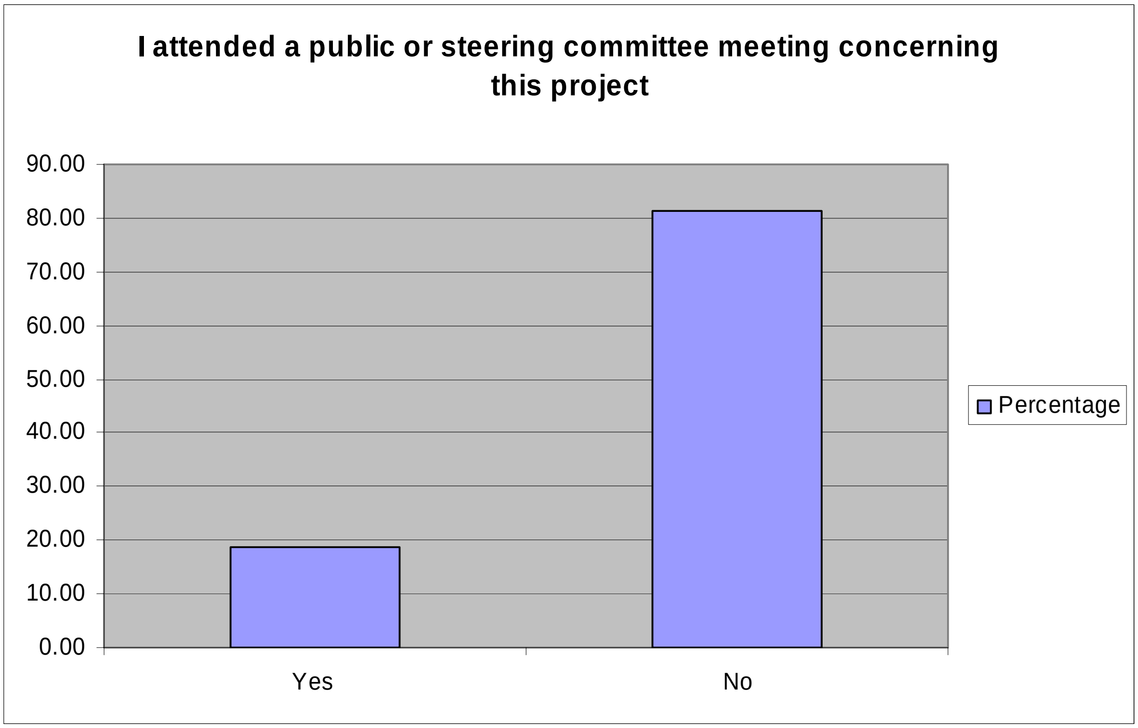
1. I live or work near this creek: Lilly Creek, Pipe Creek, Big Duck Creek, Little Duck Creek



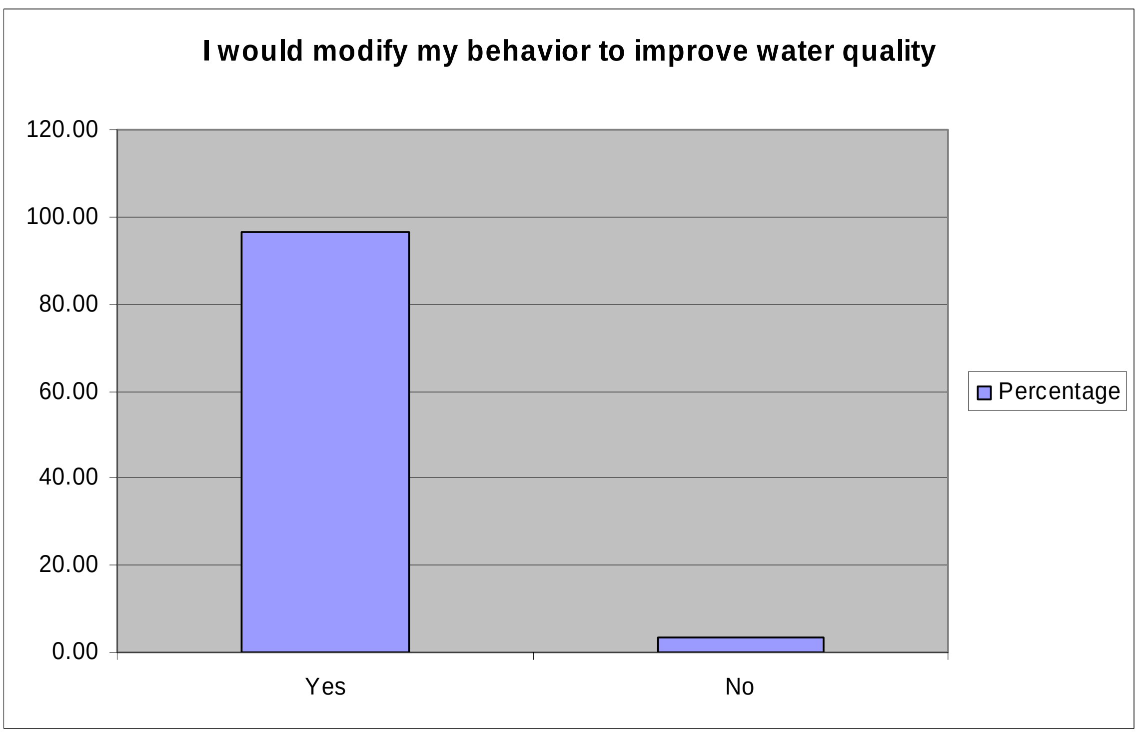
2. I feel watersheds are important and should be protected?



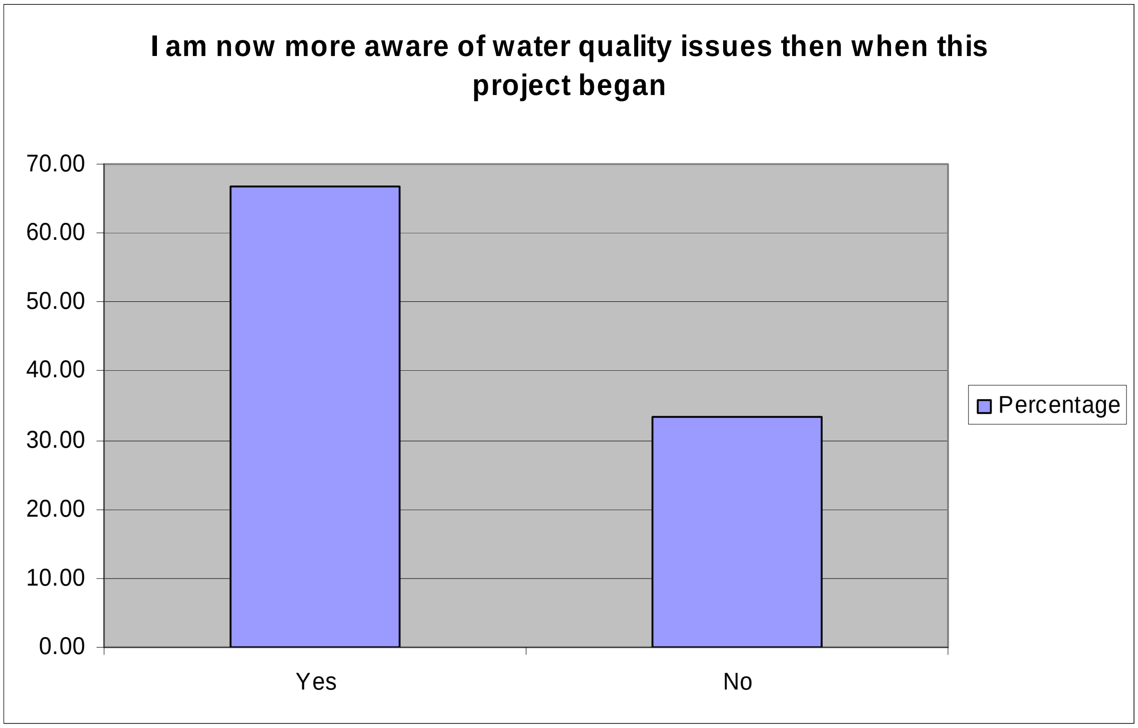
3. I attended a public or steering committee meeting concerning this project?



4. I would modify my behavior to improve water quality?



5. I am now more aware of water quality issues then when this project began?



6. Please list any water quality issues or concerns you have:

Responses

Tires, bottle in creek, fallen trees
Pipe Creek needs dredged and debris removed for better water flow and to prevent flooding
Runoff from Cattails Golf Course/additional sewage from new houses
sewage emptying into creeks; chemical spills
failing septics and contaminated field tiles
trash, tires, bottles, etc thrown into pipe creek; fallen trees blocking the flow; flooding
trees falling across creeks and blocking water flow.
chemical runoff, trash, animal carcasses
industrial, confined animal pollution
farm runoff; industrial uses
elwood conservation club flooding
too much lime; not good for drinking; damages indoor plumbing
nitrates and PCBs
CAFOs
non-existance of storm sewage
CAFOs
Elwoods CSOs
Why isn't there any fish in big duck creek?
dumping
pollution in water, flooding
overflow
to make sure we have quality water
Keep Up!
contamination of ground water by farm chemicals, industry, etc.
cancer rates and Madison county