Illinois
Environmental
Protection Agency

Bureau of Water
P.O. Box 19276
Springfield, IL 62794-9276

June 2008

IEPA/BOW/08-008

South Fork Saline - Lake Egypt Watershed TMDL Report

TMDL Development for the South Fork Saline River/Lake of Egypt Watershed, Illinois

This file contains the following documents:

1) U.S. EPA Approval letter for Stage Three TMDL Report

2) Stage One Report: Third Quarter Draft Report

3) Stage Two Report: Data Report

4) Stage Three Report: TMDL Development

5) Implementation Plan

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

JUL 18 2008

REPLY TO THE ATTENTION OF:

WW-16J

Marcia Willhite, Chief
Bureau of Water
Illinois Environmental Protection Agency
P.O. Box 19276
Springfield, Illinois 62794-9276

RECEIVED

JUL 24 2008

BUREAU OF WATER
BUREAU CHIEF'S OFF

Dear Ms. Willhite:

The U. S. Environmental Protection Agency has reviewed the final Total Maximum Daily Loads from the Illinois Environmental Protection Agency for the South Fork Saline River/Lake of Egypt Watershed in Illinois. The TMDLs are for several pollutants in several waterbodies in the watershed, as discussed in the enclosure, and addresses the recreational use and aquatic life impairments in these waterbodies.

Based on this review, EPA has determined that Illinois's TMDLs meet the requirements of Section 303(d) of the Clean Water Act and EPA's implementing regulations at 40 C.F.R. Part 130. Therefore, EPA hereby approves 32 TMDLs for 39 impairments in the South Fork Saline River/Lake of Egypt Watershed in Illinois. The statutory and regulatory requirements, and EPA's review of Illinois's compliance with each requirement, are described in the enclosed decision document.

We wish to acknowledge Illinois's effort in submitting this TMDL and look forward to future TMDL submissions by the State of Illinois. If you have any questions, please contact Kevin Pierard, Chief of the Watersheds and Wetlands Branch, at 312-886-4448.

Sincerely yours,

Tinka G. Hyde
Acting Director, Water Division

Enclosure

cc: Dean Studer, IEPA

CDM

Illinois Environmental
Protection Agency

South Fork Saline River/Lake of Egypt Watershed TMDL
Stage One
Third Quarter Draft Report

June 2006

Draft Report

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Acronyms

°F	degrees Fahrenheit
BMP	best management practice
cfu	colony forming units
CWA	Clean Water Act
DMR	Discharge Monitoring Reports
DO	dissolved oxygen
ft	Foot or feet
GIS	geographic information system
HUC	Hydrologic Unit Code
IDA	Illinois Department of Agriculture
IDNR	Illinois Department of Natural Resources
IL-GAP	Illinois Gap Analysis Project
ILLCP	Illinois Interagency Landscape Classification Project
Illinois EPA	Illinois Environmental Protection Agency
INHS	Illinois Natural History Survey
IPCB	Illinois Pollution Control Board
LA	load allocation
LC	loading capacity
lb/d	pounds per day
mgd	Million gallons per day
mg/L	milligrams per liter
MOS	margin of safety
MUID	Map Unit Identification
NA	Not applicable
NASS	National Agricultural Statistics Service
NCDC	National Climatic Data Center
NED	National Elevation Dataset
NPDES	National Pollution Discharge Elimination System
NRCS	National Resource Conservation Service
PCS	Permit Compliance System
SSURGO	Soil Survey Geographic Database
STATSGO	State Soil Geographic
STORET	Storage and Retrieval
STP	Sanitary Treatment Plant

TDS	Total dissolved solids
TMDL	total maximum daily load
TSS	Total suspended solids
ug/L	Micrograms per liter
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WLA	waste load allocation
WTP	Water Treatment Plant

Section 1
Goals and Objectives for South Fork Saline River/Lake of Egypt Watershed (0514020401)

1.1 Total Maximum Daily Load (TMDL) Overview

A Total Maximum Daily Load, or TMDL, is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs are a requirement of Section 303(d) of the Clean Water Act (CWA). To meet this requirement, the Illinois Environmental Protection Agency (Illinois EPA) must identify water bodies not meeting water quality standards and then establish TMDLs for restoration of water quality. Illinois EPA lists water bodies not meeting water quality standards every two years. This list is called the 303(d) list and water bodies on the list are then targeted for TMDL development.

In general, a TMDL is a quantitative assessment of water quality problems, contributing sources, and pollution reductions needed to attain water quality standards. The TMDL specifies the amount of pollution or other stressor that needs to be reduced to meet water quality standards, allocates pollution control or management responsibilities among sources in a watershed, and provides a scientific and policy basis for taking actions needed to restore a water body.

Water quality standards are laws or regulations that states authorize to enhance water quality and protect public health and welfare. Water quality standards provide the foundation for accomplishing two of the principal goals of the CWA. These goals are:

- Restore and maintain the chemical, physical, and biological integrity of the nation's waters
- Where attainable, to achieve water quality that promotes protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water

Water quality standards consist of three elements:

- The designated beneficial use or uses of a water body or segment of a water body
- The water quality criteria necessary to protect the use or uses of that particular water body
- An antidegradation policy

Examples of designated uses are recreation and protection of aquatic life. Water quality criteria describe the quality of water that will support a designated use. Water quality criteria can be expressed as numeric limits or as a narrative statement. Antidegradation policies are adopted so that water quality improvements are conserved, maintained, and protected.

1.2 TMDL Goals and Objectives for South Fork Saline River/Lake of Egypt Watershed

The Illinois EPA has a three-stage approach to TMDL development. The stages are:

- Stage 1 – Watershed Characterization, Data Analysis, Methodology Selection
- Stage 2 – Data Collection (optional)
- Stage 3 – Model Calibration, TMDL Scenarios, Implementation Plan

This report addresses Stage 1 TMDL development for the South Fork Saline River/ Lake of Egypt watershed. Stage 2 and 3 will be conducted upon completion of Stage 1. Stage 2 is optional as data collection may not be necessary if additional data are not required to establish the TMDL.

Following this process, the TMDL goals and objectives for the South Fork Saline River/Lake of Egypt watershed will include developing TMDLs for all impaired water bodies within the watershed, describing all of the necessary elements of the TMDL, developing an implementation plan for each TMDL, and gaining public acceptance of the process. Following are the impaired water body segments in the South Fork Saline River/Lake of Egypt watershed for which a TMDL will be developed:

- South Fork Saline River (ATH 02)
- South Fork Saline River (ATH 05)
- South Fork Saline River (ATH 14)
- Sugar Creek (ATHG01)
- Sugar Creek (ATHG05)
- Brier Creek (ATHS01)
- East Palzo Creek (ATHV01)
- Lake of Egypt (RAL)

These impaired water body segments are shown on Figure 1-1. There are eight impaired segments within the South Fork Saline River/Lake of Egypt watershed. Table 1-1 lists the water body segment, water body size, and potential causes of impairment for the water body.

Table 1-1 Impaired Water Bodies in South Fork Saline River/Lake of Egypt Watershed

Water Body Segment ID	Water Body Name	Size	Causes of Impairment with Numeric Water Quality Standards	Causes of Impairment with Assessment Guidelines
ATH 02	South Fork Saline River	7.98 miles	Manganese, pH, dissolved oxygen, total fecal coliform	Sedimentation/siltation, habitat alterations (streams), total suspended solids (TSS)
ATH 05	South Fork Saline River	7.95 miles	Cadmium, iron, manganese, sulfates, pH, dissolved oxygen, total dissolved solids (TDS)	Sedimentation/siltation, habitat alterations (streams), TSS
ATH 14	South Fork Saline River	4.04 miles	Dissolved oxygen	
ATHG01	Sugar Creek	4.19 miles	Cadmium, copper, zinc, iron, manganese, nickel, silver, sulfates, pH, dissolved oxygen, TDS	Sedimentation/siltation, TSS, total phosphorus
ATHG05	Sugar Creek	0.9 miles	Manganese, pH, dissolved oxygen, total fecal coliform	
ATHS01	Brier Creek	3.3 miles	Zinc, iron, manganese, silver, sulfates, pH, dissolved oxygen, TDS	
ATHV01	East Palzo Creek	3.16 miles	Copper, iron, manganese, pH, TDS	
RAL	Lake of Egypt	2,300 acres	Manganese	

Illinois EPA is currently only developing TMDLs for parameters that have numeric water quality standards, and therefore the remaining sections of this report will focus on the manganese, pH, dissolved oxygen, total fecal coliform, cadmium, iron, sulfates, TDS, copper, zinc, nickel, and silver impairments in the South Fork Saline River/Lake of Egypt watershed. For potential causes that do not have numeric water quality standards as noted in Table 1-1, TMDLs will not be developed at this time. However, in the implementation plans completed during Stage 3 of the TMDL, many of these potential causes may be addressed by implementation of controls for the pollutants with water quality standards.

The TMDL for the segments listed above will specify the following elements:

- Loading Capacity (LC) or the maximum amount of pollutant loading a water body can receive without violating water quality standards
- Waste Load Allocation (WLA) or the portion of the TMDL allocated to existing or future point sources
- Load Allocation (LA) or the portion of the TMDL allocated to existing or future nonpoint sources and natural background
- Margin of Safety (MOS) or an accounting of uncertainty about the relationship between pollutant loads and receiving water quality

These elements are combined into the following equation:

$$TMDL = LC = \Sigma WLA + \Sigma LA + MOS$$

The TMDL developed must also take into account the seasonal variability of pollutant loads so that water quality standards are met during all seasons of the year. Also, reasonable assurance that the TMDL will be achieved will be described in the implementation plan. The implementation plan for the South Fork Saline River/Lake of Egypt watershed will describe how water quality standards will be attained. This implementation plan will include recommendations for implementing best management practices (BMPs), cost estimates, institutional needs to implement BMPs and controls throughout the watershed, and timeframe for completion of implementation activities.

1.3 Report Overview

The remaining sections of this report contain:

- **Section 2 South Fork Saline River/Lake of Egypt Watershed Characteristics** provides a description of the watershed's location, topography, geology, land use, soils, population, and hydrology
- **Section 3 Public Participation and Involvement** discusses public participation activities that occurred throughout the TMDL development
- **Section 4 South Fork Saline River/Lake of Egypt Watershed Water Quality Standards** defines the water quality standards for the impaired water body
- **Section 5 South Fork Saline River/Lake of Egypt Watershed Characterization** presents the available water quality data needed to develop TMDLs, discusses the characteristics of the impaired reservoirs in the watershed, and also describes the point and non-point sources with potential to contribute to the watershed load.
- **Section 6 Approach to Developing TMDL and Identification of Data Needs** makes recommendations for the models and analysis that will be needed for TMDL development and also suggests segments for Stage 2 data collection.

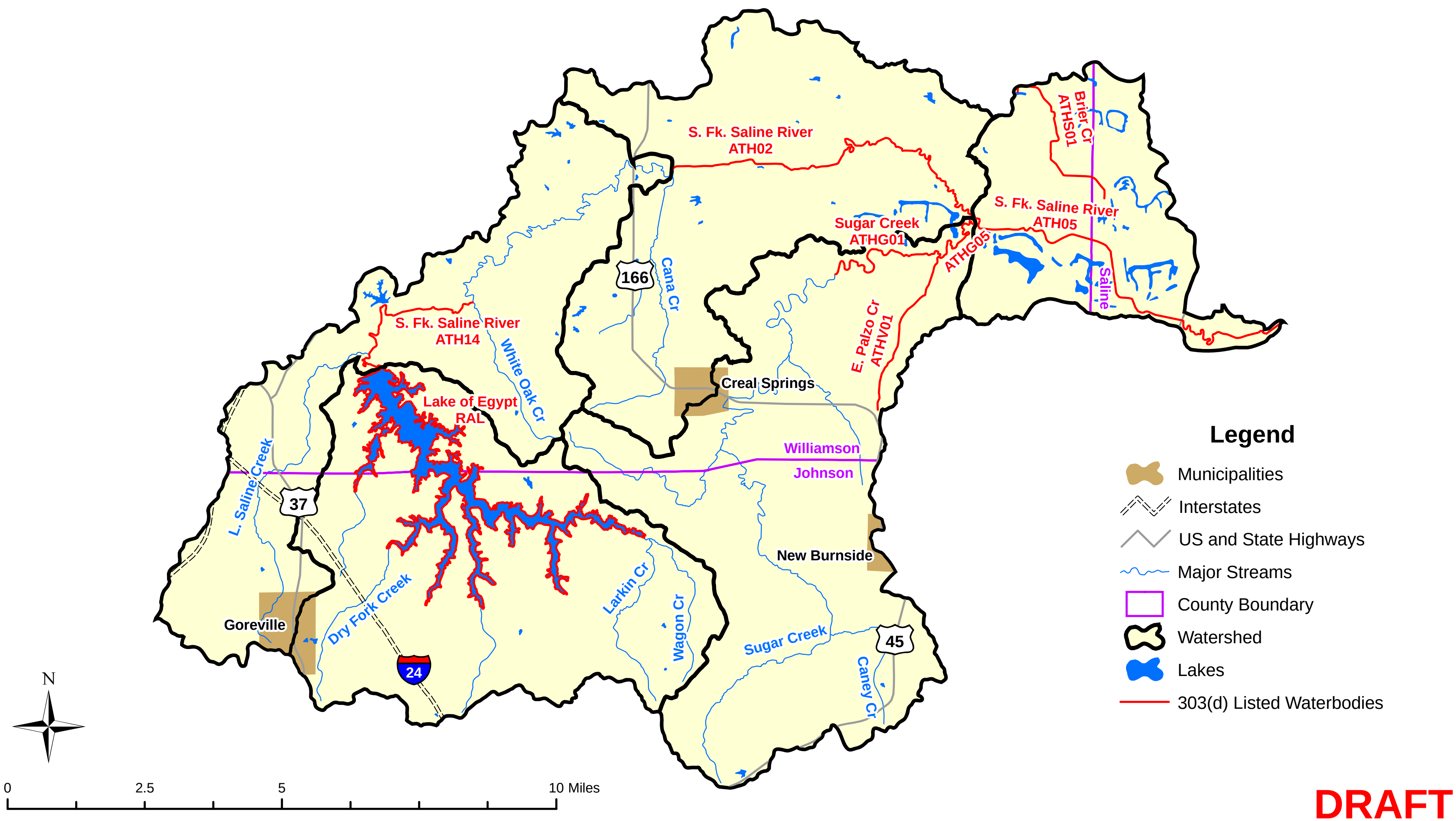

Figure 1-1
Saline Creek - Lake of Egypt Watershed

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Section 2
South Fork Saline River/Lake of Egypt Watershed Description

2.1 South Fork Saline River/Lake of Egypt Watershed Location

The South Fork Saline River/Lake of Egypt watershed (Figure 1-1) is located in southern Illinois, flows in an easterly direction, and drains approximately 94,000 acres within the state of Illinois. The watershed covers land within Williamson, Johnson, and Saline Counties.

2.2 Topography

Topography is an important factor in watershed management because stream types, precipitation, and soil types can vary dramatically by elevation. National Elevation Dataset (NED) coverages containing 30-meter grid resolution elevation data are available from the USGS for each 1:24,000-topographic quadrangle in the United States. Elevation data for the South Fork Saline River/Lake of Egypt watershed was obtained by overlaying the NED grid onto the GIS-delineated watershed. Figure 2-1 shows the elevations found within the watershed.

Elevation in the South Fork Saline River/Lake of Egypt watershed ranges from 830 feet above sea level in the headwaters to 367 feet at its most downstream point in the northeast corner of the watershed. The absolute elevation change is 115 feet over the approximately 27-mile stream length of South Fork Saline River within the watershed boundary, which yields a stream gradient of approximately 4.2 feet per mile.

2.3 Land Use

Land use data for the South Fork Saline River/Lake of Egypt watershed were extracted from the Illinois Gap Analysis Project (IL-GAP) Land Cover data layer. IL-GAP was started at the Illinois Natural History Survey (INHS) in 1996, and the land cover layer was the first component of the project. The IL-GAP Land Cover data layer is a product of the Illinois Interagency Landscape Classification Project (IILCP), an initiative to produce statewide land cover information on a recurring basis cooperatively managed by the United States Department of Agriculture National Agricultural Statistics Service (NASS), the Illinois Department of Agriculture (IDA), and the Illinois Department of Natural Resources (IDNR). The land cover data were generated using 30-meter grid resolution satellite imagery taken during 1999 and 2000. The IL-GAP Land Cover data layer contains 23 land cover categories, including detailed classification in the vegetated areas of Illinois. Appendix A contains a complete listing of land cover categories. (Source: IDNR, INHS, IDA, USDA NASS's 1:100,000 Scale Land Cover of Illinois 1999-2000, Raster Digital Data, Version 2.0, September 2003.)

The land use of the South Fork Saline River/Lake of Egypt watershed was determined by overlaying the IL-GAP Land Cover data layer onto the GIS-delineated watershed. Table 2-1 contains the land uses contributing to the South Fork Saline River/Lake of Egypt watershed, based on the IL-GAP land cover categories and also includes the area of each land cover category and percentage of the watershed area. Figure 2-2 illustrates the land uses of the watershed.

The land cover data reveal that approximately 49,279 acres, representing nearly 52 percent of the total watershed area, are devoted to agricultural activities. Corn and soybean farming account for nearly 6 percent and 7 percent of the watershed area, respectively and rural grassland accounts for 36 percent. Upland occupies approximately 25 percent of the total watershed area. Wetlands and surface water represent approximately 11 and 5 percent, respectively. Other land cover categories represent less that 5 percent of the watershed area.

Table 2-1 Land Use in South Fork Saline River/Lake of Egypt Watershed

Land Cover Category	Area (Acres)	Percentage
Corn	5,534	5.9%
Soybeans	6,361	6.7%
Winter Wheat	1,916	2.0%
Other Small Grains & Hay	830	0.9%
Winter Wheat/Soybeans	555	0.6%
Other Agriculture	106	0.1%
Rural Grassland	33,979	36.0%
Upland	23,528	24.9%
Forested Areas	3,209	3.4%
High Density	264	0.3%
Low/Medium Density	574	0.6%
Urban Open Space	1,620	1.7%
Wetlands	10,816	11.4%
Surface Water	4,919	5.2%
Barren & Exposed Land	261	0.3%
Total	**94,472**	**100%**

1. Forested areas include partial canopy/savannah upland and coniferous.
2. Wetlands include shallow marsh/wet meadow, deep marsh, floodplain forest, swamp, and shallow water.

2.4 Soils

Two types of soil data are available for use within the state of Illinois through the National Resource Conservation Service (NRCS). General soils data and map unit delineations for the entire state are provided as part of the State Soil Geographic (STATSGO) database. Soil maps for the database are produced by generalizing detailed soil survey data. The mapping scale for STATSGO is 1:250,000. More detailed soils data and spatial coverages are available through the Soil Survey Geographic (SSURGO) database for a limited number of counties. For SSURGO data, field mapping methods using national standards are used to construct the soil maps. Mapping scales generally range from 1:12,000 to 1:63,360 making SSURGO the most detailed level of NRCS soil mapping.

The South Fork Saline River/Lake of Egypt watershed falls within Williamson, Johnson, and Saline Counties. At this time, only STATSGO data are available for these counties. Figure 2-3 displays the STATSGO soil map units in the South Fork Saline River/Lake of Egypt watershed. Attributes of the spatial coverage can be linked to the STATSGO database, which provides information on various chemical and physical soil characteristics for each map unit. Of particular interest for TMDL development are the hydrologic soil group, the K-factor of the Universal Soil Loss Equation, and depth to the water table. The following sections describe and summarize the specified soil characteristics for the Saline River watershed.

2.4.1 South Fork Saline River/Lake of Egypt Watershed Soil Characteristics

Table 2-2 contains the STATSGO Map Unit IDs (MUIDs) for the South Fork Saline River/Lake of Egypt watershed along with area, dominant hydrologic soil group, and K-factor range. Each of these characteristics is described in more detail in the following paragraphs. The predominant soil type in the watershed are soils categorized as a fine-grained and made up of silts and clays with a liquid limit of less than 50 percent that tend toward a lean clay.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils are assigned to one of four groups. They are grouped according to their infiltration rates under saturated conditions during long duration storm events. Hydrologic soil groups B, C, and D are found within the South Fork Saline River/Lake of Egypt watershed with the majority of the watershed falling into category C. Category C soils are defined as "soils having a slow infiltration rate when thoroughly wet." C soils consist "chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture." These soils have a slow rate of water transmission (NRCS 2005).

A commonly used soil attribute is the K-factor. The K-factor:

> *Indicates the susceptibility of a soil to sheet and rill erosion by water.* (The K-factor) *is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion. Losses are expressed in tons per acre per year. These estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.02 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water (NRCS 2005).*

The distribution of K-factor values in the South Fork Saline River/Lake of Egypt watershed range from 0.17 to 0.43.

Table 2-2 South Fork Saline River/Lake of Egypt Watershed Soil Characteristics

STATSGO Map Unit ID	Acres	Percent of Watershed	Dominant Hydrologic Soil Group	K-factor Range
IL037	905	1%	C	0.28-0.43
IL038	16528	17%	C	0.24-0.43
IL063	12887	14%	B/C	0.17-0.43
IL064	42325	45%	C	0.17-0.43
IL069	19121	20%	C	0.2-0.43
IL070	2684	3%	B	0.24-0.43
TOTAL	**94450**	**100%**		

2.5 Population

Population data were retrieved from Census 2000 TIGER/Line Data from the U.S. Bureau of the Census. Geographic shape files of census blocks were downloaded for every county containing any portion of the watersheds. The block files were clipped to each watershed so that only block populations associated with the watershed would be counted. The census block demographic text file (PL94) containing population data were downloaded and linked to each watershed and summed. City populations were taken from the U.S. Bureau of the Census. For municipalities that are located across watershed borders, the population was estimated based on the percentage of area of municipality within the watershed boundary.

Approximately 15,500 people reside in the watershed. The municipalities in the South Fork Saline River/Lake of Egypt watershed are shown in Figure 1-1. The Goreville is the largest population center in the watershed and contributes an estimated 750 people to total watershed population.

2.6 Climate and Streamflow

2.6.1 Climate

Southern Illinois has a temperate climate with hot summers and cold, snowy winters. Monthly precipitation and temperature data from the Marion 4NNE station (station id. 5342) in Williamson county were extracted from the NCDC database for the years of 1948 through 1998. Marion, Illinois is just north of the basin and was chosen to be representative of meteorological conditions throughout the South Fork Saline River/Lake of Egypt watershed.

Table 2-3 contains the average monthly precipitation along with average high and low temperatures for the period of record. The average annual precipitation is approximately 45 inches.

Table 2-3 Average Monthly Climate Data in Marion, Illinois

Month	Total Precipitation (inches)	Maximum Temperature (degrees F)	Minimum Temperature (degrees F)
January	3.4	38	20
February	3.2	44	24
March	4.5	55	33
April	4.3	66	43
May	4.7	75	53
June	4.0	83	62
July	3.8	87	66
August	3.4	86	64
September	3.3	79	56
October	2.8	68	44
November	4.2	55	35
December	3.5	43	25
Total	**45.1**		

2.6.2 Streamflow

Analysis of the South Fork Saline River/Lake of Egypt watershed requires an understanding of flow throughout the drainage area. USGS gage 03382100 (South Fork Saline River near Carrier Mills, Illinois) was the only available data gage within the watershed with current data (Figure 2-4). The gage is located on the ATH05 segment of the South Fork Saline River where US 45 crosses the river.

Data were available for the gage from the USGS for the years 1965 through 2004.

The average monthly flows recorded at the gage range from 21 cubic feet per second (cfs) in September to 319 cfs in March with a mean annual monthly flow of 164 cfs (Figure 2-5).

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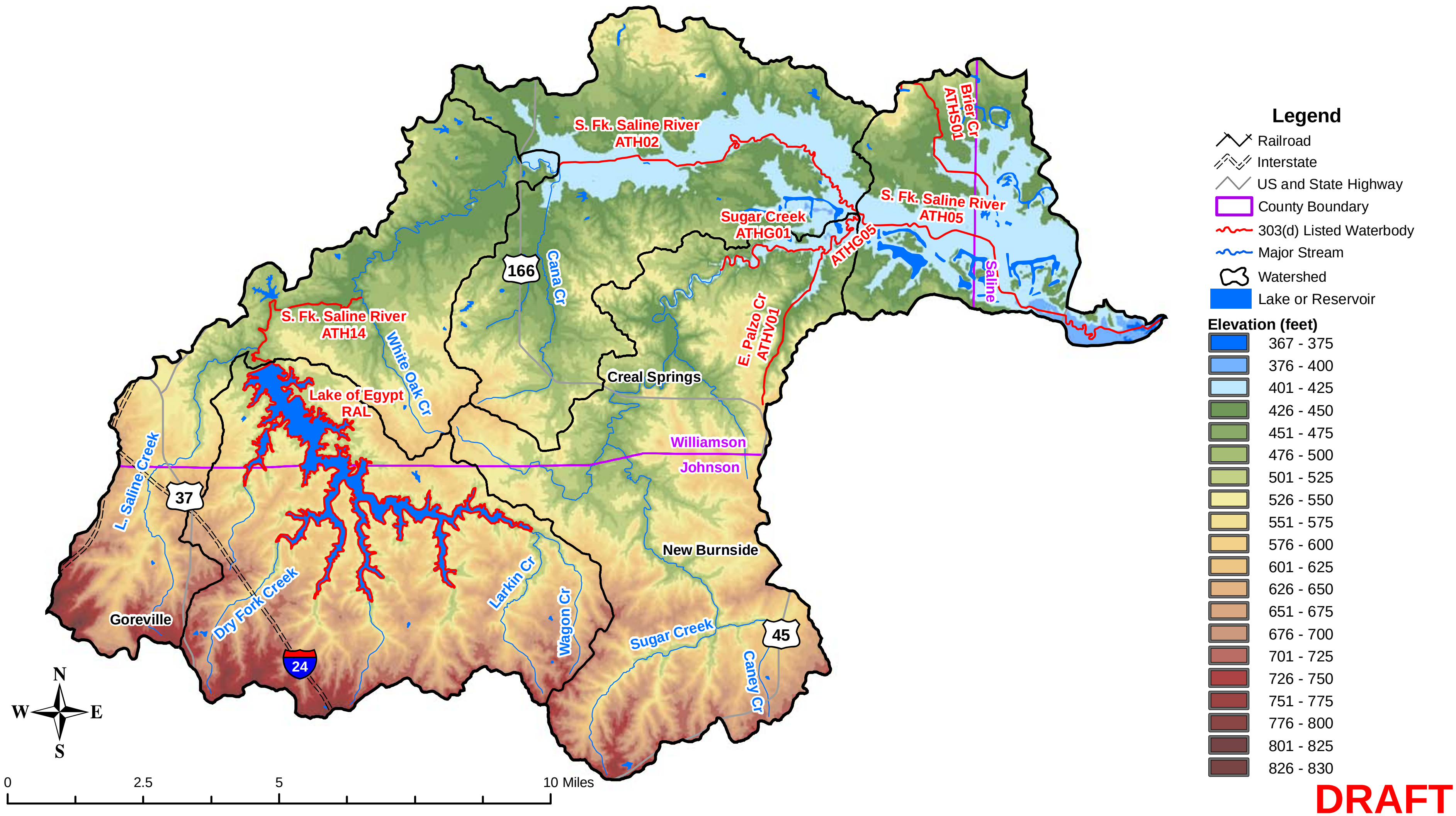

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Figure 2-1
Saline Creek - Lake of Egypt Watershed
Elevation

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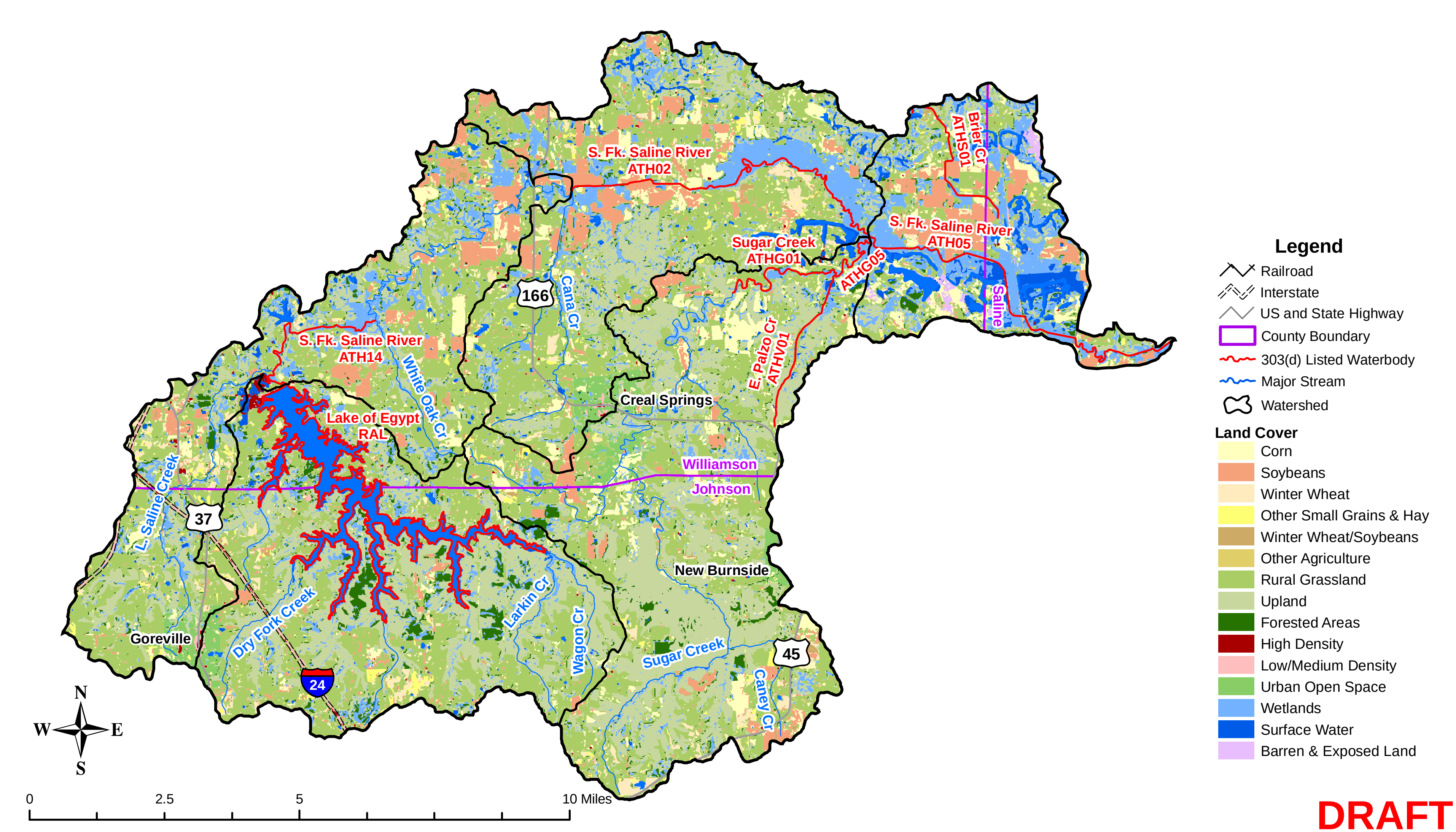

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Figure 2-2
Saline Creek - Lake of Egypt Watershed
Land Use

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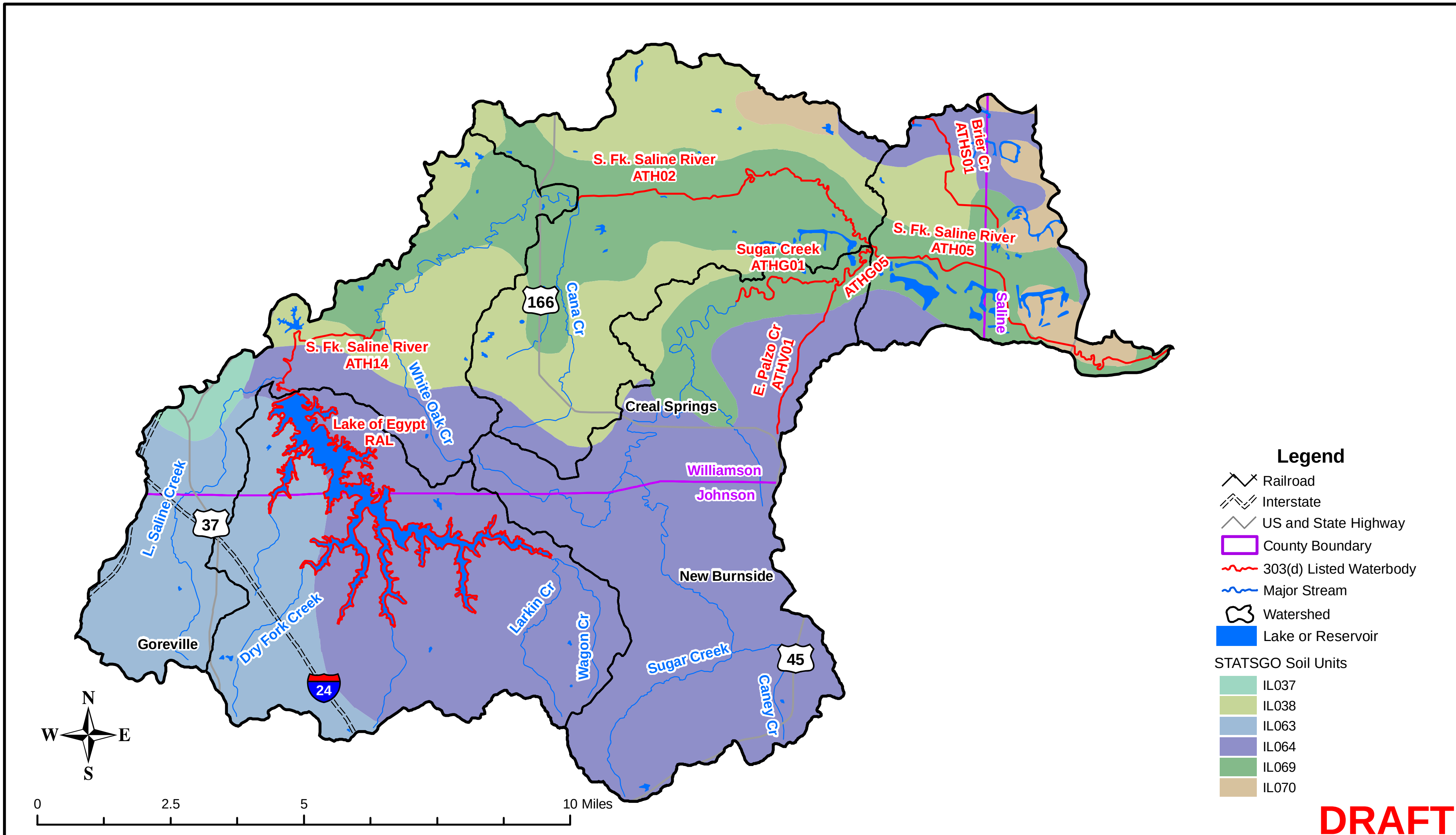

Figure 2-3
Saline Creek - Lake of Egypt Watershed
Soils

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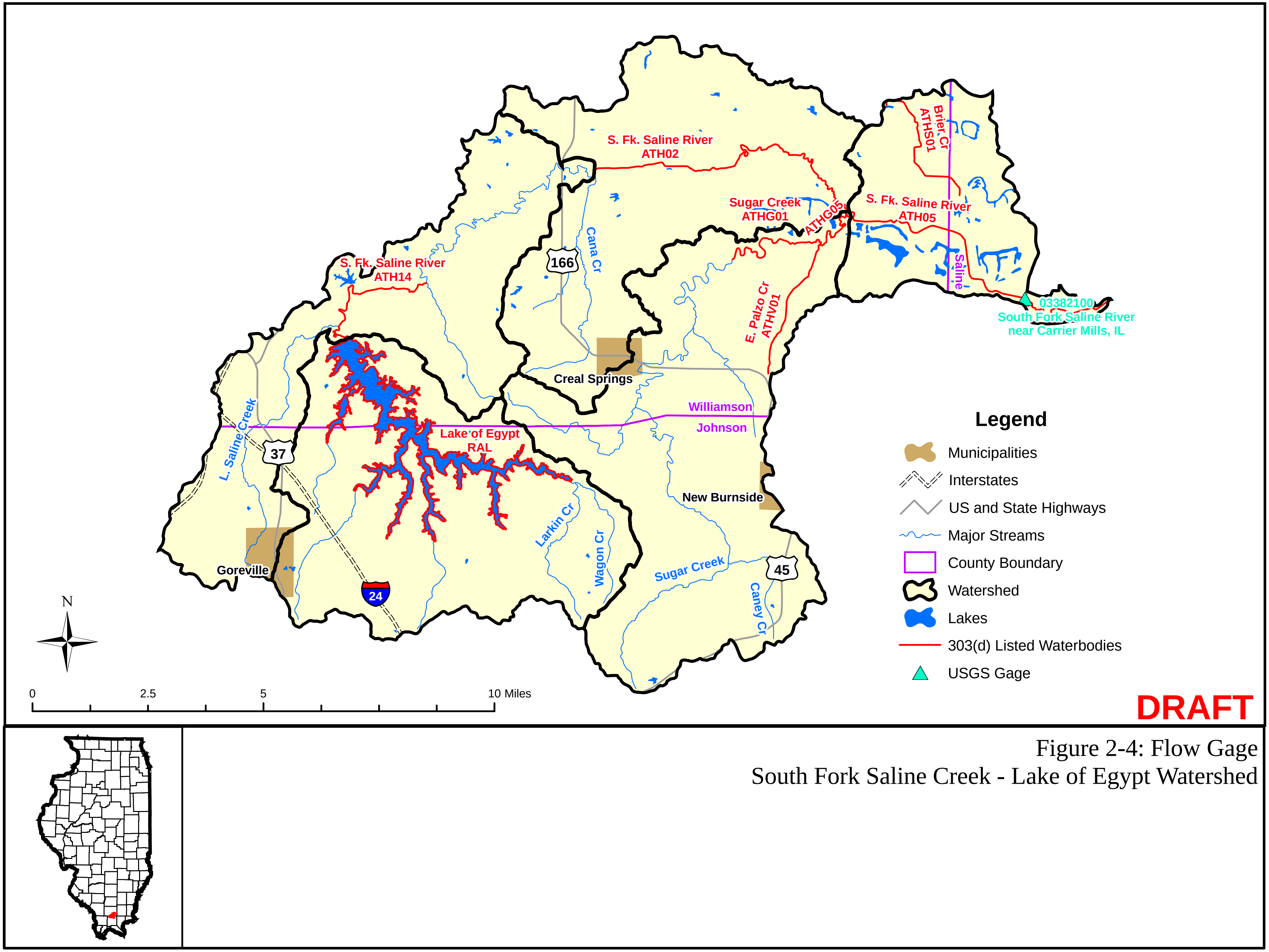

Figure 2-4: Flow Gage
South Fork Saline Creek - Lake of Egypt Watershed

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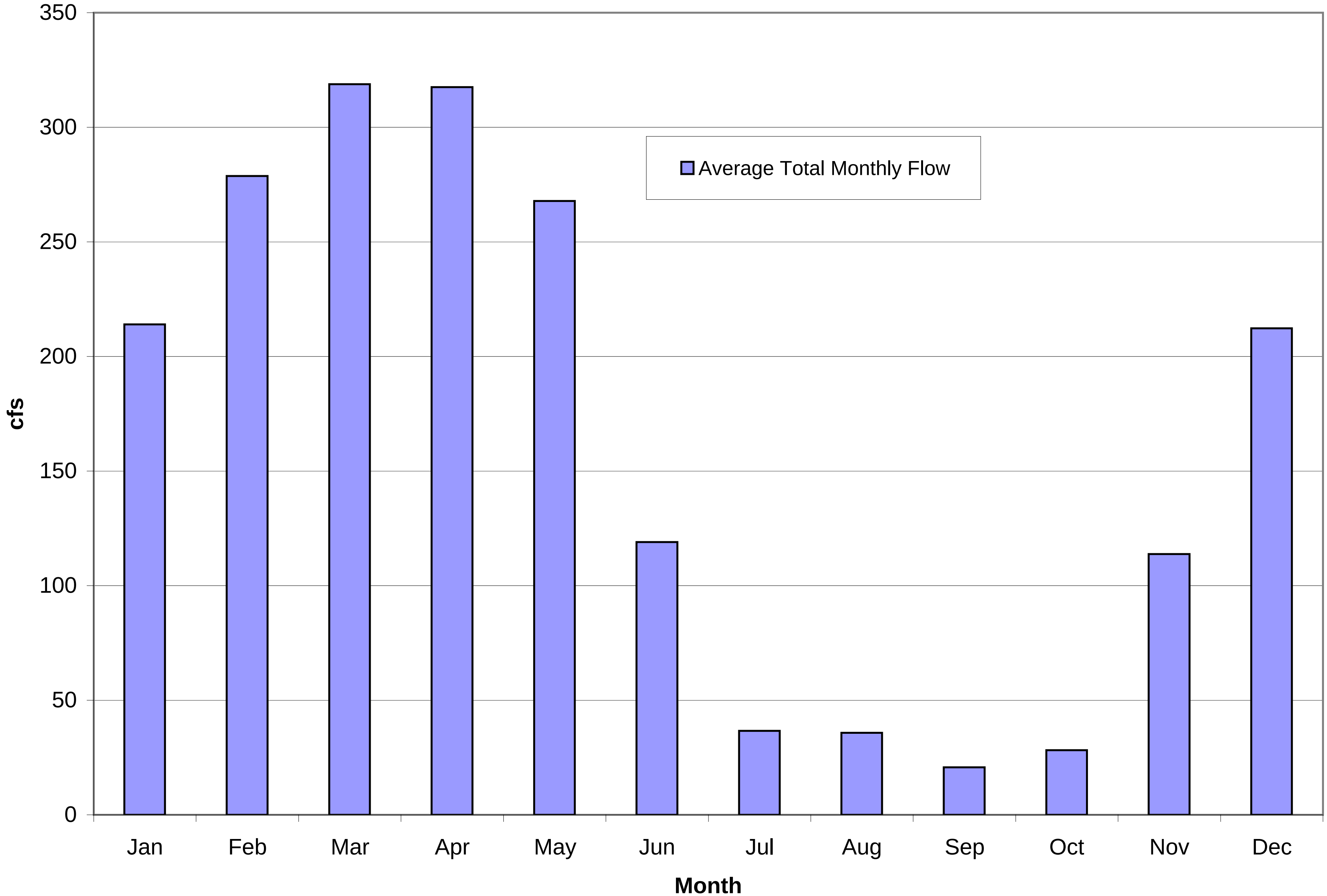

CDM

T:\GIS\WRITEUP\2 Saline River-S Fork_Lake Egypt\Data\Saline-precip-temp-flow.xlsSaline flow

Figure 2-5
Streamflow at USGS Gage 03382100
South Fork Saline River near Carrier Mills ,IL

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Section 3
Public Participation and Involvement

3.1 South Fork Saline River/Lake of Egypt Watershed Public Participation and Involvement

Public knowledge, acceptance, and follow through are necessary to implement a plan to meet recommended TMDLs. It is important to involve the public as early in the process as possible to achieve maximum cooperation and counter concerns as to the purpose of the process and the regulatory authority to implement any recommendations.

Illinois EPA, along with CDM, will hold up to four public meetings within the watershed throughout the course of the TMDL development. This section will be updated once public meetings have occurred.

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Section 4
South Fork Saline River/Lake of Egypt Watershed Water Quality Standards

4.1 Illinois Water Quality Standards

Water quality standards are developed and enforced by the state to protect the "designated uses" of the state's waterways. In the state of Illinois, setting the water quality standards is the responsibility of the Illinois Pollution Control Board (IPCB). Illinois is required to update water quality standards every three years in accordance with the CWA. The standards requiring modifications are identified and prioritized by Illinois EPA, in conjunction with USEPA. New standards are then developed or revised during the three-year period.

Illinois EPA is also responsible for developing scientifically based water quality criteria and proposing them to the IPCB for adoption into state rules and regulations. The Illinois water quality standards are established in the Illinois Administrative Rules Title 35, Environmental Protection; Subtitle C, Water Pollution; Chapter I, Pollution Control Board; Part 302, Water Quality Standards.

4.2 Designated Uses

The waters of Illinois are classified by designated uses, which include: General Use, Public and Food Processing Water Supplies, Lake Michigan, and Secondary Contact and Indigenous Aquatic Life Use (Illinois EPA 2005). The designated uses applicable to the South Fork Saline River/Lake of Egypt watershed are the General Use and Public and Food Processing Water Supplies Use.

4.2.1 General Use

The General Use classification is defined by IPCB as standards that "will protect the state's water for aquatic life, wildlife, agricultural use, secondary contact use and most industrial uses and ensure the aesthetic quality of the state's aquatic environment." Primary contact uses are protected for all General Use waters whose physical configuration permits such use.

4.2.2 Public and Food Processing Water Supplies

The Public and Food Processing Water Supplies Use is defined by IPCB as standards that "are cumulative with the general use standards of Subpart B and must be met in all waters designated in Part 303 at any point at which water is withdrawn for treatment and distribution as a potable supply or for food processing."

4.3 Illinois Water Quality Standards

To make 303(d) listing determinations for aquatic life uses, Illinois EPA first collects biological data and if this data suggests that an impairment to aquatic life exists, a comparison of available water quality data with water quality standards will then occur. For public and food processing water supply waters, Illinois EPA compares available data with water quality standards to make impairment determinations. Tables 4-1 and 4-2 present the water quality standards of the potential causes of impairment for both lakes and streams within the South Fork Saline River/Lake of Egypt watershed. Only constituents with numeric water quality standards will have TMDLs developed at this time.

Table 4-1 Summary of Water Quality Standards for Potential South Fork Saline River/Lake of Egypt Watershed Lake Impairments

Parameter	Units	General Use Water Quality Standard	Public and Food Processing Water Supplies
Manganese (total)	µg/L	1000	150

µg/L = micrograms per liter

Table 4-2 Summary of Water Quality Standards for Potential South Fork Saline River/Lake of Egypt Watershed Stream Impairments

Parameter	Units	General Use Water Quality Standard	Public and Food Processing Water Supplies
Cadmium(5)	µg/L	Acute standard for dissolved Cadmium(1) = (exp[-2.918 + 1.128 x ln(H)]) x {1.138672-(ln(H) x 0.041838)}* Chronic standard(2) for dissolved Cadmium= (exp[-3.490+0.7852 x ln(H)]) x {1.101672-(ln(H) x 0.041838)}*	10 (total Cadmium)
Copper (dissolved)	µg/L	Acute standard(1) = (exp[-1.464+0.9422 x ln(H)]) x 0.960* Chronic standard(2) = (exp[-1.465+0.8545 x ln(H)]) x 0.960*	No numeric standard
Habitat Alterations (Streams)	NA	No numeric standard	No numeric standard
Iron (dissolved)	µg/L	1000	300
Manganese (total)	µg/L	1000	150

Table 4-2 Summary of Water Quality Standards for Potential South Fork Saline River/Lake of Egypt Watershed Stream Impairments (Continued)

Nickel (dissolved)	µg/L	Acute standard[(1)] = (exp[0.5173+0.8460 x ln(H)]) x 0.998* Chronic standard[(2)] = (exp[-2.286+0.8460 x ln(H)]) x 0.997*	No numeric standard
Oxygen, Dissolved	mg/L	5.0 instantaneous minimum; 6.0 minimum during at least 16 hours of any 24 hour period	No numeric standard
pH		6.5 minimum 9.0 maximum	No numeric standard
Sedimentation/ Siltation	NA	No numeric standard	No numeric standard
Silver (total)	µg/L	5	No numeric standard
Sulfates	mg/L	500	250
Total Dissolved Solids	mg/L	1000	500
Total Fecal Coliform	Count/ 100 mL	May through Oct – 200[(3)], 400[(4)] Nov though Apr – no numeric standard	2000[(3)]
Total Phosphorus - Statistical Guideline	NA	No numeric standard	No numeric standard
Total Suspended Solids	NA	No numeric standard	No numeric standard
Zinc (dissolved)	µg/L	Acute standard[(1)] = (exp[0.9035+0.8473 x ln(H)]) x 0.978* Chronic standard[(2)] = (exp[-0.8165+0.8473 x ln(H)]) x 0.986*	No numeric standard

µg/L = micrograms per liter exp(x) = base natural logarithms raised to the x- power

mg/L = milligrams per liter ln(H) = natural logarithm of hardness of the receiving water in mg/L

NA = Not Applicable * = conversion factor for multiplier for dissolved metals

[(1)] Not to be exceeded except as provided in 35 Ill. Adm. Code 302.208(d).

[(2)] Not to be exceeded by the arithmetic average of at least four consecutive samples collected over any period of at least four days except as provided in 35 Ill. Adm. Code 302.208(d). The samples used to demonstrate attainment or lack of attainment with a chronic standard must be collected in a manner that assures an average representative of the sampling period. To calculate attainment status of chronic metals standards, the concentration of the metal in each sample is divided by the calculated water quality standard for the sample to determine a quotient. The water quality standard is attained if the mean of the sample quotients is less than or equal to one for the duration of the averaging period.

[(3)] Geometric mean based on a minimum of 5 samples taken over not more than a 30 day period.

[(4)] Standard shall not be exceeded by more than 10% of the samples collected during any 30 day period.

[(5)] General Use Standard is for dissolved cadmium while Public and Food Processing Water Supplies Standard is for total cadmium.

4.4 Potential Pollutant Sources

In order to properly address the conditions within the South Fork Saline River/Lake of Egypt watershed, potential pollution sources must be investigated for the pollutants where TMDLs will be developed. The following is a summary of the potential sources associated with the listed causes for the 303(d) listed segments in this watershed. They are summarized in Table 4-3.

Table 4-3 Summary of Potential Sources for South Fork Saline River/Lake of Egypt Watershed

Segment ID	Segment Name	Potential Causes	Potential Sources
ATH 02	South Fork Saline River	Manganese, pH, sedimentation/siltation, dissolved oxygen, habitat alterations (streams), total fecal coliform, total suspended solids	Industrial point sources, agriculture, crop-related sources, nonirrigated crop production, resource extraction, surface mining, acid mine drainage, hydromodification, channelization, source unknown
ATH 05	South Fork Saline River	Cadmium, iron, manganese, sulfates, pH, sedimentation/ siltation, dissolved oxygen, total dissolved solids, habitat alterations (streams), total suspended solids	Resource extraction, surface mining, acid mine drainage, hydromodification, channelization, source unknown
ATH 14	South Fork Saline River	Dissolved oxygen	Industrial point sources, municipal point sources
ATHG01	Sugar Creek	Cadmium, copper, zinc, iron, manganese, nickel, silver, sulfates, pH, sedimentation/siltation, dissolved oxygen, total dissolved solids, total suspended solids, total phosphorus	Resource extraction, surface mining, mine tailings, acid mine drainage, source unknown
ATHG05	Sugar Creek	Manganese, pH, dissolved oxygen, total fecal coliform	Resource extraction, surface mining, acid mine drainage, source unknown
ATHS01	Brier Creek	Zinc, iron, manganese, silver, sulfates, pH, dissolved oxygen, total dissolved solids	Resource extraction, surface mining, acid mine drainage
ATHV01	East Palzo Creek	Copper, iron, manganese, pH, total dissolved solids	Resource extraction, surface mining, acid mine drainage
RAL	Lake of Egypt	Manganese	Source unknown

Section 5
South Fork Saline River/Lake of Egypt Watershed Characterization

Data were collected and reviewed from many sources in order to further characterize the South Fork Saline River/Lake of Egypt watershed. Data have been collected in regards to water quality, reservoirs, and both point and nonpoint sources. This information is presented and discussed in further detail in the remainder of this section.

5.1 Water Quality Data

There are 13 historic water quality stations within the South Fork Saline River/Lake of Egypt watershed that were used for this report. Figure 5-1 shows the water quality data stations within the watershed that contain data relevant to the impaired segments.

The impaired water body segments in the South Fork Saline River/Lake of Egypt watershed were presented in Section 1. Refer to Table 1-1 for impairment information specific to each segment. The following sections address both stream and lake impairments. Data are summarized by impairment and discussed in relation to the relevant Illinois numeric water quality standard. Data analysis is focused on all available data collected since 1990. The information presented in this section is a combination of USEPA Storage and Retrieval (STORET) database and Illinois EPA database data. STORET data are available for stations sampled prior to January 1, 1999 while Illinois EPA data (electronic and hard copy) are available for stations sampled after that date. The following sections will first discuss South Fork Saline River/Lake of Egypt watershed stream data followed by Lake of Egypt reservoir data.

5.1.1 Stream Water Quality Data

The South Fork Saline River/Lake of Egypt watershed has four impaired streams within its drainage area that are addressed in this report. There are eight active water quality stations on impaired segments (see Figure 5-1). The data summarized in this section include water quality data for impaired constituents as well as parameters that could be useful in future modeling and analysis efforts. All historic data are available in Appendix B.

5.1.1.1 Dissolved Oxygen

The following stream segments within the South Fork Saline River/Lake of Egypt watershed are listed for impairments caused by DO: South Fork Saline River Segments ATH02, ATH05, and ATH14; Sugar Creek Segments ATHG01 and ATHG05; and Brier Creek Segment ATHS01. Table 5-1 summarizes the available historic DO data since 1990 for the impaired stream segments (raw data contained in Appendix B). The table also shows the number of violations for each segment. A sample was considered a violation if it was below 5.0 mg/L. The average DO concentration is not below the standard (5.0 mg/L instantaneous minimum) on any of the impaired segments. Minimum values for all segments are below the DO standard.

Figure 5-2 shows the instantaneous DO concentrations over time on South Fork Saline River segments ATH14, ATH02, and ATH05. Figure 5-3 shows the instantaneous DO concentrations over time on Sugar Creek segments ATHG01 and ATHG05.

Table 5-1 Existing Dissolved Oxygen Data for South Fork Saline River/Lake of Egypt Watershed Impaired Stream Segments

Sample Location and Parameter	Illinois WQ Standard (mg/L)	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Violations
South Fork Saline River Segment ATH14; Sample Locations ATH08, ATH-LE-C1, ATH-LE-C2, ATH14, and ATH-LE-C3						
DO	5.0[(1)]	1993-2000; 8	5.6	7.3	4.4	1
South Fork Saline River Segment ATH02; Sample Location ATH02						
DO	5.0[(1)]	1990-2003; 122	7.8	14.0	2.8	15
South Fork Saline River Segment ATH05; Sample Location ATH05						
DO	5.0[(1)]	1990-2003; 156	8.8	14.7	3.5	4
Sugar Creek Segment ATHG01; Sample Location ATHG01						
DO	5.0[(1)]	1990-2003; 121	6.6	14.0	0.1	41
Sugar Creek Segment ATHG05; Sample Location ATHG05						
DO	5.0[(1)]	1993-2003; 40	7.0	14.2	1.2	16
Brier Creek Segment ATHS01; Sample Location ATHS01						
DO	5.0[(1)]	1993; 2	5.8	9.2	2.4	1

(1) Instantaneous Minimum

Table 5-2 contains information on data availability for other parameters that may be useful in data needs analysis and future modeling efforts for DO. Where available, all nutrient, BOD, and total organic carbon data has been collected for possible future use.

Table 5-2 Data Availability for DO Data Needs Analysis and Future Modeling Efforts

Sample Location and Parameter	Available Period of Record Post 1990	Number of Samples
South Fork Saline River Segment ATH14; Sample Locations ATH08, ATH-LE-C1, ATH-LE-C2, ATH14, and ATH-LE-C3		
Ammonia, Unionized (Calc Fr Temp-pH-NH4) (mg/L)	1993	3
Ammonia, Unionized (mg/L as N)	1993	3
BOD	2000	5
BOD, Carbonaceous	2000	5
Carbon, Total Organic (mg/L as C)	1993-2000	7
COD, .025N K2CR2O7 (mg/L)	1993	2
COD, Bottom Deposits, Dry Weight (mg/kg)	1993	2
Nitrite plus Nitrate, Total 1 Det. (mg/L as N)	1993-2000	8
Nitrogen Kjeldahl Total Bottom Dep Dry Wt mg/kg	1993	2
Nitrogen, Ammonia, Total (mg/L as N)	1993-2000	8
Nitrogen, Kjeldahl, Total (mg/L as N)	1993	3
Phosphorus, Dissolved (mg/L as P)	1993	3
Phosphorus, Total (mg/L as P)	1993-2000	8
Phosphorus, Total, Bottom Deposit (mg/kg-P Dry Wgt)	1993	2
South Fork Saline River Segment ATH02; Sample Location ATH02		
Ammonia, Unionized (Calc Fr Temp-pH-NH4) (mg/L)	1990-1998	80
Ammonia, Unionized (mg/L as N)	1990-1998	80
Carbon, Total Organic (mg/L as C)	1993-2002	61
COD, .025N K2CR2O7 (mg/L)	1990-1993	32
Nitrite plus Nitrate, Total 1 Det. (mg/L as N)	1990-1998	80
Nitrogen, Ammonia, Total (mg/L as N)	1990-2002	113
Nitrogen, Kjeldahl, Total (mg/L as N)	1993-2000	8
Nitrogen, Nitrite (NO2) + Nitrate (NO3) (mg/L)	1999-2002	33

Table 5-2 Data Availability for DO Data Needs Analysis and Future Modeling Efforts continued		
South Fork Saline River Segment ATH02; Sample Location ATH02 continued		
Oxygen, Dissolved, Percent of Saturation (%)	1990-1998	78
Phosphorus, Dissolved (mg/L as P)	1990-2002	113
Phosphorus, Total (mg/L as P)	1990-2002	112
South Fork Saline River Segment ATH05; Sample Location ATH05		
Ammonia, Unionized (Calc Fr Temp-pH-NH4) (mg/L)	1990-1998	160
Ammonia, Unionized (mg/L as N)	1990-1998	160
Carbon, Total Organic (mg/L)	1990-2002	191
COD, .025N K2CR2O7 (mg/L)	1990-1993	68
Nitrite plus Nitrate, Total 1 Det. (mg/L as N)	1990-1998	160
Nitrogen, Ammonia (NH3), Total mg/L	1990-2002	193
Nitrogen, Kjeldahl, Total mg/L	1990-2002	186
Nitrogen, Nitrite (NO2) + Nitrate (NO3) (mg/L)	1999-2002	33
Oxygen, Dissolved, Percent of Saturation (%)	1990-1998	156
Phosphorus as P, Dissolved mg/L	1990-2002	191
Phosphorus as P, Total mg/L	1990-2002	191
COD, Bottom Deposits, Dry Weight (mg/kg)	1993	1
Nitrogen Kjeldahl Total Bottom Dep Dry Wt mg/kg	1993	1
Phosphorus, Total, Bottom Deposit (mg/kg-P Dry Wgt)	1993	1
Sugar Creek Segment ATHG01; Sample Location ATHG01		
Ammonia, Unionized (Calc Fr Temp-pH-NH4) (mg/L)	1990-1998	81
Ammonia, Unionized (mg/L as N)	1990-1998	81
Carbon, Total Organic (mg/L)	1993-2000	7
COD, .025N K2CR2O7 (mg/L)	1990-1993	34
COD, Bottom Deposits, Dry Weight (mg/kg)	1993	1
Nitrite plus Nitrate, Total 1 Det. (mg/L as N)	1990-1998	81
Nitrogen Kjeldahl Total Bottom Dep Dry Wt mg/kg	1993	1
Nitrogen, Ammonia (NH3), Total mg/L	1990-2003	113
Nitrogen, Kjeldahl, Total mg/L	1993-2000	10
Nitrogen, Nitrite (NO2) + Nitrate (NO3) (mg/L)	1999-2002	32
Oxygen, Dissolved, Percent of Saturation (%)	1990-1998	78
Phosphorus, Dissolved (mg/L as P)	1990-2003	111
Phosphorus, Total (mg/L as P)	1990-2003	113
Phosphorus, Total, Bottom Deposit (mg/kg-P Dry Wgt)	1993	1
Sugar Creek Segment ATHG05; Sample Location ATHG05		
Ammonia, Unionized (Calc Fr Temp-pH-NH4) (mg/L)	1993	3
Ammonia, Unionized (mg/L as N)	1993	3
Carbon, Total Organic (mg/L)	1993-2000	5
COD, .025N K2CR2O7 (mg/L)	1993	2
COD, Bottom Deposits, Dry Weight (mg/kg)	1993	1
Nitrite plus Nitrate, Total 1 Det. (mg/L as N)	1993	3
Nitrogen Kjeldahl Total Bottom Dep Dry Wt mg/kg	1993	1
Nitrogen, Ammonia (NH3), Total mg/L	1993-2002	28
Nitrogen, Kjeldahl, Total mg/L	1993-2000	8
Nitrogen, Nitrite (NO2) + Nitrate (NO3) (mg/L)	1999-2002	25
Oxygen, Dissolved, Percent of Saturation (%)	1993	3
Phosphorus as P, Dissolved mg/L	1993-2002	28
Phosphorus as P, Total mg/L	1993-2002	28
Phosphorus, Total, Bottom Deposit (mg/kg-P Dry Wgt)	1993	1
Brier Creek Segment ATHS01; Sample Location ATHS01		
Ammonia, Unionized (Calc Fr Temp-pH-NH4) (mg/L)	1993	3
Ammonia, Unionized (mg/L as N)	1993	3
Carbon, Total Organic (mg/L as C)	1993	3
COD, .025N K2CR2O7 (mg/L)	1993	2
Nitrogen, Ammonia, Total (mg/L as N)	1993	3
Nitrogen, Kjeldahl, Total (mg/L as N)	1993	2
Oxygen, Dissolved, Percent of Saturation (%)	1993	2
Phosphorus, Dissolved (mg/L as P)	1993	3
Phosphorus, Total (mg/L as P)	1993	3

5.1.1.2 pH

The following stream segments in the South Fork Saline River/Lake of Egypt watershed are listed for impairments caused by pH: South Fork Saline River Segments ATH02 and ATH05; Sugar Creek Segments ATHG01 and ATHG05; Brier Creek Segment ATHS01; and East Palzo Creek Segment ATHV01. Table 5-2 summarizes the available historic pH data since 1990 for the impaired stream segments (raw data contained in Appendix B). The table also shows the number of violations for each segment. A sample was considered a violation if the value was not within the 6.5-9.0 pH range. The average pH concentration was within the standard range only on segments ATH02 of South Fork Saline River and ATHG05 of Sugar Creek. Violations on all segments occurred when pH levels dropped below 6.5. Figures 5-4 and 5-5 show pH values recorded over time on the South Fork Saline River and Sugar Creek respectively.

Table 5-3 Existing pH Data for South Fork Saline River/Lake of Egypt Watershed Impaired Stream Segments

Sample Location and Parameter	Illinois WQ Standard (su)	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Violations
South Fork Saline River Segment ATH02; Sample Location ATH02						
pH	6.5-9.0	1990-2003; 123	7.1	8.5	6.0	12
South Fork Saline River Segment ATH05; Sample Location ATH05						
pH	6.5-9.0	1990-2003; 202	5.6	7.7	2.6	127
Sugar Creek Segment ATHG01; Sample Location ATHG01						
pH	6.5-9.0	1990-2003; 122	4.5	7.5	2.3	112
East Palzo Creek Segment ATHV01; Sample Location ATHV01						
pH	6.5-9.0	1993; 3	3.8	4.6	2.5	3
Sugar Creek Segment ATHG05; Sample Location ATHG05						
pH	6.5-9.0	1993-2003; 40	6.7	7.9	6.0	16
Brier Creek Segment ATHS01; Sample Location ATHS01						
pH	6.5-9.0	1993; 3	2.9	3.1	2.8	3

5.1.1.3 Total Fecal Coliform

Segments ATH02 of South Fork Saline River and ATHG05 of Sugar Creek are listed for impairment caused by total fecal coliform. The general use water quality standard for total fecal coliform is:

- 200 cfu/100 mL geometric mean based on a minimum of five samples taken over not more than a 30 day period during the months of May through October

- 400 cfu/100 mL which shall not be exceeded by more than 10 percent of the samples collected during any 30 day period during the months of May through October

There are no instances since 1990 where at least five samples have been collected during a 30 day period. The summary of data presented in Table 5-4 reflect single samples compared to the standards during the appropriate months. Figure 5-6 shows the total fecal coliform samples collected over time at ATH02 and ATHG05.

Table 5-4 Total Fecal Coliform Data for South Fork Saline River/Lake of Egypt Watershed Impaired Stream Segments

Sample Location and Parameter	Period of Record and Number of Data Points	Geometric mean of all samples	Maximum	Minimum	Number of samples > 200 (1)	Number of samples > 400 (1)
South Fork Saline River Segment ATH02; Sample Location ATH02						
Total Fecal Coliform (cfu/100 mL)	1990-2004; 117	214	20000	6	34	18
Sugar Creek Segment ATHG05; Sample Location ATHG05						
Total Fecal Coliform (cfu/100 mL)	2000-2004, 41	109	3200	2	4	3

(1) Samples collected during the months of May through October

5.1.1.4 Other Constituents

The following sections contain information on each segment's listed potential impairment causes with respect to TDS, sulfates, and metals.

5.1.1.4.1 Manganese

The general use water quality standard for manganese is a maximum total concentration of 1,000 µg/L. Table 5-5 summarizes the available historic manganese data since 1990 for the impaired stream segments. The table also shows the number of violations for each segment. Only segments ATH02 of South Fork Saline River and ATHG05 of Sugar Creek have average total manganese values below the general use standard. Figures 5-7 and 5-8 show the total manganese concentrations over time on South Fork Saline River and Sugar Creek respectively.

Table 5-5 Historic Manganese Data for South Fork Saline River/Lake of Egypt Watershed Impaired Stream Segments

Sample Location and Parameter	Illinois WQ Standard (µg/L)	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Violations
South Fork Saline River Segment ATH02; Sampling Location ATH02						
Total Manganese	1000	1990-2003; 124	433	1,500	110	6
South Fork Saline River Segment ATH05; Sampling Location ATH05						
Total Manganese	1000	1990-2003; 125	3,155	18,000	170	112
Sugar Creek Segment ATHG01; Sampling Location ATHG01						
Total Manganese	1000	1990-2003; 124	12,557	77,000	15	6
Sugar Creek Segment ATHG05; Sampling Location ATHG05						
Total Manganese	1000	1993-2003; 40	716	3,800	160	7
Brier Creek Segment ATHS01; Sampling Location ATHS01						
Total Manganese	500	1993; 3	18,000	21,000	13,000	3
East Palzo Creek Segment ATHV01; Sampling Location ATHV01						
Total Manganese	1000	1993; 3	5,700	9,000	2,800	3

5.1.1.4.2 TDS and Sulfates

The general use water quality standard for TDS is 1,000 mg/L. Conductivity is directly proportional to the TDS concentration. Although there is no standard for conductivity, a conductivity value of 1,667 µS/cm corresponds to 1,000 mg/L of TDS (305(b) guideline). An exceedance of 1,667 µS/cm of conductivity is indicative of an exceedance of the TDS standard. Only conductivity data were analyzed to investigate TDS impairments because substantially more data were available for conductivity than for TDS. The general use water quality standard for sulfate is 250 mg/L. Table 5-6 contains a summary of both sulfate and conductivity data for each impaired segment. Figures 5-9 and 5-10 show the sulfate concentrations and conductivity measurements over time on South Fork Saline River and Sugar Creek respectively.

Table 5-6 Historic Sulfate and TDS Data for South Fork Saline River/Lake of Egypt Watershed Impaired Stream Segments

Sample Location and Parameter	Illinois WQ Standard	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Violations
South Fork Saline River Segment ATH05; Sampling Location ATH05						
Sulfates	500 (mg/L)	1990-2002; 108	397	1,390	61	25
TDS/Conductivity	1,000 mg/L - 1,667 µS/cm	1990-2003; 122	830	1,832	100	1
Sugar Creek Segment ATHG01; Sampling Location ATHG01						
Sulfates	500 (mg/L)	1990-2003; 110	794	4,010	10	8
TDS/Conductivity	1,000 mg/L - 1,667 µS/cm	1990-2003; 122	1,529	6,840	113	37
Brier Creek Segment ATHS01; Sampling Location ATHS01						
Sulfates	500 (mg/L)	1993; 3	1,338	1,420	1,245	3
TDS/Conductivity	1,000 mg/L - 1,667 µS/cm	1993; 2	1,397	2,400	394	1
East Palzo Creek Segment ATHV01; Sampling Location ATHV01						
TDS/Conductivity	1,000 mg/L - 1,667 µS/cm	None	NA	NA	NA	NA

5.1.1.4.3 Metals

Table 5-7 contains a summary of metal data collected on impaired segments. The standards for cadmium, copper, nickel, and zinc are dependent on hardness. Hardness data have been collected in conjunction with these parameters. The number of violations presented in Table 5-7 for these parameters represent violations of the general use chronic standard. Figure 5-11 shows cadmium concentration overtime on South Fork Saline River and Sugar Creek. Figure 5-12 shows iron concentrations over time on the same segments (ATH05 and ATHG01). Figure 5-13 shows the copper and silver concentrations over time on Sugar Creek Segment ATHG01 while Figure 5-14 shows the nickel and zinc concentrations over time on the same segment. Charts were not developed for Brier Creek or East Palzo Creek due to low data availability.

Table 5-7 Historic Metals Data for South Fork Saline River/Lake of Egypt Watershed Impaired Stream Segments

Sample Location and Parameter	Illinois WQ Standard (µg/L)	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Violations
South Fork Saline River Segment ATH05; Sampling Location ATH05						
Cadmium	Hardness dependent	1990-2003; 118	4.1	30	3	48[1]
Iron (dissolved)	1000	1990-2003; 124	2,467	47,000	50	58
Sugar Creek Segment ATHG01; Sampling Location ATHG01						
Cadmium	Hardness dependent	1990-2003; 118	29.5	270	3	76[1]
Copper	Hardness dependent	1990-2003; 122	31.0	310	5	36
Iron (dissolved)	1000	1990-2003; 123	108,305	750,000	50	119
Nickel	Hardness dependent	1990-2003; 112	476	2,800	13	111
Silver	5	1990-2003; 124	4.8	48.0	3.0	12
Zinc	Hardness dependent	1990-2003; 116	1,339	8,600	81	115
East Palzo Creek Segment ATHV01; Sampling Location ATHV01						
Copper	Hardness dependent	1993; 3	49.7	110	5	2
Iron (dissolved)	1000	1993; 3	24,000	59,000	3,900	3
Brier Creek Segment ATHS01; Sampling Location ATHS01						
Iron (dissolved)	1000	1993; 3	125,333	243,000	58,000	3
Silver	5	1993; 3	7	15	3	1
Zinc	Hardness dependent	1993; 2	1,250	1,400	1,100	2

(1) Value was not considered a violation if it was below the detection limit.

5.1.2 Lake and Reservoir Water Quality Data

Lake of Egypt is the only impaired lake segment within the watershed that is addressed in this report. It is listed for impairment caused by manganese. The data summarized in this section include water quality data for that constituent as well as parameters that could be useful in future modeling and analysis efforts. All historic data are available in Appendix B.

5.1.2.1 Lake of Egypt

There are three active stations in Lake of Egypt (see Figure 5-1). An inventory of all available manganese data are presented in Table 5-8.

Table 5-8 Lake of Egypt Data Inventory for Manganese

Lake of Egypt; Sample Locations RAL-1, RAL-2, and RAL-3		
RAL-1	**Period of Record**	**Number of Samples**
Total Manganese	2000	5
Manganese in Bottom Deposits	1994-2000	4
RAL-2		
Total Manganese	NA	NA
Manganese in Bottom Deposits	NA	NA
RAL-3		
Total Manganese	NA	NA
Manganese in Bottom Deposits	1994-2000	5

Table 5-9 contains information on data availability for other parameters that may be useful in data needs analysis and future modeling efforts for manganese. DO at varying depths as well as total phosphorus data has been collected where available.

Table 5-9 Lake of Egypt Data Availability for Data Needs Analysis and Future Modeling Efforts

Lake of Egypt; Sample Locations RAL-1, RAL-2, and RAL-3		
RAL-1	**Period of Record**	**Number of Samples**
Dissolved Oxygen (mg/L)	1990-2000	51
Phosphorus, Dissolved (mg/L as P)	1991-1997	40
Phosphorus, Total (mg/L as P)	1990-1998	68
Phosphorus, Total, Bottom Deposit (mg/kg-P Dry Wgt)	1994-1997	4
RAL-2		
Dissolved Oxygen (mg/L)	1991-2000	391
Phosphorus, Dissolved (mg/L as P)	1991-1997	20
Phosphorus, Total (mg/L as P)	1990-1997	31
RAL-3		
Dissolved Oxygen (mg/L)	1991-2000	123
Phosphorus, Dissolved (mg/L as P)	1991-1997	20
Phosphorus, Total (mg/L as P)	1990-1997	32
Phosphorus, Total, Bottom Deposit (mg/kg-P Dry Wgt)	1994-1997	4

5.1.2.1.2 Manganese

The applicable water quality standard for manganese is 1,000 µg/L for general use and 150 µg/L for public water supplies. Table 5-10 summarizes available manganese data for Lake of Egypt. Four out of five samples taken in 2000 violated the public water supply standard. The maximum sampled total manganese concentration was 170 mg/L.

Table 5-10 Average Total Manganese Concentrations in Lake of Egypt

	ROI-1			
Year	**Water Quality Standard (mg/L)**	**Data Count**	**Number of Violations**	**Average**
2001	General Use: 1000	5	0	156
	Public Water Supply: 150		4	

5.2 Reservoir Characteristic

There is one impaired reservoir in the South Fork Saline River/Lake of Egypt watershed. Reservoir information that can be used for future modeling efforts was collected from GIS analysis, the US Army Corps of Engineers, the Illinois EPA, and USEPA water quality data. The following sections will discuss the available data for the reservoir.

5.2.1 Lake of Egypt

Table 5-11 Lake of Egypt Dam Information (U.S. Army Corps of Engineers

Dam Length	2,850 feet
Dam Height	55 feet
Maximum Discharge	40,666 cfs
Maximum Storage	82,942 acre-feet
Normal Storage	41,215 acre-feet
Spillway Width	200 feet
Outlet Gate Type	U

Lake of Egypt is located in Williamson and Jackson Counties, has a surface area of 2,300 acres and over 90 miles of shoreline. The lake is located south of Marion, northeast of Goreville, and west of Creal Springs. Water from the lake is utilized by the Lake of Egypt Public Works Department to supply approximately one million gallons per day of drinking water to Union, Jackson, and Williamson Counties (IEPA Source Water Assessment Program, 2002).

Table 5-12 contains depth information for each sampling location on the lake. The average maximum depth in Lake of Egypt is 38.6 feet.

Table 5-12 Average Depths (ft) for Lake of Egypt (Illinois EPA 2002 and USEPA 2002a)

Year	RAL-1	RAL-2	RAL-3
1990	39.5	29.6	10.3
1991	37.9	28.5	8.9
1992	37.2	28.5	9.8
1993	37.5	28.9	10.0
1994	39.1	29.5	9.2
1995	40.6	30.0	9.3
1996	40.6	29.9	9.4
1997	37.0	30.2	10.4
1998	37.3	28.2	9.8
2000	39.2	29.8	8.7
Average	**38.6**	**29.3**	**9.6**

5.3 Point Sources

Point sources for the South Fork Saline River/Lake of Egypt watershed have been separated into municipal/industrial sources and mining discharges. Available data have been summarized and are presented in the following sections.

5.3.1 Municipal and Industrial Point Sources

Permitted facilities must provide Discharge Monitoring Reports (DMRs) to Illinois EPA as part of their NPDES permit compliance. DMRs contain effluent discharge sampling results, which are then maintained in a database by the state. There are five point sources located within the South Fork Saline River/Lake Egypt watershed. Figure 5-15 shows these facilities. In order to assess point source contributions to the watershed, the data have been examined by receiving water and then by the downstream impaired segment that has the potential to receive the discharge. Receiving waters were determined through information contained in the USEPA Permit Compliance System (PCS) database. Maps were used to determine downstream impaired receiving water information when PCS data were not available. The causes of impairment for each segment or downstream segment were considered when reviewing

DMR data. Data have been summarized for any sampled parameter that is associated with a downstream impairment (i.e., all available nutrient and BOD data were reviewed for segments that are impaired for DO). This will help in future model selection as well as source assessment and load allocation.

5.3.1.1 South Fork Saline River Segment ATH 02

There is one point source with the potential to contribute discharge to South Fork Saline River Segment ATH 02. Segment ATH 02 is listed as impaired for manganese, pH, DO, and total fecal coliform. Table 5-13 contains a summary of available and pertinent DMR data for this point source. The data do not contain any information on manganese or fecal coliform. The discharger is located a considerable distance upstream of segment ATH02 on a non-impaired stream.

Table 5-13 Effluent Data from Point Sources Discharging Upstream of South Fork Saline River Segment ATH 02 (Illinois EPA 2005)

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
Creal Springs STP 1994 - 2004 ILG580125	Cana Creek/South Fork Saline River Segment ATH 02	Average Daily Flow	0.224 mgd	NA
		CBOD, 5-day	21.5 mg/L	16.0
		pH	7.68 su	

5.3.1.2 South Fork Saline River Segment ATH14 and Lake of Egypt Segment RAL

There are four point sources with the potential to contribute discharge to Lake of Egypt segment RAL and South Fork Saline River segment ATH14 directly or through tributaries. Lake of Egypt is listed for manganese. South Fork Saline River Segment ATH14 is listed for DO. Table 5-14 contains a summary of available DMR data for these point sources. Manganese data were not available for these locations.

Table 5-14 Effluent Data from Point Sources Discharging Upstream of Lake of Egypt and South Fork Saline River Segment ATH14 (Illinois EPA 2005)

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
Goreville STP 1994 - 2005 ILG580116	Little Saline Creek/South Fork Saline River Segment ATH14	Average Daily Flow	0.06 mgd	NA
		CBOD, 5-day	28.5 mg/L	5.32
Lake of Egypt Sewer and Water Dist 1992 - 2005 ILG580053/IL0061964	Little Saline Creek and Lake of Egypt/South Fork Saline River Segment ATH14 and Lake of Egypt RAL	Average Daily Flow	0.225 mgd	NA
		CBOD, 5-day	49.8 mg/L	5.98
		Nitrogen, Ammonia	6.25 mg/L	—
Lake of Egypt WTP 1995 - 2003 ILG640036/IL0076261	Little Saline Creek /Lake of Egypt Segment RAL	Average Daily Flow	0.065 mgd	NA
Southern Ill Power-Marion 1989 - 2005 IL0004316	Little Saline Creek and Lake of Egypt/Lake of Egypt Segment RAL	Average Daily Flow	88.6 mgd	NA

5.3.1.3 Other Stream Segments

There are no permitted facilities that discharge directly to or upstream of South Fork Saline River Segment ATH 05, Sugar Creek Segments ATHG01 or ATHG05, Brier Creek Segment ATHS01, and East Palzo Creek Segment ATHV01.

5.3.2 Mining Discharges

There are two NPDES permits for mining within the South Fork Saline River/Lake of Egypt watershed. The permits are both held by Peabody Coal Company under the Will Scarlet Mine name. Data from the Illinois Natural Resources Geospatial Data Clearinghouse were also reviewed for coal mine information. Figure 5-16 shows the locations of permitted outfalls within the watershed as well as the historic locations of coal mines in the area.

Data provided from the state of Illinois include DMRs for permit IL0004197 and IL0064068. DMRs for the last three years were provided for Outfalls 001 and 002 under permit IL0064068. DMRs for IL0004197 are only available for outfalls 035 and 040. Outfalls 001 and 002 are from very small basins and are expected to discharge following heavy precipitation events only. Therefore, no DMR data were available for these outfalls. Outfall 040 was an original outfall but the applicant has proposed and was approved to construct a small wetland area to provide additional treatment for the discharges from the outfall. Once constructed, the discharge from the wetland was designated as Outfall 041 and located approximately 100 feet below Outfall 040. Outfall 041 has only been completed recently and no data are yet available for its discharges. However, future discharges are anticipated to be similar in quality and quantity to past discharges from Outfall 040. Table 5-15 contains a summary of available relevant data from each outfall with DMRs.

Table 5-15 Sulfate, Iron, and pH Pipe Outfall Concentrations

Permit ID and Sample Dates	Pipe Outfall	Flow (cfs)				pH				Iron (mg/L)				Sulfate (mg/L)			
		# of Samples	Minimum	Maximum	Average	# of Samples	Minimum	Maximum	Average	# of Samples	Minimum	Maximum	Average	# of Samples	Minimum	Maximum	Average
IL0004197	035	22	0.0	0.7	0.1	14	6.95	8.02	7.52	14	0.1	5.3	2.4	14	104	1414	794
12/01-12/03	040	22	0.0	0.1	0.0	17	6.22	7.84	7.07	0				17	1232	2823	2083
IL0064068	001	37	0.0	4.3	2.4	36	6.21	8.95	7.57	36	0.1	2.8	0.5	36	640	1994	1554
12/01-2/05	002	37	0.0	0.1	0.0	22	6.82	8.15	7.52	22	0.1	1.8	0.5	22	19	634	169

The state also noted that a portion of another reclaimed and abandoned mine facility is located in the extreme northeast portion of the watershed (Figure 5-16). This facility was previously known as Sierra Coal Company. The NPDES permit for the facility was terminated several years ago, and therefore, the state has no available DMRs available for discharges from the site. The boundaries of the reclaimed mine extend well beyond the delineated watershed boundary, and it is not known, which, if any, of the post-mining discharges from the mine might be located within the watershed.

An Intensive Basin Survey of the Saline River was performed in 1993. Coal mines were assessed and according to the report, there were other mining sites impacting segments within the South Fork Saline River/Lake of Egypt watershed. The Thunderbird Colleries Carmac Mining Company was identified in the basin report as located west of Dykersburg and containing several hundred acres of pre-law surface and underground mines. The report stated that acid surface and ground water flows enter Brier Creek on a continual basis. The Abandoned Mined Lands Reclamation Division initiated reclamation in 1994.

Also in the area, the Stonefort Mining Company Palzo mine was identified as a 300 acre site located in Williamson County that was flowing directly to Sugar Creek despite efforts to reclaim the area. The survey stated that extensive reclamation efforts at the site have had only limited success and that this site was the most significant contributor of acid water to Sugar Creek and the South Fork. Continued monitoring is being conducted regularly below the Palzo mine by the Abandoned Mined Lands Reclamation Division of the Office of Mines and Minerals, Department of Natural Resources as part of an on-going monitoring program to chart the improvement in the water quality of the South Fork of the Saline River after the reclamation of several abandoned mines within the watershed.

5.4 Nonpoint Sources

There are many potential nonpoint sources of pollutant loading to the impaired segments in the South Fork Saline River/Lake of Egypt watershed. This section will discuss site-specific cropping practices, animal operations, and area septic systems. Data were collected through communication with local NRCS, Soil and Water Conservation District (SWCD), Public Health Department, and County Tax Department officials.

5.4.1 Crop Information

A small portion of the land found within the South Fork Saline River/Lake of Egypt watershed is devoted to crops. Corn and soybean farming account for approximately 6 percent and 7 percent of the watershed respectively. Tillage practices can be categorized as conventional till, reduced till, mulch-till, and no-till. The percentage of each tillage practice for corn, soybeans, and small grains by county are generated by the Illinois Department of Agriculture from County Transect Surveys. The most recent survey was conducted in 2004. Data specific to the South Fork Saline River/Lake of Egypt watershed were not available; however, the Williamson, Johnson and Saline County practices were available and are shown in the tables below.

Table 5-16 Tillage Practices in Johnson County

Tillage System	Corn	Soybean	Small Grain
Conventional	61%	36%	0%
Reduced - Till	4%	0%	0%
Mulch - Till	0%	0%	0%
No - Till	36%	64%	0%

Table 5-17 Tillage Practices in Williamson County

Tillage System	Corn	Soybean	Small Grain
Conventional	28%	21%	38%
Reduced - Till	17%	21%	0%
Mulch - Till	0%	15%	0%
No - Till	55%	42%	63%

Table 5-18 Tillage Practices in Saline County

Tillage System	Corn	Soybean	Small Grain
Conventional	51%	31%	3%
Reduced - Till	19%	19%	3%
Mulch - Till	5%	11%	0%
No - Till	24%	38%	93%

5.4.2 Animal Operations

Watershed specific animal numbers were not available for the South Fork Saline River/Lake of Egypt watershed. Data from the National Agricultural Statistics Service were reviewed and are presented below to show countywide livestock numbers.

Table 5-19 Williamson County Animal Population (2002 Census of Agriculture)

	1997	2002	Percent Change
Cattle and Calves	9,362	9,774	0%
Beef	4,836	5,104	4%
Dairy	58	14	-76%
Hogs and Pigs	6,475	8,221	27%
Poultry	567	298	-47%
Sheep and Lambs	103	111	8%
Horses and Ponies	NA	814	NA

Table 5-20 Johnson County Animal Population (2002 Census of Agriculture)

	1997	2002	Percent Change
Cattle and Calves	18,093	17,190	-5%
Beef	8,441	9,187	9%
Dairy	56	175	213%
Hogs and Pigs	6,241	8,421	35%
Poultry	550	337	-39%
Sheep and Lambs	92	94	2%
Horses and Ponies	NA	969	NA

Table 5-21 Saline County Animal Population (2002 Census of Agriculture)

	1997	2002	Percent Change
Cattle and Calves	6,783	6,667	-2%
Beef	3,391	3,442	2%
Dairy	130	108	-17%
Hogs and Pigs	29,516	19,520	-34%
Poultry	Not Disclosed		NA
Sheep and Lambs	Not Disclosed		NA
Horses and Ponies	NA	557	NA

The Illinois EPA provided a GIS shapefile illustrating the location of livestock facilities in the Saline River Basin, which contains the South Fork Saline River/Lake of Egypt watershed. In 2001, Illinois EPA assessed the potential impact of each facility on water quality with regard to the size of the facility, the site condition and management, pollutant transport efficiency, and water resources vulnerability. The GIS data have been used as reference since the surveys were conducted four years ago. Six animal facilities existed at the time of the survey. Two of the facilities were assessed to have a slight impact while the remaining facilities were either not assessed or assessed to have no impact. The facilities assessed to have slight impact were located in the South Fork Saline River subwatershed for segment ATH02 and the Little Saline Creek subwatershed which does not have an impaired segment. Of the sites that were not assessed, one was a hog operation located within the impaired ATH02 subbasin. Again, the remaining sites were assessed to have no impact or were not located near an impaired water body.

5.4.3 Septic Systems

Many households in rural areas of Illinois that are not connected to municipal sewers make use of onsite sewage disposal systems, or septic systems. There are a variety of types of septic systems, but the most common septic system is composed of a septic tank draining to a septic field, where nutrient removal occurs. However, the degree of nutrient removal is limited by soils and system upkeep and maintenance.

Information on sewered and septic municipalities was obtained from Williamson, Johnson, and Saline county health departments. The number of septic systems was not available for Williamson County. Johnson County Health Department was able to estimate the number of septic systems that exist within the watershed. Because the Johnson County Health Department was unable to provide estimates of the number of septic systems, the tax assessor was contacted to provide estimates of the number of existing residences within the watershed. Together, the estimated number of residences obtained from the tax assessor and the data from the U.S. Census Bureau were used to estimate the number of septic systems in Johnson County within the watershed. Table 5-22 is a summary of the available septic system data in the South Fork Saline River/Lake of Egypt watershed.

Table 5-22 Estimated Septic Systems in the South Fork Saline River/Lake of Egypt Watershed

County	Estimated No. of Septic Systems	Source of Septic Areas/ No. of Septic Systems
Williamson	NA	Health Department
Johnson	2,100	Health Department/Tax Assessor, U.S. Census Bureau
Saline	120	Health Department
Total	**2,220**	

It is estimated that there are at least 2,200 septic systems in the South Fork Saline River/Lake of Egypt watershed. Creal Springs and Goreville are connected to municipal sewers. The remaining residential areas in the watershed are served by septic systems. Land use data (see Section 2.3) indicates that there are residences located around the Lake of Egypt. Williamson County estimates that 90 percent of the septic systems in the county produce surface discharges and that 60 to 70 percent of septic systems are not properly maintained. Conditions in Johnson County could be similar.

5.5 Watershed Studies and Other Watershed Information

Previous planning efforts have been conducted within the South Fork Saline River/Lake of Egypt watershed. An Intensive Survey of the Saline River Basin was conducted in 1993 and the summer of 2000. A facility related stream survey was conducted in July 2000 for the Southern Illinois Power Cooperation WWTP. Data from both surveys were incorporated into the Stage One report and information contained within each will be used as reference during Stage 3 TMDL development. Further investigation into watershed-specific groups and associated activities will be conducted.

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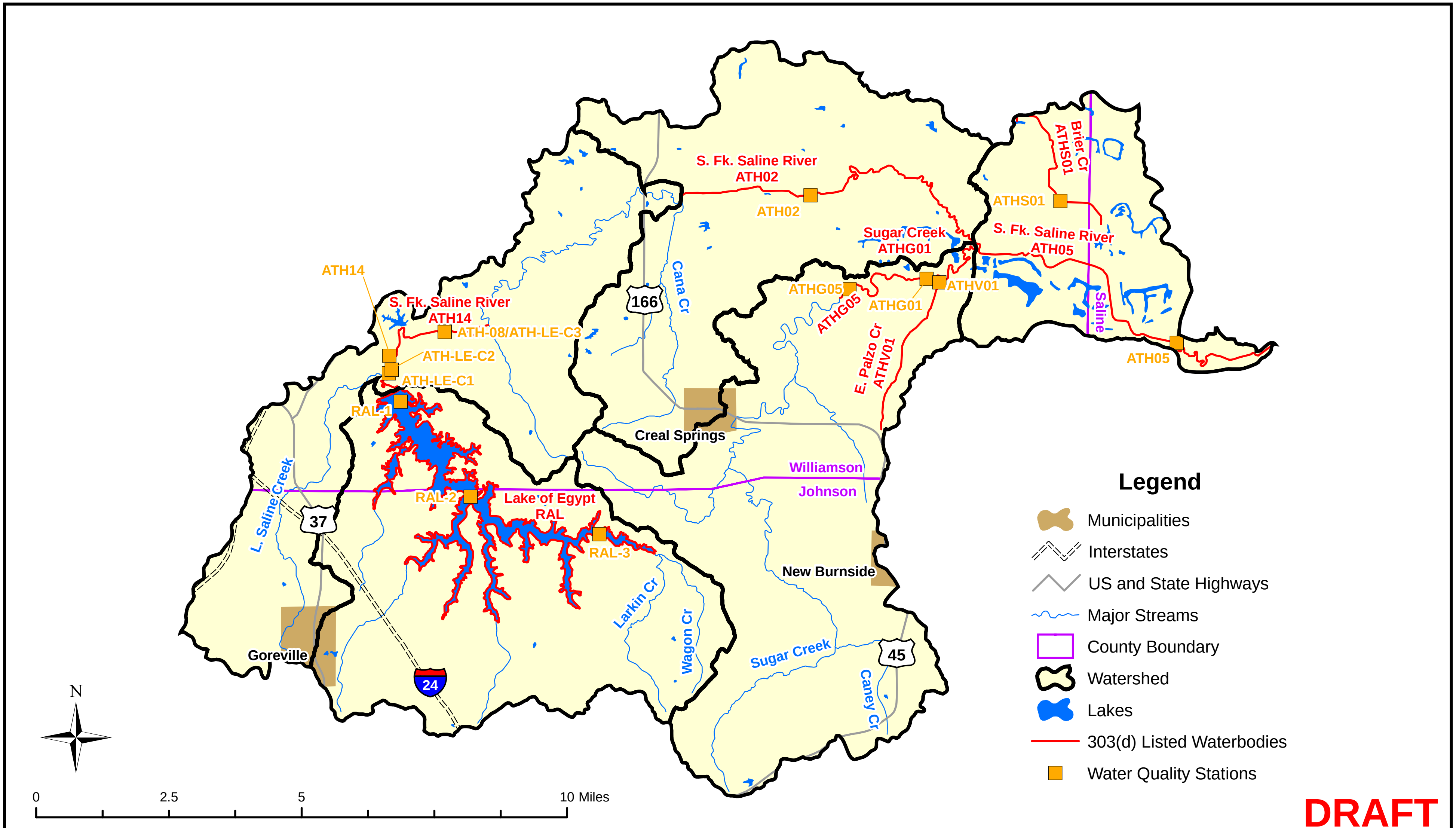

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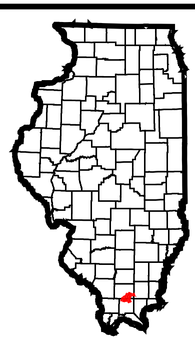

Figure 5-1
Water Quality Stations
Saline River - Lake of Egypt Watershed

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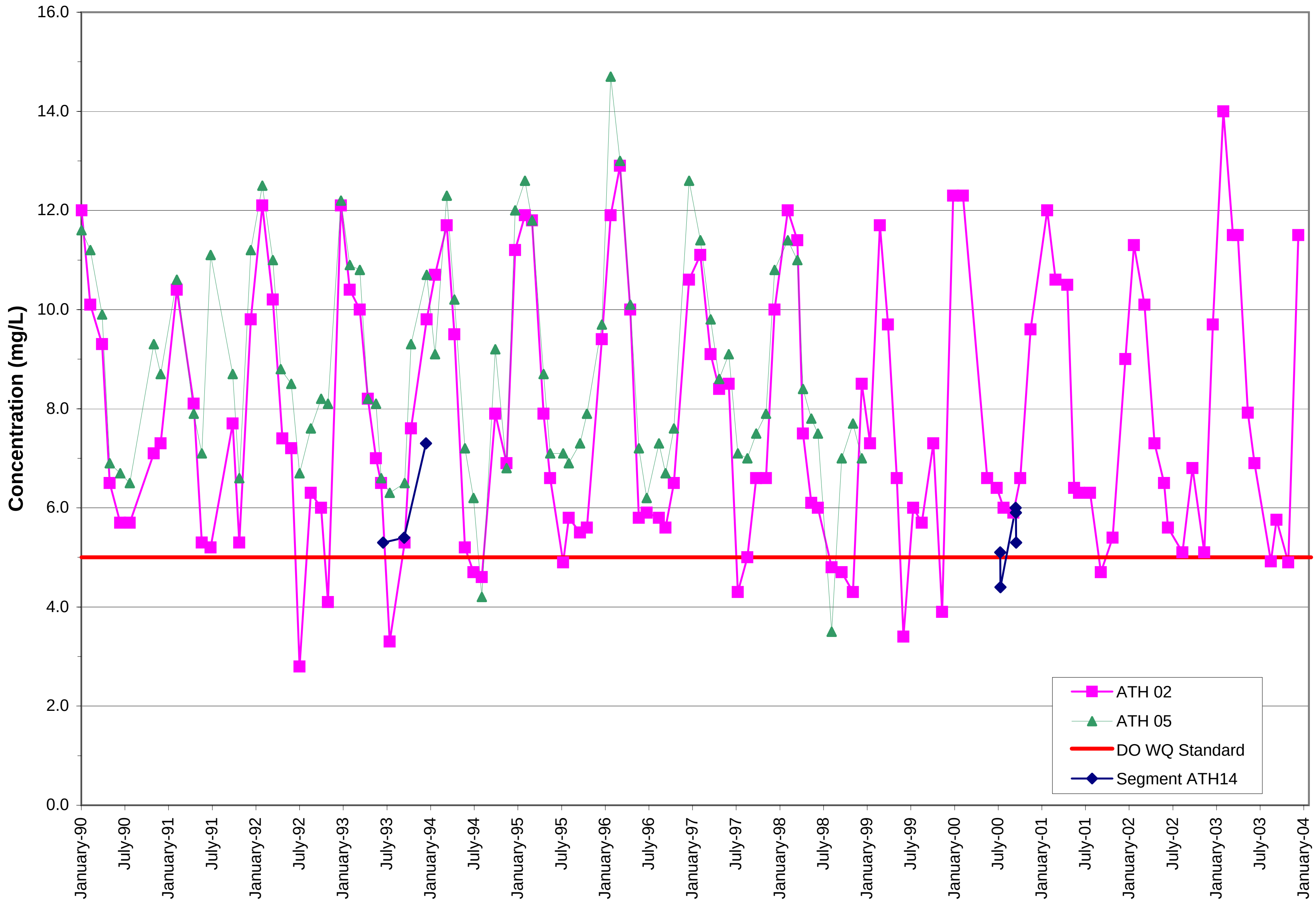

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T:\GIS\2 Saline River-S Fork_Lake Egypt\Data\Saline-stream-DO.xlsSaline River DO Chart

Figure 5-2:
South Fork Saline River
DO Concentrations

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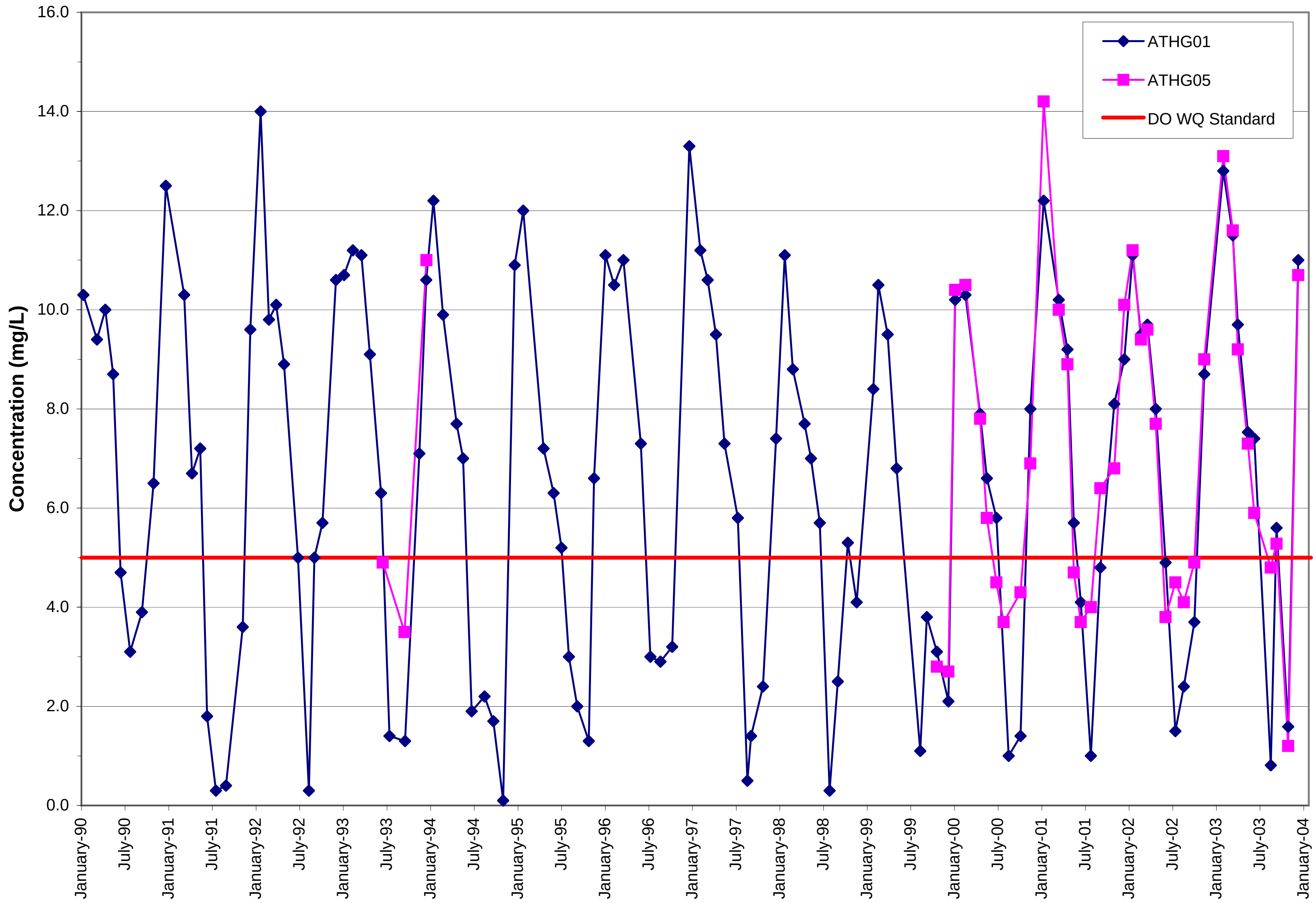

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Figure 5-3:
Sugar Creek
DO Concentrations

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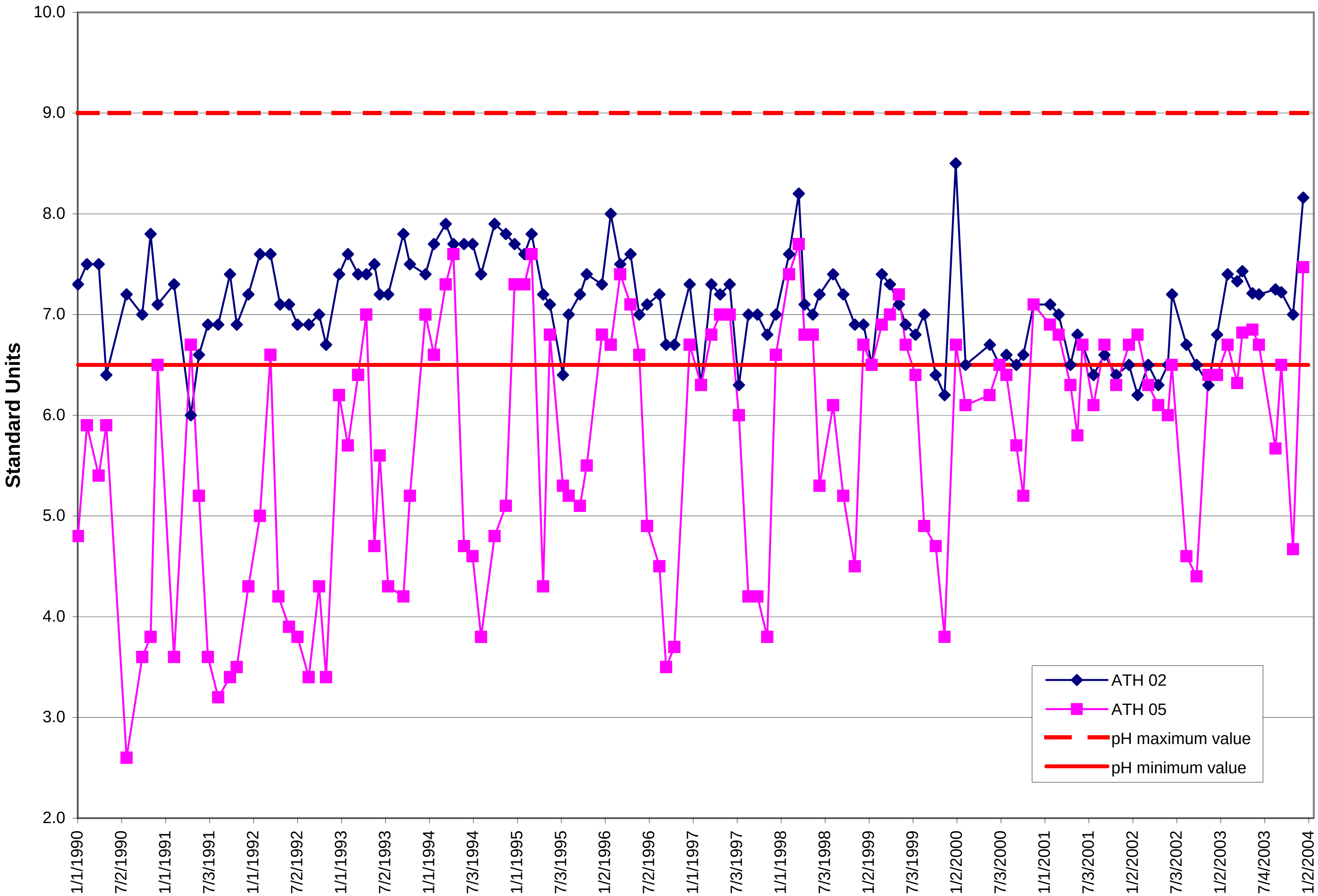

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Figure 5-4:
South Fork Saline River
pH Values

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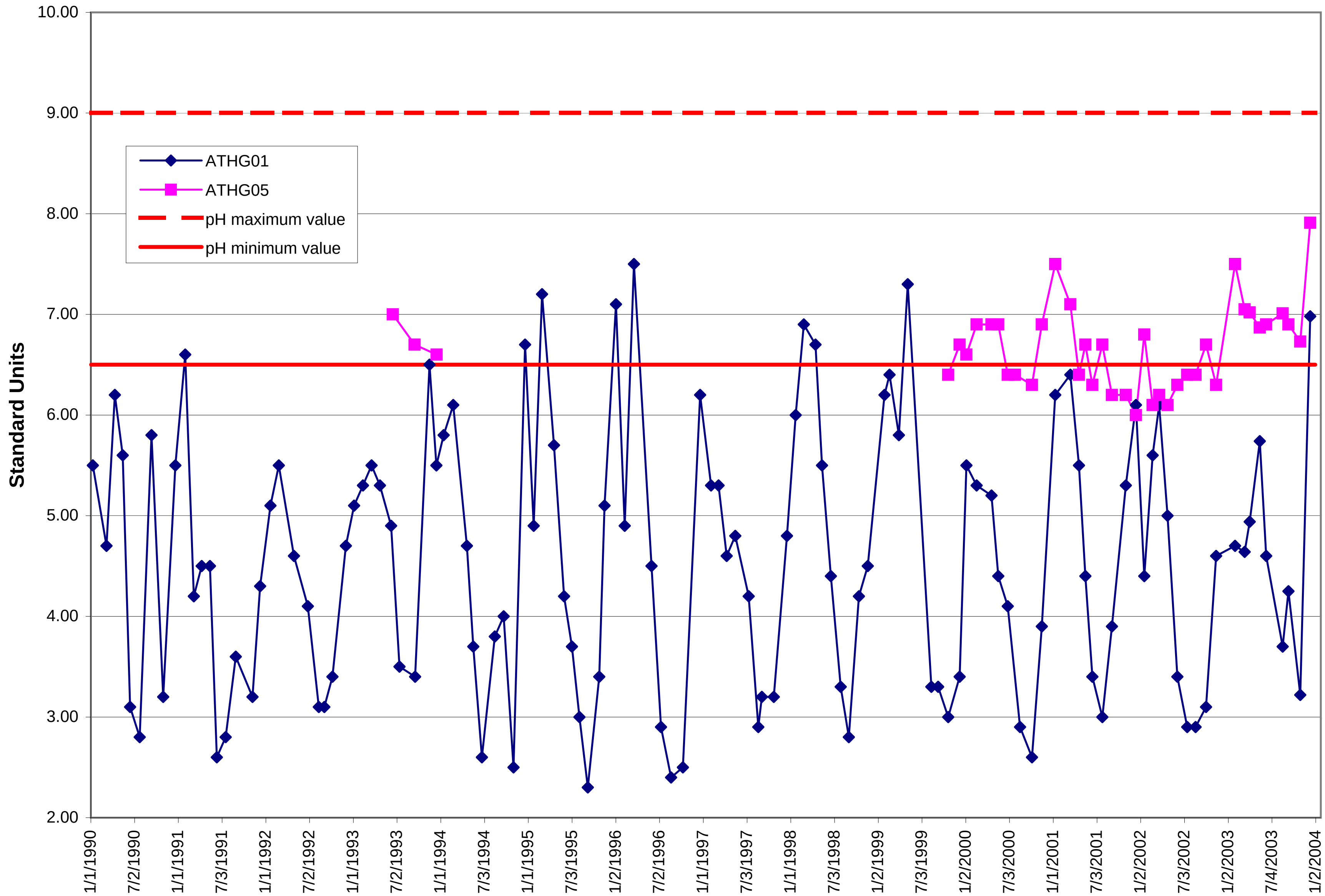

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Figure 5-5:
Sugar Creek
pH Values

T:\GIS\2 Saline River-S Fork_Lake Egypt\Data\Saline-stream-pH.xlsSugar pH Chart

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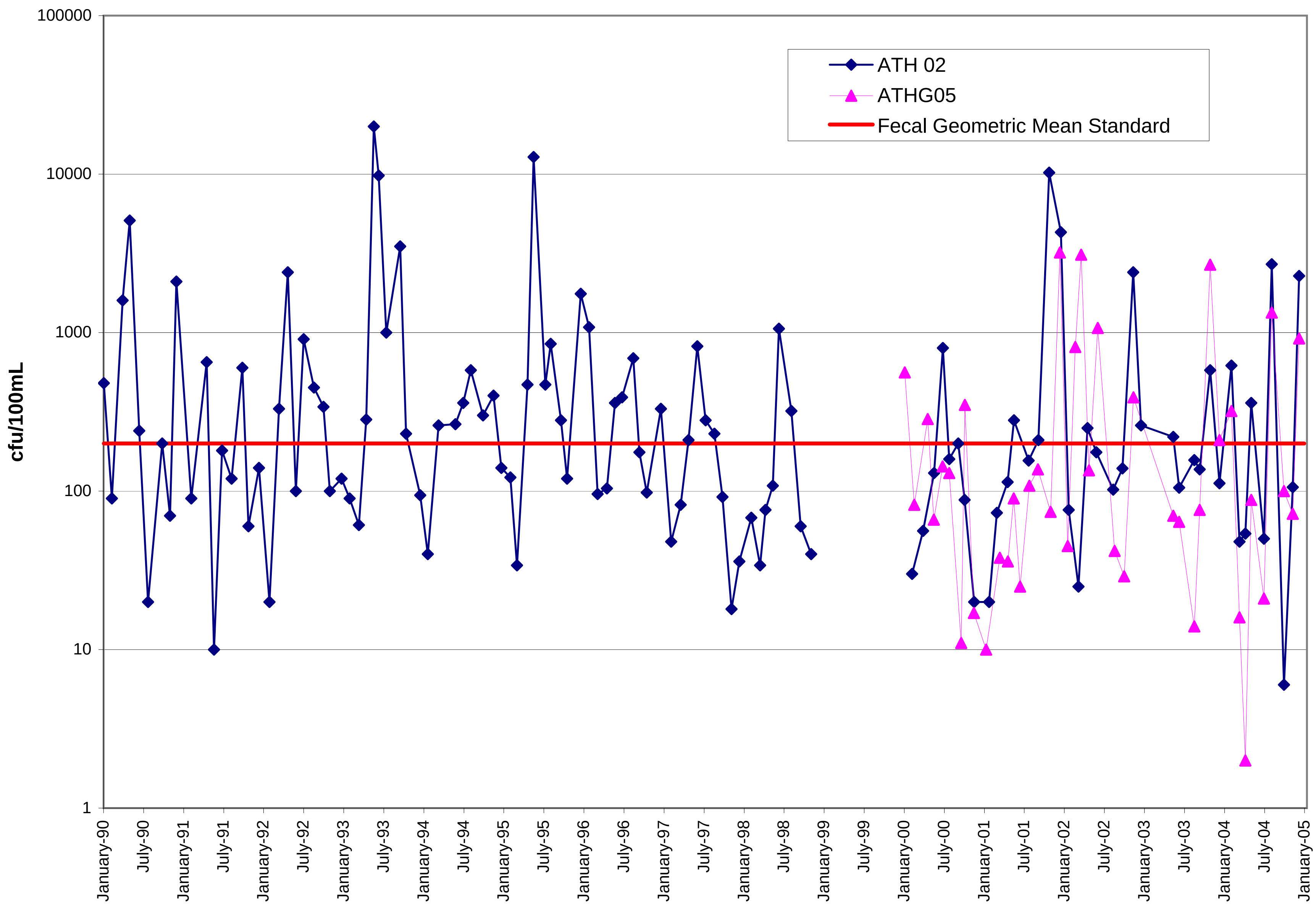

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Figure 5-6:
Total Fecal Coliform
South Fork Saline River ATH02 and Sugar Creek ATHG05

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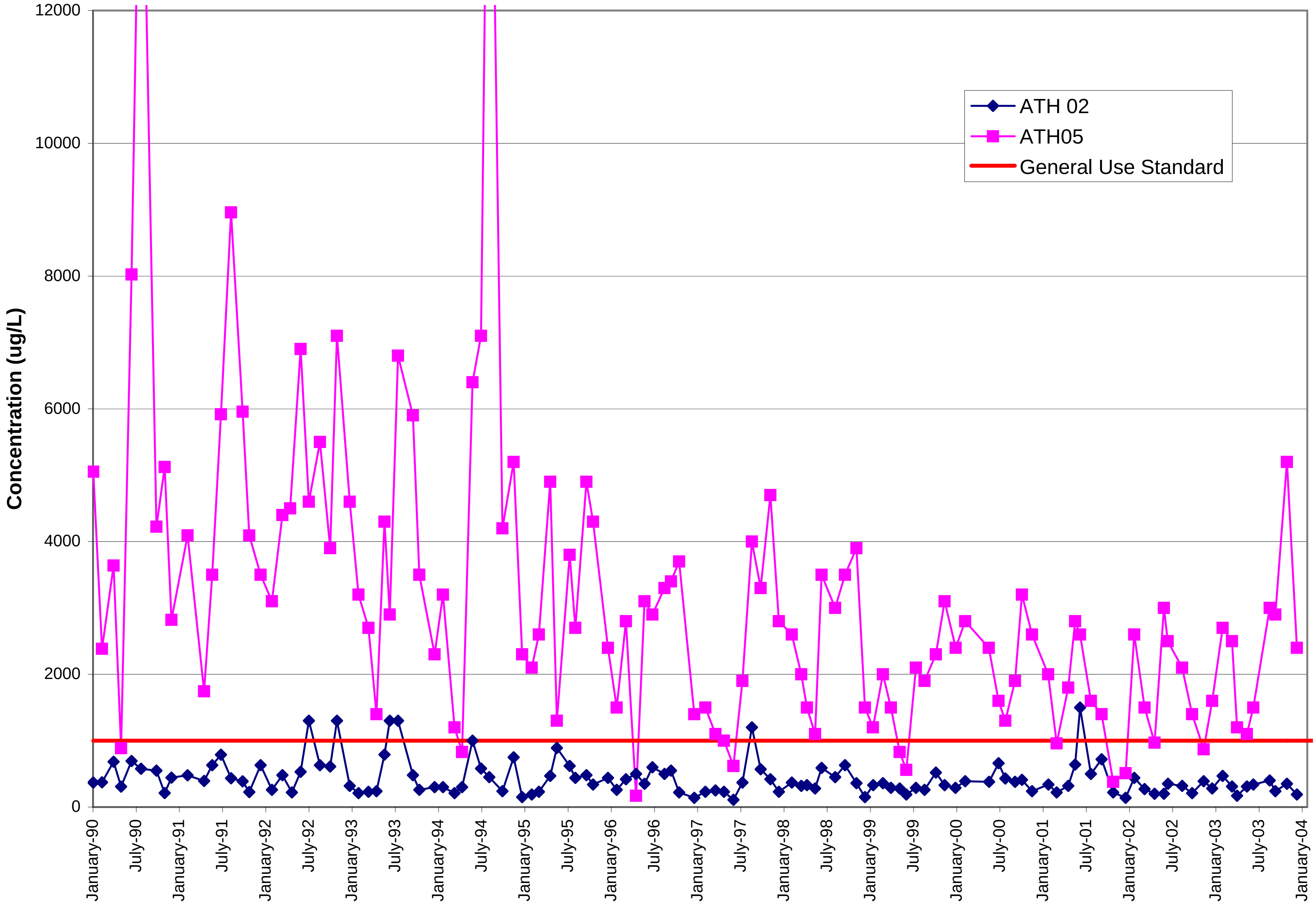

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Figure 5-7:
South Fork Saline River
Total Manganese Concentrations

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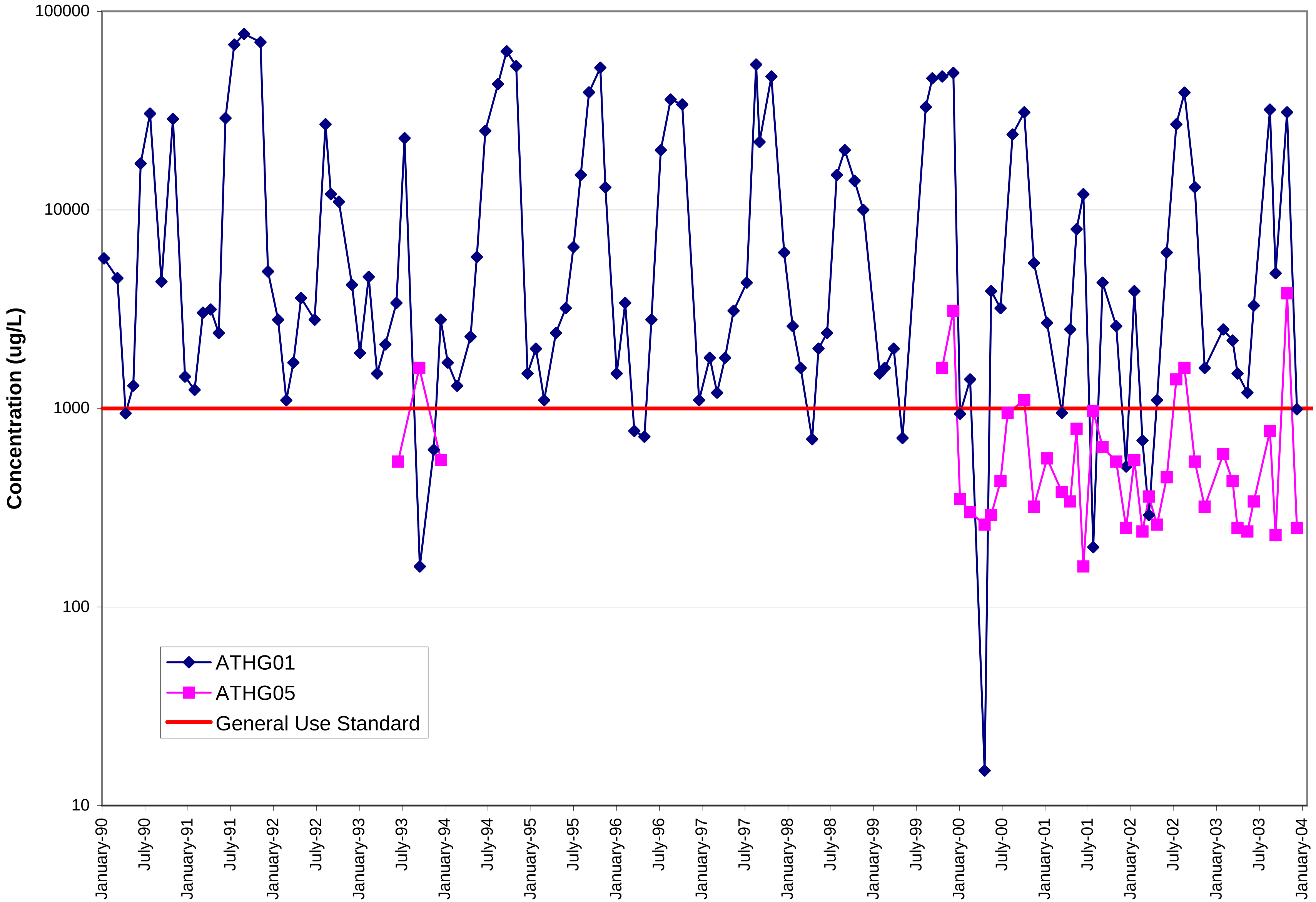

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Figure 5-8:
Sugar Creek
Total Manganese Concentrations

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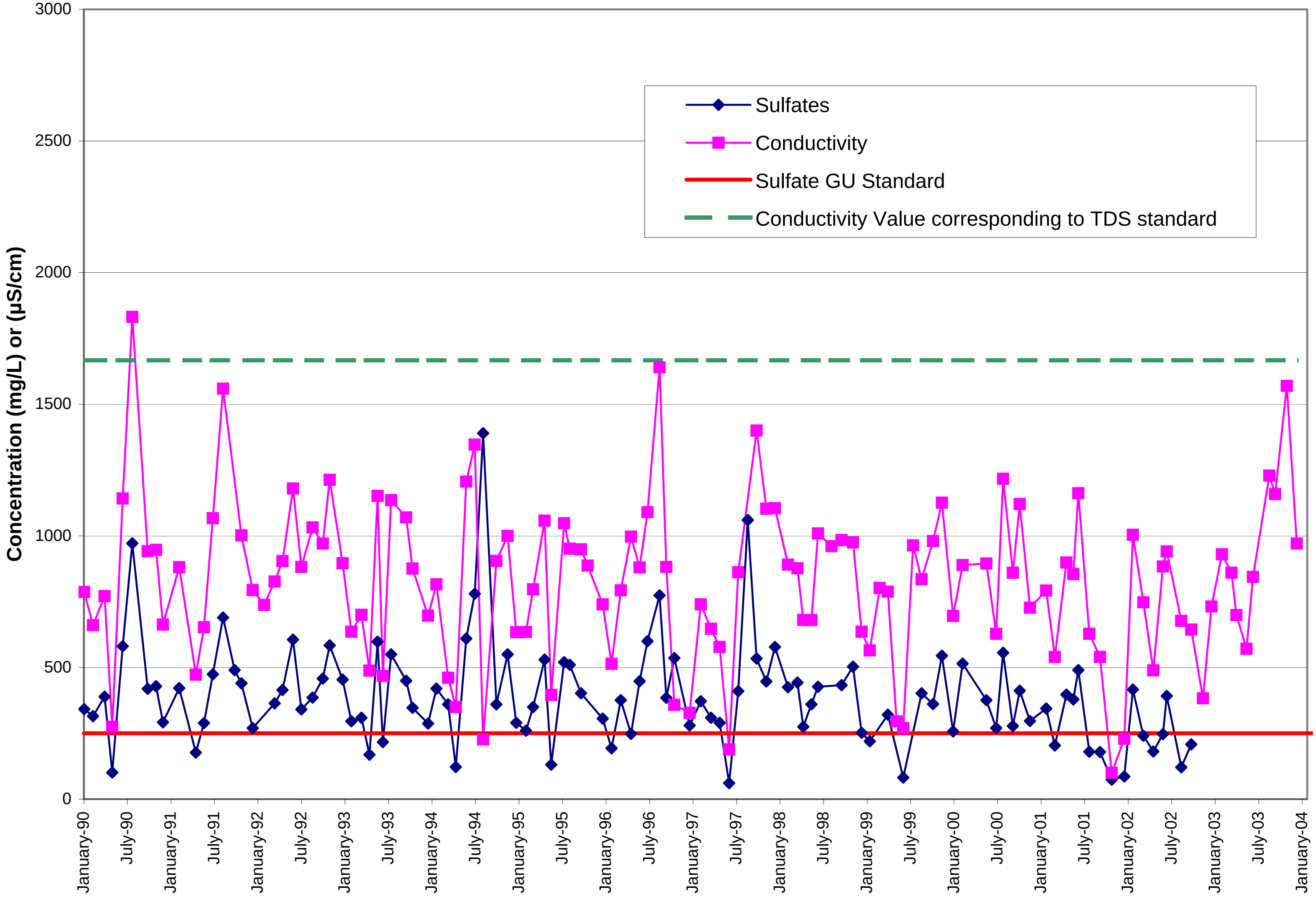

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Figure 5-9:
South Fork Saline River Segment ATH05
Conductivity Values and Sulfate Concentrations

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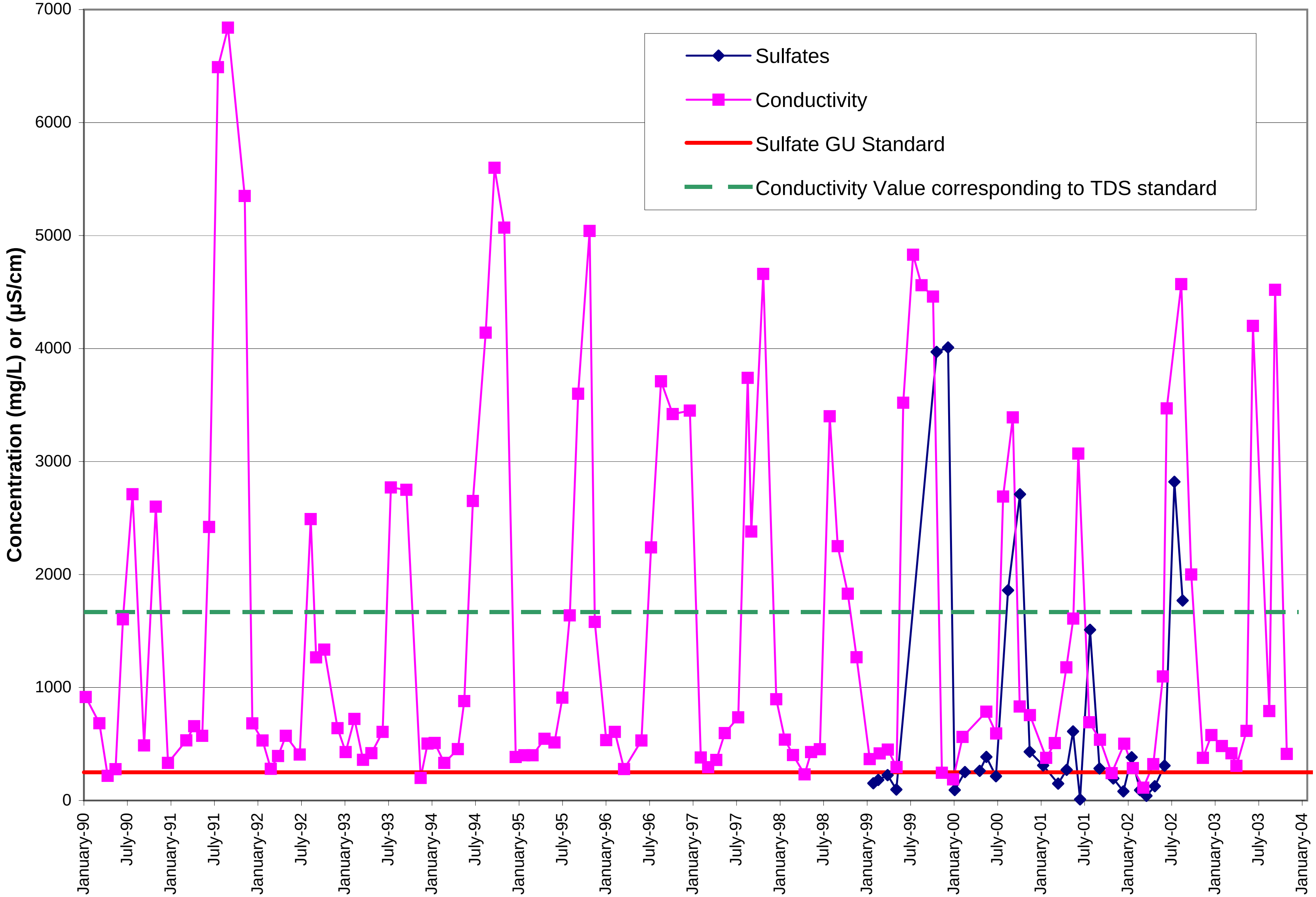

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Figure 5-10:
Sugar Creek Segment ATHG01
Conductivity Values and Sulfate Concentrations

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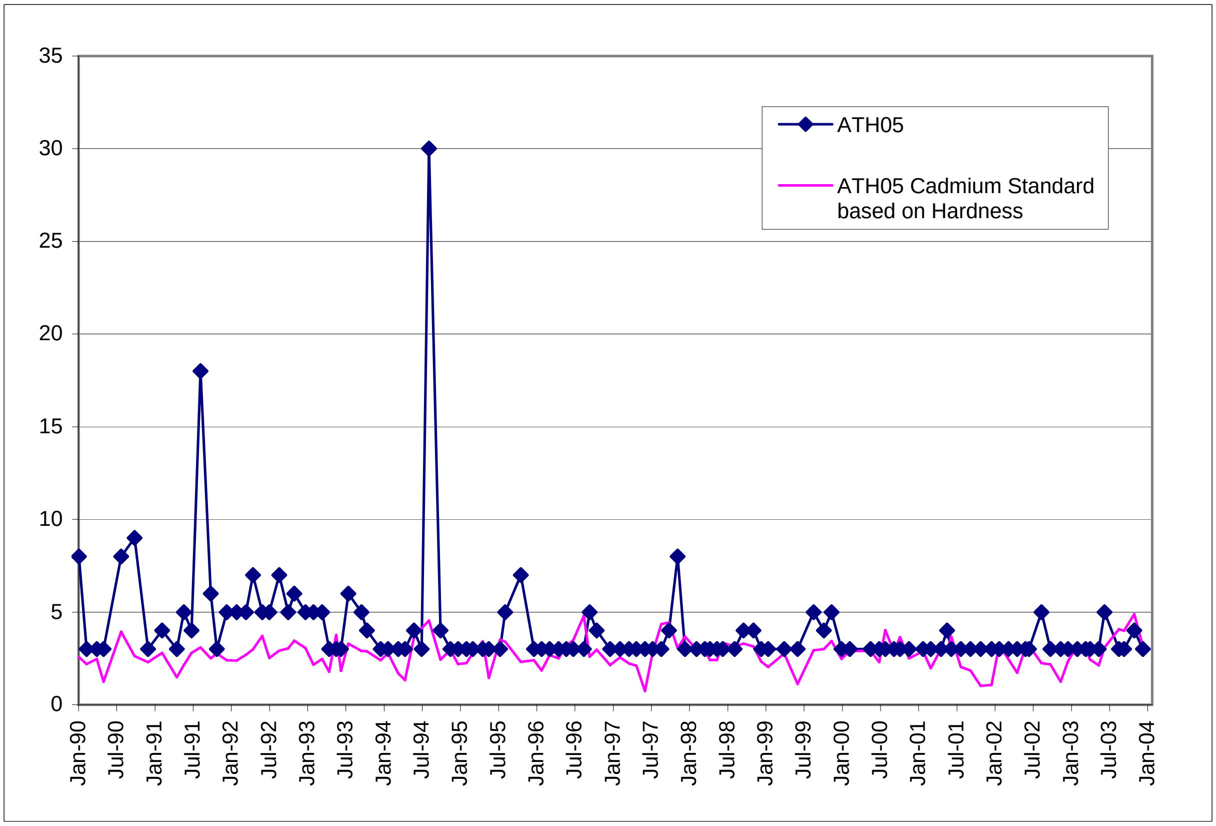

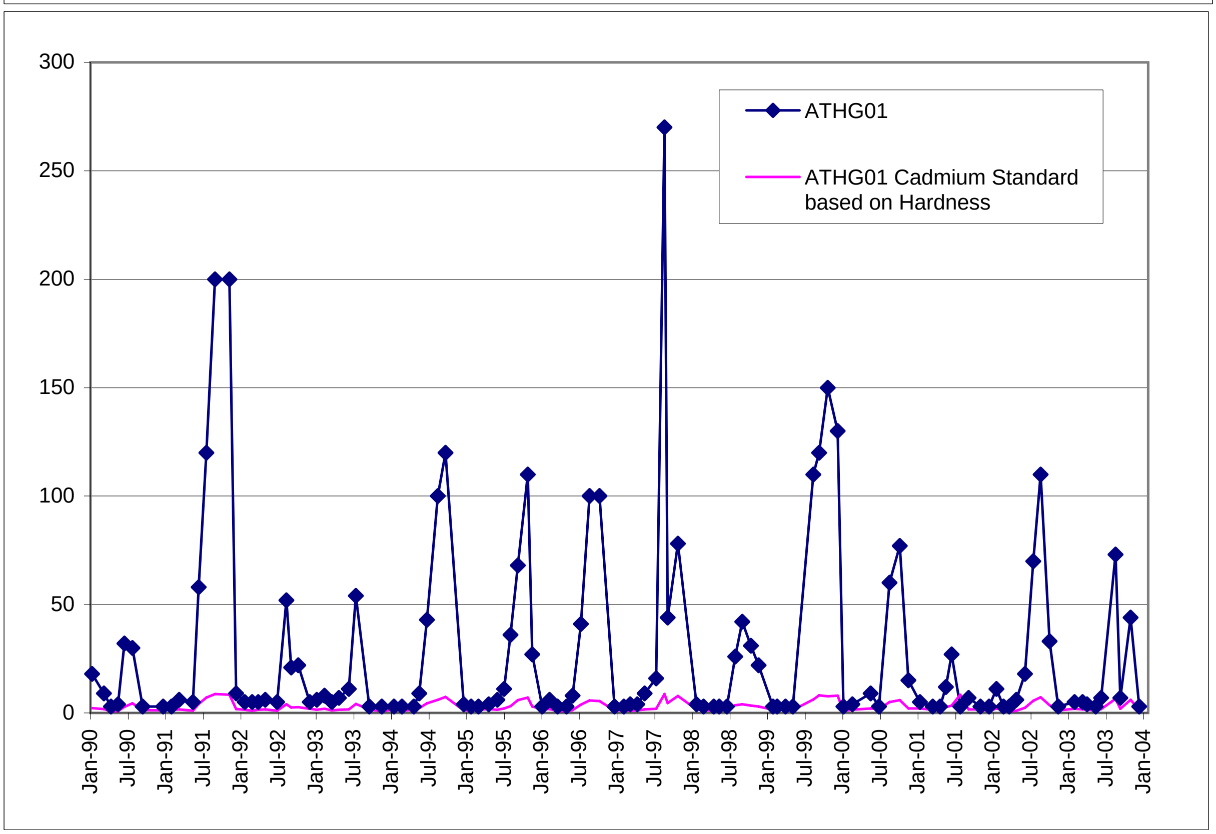

Figure 5-11:
South Fork Saline River and Sugar Creek
Dissolved Cadmium Concentrations

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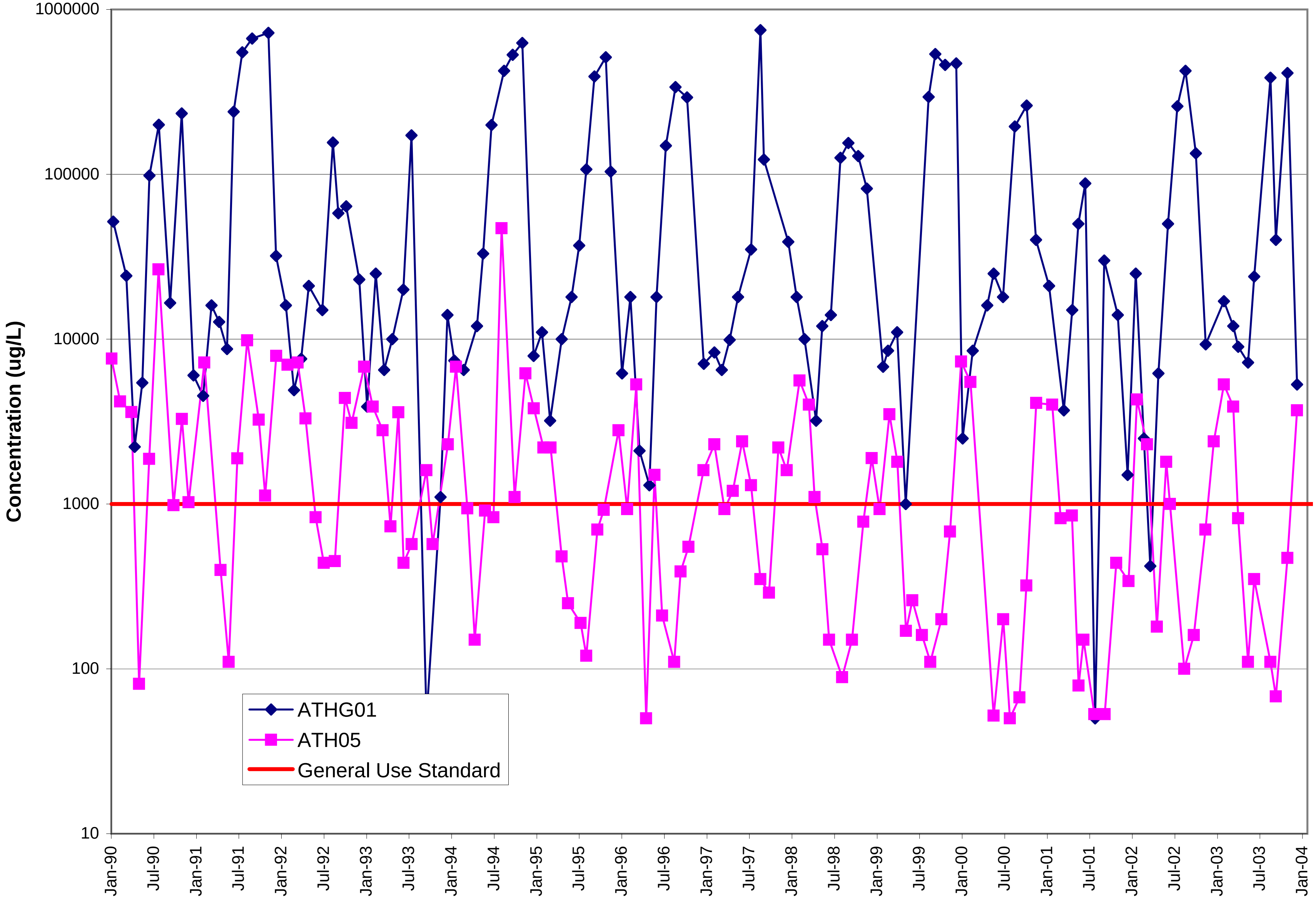

Figure 5-12:
South Fork Saline River
and Sugar Creek
Iron Concentrations

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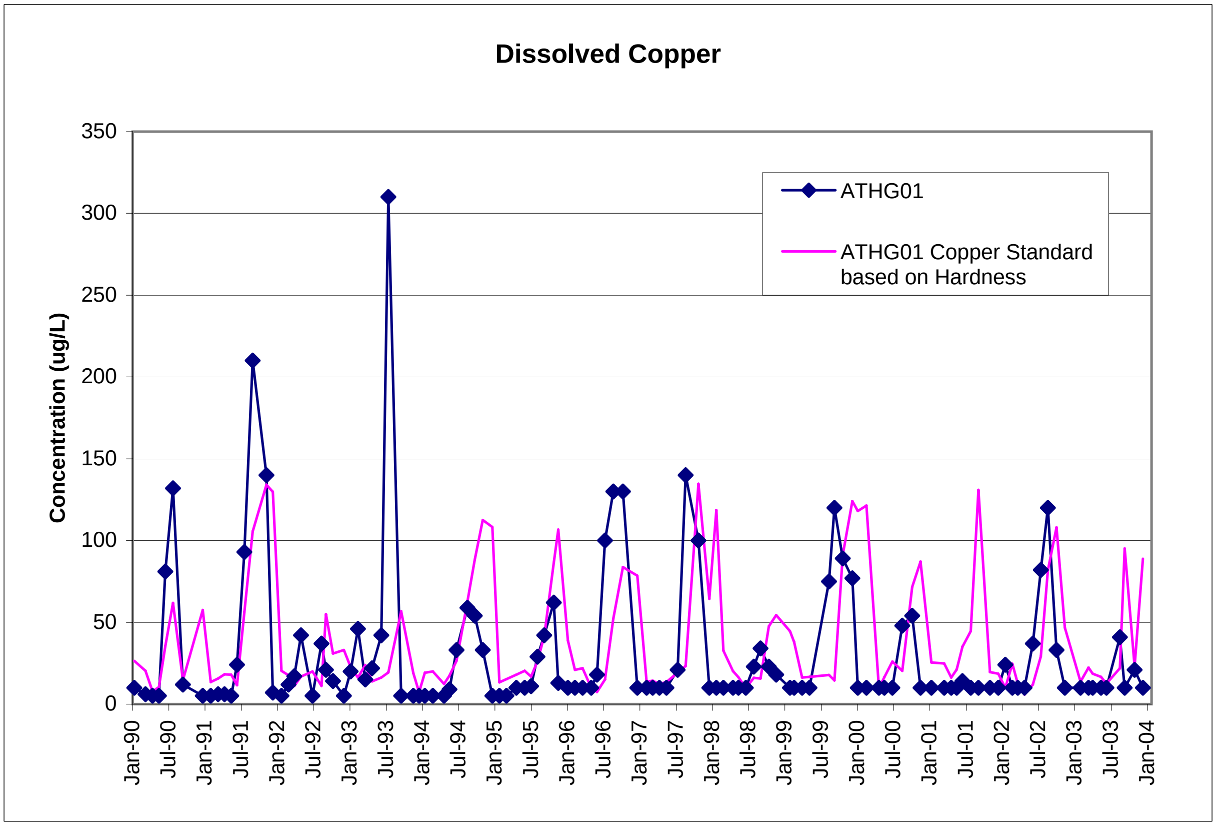

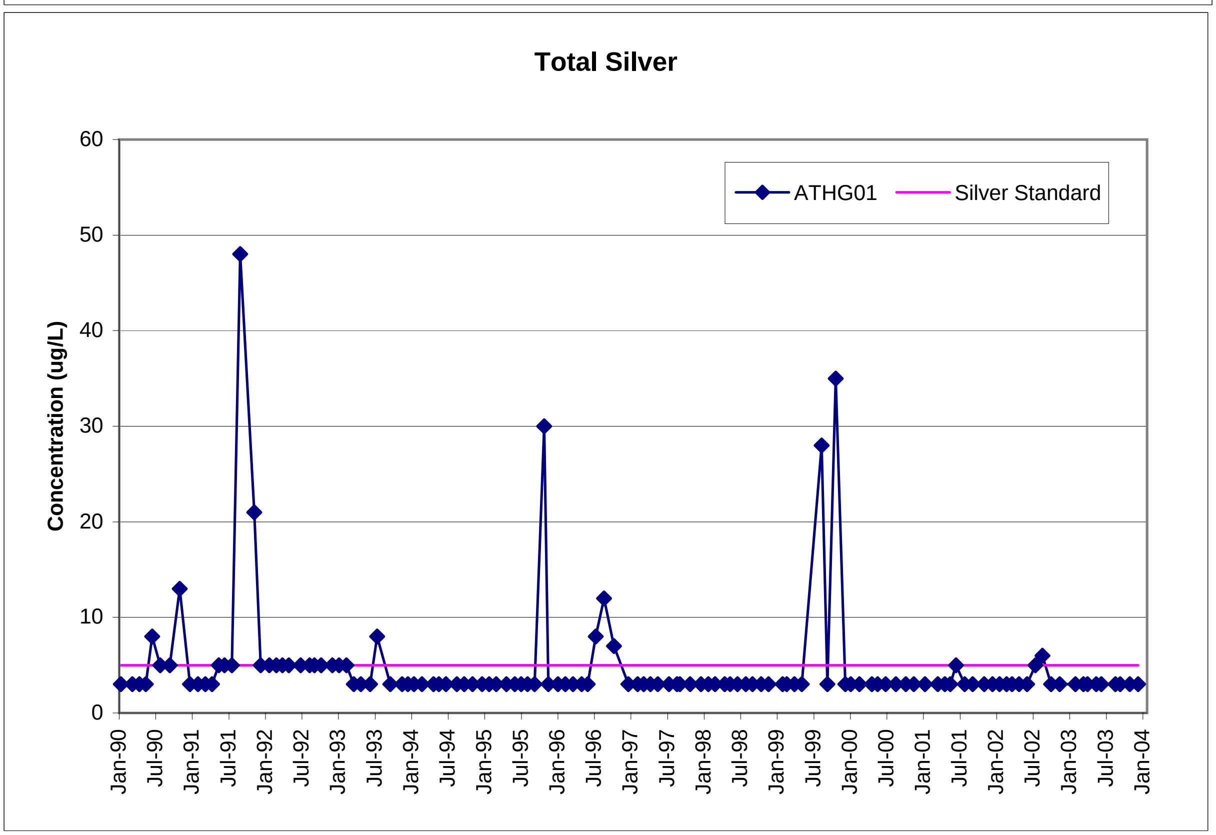

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Figure 5-13:
Sugar Creek
Dissolved Copper and Total Silver Concentrations

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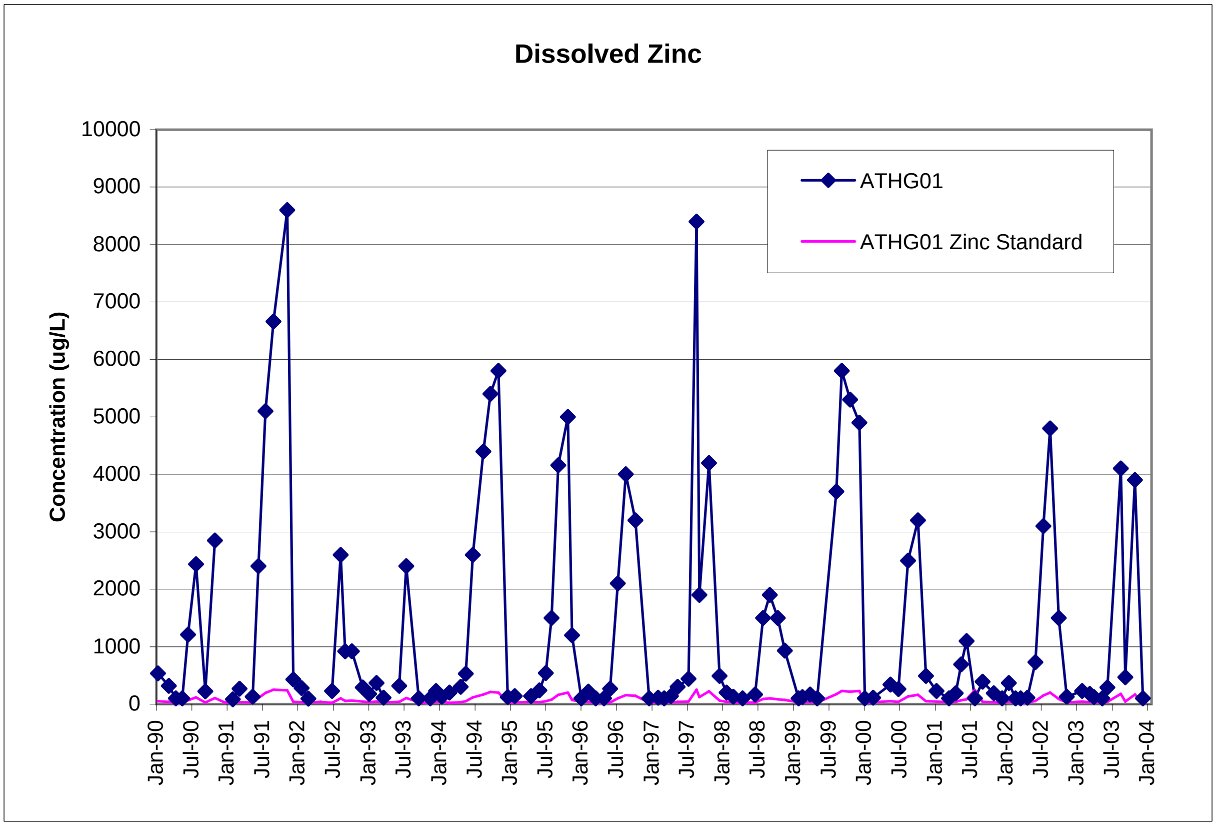

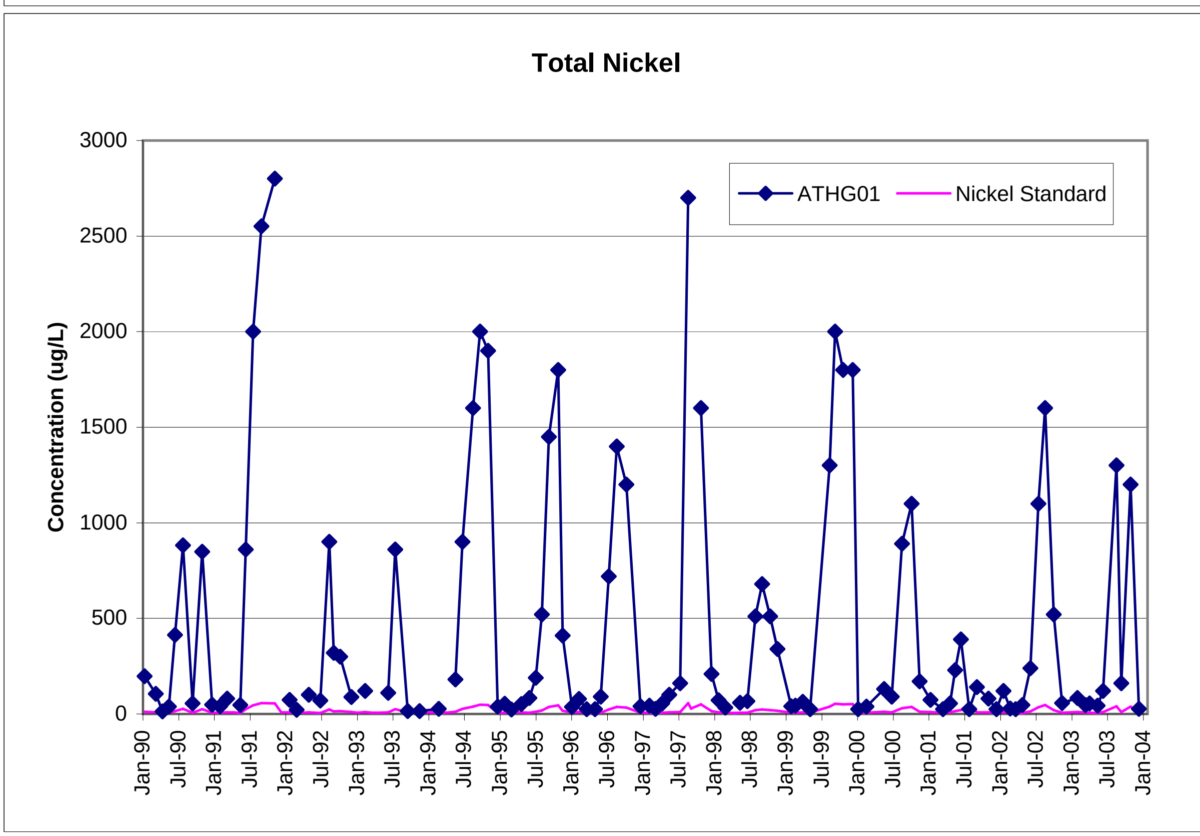

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Figure 5-14:
Sugar Creek
Dissolved Zinc and Nickel Concentrations

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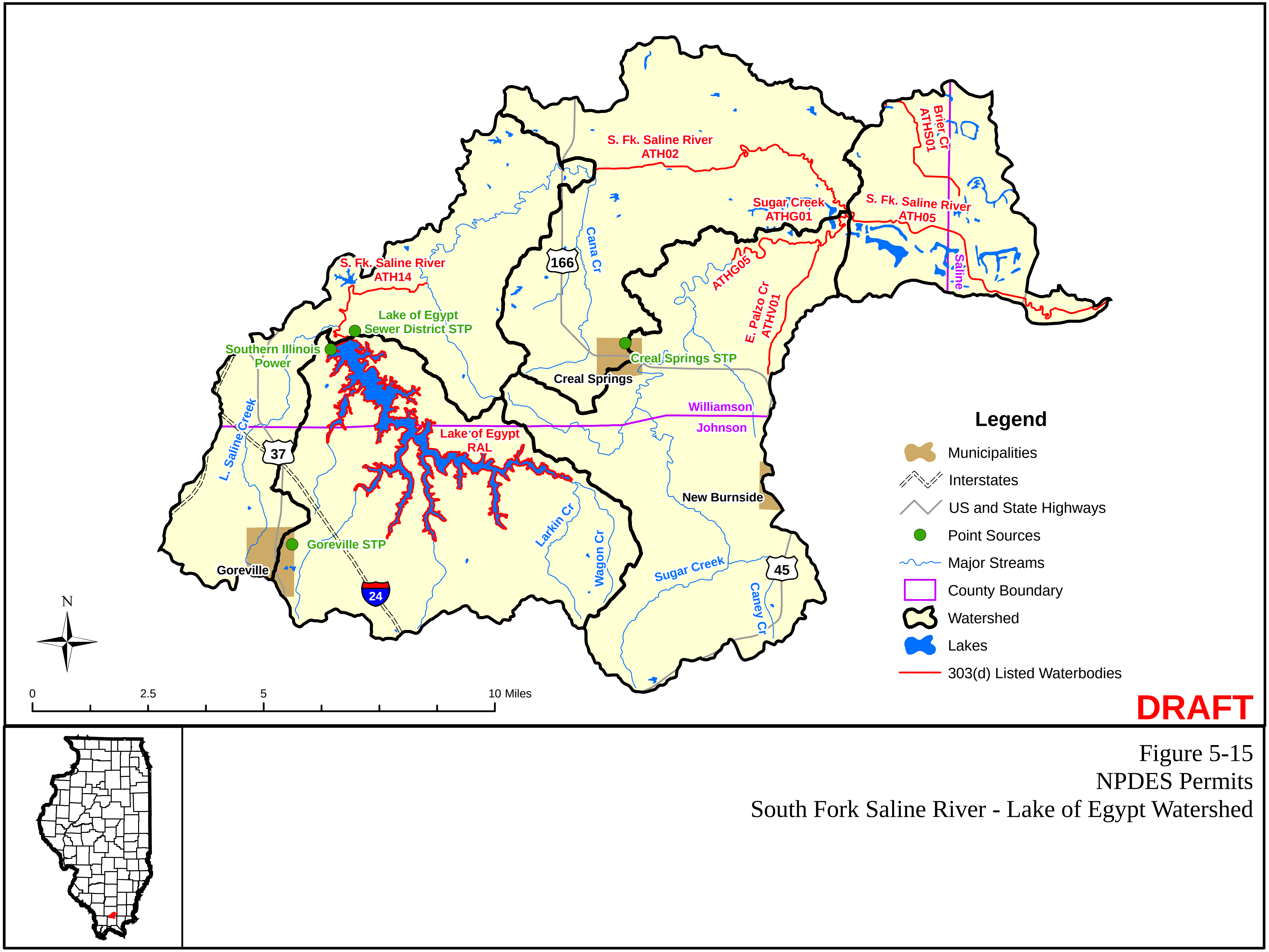

Figure 5-15
NPDES Permits
South Fork Saline River - Lake of Egypt Watershed

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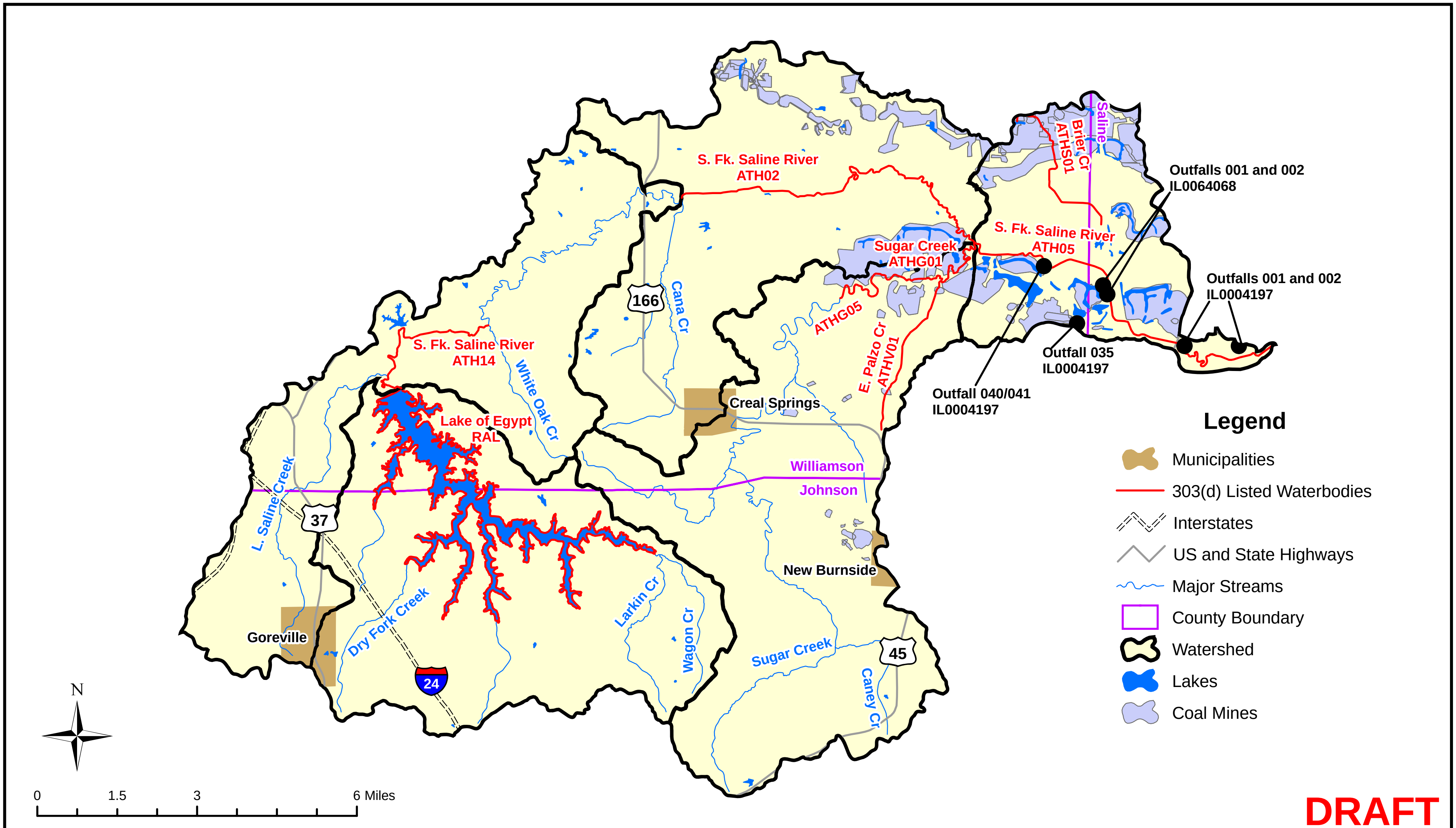

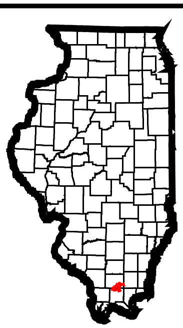

Figure 5-16
Locations of Coal Mines
South Fork Saline River- Lake of Egypt Watershed

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Section 6
Approach to Developing TMDL and Identification of Data Needs

Illinois EPA is currently developing TMDLs for pollutants that have numeric water quality standards. Of the pollutants impairing stream segments in the South Fork Saline River/Lake of Egypt watershed, manganese, pH, DO, total fecal coliform, cadmium, iron, sulfates, TDS, copper, zinc, nickel and silver are all of the parameters with numeric water quality standards. For the Lake of Egypt, manganese is the only parameter a with numeric water quality standard. Illinois EPA believes that addressing these impairments should lead to an overall improvement in water quality due to the interrelated nature of the other listed pollutants. Recommended technical approaches for developing TMDLs for streams and lakes are presented in this section. Additional data needs are also discussed.

6.1 Simple and Detailed Approaches for Developing TMDLs

The range of analyses used for developing TMDLs varies from simple to complex. Examples of a simple approach include mass-balance, load-duration, and simple watershed and receiving water models. Detailed approaches incorporate the use of complex watershed and receiving water models. Simple approaches typically require less data than detailed approaches and therefore these are the analyses recommended for the South Fork Saline River/Lake of Egypt watershed except for stream segments where major point sources whose NDPES permit may be affected by the TMDL's WLA. Establishing a link between pollutant loads and resulting water quality is one of the most important steps in developing a TMDL. As discussed above, this link can be established through a variety of techniques. The objective of the remainder of this section is to recommend approaches for establishing these links for the constituents of concern in the South Fork Saline River/Lake of Egypt watershed.

6.2 Approaches for Developing TMDLs for Stream Segments in South Fork Saline River/Lake of Egypt Watershed

Stream segments with major point sources in the South Fork Saline River/Lake of Egypt watershed are segments ATH14 and ATH02 of the South Fork Saline River. South Fork Saline River segment ATH05, Sugar Creek segments ATHG01 and ATHG05, East Palzo Creek segment ATHV01 and Brier Creek segment ATHS01 do not have major point sources discharging to them. However, many of these segments are potentially impacted by mining in the area. Approaches for developing TMDLs for areas with and without major point sources are described below.

6.2.1 Recommended Approach for DO TMDLs for Stream Segments without Major Point Sources

South Fork Saline River segment ATH05, Sugar Creek segments ATHG01 and ATHG05, and Brier Creek segment ATHS01 do not have major point sources discharging to them. The data for these segments are limited but available data does suggest impairment of the DO standard. Segment ATHS01 of Brier Creek only has three data points available from 1993. It is recommended that more data be collected on this segment. Once adequate data has been collected for Brier Creek, it is recommended that a simplified approach that involves simulating pollutant oxidation and stream reaeration only within a spreadsheet model be used for the DO TMDLs for these segments. This model simulates steady-state stream DO as a function of carbonaceous and nitrogenous pollutant oxidation and atmospheric reaeration. The model allows for non-uniform stream hydraulics, hydrology, and pollutant loadings at any level of segmentation. It is also free of numerical dispersion as it relies on well-known analytical solutions rather than numerical approximations of the fundamental equations. The model assumes plug flow (no hydrodynamic dispersion), which is likely an acceptable assumption for most small to medium sized streams. The model also does not incorporate the impacts of stream plant life, which generally require site-specific data for meaningful parameterization. A watershed model will not be used for these segments. Using the spreadsheet model iteratively, the BOD loads estimated to cause the DO impairments and to maintain a DO of 5.0 mg/L will be calculated. These calculated loads will become the basis for recommending TMDL reductions if necessary.

6.2.2 Recommended Approach for DO TMDLs for Segments with Major Point Sources

South Fork Saline River segments ATH02 and ATH14 have point sources discharging directly to or upstream of them. For these segments a more complicated approach that would also incorporate the impacts of stream plant activity, and possibly sediment oxygen demand (SOD), and would require a more sophisticated numerical model and an adequate level of measured data to aide in model parameterization is recommended.

Adequate data exists for segment ATH02 while available instream water quality data for the segment ATH14 are limited, particularly spatial data. Therefore additional data collection is recommended for this segment (ATH14). Specific data requirements include a synoptic (snapshot in time) water quality survey of this reach with careful attention to the location of the point source dischargers. This survey should include measurements of flow, hydraulics, DO, temperature, nutrients, and CBOD. The collected data will be used to support the model development and parameterization and will lend significant confidence to the TMDL conclusions.

This newly collected data could then be used to support the development and parameterization of a more sophisticated DO model for this stream and therefore, the use of the QUAL2E model (Brown and Barnwell 1985) could be utilized to accomplish the TMDL analysis for South Fork Saline River. QUAL2E is well-known and USEPA-supported. It simulates DO dynamics as a function of nitrogenous and carbonaceous oxygen demand, atmospheric reaeration, SOD, and phytoplankton photosynthesis and respiration. The model also simulates the fate and transport of nutrients and BOD and the presence and abundance of phytoplankton (as chlorophyll-a). Stream hydrodynamics and temperature are important controlling parameters in the model. The model is essentially only suited to steady-state simulations.

In addition to the QUAL2E model, a simple watershed model such as PLOAD, Unit Area Loads or the Watershed Management Model is recommended to estimated BOD and nutrient loads from non-point sources in the watershed. This model will allow for allocation between point and nonpoint source loads and provide an understanding of percentage of loadings from point sources and nonpoint sources in the watershed.

6.2.3 Recommended Approach for pH TMDLs in Non-Mining Impacted Areas

South Fork Saline River segment ATH02 is listed for a pH impairment. The numbers of impairments are few in relation to the amount of data collected on this segment. In addition, resource extraction that could be a source of impairment is not present in this area of the watershed. Therefore a spreadsheet approach will be utilized, which takes into account natural conditions such as acid rain and soil buffering capacity.

6.2.4 Recommended Approach for pH TMDLs in Mining Impacted Areas

South Fork Saline River segment ATH05, Sugar Creek segments ATHG01 and ATHG05, East Palzo Creek segment ATHV01, and Brier Creek segment ATHS01 are all listed for impairments caused by pH. Segments ATHS01 of Brier Creek and ATHV01 of East Palzo Creek have only three samples available since 1993. It is recommended that more data be collected on these segments. Once adequate data are available for all segments, the procedure used to develop the pH TMDLs in mining areas will be based on an analytical procedure developed by the Kentucky Department of Environmental Protection (2001). The procedure calculates a maximum allowable hydrogen ion loading in the water column to maintain pH standards.

6.2.5 Recommended Approach for Fecal Coliform TMDLs

Segment ATH02 of South Fork Saline River and segment ATHG05 of Sugar Creek are listed as impaired for total fecal coliform. The standard is based on a geometric mean of at least 5 samples collected in a 30 day period during the months of May through October. There have been no instances when this is the case, however, the amount of data available is adequate for TMDL development. The recommended approach for developing TMDLs for these segments is use of the load-duration curve method. The load-duration methodology uses the cumulative frequency distribution of streamflow and pollutant concentration data to estimate the allowable loads for a waterbody.

6.2.6 Recommended Approach for Manganese TMDLs in Non-Mining Impacted Areas

Segment ATH02 of the South Fork Saline River listed for manganese. No apparent sources of manganese have been identified to date and therefore, an empirical loading and spreadsheet analysis will be utilized to calculate this TMDL.

6.2.7 Recommended Approach for Manganese, Sulfates, TDS, and Metal TMDLs in Mining Impacted Areas

Segments impaired for manganese, TDS, sulfates and metals in areas where mining or abandoned mines exist include Segment ATH05 of South Fork Saline River, Segments ATHG01 and ATHG05 of Sugar Creek, Segment ATHS01 of Brier Creek, and Segment ATHV01 of East Palzo Creek. For these segments, a Monte Carlo simulation will be utilized to estimate a long-term average instream concentration needed to meet water quality standards. In order to use the Monte Carlo simulation, more data will need to be collected on Brier Creek and East Palzo Creek. Once adequate data is available for all segments, a distribution based on existing data are inputted in the Monte Carlo simulation program. This distribution is based on the amount of existing data available. Using this defined distribution, the computer simulation program randomly generates values to determine what long-term average (LTA) would be needed so that water quality criteria are met 99.9 percent of the time or so that water quality criteria are exceeded less than once every three years. The TMDL for manganese, TDS, sulfates and metals will be based on this LTA.

6.3 Approaches for Developing a TMDL for Lake of Egypt

Recommended TMDL approaches for Lake of Egypt will be discussed in this section. It is assumed that enough data exists to develop a simple model for use in TMDL development.

6.3.1 Recommended Approach for Manganese TMDL

The Lake of Egypt is a source of public water. Therefore, the applicable water quality standard for manganese in the lake is 150 µg/L. For this TMDL, manganese will not be analyzed because it is assumed that development of a DO TMDL will control the manganese concentrations. The TMDL will first investigate dissolved oxygen levels throughout the water column. The lake is not impaired for DO, however DO compliance is assessed at one-foot depth from the surface. A preliminary review of DO concentrations at greater depths shows that DO levels in the summer have been recorded as low as 0.1 mg/L (sampled at 38 foot depth on 8/17/2000). The manganese target will then be maintenance of hypolimnetic DO concentrations above zero, because the only controllable source of manganese to the lake is the release of manganese from lake sediments during periods when there is no DO in lake bottom waters. The cause of the lack of DO in lake bottom waters is unknown and it is recommended that a spreadsheet analysis be utilized to calculate this TMDL.

CDM

Illinois Environmental
Protection Agency

Stage 2 Data Report

March 2007

Final Report

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Contents

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Figures

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Tables

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Section 1
Introduction

The Illinois Environmental Protection Agency (Illinois EPA) has a three-stage approach to total maximum daily load (TMDL) development. The stages are:

Stage 1 – Watershed Characterization, Data Analysis, Methodology Selection

Stage 2 – Data Collection (optional)

Stage 3 – Model Calibration, TMDL Scenarios, Implementation Plan

This report addresses data collection associated with Stage 2 TMDL development for the following watersheds:

- Bay Creek
- Cahokia Creek/Holiday Shores Lake
- Cedar Creek/Cedar Lake
- Crab Orchard Creek/Crab Orchard Lake
- Crooked Creek
- Little Wabash River
- Mary's River/North Fork Cox Creek
- Sangamon River/Lake Decatur
- Shoal Creek
- South Fork Saline River/Lake of Egypt
- South Fork Sangamon River/Lake Taylorville

Sampling has been completed based on the recommendations presented in Section 6 of each watershed's Stage 1 TMDL report and the sampling plan described within the quality assurance project plan (QAPP). The Stage 2 data will supplement existing data collected and assessed as part of Stage 1 of TMDL development and will support the development of TMDLs under Stage 3 of the process. Where adequate supporting data exist, data collected during Stage 2 activities may also be used to support the delisting of certain parameters from the state 303(d) list.

The remaining sections of this report contain:

- **Section 2 Field Activities** includes information on sampling locations as well as field parameter, grab sample and continuous monitoring data
- **Section 3 Quality Assurance Review** discusses changes in the sampling plan from the original QAPP, data verification and validity, and conformance to the data quality objectives
- **Section 4 Conclusions** summarizes the Stage 2 work and makes recommendations for moving forward

Section 2
Field Activities

TMDL streams were sampled by CDM twice during the fall of 2006 to collect data needed to support water quality modeling and TMDL development. The first round of Stage 2 data collection took place between August 28 and September 29, 2006. The second round of Stage 2 data collection took place between October 16 and November 17, 2006. In addition, three segments within the Little Wabash River watershed were sampled by Illinois EPA between April and August of 2006. Over the course the sampling project, 32 streams (out of a possible 33) and one lake were sampled within the eleven Stage 2 watersheds. Table 2-1 contains data collection dates for each watershed.

Table 2-1: Stage 2 Data Collection Field Dates

Watershed	First Round Dates (2006)	Second Round Dates (2006)
Bay Creek	9/25-9/29	10/30-11/6
Cahokia Creek/Holiday Shores Lake	8/28-9/6	10/16-10/20
Cedar Lake	9/5-9/14	10/30-11/6
Crab Orchard Lake	9/5-9/14	10/30-11/6
Crooked Creek	9/5-9/14	10/16-10/20
South Fork Saline River/Lake of Egypt	9/25-9/29	10/30-11/6
Little Wabash River - CDM	9/5-9/14	10/30-11/16
Little Wabash River – Illinois EPA	4/18-8/8	
Mary's River	9/5-9/14	10/16-10/20
Sangamon River/Lake Decatur	8/28-9/6	10/30-11/3
Shoal	8/28-9/6	10/16-10/20
South Fork Sangamon River/Lake Taylorville	8/28-9/6	10/30-11/3

Sampling was conducted in accordance with the QAPP by CDM personnel at stream and lake locations with sufficient water and access. When time permitted, alternate locations were investigated if water and/or access were limited at original locations. Figures 2-1 through 2-11 show sampling locations used for Stage 2 data collection for each watershed. Refer to section 3.1 for further information related to sampling location changes from the original QAPP. Appendix A contains pictures of each sampling location. The sampling and analysis activities conducted at each sampling location included:

- In-stream field parameterization
- Grab samples for laboratory analysis
- Continuous monitoring
- Stream gaging

2.1 Instream field parameters

Water quality measurements for pH, temperature, dissolved oxygen (DO), conductivity, and turbidity were taken at each accessible sampling location where water was present using an In-Situ 9500 Profiler water quality meter. In-Situ 9500 Profilers were calibrated each morning of field activity. Water quality readings were taken at each accessible site with adequate water at the center of flow and values were recorded in field books. These values are presented in Table 2-2. Table 2-2 also contains sample location latitude and longitude as well as explanatory information as to why a limited number of sites were not sampled.

At each site with adequate and safely wadeable streamflow, flow measurements were recorded using a Marsh McBirney 2000 flow meter. Appendix B contains flow meter data and stream discharge analysis for these sites.

2.2 Grab Samples

Grab samples were collected based on the causes of impairment identified in the 303(d) list as well as data needed to support TMDL development under Stage 3. Samples collected on Owl Creek and South Fork Sangamon River were analyzed by Prairie Analytical Laboratories in Springfield, IL and all other samples collected by CDM were analyzed by ARDL, Inc in Mt. Vernon, IL. Samples were delivered in person to the laboratory or exchanged with laboratory personnel in the field. Select segments in the Little Wabash watershed (Elm River segment CD01, and Little Wabash River segments C09 and C33) were sampled by Illinois EPA and analyzed by the Illinois EPA Laboratory in Champaign, IL.

Table 2-3 contains data collected at each location associated with impairment status. Values shown in bold face with gray background violated the applicable water quality standard. All data analyzed by the laboratories are contained in Appendix C. This appendix includes the data shown in Table 2-3 as well as all other parameters that were sampled in order to support Stage 3 TMDL development. In addition, Appendix C shows data qualifiers as well as detection limits for all samples.

2.3 Continuous Monitoring

In-Situ 9500 Professional XP multi-parameter data-logging sondes were used for continuous data measurements on streams impaired by low DO and/or pH. The sondes were calibrated prior to deployment then deployed for at least 3 days at select locations with adequate water and access. DO, pH, conductivity and temperature data were recorded at 15 minute intervals during sonde deployment, after which the sonde was removed and data were downloaded to a laptop computer. The continuous data associated with impairment causes are presented in Appendix D. Because sondes were not field checked at the time of retrieval, there is a possibility that some experienced times of drying or build-up of sedimentation during deployment. A column was added to the data presented in Appendix D to estimate acceptable or “suspect” data. Data were deemed suspect when low conductivity or high temperature values indicate that the meter was likely out of the water or also at times when field log books indicated that the sonde had not yet been deployed or had been pulled from the stream. The data that were deemed acceptable were plotted on Figures D-1 through D-26. The charts are grouped by watershed and show data collected during the first and second round of sampling at each location.

Violations of the instantaneous DO standard (5.0 mg/L minimum) were not recorded during either monitoring period on the following segments that are currently listed for impairment caused by low DO:

- Cedar Creek AJF16 (Figure D-1)
- Big Muddy River N99 (Figure D-4)
- Shoal Creek OI05 (Figures D-22 and D-23)
- South Fork Saline River ATH08 (Figure D-24)

According to Table B-2 of the Illinois Integrated Water Quality Report (2006), the aquatic life use may also be impaired if DO concentrations are below 6.0 mg/L for more than 16 hours of any 24 hour period. Appendix D also contains this analysis for the segments that did not violate the instantaneous minimum standard. The number of values recorded below 6.0 mg/L during any 24 hour period were counted and if any count was above 64 (64 values equates to 16 hours worth of data), the stream was considered to be potentially impaired by low DO. The following segments did not experience a violation of either the 5.0 mg/L instantaneous standard or the 6.0 mg/L standard as described above:

- Cedar Creek AJF16 (Figure D-1)
- Shoal Creek OI05 (Figures D-22 and D-23)
- South Fork Saline River ATH08 (Figure D-24)

Violations of the pH standard (6.5 minimum, 9.0 maximum) were not recorded during either monitoring period on the following segments that are currently listed for impairment caused by pH:

- Crab Orchard Creek ND12 (Figure D-5)
- Briers Creek ATHS01 (Figure D-25)

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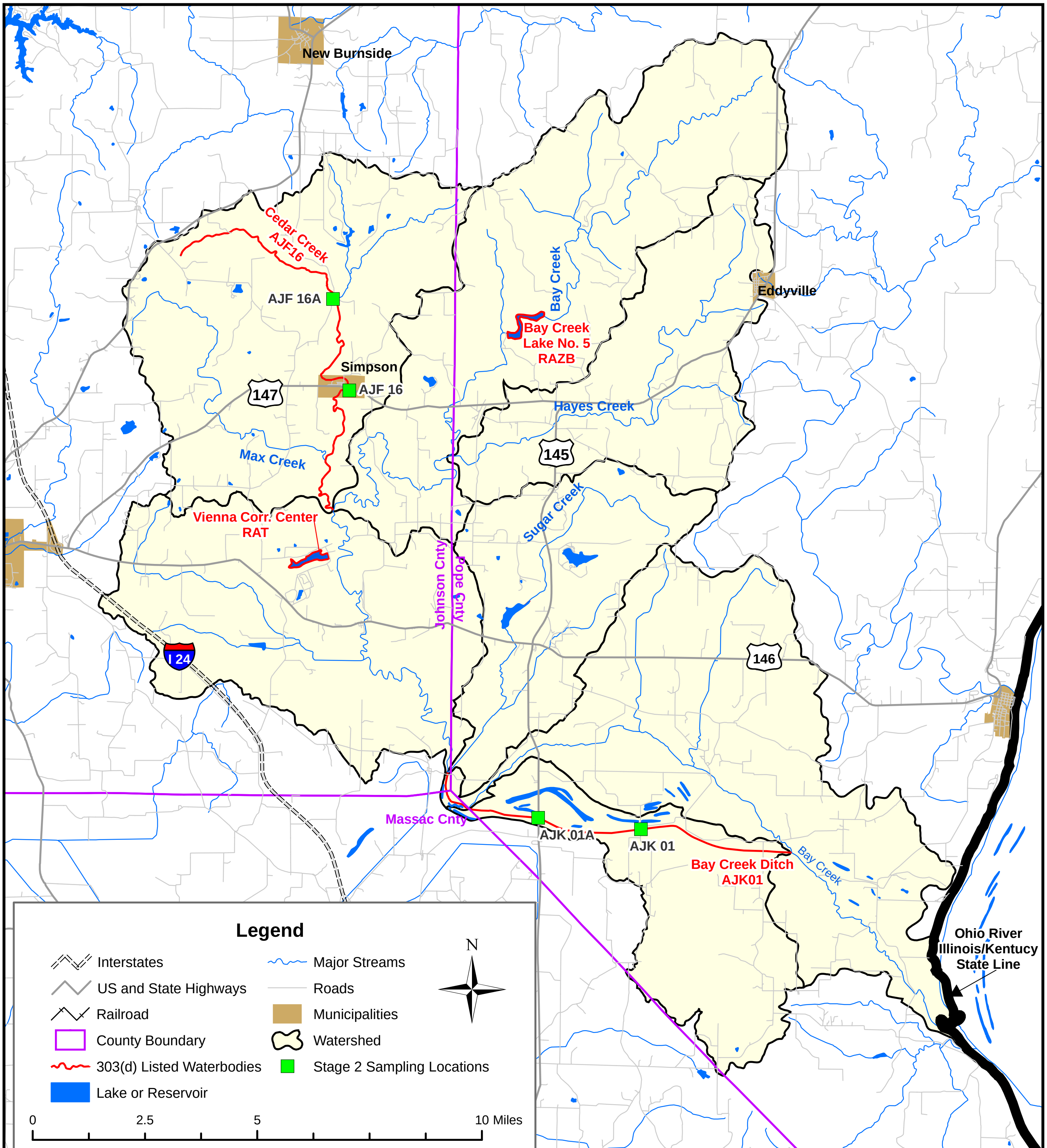

Figure 2-1
Stage 2 Sampling Locations
Bay Creek Watershed

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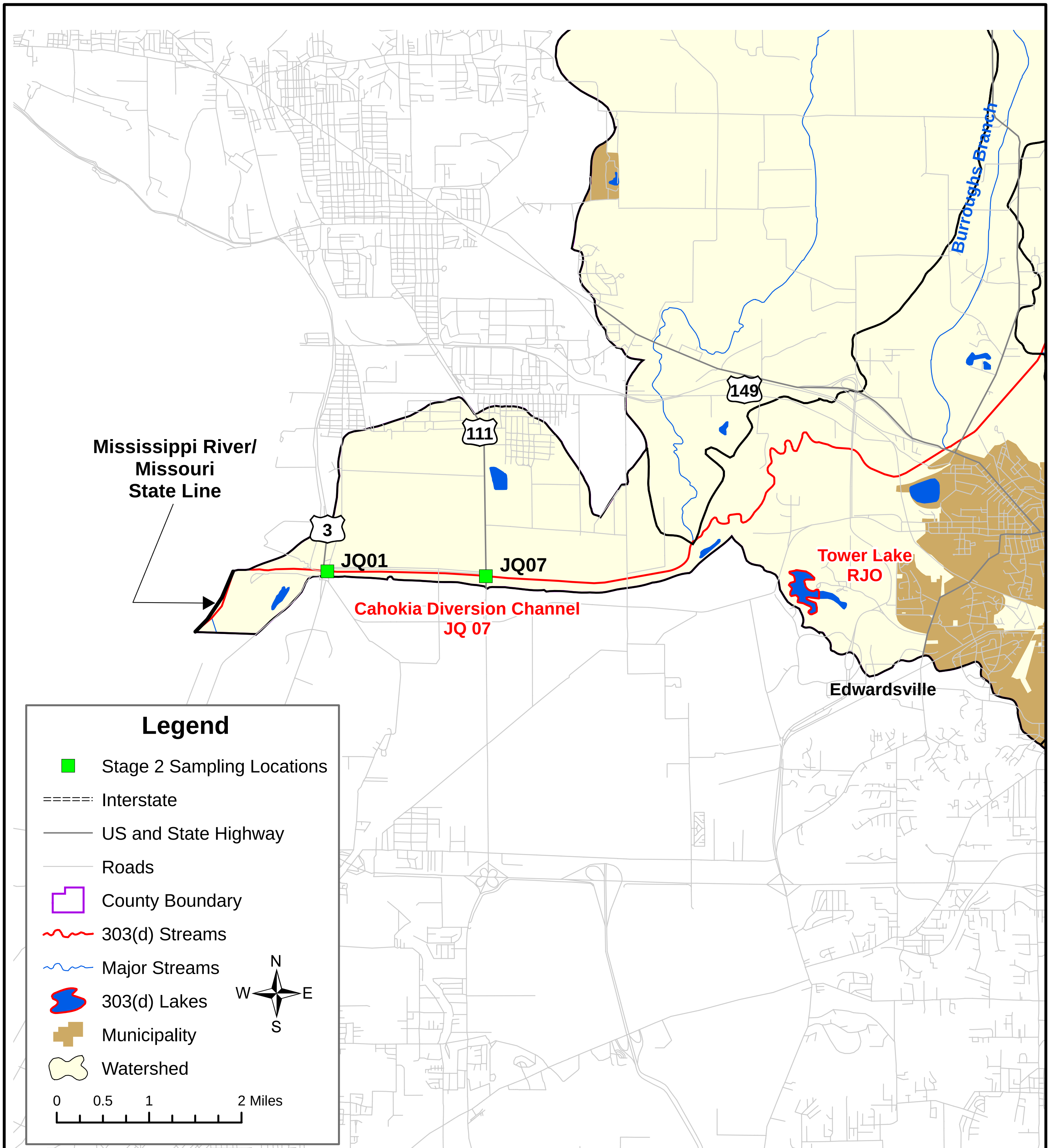

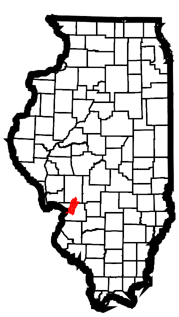

Figure 2-2:
Stage 2 Sampling Locations
Cahokia Creek/Holiday Shores Lake Watershed

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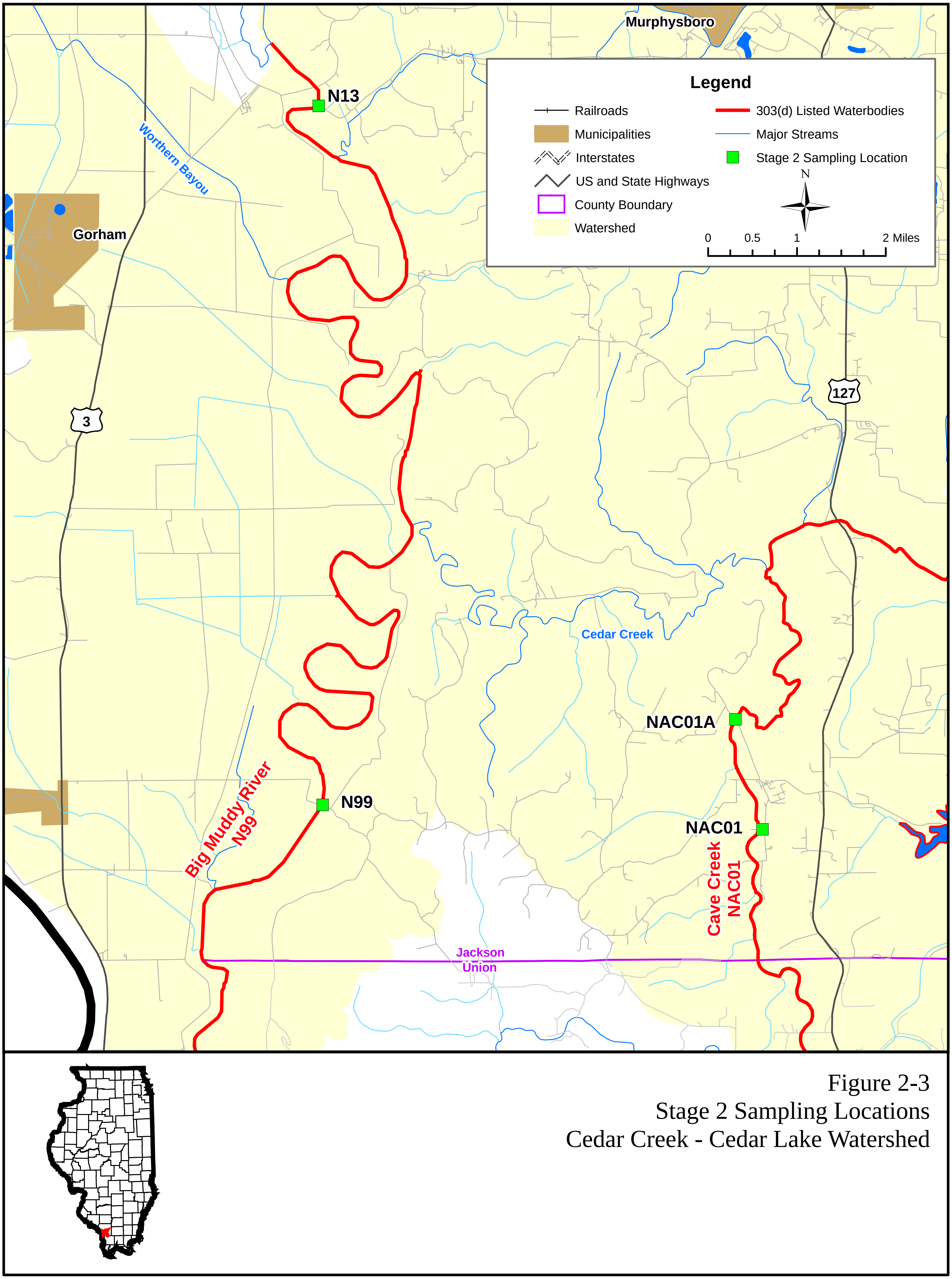

Figure 2-3
Stage 2 Sampling Locations
Cedar Creek - Cedar Lake Watershed

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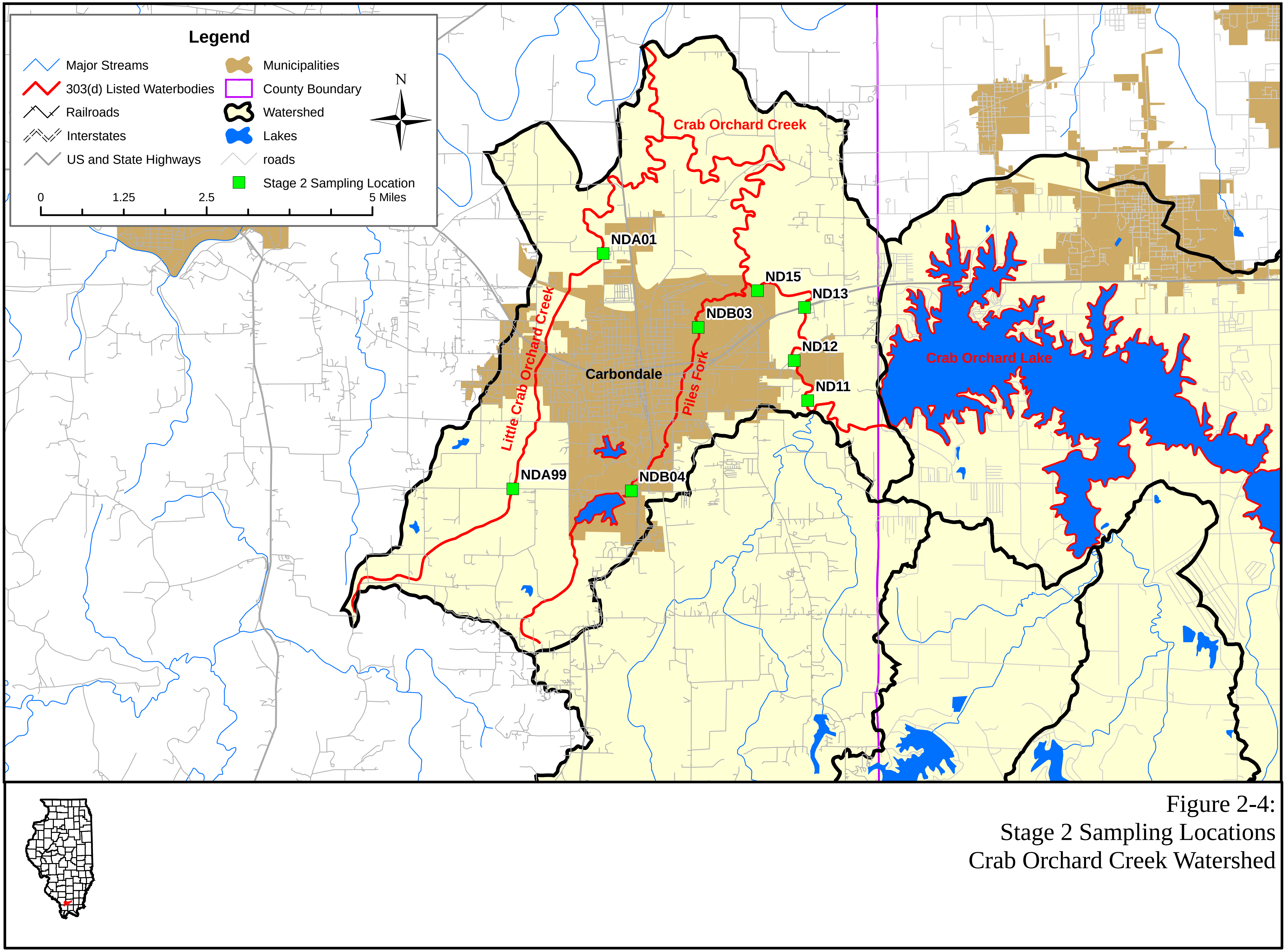

Figure 2-4:
Stage 2 Sampling Locations
Crab Orchard Creek Watershed

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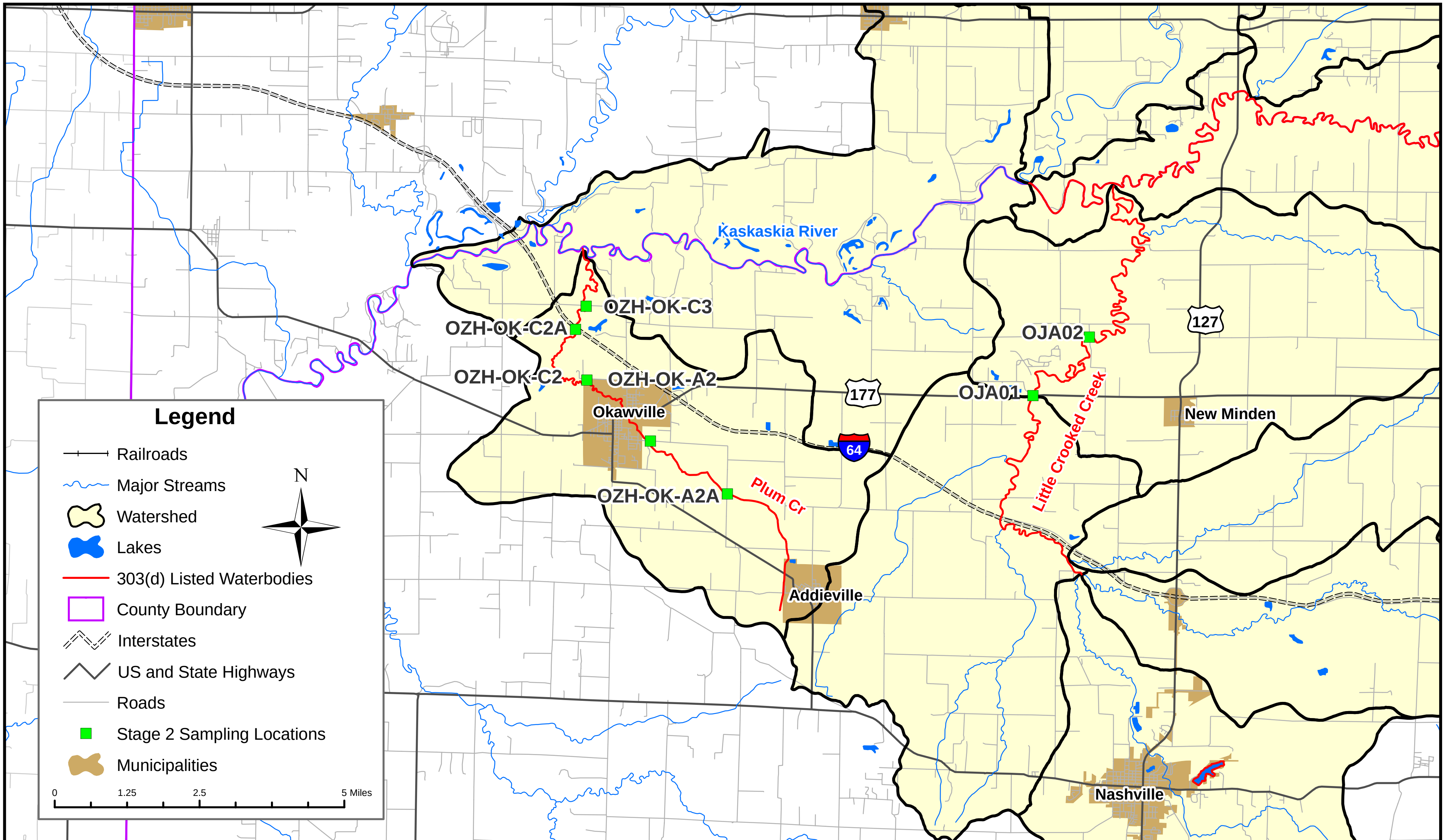

Figure 2-5
Stage 2 Sampling Locations
Crooked Creek Watershed

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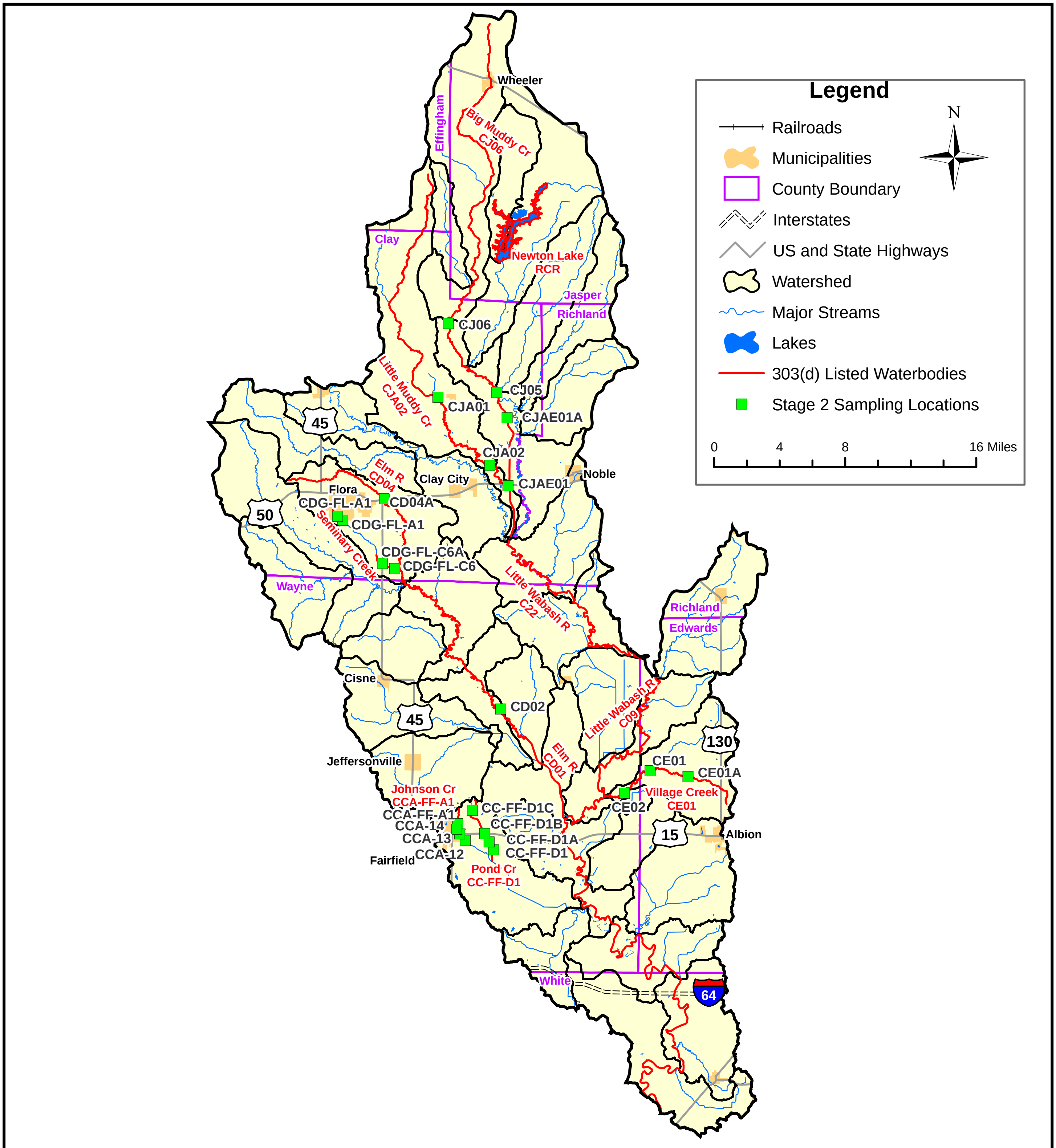

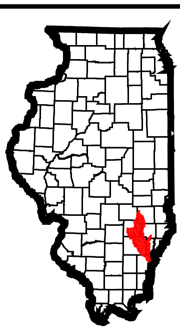

Figure 2-6:
Stage 2 Sampling Locations
Little Wabsash River Watershed

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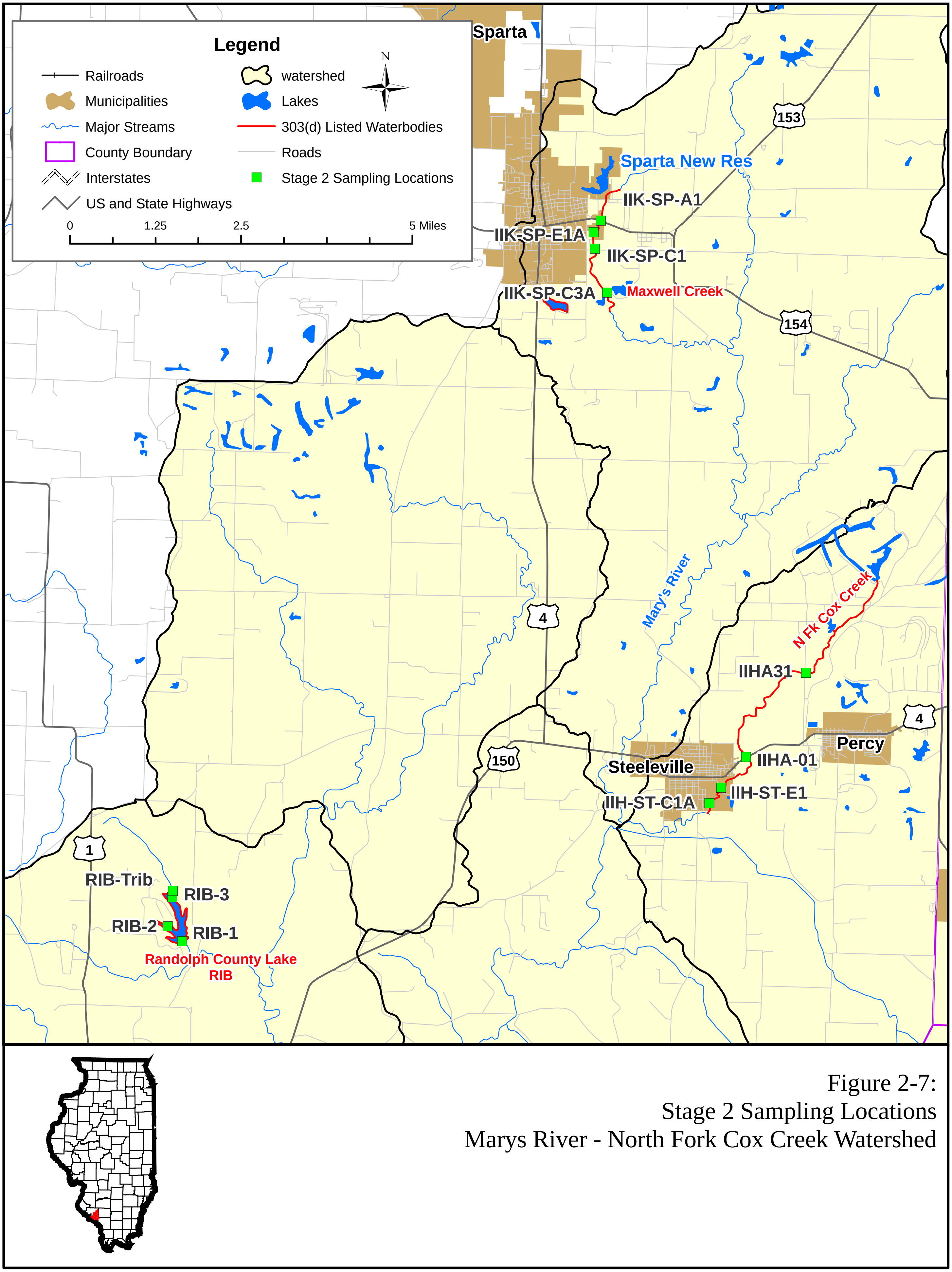

Figure 2-7:
Stage 2 Sampling Locations
Marys River - North Fork Cox Creek Watershed

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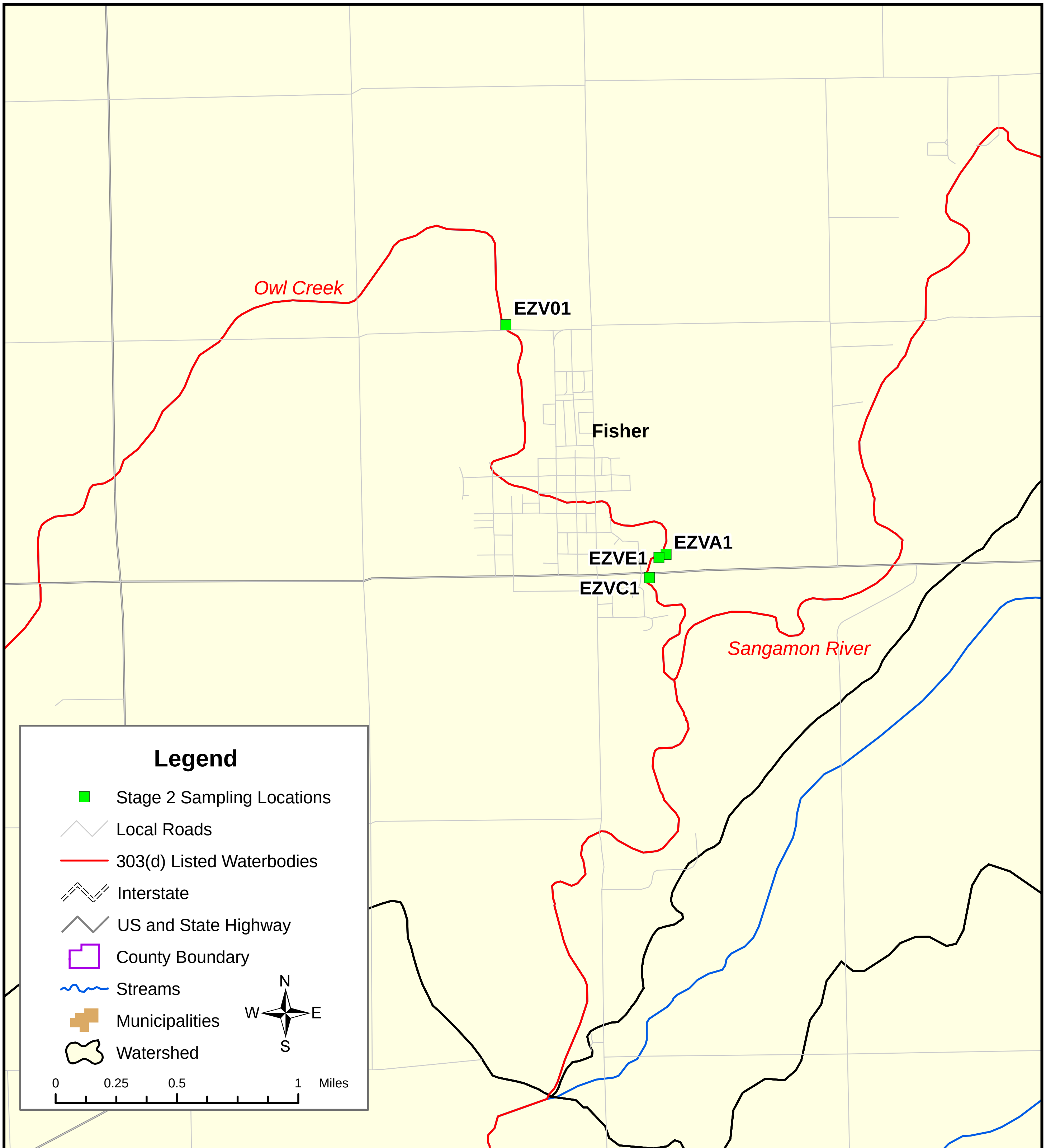

Figure 2-8:
Stage 2 Sampling Locations
Sangamon River - Lake Decatur Watershed

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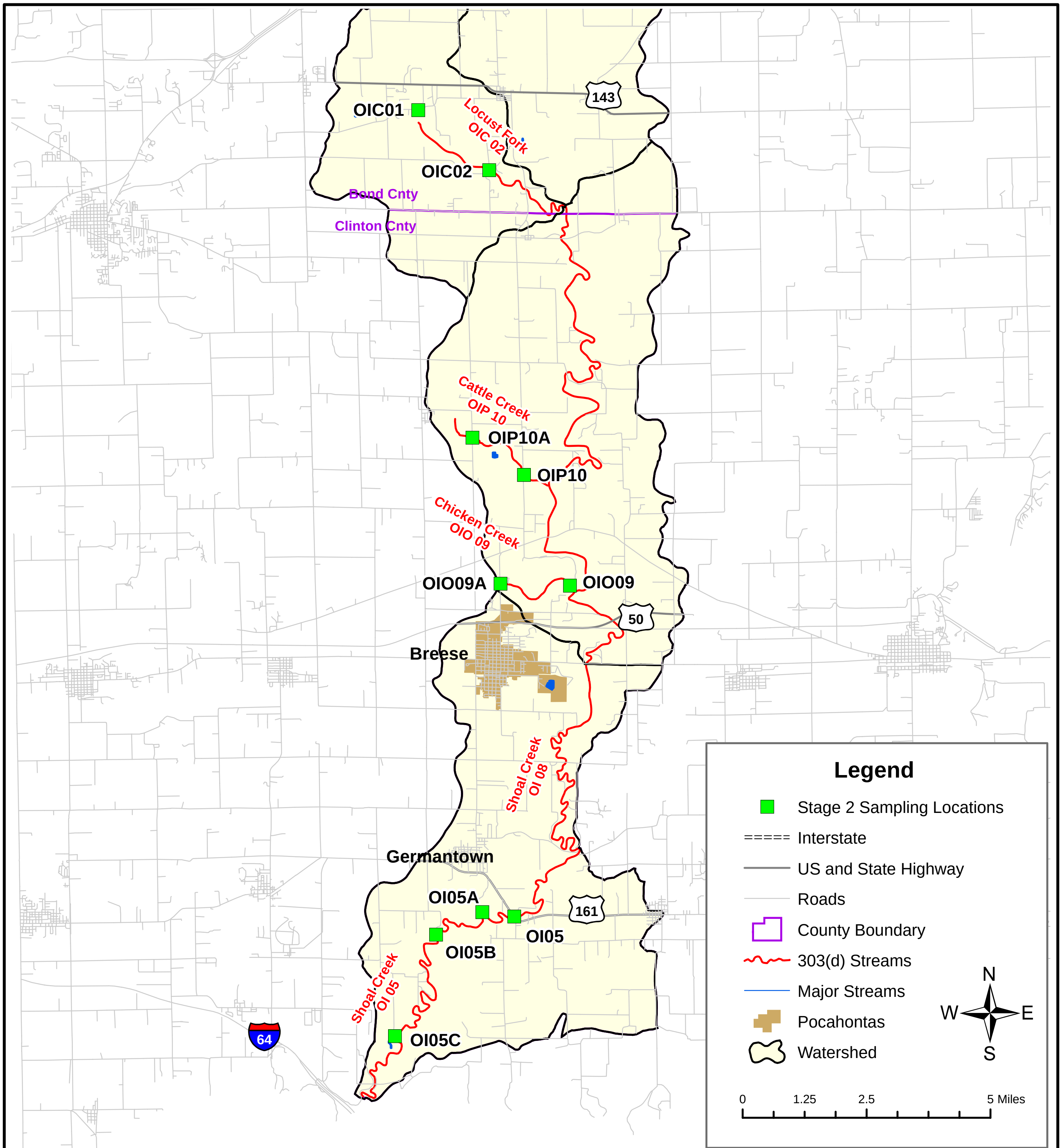

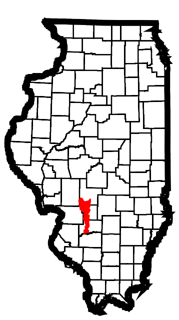

Figure 2-9:
Stage 2 Sampling Locations
Shoal Creek Watershed

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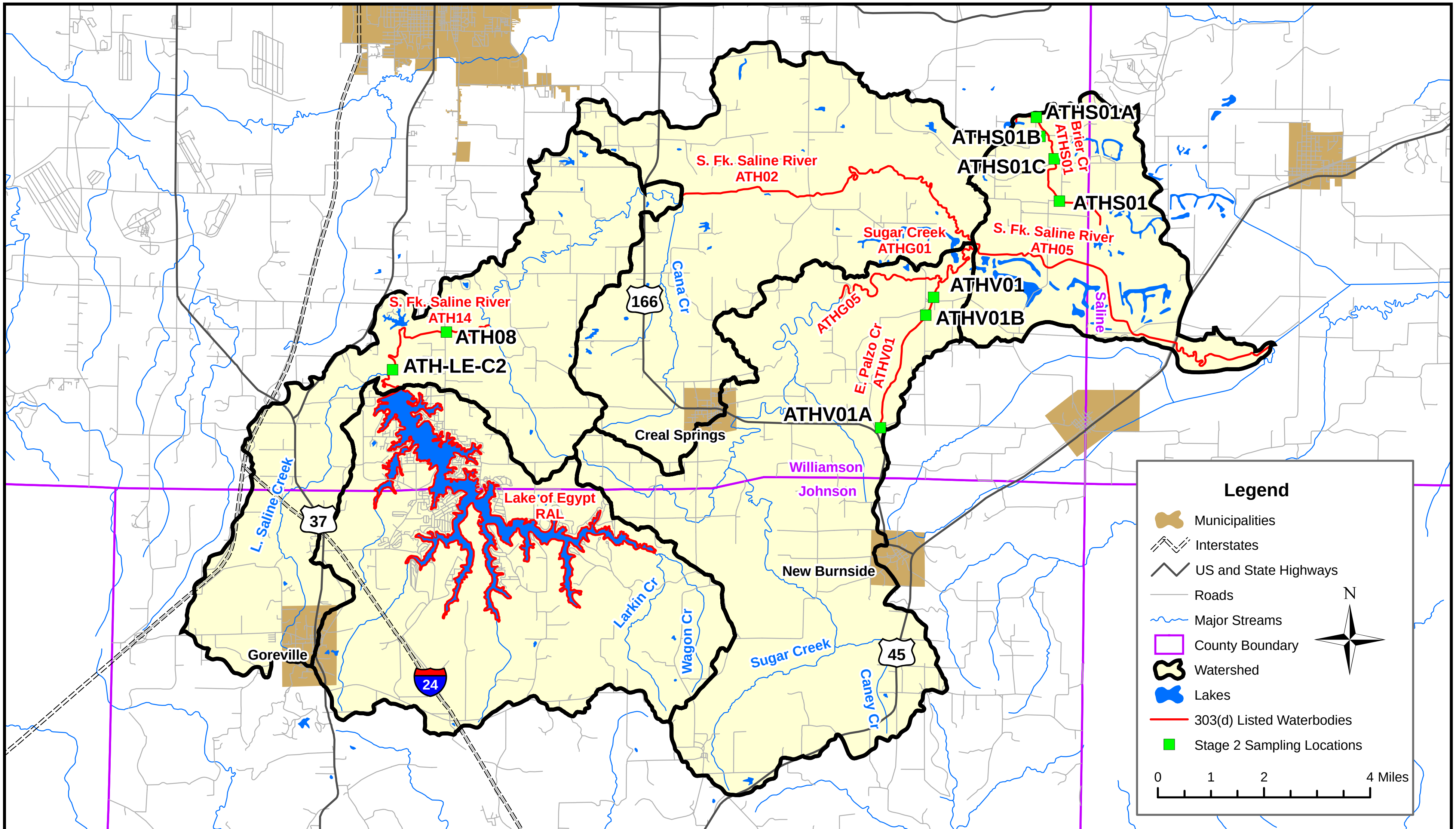

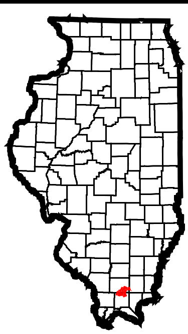

Figure 2-10
Stage 2 Sampling Locations
South Fork Saline River - Lake of Egypt Watershed

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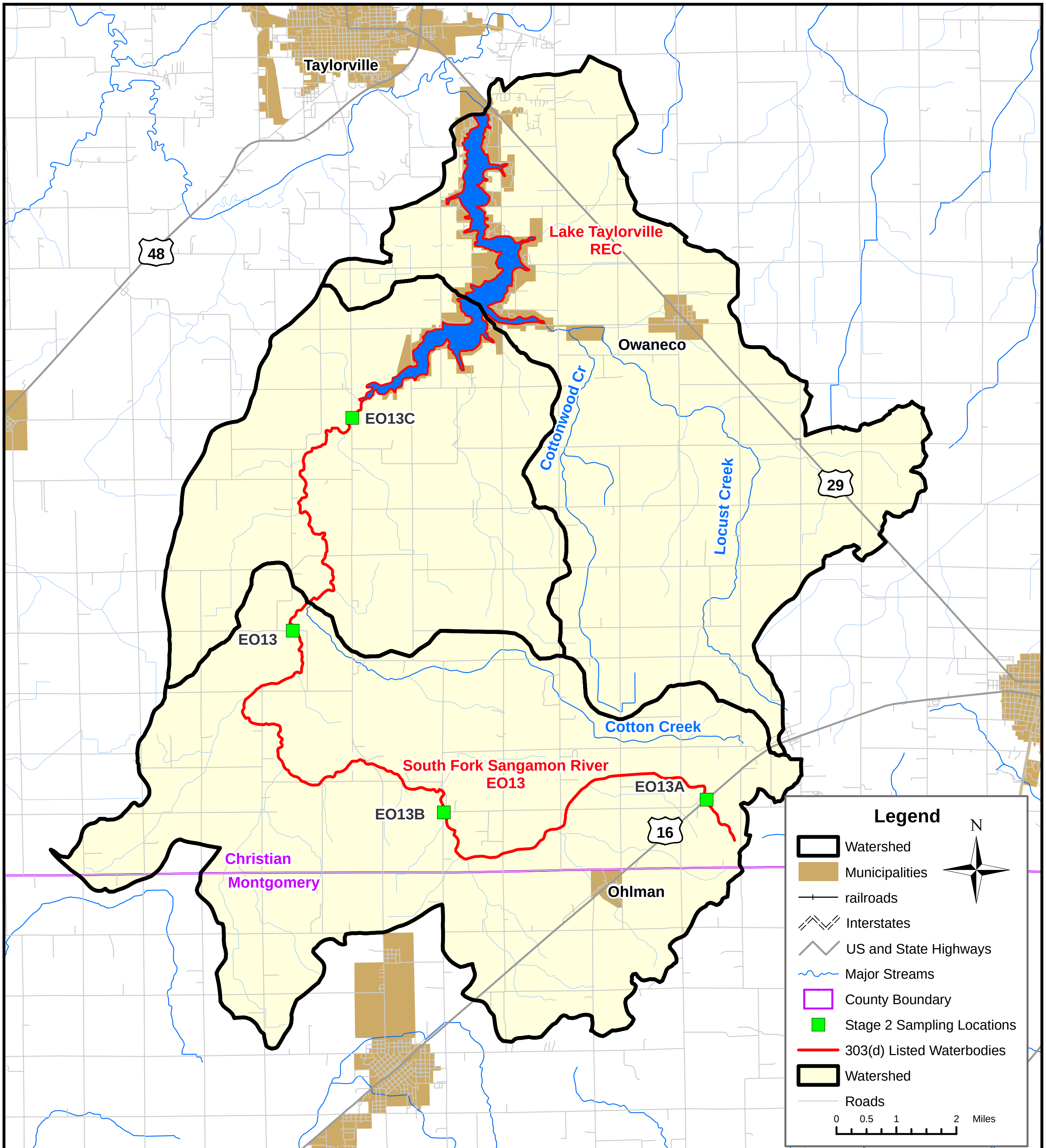

Figure 2-11:
Stage 2 Sampling Locations
South Fork Sangamon River - Lake Taylorville Watershed

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Table 2-2: Field Measurements

Watershed	Water body	Sample Site	Latitude	Longitude	Date	Time	pH (s.u.)	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/l)	Temp. °C	Depth (ft)
Bay Creek	Cedar Creek	AJF16	37.4661	88.7508	9/25/2006	18:00	6.5	117.0	7.8	8.9	63.9	NA
	Cedar Creek	AJF16	37.4661	88.7508	11/3/2006	11:05	7.2	164.5	8.6	11.0	7.0	NA
	Cedar Creek	AJF16A	37.4954	88.7592	9/25/2006	18:15	6.6	81.0	15.6	9.4	64.0	NA
	Cedar Creek	AJF16A	37.4954	88.7592	11/2/2006	13:30	7.3	101.8	5.4	11.6	9.2	NA
	Bay Creek Ditch	AJK01	37.3245	88.6337	9/25/2006	15:58	6.3	74.0	17.2	5.6	66.6	NA
	Bay Creek Ditch	AJK01	37.3245	88.6337	10/31/2006	8:15	7.2	91.6	20.4	8.2	12.8	NA
	Bay Creek Ditch	AJK01A	37.3282	88.6747	9/25/2006	NOT SAMPLED *Site flooded over banks into surrounding fields with no access/alternate site not located*						NA
	Bay Creek Ditch	AJK01A	37.3282	88.6747	10/31/2006	8:45	7.1	91.1	44.5	6.1	13.2	NA
Cahokia Creek/Holiday Shores Lake	Cahokia Diversion Ditch	JQ01	38.8054	90.1023	8/31/2006	13:40	7.4	606.7	62.3	3.4	23.9	NA
	Cahokia Diversion Ditch	JQ01	38.8054	90.1023	10/17/2006	14:45	8.3	459.8	92.9	9.6	12.6	NA
	Cahokia Diversion Ditch	JQ07	38.8050	90.0673	8/31/2006	14:45	7.4	498.6	68.0	5.3	23.0	NA
	Cahokia Diversion Ditch	JQ07	38.8050	90.0673	10/17/2006	14:15	8.3	427.0	115.8	9.4	12.8	NA
Cedar Creek	Big Muddy River	N13	37.7392	89.4284	9/7/2006	11:15	7.6	646.1	45.5	8.1	29.9	NA
	Big Muddy River	N13	37.7392	89.4284	11/1/2006	10:45	7.1	319.1	258.5	8.2	11.2	NA
	Big Muddy River	N99	37.6252	89.4284	9/7/2006	12:15	7.7	749.5	40.2	10.1	23.6	NA
	Big Muddy River	N99	37.6252	89.4284	11/1/2006	9:45	7.4	333.4	188.4	7.8	11.5	NA
	Cave Creek	NAC01	37.6154	89.3395	9/11/2006	11:45	7.8	288.4	N/A	7.6	20.4	NA
	Cave Creek	NAC01	37.6154	89.3395	11/1/2006	11:45	7.8	213.2	24.0	10.6	9.8	NA
	Cave Creek	NAC01A	37.6380	89.5660	9/11/2006	11:15	7.5	330.3	N/A	4.9	20.5	NA
	Cave Creek	NAC01A	37.6380	89.5660	11/1/2006	12:15	7.7	227.7	20.6	10.1	10.2	NA
Crab Orchard Creek	Crab Orchard Creek	ND11	37.7198	89.1717	9/6/2006	12:15	7.3	385.9	N/A	5.2	20.1	NA
	Crab Orchard Creek	ND11	37.7198	89.1717	11/1/2006	14:00	7.7	229.6	26.7	10.1	11.7	NA
	Crab Orchard Creek	ND12	37.7286	89.1753	9/6/2006	13:15	7.3	502.7	N/A	6.4	24.2	NA
	Crab Orchard Creek	ND12	37.7286	89.1753	11/1/2006	15:00	7.7	233.4	52.2	10.4	11.7	NA
	Crab Orchard Creek	ND13	37.7402	89.1723	9/6/2006	15:00	7.4	494.1	N/A	6.0	22.2	NA
	Crab Orchard Creek	ND13	37.7402	89.1723	11/1/2006	15:45	7.3	234.7	19.0	11.1	11.8	NA
	Crab Orchard Creek	ND15	37.7440	89.1852	9/6/2006	16:30	7.0	470.0	N/A	6.8	22.4	NA
	Crab Orchard Creek	ND15	37.7440	89.1852	11/1/2006	NOT SAMPLED *Site located behind Walmart parking lot and not accessible due to large chain link fence/no available alternate sites*						NA
	Little Crab Orchard Creek	NDA01	37.7525	89.2276	9/6/2006	18:00	7.3	242.5	N/A	2.1	19.2	NA
	Little Crab Orchard Creek	NDA01	37.7525	89.2276	11/2/2006	8:30	7.0	225.5	30.4	8.2	6.3	NA
	Little Crab Orchard Creek	NDA99	37.7011	89.2531	9/9/2006	NOT SAMPLED *Site dry and road crossings in the vacinity of site were also dry*						NA
	Little Crab Orchard Creek	NDA99	37.7011	89.2531	11/2/2006	10:30	8.7	190.5	17.0	12.3	5.5	NA
	Piles Fork	NDB03	37.7361	89.2016	9/7/2006	10:00	7.3	404.0	7.4	1.6	18.5	NA
	Piles Fork	NDB03	37.7361	89.2016	11/2/2006	9:15	7.7	240.7	25.5	10.3	7.3	NA
	Piles Fork	NDB04	37.7004	89.2205	9/9/2006	7:40	7.7	753.7	7.8	3.6	17.6	NA
	Piles Fork	NDB04	37.7004	89.2205	11/2/2006	11:00	8.1	154.9	56.5	11.5	10.2	NA
Crooked Creek	Little Crooked Creek	OJA-01	38.4416	89.4170	9/7/2006	17:45	7.0	274.0	22.5	3.7	20.3	NA
	Little Crooked Creek	OJA-01	38.4416	89.4170	10/19/2006	14:05	7.5	335.4	84.1	4.7	12.0	NA
	Little Crooked Creek	OJA-02	38.4564	89.3992	9/8/2006	11:15	7.0	284.8	20.2	3.1	19.7	NA
	Little Crooked Creek	OJA-02	38.4564	89.3992	10/19/2006	14:35	7.3	332.5	48.1	3.8	12.4	NA
	Plum Creek	OZH-OK-A2	38.4290	89.5387	9/8/2006	14:00	7.9	663.3	10.4	6.8	23.9	NA
	Plum Creek	OZH-OK-A2	38.4290	89.5387	10/19/2006	10:50	7.6	390.6	51.8	5.3	11.2	NA
	Plum Creek	OZH-OK-A2A	38.4160	89.5140	9/8/2006	16:45	7.8	503.2	56.9	8.5	22.3	NA
	Plum Creek	OZH-OK-A2A	38.4160	89.5140	10/19/2006	11:20	7.8	341.6	74.7	9.0	9.8	NA
	Plum Creek	OZH-OK-C2	38.4441	89.5592	9/8/2006	12:45	7.3	367.1	11.2	1.1	18.8	NA
	Plum Creek	OZH-OK-C2	38.4441	89.5592	10/19/2006	10:15	7.4	361.7	66.4	2.5	12.0	NA
	Plum Creek	OZH-OK-C2A	38.4568	89.5630	9/8/2006	17:30	7.8	977.9	13.4	4.6	20.7	NA
	Plum Creek	OZH-OK-C2A	38.4568	89.5630	10/19/2006	13:40	7.7	433.1	48.8	3.2	11.5	NA
	Plum Creek	OZH-OK-C3	38.4626	89.5598	9/8/2006	15:00	7.7	983.2	38.5	4.1	21.2	NA
	Plum Creek	OZH-OK-C3	38.4626	89.5598	10/19/2006	9:35	7.5	384.1	556.5	5.2	11.7	NA

Table 2-2: Field Measurements

Watershed	Water body	Sample Site	Latitude	Longitude	Date	Time	pH (s.u.)	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/l)	Temp. °C	Depth (ft)
Little Wabash	Little Wabash River	C09	38.4407	88.2581	1/25/2005	14:00	7.3	415	42	12.1	1.1	NA
	Little Wabash River	C09	38.4407	88.2581	3/17/2005	8:00	8.3	700	23	14.9	7	NA
	Little Wabash River	C09	38.4407	88.2581	4/19/2005	14:30	7.8	535	50	7.3	18.8	NA
	Little Wabash River	C09	38.4407	88.2581	5/9/2005	10:30	7.3	738	60	6.7	19.7	NA
	Little Wabash River	C09	38.4407	88.2581	6/23/2005	7:30	7.7	690	47	5.1	26	NA
	Little Wabash River	C09	38.4407	88.2581	8/23/2005	13:00	7.2	290	70	4.2	27.1	NA
	Little Wabash River	C09	38.4407	88.2581	9/27/2005	16:00	7.8	533	25	7.5	24.6	NA
	Little Wabash River	C09	38.4407	88.2581	10/27/2005	14:00	7.8	550	11	8.7	11.7	NA
	Little Wabash River	C09	38.4407	88.2581	12/6/2005	13:00	7.6	375	70	11.8	1.6	NA
	Little Wabash River	C09	38.4407	88.2581	2/1/2006	13:00	7.6	390	200	9.3	6.8	NA
	Little Wabash River	C09	38.4407	88.2581	3/15/2006	10:00	6.6	150	130	6.2	12.4	NA
	Little Wabash River	C09	38.4407	88.2581	4/18/2006	16:00	7.9	572	40	8.1	20.1	NA
	Little Wabash River	C09	38.4407	88.2581	4/26/2006	10:00	7.8	580	59	7.2	17.7	NA
	Little Wabash River	C09	38.4407	88.2581	5/1/2006	9:45	7.5	543	75	6.4	16.2	NA
	Little Wabash River	C09	38.4407	88.2581	5/10/2006	10:00	7.4	475		6.2	18.5	NA
	Little Wabash River	C09	38.4407	88.2581	5/17/2006	11:00	7.4	421	70	7.4	14.7	NA
	Little Wabash River	C09	38.4407	88.2581	5/24/2006	9:45	7.5	473		6.6	18.9	NA
	Little Wabash River	C09	38.4407	88.2581	5/31/2006	10:20	7.2	352		4	25.3	NA
	Little Wabash River	C09	38.4407	88.2581	6/7/2006	10:15	7.2	345		4.3	23.3	NA
	Little Wabash River	C09	38.4407	88.2581	6/15/2006	8:50	7.4	536	55	5.2	23.9	NA
	Little Wabash River	C09	38.4407	88.2581	6/22/2006	10:05	7.5	608	65	4.4	28.4	NA
	Little Wabash River	C09	38.4407	88.2581	6/27/2006	10:40	7.44	462	64	4.9	24.17	NA
	Little Wabash River	C09	38.4407	88.2581	7/5/2006	10:30	7.2	321		4.4	27.5	NA
	Little Wabash River	C09	38.4407	88.2581	7/12/2006	10:30	7.3	456		3.8	25.3	NA
	Little Wabash River	C09	38.4407	88.2581	7/20/2006	10:00	7.4	372		4.8	29.4	NA
	Little Wabash River	C09	38.4407	88.2581	7/27/2006	10:00	7.2	239		4.8	26.4	NA
	Little Wabash River	C09	38.4407	88.2581	8/1/2006	8:30	7.3	306	65	4.5	30.3	NA
	Little Wabash River	C09	38.4407	88.2581	8/8/2006	11:05	7.3	392	55	4.75	28.4	NA
	Little Wabash River	C33	38.2699	88.1377	4/18/2006	11:00	7.1	418	35	4.4	19.8	NA
	Little Wabash River	C33	38.2699	88.1377	4/26/2006	12:15	7.7	607	56	6	19	NA
	Little Wabash River	C33	38.2699	88.1377	5/1/2006	11:45	7.7	597	58	6.8	16.8	NA
	Little Wabash River	C33	38.2699	88.1377	5/10/2006	12:20	7.3	409		5.3	18.7	NA
	Little Wabash River	C33	38.2699	88.1377	5/17/2006	14:00	7.4	462	90	7.2	15.5	NA
	Little Wabash River	C33	38.2699	88.1377	5/24/2006	12:15	7.4	494		6.4	19.9	NA
	Little Wabash River	C33	38.2699	88.1377	5/31/2006	12:40	7.2	449		3.9	25.4	NA
	Little Wabash River	C33	38.2699	88.1377	6/7/2006	12:30	6.8	286		3	23.01	NA
	Little Wabash River	C33	38.2699	88.1377	6/15/2006	11:05	7.5	511	45	8.1	25.1	NA
	Little Wabash River	C33	38.2699	88.1377	6/22/2006	12:00	7.2	546	38	3	29.8	NA
	Little Wabash River	C33	38.2699	88.1377	6/27/2006	11:50	7.4	548	61	4.8	26.17	NA
	Little Wabash River	C33	38.2699	88.1377	7/5/2006	13:00	7.3	334		5.8	29	NA
	Little Wabash River	C33	38.2699	88.1377	7/12/2006	12:30	7.1	326		3.4	25.3	NA
	Little Wabash River	C33	38.2699	88.1377	7/20/2006	12:20	6.9	247		3.4	29.9	NA
	Little Wabash River	C33	38.2699	88.1377	7/27/2006	12:10	7.5	308		6.4	27.4	NA
	Little Wabash River	C33	38.2699	88.1377	8/1/2006	10:30	7.3	296	40	4.7	30.8	NA
	Little Wabash River	C33	38.2699	88.1377	8/8/2006	13:30	7.3	361	40	4.9	29.8	NA
	Johnson Creek	CCA12	38.3732	88.3449	9/9/2006	13:05	8.2	1402.0	13.4	14.2	28.4	NA
	Johnson Creek	CCA12	38.3732	88.3449	11/14/2006	9:45	7.5	651.4	645.5	7.7	7.0	NA
	Johnson Creek	CCA13	38.3789	88.3511	9/9/2006	14:30	8.6	1517.0	3.1	14.9	25.4	NA
	Johnson Creek	CCA13	38.3789	88.3511	11/14/2006	10:15	7.7	649.4	19.0	12.8	8.1	NA
	Johnson Creek	CCA14A	38.3830	88.3546	9/9/2006	15:25	7.6	836.0	3.6	5.7	21.6	NA

Table 2-2: Field Measurements

Watershed	Water body	Sample Site	Latitude	Longitude	Date	Time	pH (s.u.)	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/l)	Temp. °C	Depth (ft)
Little Wabash (cont.)	Johnson Creek	CCA14A	38.3830	88.3546	11/14/2006	10:25	7.7	694.2	2.4	12.5	8.0	NA
	Johnson Creek	CCAFFA1A	38.3881	88.3535	9/10/2006	10:50	7.4	788.0	5.9	3.8	19.8	NA
	Johnson Creek	CCAFFA1A	38.3881	88.3535	11/14/2006	10:45	7.4	789.8	4.3	12.3	7.5	NA
	Pond Creek	CCFFD1	38.3648	88.3130	9/9/2006	10:30	7.7	576.0	8.6	7.1	19.5	NA
	Pond Creek	CCFFD1	38.3648	88.3130	10/31/2006	10:10	7.6	8719.7	29.2	8.2	3.8	NA
	Pond Creek	CCFFD1A	38.3720	88.3181	9/9/2006	NOT SAMPLED *Site Dry/no available alternate sites*						NA
	Pond Creek	CCFFD1A	38.3720	88.3181	11/9/2006	12:15	7.3	742.5	9.1	11.2	13.6	NA
	Pond Creek	CCFFD1B	38.3793	88.3230	9/9/2006	11:45	7.5	784.0	10.0	8.6	22.9	NA
	Pond Creek	CCFFD1B	38.3793	88.3230	11/9/2006	11:35	7.3	827.9	4.1	12.1	12.7	NA
	Pond Creek	CCFFD1C	38.3999	88.3370	9/10/2006	12:10	8.0	3941.0	17.8	11.9	19.3	NA
	Pond Creek	CCFFD1C	38.3999	88.3370	10/31/2006	11:20	8.8	1394.0		14.4	4.4	NA
	Elm River	CD01	38.5184	88.1320	1/26/2005	13:00	7.1	388	36	9.1	1.4	NA
	Elm River	CD01	38.5184	88.1320	3/15/2005	11:30	8.4	950	7.2	14.6	6.2	NA
	Elm River	CD01	38.5184	88.1320	4/20/2005	11:30	7.4	670	60	6.7	20.1	NA
	Elm River	CD01	38.5184	88.1320	5/5/2005	13:00	7.5	625	27	7.6	13.8	NA
	Elm River	CD01	38.5184	88.1320	6/23/2005	10:00	7.5	1050	22	5.2	24.7	NA
	Elm River	CD01	38.5184	88.1320	8/18/2005	11:00	7.6	730	34	3.6	24.6	NA
	Elm River	CD01	38.5184	88.1320	9/29/2005	11:30	7.6	700	17	3.6	18.5	NA
	Elm River	CD01	38.5184	88.1320	10/18/2005	11:30	7.5	680	8.2	5.9	15	NA
	Elm River	CD01	38.5184	88.1320	12/8/2005	10:30	7.4	321	65	9.6	0.3	NA
	Elm River	CD01	38.5184	88.1320	2/1/2006	15:00	7.5	430	80	9.1	7	NA
	Elm River	CD01	38.5184	88.1320	3/1/2006	13:30	7.4	840	42	10.2	9.1	NA
	Elm River	CD01	38.5184	88.1320	4/6/2006	11:00	7.3	440	90	8.6	13.5	NA
	Elm River	CD01	38.5184	88.1320	4/18/2006	14:30	7.3	670	40	5.6	20.9	NA
	Elm River	CD01	38.5184	88.1320	4/26/2006	11:15	7.5	860		6.2	15.9	NA
	Elm River	CD01	38.5184	88.1320	5/1/2006	11:00	7.4	958		5.9	15.2	NA
	Elm River	CD01	38.5184	88.1320	5/10/2006	11:10	7.2	489		5	18.2	NA
	Elm River	CD01	38.5184	88.1320	5/17/2006	9:30	7.1	484	35	7	13.8	NA
	Elm River	CD01	38.5184	88.1320	5/24/2006	11:20	7.2	594		5.7	18.5	NA
	Elm River	CD01	38.5184	88.1320	5/31/2006	11:30	7.2	605		3.8	25.7	NA
	Elm River	CD01	38.5184	88.1320	6/7/2006	11:25	7	346		4.5	23.4	NA
	Elm River	CD01	38.5184	88.1320	6/15/2006	9:50	7.1	622		4.6	22.5	NA
	Elm River	CD01	38.5184	88.1320	6/22/2006	11:15	7.1	443		4.6	27.9	NA
	Elm River	CD01	38.5184	88.1320	6/27/2006	9:15	6.77	229	91	5	21.95	NA
	Elm River	CD01	38.5184	88.1320	7/5/2006	11:50	7.2	588		3.6	26.6	NA
	Elm River	CD01	38.5184	88.1320	7/12/2006	11:30	7.2	569		4.2	23.9	NA
	Elm River	CD01	38.5184	88.1320	7/20/2006	11:15	7	285		2.8	28.2	NA
	Elm River	CD01	38.5184	88.1320	7/27/2006	11:05	7.1	346		3.5	25.8	NA
	Elm River	CD01	38.5184	88.1320	8/1/2006	9:20	7.3	382		4	27.8	NA
	Elm River	CD01	38.5184	88.1320	8/8/2006	12:20	7.1	425		4.1	26.3	NA
	Elm River	CD02	38.6751	88.4362	9/8/2006	17:45	7.5	344.0	15.9	8.1	23.2	NA
	Elm River	CD02	38.6751	88.4362	11/8/2006	NOT SAMPLED *Miscommunication between field crews caused error in sampling*						NA
	Elm River	CD02A	38.4894	88.3051	9/12/2006	12:51	7.2	404.0	15.7	3.8	22.0	NA
	Elm River	CD02A	38.4894	88.3051	11/8/2006	NOT SAMPLED *Miscommunication between field crews caused error in sampling*						NA
	Seminary Creek	CDFGLC6	38.6180	88.4384	9/8/2006	12:25	7.7	708.0	4.2	6.6	19.5	NA
	Seminary Creek	CDFGLC6	38.6180	88.4384	11/8/2006	17:00	7.5	527.6	17.5	10.5	12.4	NA
	Seminary Creek	CDFGLC6A	38.6135	88.4245	9/8/2006	11:10	7.7	720.0	201.2	7.0	20.1	NA
	Seminary Creek	CDFGLC6A	38.6135	88.4245	11/8/2006	16:45	7.3	561.7	15.1	12.0	13.5	NA
	Seminary Creek	CDGFLA1	38.6561	88.4832	9/8/2006	15:40	7.9	558.0	7.0	10.0	22.0	NA
	Seminary Creek	CDGFLA1	38.6561	88.4832	11/8/2006	14:45	7.3	385.0	12.5	14.3	12.7	NA

Table 2-2: Field Measurements

Watershed	Water body	Sample Site	Latitude	Longitude	Date	Time	pH (s.u.)	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/l)	Temp. °C	Depth (ft)
Little Wabash (cont.)	Seminary Creek	CDGFLA1A	38.6595	88.4890	9/8/2006	13:45	7.4	362.0	22.7	2.6	19.0	NA
	Seminary Creek	CDGFLA1A	38.6595	88.4890	11/8/2006	15:50	7.2	429.8	16.8	15.1	12.7	NA
	Village Creek	CE01	38.4348	88.1369	9/6/2006	17:30	8.1	610.0	11.4	9.9	24.9	NA
	Village Creek	CE01	38.4348	88.1369	11/14/2006	8:45	7.5	697.9	8.0	10.6	6.8	NA
	Village Creek	CE01A	38.4294	88.0943	9/12/2006	17:05	7.2	327.0	145.2	5.8	22.6	NA
	Village Creek	CE01A	38.4294	88.0943	11/9/2006	13:45	7.2	607.2	8.7	11.2	14.2	NA
	Village Creek	CE02	38.4150	88.1659	9/6/2006	15:20	7.8	568.0	15.7	7.9	25.0	NA
	Village Creek	CE02	38.4150	88.1659	11/9/2006	12:55	7.5	587.4	14.1	10.7	13.1	NA
	Big Muddy Creek	CJ05	38.7693	88.3093	9/7/2006	16:45	8.2	63.1	11.4	10.5	23.6	NA
	Big Muddy Creek	CJ05	38.7693	88.3093	11/8/2006	11:30	7.4	457.0	32.5	12.4	8.3	NA
	Big Muddy Creek	CJ06	38.8298	88.3642	9/7/2006	18:10	7.5	588.0	34.6	4.9	21.8	NA
	Big Muddy Creek	CJ06	38.8298	88.3642	11/8/2006	11:00	7.3	455.1	15.8	11.6	10.6	NA
	Little Muddy Creek	CJA01	38.7647	88.3760	9/12/2006	10:20	7.0	321.0	9.5	3.4	20.9	NA
	Little Muddy Creek	CJA01	38.7647	88.3760	11/13/2006	12:00	7.0	267.9	113.2	10.1	7.4	NA
	Little Muddy Creek	CJA02	38.7047	88.3174	9/7/2006	14:20	6.8	554.0	45.9	2.8	20.4	NA
	Little Muddy Creek	CJA02	38.7047	88.3174	11/8/2006	12:30	7.0	497.0	35.8	9.3	10.4	NA
	Big Muddy Diversion Ditch	CJAE01	38.6865	88.2967	9/7/2006	12:10	7.1	1946.0	26.9	9.1	22.2	NA
	Big Muddy Diversion Ditch	CJAE01	38.6865	88.2967	11/8/2006	13:05	7.3	478.2	30.8	10.8	11.7	NA
	Big Muddy Diversion Ditch	CJAE01A	38.7467	88.2977	9/7/2006	15:45	8.1	908.0	6.5	10.3	24.3	NA
	Big Muddy Diversion Ditch	CJAE01A	38.7467	88.2977	11/13/2006	12:30	7.6	452.9	37.8	9.8	8.2	NA
Mary's River/North Fork Cox Creek	North Fork Cox Creek	IIHA01	38.0114	89.6460	9/9/2006	17:40	7.9	2073.0	N/A	10.0	22.0	NA
	North Fork Cox Creek	IIHA01	38.0114	89.6460	10/18/2006	14:25	8.3	2995.0	13.5	8.1	15.4	NA
	North Fork Cox Creek	IIHA31	38.0293	89.6303	9/9/2006	17:10	8.2	3491.0	N/A	9.6	23.9	NA
	North Fork Cox Creek	IIHA31	38.0293	89.6303	10/18/2006	14:45	8.4	3215.0	8.5	8.6	15.5	NA
	North Fork Cox Creek	IIHA-STC1	38.0015	89.6557	9/9/2006	16:15	7.8	3019.0	N/A	7.1	21.9	NA
	North Fork Cox Creek	IIHA-STC1	38.0015	89.6557	10/18/2006	14:00	8.1	1990.0	20.0	7.0	14.9	NA
	North Fork Cox Creek	IIHA-STE1	38.0048	89.6526	9/9/2006	15:45	7.8	3422.0	N/A	6.9	20.7	NA
	North Fork Cox Creek	IIHA-STE1	38.0048	89.6526	10/18/2006	13:40	8.0	2505.0	16.3	6.0	14.7	NA
	Maxwell Creek	IIKSPA1	38.1242	89.6870	9/7/2006	NOT SAMPLED						NA
	Maxwell Creek	IIKSPA1	38.1242	89.6870	10/17/2006	*Site dry during both visits/available alternate locations also dry*						NA
	Maxwell Creek	IIKSPC1	38.1182	89.6885	9/7/2006	15:30	7.3	968.1	4.8	2.0	24.3	NA
	Maxwell Creek	IIKSPC1	38.1182	89.6885	10/17/2006	8:20	7.1	561.5	22.3	20.2	18.4	NA
	Maxwell Creek	IIKSPC3A	38.1090	89.6850	9/7/2006	15:00	7.5	997.0	4.4	2.6	21.6	NA
	Maxwell Creek	IIKSPC3A	38.1090	89.6850	10/17/2006	8:45	7.5	457.8	19.2	6.5	15.4	NA
	Maxwell Creek	IIKSPE1A	38.1218	89.6889	9/7/2006	NOT SAMPLED						NA
	Maxwell Creek	IIKSPE1A	38.1218	89.6889	10/17/2006	*Site dry during both visits/available alternate locations also dry*						NA
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:00	9.1	279.7	N/A	13.9	25.6	1
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:02	9.1	279.5	N/A	13.9	24.9	2
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:04	9.1	279.2	N/A	13.8	24.7	3
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:06	9.1	278.8	N/A	13.9	24.6	4
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:08	9.0	279.3	N/A	13.2	24.4	5
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:10	9.0	279.7	N/A	12.6	24.3	6
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:12	8.9	280.4	N/A	11.8	24.2	7
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:14	8.2	286.0	N/A	6.2	23.9	8
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:16	7.8	287.4	N/A	4.4	23.7	9
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:18	7.6	288.9	N/A	2.5	23.5	10
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:20	7.3	290.3	N/A	0.3	23.1	11
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:22	7.3	296.0	N/A	0.1	22.7	12
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:24	7.1	317.6	N/A	0.0	21.2	13
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:26	7.1	332.7	N/A	0.0	18.5	14
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:28	7.1	330.3	N/A	0.0	17.1	15

Table 2-2: Field Measurements

Watershed	Water body	Sample Site	Latitude	Longitude	Date	Time	pH (s.u.)	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/l)	Temp. °C	Depth (ft)
Mary's River/North Fork Cox Creek (cont.)	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:30	7.1	329.6	N/A	0.0	16.1	16
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:32	7.1	329.9	N/A	0.0	14.7	17
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:34	7.1	330.0	N/A	0.0	13.6	18
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:36	7.1	332.4	N/A	0.0	12.4	19
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:38	7.1	335.4	N/A	0.0	11.8	20
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:40	7.1	341.7	N/A	0.0	11.3	21
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:42	7.1	347.9	N/A	0.0	10.9	22
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:44	7.1	350.1	N/A	0.0	10.8	23
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:46	7.1	352.6	N/A	0.0	10.6	24
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:48	7.0	363.8	N/A	0.0	10.2	25
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	8.0	306.1	5.6	7.1	15.8	0
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.8	305.0	6.7	5.4	15.7	3.28
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.8	304.9	5.9	5.4	15.7	6.56
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.8	303.6	6.6	5.3	15.6	9.84
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.7	303.5	7.1	5.3	15.6	13.12
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.6	304.0	11.9	4.5	13.3	16.4
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.5	371.4	9.8	0.6	12.7	19.68
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.6	392.9	8.3	0.5	10.9	22.96
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.5	435.0	63.4	0.3	10.1	26.24
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:00	9.0	286.4	N/A	13.3	27.0	1
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:02	9.0	282.2	N/A	13.8	26.8	2
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:04	9.1	279.7	N/A	14.7	25.0	3
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:06	9.0	280.2	N/A	14.3	24.7	4
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:08	8.9	282.2	N/A	12.5	24.4	5
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:10	8.6	286.3	N/A	9.0	24.1	6
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:12	8.1	290.2	N/A	6.0	24.0	7
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:14	7.8	292.2	N/A	4.0	23.9	8
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:16	7.7	292.7	N/A	3.1	23.8	9
	Randolph County Lake	RIB-2	37.9738	89.8000	10/18/2006	12:05	8.0	304.9	10.3	7.1	16.0	0
	Randolph County Lake	RIB-2	37.9738	89.8000	10/18/2006	12:05	7.9	304.5	7.0	6.7	15.9	3.28
	Randolph County Lake	RIB-2	37.9738	89.8000	10/18/2006	12:05	7.8	304.5	6.6	6.4	15.9	6.56
	Randolph County Lake	RIB-2	37.9738	89.8000	10/18/2006	12:05	7.8	304.5	6.3	6.3	15.8	9.84
	Randolph County Lake	RIB-3	37.9800	89.7990	9/9/2006	13:00	9.0	283.0	N/A	13.2	26.4	1
	Randolph County Lake	RIB-3	37.9800	89.7990	9/9/2006	13:02	9.0	283.3	N/A	12.9	26.5	2
	Randolph County Lake	RIB-3	37.9800	89.7990	9/9/2006	13:04	9.0	281.0	N/A	12.8	25.8	3
	Randolph County Lake	RIB-3	37.9800	89.7990	9/9/2006	13:06	9.0	280.4	N/A	12.9	25.0	4
	Randolph County Lake	RIB-3	37.9800	89.7990	9/9/2006	13:08	9.0	279.7	N/A	12.9	24.6	5
	Randolph County Lake	RIB-3	37.9800	89.7990	9/9/2006	13:10	9.0	279.7	N/A	12.6	24.5	6
	Randolph County Lake	RIB-3	37.9800	89.7990	10/18/2006	11:15	8.0	305.0	8.8	7.9	16.0	0
	Randolph County Lake	RIB-3	37.9800	89.7990	10/18/2006	11:15	7.9	304.7	8.7	7.1	16.0	3.28
	Randolph County Lake	RIB-3	37.9800	89.7990	10/18/2006	11:15	7.8	304.7	10.4	6.7	16.0	6.56
	Randolph County Lake Tributary	RIB-Trib	37.9813	89.7988	9/9/2006	13:20	9.0	284.0	N/A	12.9	28.4	NA
	Randolph County Lake Tributary	RIB-Trib	37.9813	89.7988	10/18/2006	11:45	8.1	341.7	46.3	8.3	16.2	NA
Sangamon River/Lake Decatur	Owl Creek	EZV01	40.3254	88.3531	8/30/2006	12:50	7.4	669.0	50.8	8.5	21.2	NA
	Owl Creek	EZV01	40.3254	88.3531	11/2/2006	9:25	8.2	856.7		12.2	5.1	NA
	Owl Creek	EZVA1	40.3115	88.3409	8/30/2006	11:05	7.7	606.9	52.3	6.5	19.0	NA
	Owl Creek	EZVA1	40.3115	88.3409	11/2/2006	10:33	8.2	856.3		11.8	4.7	NA
	Owl Creek	EZVC1	40.3101	88.3423	8/30/2006	10:25	7.3	1450.0	25.6	5.0	21.0	NA
	Owl Creek	EZVC1	40.3101	88.3423	11/2/2006	12:20	8.1	990.7		11.7	6.0	NA
	Owl Creek	EZVE1	40.3113	88.3415	8/30/2006	10:45	7.5	1497.0	20.3	11.1	21.5	NA
	Owl Creek	EZVE1	40.3113	88.3415	11/2/2006	12:59	8.3	859.8		12.5	6.1	NA

Table 2-2: Field Measurements

Watershed	Water body	Sample Site	Latitude	Longitude	Date	Time	pH (s.u.)	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/l)	Temp. °C	Depth (ft)
Shoal Creek	Shoal Creek	OI05	38.5361	89.5213	9/1/2006	12:35	7.5	563.4	38.7	9.1	22.9	NA
	Shoal Creek	OI05	38.5361	89.5213	10/17/2006	11:30	7.9	604.4	39.7	8.5	12.0	NA
	Shoal Creek	OI05A	38.5370	89.5330	9/1/2006	NOT SAMPLED *Site located at end of private road with chained fence/alternate location not located*						NA
	Shoal Creek	OI05A	38.5370	89.5330	10/17/2006							NA
	Shoal Creek	OI05B	38.5333	89.5496	9/1/2006	14:20	7.8	542.2	43.0	10.8	26.2	NA
	Shoal Creek	OI05B	38.5333	89.5496	10/17/2006	11:15	7.9	542.4	72.7	8.7	12.3	NA
	Shoal Creek	OI05C	38.5020	89.5661	9/1/2006	15:40	7.8	535.3	43.5	10.2	23.5	NA
	Shoal Creek	OI05C	38.5020	89.5661	10/16/2006	10:30	8.0	578.9	46.0	9.4	12.1	NA
	Locust Fork	OIC01	38.7715	89.5556	8/31/2006	NOT SAMPLED *Site dry/no other road crossings on segment*						NA
	Locust Fork	OIC01	38.7715	89.5556	10/19/2006	12:20	7.8	401.1	24.3	3.8	10.0	NA
	Locust Fork	OIC02	38.7536	89.5288	8/31/2006	17:50	8.0	499.6	23.2	9.4	24.2	NA
	Locust Fork	OIC02	38.7536	89.5288	10/17/2006	13:00	7.7	422.2	26.9	5.2	14.2	NA
	Chicken Creek	OIO09	38.6407	89.5025	9/1/2006	NOT SAMPLED *Sites dry during both visits/sites located at only two road crossings on segment*						NA
	Chicken Creek	OIO09	38.6407	89.5025	10/17/2006							NA
	Chicken Creek	OIO09A	38.6373	89.5260	9/1/2006							NA
	Chicken Creek	OIO09A	38.6373	89.5260	10/17/2006							NA
	Cattle Creek	OIP10	38.6649	89.5170	8/31/2006	NOT SAMPLED *Site dry/no other road crossings on segment*						NA
	Cattle Creek	OIP10	38.6649	89.5170	10/17/2006	12:05	7.9	928.0	105.6	2.0	14.2	NA
	Cattle Creek	OIP10A	38.6744	89.5359	8/31/2006	NOT SAMPLED *Site dry/no other road crossings on segment*						NA
	Cattle Creek	OIP10A	38.6744	89.5359	10/17/2006							NA
South Fork Saline River/Lake of Egypt	South Fork Saline River	ATH08	37.6399	88.9281	9/26/2006	10:20	7.1	165.0	0.6	8.7	23.6	NA
	South Fork Saline River	ATH08	37.6399	88.9281	10/31/2006	11:15	6.6	213.1	10.0	8.8	19.0	NA
	South Fork Saline River	ATH14	NA	NA	9/26/2006	NOT SAMPLED *Sites located on private property and/or not accessible by roads* *No other road crossings available on segment*						NA
	South Fork Saline River	ATH14	NA	NA	10/31/2006							NA
	South Fork Saline River	ATHLEC1	NA	NA	9/26/2006							NA
	South Fork Saline River	ATHLEC1	NA	NA	10/31/2006							NA
	South Fork Saline River	ATHLEC2	37.6295	88.9465	9/26/2006	9:45	6.6	81.0	15.6	9.4	18.1	NA
	South Fork Saline River	ATHLEC2	37.6295	88.9465	10/31/2006	12:00	6.8	137.7	11.6	9.6	17.1	NA
	Briers Creek	ATHS01	37.6766	88.7178	9/11/2006	11:30	7.6	1997.0	2.0	9.1	21.3	NA
	Briers Creek	ATHS01	37.6766	88.7178	9/27/2006	9:00	7.3	1392.0	3.4	10.2	15.5	NA
	Briers Creek	ATHS01	37.6766	88.7178	10/30/2006	16:30	7.1	1281.0	19.6	9.4	13.7	NA
	Briers Creek	ATHS01	37.6766	88.7178	11/15/2006	10:25	7.0	700.1	185.3	4.6	9.4	NA
	Briers Creek	ATHS01A	37.6995	88.7257	9/11/2006	10:00	7.1	765.0	5.6	9.7	17.9	NA
	Briers Creek	ATHS01A	37.6995	88.7257	9/27/2006	11:30	7.5	817.0	1.9	9.7	17.0	NA
	Briers Creek	ATHS01A	37.6995	88.7257	11/2/2006	12:00	8.0	862.8	3.0	8.5	9.5	NA
	Briers Creek	ATHS01A	37.6995	88.7257	11/15/2006	11:10	6.8	226.1	36.3	5.4	10.2	NA
	Briers Creek	ATHS01B	37.6943	88.7245	9/11/2006	10:25	7.2	507.0	6.2	9.5	17.8	NA
	Briers Creek	ATHS01B	37.6943	88.7245	9/27/2006	10:35	6.7	500.0	0.5	9.7	17.3	NA
	Briers Creek	ATHS01B	37.6943	88.7245	11/2/2006	12:20	7.4	726.7	2.9	9.9	9.5	NA
	Briers Creek	ATHS01B	37.6943	89.7640	11/15/2006	11:30	6.8	198.9	69.1	4.0	10.0	NA
	Briers Creek	ATHS01C	37.6882	88.7195	9/11/2006	12:55	6.8	2071.0	21.5	6.3	19.0	NA
	Briers Creek	ATHS01C	37.6882	88.7195	9/27/2006	9:30	7.0	1571.0	2.2	9.8	15.1	NA
	Briers Creek	ATHS01C	37.6882	88.7195	10/31/2006	14:30	7.4	1296.0	4.5	9.4	12.0	NA
	Briers Creek	ATHS01C	37.6882	88.7195	11/15/2006	10:45	7.0	848.6	90.7	8.8	9.5	NA
	East Palzo Creek	ATHV01	37.6502	88.7608	9/11/2006	10:40	6.9	375.0	16.4	6.7	22.7	NA
	East Palzo Creek	ATHV01	37.6502	88.7608	9/27/2006	NOT SAMPLED *Site flooded over road with no safe access/no other road crossings on segment*						NA
	East Palzo Creek	ATHV01	37.6502	88.7608	10/31/2006	13:40	6.5	490.6	14.2	7.6	12.4	NA
	East Palzo Creek	ATHV01	37.6502	88.7608	11/15/2006	10:00	6.3	554.5	200.0	5.1	9.4	NA
	East Palzo Creek	ATHV01A	37.6143	88.7788	9/11/2006	8:25	7.2	1878.0	1.7	6.6	18.8	
	East Palzo Creek	ATHV01A	37.6143	88.7788	9/27/2006	NOT SAMPLED *Site dry/no other road crossings on segment*						NA
	East Palzo Creek	ATHV01A	37.6143	88.7788	10/31/2006							NA
	East Palzo Creek	ATHV01A	37.6143	88.7788	11/15/2006	9:05	6.8	158.9	81.9	9.0	9.4	NA
	East Palzo Creek	ATHV01B	37.6452	88.7635	9/11/2006	8:55	6.9	481.0	28.8	6.0	19.1	NA
	East Palzo Creek	ATHV01B	37.6452	88.7635	9/26/2006	12:30	6.2	405.0	4.6	10.9	17.4	NA
	East Palzo Creek	ATHV01B	37.6452	88.7635	10/31/2006	13:00	6.4	498.2	23.8	8.7	12.4	NA
	East Palzo Creek	ATHV01B	37.6452	88.7635	11/15/2006	9:35	6.1	435.0	243.8	5.6	9.4	NA

Table 2-2: Field Measurements

Watershed	Water body	Sample Site	Latitude	Longitude	Date	Time	pH (s.u.)	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/l)	Temp. °C	Depth (ft)
South Fork Sangamon River/ Lake Taylorville	South Fork Sangamon River	EO13	39.4072	89.3164	8/30/2006	18:10	7.3	719.3	7.2	6.3	20.4	NA
	South Fork Sangamon River	EO13	39.4072	89.3164	11/2/2006	16:50	7.7	528.5		6.5	6.1	NA
	South Fork Sangamon River	EO13A	39.2700	89.1880	8/30/2006	19:55	7.3	754.7	7.6	9.7	21.6	NA
	South Fork Sangamon River	EO13A	39.2700	89.1880	11/2/2006	NOT SAMPLED *Miscommunication between field crews caused error in sampling*						NA
	South Fork Sangamon River	EO13B	39.3630	89.2700	8/30/2006	19:25	7.6	1112.0	60.1	8.3	21.6	NA
	South Fork Sangamon River	EO13B	39.3630	89.2700	11/2/2006	NOT SAMPLED *Miscommunication between field crews caused error in sampling*						NA
	South Fork Sangamon River	EO13C	39.4590	89.2970	8/30/2006	18:55	7.0	56.9	96.0	3.8	21.1	NA
	South Fork Sangamon River	EO13C	39.4590	89.2970	11/2/2006	16:25	8.2	954.1		5.8	6.4	NA

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Table 2-3: Data Associated with Impairment Status

Watershed	Water body	Sample Site	Date	Time	Causes of Impairment												
					pH[1]	DO[1]	Total Mn	Sulfates	TDS	Total Boron	Dissolved Zinc [6]	Dissolved Iron	Total Silver	Dissolved Copper [6]	TP	Atrazine [5]	Ammonia
					s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L
Bay Creek	Cedar Creek	AJF16	9/25/2006	18:00		8.9	0.25										
			11/3/2006	11:05		11.0	0.12										
		AJF16A	9/25/2006	18:15		9.4	0.23										
			11/2/2006	13:30		11.6	0.08										
	Bay Creek Ditch	AJK01	9/25/2006	15:58		5.6	0.16										
			10/31/2006	8:15		8.2	0.05										
		AJK01A	10/31/2006	8:45		6.1	0.06										
Cahokia Creek/Holiday Shores Lake	Cahokia Diversion Ditch	JQ07	10/4/2006	16:35		5.3								ND			
			10/17/2006	14:15		9.4								ND			
		JQ01	10/4/2006	16:20		**3.4**								ND			
			10/17/2006	14:45		9.6								ND			
Cedar Creek	Big Muddy River	N99	9/7/2006	12:15		10.1		186									
			11/1/2006	9:45		7.8		75									
		N13	9/7/2006	11:15		8.1		144									
			11/1/2006	10:45		8.2		68									
	Cave Creek	NAC01	9/11/2006	11:45		7.6											
			11/1/2006	11:45		10.6											
		NAC01A	9/11/2006	11:15		**4.9**											
			11/1/2006	12:15		10.1											
Crab Orchard Lake	Crab Orchard Creek	ND11	9/6/2006	12:15	7.3	5.2	1.00										
			11/1/2006	14:00	7.7	10.1	0.26										
		ND12	9/6/2006	13:15	7.3		0.17										
			11/1/2006	15:00	7.7		ND										
		ND13	9/6/2006	15:00		6.0											
			11/1/2006	15:45		11.1											
		ND15	9/6/2006	16:30		6.8											
	Little Crab Orchard Creek	NDA01	9/6/2006	18:00		**2.1**	**2.00**										
			11/2/2006	8:30		8.2	0.20										
		NDA99	11/2/2006	10:30		12.3	0.03										
	Piles Fork	NDB03	9/7/2006	10:00		**1.6**											
			11/2/2006	9:15		10.3											
		NDB04	9/9/2006	7:40		**3.6**											
			11/2/2006	11:00		11.5											
Crooked Creek	Plum Creek	OZH-OK-A2	9/8/2006	14:00		6.8	0.65										
			10/19/2006	10:50		5.3	0.33										
		OZH-OK-A2A	9/8/2006	16:25		8.5	0.20										
			10/19/2006	11:20		9.0	0.22										
		OZH-OK-C2	9/8/2006	12:45		**1.1**											
			10/19/2006	10:15		**2.5**											
		OZH-OK-C2A	9/8/2006	17:30		**4.6**											
			10/19/2006	13:40		**3.2**											
		OZH-OK-C3	9/9/2006	15:00		**4.1**	0.30										
			10/19/2006	9:35		5.2	0.77										
	Little Crooked Creek	OJA-01	9/7/2006	17:45		**3.7**	0.14										
			10/19/2006	14:05		**4.7**	0.17										
		OJA-02	9/8/2006	11:15		**3.1**	0.14										
			10/19/2006	14:35		**3.8**	0.17										

Table 2-3: Data Associated with Impairment Status

Watershed	Water body	Sample Site	Date	Time	Causes of Impairment												
					pH(1)	DO(1)	Total Mn	Sulfates	TDS	Total Boron	Dissolved Zinc (6)	Dissolved Iron	Total Silver	Dissolved Copper (6)	TP	Atrazine (5)	Ammonia
					s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L
Little Wabash	Village Creek	CE01	9/6/2006	17:30		9.9	0.17										
			11/14/2006	8:45		10.6	0.10										
		CE02	9/6/2006	15:20		7.9	0.80										
			11/9/2006	12:55		10.7	0.11										
		CE01A	9/12/2006	17:05		5.8	0.41										
			11/9/2006	13:45		11.2	0.08										
	Johnson Creek	CCAFFA1A	9/10/2006	10:50		**3.8**											
			11/14/2006	10:45		12.3											
		CCA12	9/9/2006	13:05		14.2											
			11/14/2006	9:45		7.7											
		CCA13	9/9/2006	14:30		14.9											
			11/14/2006	10:15		12.8											
		CCA14A	9/9/2006	15:25		5.7											
			11/14/2006	10:25		12.5											
	Pond Creek	CCFFD1	9/9/2006	10:30		7.1											
			10/31/2006	10:10		8.2											
		CCFFD1A	11/9/2006	12:15		11.2											
		CCFFD1B	9/9/2006	11:45		8.6											
			11/9/2006	11:35		12.1											
		CCFFD1C	9/10/2006	12:10		11.9											
			10/31/2006	11:20		14.4											
	Seminary Creek	CDGFLA1	9/8/2006	15:40		10.0											
			11/8/2006	14:45		14.3											
		CDGFLA1A	9/8/2006	13:45		**2.6**											
			11/8/2006	15:50		15.1											
		CDFGLC6	9/8/2006	12:25		6.6											
			11/8/2006	17:00		10.5											
		CDFGLC6A	9/8/2006	11:10		7.0											
			11/8/2006	16:45		12.0											
	Big Muddy Creek	CJ06	9/7/2006	18:10		**4.9**	0.54										
			11/8/2006	11:00		11.6	0.39										
		CJ05	9/7/2006	16:45		10.5	0.04										
			11/8/2006	11:30		12.4	0.07										
	Little Muddy Creek	CJA02	9/7/2006	4:20		**2.8**	**1.30**										
			11/8/2006	12:30		9.3	0.39										
		CJA01	9/12/2006	10:20		**3.4**	**1.30**										
			11/13/2006	12:00		10.1	0.17										
	Big Muddy Diversion Ditch	CJAE01	9/7/2006	12:10		9.1											
			11/8/2006	13:05		10.8											
		CJAE01A	9/7/2006	15:45		10.3											
			11/13/2006	12:30		9.8											

Table 2-3: Data Associated with Impairment Status

Watershed	Water body	Sample Site	Date	Time	Causes of Impairment												
					pH[1]	DO[1]	Total Mn	Sulfates	TDS	Total Boron	Dissolved Zinc[6]	Dissolved Iron	Total Silver	Dissolved Copper[6]	TP	Atrazine[5]	Ammonia
					s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L
Little Wabash	Elm River	CD02A	9/12/2006	12:51		**3.8**											
		CD02	9/8/2006	17:45		8.1											
		CD01	4/18/2006	14:30												0.12	
			4/26/2006	11:15												0.16	
			5/1/2006	11:00												0.27	
			5/17/2006	9:30												**19.00**	
			5/24/2006	11:20												**15.00**	
			5/31/2006	11:30												8.30	
			6/7/2006	11:25												5.70	
			6/15/2006	9:50												2.80	
			6/22/2006	11:15												1.20	
			6/27/2006	9:15												4.20	
			7/5/2006	11:50												2.40	
			7/12/2006	11:30												0.92	
			7/20/2006	11:15												2.40	
			7/27/2006	11:05												2.60	
			8/1/2006	9:20												2.60	
			8/8/2006	12:20												1.60	
	Little Wabash River	C33[4]	4/18/2006	11:00												0.55	
			4/26/2006	12:15			**0.35**									1.10	
			5/1/2006	11:45			**0.50**									0.71	
			5/10/2006	12:20			**0.41**										
			5/17/2006	14:00												**19.00**	
			5/24/2006	12:15			**0.38**									8.10	
			5/31/2006	12:40			**0.37**									**13.00**	
			6/7/2006	12:30			**0.44**									6.30	
			6/15/2006	11:05												5.30	
			6/22/2006	12:00			**0.76**									2.60	
			6/27/2006	11:50												2.50	
			7/5/2006	13:00			**0.50**									1.70	
			7/12/2006	12:30			**0.54**									1.00	
			7/20/2006	12:20			**0.46**									2.30	
			7/27/2006	12:10												0.64	
			8/1/2006	10:30												0.66	
			8/8/2006	13:30												0.50	

Table 2-3: Data Associated with Impairment Status

Watershed	Water body	Sample Site	Date	Time	Causes of Impairment												
					pH (1)	DO (1)	Total Mn	Sulfates	TDS	Total Boron	Dissolved Zinc (6)	Dissolved Iron	Total Silver	Dissolved Copper (6)	TP	Atrazine (5)	Ammonia
					s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L
Little Wabash	Little Wabash River	C09	3/17/2005	8:00		14.9											
			4/19/2005	14:30		7.3											
			5/9/2005	10:30		6.7											
			6/23/2005	7:30		5.1											
			8/23/2005	13:00		**4.2**											
			9/27/2005	16:00		7.5											
			10/27/2005	14:00		8.7											
			12/6/2005	13:00		11.8											
			2/1/2006	12:30		9.3											
			3/15/2006	10:00		6.2											
			4/18/2006	16:00												0.27	
			4/26/2006	10:00									ND			0.62	
			5/1/2006	9:45									ND			0.59	
			5/10/2006	10:00									ND				
			5/17/2006	11:00									ND			**20.00**	
			5/24/2006	9:45									ND			6.30	
			5/31/2006	10:20									ND			**24.00**	
			6/7/2006	10:15									ND			4.20	
			6/15/2006	8:50									ND			1.80	
			6/22/2006	10:05									ND			1.20	
			6/27/2006	10:40									ND			1.50	
			7/5/2006	10:30									ND			1.20	
			7/12/2006	10:30									ND			0.96	
			7/20/2006	10:00									ND			1.60	
			7/27/2006	10:00									ND			0.72	
			8/1/2006	8:30									ND			0.63	
			8/8/2006	11:05									ND			0.40	
			8/18/2006	16:00									ND				
Mary's River/North Fork Cox Creek	North Fork Cox Creek	IIHA31	9/9/2006	17:10				**1610**	**3110**								
			10/18/2006	14:45				**1830**	**2830**								
		IIHA01	9/9/2006	17:40				**1850**	**3090**								
			10/18/2006	14:25				**1630**	**2540**								
		IIHA-STE1	9/9/2006	15:40					**3090**								
			10/18/2006	13:40					**1340**								
		IIHA-STC1	9/9/2006	16:15					**2530**								
			10/18/2006	14:00					**1400**								
	Maxwell Creek	IIKSPC1	9/7/2006	15:30		**2.0**											
			10/17/2006	8:20		20.2											
		IIKSPC3A	9/7/2006	15:00		**2.6**											
			10/17/2006	8:45		6.5											
	Randolph County Lake	RIB-1 (3)	9/9/2006	12:00											0.04		
			10/18/2006	10:45											**0.130**		
		RIB-2 (3)	9/9/2006	14:00											0.04		
			10/18/2006	12:05											**0.053**		
		RIB-3 (3)	9/9/2006	13:00											0.04		
			10/18/2006	11:15											**0.100**		

Table 2-3: Data Associated with Impairment Status

Watershed	Water body	Sample Site	Date	Time	Causes of Impairment												
					pH[1]	DO[1]	Total Mn	Sulfates	TDS	Total Boron	Dissolved Zinc [6]	Dissolved Iron	Total Silver	Dissolved Copper [6]	TP	Atrazine [5]	Ammonia
					s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L
Sangamon River/ Lake Decatur	Owl Creek	EZV01	8/30/2006	12:50		8.5											
			11/2/2006	9:25		12.2											
		EZVA1	8/30/2006	11:05		6.5											
			11/2/2006	10:33		11.8											
		EZVE1	8/30/2006	10:45		11.1											
			11/2/2006	12:59		12.5											
		EZVC1	8/30/2006	10:25		**5.0**											
			11/2/2006	12:20		11.7											
Shoal Creek	Shoal Creek	OI05	9/1/2006	12:35		9.1											
			10/17/2006	11:30		8.5											
		OI05B	9/1/2006	14:20		10.8											
			10/17/2006	11:15		8.7											
		OI05C	9/1/2006	15:40		10.2											
			10/16/2006	10:30		9.4											
	Locust Fork	OIC01	10/19/2006	12:20		**3.8**	0.18										
		OIC02	8/31/2006	17:50		9.4	0.35										
			10/17/2006	13:00		5.2	0.08										
	Cattle Creek	OIP10	10/17/2006	12:05		**2.0**			928[2]					0.021			5.8
South Fork Saline River/ Lake of Egypt	Briers Creek	ATHS01	9/11/2006	11:30	7.6	9.1	0.65	**1250**	**1960**		0.020	0.310	ND				
			9/27/2006	9:00	7.3	10.2	**2.00**	**951**	**1490**		0.022	ND	ND				
			10//2006	11:30							ND	ND					
			10/30/2006	16:30			**1.50**	**656**	**1120**		0.035	ND	ND				
			11/15/2006	10:25			**1.40**	281	469		0.028	**1.10**	ND				
		ATHS01A	9/27/2006	11:30	7.5	9.7	0.10	294	678		ND	**1.10**	ND				
			10/4/2006	10:50							ND	ND					
			11/2/2006	12:00	8.0	8.5	0.11	219	597		0.012	ND	ND				
			11/15/2006	11:10	6.8	5.4	0.12	65	213		ND	**1.40**	ND				
		ATHS01B	9/13/2006	10:40			0.18	143	418			ND	ND				
			9/27/2006	10:35	6.7	9.7	0.17	196	414		ND	ND	ND				
			10/4/2006	11:05							0.013	ND					
			11/2/2006	12:20	7.4	9.9	0.22	373	608		0.018	ND	ND				
			11/15/2006	11:30	6.8	**4.0**						**2.10**					
		ATHS01C	9/11/2006	12:55			**8.70**	**1290**	**2150**			**5.00**	ND				
			9/27/2006	9:30	7.0	9.8	**4.10**	**1100**	**1660**		ND	0.78	ND				
			10/4/2006	11:20							ND	**2.20**					
			10/31/2006	14:30	7.4	9.4	**1.90**	**691**	**1190**		ND	0.17	ND				
			11/15/2006	10:45	7.0	8.8	0.93	338	667		ND	0.470	ND				

Table 2-3: Data Associated with Impairment Status

Watershed	Water body	Sample Site	Date	Time	Causes of Impairment												
					pH(1)	DO(1)	Total Mn	Sulfates	TDS	Total Boron	Dissolved Zinc (6)	Dissolved Iron	Total Silver	Dissolved Copper (6)	TP	Atrazine (5)	Ammonia
					s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L
South Fork Saline River/ Lake of Egypt	East Palzo Creek	ATHV01A	9/11/2006	10:40	6.9	6.7	**1.40**		**1560**			ND					
			10/31/2006	13:40	6.5	7.6	**1.80**		375			0.160		ND			
			11/15/2006	10:00	**6.3**	5.1	0.09		211			**2.60**		ND			
		ATHV01	9/11/2006	10:40	6.9	6.7	0.38		262			ND					
			10/4/2006	12:30								0.13		ND			
			10/31/2006	13:40	6.5	7.6	**1.80**		375			0.16		ND			
			11/15/2006	10:00	**6.3**	5.1	**2.10**		324			0.340		ND			
		ATHV01B	9/11/2006	8:55	6.9	6.0	0.41		388			ND					
			9/26/2006	12:30	**6.2**	10.9	1.00		323			ND		ND			
			10/4/2006	11:50								ND		ND			
			10/31/2006	13:00	**6.4**	8.7	**1.60**		341			ND		ND			
			11/15/2006	9:35	**6.1**	5.6	**1.60**		225			0.100		ND			
	South Fork Saline River	ATHLEC2	9/26/2006	9:45		9.4											
			10/31/2006	12:00		9.6											
		ATH08	9/26/2006	10:20		8.7											
			10/31/2006	11:15		8.8											
South Fork Sangamon River/ Lake Taylorville	South Fork Sangamon River	EO13A	8/30/2006	19:55		9.7	0.61			0.05							
		EO13	8/30/2006	18:10		6.3	0.49			0.20							
			11/2/2006	16:50		6.5	0.33			0.08							
		EO13B	8/30/2006	19:25		8.3	**1.18**			0.20							
		EO13C	8/30/2006	18:55		**3.8**	**5.49**			0.27							
			11/2/2006	16:25		5.8	0.38			0.13							

Shaded cells indicate exceedances of the applicable water quality standard

1 pH and DO values in this table represent field parameters sampled using the In-Site 9500 Profiler. Continuous DO and pH data are available in Appendix D.

2 Value shown is for conductivity. TDS standard corresponds to 1667 uS/cm specific conductance

3 Values shown were collected at one-foot depth.

4 Segment C33 is a source of public water. Therefore the applicable manganese standard is 150 ug/L.

5 Chronic criteria for atrazine is 9 ug/L and a single exceedance of this value indicates a potential cause of impairment

6 Corresponding hardness values were used to calculate standards. Analytical data can be found in Appendix C.

Section 3
Quality Assurance Review

A review was conducted to assess the quality and usability of data generated from Stage 2 work activities and to review compliance with the original sampling plan and objectives developed for the QAPP. Field and laboratory methods were deemed in accordance with the QAPP. Minor deviations from the original plan occurred and all are discussed below.

3.1 Deviations from original Sampling Plan (QAPP)

The following issues and/or concerns developed during the sampling events:

- Sampling during the week of September 25th followed a heavy precipitation event which resulted in high stream flows and flooding at Bay Creek Ditch segment AJK01A and East Palzo Creek segment ATHV01.
- In-field filtering was not performed for dissolved phosphorus or dissolved metal samples. Illinois EPA requested additional information on this procedure. CDM along with ARDL, Inc drafted text for Illinois EPA to validate this sampling practice. Total versus dissolved samples are discussed further in section 3.2.2.
- All locations on Chicken Creek (OIO09) were dry during both sample periods; therefore no samples were collected for this segment.
- The following sites had no water during either sampling event: Maxwell Creek IIKSPA1 and IIKSPE1A, and Cattle Creek OIP10A. Alternate locations were not found.
- Access was not available to the following sites during either sampling event: Shoal Creek OIO5A, South Fork Saline River sites ATH14 and ATHLEC1. Alternate locations were not found.
- Site EZVA1 on Owl Creek was moved from the location proposed in the QAPP to the intersection of Owl Creek and County Road 3100 due to better stream flow.
- Only one round of sampling was conducted at the following sites due to access or water volume issues (refer to Table 2-2 for specific dates and issues): Locust Fork OIC01, Cattle Creek OIP10, Crab Orchard Creek ND15, Little Crab Orchard Creek NDA99, Pond Creek CCFFD1A, East Palzo Creek ATHV01 and ATHV01A, and Bay Creek Ditch AJK01A.
- Due to field crew error only one round of sampling was conducted at South Fork Sangamon River EO13A and EO13B and Elm River locations CD02 and CD02A.

3.2 Data Verification and Validation

A data quality review was performed on all laboratory data. The review consisted of an evaluation of laboratory QC and field QC samples. Laboratory QC included an evaluation of method blanks, matrix spikes, matrix spike duplicates, laboratory control samples and holding times. Field QC included an evaluation of field duplicates. No decontamination rinsate blanks were collected.

No laboratory violation resulted in the qualification of CDM collected data. While some matrix spikes had percent recoveries outside of the established limits, all other QC associated with the samples were acceptable. When a matrix spike was reported outside of the control limits, the laboratory control samples had percent recoveries within the established control limits, indicating a matrix effect on the sample analysis and no need to qualify the data. All samples were analyzed within the control limits.

An evaluation of the phosphorus data (total versus dissolved) was performed to determine the effects of filtering the samples immediately versus waiting up to 48 to 64 hours. All samples were received by the laboratories on ice and at 4^0C (+/-). A total of 161 samples have been analyzed for both total and dissolved phosphorus by method 365.2. Of the 161 samples, a total of 10 samples sets had a phosphorus concentration of greater than 1 mg/L (100 times higher than the reporting limit and considered significant when controlling based on RPDs). One of these samples had relative percent difference (RPD) between the total and dissolved fraction of the sample of greater than 100. Precision values of less that 25 % RPD are considered acceptable for sample results reported significantly above the reporting limit. Sample EO13C had total phosphorus measured at 2.09 mg/L and dissolved phosphorus measured at 0.52 mg/L. The TSS measured in this sample was 159 mg/L. The suspended solids contained in this sample may have absorbed the available phosphorus, but all other results in samples with phosphorus concentrations above 1mg/L show that this reaction is not taking place. Sampling or analytical variations may explain the elevated RPD between the sample and the duplicate. Total phosphorus and dissolved phosphorus results for samples with phosphorus concentrations above 1 mg/L are not significantly different.

Looking at all other results, there does not appear to be a correlation between the difference of total and dissolved phosphorus and the TSS concentration. Suspended solids absorbing dissolved phosphorus would be the likely mechanism for lowering the dissolved phosphorus concentrations. Based on the lack of this correlation, dissolved phosphorus concentration would not be significantly different if the samples were filtered immediately versus filtering at the laboratory 48-hours after collection.

Finally, field and laboratory quality control data were collected to assess bias associated between field and laboratory methods. Positive sample results and relative percent difference (RPD) are presented in Table 3-1.

3.3 Data Quality Objectives

The data generated during the Stage 2 investigation conformed to the data quality objectives established in the QAPP. A completeness criterion of 90% was established and easily achieved. No data have been qualified that were collected by CDM personnel and analyzed by ARDL, Inc or Prairie Analytical laboratories. Data qualifiers were applied to some of the data collected by Illinois EPA personnel. All qualifiers are included with the laboratory data contained in Appendix C.

Table 3-1: Duplicate Pair Sample Results

SampleLocation	Parameter	Result	Units	Collection Date	RPD(%)
AJK01-DUP	Solids, total suspended	24.2	MG/L	9/25/2006	
AJK01	Solids, total suspended	25	MG/L	9/25/2006	3.252033
ATHS01A-DUP	Hardness (CA/MG)	435.1	MG CACO3/L	11/2/2006	
ATHS01A	Hardness (CA/MG)	445	MG CACO3/L	11/2/2006	2.249744
ATHS01A-DUP	Solids, total dissolved	604	MG/L	11/2/2006	
ATHS01A	Solids, total dissolved	597	MG/L	11/2/2006	-1.1657
ATHS01A-DUP	Chloride	5.13	MG/L	9/27/2006	
ATHS01A	Chloride	5.1	MG/L	9/27/2006	-0.64556
ATHS01A-DUP	Solids, total dissolved	675	MG/L	9/27/2006	
ATHS01A	Solids, total dissolved	678	MG/L	9/27/2006	0.443459
ATHS01A-DUP	Sulfate	290.63	MG/L	9/27/2006	
ATHS01A	Sulfate	294	MG/L	9/27/2006	1.154242
ATHS01C-DUP	Chloride	5.38	MG/L	9/11/2006	
ATHS01C	Chloride	5.4	MG/L	9/11/2006	0.388903
ATHS01C-DUP	Sulfate	1297.83	MG/L	9/11/2006	
ATHS01C	Sulfate	1290	MG/L	9/11/2006	-0.60514
ATHS01-FIELDDUP	Alkalinity	113	MG/L	10/30/2006	
ATHS01	Alkalinity	108	MG/L	10/30/2006	-4.52489
ATHS01-FIELDDUP	Chloride	4.9	MG/L	10/30/2006	
ATHS01	Chloride	4.9	MG/L	10/30/2006	0
ATHS01-FIELDDUP	Hardness (CA/MG)	673	MG CACO3/L	10/30/2006	
ATHS01	Hardness (CA/MG)	668	MG CACO3/L	10/30/2006	-0.74571
ATHS01-FIELDDUP	Iron	68200	MG/KG	10/30/2006	
ATHS01	Iron	93800	MG/KG	10/30/2006	31.60494
ATHS01-FIELDDUP	Manganese	1130	MG/KG	10/30/2006	
ATHS01	Manganese	1480	MG/KG	10/30/2006	26.81992
ATHS01-FIELDDUP	Manganese	1.5	MG/L	10/30/2006	
ATHS01	Manganese	1.5	MG/L	10/30/2006	0
ATHS01-FIELDDUP	Nitrate-Nitrite	0.06	MG/L	10/30/2006	
ATHS01	Nitrate-Nitrite	0.06	MG/L	10/30/2006	-11.9658
ATHS01-FIELDDUP	Phosphorus, diss	0.05	MG/L	10/30/2006	
ATHS01	Phosphorus, diss	0.05	MG/L	10/30/2006	8.163265
ATHS01-FIELDDUP	Phosphorus, total	0.04	MG/L	10/30/2006	
ATHS01	Phosphorus, total	0.03	MG/L	10/30/2006	-26.8657
ATHS01-FIELDDUP	Solids, total	69.7	%	10/30/2006	
ATHS01	Solids, total	74.5	%	10/30/2006	6.65742
ATHS01-FIELDDUP	Solids, total dissolved	1040	MG/L	10/30/2006	
ATHS01	Solids, total dissolved	1070	MG/L	10/30/2006	2.843602
ATHS01-FIELDDUP	Solids, total suspended	4.3	MG/L	10/30/2006	
ATHS01	Solids, total suspended	5.6	MG/L	10/30/2006	26.26263
ATHS01-FIELDDUP	Sulfate	662	MG/L	10/30/2006	
ATHS01	Sulfate	604	MG/L	10/30/2006	-9.16272
ATHS01-FIELDDUP	Zinc	106	MG/KG	10/30/2006	
ATHS01	Zinc	116	MG/KG	10/30/2006	9.009009
ATHS01-FIELDDUP	Zinc, diss	0.02	MG/L	10/30/2006	
ATHS01	Zinc, diss	0.03	MG/L	10/30/2006	8.333333
ATHS01-DUP	Alkalinity	60.9	MG/L	11/15/2006	
ATHS01	Alkalinity	56.8	MG/L	11/15/2006	-6.96686
ATHS01-DUP	Hardness (CA/MG)	340.14	MG CACO3/L	11/15/2006	
ATHS01	Hardness (CA/MG)	337	MG CACO3/L	11/15/2006	-0.92743
ATHS01-DUP	Solids, total dissolved	481	MG/L	11/15/2006	

Table 3-1: Duplicate Pair Sample Results (continued)

SampleLocation	Parameter	Result	Units	Collection Date	RPD(%)
ATHS01	Solids, total suspended	151	MG/L	11/15/2006	-104.43
ATHS01-DUP	Hardness (CA/MG)	1035.17	MG CACO3/L	9/27/2006	
ATHS01	Hardness (CA/MG)	1030	MG CACO3/L	9/27/2006	-0.50069
ATHV01B-DUP	Alkalinity	15.3	MG/L	9/26/2006	
ATHV01B	Alkalinity	15.3	MG/L	9/26/2006	0
ATHV01B-DUP	Solids, total	72.5	%	9/26/2006	
ATHV01B	Solids, total	71.9	%	9/26/2006	-0.83102
CCFFD1-DUP	Chlorophyll	5.5	MG/CU.M.	9/9/2006	
CCFFD1	Chlorophyll	5	MG/CU.M.	9/9/2006	-9.52381
CE01A-DUP	Solids, total suspended	134	MG/L	9/12/2006	
CE01A	Solids, total suspended	137	MG/L	9/12/2006	2.214022
CJA02-DUP	Biological Oxygen Demand	4	MG/L	11/8/2006	
CJA02	Biological Oxygen Demand	3.7	MG/L	11/8/2006	-7.79221
EO13-DUP	Biological Oxygen Demand	6.3	MG/L	11/2/2006	
EO13	Biological Oxygen Demand	6.3	MG/L	11/2/2006	0
EO13-DUP	Solids, total suspended	8.4	MG/L	11/2/2006	
EO13	Solids, total suspended	7.6	MG/L	11/2/2006	-10
IIAA01-DUP	Chloride	21.71	MG/L	9/9/2006	
IIAA01	Chloride	21.7	MG/L	9/9/2006	-0.0258
IIAA01-DUP	Sulfate	1832.11	MG/L	9/9/2006	
IIAA01	Sulfate	1850	MG/L	9/9/2006	0.971725
IIHA01-DUP	Chloride	21.71	MG/L	9/9/2006	
IIHA01	Chloride	21.7	MG/L	9/9/2006	-0.0258
IIHA01-DUP	Sulfate	1832.11	MG/L	9/9/2006	
IIHA01	Sulfate	1850	MG/L	9/9/2006	0.971725
IIHA31-DUP	Hardness (CA/MG)	1290.87	MG CACO3/L	9/9/2006	
IIHA31	Hardness (CA/MG)	1300	MG CACO3/L	9/9/2006	0.704783
IIHA31-DUP	Hardness (CA/MG)	1306.27	MG CACO3/L	10/18/2006	
IIHA31	Hardness (CA/MG)	1280	MG CACO3/L	10/18/2006	-2.0315
IIHA31-DUP	Chloride	19.5	MG/L	10/18/2006	
IIHA31	Chloride	19.4	MG/L	10/18/2006	-0.51363
IIHA31-DUP	Solids, total dissolved	2850	MG/L	10/18/2006	
IIHA31	Solids, total dissolved	2830	MG/L	10/18/2006	-0.70423
IIHA31-DUP	Sulfate	1783.35	MG/L	10/18/2006	
IIHA31	Sulfate	1830	MG/L	10/18/2006	2.582091
IIHA-STE1-DUP	Solids, total dissolved	3100	MG/L	9/9/2006	
IIHA-STE1	Solids, total dissolved	3090	MG/L	9/9/2006	-0.3231
IIKSPC3A-DUP	Biological Oxygen Demand	11	MG/L	9/7/2006	
IIKSPC3A	Biological Oxygen Demand	11	MG/L	9/7/2006	0
JQ01-DUP	Chlorophyll	11.8	MG/CU.M.	8/31/2006	
JQ-01	Chlorophyll	13.2	MG/CU.M.	8/31/2006	11.2
JQ01-DUP	Hardness (CA/MG)	221.3	MG CACO3/L	8/31/2006	
JQ-01	Hardness (CA/MG)	221	MG CACO3/L	8/31/2006	-0.13565
ND11-DUP	Solids, total suspended	16.2	MG/L	11/1/2006	
ND11	Solids, total suspended	15	MG/L	11/1/2006	-7.69231
ND11-DUP	Alkalinity	90.2	MG/L	9/6/2006	
ND11	Alkalinity	90.2	MG/L	9/6/2006	0
NDA01-DUP	Solids, total suspended	18.2	MG/L	9/6/2006	
NDA01	Solids, total suspended	16.6	MG/L	9/6/2006	-9.1954
NDB04-DUP	Chlorophyll	26.9	MG/CU.M.	11/2/2006	
NDB04	Chlorophyll	25.7	MG/CU.M.	11/2/2006	-4.56274
OI05C-DUP	Biological Oxygen Demand	4.6	MG/L	9/1/2006	
OI05C	Biological Oxygen Demand	5.1	MG/L	9/1/2006	10.30928
OIC02-DUP	Solids, total suspended	14	MG/L	8/31/2006	
OIC02	Solids, total suspended	13.7	MG/L	8/31/2006	-2.16606
OIC02-DUP	Solids, total suspended	18.5	MG/L	10/17/2006	

Table 3-1: Duplicate Pair Sample Results (continued)

SampleLocation	Parameter	Result	Units	Collection Date	RPD(%)
OIC02	Solids, total suspended	16.8	MG/L	10/17/2006	-9.63173
OIP10-DUP	Hardness (CA/MG)	278.52	MG CACO3/L	10/17/2006	
OIP10	Hardness (CA/MG)	286	MG CACO3/L	10/17/2006	2.650039
OZH-OK-A2A-DUP	Chlorophyll	155.4	MG/CU.M.	9/8/2006	
OZH-OK-A2A	Chlorophyll	126	MG/CU.M.	9/8/2006	-20.8955

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Section 4
Conclusions

Data collected during Stage 2 have been deemed adequate and usable for Stage 3 TMDL development (see discussion in Section 3). Table 4-1 contains information for each segment sampled during Stage 2 with regards to its impairment status. The table contains information on the number of historic samples available prior to Stage 2 data collection, the number of historic violations as well as the date of the last recorded violation. The intention of this table is to assist any future determination on the impairment status of the Stage 2 stream segments.

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Table 4-1: Impairment Status

Watershed	Stream Name	Segment	Parameter of Concern	Historic Data Count	Number of Historic Violations	Date of Last Recorded Violation	Stage 2 Data Count	Number of Violations	Suggested Status
Bay Creek	Cedar Creek	AJF16	Dissolved Oxygen	1	1	2000	Continuous	0	Delist
			Manganese	1	0	-	4	0	Delist
	Bay Creek Ditch	AJK01	Dissolved Oxygen	3	3	1987	Continuous	Multiple	Impaired
			Manganese	3	3	1987	3	0	Delist
Cahokia Creek/ Holiday Shores Lake	Cahokia Diversion Ditch	JQ07	Dissolved Oxygen	147	130	2005	Continuous	Multiple	Impaired
			Copper	5	1	1998	4	0	Delist
Cedar Creek	Big Muddy River	N99	Dissolved Oxygen	3	1	2002	Continuous	*	Impaired
			Sulfates	3	0	-	4	0	Delist
	Cave Creek	NAC01	Dissolved Oxygen	2	1	1995	Continuous	1	Impaired
Crab Orchard Lake	Crab Orchard Creek	ND11	Dissolved Oxygen	2	1	2000	Continuous	Multiple	Impaired
			Manganese	2	2	2000	2	0	Delist
			pH	3	2	2004	Continuous	Multiple	Impaired
	Crab Orchard Creek	ND12	pH	3	1	2004	Continuous	0	Delist
			Manganese	2	1	2000	2	0	Delist
	Crab Orchard Creek	ND13	Dissolved Oxygen	4	4	2000	Continuous	Multiple	Impaired
	Little Crab Orchard Creek	NDA01	Dissolved Oxygen	2	1	1995	Continuous	Multiple	Impaired
			Manganese	2	1	1995	3	1	Impaired
	Piles Fork	NDB03	Dissolved Oxygen	2	1	1995	Continuous	Multiple	Impaired
Crooked Creek	Plum Creek	OZH-OK-A2	Dissolved Oxygen	1	1	2002	Continuous	Multiple	Impaired
	Plum Creek		Manganese	1	1	2002	4	0	Delist
	Plum Creek	OZH-OK-C2	Dissolved Oxygen	1	1	2002	Continuous	Multiple	Impaired
	Plum Creek	OZH-OK-C3	Dissolved Oxygen	1	1	2002	Continuous	Multiple	Impaired
	Plum Creek		Manganese	1	1	2002	2	0	Delist
	Little Crooked Creek	OJA-01	Dissolved Oxygen	5	4	2002	Continuous	Multiple	Impaired
			Manganese	5	2	2002	4	0	Delist

Table 4-1: Impairment Status

Watershed	Stream Name	Segment	Parameter of Concern	Historic Data Count	Number of Historic Violations	Date of Last Recorded Violation	Stage 2 Data Count	Number of Violations	Suggested Status
Little Wabash	Little Wabash River	C09	Dissolved Oxygen	43	7	2003	Continuous	Multiple	Impaired
			Silver	43	1	2002	18	0	Delist
			Atrazine	2	1	1991	16	2	Impaired
		C33	Dissolved Oxygen	5	3	2002	Continuous	Multiple	Impaired
			Manganese	5	5	2002	10	10	Impaired
			Atrazine	NA	NA	NA	16	2	Impaired
	Village Creek	CE01	Dissolved Oxygen	1	0	NA	Continuous	Multiple	Impaired
			Manganese	1	1	2002	6	0	Delist
	Johnson Creek	CCAFFA1	Dissolved Oxygen	1	1	1997	Continuous	Multiple	Impaired
	Pond Creek	CCFFD1	Dissolved Oxygen	1	1	1997	Continuous	Multiple	Impaired
	Elm River	CD01	Atrazine	8	3	2002	16	2	Impaired
		CD02	Dissolved Oxygen	3	2	2003	Continuous	Multiple	Impaired
	Seminary Creek	CDGFLA1	Dissolved Oxygen	1	1	1998	Continuous	Multiple	Impaired
	Seminary Creek	CDFGLC6	Dissolved Oxygen	1	1	1998	Continuous	Multiple	Impaired
	Big Muddy Creek	CJ06	Dissolved Oxygen	3	1	2002	Continuous	Multiple	Impaired
			Manganese	2	1	2002	6	0	Delist
	Little Muddy Creek	CJA02	Dissolved Oxygen	4	3	2002	Continuous	Multiple	Impaired
			Manganese	4	3	2002	4	2	Impaired
	Big Muddy Diversion Ditch	CJAE01	Dissolved Oxygen	1	0	2000	Continuous	Multiple	Impaired
Mary's River/ North Fork Cox Creek	North Fork Cox Creek	IIHA31	Sulfates	2	2	1995	4	4	Impaired
			TDS	2	2	1995	4	4	Impaired
	North Fork Cox Creek	IIHA-STC1	TDS	1	1	1995	4	2	Impaired
	Maxwell Creek	IIKSPC1A	Dissolved Oxygen	2	2	19999	Continuous	Multiple	Impaired
	Randolph County Lake	RIB	Total Phosphorus	11	3	1993	6	2	Impaired
Sangamon River/ Lake Decatur	Owl Creek	EZV	Dissolved Oxygen	3	1	1998	Continuous	Multiple	Impaired

Table 4-1: Impairment Status

Watershed	Stream Name	Segment	Parameter of Concern	Historic Data Count	Number of Historic Violations	Date of Last Recorded Violation	Stage 2 Data Count	Number of Violations	Suggested Status
Shoal Creek	Shoal Creek	OI05	Dissolved Oxygen	3	1	2002	Continuous	0	Delist
	Locust Fork	OIC01	Dissolved Oxygen	3	1	1991	Continuous	Multiple	Impaired
			Manganese	3	1	1991	2	0	Delist
	Chicken Creek	OIO09	Dissolved Oxygen	2	1	1991	0	0	No Water
	Cattle Creek	OIP10	Dissolved Oxygen	3	2	1991	Continuous	Multiple	Impaired
			Ammonia	3	1	1991	1	0	Delist
			TDS	3	1	1991	1	0	Delist
South Fork Saline River/ Lake of Egypt	Briers Creek	ATHS01	Zinc	2	2	1993	13	0	Delist
			Iron	3	3	1993	16	3	Impaired
			Manganese	3	3	1993	8	4	Impaired
			Silver	3	1	1993	12	0	Delist
			Sulfates	3	3	1993	16	6	Impaired
			TDS	2	1	1993	16	9	Impaired
			pH	3	3	1993	Continuous	0	Delist
			Dissolved Oxygen	2	1	1993	Continuous	1	Impaired
	East Palzo Creek	ATHV01	Copper	3	2	1993	5	0	Delist
			Iron	3	3	1993	7	1	Impaired
			Manganese	3	3	1993	7	3	Impaired
			TDS	0		-	7	1	Impaired
			pH	3	3	1993	Continuous	Multiple	Impaired
	South Fork Saline River	ATH14	Dissolved Oxygen	8	1	2000	Continuous	0	Delist
South Fork Sangamon/ Lake Taylorville	South Fork Sangamon River	EO13	Dissolved Oxygen	1	1	1989	Continuous	Multiple	Impaired
			Boron	1	1	1989	6	0	Delist
			Manganese	1	1	1989	6	2	Impaired

* Continuous data did not violate the 5.0 mg/L instantaneous DO standard, however, continuous data collected at site N13 experienced more than 16 hours below 6.0 mg/L in a 24 hour period

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For Appendices, please contact Jennifer Clarke at the Illinois EPA for information.

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South Fork Saline River/Lake of Egypt Implementation Plan

FINAL REPORT

February 28, 2008

Submitted to:
Illinois Environmental Protection Agency
1021 N. Grand Avenue East
Springfield, IL 62702

Submitted by:
Tetra Tech

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KEY FINDINGS

The TMDLs developed for the impaired waterbodies in the South Fork Saline River/Lake of Egypt Watershed were approved by USEPA in November 2007. The recommendation of the TMDL report is taht significant reductions of manganese, metals, total dissolved solids (TDS), and sulfates are needed to attain water quality standards in several stream segments in the watershed. In addition, reductions of manganese loads to the Lake of Egypt are required to bring this segment into compliance.

The largest potential sources of pollutant loading in the watershed are abandoned mine discharges (AMDs). The BMPs best suited to controlling pollutant loads from AMDs in this watershed are passive treatments including: aerobic wetlands, anaerobic wetlands, limestone channels, anoxic limestone drains, and vertical flow systems.

Manure from animal operations also contributes nutrients, pathogens, and biodegradable organic material to the impaired streams in the watershed. In addition, animals with access to stream channels deposit fecal material directly into or near the stream and erode the banks as they climb in and out. This erosion leads to increased loads of sediment and manganese, a metal common in soils. The BMPs most likely to control loading from animal operations are 1) proper handling, storage, and final disposal practices for manure, 2) vegetative controls such as grassed waterways, filter strips, and constructed wetlands, 3) manure composting, and 4) restoration of riparian buffers.

Crop production in the watershed results in loadings of nutrients, sediment, manganese, and pesticides to the watershed. Application of fertilizers and pesticides contributes phosphorus and atrazine to the waterbodies when rain events wash pollutants into nearby streams or through underlying tile drain systems. Increased rates of erosion result in excessive sediment and manganese loads. The most cost-effective management strategy that addresses all pollutants of concern is conservation tillage. Other effective practices include grassed waterways, filter strips, fertilizer and pesticide management, and restoration of riparian buffers.

Pollutant loads from point sources in the watershed may be significant, but the actual loads are difficult to estimate because several of the facilities are not required to monitor for the TMDL pollutants. Given that most of these facilities provide at least a secondary level of wastewater treatment, it is not likely that IEPA will require them to upgrade their plants to reduce nutrient or organic loading. However, the State may request that facilities submit TMDL pollutant data to verify that water quality standards are being met.

The number of onsite wastewater treatment systems in the watershed is relatively sparse and loading from this source is likely not significant relative to the other sources. However, failing onsite systems may cause localized water quality impacts as well as risks to human health. Identifying these systems through a routine inspection program and encouraging proper maintenance and upkeep will minimize these impacts.

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1.0 INTRODUCTION

The Clean Water Act and U. S. Environmental Protection Agency (USEPA) regulations require that states develop Total Maximum Daily Loads (TMDLs) for waters identified as impaired on the Section 303(d) lists. Several waterbodies in the South Fork Saline River/Lake of Egypt Watershed were listed on the Illinois' 2006 303(d) list as described in Table 1-1 and shown in Figure 1-1.

Table 1-1. 2006 303(d) List Information for the South Fork Saline River/Lake of Egypt Watershed.

Waterbody Name	Waterbody Segment	Segment and Lake Size (Segment Length in Miles, Lake Area in Acres)	Cause of Impairment	Impaired Designated Use
South Fork Saline River	ATH 02	7.98	Dissolved Oxygen	Aquatic Life
			Fecal Coliform	Primary Contact Recreation
			Manganese	Aquatic Life
			pH	Aquatic Life
			Sedimentation/Siltation	Aquatic Life
			Total Suspended Solids	Aquatic Life
South Fork Saline River	ATH 05	7.95	Cadmium	Aquatic Life
			Iron	Aquatic Life
			Manganese	Aquatic Life
			pH	Aquatic Life
			Sulfates	Aquatic Life
			Sedimentation/Siltation	Aquatic Life
			Total Suspended Solids	Aquatic Life
South Fork Saline River	ATH 14	4.04	Dissolved Oxygen[1]	Aquatic Life
Sugar Creek	ATHG 01	4.19	Cadmium	Aquatic Life
			Copper	Aquatic Life
			Iron	Aquatic Life
			Manganese	Aquatic Life
			Nickel	Aquatic Life
			Dissolved Oxygen	Aquatic Life
			pH	Aquatic Life
			Silver	Aquatic Life
			Sulfates	Aquatic Life
			Total Dissolved Solids	Aquatic Life
			Zinc	Aquatic Life
			Total Phosphorus	Aquatic Life
			Sedimentation/Siltation	Aquatic Life
			Total Suspended Solids	Aquatic Life
Sugar Creek	ATHG 05	0.9	Fecal Coliform	Primary Contact Recreation
			Manganese	Aquatic Life
			Dissolved Oxygen	Aquatic Life

Waterbody Name	Waterbody Segment	Segment and Lake Size (Segment Length in Miles, Lake Area in Acres)	Cause of Impairment	Impaired Designated Use
			pH	Aquatic Life
Brier Creek	ATHS 01	3.3	Iron	Aquatic Life
			Manganese	Aquatic Life
			Dissolved Oxygen	Aquatic Life
			Sulfates	Aquatic Life
			Total Dissolved Solids	Aquatic Life
			Zinc[1]	Aquatic Life
			Silver[1]	Aquatic Life
			pH[1]	Aquatic Life
East Palzo Creek	ATHV 01	3.16	Manganese	Aquatic Life
			pH	Aquatic Life
			Total Dissolved Solids	Aquatic Life
			Copper[1]	Aquatic Life
Lake of Egypt	RAL	2,300	Manganese	Public Water Supplies

[1]Recommended for de-listing as a result of the TMDL study.

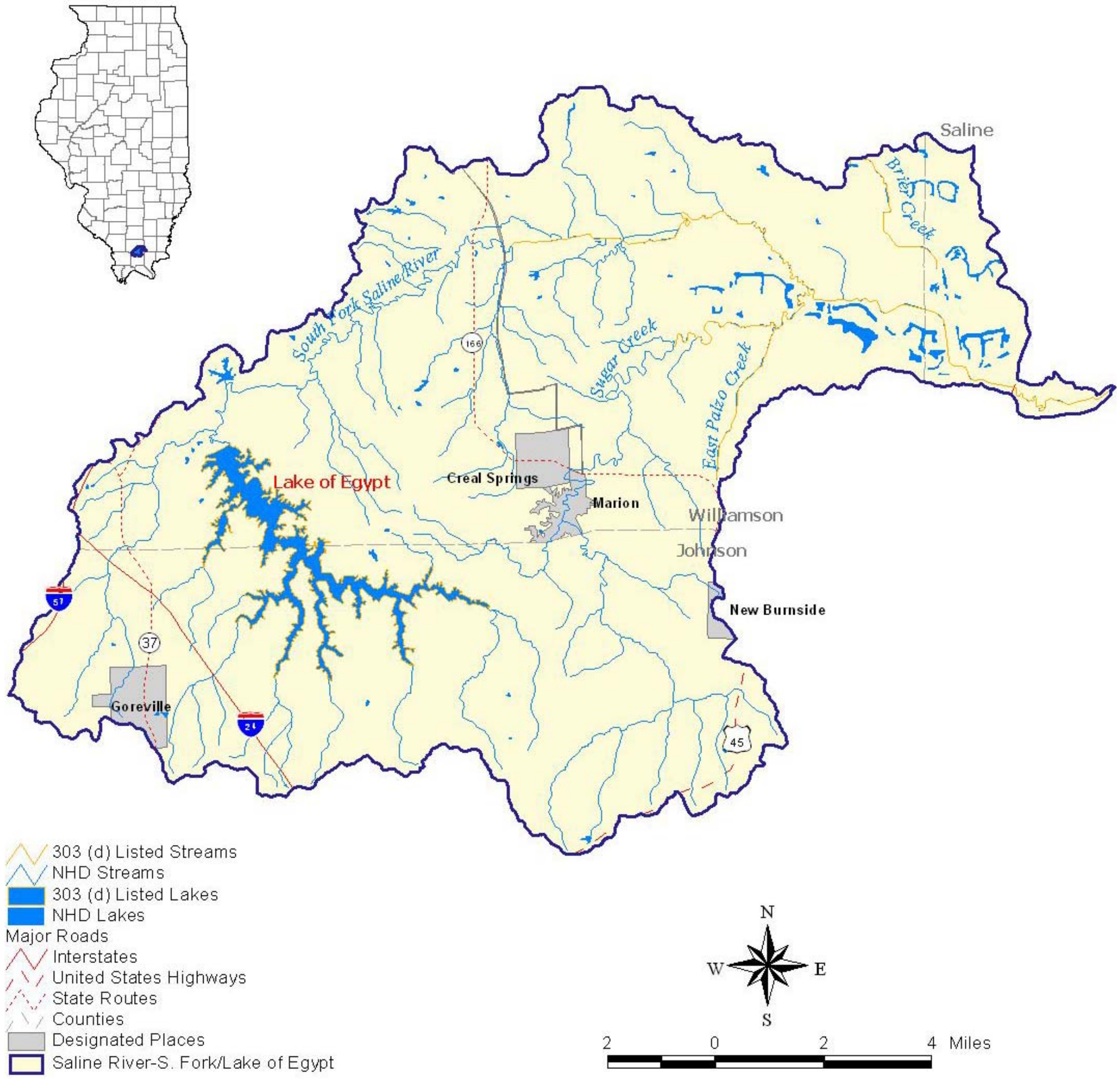

Figure 1-1. 303(d) Listed Waterbodies in the South Fork Saline River/Lake of Egypt Watershed.

IEPA is currently developing TMDLs for pollutants that have numeric water quality standards. Of the pollutants impairing waterbodies in the South Fork Saline River/Lake of Egypt watershed, cadmium, copper, dissolved oxygen, fecal coliform, iron, manganese, nickel, pH, silver, sulfates, TDS, and zinc have numeric water quality standards. IEPA believes that addressing these impairments should lead to an overall improvement in water quality due to the interrelated nature of the other listed pollutants.

This project is being initiated in three stages. Stage One was completed in January of 2007 and involved the characterization of the watershed, an assessment of the available water quality data, and identification of potential technical approaches for developing the TMDLs. Stage Two involved additional data collection for waters where a TMDL could not be developed using the Stage One data. (Stage Two data were collected for Brier Creek and East Palzo Creek). The first part of Stage Three involved modeling and TMDL analyses for the South Fork Saline River/Lake of Egypt Watershed impairments. The final component of Stage Three is this implementation plan, outlining how the TMDL reductions can be achieved.

The TMDLs for the waterbodies in the South Fork Saline River/Lake of Egypt Watershed were developed using the load duration curve approach, and the QUAL2K, MINEQL+, and BATHTUB models depending on the pollutant causing the impairment as well as the hydraulic function of the listed reach. Due to the number of listed segments in the watershed, this report will not detail the TMDL process. Readers interested in the details of each TMDL may refer to the TMDL report for the watershed which is available at:

http://www.epa.state.il.us/water/tmdl/

2.0 DESCRIPTION OF WATERBODY AND WATERSHED CHARACTERISTICS

The purpose of this section of the report is to provide a brief background of the South Fork Saline River/Lake of Egypt watershed. More detailed information on the soils, topography, land use/land cover, climate, and population is available in the Stage One Watershed Characterization Report.

Soils in the watershed are primarily IL064 (Grantsburg-Zanesville-Wellston), IL069 (Bonnie-Belknap-Piopolis), IL038 (Bluford-Ava-Hickory), and IL063 (Hosmer-Zanesville-Belknap). Soil erodibility factors reported for these soils in the SSURGO database range from 0.24 to 0.55, indicating moderate soil erodibility. Soils identified by SSURGO as highly erodible generally have slopes greater than 5 percent and represent 62 percent of the total watershed area (Figure 2-1). Most of the highly erodible soils are currently on forested land and lands used for pasture.

Land use/land cover in the watershed is largely forest (47 percent) and pasture/hay (34 percent) based on satellite imagery collected around 2001 (INHS, 2003) (Figure 2-2). Additional land use/land cover includes urban areas (9 percent), cultivated cropland (4 percent), open water (4 percent), and wetlands (2 percent).

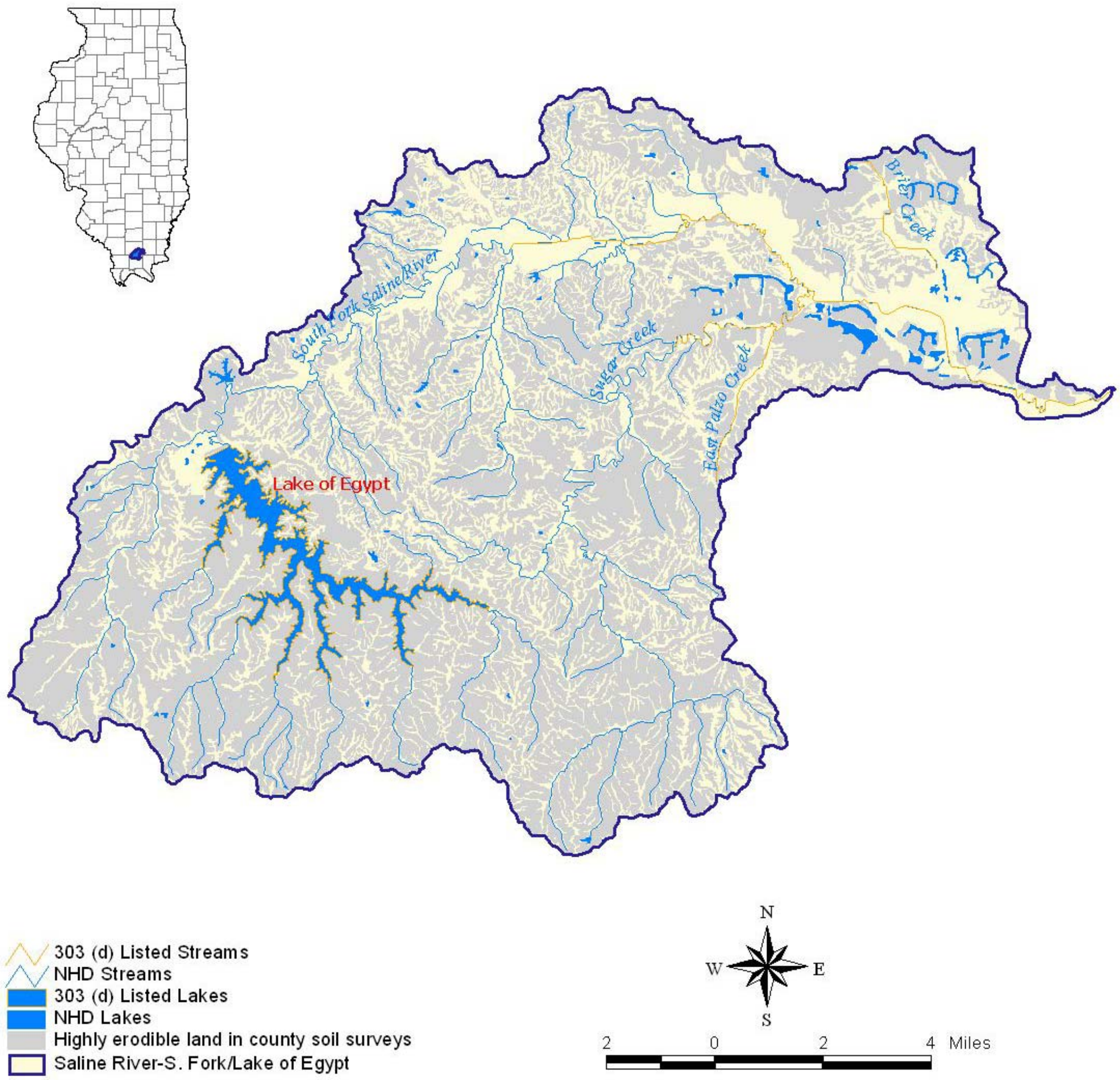

Figure 2-1. Highly Erodible Soils in the South Fork Saline River/Lake of Egypt Watershed.

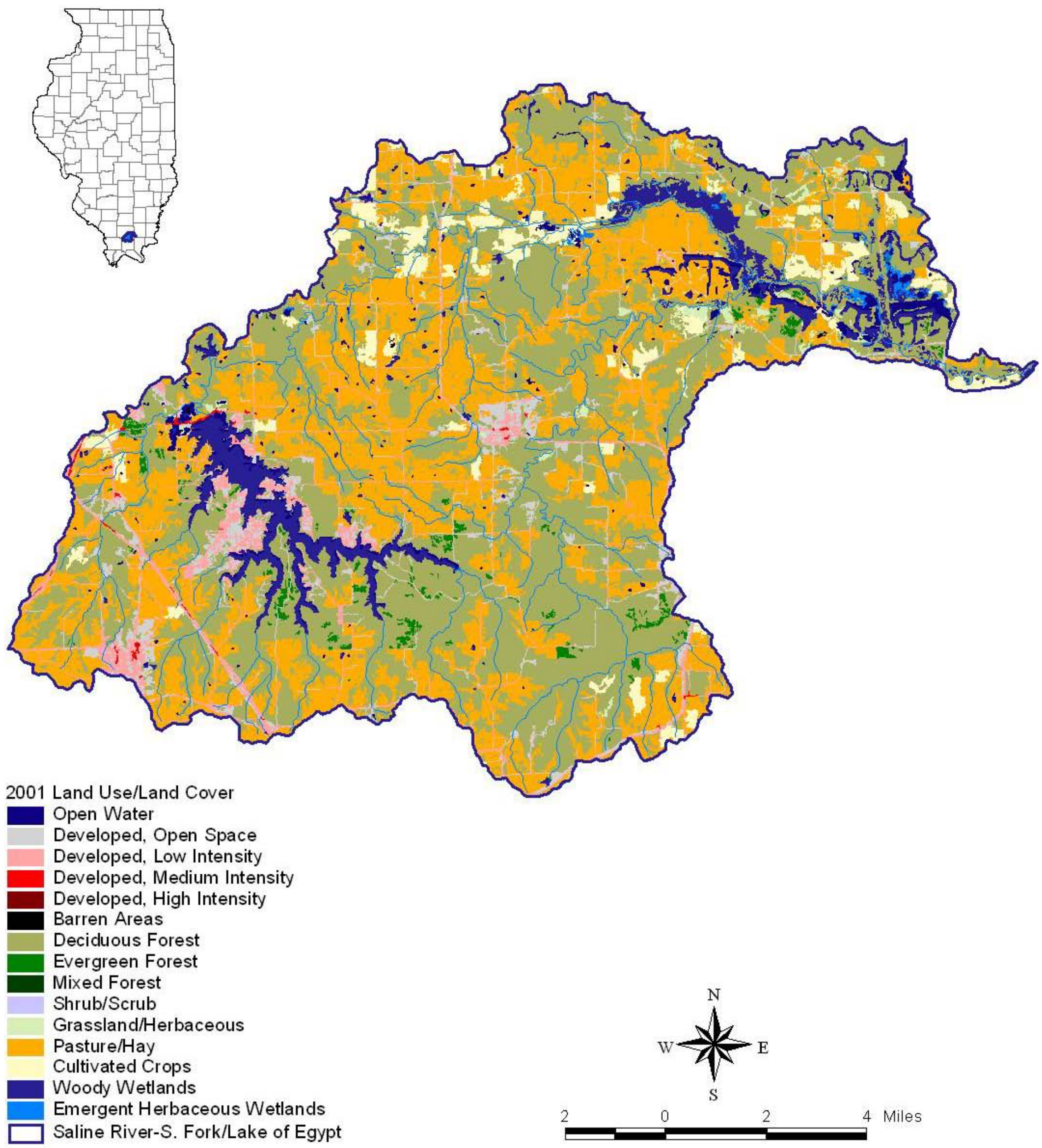

Figure 2-2. Land Use/Land Cover in the South Fork Saline River/Lake of Egypt Watershed (Year 2001 NLCD Data).

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3.0 WATER QUALITY DATA, IMPAIRMENTS, AND TMDL ALLOCATIONS

Waters in the South Fork Saline River/Lake of Egypt watershed are currently listed for several causes of impairment (see Table 1-1). Those causes of impairment that received TMDLs (cadmium, copper, fecal coliform, iron, manganese, nickel, pH, silver, sulfates, TDS, and zinc) are addressed in this implementation plan. This section presents the applicable water quality standards for each parameter and a summary of the listed reaches and TMDL allocations in the watershed. More detailed discussions of the available water quality data and TMDL development are presented in the Stage One Watershed Characterization Report and Stage Three TMDL Development Report, respectively. For the purposes of this report, which is targeted for stakeholders in the watershed, loads for mass-based pollutants are expressed in pounds per day or pounds per year. The TMDL report expressed loads in kilograms because the simulation models run and generate output in metric units.

To assess the designated use support for Illinois waterbodies, the IEPA uses rules and regulations adopted by the Illinois Pollution Control Board (IPCB). The following are the use support designations applicable in the South Fork Saline River/Lake of Egypt Watershed:

General Use Standards - These standards protect for aquatic life, wildlife, agricultural use, primary contact recreation (where physical configuration of the waterbody permits it), secondary contact recreation, and most industrial uses. Primary contact recreation includes any recreational or other water use in which there is prolonged and intimate contact with the water involving considerable risk of ingesting water in quantities sufficient to pose a significant health hazard, such as swimming and water skiing. Secondary contact recreation includes any recreational or other water use in which contact with the water is either incidental or accidental and in which the probability of ingesting appreciable quantities of water is minimal, such as fishing, commercial and recreational boating, and any limited contact incident to shoreline activity. These standards are also designed to ensure the aesthetic quality of the state's aquatic environment.

Public and Food Processing Water Supply Standards – These standards are cumulative with the general use standards and apply to waters of the state at any point at which water is withdrawn for treatment and distribution as a potable supply to the public or for food processing.

3.1 Cadmium

3.1.1 Water Quality Standards

The numeric general use water quality standards for cadmium are hardness dependent and the TMDLs for cadmium in this watershed were based on the minimum hardness observed in the watershed (46 mg/L). The acute water quality standard for total cadmium at a hardness of 46 mg/L is 4.06 μg/L and the chronic water quality standard is 0.62 μg/L. The public and food processing water supplies standard for total cadmium is 10 μg/L.

3.1.2 Impairments in the South Fork Saline River/Lake of Egypt Watershed

Two waterbodies in the South Fork Saline River/Lake of Egypt Watershed are listed for cadmium. Table 3-1 summarizes the cadmium data collected in these impaired reaches and Figure 3-1 shows the location of these impaired reaches.

Table 3-1. Summary of Cadmium Data Collected in the Listed Reaches of the South Fork Saline River/Lake of Egypt Watershed.

Waterbody Name (Segment ID)	Number of Samples	Minimum Cadmium (μg/L)	Average Cadmium (μg/L)	Maximum Cadmium (μg/L)	Exceedance (percent)
South Fork Saline River (ATH 05)	44	3	3.34	6	11
Sugar Creek (ATHG 01)	43	3	28	160	48

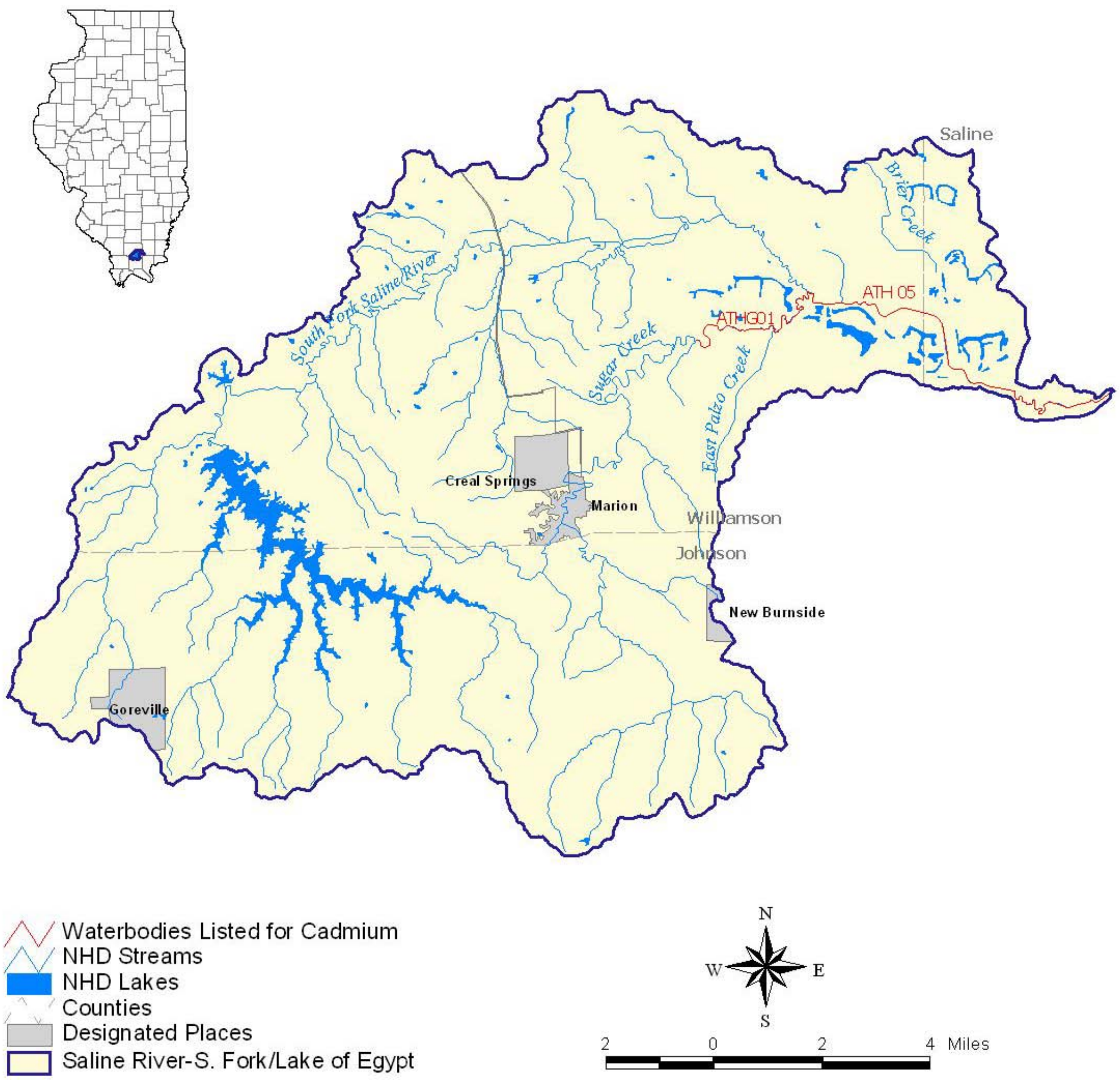


Figure 3-1. Waterbodies Listed for Cadmium Impairment in the South Fork Saline River/Lake of Egypt Watershed.

3.1.3 TMDL Allocations

TMDLs were developed using the load duration approach, and allocations for cadmium were calculated for five flow regimes. The allocations for each reach and flow percentile are summarized in Table 3-2. Values presented in the tables are given in pounds per day (lb/d) with the exception of the TMDL reductions which are given as percentages.

Table 3-2. Cadmium TMDL Allocations for Waterbodies in the South Fork Saline River/Lake of Egypt watershed.

Cadmium TMDLs (lb/d)		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Segment	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
South Fork Saline River (ATH 05)	Current Load	55.12	1.98	0.88	0.44	0.22
	TMDL= LA+WLA+MOS	74.74	1.54	1.10	0.44	0.22
	LA	67.24	1.32	1.10	0.44	0.22
	WLA: Facility	0	0	0	0	0
	MOS (10%)	7.50	0.22	0.22	0.00	0.00
	TMDL Reduction	**0%**	**27%**	**0%**	**27%**	**27%**
Sugar Creek (ATHG 01)	Current Load	8.82	0.66	1.10	2.43	1.54
	TMDL= LA+WLA+MOS	10.58	0.44	0.22	0.00	0.00
	LA	9.70	0.44	0.22	0.00	0.00
	WLA: Facility	0	0	0	0	0
	MOS (10%)	1.10	0.00	0.00	0.00	0.00
	TMDL Reduction	**0%**	**39%**	**79%**	**96%**	**98%**

3.2 Copper

3.2.1 Water Quality Standards

The numeric general use water quality standards for copper are hardness dependent and the TMDLs for copper in this watershed were based on the minimum hardness observed in the watershed (46 mg/L). . The acute water quality standard for total copper at a hardness of 46 mg/L is 8.53 μg/L and the chronic water quality standard is 6.09 μg/L.

3.2.2 Impairments in the South Fork Saline River/Lake of Egypt Watershed

One waterbody in the South Fork Saline River/Lake of Egypt Watershed is listed for copper. Table 3-3 summarizes the copper data collected in this impaired reach and Figure 3-2 shows the location of this reach.

Table 3-3. Summary of Copper Data Collected in the Listed Reaches of the South Fork Saline River/Lake of Egypt Watershed.

Waterbody Name (Segment ID)	Number of Samples	Minimum Copper (μg/L)	Average Copper (μg/L)	Maximum Copper (μg/L)	Exceedance (percent)
Sugar Creek (ATHG 01)	43	10	27	130	35

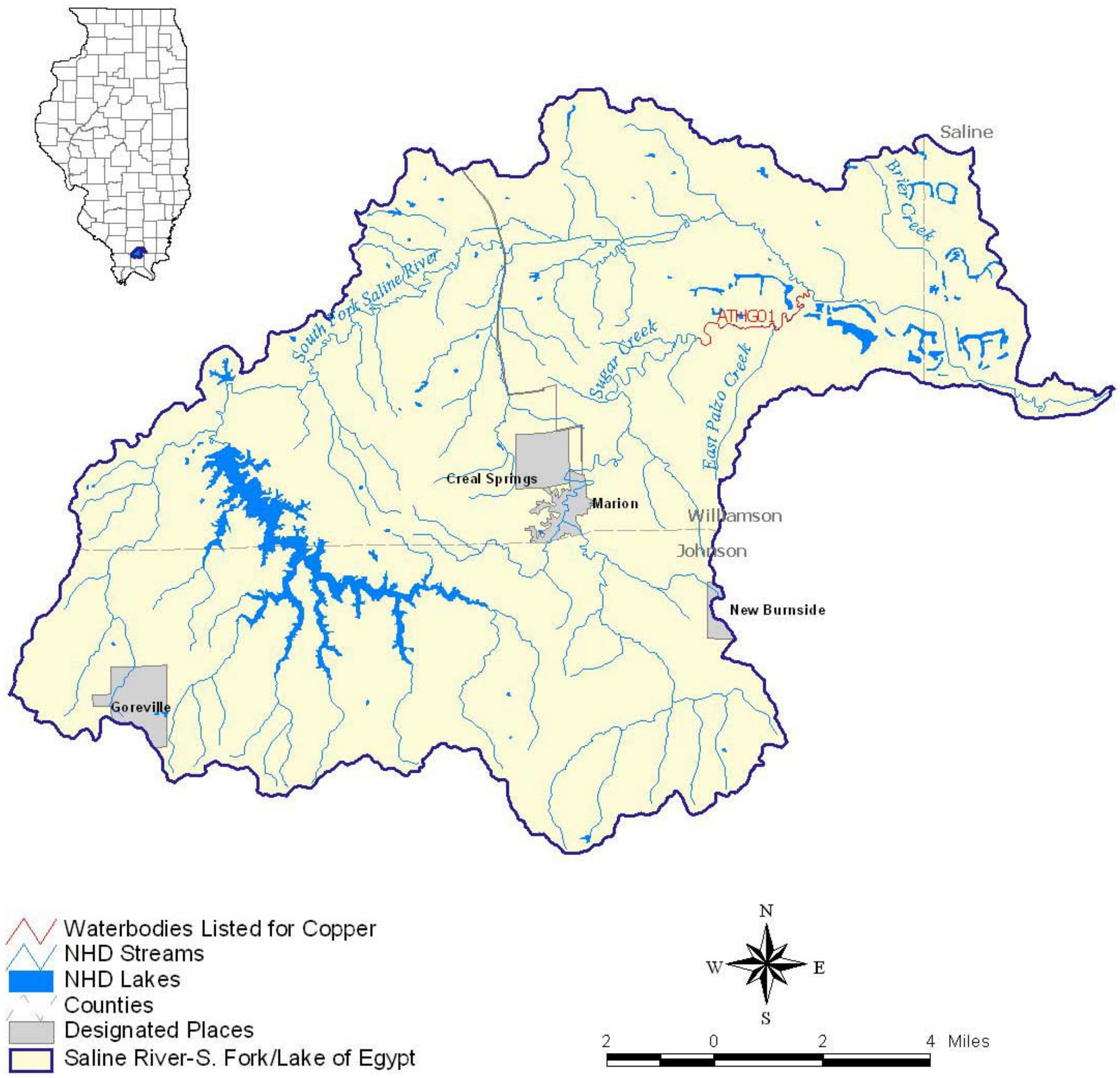


Figure 3-2. Waterbodies Listed for Copper Impairment in the South Fork Saline River/Lake of Egypt Watershed.

3.2.3 TMDL Allocations

TMDLs were developed using the load duration approach, and allocations for copper were calculated for five flow regimes. The allocations for the reach and flow percentile are summarized in Table 3-4. Values presented in the table are given in pounds per day (lb/d) with the exception of the TMDL reductions which are given as percentages.

Table 3-4. Copper TMDL Allocations for Waterbodies in the South Fork Saline River/Lake of Egypt watershed.

Copper TMDLs (lb/d)		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Segment	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Sugar Creek (ATHG 01)	Current Load	39.49	4.55	1.77	1.85	0.82
	TMDL= LA+WLA+MOS	22.45	3.88	0.51	0.22	0.08
	LA	20.21	3.49	0.46	0.20	0.07
	WLA: Facility	0	0	0	0	0
	MOS (10%)	2.25	0.39	0.05	0.02	0.01
	TMDL Reduction	**49%**	**23%**	**74%**	**89%**	**91%**

3.3 Fecal Coliform

Fecal coliform is a commonly used indicator to test for the presence of fecal matter and pathogenic organisms. Because so many disease-causing organisms exist in the environment, it is less expensive to test for an indicator organism, such as fecal coliform bacteria, than it is to test for each individual pathogen. For this reason, most water quality regulations and water quality standards are written in terms of fecal coliform counts.

Unlike other water quality parameters which report concentration as mass per volume (e.g., mg/L or ppm), fecal coliform is usually reported as the number of bacterial colonies, or colony forming units, observed in 100 milliliters of sample. The abbreviated units for this measurement are cfu/100 mL; in some cases the cfu is omitted.

In general, TMDLs are reported as a load per day of pollutant (e.g., lb/d), rather than as a concentration (e.g., mg/L). This allows for comparison of the contribution from each source, which depends not only on the pollutant concentration, but also on the volume of water. TMDLs for fecal coliform must also be reported as a daily load (or in this case a count), rather than a concentration. The daily loads are often on the order of billions and trillions of counts per day, and require the use of scientific notation for reporting.

Scientific notation was developed to write very small and very large numbers. This report deals with very large numbers, so the scientific format can be thought of as the number of zeros that must be added to a number (called the coefficient) for it to be displayed in normal format. The “E” in the scientific notation stands for exponent, and the two digit number that follows is the number of zeros to be added. For example, the number “1,000” can also be written as 1E03 because you add three zeros after the number one to get 1,000. The use of decimal places on the coefficient allows for reporting additional significant figures: 4.567E06 = 4,567,000. For this report, only two decimal places will be used, so that the previous example, rounded up, would be shown as 4.57E06.

3.3.1 Water Quality Standards

The fecal coliform water quality standards vary by season and designated use. For general use waterbodies during the months May through October, no more than 10 percent of samples collected within a 30-day period should exceed 400 cfu/100 mL, and the geometric mean of at least five samples collected within a 30-day period should not exceed 200 cfu/100 mL. From November through April, no numeric standard applies for general use waters. Public food and water processing supplies have a year round standard that the geometric mean of at least five samples collected within a 30-day period should not exceed 2,000 cfu/100 mL.

3.3.2 Impairments in the South Fork Saline River/Lake of Egypt Watershed

Two waterbodies in the South Fork Saline River/Lake of Egypt Watershed are listed for fecal coliform. Table 3-5 summarizes the fecal coliform data collected in these impaired reaches. Figure 3-3 shows the location of these impaired reaches.

Table 3-5. Summary of Fecal Coliform Data Collected in the Listed Reaches of the South Fork Saline River/Lake of Egypt Watershed.

Waterbody Name (Segment ID)	Number of Samples	Minimum Fecal Coliform (cfu/100mL)	Average Fecal Coliform (cfu/100mL)	Maximum Fecal Coliform (cfu/100mL)	Exceedance (percent)
South Fork Saline River (ATH 02)	117	6	902	20,000	47
Sugar Creek (ATHG 05)	41	2	414	3,200	32

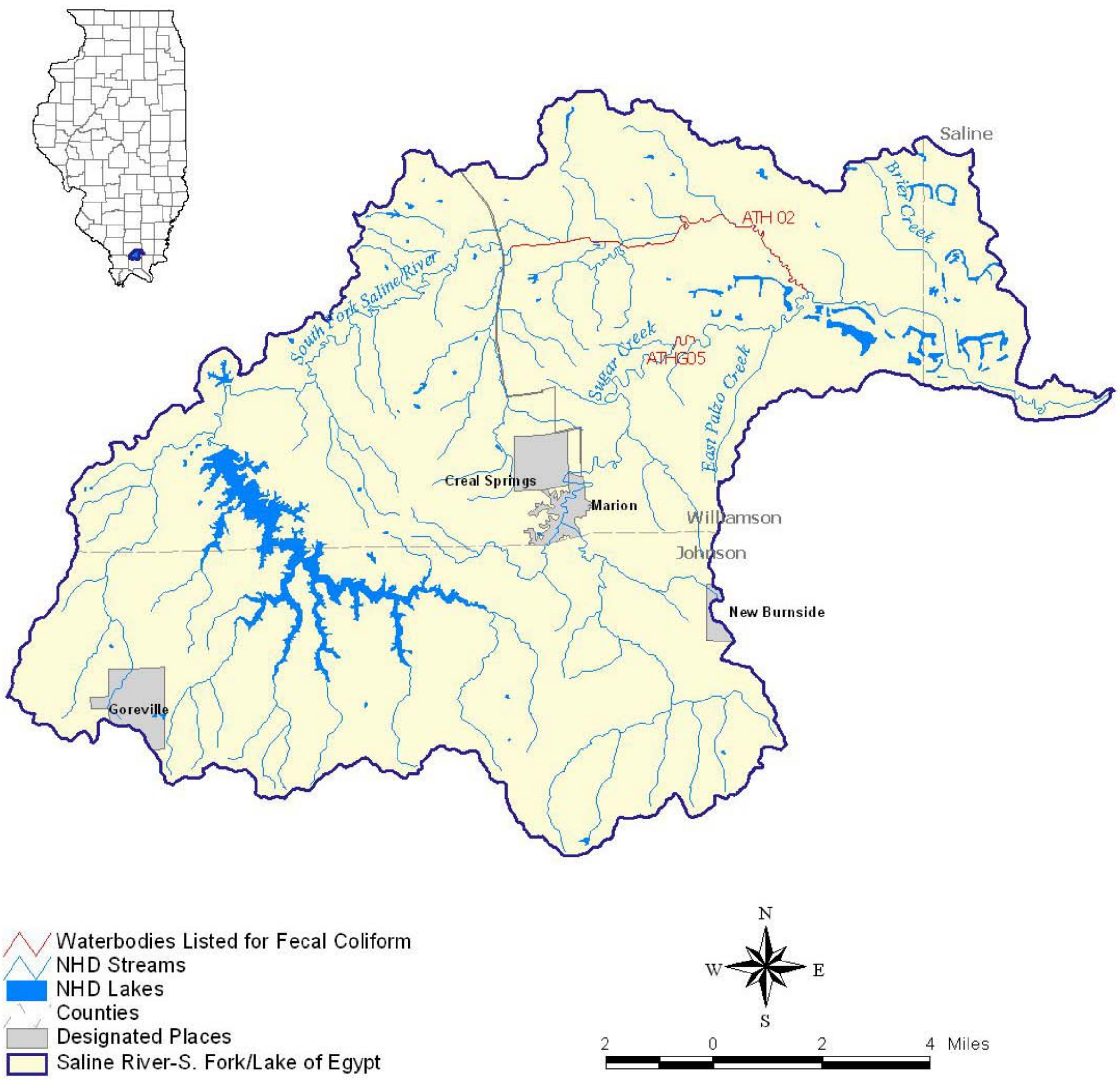


Figure 3-3. Waterbodies Listed for Fecal Coliform Impairment in the South Fork Saline River/Lake of Egypt Watershed.

3.3.3 TMDL Allocations

The fecal coliform TMDLs for impairments in the South Fork Saline River/Lake of Egypt watershed are based on a load duration approach which outputs separate reductions for five flow regimes. The reductions for the two listed segments are summarized in Table 3-6.

Table 3-6. Fecal Coliform Reductions by Flow Regime for Waterbodies in the South Fork Saline River/Lake of Egypt Watershed.

Fecal Coliform TMDLs (cfu/d)		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Segment	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
South Fork Saline River (ATH 02)	Current Load	2.33E+14	1.39E+13	1.88E+11	4.85E+11	7.34E+10
	TMDL= LA+WLA+MOS	1.13E+13	2.83E+11	4.71E+10	2.77E+10	1.47E+10
	LA	1.13E+13	2.74E+11	3.89E+10	2.38E+10	1.08E+10
	WLA: Lake of Egypt Sewer District STP	3.33E+09	3.33E+09	3.33E+09	1.70E+09	1.70E+09
	WLA: Village of Goreville STP	1.21E+09	1.21E+09	1.21E+09	4.54E+08	4.54E+08
	WLA: City of Creal Springs STP	3.70E+09	3.70E+09	3.70E+09	1.70E+09	1.70E+09
	MOS (Implicit)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	TMDL Reduction	**95%**	**98%**	**75%**	**94%**	**80%**
Sugar Creek (ATHG 05)	Current Load	No Data	2.33E+11	1.02E+10	1.48E+11	1.05E+10
	TMDL= LA+WLA+MOS	5.14E+12	4.35E+10	1.90E+10	1.10E+10	6.02E+09
	LA	5.14E+12	4.35E+10	1.90E+10	1.10E+10	6.02E+09
	WLA: Facility	0	0	0	0	0
	MOS (Implicit)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	TMDL Reduction	No Data	**81%**	**0%**	**93%**	**43%**

3.4 Iron

3.4.1 Water Quality Standards

The general use water quality standard for iron is 1,000 µg/L, and the public and food processing water supply standard is 300 µg/L.

3.4.2 Impairments in the South Fork Saline River/Lake of Egypt Watershed

Four waterbodies in the South Fork Saline River/Lake of Egypt Watershed are impaired for iron. Table 3-7 summarizes the iron data collected in the impaired segments and Figure 3-4 shows the location of the impaired reaches.

Table 3-7. Summary of Iron Data Collected in the Listed Reaches of the South Fork Saline River/Lake of Egypt Watershed.

Waterbody Name (Segment ID)	Number of Samples	Minimum Iron (µg/L)	Average Iron (µg/L)	Maximum Iron (µg/L)	Exceedance (percent)
South Fork Saline River (ATH 05)	44	50	1,363	7,300	30
Sugar Creek (ATHG 01)	43	50	102,383	537,000	93
Brier Creek (ATHS 01)	5	310	75,482	243,000	80
East Palzo Creek (ATHV 01)	3	3,900	24,000	59,000	100

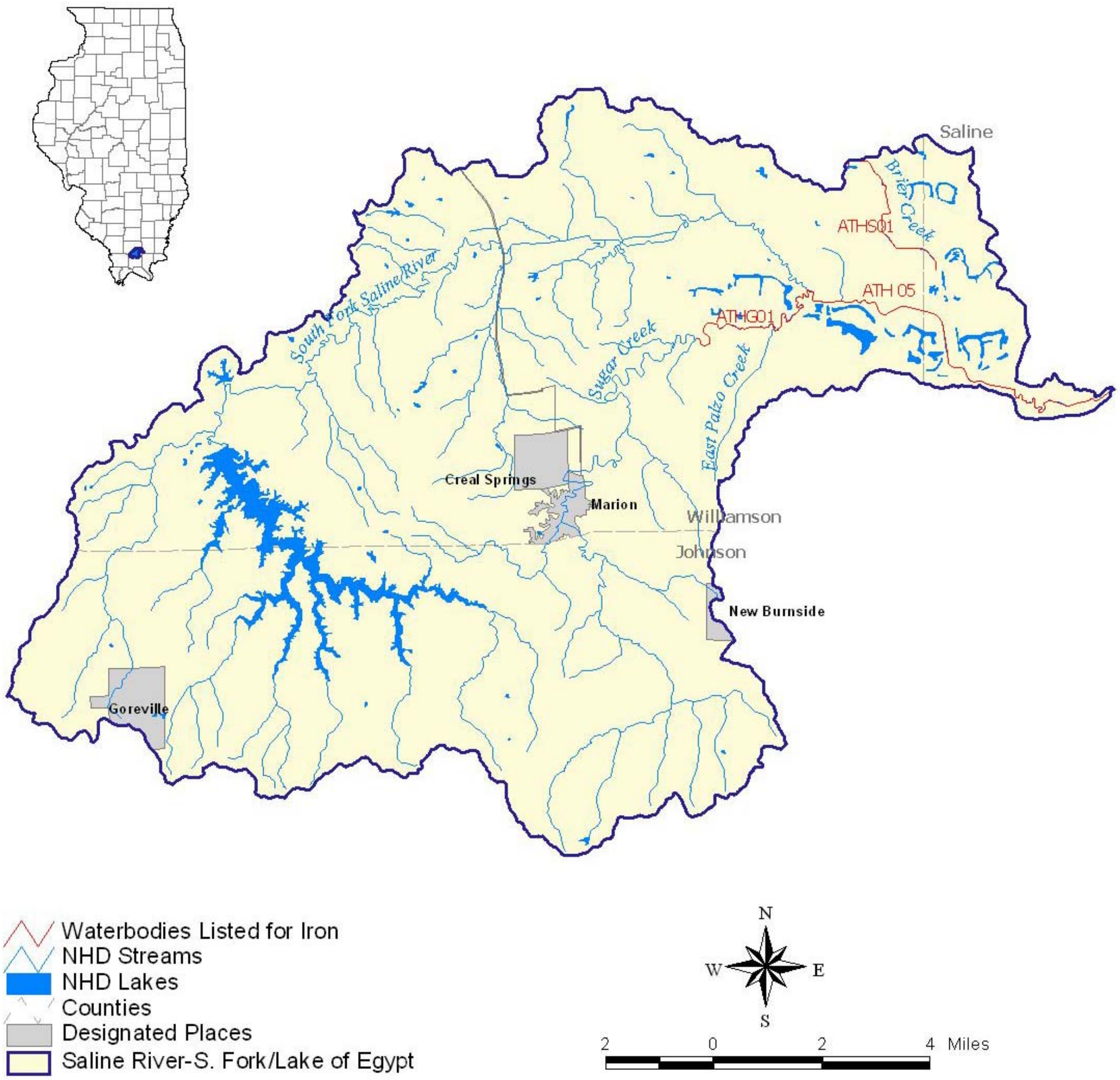


Figure 3-4. Waterbodies Listed for Iron Impairment in the South Fork Saline River/Lake of Egypt Watershed.

3.4.3 TMDL Allocations

The iron TMDLs for impairments in the South Fork Saline River/Lake of Egypt watershed are based on a load duration approach which outputs separate reductions for five flow regimes. The reductions for the four listed segments are summarized in Table 3-8.

Table 3-8. Iron Reductions by Flow Regime for Waterbodies in the South Fork Saline River/Lake of Egypt Watershed.

Iron TMDLs (lb/d)		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Segment	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
South Fork Saline River (ATH 05)	Current Load	6,255	1,642	1,287	534	9
	TMDL= LA+WLA+MOS	18,393	470	276	101	31
	LA	16,151	423	247	93	29
	WLA: Southern Illinois Power - Marion Outfall 002	157	0	0	0	0
	WLA: Southern Illinois Power - Marion Outfalls A02 and A05	9	0	0	0	0
	WLA: Federal Landscaping Company Outfall 001	57	0	0	0	0
	WLA: Peabody Coal Co- Will Scarlet Outfall 001	148	0	0	0	0
	WLA: Centennial pipeline, LLC Outfalls 004,005,006,013	33	0	0	0	0
	MOS (10%)	1,839	46	26	11	2
	TMDL Reduction	**0%**	**74%**	**81%**	**83%**	**0%**
Sugar Creek (ATHG 01)	Current Load	5,545	2,509	2,529	7,661	4,306
	TMDL= LA+WLA+MOS	2,218	454	60	26	9
	LA	1,995	410	53	24	9
	WLA: Facility	0	0	0	0	0
	MOS (10%)	223	46	7	2	0
	TMDL Reduction	**64%**	**84%**	**98%**	**<99%**	**<99%**

Iron TMDLs (lb/d)		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Segment	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Brier Creek (ATHS 01)	Current Load	No Data	1881.58	0.69	63.82	No Data
	TMDL= LA+WLA+MOS	392.26	27.99	2.21	0.85	0.64
	LA	295.42	25.19	1.99	0.77	0.57
	WLA: Federal Landscaping Company Outfall 001	57.32	0.00	0.00	0.00	0.00
	MOS (10%)	39.23	2.80	0.22	0.09	0.06
	TMDL Reduction	No Data	**99%**	**0%**	**99%**	No Data
East Palzo Creek (ATHV 01)	Current Load	No Data	70.88	No Data	No Data	31.63
	TMDL= LA+WLA+MOS	466.35	9.21	5.60	2.12	0.54
	LA	419.71	8.29	5.04	1.91	0.48
	WLA: Facility	0	0	0	0	0
	MOS (10%)	46.63	0.92	0.56	0.21	0.05
	TMDL Reduction	No Data	**88%**	No Data	No Data	**98%**

3.5 Manganese

3.5.1 Water Quality Standards

The general use water quality standard for manganese is 1,000 µg/L, and the public and food processing water supply standard is 150 µg/L.

3.5.2 Impairments in the South Fork Saline River/Lake of Egypt Watershed

Seven waterbodies in the South Fork Saline River/Lake of Egypt watershed are impaired for manganese. The six listed streams are all impaired for their general use designation and the Lake of Egypt is impaired for the public water supply designated use. Table 3-9 summarizes the manganese data collected in the impaired segments and Figure 3-5 shows the location of the waterbodies.

Table 3-9. Summary of Manganese (Mn) Data Collected in the Listed Reaches of the South Fork Saline River/Lake of Egypt Watershed.

Waterbody Name (Segment ID)	Number of Samples	Minimum Mn (µg/L)	Average Mn (µg/L)	Maximum Mn (µg/L)	Exceedance (percent)
South Fork Saline River (ATH 02)	124	110	433	1,500	5
South Fork Saline River (ATH 05)	44	380	1,972	5,200	84
Sugar Creek (ATHG 01)	43	15	10,618	49,000	79
Sugar Creek (ATHG 05)	43	15	10,618	49,000	79
Brier Creek (ATHS 01)	7	650	8,507	21,000	86
East Palzo Creek (ATHV 01)	6	380	3,563	9,000	83
Lake of Egypt (RAL)	5	110	156	170	80

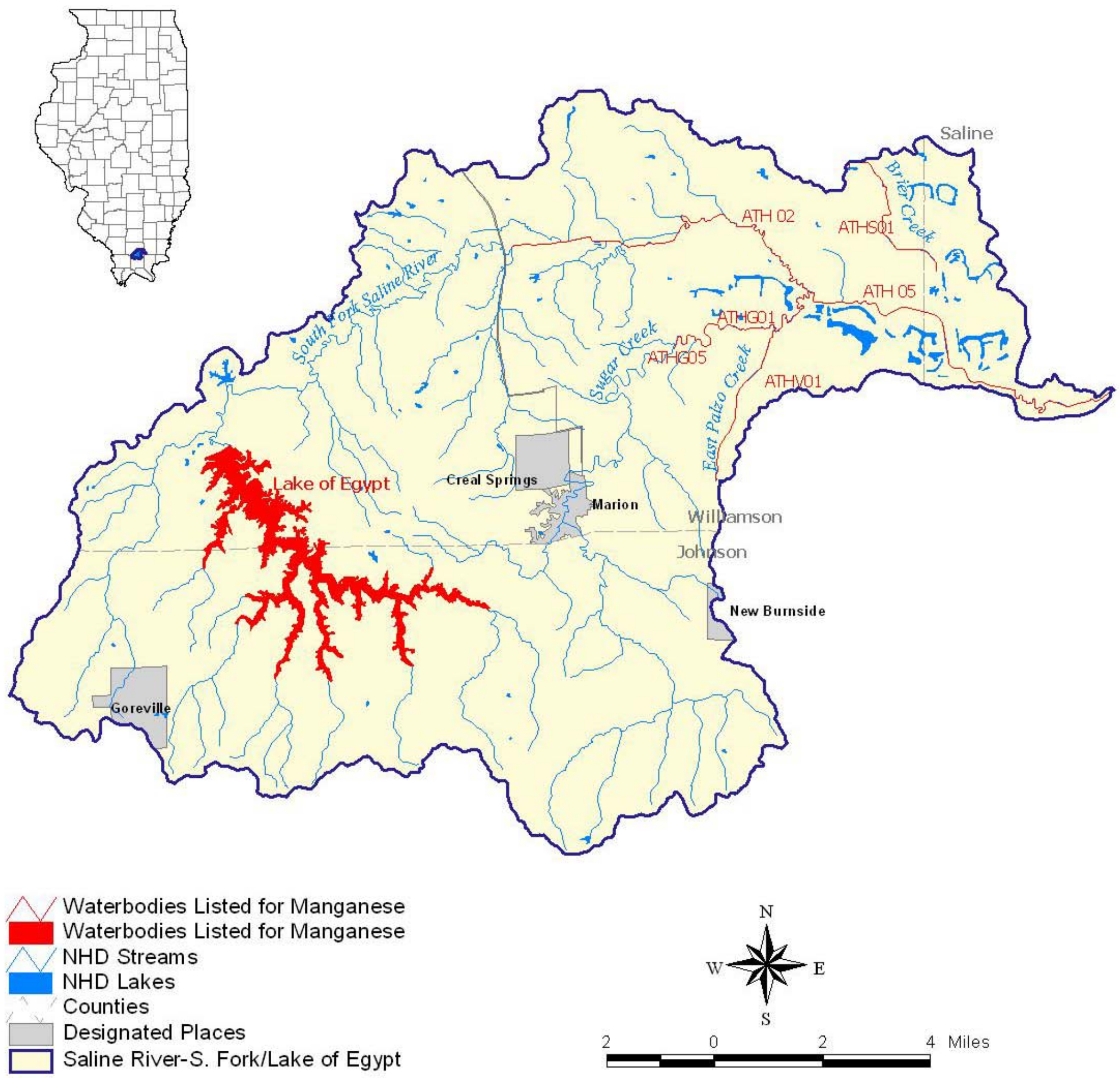


Figure 3-5. Waterbodies Listed for Manganese Impairment in the South Fork Saline River/Lake of Egypt Watershed.

3.5.3 TMDL Allocations

Stream TMDLs were developed using the load duration approach, and allocations for manganese were calculated for five flow regimes. The allocations for the reach and flow percentile are summarized in Table 3-10. Values presented in the table are given in pounds per day (lb/d) with the exception of the TMDL reductions which are given as percentages.

Table 3-10. Manganese TMDL Allocations for Waterbodies in the South Fork Saline River/Lake of Egypt watershed.

Manganese TMDLs (lb/d)		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Segment	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
South Fork Saline River (ATH 02)	Current Load	4,605	721	99	73	26
	TMDL= LA+WLA+MOS	3,543	1,093	82	49	22
	LA	3,188	983	75	44	20
	WLA: Facility	0	0	0	0	0
	MOS (10%)	355	110	9	4	2
	TMDL Reduction	**31%**	**0%**	**25%**	**40%**	**31%**
South Fork Saline River (ATH 05)	Current Load	9,381	3,089	688	287	95
	TMDL= LA+WLA+MOS	18,393	1,931	276	108	31
	LA	16,519	1,737	247	97	29
	WLA: Federal Landscaping Company Outfall 001	33	0	0	0	0
	WLA: Peabody Coal Co- Will Scarlet Outfall 001	Historic Levels[1]	0	0	0	0
	MOS (10%)	1,839	194	26	11	2
	TMDL Reduction	**0%**	**44%**	**64%**	**66%**	**70%**
Sugar Creek (ATHG 01)	Current Load	2,086	500	309	686	439
	TMDL= LA+WLA+MOS	2,632	406	60	26	9
	LA	2,370	364	53	24	9
	WLA: Facility	0	0	0	0	0
	MOS (10%)	262	40	7	2	0
	TMDL Reduction	**0%**	**27%**	**83%**	**97%**	**98%**
Sugar Creek (ATHG 05)	Current Load	1,975	474	292	649	416
	TMDL= LA+WLA+MOS	2,495	383	57	25	9
	LA	2,245	345	51	22	8
	WLA: Facility	0	0	0	0	0
	MOS (10%)	249	38	6	2	1
	TMDL Reduction	0	**27%**	**83%**	**97%**	**98%**
Brier Creek	Current Load	135.63	162.61	1.44	17.02	No Data

Manganese TMDLs (lb/d)		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Segment	TMDL Component	0-10	10-40	40-60	60-90	90-100
	TMDL= LA+WLA+MOS	67.82	27.99	2.21	0.85	0.64
	LA	28.66	25.19	1.99	0.77	0.57
	WLA: Federal Landscaping Company Outfall 001	33.07	0.00	0.00	0.00	0.00
	MOS (10%)	6.78	2.80	0.22	0.09	0.06
	TMDL Reduction	**55%**	**85%**	**0%**	**96%**	No Data
East Palzo Creek (ATHV 01)	Current Load	No Data	69.89	1.00	No Data	4.83
	TMDL= LA+WLA+MOS	466.35	35.61	2.63	2.12	0.54
	LA	419.71	32.05	2.37	1.91	0.48
	WLA: Facility	0	0	0	0	0
	MOS (10%)	46.63	3.56	0.26	0.21	0.05
	TMDL Reduction	No Data	**54%**	**0%**	No Data	**90%**

[1] Permit specifies that manganese load will not exceed "historic levels".

Lake TMDLs were developed based on an annual BATHTUB simulation and are not broken out by flow regime (Table 3-11). Values presented in the tables are given in pounds per day (lb/d) with the exception of the TMDL reductions which are given as percentages.

For the lake, a reverse BATHTUB model was used to estimate the required reductions based on samples of manganese collected in the water column. A reduction in loading of 14 percent is required to maintain the water quality standard.

Table 3-11. Manganese TMDL Allocations for the Lake of Egypt.

Lake	Category	Manganese (lb/yr)	Manganese (lb/d)
Lake of Egypt (RAL)	Existing Load	9,021	25
	Loading Capacity	8,223	23
	Wasteload Allocation	0	0
	Margin of Safety	434	1
	Load Allocation	7,789	21
	TMDL Reduction	14%	14%

3.6 Nickel

3.6.1 Water Quality Standards

The numeric general use water quality standards for nickel are hardness dependent and the TMDLs for nickel in this watershed were based on the minimum hardness observed in the watershed (46 mg/L). . The acute water quality standard for total copper at a hardness of 46 mg/L is 42.79 μg/L and the chronic water quality standard is 2.59 μg/L.

3.6.2 Impairments in the South Fork Saline River/Lake of Egypt Watershed

One waterbody in the South Fork Saline River/Lake of Egypt Watershed is listed for nickel. Table 3-12 summarizes the nickel data collected in this impaired reach and Figure 3-6 shows the location of this impaired reach.

Table 3-12. Summary of Nickel Data Collected in the Listed Reaches of the South Fork Saline River/Lake of Egypt Watershed.

Waterbody Name (Segment ID)	Number of Samples	Minimum Nickel (μg/L)	Average Nickel (μg/L)	Maximum Nickel (μg/L)	Exceedance (percent)
Sugar Creek (ATHG 01)	43	25	423	2,100	74

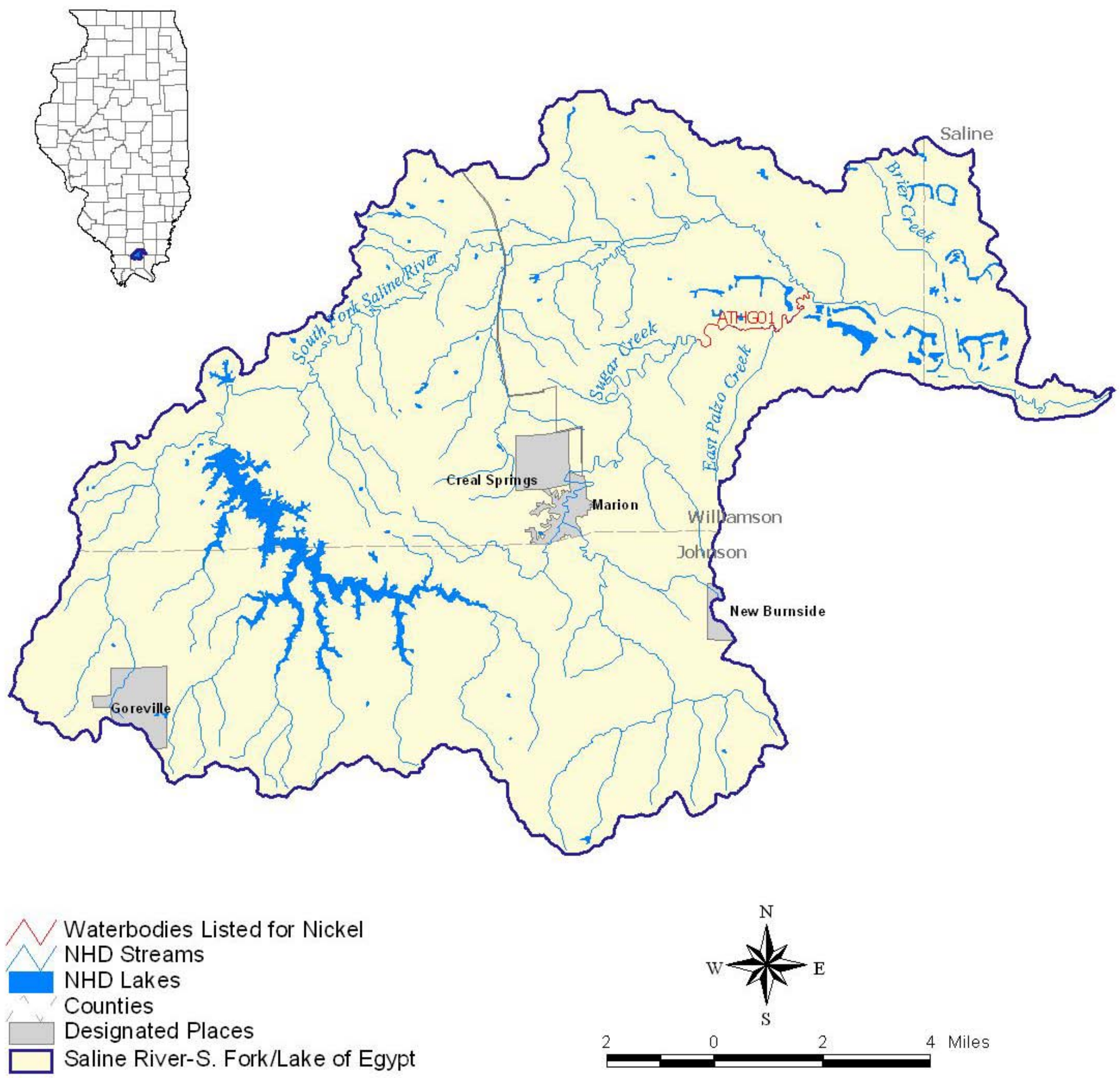


Figure 3-6. Waterbodies Listed for Nickel Impairment in the South Fork Saline River/Lake of Egypt Watershed.

3.6.3 TMDL Allocations

TMDLs were developed using the load duration approach, and allocations for nickel were calculated for five flow regimes. The allocations for the reach and flow percentile are summarized in Table 3-13. Values presented in the table are given in pounds per day (lb/d) with the exception of the TMDL reductions which are given as percentages.

Table 3-13. Nickel TMDL Allocations for Waterbodies in the South Fork Saline River/Lake of Egypt watershed.

Nickel TMDLs (lb/d)		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Segment	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Sugar Creek (ATHG 01)	Current Load	65.82	16.66	12.14	29.96	17.74
	TMDL= LA+WLA+MOS	112.65	14.26	2.55	1.11	0.40
	LA	101.39	12.84	2.30	1.00	0.36
	WLA: Facility	0	0	0	0	0
	MOS (10%)	11.27	1.43	0.26	0.11	0.04
	TMDL Reduction	**0%**	**23%**	**81%**	**97%**	**98%**

3.7 pH

3.7.1 Water Quality Standards

The water quality standards for pH specify that it should be within a range with a minimum of 6.5 and maximum of 9.0. This is with the exception of pH levels outside this range due to natural causes.

3.7.2 Impairments in the South Fork Saline River/Lake of Egypt Watershed

Five waterbodies in the South Fork Saline River/Lake of Egypt Watershed are impaired for pH. Table 3-14 summarizes the pH data collected for these segments and Figure 3-7 shows the location of the segments in the watershed listed for pH.

Table 3-14. Summary of PH Data Collected in the Listed Reaches of the South Fork Saline River/Lake of Egypt Watershed.

Waterbody Name (Segment ID)	Number of Samples	Minimum pH (SU)	Average pH (SU)	Maximum pH (SU)	Below 6.5 Exceedance (percent)
South Fork Saline River (ATH 02)	44	6.20	6.86	8.50	16
South Fork Saline River (ATH 05)	44	3.80	6.22	7.47	52
Sugar Creek (ATHG 01)	43	2.60	4.59	7.30	95
Sugar Creek (ATHG 05)	37	6.00	6.67	7.91	43
East Palzo Creek (ATHV 01)	6	2.50	5.20	6.90	67

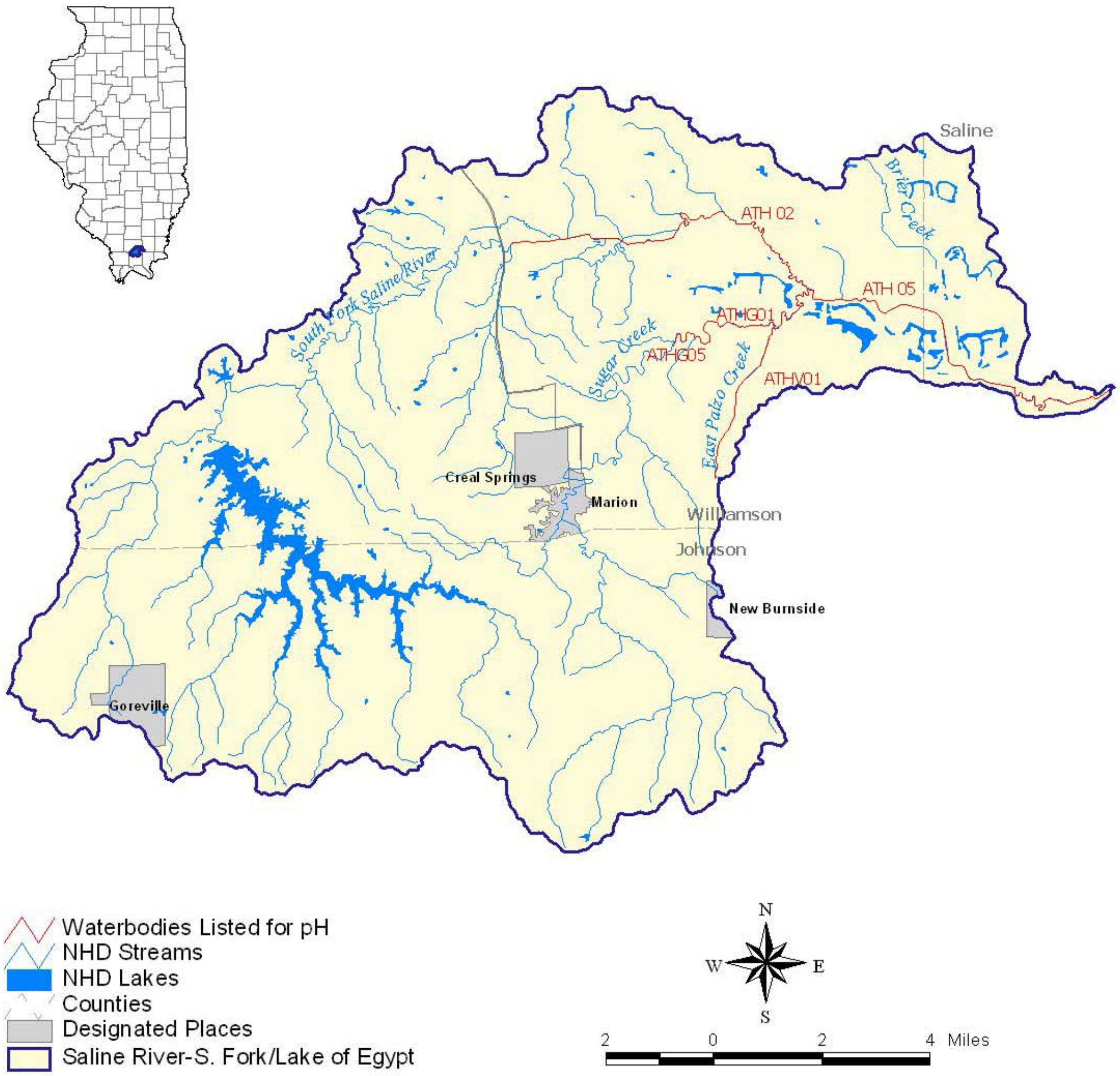


Figure 3-7. Waterbodies Listed for pH Impairment in the South Fork Saline River/Lake of Egypt Watershed.

3.7.3 TMDL Allocations

Because pH is not a load, but rather a measure of acidity and/or alkalinity of a given solution, this TMDL uses *an other appropriate measure* (40 CFR section 130.2(i)) rather than an actual mass-per-unit time measure. For this TMDL, the State's numeric pH criterion (6.5 – 9.0 SU) is used as the TMDL target. Thus, the TMDL ensures that both point and nonpoint source activities meet the pH criterion at the point of discharge.

3.8 Silver

3.8.1 Water Quality Standards

The general use water quality standard for silver is 5 µg/L.

3.8.2 Impairments in the South Fork Saline River/Lake of Egypt Watershed

One waterbody in the South Fork Saline River/Lake of Egypt Watershed is listed for silver. Table 3-15 summarizes the silver data collected in this impaired reach and Figure 3-8 shows the location of this reach.

Table 3-15. Summary of Silver Data Collected in the Listed Reaches of the South Fork Saline River/Lake of Egypt Watershed.

Waterbody Name (Segment ID)	Number of Samples	Minimum Silver (µg/L)	Average Silver (µg/L)	Maximum Silver (µg/L)	Exceedance (percent)
Sugar Creek (ATHG 01)	43	3	4.5	35	7

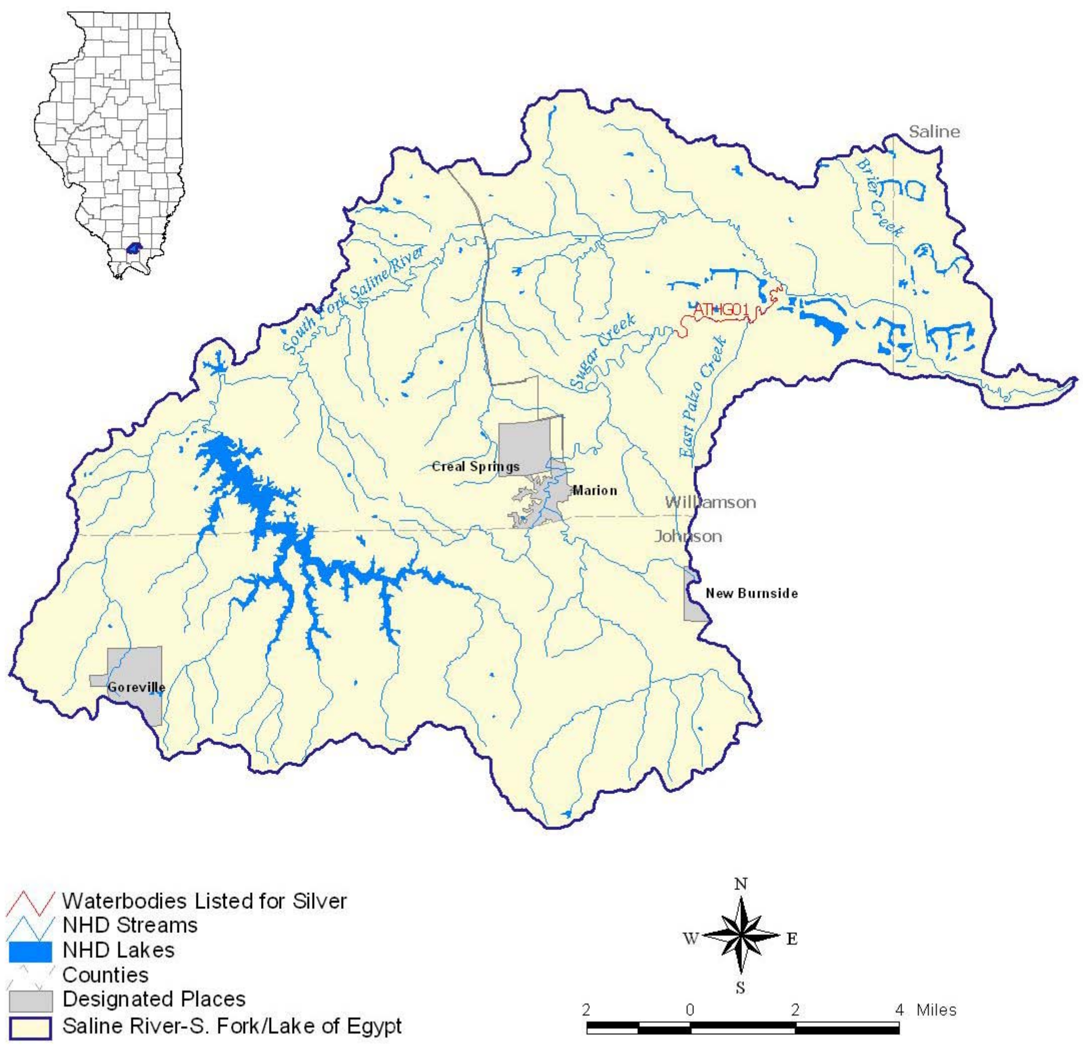


Figure 3-8. Waterbodies Listed for Silver Impairment in the South Fork Saline River/Lake of Egypt Watershed.

3.8.3 TMDL Allocations

TMDLs were developed using the load duration approach, and allocations for silver were calculated for five flow regimes. The allocations for the reach and flow percentile are summarized in Table 3-16. Values presented in the table are given in pounds per day (lb/d) with the exception of the TMDL reductions which are given as percentages.

Table 3-16. Silver TMDL Allocations for Waterbodies in the South Fork Saline River/Lake of Egypt watershed.

Silver TMDLs (lb/d)		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Segment	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Sugar Creek (ATHG 01)	Current Load	7.90	1.37	0.18	0.58	0.33
	TMDL= LA+WLA+MOS	13.16	2.28	0.30	0.10	0.05
	LA	11.85	2.05	0.27	0.09	0.04
	WLA: Facility	0	0	0	0	0
	MOS (10%)	1.32	0.23	0.03	0.01	0.01
	TMDL Reduction	**0%**	**0%**	**0%**	**84%**	**87%**

3.9 Sulfates

3.9.1 Water Quality Standards

The general use water quality standard for sulfates is 500 mg/l.

3.9.2 Impairments in the South Fork Saline River/Lake of Egypt Watershed

Three waterbodies in the South Fork Saline River/Lake of Egypt Watershed are impaired for sulfates. Table 3-17 summarizes the sulfates data collected for these segments and Figure 3-9 shows the location of the segments.

Table 3-17. Summary of Sulfates Data Collected in the Listed Reaches of the South Fork Saline River/Lake of Egypt Watershed.

Waterbody Name (Segment ID)	Number of Samples	Minimum Sulfates (mg/L)	Average Sulfates (mg/L)	Maximum Sulfates (mg/L)	Exceedance (percent)
South Fork Saline River (ATH 05)	33	54	295	556	12
Sugar Creek (ATHG 01)	30	10	794	4,010	27
Brier Creek (ATHS 01)	7	281	1,022	1,420	86

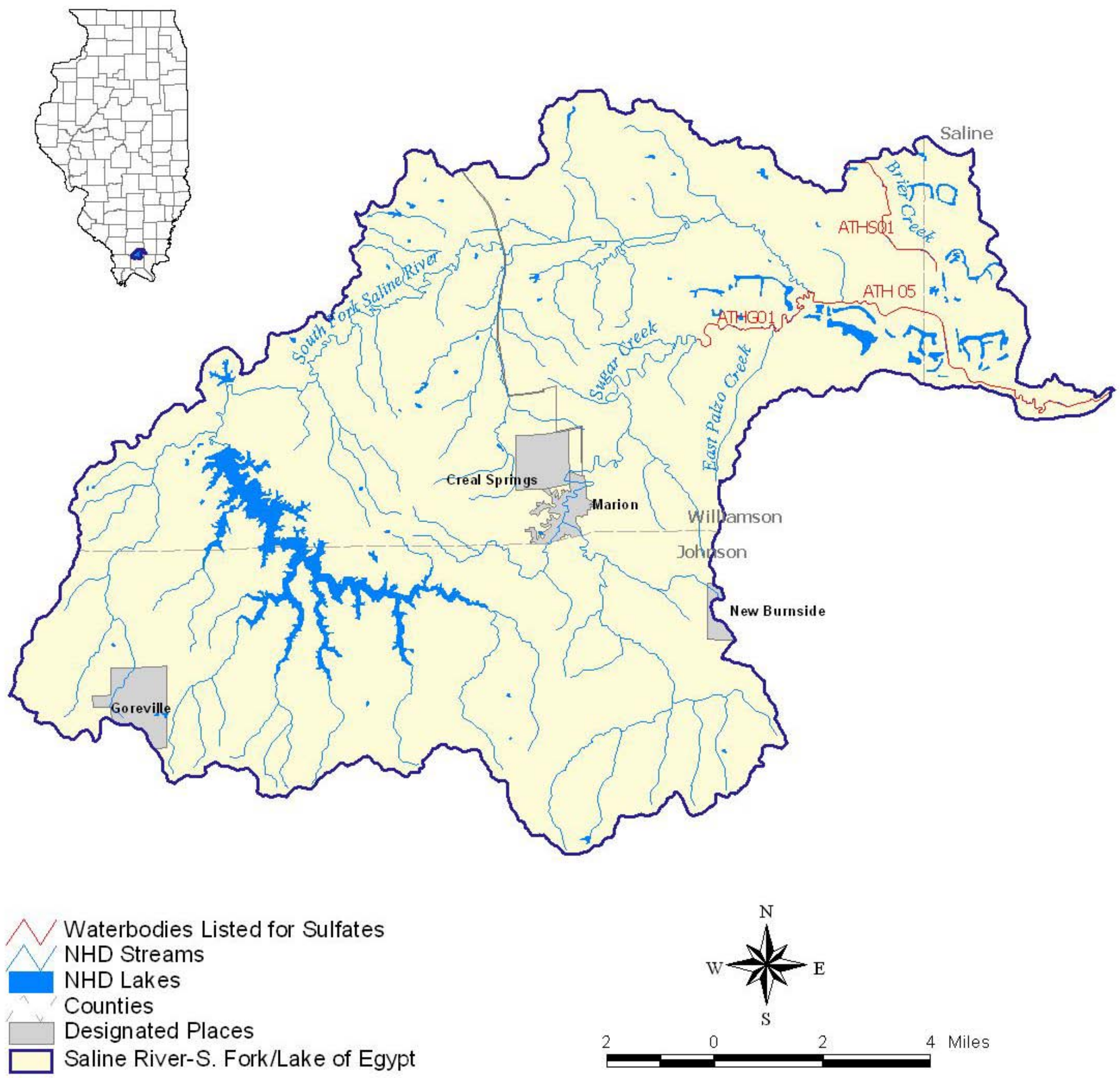


Figure 3-9. Waterbodies Listed for Sulfates Impairment in the South Fork Saline River/Lake of Egypt Watershed.

3.9.3 TMDL Allocations

The sulfates TMDLs for impairments in the South Fork Saline River/Lake of Egypt watershed are based on a load duration approach which outputs separate reductions for five flow regimes. The reductions for the three listed segments are summarized in Table 3-18.

Table 3-18. Sulfates Reductions by Flow Regime for Waterbodies in the South Fork Saline River/Lake of Egypt Watershed.

Sulfates TMDLs (lb/d)		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Segment	TMDL Component	0-10	10-40	40-60	60-90	90-100
South Fork Saline River (ATH 05)	Current Load	1,585,455	521,362	107,835	58,685	10,904
	TMDL= LA+WLA+MOS	9,196,378	965,487	137,542	53,938	15,104
	LA	8,200,051	868,938	123,789	48,546	13,594
	WLA: Peabody Coal Co- Will Scarlet Outfall 041	1,296	0	0	0	0
	WLA: Federal Landscaping Company Outfall 001	29,209	0	0	0	0
	WLA: Peabody Coal Co- Will Scarlet Outfall 001	47,481	0	0	0	0
	MOS (10%)	919,637	96,549	13,755	5,395	1,510
	TMDL Reduction	**0%**	**0%**	**0%**	**17%**	**0%**
Sugar Creek (ATHG 01)	Current Load	206,460	50,993	21,797	50,446	37,073
	TMDL= LA+WLA+MOS	1,316,310	227,598	29,829	11,023	4,669
	LA	1,184,679	204,840	26,846	9,921	4,202
	WLA: Facility	0	0	0	0	0
	MOS (10%)	131,631	22,760	2,983	1,102	467
	TMDL Reduction	**0%**	**0%**	**0%**	**80%**	**89%**
Brier Creek (ATHS 01)	Current Load	64,494	9,641	2,765	1,149	No Data
	TMDL= LA+WLA+MOS	33,907	3,871	1,107	425	320
	LA	1,307	3,486	996	384	287
	WLA: Federal Landscaping Company Outfall 001	29,209	0	0	0	0
	MOS (10%)	3,391	388	110	42	31
	TMDL Reduction	**53%**	**64%**	**64%**	**67%**	No Data

3.10 TDS

3.10.1 Water Quality Standards

The general use water quality standard for TDS is 1,000 mg/l.

3.10.2 Impairments in the South Fork Saline River/Lake of Egypt Watershed

Four waterbodies in the South Fork Saline River/Lake of Egypt Watershed are impaired for TDS. Table 3-19 summarizes the TDS data collected in the impaired segments and Figure 3-10 shows the location of the reaches.

Table 3-19. Summary of TDS Data Collected in the Listed Reaches of the South Fork Saline River/Lake of Egypt Watershed.

Waterbody Name (Segment ID)	Number of Samples	Minimum TDS (mg/L)	Average TDS (mg/L)	Maximum TDS (mg/L)	Exceedance (percent)
South Fork Saline River (ATH 05)	122	60	498	1,099	1
Sugar Creek (ATHG 01)	121	68	920	4,103	31
Brier Creek (ATHS 01)	6	236	1,119	1,960	67
East Palzo Creek (ATHV 01)	3	211	715	1,560	33

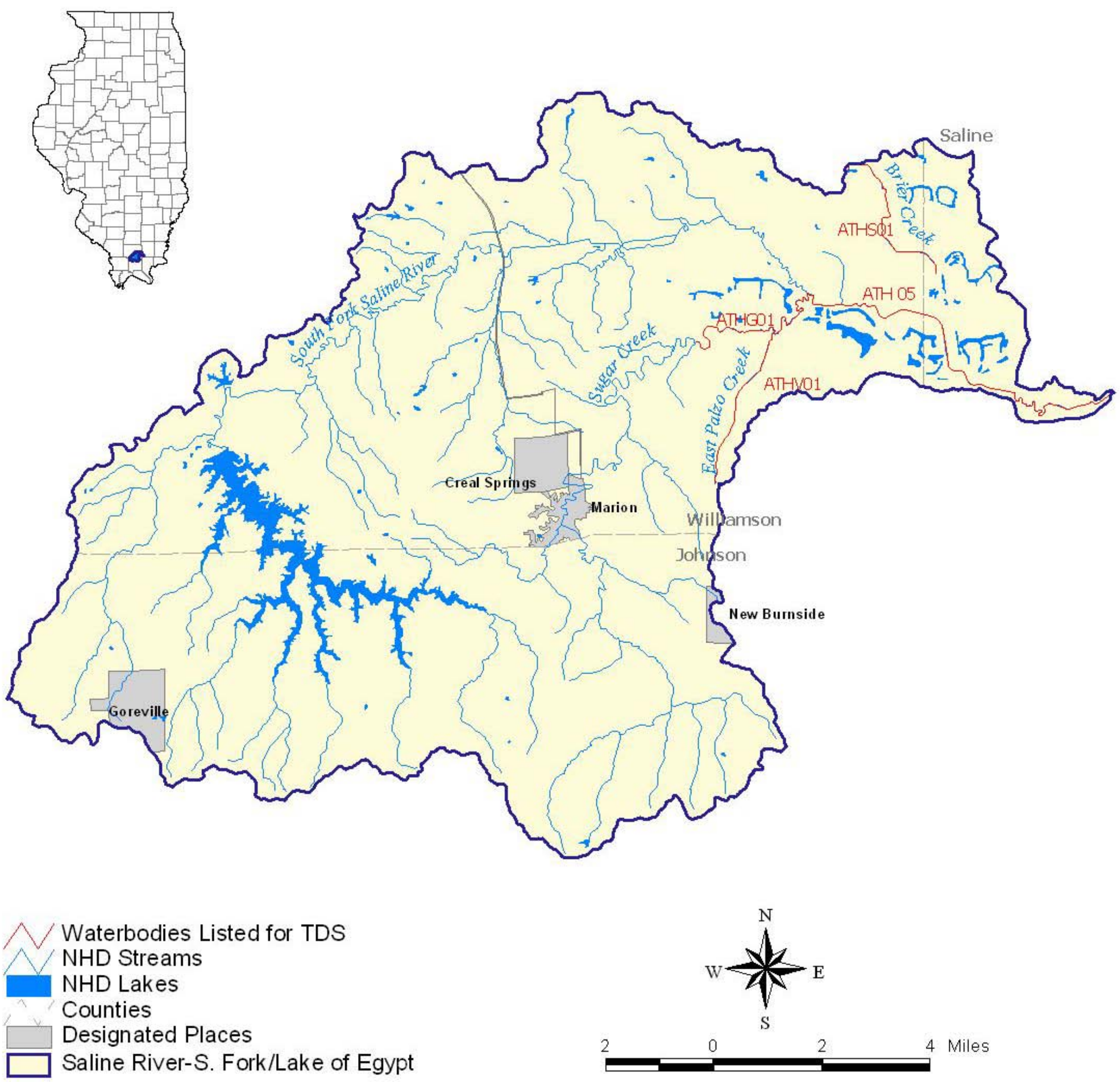


Figure 3-10. Waterbodies Listed for TDS Impairment in the South Fork Saline River/Lake of Egypt Watershed.

3.10.3 TMDL Allocations

The TDS TMDLs for impairments in the South Fork Saline River/Lake of Egypt watershed are based on a load duration approach which results in separate reductions for five flow regimes. The reductions for the three listed segments are summarized in Table 3-20.

Table 3-20. TDS Reductions by Flow Regime for Waterbodies in the South Fork Saline River/Lake of Egypt Watershed.

TDS TMDLs (lb/d)		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Segment	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
South Fork Saline River (ATH 05)	Current Load	2,526,660	727,445	231,179	74,820	38,208
	TMDL= LA+WLA+MOS	21,952,644	1,930,972	210,358	107,879	38,837
	LA	19,710,147	1,737,875	189,322	97,091	34,954
	WLA: Southern Illinois Power - Marion Outfall 002	38,889	0	0	0	0
	WLA: Southern Illinois Power - Marion Outfalls A02 and A05	8,344	0	0	0	0
	MOS (10%)	2,195,264	193,098	21,036	10,787	3,885
	TMDL Reduction	**0%**	**0%**	**18%**	**0%**	**9%**
Sugar Creek (ATHG 01)	Current Load	4,058,148	749,192	181,321	70,951	24,310
	TMDL= LA+WLA+MOS	1,400,608	464,275	71,328	25,937	8,170
	LA	1,260,547	417,848	64,194	23,345	7,355
	WLA: Facility	0	0	0	0	0
	MOS (10%)	140,062	46,427	7,132	2,595	818
	TMDL Reduction	**69%**	**44%**	**65%**	**67%**	**70%**
Brier Creek (ATHS 01)	Current Load	101,047	11,149	4,336	201	No Data
	TMDL= LA+WLA+MOS	67,816	7,743	2,213	851	637
	LA	52,690	6,969	1,991	765	575
	WLA: Facility	8,344	0	0	0	0
	MOS (10%)	6,781	774	220	86	64
	TMDL Reduction	**40%**	**37%**	**54%**	**0%**	No Data
East Palzo Creek (ATHV 01)	Current Load	No Data	260.15	79.37	No Data	No Data
	TMDL= LA+WLA+MOS	9060.99	692.25	50.71	41.89	15.43
	LA	8154.89	621.70	46.30	37.48	13.23
	WLA: Facility	0	0	0	0	0
	MOS (10%)	906.10	68.34	4.41	4.41	2.20
	TMDL Reduction	No Data	**0%**	**42%**	No Data	No Data

3.11 Zinc

3.11.1 Water Quality Standards

The numeric general use water quality standards for zinc are hardness dependent and the TMDLs for zinc in this watershed were based on the minimum hardness observed in the watershed (46 mg/L). The acute water quality standard for zinc at a hardness of 46 mg/L is 63.28 μg/L and the chronic water quality standard is 11.33 μg/L.

3.11.2 Impairments in the South Fork Saline River/Lake of Egypt Watershed

One waterbody in the South Fork Saline River/Lake of Egypt Watershed is listed for zinc. Table 3-21 summarizes the zinc data collected in this impaired reach and Figure 3-11 shows the location of this segment.

Table 3-21. Summary of Zinc Data Collected in the Listed Reaches of the South Fork Saline River/Lake of Egypt Watershed.

Waterbody Name (Segment ID)	Number of Samples	Minimum Zinc (μg/L)	Average Zinc (μg/L)	Maximum Zinc (μg/L)	Exceedance (percent)
Sugar Creek (ATHG 01)	43	100	1,203	5,900	100

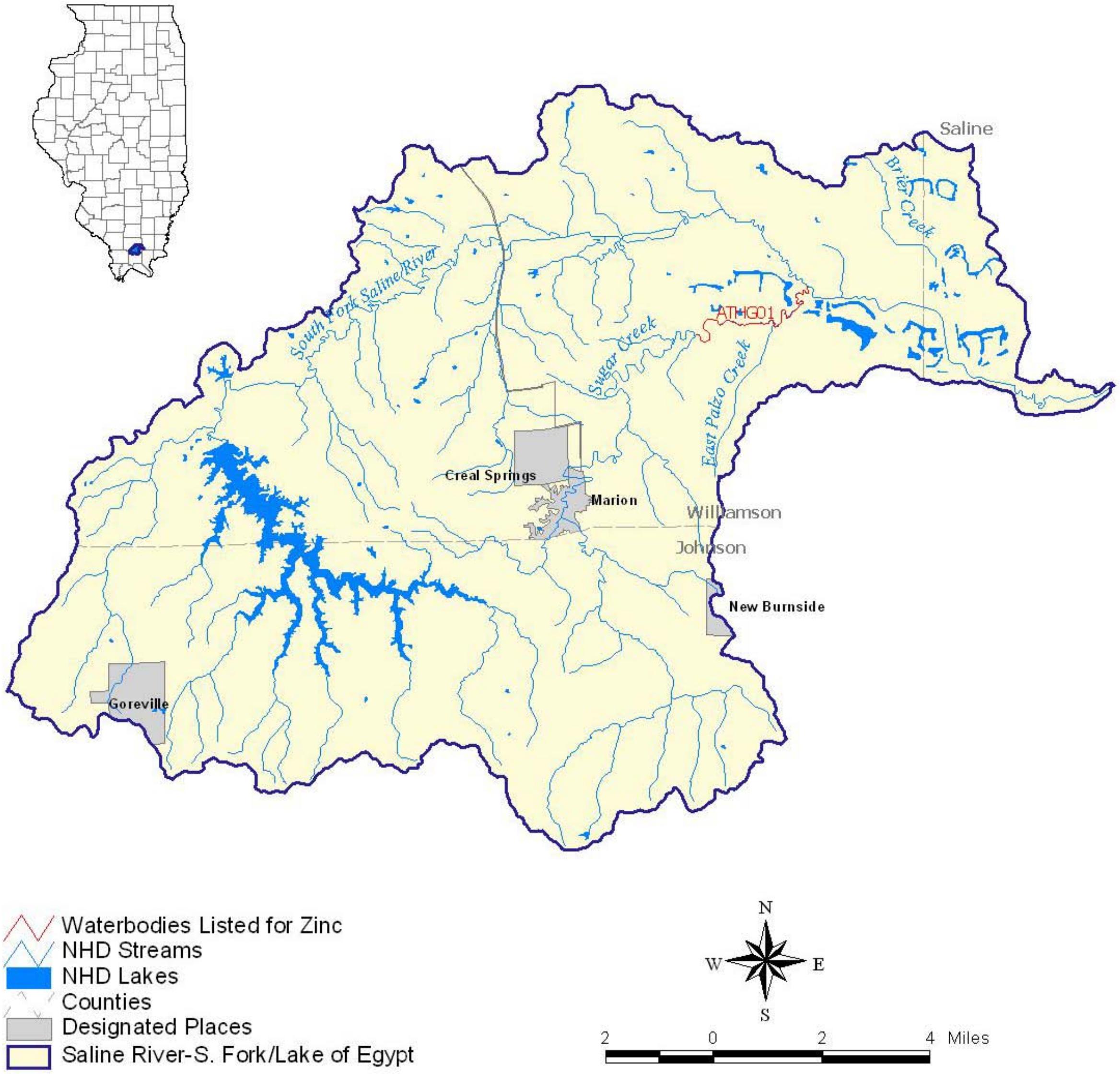


Figure 3-11. Waterbodies Listed for Zinc Impairment in the South Fork Saline River/Lake of Egypt Watershed.

3.11.3 TMDL Allocations

TMDLs were developed using the load duration approach, and allocations for zinc were calculated for five flow regimes. The allocations for the reach and flow percentile are summarized in Table 3-22. Values presented in the table are given in pounds per day (lb/d) with the exception of the TMDL reductions which are given as percentages.

Table 3-22. Zinc TMDL Allocations for Waterbodies in the South Fork Saline River/Lake of Egypt watershed.

Zinc TMDLs (lb/d)		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Segment	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Sugar Creek (ATHG 01)	Current Load	263.26	45.52	34.90	84.17	50.43
	TMDL= LA+WLA+MOS	166.58	28.80	3.77	1.64	0.59
	LA	149.92	25.92	3.40	1.48	0.53
	WLA: Facility	0	0	0	0	0
	MOS (10%)	16.66	2.88	0.38	0.16	0.06
	TMDL Reduction	**43%**	**43%**	**90%**	**98%**	**99%**

4.0 POLLUTANT SOURCES IN THE SOUTH FORK SALINE RIVER/LAKE OF EGYPT WATERSHED

The South Fork Saline River/Lake of Egypt Watershed contains waterbodies listed for impairments due to cadmium, copper, fecal coliform, iron, manganese, nickel, pH, silver, sulfates, TDS, and zinc. Both point and nonpoint sources contribute to the impairments. This section describes each major source category as well as the impacts and contributions to pollutant loading in this watershed.

4.1 Point Source Dischargers

There are eight facilities regulated by the National Pollutant Discharge Elimination System (NPDES) that are allowed to discharge industrial or municipal wastewater to waterbodies located in the South Fork Saline River/Lake of Egypt Watershed. Information on these dischargers is shown in Table 4-1 and Table 4-2. Blank cells in the table indicate that permit information was not available for that parameter.

Table 4-1. Wastewater Treatment Plants Discharging to Impaired Streams within the South Fork Saline River/Lake of Egypt Watershed.

Facility Name	Permit Number	Receiving Stream	Design Average Flow (MGD)	Design Maximum Flow (MGD)	Daily Fecal Coliform Limit (cfu/100 mL)	CBOD Limit (mg/L)	Suspended Solids Limit (mg/L)	pH
Lake of Egypt Sewer District STP	ILG580053	Little Saline Creek and Lake of Egypt	0.225	0.44	Disinfection Exemption	25 M. Avg 40 W. Avg	37 M. Avg 45 W. Avg	> 6 and < 9
Village of Goreville STP	ILG580116	Little Saline Creek	0.06	0.16	Disinfection Exemption	25 M. Avg 40 W. Avg	37 M. Avg 45 W. Avg	> 6 and < 9
City of Creal Springs STP	ILG580125	Cana Creek	0.224	0.488	Disinfection Exemption	25 M. Avg 40 W. Avg	37 M. Avg 45 W. Avg	> 6 and < 9
Peabody Coal Company	IL0004197	South Fork Saline River	Discharges are in response to precipitation and are not related to any wastewater production.					> 6 and < 9
Southern Illinois Power Cooperative - Marion Station	IL0004316	Little Saline Creek and Lake of Egypt						
Federal Landscaping Company	IL0062669	Unnamed Tributary to South Fork Saline River						
Peabody Coal Company	IL0064068	South Fork Saline River	Discharges are in response to precipitation and are not related to any wastewater production.					
Centennial Pipeline, LLC	IL0075272 (Pipes 004,005,006,013)	Cana Creek, South Fork Saline River, and Unnamed Tributary of Cana Creek					15 M. Avg 30 D. Max	> 6 and < 9

Notes: The Shell Pipeline-Clay City used to hold a permit (IL0076074) to discharge into an unnamed tributary to Salt Creek; however, this facility ceased operations in April 2007; N/A = Not Available; M. Avg = Monthly Average; W. Avg = Weekly Average

Table 4-2. NPDES permits discharging metals, TDS, and pH to impaired streams within the South Fork Saline River/Lake of Egypt Watershed.

Parameter	Load Limits lbs/day DAF (DMF) 30 Day Average	Load Limits lbs/day DAF (DMF) Daily Maximum	Concentration Limits (mg/l) 30 Day Average	Concentration Limits (mg/l) Daily Maximum
Southern Illinois Power Cooperative - Marion Station: Outfall 002 Ash Pond No. 4 Effluent				
Approximate Flow	4.66 MGD per day plus intermittent flows from coal pile runoff, slag storage pile runoff, and scrubber sludge disposal area runoff			
pH	In range of 6 to 9 Standard Units			
Oil and Grease			15	20
Total Suspended Solids			15	30
TDS				1,000
Iron (total)			2	4
Boron				(9.0 mg/l (Flow 005 + Flow 002)) - (Flow 005)(Conc. 005) / Flow 002
Copper			0.023	0.037
Flouride			1.4	
Southern Illinois Power Cooperative - Marion Station: Outfall 003 Condenser Cooling Water				
Approximate Flow	229.8 MGD			
Total Residual Chlorine				0.2
Southern Illinois Power Cooperative - Marion Station: Outfall 005 Ash Pond No. 4 Effluent				
Approximate Flow	Intermittent			
pH	In range of 6 to 9 Standard Units			
Oil and Grease			15	20
Total Suspended Solids			15	30
TDS				1,000
Boron				9

Parameter	Load Limits lbs/day DAF (DMF)		Concentration Limits (mg/l)	
	30 Day Average	Daily Maximum	30 Day Average	Daily Maximum
Southern Illinois Power Cooperative - Marion Station: Outfall A02 and A05 Chemical Metal Cleaning Wastewater				
Iron (total)			1	1
Copper (total)			1	1
Southern Illinois Power Cooperative - Marion Station: Outfall 006 Storm Water Associated with Industrial Activity				
This outfall requires a Storm Water Pollution Prevention Plan (SWPPP)				
Peabody Coal Mine Outfall: 041 (Reclamation Area Drainage)				
Discharge Conditions	No discharge is allowed from Outfall No. 041 during "low flow" (less than 3.1 times the flow rate being discharged from Outfall 041) or "no flow" conditions in the receiving stream, unless such discharge meets the water quality standards of 35 Ill. Adm. Code 302. See special condition No. 9 in the NPDES permit for further details.			
pH	The pH shall not be less than 6.0 nor greater than 9.0			
Settleable Solids (ml/l)				0.5
Sulfates				3105
Chlorides				500
Peabody Coal Mine Outfalls: 001, 002				
Discharge Conditions	The special stormwater effluent standards apply only on approval from the Agency. To obtain approval, a request with supporting documentation shall be submitted 45 days prior to the month that the permittee proposes the discharge to be classified as a stormwater discharge. The documentation supporting the request shall include analysis results indicating the discharge will consistently comply with reclamation area discharge effluent standards. The Agency will notify the permittee upon approval of the change.			
pH	The pH shall not be less than 6.0 nor greater than 9.0			
Settleable Solids (ml/l)				0.5
Federal Landscaping Co. Outfall: 001				
Total Suspended Solids			35	70
Iron (total)			3.5	7
pH	The pH shall not be less than 6.0 nor greater than 9.0			
Alkalinity/Acidity	Total acidity shall not exceed total alkalinity			
Manganese			2	4
Sulfates				3500
Chlorides				1000

Parameter	Load Limits lbs/day DAF (DMF)		Concentration Limits (mg/l)	
	30 Day Average	Daily Maximum	30 Day Average	Daily Maximum
Settleable Solids (ml/l)				0.5
Peabody Coal Mine Outfall: 001				
Discharge Conditions	No discharge is allowed from Outfall No. 001 during "low flow" (less than 0.8 times the flow rate being discharged from Outfall 001) or "no flow" conditions in the receiving stream, unless such discharge meets the water quality standards of 35 Ill. Adm. Code 302. See special condition No. 7 in the NPDES permit for further details.			
Total Suspended Solids			35	70
Iron (total)			3.5	7
pH	The pH shall not be less than 6.0 nor greater than 9.0			
Alkalinity/Acidity	Total acidity shall not exceed total alkalinity			
Sulfates				2240
Chlorides				500
Manganese	Discharge manganese concentrations shall not exceed historic levels.			
Settleable Solids (ml/l)				0.5
Centennial Pipeline Outfalls: 001-011 Hydrostatic Test Water				
pH	The pH shall not be less than 6.0 nor greater than 9.0			
Total Suspended Solids			15	30
Iron (total)			2	4
Oil and Grease			15	30
Total Residual Chlorine				0.05

4.1.1 Trace Metals

Cadmium, copper, nickel, silver, and zinc are all trace metals. None of the point source dischargers in the watershed are required to monitor for these trace metals so it is not possible to accurately estimate the existing load. South Fork Saline River and Sugar Creek both have one segment currently listed for trace metals. All of the point source dischargers in the watershed drain to the South Fork Saline River segment ATH 05, which is listed for cadmium. None of the dischargers in the watershed are permitted to discharge to segment ATHG 01 of Sugar Creek which is listed for cadmium, copper, nickel, silver, and zinc.

4.1.2 pH

All of the point source dischargers in the watershed have permit limits for pH. pH has a General Use water quality standard for pH is a range with a minimum of 6.5 and maximum of 9.0. All point sources have to meet the state's general use water quality standards for pH.

4.1.3 Fecal Coliform

Sewage from treatment plants treating domestic and/or municipal waste contains fecal coliform bacteria, which is indigenous to sanitary sewage. In Illinois, a number of these treatment plants have applied for and received disinfection exemptions, which allow a facility to discharge wastewater without disinfection. All of these treatment facilities are required to comply with the geometric mean fecal coliform water quality standard of 200 cfu/100 mL at the closest point downstream where recreational use occurs in the receiving water or where the water flows into a fecal-impaired segment. Facilities with year-round disinfection exemptions may be required to provide the Agency with updated information to demonstrate compliance with these requirements. Facilities directly discharging into a fecal-impaired segment may have their year-round disinfection exemption revoked through future NPDES permitting actions.

Sewage treatment plants are likely the only point source inputs of fecal coliform in the South Fork Saline River/Lake of Egypt watershed. Each of the plants in the watershed operates under a disinfection exemption for primary effluent. Disinfection of excessive flows, however, is required. Loads from the primary and excessive flow discharge pipes are difficult to quantify given the lack of monitoring data. Table 4-3 estimates the loads from point sources assuming average daily design flow from each point source and the water quality standard of 200 cfu/100 mL; this estimate may under or over estimate actual loads. Meeting fecal coliform water quality standards may require that these facilities disinfect and monitor the primary effluent. This implementation plan does address plant upgrades to include a disinfection process step in Section 5.3.

Table 4-3. Average Daily Permitted Fecal Coliform Loads from Facilities Carrying Permit Limitations.

Facility Name	Permit Number	Receiving Stream	Fecal coliform (cfu/d)
Lake of Egypt Sewer District STP	ILG580053	Little Saline Creek and Lake of Egypt	1.70E+09
Village of Goreville STP	ILG580116	Little Saline Creek	4.54E+08
City of Creal Springs STP	ILG580125	Cana Creek	1.70E+09

4.1.4 Iron, Sulfates, TDS, and Manganese

Several NPDES permitted facilities in the South Fork Saline River/Lake of Egypt watershed are permitted to discharge iron, sulfates, TDS, and manganese (see Table 4-2). Discharges of these pollutants from these facilities is likely to occur during high flows due to stormwater runoff, but there are limited data with which to estimate the magnitude of the loads.

4.2 Abandoned Mine Dischargers

An Intensive Basin Survey of the Saline River was performed in 1993. Abandoned coal mines were assessed and, according to the report, were found to be impacting segments within the South Fork Saline River/Lake of Egypt watershed. For example, the Stonefort Mining Company Palzo mine was identified as a 300 acre site located in Williamson County that was flowing directly to Sugar Creek despite efforts to reclaim the area. The survey stated that extensive reclamation efforts at the site have had only limited success and that this site was the most significant contributor of acid water to Sugar Creek and the South Fork Saline River. Continued monitoring is being conducted regularly below the Palzo mine by the Abandoned Mined Lands Reclamation Division of the Office of Mines and Minerals, Department of Natural Resourced as part of an on-going monitoring program to chart the improvement in the water quality of the South Fork of the Saline River after the reclamation of several abandoned mines. There is insufficient information on the location of AMD areas in the South Fork Saline River/Lake of Egypt watershed to estimate loading of TMDL pollutants to the watershed from this source.

4.3 Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems are not typically a significant source of pollutant loading if they are operating as designed. However, if the failure rates of systems in this watershed are high, then the loading from this source may be significant. Systems that are placed on unsuitable soils, not maintained properly, or are connected to subsurface drainage systems can contribute relatively high loading rates to receiving waterbodies. At this time there is a limited amount of information on the proportion of onsite wastewater treatment systems in the watershed that are failing. It is suggested that each system in the watershed be inspected to accurately quantify the loading from this source. Systems older than 20 years and those located close to the impaired lakes or streams should be prioritized for inspection.

4.3.1 pH

Five stream segments are listed for pH in the South Fork Saline River/Lake of Egypt watershed, South Fork Saline River segments ATH 02 and ATH 05, Sugar Creek segments ATHG 01 and ATHG 05, and East Palzo Creek. Nutrient load contributions from septic systems to the environment may result in an increase in algae growth which will adversely affect pH levels. When algae growth occurs carbon dioxide is consumed, raising the pH in a waterbody. When algae respire, carbon dioxide is released, lowering a waterbodies pH.

4.3.2 Fecal Coliform

South Fork Saline River segment ATH 02 and Sugar Creek segment ATHG 05 are impaired for fecal coliform. Approximately 4,150 people are served by onsite wastewater treatment systems according to the Stage 1 report. To approximate the fecal coliform loading rate from onsite wastewater systems, a rough calculation based on the population served by onsite systems and typical loading rates reported in the literature was assumed.

In a properly functioning septic system, wastewater effluent leaves the septic tank and percolates through the system drainfield. Fecal coliform concentrations are typically reduced by 99.99 percent (Siegrist et al., 2000). Failing systems that short circuit the soil adsorption field, result in ponding on the ground surface, or backup into homes will have concentrations typical of raw (untreated) sewage. Direct discharge systems that intentionally bypass the drainfield by connecting the septic tank directly to a waterbody or other transport line (such as an agricultural tile drain) will also have concentrations similar to raw sewage.

A properly functioning onsite wastewater treatment system typically achieves fecal coliform concentrations of 100 to 10,000 cfu/100 mL (Siegrist et al., 2000). A malfunctioning system, however, does not provide adequate soil-zone treatment, and concentrations of 1E06 to 1E08 cfu/100 mL are typical (Siegrist et al., 2000). Translating these concentrations to daily loads from the population served is achieved by assuming a wastewater generation rate. Rates reported in the literature are typically 120 gpd (gallons per person per day). In addition, assumptions regarding the rate of failure are needed. As discussed above, estimating failure rates in this watershed is difficult because a formal inspection program does not exist.

Fecal coliform loading rates under five scenarios were calculated to show the range of loading from this source. Table 4-4 shows the range of fecal coliform load if 0, 7, 15, 30, and 60 percent of systems in the watershed are failing. Note that when a failure rate other than 0 is assumed, the total load is displayed equivalent to the load from failing systems because only two decimal places are shown in the number format (e.g., 3,000,000,000 plus 2,260,000,000,000 equals 2,263,000,000,000 which displays as 2.26E12).

Table 4-4. Failure Rate Scenarios and Resulting Fecal Coliform Loads in the South Fork Saline River/Lake of Egypt Watershed.

Failure Rate (%)	Load From Normal Systems (cfu/d)	Load From Failing Systems (cfu/d)	Total Load (cfu/d)
0	1.18E+09 to 1.18E+11	0.00E+00	1.18E+09 to 1.18E+11
0.58	1.17E+09 to 1.17E+11	9.11E+10 to 9.11E+12	9.23E+10 to 9.23E+12
7[1]	1.10E+09 to 1.10E+11	1.10E+12 to 1.10E+14	1.10E+12 to 1.10E+14
15	1.00E+09 to 1.00E+11	2.36E+12 to 2.36E+14	2.36E+12 to 2.36E+14
30	8.25E+08 to 8.25E+10	4.71E+12 to 4.71E+14	4.71E+12 to 4.71E+14
60	4.71E+08 to 4.71E+10	9.43E+12 to 9.43E+14	9.43E+12 to 9.43E+14

[1] This is the average annual failure rate across the nation.

4.4 Animal Operations

Pollutant loading from animal operations can be a problem in both confined and pasture-based systems. Though the exact location of animal operations in the watershed is not known, countywide statistics indicate that a large number of livestock, swine, and poultry may exist. Figure 4-1 shows an example of poorly managed animal wastes that may contaminate nearby surface waters.

(Photo courtesy of USDA NRCS.)

Figure 4-1. Example of Poorly Managed Animal Waste.

Agricultural animal operations are a potentially large source of pollutant loading if adequate best management practices (BMPs) are not in place to protect surface waters. Livestock operations either consist of confined or pasture-based systems. If a confined operation has greater than 1,000 animal units or is determined to threaten water quality, the operation requires a federal Concentrated Animal Feeding Operation (CAFO) permit. CAFOs are required to develop a nutrient management plan (NMP) as part of the CAFO permitting process (USEPA, 2003) which consists of manure management and disposal strategies that minimize the release of excess nutrients into surface and ground water. The CAFO BMPs are based on NRCS standards and technical expertise.

4.4.1 pH

pH levels in five stream segments within the watershed did not meet the 6.5 to 9 standard, South Fork Saline River segments ATH 02 and ATH 05, Sugar Creek segments ATHG 01 and ATHG 05, and East Palzo Creek. Animal operations, like septic systems and crop production, are expected to increase nutrient loads to the lake. Increased nutrient levels cause eutrophication in the lake which adversely effect pH levels.

4.4.2 Fecal Coliform

Fecal coliform impairments occur on South Fork Saline River segment ATH 02 and Sugar Creek segment ATHG 05; Johnson and Williamson counties contain animal operations that likely contribute to this load. The county statistics presented in the Stage 1 report are listed below for cattle, poultry, swine, and sheep in the watershed (Table 4-5).

Table 4-5. Estimated Number of Livestock and Poultry in Williamson and Johnson County in the South Fork Saline River/Lake of Egypt Watershed.

Animal	Number of Head
Poultry	132
Beef cattle	2,439
Dairy cattle	31
Hogs and pigs	2,897
Sheep and lambs	36
Horses and ponies	156

Fecal coliform loading rates are usually given as the bacterial count per animal unit per day. Table 4-6 lists the number of animals equivalent to one animal unit (IDA, 2001) for each of the livestock and poultry classes likely present in the watershed, as well as the fecal coliform loading rate (USEPA, 2002a; USEPA, 1999a) from one animal unit. In addition, the table lists the total number of animal units in the watershed and resulting fecal coliform load. Table 4-6 shows the relative contribution from each category to the potential load. Note that these loads do not address the proportion of the fecal coliform load that might eventually reach a waterbody. A substantial proportion of the load from these animals likely never reaches a waterbody.

Table 4-6. Animal Unit Data and Fecal Coliform Loading Rates for the South Fork Saline River/Lake of Egypt Watershed.

Animal	Number of Animals in One Animal Unit	Number of Animal Units in Watershed	Fecal Coliform Load (cfu/au/d)	Total Fecal Coliform Load (cfu/d)
Poultry	50	3	9.74E+14	2.57E+15
Beef cattle	1	2,439	3.71E+13	9.05E+16
Dairy cattle	0.71	43	2.87E+13	1.23E+15
Hogs and pigs	2.5	1,159	3.71E+13	4.30E+16
Sheep and lambs	10	4	8.90E+10	3.16E+11
Horses and ponies	0.5	313	2.00E+11	6.25E+13
Total Fecal Coliform Load from Agricultural Animals in the South Fork Saline River/Lake of Egypt Watershed				**1.37E+17**

4.5 Crop Production

Four percent of the land in the South Fork Saline River/Lake of Egypt watershed is used for production of corn, soybeans, wheat, and other small grains. Due to application of commercial fertilizer, manure, and pesticides, as well as increased rates of erosion, pollutant loads from croplands are relatively high compared to other land uses. This section of the implementation plan describes the mechanisms of pollutant loading from farmland for each of the TMDL pollutants causing impairments in the watershed.

4.5.1 Manganese

Impairments due to manganese occur in all seven listed waterbodies. Manganese is found naturally in the environment in groundwater and soils. Because crop production tends to increase rates of erosion, the sediment bound manganese loads tend to increase from this land use. In addition, much of the land farmed in this watershed is classified as highly erodible (Figure 2-1).

Typical concentrations of manganese in Southern Illinois range from 4 to 200 milligrams of manganese per kilogram of soil (mg/kg) with an average value of 23 mg/kg (Ebelhar, 2007). Based on data presented by Czapar et al. (2006), conventional chisel plow crop production activities in Midwestern states result in sediment loads of 7.5 tons/ac/yr. Approximately 4,000 acres of land are used for crop production in the South Fork Saline River/Lake of Egypt Watershed. Assuming a manganese concentration of 23 mg/kg percent yields an estimated loading rate from this source of 0.69 tons/yr. Table 4-7 estimates the potential manganese loads from crop production in each of the listed waterbodies drainage areas.

Table 4-7. Potential Manganese Loads from Crop Production in the Crooked Creek Lake Watersheds.

Waterbody	Manganese Load (lb/yr)
South Fork Saline River (ATH 02)	731
South Fork Saline River (ATH 05)	1313
Sugar Creek (ATHG 01)	214
Sugar Creek (ATHG 05)	149
Brier Creek (ATHS 01)	32
East Palzo Creek (ATHV 01)	34
Lake of Egypt (RAL)	26

4.5.2 pH

Crop production in the watershed is expected to increase nutrient loads to the waterbodies. The increased nutrient loads can cause excessive algae growth, which lowers the pH of the waterbody.

4.6 Streambank and Lake Shore Erosion

Excessive erosion of streambanks and lake shores quickly degrades water quality and habitat. Manganese contributes to the overall composition of sediment. Once sediment reaches a waterbody, manganese may be released through chemical transformations. Manganese also effects water treatment operations and is detrimental to aquatic life at high concentrations.

In addition to the release of manganese, erosion will also reduce the stability of streambanks by undercutting the roots of established vegetation and altering the channel geometry. Loss of vegetative canopy and widening of a stream channel will allow more sunlight to reach the water column which may 1) increase rates of eutrophication, 2) increase water temperatures, and 3) decrease the amount of dissolved oxygen the water can hold.

Without quantitative estimates of streambank and shoreline erosion, it is not possible to estimate the manganese loading from this source. Fortunately several of the BMPs described in Section 5.0 that control pollutant loads and runoff volumes will also help control streambank and lakeshore erosion.

4.7 Internal Loading from Lake Bottom Sediments

The Lake of Egypt is listed for manganese. Manganese may be released from bottom sediments under anoxic conditions. Manganese may be released internally from lake sediments when oxygen concentrations near the bottom of the lake reach low levels. Low dissolved oxygen in lakes may be caused by degradation of organic material or respiration of algae in the absence of sunlight. Conditions for low dissolved oxygen are most severe during the summer months when the water temperatures are higher and the water is able to contain less oxygen.

The Lake of Egypt is monitored for dissolved oxygen and Figure 4-2 shows the measurements relative to depth. Figure 4-2 indicates that anoxic conditions may sometimes occur in the lower depths of the lake, which suggests that manganese could be released from the sediment. However, quantitative estimates cannot be made without additional data.

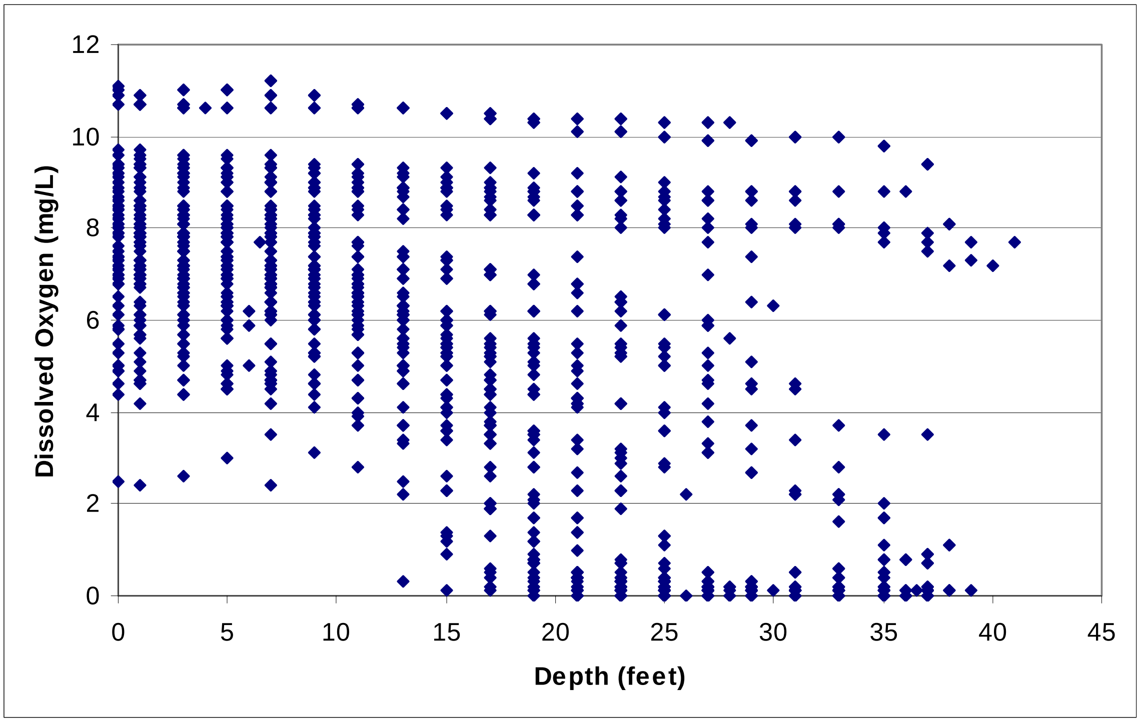


Figure 4-2. Dissolved Oxygen Profile for the Lake of Egypt.

4.8 Domestic Pets and Wildlife Populations

Domestic pets such as cats and dogs and wildlife animals such as deer, geese, ducks, etc., can be significant sources of loading in watersheds that have high densities of urban populations or rural communities with relatively undisturbed land use patterns. In the South Fork Saline River/Lake of Egypt watershed, where the majority of land is forest and land used for pastures and hay production, these sources are likely not significant relative to the loading from other sources.

5.0 BEST MANAGEMENT PRACTICES

Controlling pollutant loading to the impaired reaches of the South Fork Saline River/Lake of Egypt watershed will require implementation of various BMPs depending on the pollutant(s) of concern and major sources of loading. This section describes BMPs that may be used to reduce loading from abandoned mine lands, point source dischargers, onsite wastewater treatment systems, agricultural operations, inlake resuspension, and streambank erosion.

The net costs associated with the BMPs described in this plan depend on the cost of construction (for structural BMPs), maintenance costs (seeding, grading, etc.), and operating costs (electricity, fuel, labor, etc.). In addition, some practices require that land be taken out of farm production and converted to treatment areas, which results in a loss of income from the cash crop. On the other hand, taking land out of production does save money on future seed, fertilizer, labor, etc., and this must be accounted for as well. This section describes how the various costs apply to each BMP, and presents an estimate of the annualized cost spread out over the service life. Incentive plans, and cost share programs are discussed separately in Section 8.0.

The costs presented in this section are discussed in year 2004 dollars because this is the latest year for which gross income estimates for corn and soybean production are available. Market prices can fluctuate significantly from year to year based on supply and demand factors, so applying straight rates of inflation to convert crop incomes from one year to the next is not appropriate. The cost to construct, maintain, and operate the BMPs is assumed to follow a yearly inflation rate of 3 percent since these components are not as dependent on such factors as weather and consumer demand. Therefore, all prices for BMP costs have been converted to year 2004 dollars to develop a net cost for each BMP. Inflated prices are rounded to the nearest quarter of a dollar since most of the costs were reported in whole dollars per acre, not dollars and cents.

Gross 2004 income estimates for corn and soybean in Illinois are $510/ac and $473/ac, respectively (IASS, 2004). Accounting for operating and ownership costs results in net incomes from corn and soybean farms of $140/ac and $217/ac (USDA-ERS, 2005). The average net annual income of $178/ac was therefore used to estimate the annual loss from BMPs that take a portion of land out of farm production. The average value is considered appropriate since most farms operate on a 2-year crop rotation.

5.1 Implementation Options for Mining Impacted Streams

There are several abandoned mines possibly discharging to streams within the South Fork Saline River/Lake of Egypt watershed. High metal concentrations and low pH observed in streams in the watershed also shows the impact from acid mine discharges. Further identification of the locations of the acid mine discharges and characterization of water chemistry for the discharging solutions is required to determine the best implementation method for the impaired streams. In this section, although active treatment technology and reclamation of abandoned mines will be mentioned, passive treatment technology will be discussed in detail as the way to mitigate metals and acid added to the impaired segments within the South Fork Saline River/Lake of Egypt watershed.

Reclamation of abandoned mines is a method of controlling pollutants. Reclamation involves clearing the site of vegetation, removing contaminated topsoil and coal, and creating a functional site for recreational, agricultural, or wildlife habitat purposes. Abandoned mine reclamation benefits include restoring land use for future use and improving water quality. However, reclamation projects tend to be costly and may not be appropriate for some abandoned mine sites.

Active treatment technologies and passive treatment technologies are two treatment technologies that could improve mine affected waters. Active treatments are by definition "the improvement of water quality by methods which require ongoing inputs of artificial energy and/or (bio) chemical reagents" (Younger et al, 2002). The artificial energy referred can be electrical power for pumping, mixing, aerating, etc. The reagents used in active treatment are usually alkaline liquids or solids such as calcium hydroxide, sodium hydroxide, and organic polymers. Passive treatment, on the other hand, is "the deliberate improvement of water quality using only naturally-available energy sources, in systems which require only infrequent maintenance in order to operate effectively over the entire system design life" (Younger et al, 2002). Thus, passive treatment uses natural materials to improve water quality by promoting chemical and biological processes.

The following advantages and disadvantages have been identified for both treatment technologies (Younger et al, 2002);

Advantages for active treatments;
- Precise process control: dose rates of reagents, speeds of pumps and mixers to be adjusted instantaneously in response to loading changes from sources
- Can be much smaller scale operation than passive treatments (requires smaller area so it can be placed on sites).

Disadvantages for active treatments;
- Costs of building, operation, and maintenance
- Disposal methods and costs of wastes management (sludges from the precipitation or sorption of metals, highly concentrated residual brines, etc.)

The traditional active treatment approach for treating AMD is collecting the contaminated drainage in ponds and treating with alkaline reagents to neutralize acidity and precipitate metals and raise pH. This treatment method is costly in terms of equipment, chemicals, and manpower. Estimates of this cost have been reported to be as high as $1,000,000 per day (Skousen and Ziemkiewicz, 1996).

Advantages for passive treatments include the following:
- Low operating costs
- Use of non-hazardous materials
- Work for long periods of time unattended if well-constructed
- Can be integrated with surrounding ecosystems

Disadvantages for passive treatments;
- Still new technologies
- Precise control is not feasible
- A large amount of land is likely to be necessary for high flow
- Relatively high capital costs

The selection of a passive treatment system is determined by influent water quality and the site characteristics. The following diagrams illustrate the decision process needed for passive treatments in terms of water quality parameters (Zipper and Jage, 2001, and K.L. Ford, 2003). Generally, net alkaline water is needed for an aerobic wetland. If the water is net acidic but has low dissolved oxygen, ferric iron and aluminum, an anoxic limestone drain many be selected. Higher concentrations of dissolved oxygen, ferric iron, and aluminum are more suited for anaerobic wetlands, vertical flow systems, or limestone channels.

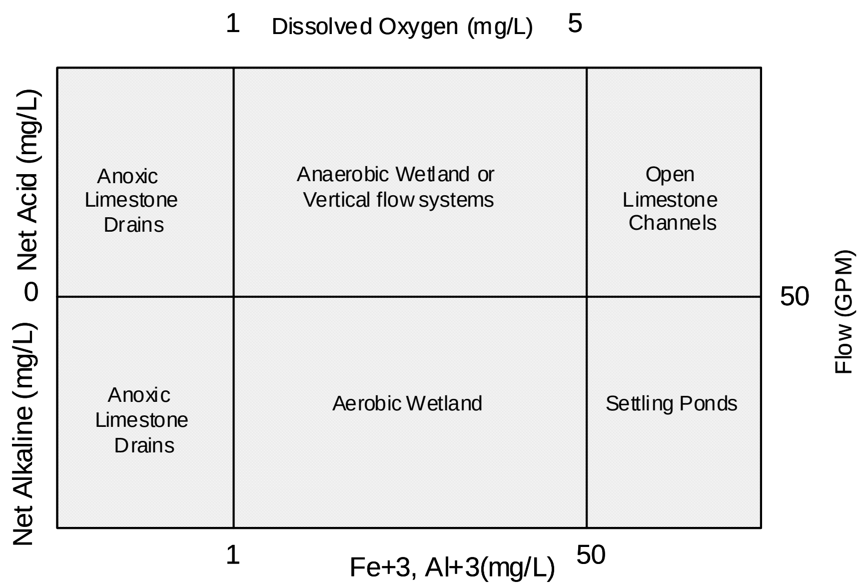


Figure 5-1. Passive treatment selection

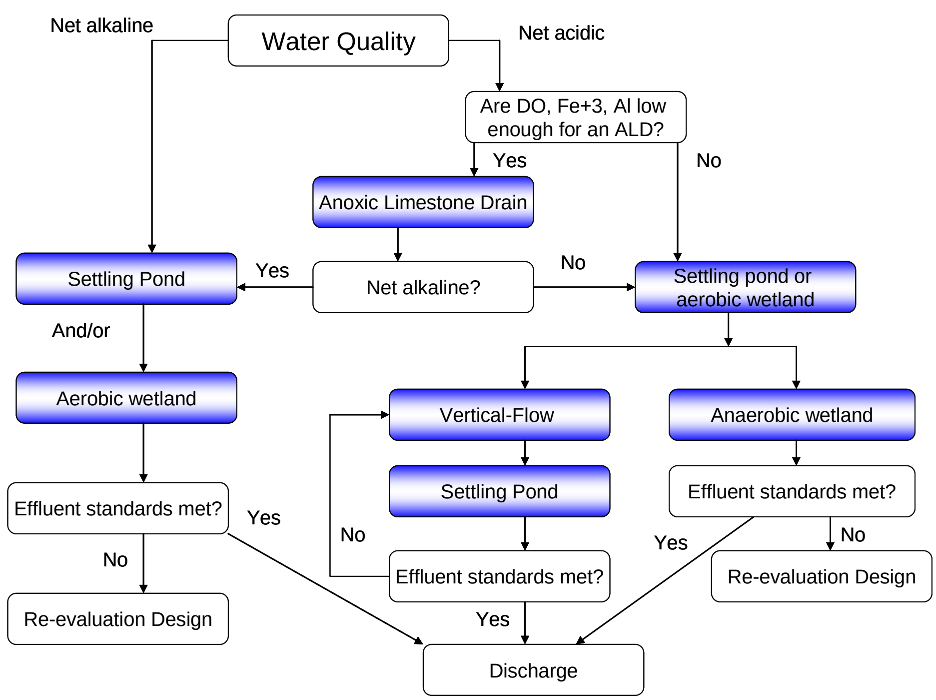


Figure 5-2. Flow chart for selecting a passive treatment system based on influent water quality.

Removal efficiency of metals and acidity by passive treatments can vary due to the different water quality conditions that are being treated by the systems, the flow conditions, and the age of the systems. Generally speaking, a properly designed passive treatment system could reduce pollutant discharges to technology-based standards. However, water quality based limitations are too stringent for most passive treatment systems (Ford, 2003). The following studies are presented to give some examples of metal and acid loading removal efficiency for different passive treatment systems.

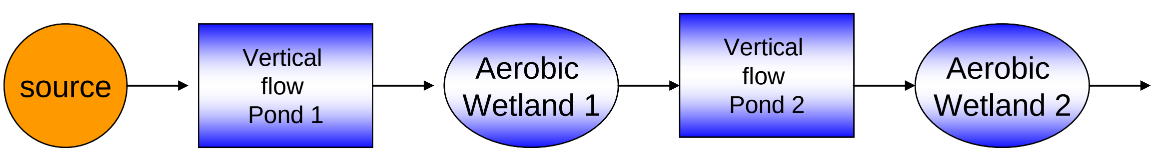
Metal removal studies:

Table 5-1 shows the extracted results from a vertical flow system study conducted in Pennsylvania and Maryland. The numbers in the first column show different sites (Watzlaf et al, 2004). The table shows changes in metal concentrations before entering the vertical flow systems and metal concentrations in the effluent of the ponds.

Table 5-1. Metal removals efficiency by vertical flow system

	Iron(mg/L)		% reduction	Manganese(mg/L)		% reduction	Aluminum(mg/L)		% reduction
	In	Out		In	Out		In	Out	
1	189	72.1	*62*	37	35.7	*4*	<0.2	<0.2	*N/A*
2	40.6	3.41	*92*	28.2	27.4	*3*	1.45	0.82	*43*
3	1.69	0.47	*72*	27.3	22	*19*	1.21	0.32	*74*
4	18.6	9.21	*50*	12.1	11.9	*2*	16.4	9.4	*43*
5	9.21	3.93	*57*	11.9	11.3	*5*	9.4	4.36	*54*
6	68.5	14.7	*79*	18.6	17.6	*5*	24.1	0.84	*97*

The next study shows an example of combining different passive treatment systems constructed in Pennsylvania. The source water goes through two vertical flow ponds and an aerobic wetland (Younger et al, 2004).



The vertical flow ponds were expected to remove aluminum and iron and generate alkalinity and the aerobic wetlands were expected to precipitate iron. The high acidity and iron concentrations required the use of a vertical flow pond. Table 5-2 shows the efficiency of each passive treatment unit.

Table 5-2. The results of water quality improvements using the combination of passive treatment systems.

	source	vertical flow pond 1 effluent	vertical flow pond 2 effluent	Aerobic wetland 2 effluent	Total reduction (%)
pH	4.05	5.98	6.11	6.11	-
alkalinity	0	117	113	47	-
acidity	947	455	223	218	-
Fe	354	225	108	79	78
Al	31	<1	<1	<1	>95
Mn	143	131	100	93	35

Acid loading removal study:

Forty nine sites in seven eastern states (Alabama, Indiana, Kentucky, Maryland, Ohio, Tennessee, and West Virginia) with 83 separate treatment system types were studied to evaluate the effectiveness of various passive treatment systems and Table 5-3 summarizes some of the findings (Ziemikiewiez et al., 2004).

Table 5-3. Acid loading reduction by various passive treatment systems.

	flow(L/S)	pH		Net acidity(mg/L)		Acid Load Treated (t/Yr)	Cost to Build
		In	Out	In	out		
Anaerobic wetlands	4.4	5.9	6.2	74	25	35.4	$ 97,925
Anaerobic wetlands	0.9	2.5	2.6	1112	588	17.4	$116,184
Anaerobic wetlands	0.6	4.3	6	83	-2	1.2	$ 20,000
Anaerobic wetlands	10.9	3	4.9	259	81	31.3	$549,901
Anoxic limestone drains	0.1	3	6.6	1515	-41	6.7	$ 3,488
Anoxic limestone drains	12.9	3.7	6.8	96	-186	130.9	$115,207
Anoxic limestone drains	3	2.9	5.9	405	74	7.1	$ 11,041
Anoxic limestone drains	0.6	3.7	6.3	98	-25	2.5	$ 39,961
Vertical flow wetlands	1.7	2.8	6.7	841	-215	21.8	$ 16,880
Vertical flow wetlands	2.3	2.8	5.1	843	22	68.7	$ 74,046
Vertical flow wetlands	0.9	3.6	6	127	81	6.8	$ 19,898
Vertical flow wetlands	1.2	3.4	6.8	53	-62	3061	$213,267
Open limestone channels	4.7	4.8	5.3	230	150	13.2	$ 950
Open limestone channels	10.9	3.7	3.9	212	141	24.1	$ 24,004
Open limestone channels	1.3	2.9	4.5	692	55	25	$ 73,184
Open limestone channels	2.1	3.5	5.3	66	30	2.8	$ 31,590

Table 5-3 indicates that manganese can be difficult to remove from solutions. One method that has been successful is to place a caustic soda treatment system (Active treatment) to raise the pH to approximately 9.5 so manganese can be precipitated as either hydroxide or carbonate. Although there were not many studies conducted on the removal efficiency of trace metals such as cadmium and copper using passive treatment systems, Cohen (1996) recommended removing these metals as sulfides in compost based anaerobic systems.

The following sections detail some major passive treatment systems that can be constructed to remove acidity and metals.

5.1.1 Anoxic Limestone Drains (ALDs)

ALDs are limestone-filled trenches that can rapidly produce bicarbonate alkalinity through limestone dissolution. They should be installed at the subsurface discharge outlet to capture the AMD. ALDs are capped with clay or compacted soil to prevent AMD contact with oxygen. The effluent is discharged into a settling pond to allow for acid neutralization, pH adjustment, and metal precipitation. ALDs are not capable of treating discharges with significant concentrations of aluminum or ferric iron because these metals can clog the system with metal hydroxides once pH ranges above 4.5 (Zipper and Jage, 2001, Skousen, 2008).

5.1.2 Aerobic Wetlands

Aerobic wetlands are shallow, surface flow wetlands planted with plants such as cattails. The systems aerate the mine waters flowing among vegetation. This slows the oxidation of metals and precipitation of metals (Zipper and Jage, 2001, Skousen, 2008).

5.1.3 Anaerobic Wetlands

Anaerobic wetlands are modified aerobic wetlands, which were made to raise water pH and increase metal precipitation. This modification was engineered by including the addition of a bed of limestone beneath an organic substance. This design encouraged the generation of bicarbonate alkalinity by both anaerobic microbial sulfate reduction and limestone dissolution (Zipper and Jage, 2001; Skousen, 2008).

5.1.4 Oxic Limestone Channels

Open channels lined with limestone to remove iron and other metals, and generating small amounts of alkalinity (Zipper and Jage, 2001; Skousen, 2008).

5.1.5 Vertical Flow Systems

Vertical flow systems have been given a variety of names such as SAPS (successive alkalinity producing systems), RAPS (reducing and alkalinity producing systems), and APS (alkalinity producing systems). These systems are able to neutralize acidity and promote metal precipitation in conditions that present difficult treatment situations to the other systems described here. Due to the active mixing of the AMD with the limestone, acid neutralization is more rapid in vertical flow systems than in anaerobic wetlands. Thus, vertical flow systems require shorter residence time and smaller surface areas. However, the systems require the addition of an oxidation/settling pond at the effluent point to allow for the precipitation and storage of the metals in solution. A settling pond should also precede the system if incoming waters contains sediment (Zipper and Jage, 2001; Skousen, 2008)

5.2 Proper Maintenance of Onsite Systems

The most effective BMP for managing loads from septic systems is regular maintenance. Unfortunately, most people do not think about their wastewater systems until a major malfunction occurs (e.g., sewage backs up into the house or onto the lawn). When not maintained properly, septic systems can cause the release of pathogens and excess nutrients into surface water. Good housekeeping measures relating to septic systems are listed below (Goo, 2004; CWP, 2004):

- Inspect system annually and pump system every 3 to 5 years, depending on the tank size and number of residents per household.
- Refrain from trampling the ground or using heavy equipment above a septic system (to prevent collapse of pipes).
- Prevent septic system overflow by conserving water, not diverting storm drains or basement pumps into septic systems, and not disposing of trash through drains or toilets.

Education is a crucial component of reducing pollution from septic systems. Many owners are not familiar with USEPA recommendations concerning maintenance schedules. Education can occur through public meetings, mass mailings, and radio and television advertisements.

The USEPA recommends that septic tanks be pumped every 3 to 5 years depending on the tank size and number of residents in the household. Annual inspections, in addition to regular maintenance, ensure that systems are functioning properly. An inspection program would help identify those systems that are currently connected to tile drain systems. All tanks discharging to tile drainage systems should be disconnected immediately.

Some communities choose to formally regulate septic systems by creating a database of all the systems in the area. This database usually contains information on the size, age, and type of system. All inspections and maintenance records are maintained in the database through cooperation with licensed maintenance and repair companies. These databases allow the communities to detect problem areas and ensure proper maintenance.

5.2.1 Effectiveness

The reductions in pollutant loading resulting from improved operation and maintenance of all systems in the watershed depends on the wastewater characteristics and the level of failure present in the watershed. Refer to Section 4.3.2 for an estimate of the fecal coliform load from failing systems.

5.2.2 Costs

Septic tanks are designed to accumulate sludge in the bottom portion of the tank while allowing water to pass into the drain field. If the tank is not pumped out regularly, the sludge can accumulate and eventually become deep enough to enter the drain field. Pumping the tank every three to five years prolongs the life of the system by protecting the drain field from solid material that may cause clogs and system backups.

The cost to pump a septic tank ranges from $250 to $350 depending on how many gallons are pumped out and the disposal fee for the area. If a system is pumped once every three to five years, this expense averages out to less than $100 per year. Septic tanks that are not maintained will likely require replacement which may cost between $2,000 and $10,000.

The cost of developing and maintaining a watershed-wide database of the onsite wastewater treatment systems in the watershed depends on the number of systems that need to be inspected. Based on Census data collected in 2000, there are approximately 1,870 households in the watershed with onsite wastewater treatment systems. After the initial inspection of each system and creation of the database, only systems with no subsequent maintenance records would need to be inspected. A recent inspection program in South Carolina found that inspections cost approximately $160 per system (Hajjar, 2000).

Education of home and business owners that use onsite wastewater treatment systems should occur periodically. Public meetings, mass mailings, and radio, newspaper, and TV announcements can all be used to remind and inform owners of their responsibility to maintain their systems (Table 5-4).

The costs associated with education and inspection programs will vary depending on the level of effort required to communicate the importance of proper maintenance and the number of systems in the area.

Table 5-4. Costs Associated with Maintaining and Replacing an Onsite Wastewater Treatment System.

Action	Cost per System	Frequency	Annual Cost per System
Pumping	$250 to $350	Once every 3 to 5 years	$70 to $85
Inspection	$160	Initially all systems should be inspected, followed by 5 year inspections for systems not on record as being maintained	Up to $32, assuming all systems have to be inspected once every five years, which is not likely
Replacement	$2,000 to $10,000	With proper maintenance, system life should be 30 years	$67 to $333
Education	$1	Public reminders should occur once per year	$1

5.3 Disinfection of Primary Effluent from Sewage Treatment Plants

The majority of the sewage treatment plants in the South Fork Saline River/Lake of Egypt watershed operate under a disinfection exemption. Reducing the fecal coliform concentrations from a primary outfall of an exempt facility to 200 cfu/100 mL will require a permit change and disinfection of the effluent prior to discharge. Common disinfection techniques include chlorination, ozonation, and ultraviolet (UV) disinfection. In most cases, chlorination is the most cost-effective alternative, although residuals and oxidized compounds are toxic to aquatic life; subsequent dechlorination may be necessary prior to discharge which will increase costs similar to the other two options (USEPA, 1999b). The options most frequently employed are discussed below.

Chlorination

Chlorine compounds used for disinfection are usually either chlorine gas or hypochlorite solutions though other liquid and solid forms are available. Oxidation of cellular material destroys pathogenic organisms. The remaining chlorine residuals provide additional disinfection, but may also react with organic material to form harmful byproducts. To reduce the impacts on aquatic life from chlorine residuals and byproducts, a dechlorination step is often included in the treatment process (USEPA, 1999b).

The advantages of chlorine disinfection are

- Generally more cost-effective relative to UV disinfection or ozonation if dechlorination is not required
- Residuals continue to provide disinfection after discharge
- Effective against a wide array of pathogens
- Capable of oxidizing some organic and inorganic compounds
- Provides some odor control
- Allows for flexible dosing

There are several disadvantages as well:

- Chlorine residuals are toxic to aquatic life and may require dechlorination, which may increase costs by 30 to 50 percent
- Highly corrosive and toxic with expensive shipping and handling costs
- Meeting Uniform Fire Code requirements can increase costs by 25 percent

- Oxidation of some organic compounds can produce toxic byproducts
- Effluent has increased concentrations of dissolved solids and chloride

More information about disinfection with chlorine is available online at
http://www.consolidatedtreatment.com/manuals/Fact_sheet_chlorine_disinfection.pdf

Ozonation

Ozone is generated onsite by passing a high voltage current through air or pure oxygen (USEPA, 1999c). The resulting gas (O_3) provides disinfection by destroying the cell wall, damaging DNA, and breaking carbon bonds. The advantages of ozonation include

- Ozone is more effective than chlorine and has no harmful residuals
- Ozone is generated onsite so there are no hazardous transport issues
- Short contact time of 10 to 30 minutes
- Elevates the DO of the effluent

Disadvantages are

- More complex technology than UV light or chlorine disinfection
- Highly reactive and corrosive
- Not economical for wastewater with high concentrations of BOD, TSS, COD, or TOC
- Initial capital, maintenance, and operating costs are typically higher than for UV light or chlorine disinfection

More information about ozonation is available online at
http://www.epa.gov/owmitnet/mtb/ozon.pdf

Ultraviolet Disinfection

UV radiation is generated by passing an electrical current through a lamp containing mercury vapor. The radiation attacks the genetic material of the organisms, destroying reproductive capabilities (NSFC, 1998).

The advantages of UV disinfection are

- Highly effective
- Destruction of pathogens occurs by physical process, so no chemicals must be transported or stored
- No harmful residuals
- Easy to operate
- Short contact time (20 to 30 min)
- Requires less space than chlorination or ozonation

Disadvantages of UV disinfection are

- Organisms can sometimes regenerate
- Turbidity and TSS can interfere with disinfection at high concentrations

- Not as cost effective compared to chlorination alone, but when fire code regulations and dechlorination are considered, costs are comparable.

More information about disinfection with UV radiation is available online at http://www.nsfc.wvu.edu/nsfc/pdf/eti/UV_Dis_tech.pdf

5.3.1 Effectiveness

Because the sewage treatment plants that operate under a disinfection exemption are not required to monitor fecal coliform concentrations in the primary effluent, it is difficult to estimate the existing load from this source. The use of disinfection techniques to reduce fecal coliform concentrations to 200 cfu/100 mL should result in a substantial reduction in loading from this source.

5.3.2 Costs

Upgrading the existing sewage treatment plants to include disinfection prior to discharge can be achieved with either chlorination, ozonation, or UV radiation processes. The costs associated with these three techniques include upfront capital costs to construct additional process units, operating and maintenance costs for chemicals, electricity, labor, etc., as well as chemical storage and fire code requirements associated with the chlorination option. The USEPA compares costs of chlorination, ozonation, and UV disinfection in a series of fact sheets available online. This information is summarized below as well as in Table 5-5. Prices in the fact sheets were listed in either 1995 or 1998 dollars and have not been updated more recently. Prices have been converted to year 2004 dollars, assuming a 3 percent per year inflation rate, for comparison with the other BMPs discussed in this plan that must be described in year 2004 dollars.

Chlorine dosage usually ranges from 5 mg/L to 20 mg/L depending on the wastewater characteristics and desired level of disinfection. The cost of adding a chlorination/dechlorination system meeting fire code requirements and treating 1 MGD of wastewater with a chlorine dosage of 10 mg/L cost approximately $1,260,000 in 1995 with annual operation and maintenance costs of $59,200 (USEPA, 1999b). If a 3 percent per year inflation rate is assumed, these costs in 2004 dollars are $1,640,000 and $77,200, respectively.

Costs for ozonation were given by USEPA (1999c) in 1998 dollars. The capital cost in 1998 for treating 1 MGD of secondary wastewater with BOD and TSS concentrations each less than 30 mg/L was $300,000. The operating and maintenance costs were listed at $18,500 plus the cost of electricity. In 2004 dollars, these costs are $358,200 and $22,000, respectively.

Ultraviolet radiation costs were listed in 1995 dollars by USEPA (1995) relative to the cost per bulb. Based on vendor information available online, approximately 40 bulbs would be required to treat 1 MGD of secondary wastewater. Based on the information presented, the capital cost in 2004 for a 1 MGD facility would be approximately $750,000 and the annual operating and maintenance costs would range from $4,500 to $5,100.

Table 5-5 compares the costs for these three disinfection technologies. Annualized costs are calculated assuming a 20-year system life for each technology before major repairs or replacement would be required.

Table 5-5. Comparison of Disinfection Costs (2004) per 1 MGD of Sewage Treatment Plant Effluent.

Technology	Capital Costs	Annual Operating and Maintenance Costs	Annualized Costs
Chlorination (10 mg/L dosage), dechlorination, fire code regulations	$1,640,000	$77,200	$159,200
Ozonation	$358,200	$22,000	$39,900, plus cost of electricity
UV Disinfection	$750,000	$4,500 to $5,100	$42,000 to $42,600

5.4 Nutrient Management Plans

The majority of nutrient loading from farmland occurs from fertilization with commercial and manure fertilizers (USEPA, 2003). In heavily fertilized areas, soil phosphorus content can increase significantly over natural levels. Parties responsible for reducing loads due to excessive fertilization include farmers and local agricultural service agencies that provide fertilization guidelines. Reducing the nutrients available to stimulate eutrophication would improve dissolved oxygen levels and could decrease algal blooms which may cause pH impairments.

The primary BMP for reducing phosphorus loading from excessive fertilization is the development of a nutrient management plan. The plan should address fertilizer application rates, methods, and timing. Initial soil phosphorus concentrations are determined by onsite soil testing, which is available from local vendors. Losses through plant uptake are subtracted, and gains from organic sources such as manure application or industrial/municipal wastewater are added. The resulting phosphorus content is then compared to local guidelines to determine if fertilizer should be added to support crop growth and maintain current phosphorus levels. In some cases, the soil phosphorus content is too high, and no fertilizer should be added until stores are reduced by crop uptake to target levels.

Soil phosphorus tests are used to measure the phosphorus available for crop growth. Test results reported in parts per million (ppm) can be converted to lb/ac by multiplying by 2 (USDA, 2003). Based on a survey of state soil testing laboratories in 1997, 64 percent of soils in Illinois had high soil phosphorus test concentrations (> 50 ppm). By 2000, the percentage of soils testing high decreased to 58 percent (USDA, 2003). Guidelines in the Illinois Agronomy Handbook (IAH) recommend maintaining soil test phosphorus content in southeastern Illinois at 25 ppm (50 lb/ac). Soils that test at or above 35 ppm (70 lb/ac) should not be fertilized until subsequent crop uptake decreases the test to 25 ppm (50 lb/ac) (IAH, 2002). Soil phosphorus tests should be conducted once every three or four years to monitor accumulation or depletion of phosphorus (USDA, 2003).

Table 5-6 and Table 5-7 show buildup, maintenance, and total application rates for various starting soil test concentrations for sample corn and soybean yields, respectively. For a complete listing of buildup and maintenance rates for the three inherent availability zones and varying yields of corn, soybeans, oats, wheat, and grasses, see Chapter 11 of the IAH.

Starting Soil Test Phosphorus	***Fertilization Guidelines***
Less than 25 ppm:	*Buildup plus maintenance*
Between 25 and 35 ppm:	*Maintenance only*
Greater than 35 ppm:	*None*

Table 5-6. Suggested Buildup and Maintenance Application Rates of P_2O_5 for Corn Production in the Low Inherent Phosphorus Availability Zone (IAH, 2002).

Starting Soil Test P ppm (lb/ac)	Buildup P_2O_5 (lb/ac)[1]	Maintenance P_2O_5 (lb/ac)[2]	Total P_2O_5 (lb/ac)
10 (20)	68	71	139
15 (30)	45	71	116
20 (40)	22	71	93
25 (50)	0	71	71
30 (60)	0	71	71
35 (70) or higher	0	0	0

[1] Rates based on buildup for four years to achieve target soil test phosphorus of 25 ppm (50 lb/ac).
[2] Maintenance rates assume a corn yield of 165 bushels per acre. The IAH lists maintenance rates discretely for yields of 90 to 200 bushels per acre.

Table 5-7. Suggested Buildup and Maintenance Application Rates of P_2O_5 for Soybean Production in the Low Inherent Phosphorus Availability Zone (IAH, 2002).

Starting Soil Test P ppm (lb/ac)	Buildup P_2O_5 (lb/ac)[1]	Maintenance P_2O_5 (lb/ac)[2]	Total P_2O_5 (lb/ac)
10 (20)	68	51	119
15 (30)	45	51	96
20 (40)	22	51	73
25 (50)	0	51	51
30 (60)	0	51	51
35 (70) or higher	0	0	0

[1] Rates based on buildup for four years to achieve target soil test phosphorus of 25 ppm (50 lb/ac).
[2] Maintenance rates assume a soybean yield of 60 bushels per acre. The IAH lists maintenance rates discretely for yields of 30 to 100 bushels per acre.

Nutrient management plans also address methods of application. Fertilizer may be applied directly to the surface, placed in bands below and to the side of seeds, or incorporated in the top several inches of the soil profile through drilled holes, injection, or tillage. Surface applications that are not followed by incorporation may result in accumulation of phosphorus at the soil surface and increased dissolved phosphorus concentrations in surface runoff (Mallarino, 2004).

Methods of phosphorus application have shown no impact on crop yield (Mallarino, 2004). The Champaign County Soil and Water Conservation District (CCSWCD) reports that deep placement of phosphorus in bands next to the seed zone requires only one-third to one-half the amount of phosphorus fertilizer to achieve the same yields and that on average, fertilizer application rates were decreased by 13 lb/ac (Stikkers, 2007). Thus, deep placement will not only reduce the amount of phosphorus available for transport, but will also result in lower fertilizer costs. Figure 5-3 shows the deep placement attachment used by the CCSWCD.

The NRCS provides additional information on nutrient management planning at:
http://efotg.nrcs.usda.gov/references/public/IL/590.pdf

The Illinois Agronomy Handbook may be found online at:
http://iah.aces.uiuc.edu/

(Photo Courtesy of CCSWCD)

Figure 5-3. Deep Placement Phosphorus Attachment Unit for Strip-till Toolbar.

For corn-soybean rotations, it is recommended that phosphorus fertilizer be applied once every two years, following harvest of the corn crop if application consists of broadcast followed by incorporation (UME, 1996). Band placement should occur prior to or during corn planting, depending on the type of field equipment available. Fertilizer should be applied when the chance of a large precipitation event is low. Application to frozen ground or snow cover should be strongly discouraged. Researchers studying loads from agricultural fields in east-central Illinois found that fertilizer application to frozen ground or snow followed by a rain event could transport 40 percent of the total annual phosphorus load (Gentry et al., 2007).

Recent technological developments in field equipment allow for fertilizer to be applied at varying rates across a field. Crop yield and net profits are optimized with this variable rate technology (IAH, 2002). Precision farming typically divides fields into 1- to 3-acre plots that are specifically managed for seed, chemical, and water requirements. Operating costs are reduced and crop yields typically increase, though upfront equipment costs may be high.

5.4.1 Effectiveness

The effectiveness of nutrient management plans (application rates, methods, and timing) in reducing phosphorus loading from agricultural land will be site specific. The following reductions are reported in the literature:

- Nutrient management plans will reduce the dissolved oxygen impairments in the watershed by reducing the nutrients available to stimulate eutrophication.
- Nutrient management plans will reduce the pH impairments in the watershed by reducing the nutrients available to stimulate eutrophication.

5.4.2 Costs

A good nutrient management plan should address the rates, methods, and timing of fertilizer application. To determine the appropriate fertilizer rates, consultants in Illinois typically charge $6 to $18 per acre, which includes soil testing, manure analysis, scaled maps, and site specific recommendations for fertilizer management (USEPA, 2003). The Champaign County Soil and Water Conservation District (2003) estimates savings of approximately $10/ac during each plan cycle (4 years) by applying fertilizer at recommended rates. Actual savings (or costs) depend on the reduction (or increase) in fertilizer application rates required by the nutrient management plan as well as other farm management recommendations.

Placing the fertilizer below and to the side of the seed bed (referred to as banding) reduces the required application by one third to one half to achieve the same crop yields. In Champaign County, phosphorus application rates were reduced by approximately 13 lb/ac with this method. The equipment needed for deep placement costs up to $113,000 (Stikkers, 2007). Alternatively the equipment can be rented or the entire process hired out. The Heartland Regional Water Coordination Initiative lists the cost for deep placement of phosphorus fertilizer at $3.50/ac per application (HRWCI, 2005).

Table 5-8 summarizes the assumptions used to develop the annualized cost for this BMP.

Table 5-8. Costs Calculations for Nutrient Management Plans.

Item	Costs and Frequency	Annualized Costs (Savings)
Soil Testing and Determination of Rates	Costs $6/ac to $18/ac Every four years	$1.50/ac/yr to $4.50/ac/yr
Savings on Fertilizer	Saves $10/ac Every four years	($2.50/ac/yr)
Deep Placement of Phosphorus	Costs $3.50/ac Every two years	$1.75/ac/yr
Average Annual Costs		**$0.75/ac/yr to $3.75/ac/yr**

5.5 Conservation Tillage

Conservation tillage practices and residue management are commonly used to control erosion and surface transport of pollutants from fields used for crop production. The residuals not only provide erosion control, but also provide a nutrient source to growing plants, and continued use of conservation tillage results in a more productive soil with higher organic and nutrient content. Increasing the organic content of soil has the added benefit of reducing the amount of carbon in the atmosphere by storing it in the soil. Researchers estimate that croplands and pasturelands could be managed to trap 5 to 17 percent of the greenhouse gases produced in the United States (Lewandrowski et al., 2004).

Several practices are commonly used to maintain the suggested 30 percent cover:

- No-till systems disturb only a small row of soil during planting, and typically use a drill or knife to plant seeds below the soil surface.
- Strip till operations leave the areas between rows undisturbed, but remove residual cover above the seed to allow for proper moisture and temperature conditions for seed germination.
- Ridge till systems leave the soil undisturbed between harvest and planting: cultivation during the growing season is used to form ridges around growing plants. During or prior to the next planting, the top half to two inches of soil, residuals, and weed seeds are removed, leaving a relatively moist seed bed.
- Mulch till systems are any practice that results in at least 30 percent residual surface cover, excluding no-till and ridge till systems.

The NRCS provides additional information on these conservation tillage practices:
no-till and strip till: **http://efotg.nrcs.usda.gov/references/public/IL/329a.pdf**
ridge till: http://efotg.nrcs.usda.gov/references/public/IL/329b.pdf
mulch till: http://efotg.nrcs.usda.gov/references/public/IL/329c.pdf

Tillage system practices are not available specifically for the South Fork Saline River/Lake of Egypt Watershed; however, countywide tillage system surveys are performed by the Illinois Department of Agriculture every two years. It is assumed that the general tillage practice trends measured in the counties is applicable to the watershed and the results of the 2006 surveys are presented in Table 5-9. Mulch till and no-till are considered conservation tillage practices: reduced till practices do not maintain 30 percent ground cover.

In 2006, the use of conservation tillage practices on corn fields occurred on less than 55 percent of the fields surveyed. Only 25 and 55 percent of corn fields in Johnson and Saline County, respectively, employ conservation tillage practices. It is more common for soybean fields to use conservation practices. At least 74 percent of soybean fields in each county use some form of conservation tillage. Practices on small grain fields in Johnson, Saline, and Williamson counties are employing 100 percent conservation tillage practices on fields surveyed, Johnson and Saline counties are using no-till practices while Williamson County is using reduced-till practices.

Table 5-9. Percentage of Agricultural Fields Surveyed with Indicated Tillage System in 2006.

Crop Field Type	Tillage Practice				Conservation Tillage
	Conventional Till	Reduced-till	Mulch Till	No Till	
Johnson County					
Corn	75	4	0	21	**25**
Soybean	27	10	6	58	**74**
Small Grain	0	0	0	100	**100**
Saline County					
Corn	45	12	14	39	**55**
Soybean	15	15	4	66	**85**
Small Grain	0	0	0	100	**100**
Williamson County					
Corn	10	35	12	43	**90**
Soybean	26	12	12	50	**74**
Small Grain	0	100	0	0	**100**

Source: IDA, 2006.

Corn residues are more durable and capable of sustaining the required 30 percent cover required for conservation tillage. Soybeans generate less residue, the residue degrades more quickly, and supplemental measures or special care may be necessary to meet the 30 percent cover requirement (UME, 1996). Figure 5-4 shows a comparison of ground cover under conventional and conservation tillage practices.

Figure 5-4. Comparison of Conventional (left) and Conservation (right) Tillage Practices.

Though no-till systems are more effective in reducing sediment loading from crop fields, they tend to concentrate phosphorus in the upper two inches of the soil profile due to surface application of fertilizer and decomposition of plant material (IAH, 2002; UME, 1996). This pool of phosphorus readily mixes with precipitation and can lead to increased concentrations of dissolved phosphorus in surface runoff. Chisel plowing may be required once every several years to reduce stratification of phosphorus in the soil profile.

5.5.1 Effectiveness

Czapar et al. (2006) summarize past and present tillage practices and their impacts on erosion control and nutrient delivery. Historically, the mold board plow was used to prepare the field for planting. This practice disturbed 100 percent of the soil surface and resulted in basically no residual material. Today, conventional tillage typically employs the chisel plow, which is not as disruptive to the soil surface and tends to leave a small amount of residue on the field (0 to 15 percent). Mulch till systems were classified as leaving 30 percent residue; percent cover was not quantified for the no-till systems in this study. The researchers used WEPP modeling to simulate changes in sediment and nutrient loading for these tillage practices. Relative to mold board plowing, chisel plowing reduced phosphorus loads leaving the field by 38 percent, strip tilling reduced loads by 80 percent, and no-till reduced loads by 85 percent. If chisel plowing is now considered conventional, then the strip till and no-till practices are capable of reducing phosphorus loads by 68 percent and 76 percent, respectively (Czapar et al., 2006).

The IAH (2002) defines conservation tillage as any tillage practice that results in at least 30 percent coverage of the soil surface by crop residuals after planting. Tillage practices leaving 20 to 30 percent residual cover after planting reduce erosion by approximately 50 percent compared to bare soil. Practices that result in 70 percent residual cover reduce erosion by approximately 90 percent (IAH, 2002). Manganese reductions will be similar since this pollutant is primarily sediment bound.

USEPA (2003) reports the findings of several studies regarding the impacts of tillage practices on pesticide loading. Ridge till practices reduced pesticide loads by 90 percent and no-till reduced loads by an average of 67 percent. In addition, no-till reduced runoff losses by 69 percent, which will protect streambanks from erosion and loss of canopy cover (USEPA, 2003).

The reductions achieved by conservation tillage reported in these studies are summarized below:

- 50 percent reduction in sediment, and likely manganese, for practices leaving 20 to 30 percent residual cover.
- 90 percent reduction in sediment, and likely manganese, for practices leaving 70 percent residual cover.
- 90 percent reduction in pesticide loading for ridge till practices.
- 67 percent reduction in pesticide loading for no-till practices.
- 69 percent reduction in runoff losses for no-till practices.

5.5.2 Costs

Conservation tillage practices generally require fewer trips to the field, saving on labor, fuel, and equipment repair costs, though increased weed production may result in higher pesticide costs relative to conventional till (USDA, 1999). In general, conservation tillage results in increased profits relative to conventional tillage (Olson and Senjem, 2002; Buman et al., 2004; Czapar, 2006). The HRWCI (2005) lists no additional costs for conservation tillage.

Hydrologic inputs are often the limiting factor for crop yields and farm profits. Conservation practices reduce evaporative losses by covering the soil surface. USDA (1999) reports a 30 percent reduction in evaporative losses when 30 percent ground cover is maintained. Harman et al. (2003) and the Southwest Farm Press (2001) report substantial yield increases during dry years on farms managed with conservation or no-till systems compared to conventional till systems.

Depending on the type of equipment currently used, replacing conventional till equipment with no-till equipment can either result in a net savings or slight cost to the producer. Al-Kaisi et al. (2000) estimate that converting conventional equipment to no-till equipment costs approximately $1.25 to $2.25/ac/yr, but that for new equipment, purchasing no-till equipment is less expensive than conventional equipment. Other researchers report a net gain when conventional equipment is sold to purchase no-till equipment (Harman et al., 2003).

Table 5-10 summarizes the available information for determining average annual cost for this BMP.

Table 5-10. Costs Calculations for Conservation Tillage

Item	Costs and Frequency	Annualized Costs (Savings)
Conversion of Conventional Equipment to Conservation Equipment	Costs presented in literature were already averaged out to yearly per acre costs: $1.25/ac/yr to $2.25/ac/yr	$1.25/ac/yr to $2.25/ac/yr
Operating Costs of Conservation Tillage Relative to Conventional Costs	$0/ac/yr	$0/ac/yr
Average Annual Costs		**$1.25/ac/yr to $2.25/ac/yr**

5.6 Cover Crops

Grasses and legumes may be used as winter cover crops to reduce soil erosion and improve soil quality (IAH, 2002). These crops also contribute nitrogen to the following crop, reducing fertilizer requirements. Grasses tend to have low seed costs and establish relatively quickly, but can impede cash crop development by drying out the soil surface or releasing chemicals during decomposition that may inhibit the growth of a following cash crop. Legumes take longer to establish, but are capable of fixing nitrogen from the atmosphere, thus reducing nitrogen fertilization required for the next cash crop. Legumes, however, are more susceptible to harsh winter environments and may not have adequate survival to offer sufficient erosion protection. Planting the cash crop in wet soil that is covered by heavy surface residue from the cover crop may impede emergence by prolonging wet, cool soil conditions. Cover crops should be killed off two or three weeks prior to planting the cash crop either by application of herbicide or mowing and incorporation, depending on the tillage practices used. Use of cover crops is illustrated in Figure 5-5.

(Photo Courtesy of NRCS)

Figure 5-5. Use of Cover Crops.

The NRCS provides additional information on cover crops at:
http://efotg.nrcs.usda.gov/references/public/IL/340.pdf

5.6.1 Effectiveness

The effectiveness of cover crops in reducing pollutant loading has been reported by several agencies. In addition to these benefits, the reduction in runoff losses will reduce erosion from streambanks, further reducing manganese loads and allowing for the establishment of vegetation and canopy cover. The reported reductions are listed below:

- 50 percent reduction in soil and runoff losses with cover crops alone. When combined with no-till systems, may reduce soil loss by more than 90 percent (IAH, 2002). Manganese reductions will likely be similar.
- Reduction in fertilizer and pesticide requirements (OSUE, 1999).
- Useful in conservation tillage systems following low-residue crops such as soybeans (USDA, 1999).

5.6.2 Costs

The National Sustainable Agriculture Information Service recommends planting ryegrass after corn harvest and hairy vetch after soybeans (Sullivan, 2003). Both seeds can be planted at a depth of ¼ to ½ inch at a rate of 20 lb/ac or broadcast at a rate of 25 to 30 lb/ac (Ebelhar and Plumer, 2007; OSUE, 1990).

Researchers at Purdue University estimate the seed cost of ryegrass and hairy vetch at $12 and $30/ac, respectively. Savings in nitrogen fertilizer (assuming nitrogen fertilizer cost of $0.30/lb) are $3.75/ac for ryegrass and $28.50/ac for hairy vetch. Yield increases in the following crop, particularly during droughts, are reported at 10 percent and are expected to offset the cost of this practice (Mannering et al., 1998). Herbicide application is estimated to cost $14.25/ac.

Accounting for the seed cost, herbicide cost, and fertilizer offset results in an average net cost of approximately $19.25/ac assuming that cover crop planting recommendations for a typical 2-year corn/soybean rotation are followed (Mannering et al., 1998). These costs do not account for yield increases which may offset the costs completely. Table 5-11 summarizes the costs and savings associated with ryegrass and hairy vetch.

Table 5-11. Costs Calculations for Cover Crops.

Item	Ryegrass	Hairy Vetch
Seed Costs	$12/ac	$30/ac
Nitrogen Fertilizer Savings	($3.75/ac)	($28.50/ac)
Herbicide Costs	$14.25/ac	$14.25/ac
Annual Costs	$22.50/ac	$15.75/ac
Average Annual Cost Assuming Ryegrass Follows Corn and Hairy Vetch Follows Soybeans: $19.25/ac		

5.7 Filter Strips

Filter strips are used in agricultural and urban areas to intercept and treat runoff before it leaves the site. If topography allows, filter strips may also be used to treat effluent from tile drain outlets. For small dairy operations, filter strips may also be used to treat milk house washings and runoff from the open lot (NRCS, 2003).

Filter strips will require maintenance, including grading and seeding, to ensure distributed flow across the filter and protection from erosion. Periodic removal of vegetation will encourage plant growth and uptake and remove nutrients stored in the plant material. Filter strips are most effective on sites with mild slopes of generally less than 5 percent, and to prevent concentrated flow, the upstream edge of a filter strip should follow one elevation contour (NCDENR, 2005). A grass filter strip is shown in Figure 5-6.

(Photo Courtesy of NRCS)

Figure 5-6. Grass Filter Strip Protecting Stream from Adjacent Agriculture.

The NRCS provides additional information on filter strips at:
http://efotg.nrcs.usda.gov/references/public/IL/393.pdf

Filter strips also serve to reduce the quantity and velocity of runoff. Filter strip sizing is dependent on site specific features such as climate and topography, but at a minimum, the area of a filter strip should be no less than 2 percent of the drainage area for agricultural land (OSUE, 1994). The minimum filter strip width suggested by NRCS (2002a) is 30 ft. The strips are assumed to function properly with annual maintenance for 30 years before requiring replacement of soil and vegetation.

5.7.1 Effectiveness

Filter strips have been found to effectively remove pollutants from agricultural runoff. The following reductions are reported in the literature (USEPA, 2003; Kalita, 2000; Woerner et al., 2006):

- 65 percent reductions for sediment (and likely manganese)
- Slows runoff velocities and may reduce runoff volumes via infiltration

5.7.2 Costs

Filter strips cost approximately $0.30 per sq ft to construct, and the system life is typically assumed to be 20 years (Weiss et al., 2007). Assuming that the required filter strip area is 2 percent of the area drained (OSUE, 1994), 870 square feet of filter strip are required for each acre of agricultural land treated. The construction cost to treat one acre of land is therefore $261/ac. The annualized construction costs are $13/ac/yr. Annual maintenance of filter strips is estimated at $0.01 per sq ft (USEPA, 2002c), for an additional cost of $8.70/ac/yr of agricultural land treated. In addition, the area converted from agricultural production to filter strip will result in a net annual income loss of $3.50. Table 5-12 summarizes the costs assumptions used to estimate the annualized cost to treat one acre of agricultural drainage with a filter strip.

Table 5-12. Costs Calculations for Filter Strips Used in Crop Production.

Item	Costs Required to Treat One Acre of Agricultural Land with Filter Strip
Construction Costs	$0.30
Annual Maintenance Costs	$0.01
Construction Costs	$261
System Life (years)	20
Annualized Construction Costs	$13
Annual Maintenance Costs	$8.70
Annual Income Loss	$3.50
Average Annual Costs	**$25/ac treated**

Filter strips used in animal operations typically treat contaminated runoff from pastures or feedlot areas or washings from the milk houses of small dairy operations (NRCS, 2003). The NRCS (2003) costs for small dairy operations (75 milk cows) assume a filter strip area of 12,000 sq ft is required. For the pasture operations, it is assumed that a filter strip area of 12,000 sq ft (30 ft wide and 400 ft long) would be required to treat runoff from a herd of 50 cattle (NRCS, 2003). The document does not explain why more animals can be treated by the same area of filter strip at the dairy operation compared to the pasture operation.

For animal operations, it is not likely that land used for growing crops would be taken out of production for conversion to a filter strip. Table 5-13 summarizes the capital, maintenance, and annualized costs for filter strips per head of animal.

Table 5-13. Costs Calculations for Filter Strips Used at Animal Operations.

Operation	Capital Costs per Head	Annual Operation and Maintenance Costs per Head	Total Annualized Costs per Head
Small dairy (75 milking cows)	$48 per head of cattle	$1.50 per head of cattle	$4 per head of cattle
Beef or other (50 cattle)	$72 per head of cattle	$2.50 per head of cattle	$6 per head of cattle

5.8 Grassed Waterways

Grassed waterways are stormwater conveyances lined with grass that prevent erosion of the transport channel. They are often used to divert clean up-grade runoff around contaminated feedlots and manure storage areas (NRCS, 2003). In addition, the grassed channel reduces runoff velocities, allows for some infiltration, and filters out some particulate pollutants. A grassed waterway providing surface drainage for a corn field is shown in Figure 5-7.

(Photo Courtesy of NRCS)

Figure 5-7. Grassed Waterway.

The NRCS provides additional information on grassed waterways at:
http://efotg.nrcs.usda.gov/references/public/IL/412.pdf

5.8.1 Effectiveness

The effectiveness of grass swales for treating agricultural runoff has not been quantified. The Center for Watershed Protection reports the following reductions in urban settings (Winer, 2000):

- 68 percent reduction of total suspended solids (similar reduction likely for manganese)

In addition, grassed waterways that allow for water infiltration may reduce atrazine loads by 25 to 35 percent (Kansas State University, 2007).

5.8.2 Costs

Grassed waterways cost approximately $0.50 per sq ft to construct (USEPA, 2002c). These stormwater conveyances are best constructed where existing bare ditches transport stormwater, so no income loss from land conversion is expected with this practice. It is assumed that the average area required for a grassed waterway is approximately 0.1 to 0.3 percent of the drainage area, or between 44 and 131 sq ft per acre. The range is based on examples in the Illinois Drainage Guide, information from the NRCS

Engineering Field Handbook, and a range of waterway lengths (100 to 300 feet). Waterways are assumed to remove phosphorus effectively for 20 years before soil, vegetation, and drainage material need to be replaced (Weiss et al., 2007). The construction cost spread out over the life of the waterway is thus $2.25/yr for each acre of agriculture draining to a grassed waterway. Annual maintenance of grassed waterways is estimated at $0.02 per sq ft (Rouge River, 2001) for an additional cost of $1.75/ac/yr of agricultural land treated. Table 5-14 summarizes the annual costs assumptions for grassed waterways.

Table 5-14. Costs Calculations for Grassed Waterways Draining Cropland.

Item	Costs Required to Treat One Acre of Agricultural Land
Costs per Square Foot	
Construction Costs	$0.50
Annual Maintenance Costs	$0.02
Costs to Treat One Acre of Agricultural Land (assuming 44 to 131 sq ft of filter strip)	
Construction Costs	$22 to $65.50
System Life (years)	20
Annualized Construction Costs	$1 to $3.25
Annual Maintenance Costs	$1 to $2.75
Annual Income Loss	$0
Average Annual Costs	**$2 to 6/ac treated**

Grassed waterways are primarily used in animal operations to divert clean water away from pastures, feedlots, and manure storage areas. Table 5-15 summarizes the capital, maintenance, and annualized costs of this practice per head of cattle as summarized by NRCS (2003).

Table 5-15. Costs Calculations for Grassed Waterways Used in Cattle Operations.

Capital Costs per Head	Annual Operation and Maintenance Costs per Head	Total Annualized Costs per Head
$0.50 to $1.50	$0.02 to $0.04	$0.05 to $0.12

5.9 Riparian Buffers

Riparian corridors, including both the stream channel and adjacent land areas, are important components of watershed ecology. The streamside forest slowly releases nutrients as twigs and leaves decompose. These nutrients are valuable to the fungi, bacteria, and invertebrates that form the basis of a stream's food chain. Tree canopies of riparian forests also cool the water in streams which can affect the composition of the fish species in the stream, the rate of biological reactions, and the amount of dissolved oxygen the water can hold. Channelization or widening of streams moves the canopy farther apart, decreasing the amount of shaded water surface, increasing water temperatures, and decreasing dissolved oxygen concentrations.

Preserving natural vegetation along stream corridors can effectively reduce water quality degradation associated with human disturbances. The root structure of the vegetation in a buffer enhances infiltration of runoff and subsequent trapping of nonpoint source pollutants. However, the buffers are only effective in this manner when the runoff enters the buffer as a slow moving, shallow "sheet"; concentrated flow in a ditch or gully will quickly pass through the buffer offering minimal opportunity for retention and uptake of pollutants.

Even more important than the filtering capacity of the buffers is the protection they provide to streambanks. The rooting systems of the vegetation serve as reinforcements in streambank soils, which help to hold streambank material in place and minimize erosion. Riparian buffers also prevent cattle access to streams, reducing streambank trampling and defecation in the stream. Due to the increase in stormwater runoff volume and peak rates of runoff associated with agriculture and development, stream channels are subject to greater erosional forces during stormflow events. Thus, preserving natural vegetation along stream channels minimizes the potential for water quality and habitat degradation due to streambank erosion and enhances the pollutant removal of sheet flow runoff from developed areas that pass through the buffer. A riparian buffer protecting the stream corridor from adjacent agricultural areas is shown in Figure 5-8.

(Photo Courtesy of NRCS)

Figure 5-8. Riparian Buffer Between Stream Channel and Agricultural Areas.

The NRCS provides additional information on riparian buffers at:
http://efotg.nrcs.usda.gov/references/public/IL/390.pdf *and*
http://efotg.nrcs.usda.gov/references/public/IL/391.pdf

5.9.1 Effectiveness

Riparian buffers should consist of native species and may include grasses, grass-like plants, forbs, shrubs, and trees. Minimum buffer widths of 25 feet are required for water quality benefits. Higher removal rates are provided with greater buffer widths. Riparian corridors typically treat a maximum of 300 ft of adjacent land before runoff forms small channels that short circuit treatment. Buffer widths based on slope measurements and recommended plant species should conform to NRCS Field Office Technical Guidelines. The following reductions are reported in the literature:

- 62 percent reduction in BOD_5 for 200 ft wide buffers (Wenger, 1999)
- 70 to 90 percent reduction of sediment (and likely manganese) (NCSU, 2002)
- Increased canopy cover provides shading which may reduce water temperatures and improve dissolved oxygen concentrations (NCSU, 2002). Wenger (1999) suggests buffer width of at least 30 ft to maintain stream temperatures.
- Increased channel stability will reduce streambank erosion and manganese loads

5.9.2 Costs

Restoration of riparian areas costs approximately $100/ac to construct and $475/ac to maintain over the life of the buffer (Wossink and Osmond, 2001; NCEEP, 2004). Maintenance of a riparian buffer should be minimal, but may include items such as period inspection of the buffer, minor grading to prevent short circuiting, and replanting/reseeding dead vegetation following premature death or heavy storms. Assuming a buffer width of 90 ft on either side of the stream channel and an adjacent treated width of 300 ft of agricultural land, one acre of buffer will treat approximately 3.3 acres of adjacent agricultural land. The cost per treated area is thus $30/ac to construct and $142.50/ac to maintain over the life of the buffer. Assuming a system life of 30 years results in an annualized cost of $59.25/yr for each acre of agriculture land treated (Table 5-16).

Table 5-16. Costs Calculations for Riparian Buffers.

Item	Costs Required to Treat One Acre of Agricultural Land
Costs per Acre of Riparian Buffer	
Construction Costs	$100
Maintenance Costs Over System Life	$475
Costs to Treat One Acre of Agricultural Land (assuming 0.3 ac of buffer)	
Construction Costs	$30
Maintenance Costs Over System Life	$142.50
System Life (Years)	30
Annualized Construction Costs	$1
Annualized Maintenance Costs	$4.75
Annual Income Loss	$53.50
Average Annual Costs	**$59.25/ac treated**

Restoration of riparian areas will protect the stream corridor from cattle trampling and reduce the amount of fecal material entering the channel. The cost of this BMP depends more on the length of channel to be protected, not the number of animals having channel access. The cost of restoration is approximately

$100/ac to construct and $475/ac to maintain over the life of the buffer (Wossink and Osmond, 2001; NCEEP, 2004). The costs per length of channel for 30 ft and 200 ft wide buffers restored on both sides of a stream channel are listed in Table 5-17. A system life of 30 years is assumed.

Table 5-17. Costs Calculations for Riparian Buffers per Foot of Channel.

Width	Capital Costs per ft	Annual Operation and Maintenance Costs per ft	Total Annualized Costs per ft
30 ft on both sides of channel	$0.14	$0.02	$0.03
60 ft on both sides of channel	$0.28	$0.04	$0.05
90 ft on both sides of channel	$0.42	$0.06	$0.07
200 ft on both sides of channel	$0.93	$0.13	$0.16

5.10 Constructed Wetlands

Constructed wetlands used to treat animal wastes are typically surface flowing systems comprised of cattails, bulrush, and reed plants. Prior to treating animal waste in a constructed wetland, storage in a lagoon or pond is required to protect the wetland from high pollutant loads that may kill the vegetation or clog pore spaces. After treatment in the wetland, the effluent is typically held in another storage lagoon and then land applied (USEPA, 2002a). Alternatively, the stored effluent can be used to supplement flows to the wetland during dry periods. Constructed wetlands that ultimately discharge to a surface waterbody will require a permit, and the receiving stream must be capable of assimilating the effluent during low flow conditions (NRCS, 2002). Figure 5-9 shows an example of a lagoon-wetland system.

(Photo courtesy of USDA NRCS.)

Figure 5-9. Constructed Wetland System for Animal Waste Treatment.

The NRCS provides additional information on constructed wetlands at
http://efotg.nrcs.usda.gov/references/public/IL/656.pdf
and
ftp://ftp.wcc.nrcs.usda.gov/downloads/wastemgmt/NEH637Ch3ConstructedWetlands.pdf

5.10.1 Effectiveness

Wetland environments treat wastewater through sedimentation, filtration, plant uptake, biochemical transformations, and volatilization. Reported pollutant reductions found in the literature are listed below:

- 59 to 80 percent reduction in BOD_5 (USEPA, 2002a)
- 53 to 81 percent reduction in total suspended solids (and likely manganese) (USEPA, 2002a)

5.10.2 Costs

Researchers of the use of constructed wetlands for animal waste management generally agree that these systems are a lower cost alternative compared to conventional treatment and land application technologies. Few studies, however, actually report the costs of constructing and maintaining these systems. A Canadian study (CPAAC, 1999) evaluated the use of a constructed wetland system for treating milk house washings as well as contaminated runoff from the feedlot area and manure storage pile of a dairy operation containing 135 head of dairy cattle. The treatment system was comprised of a pond/wetland/pond/wetland/filter strip treatment train that cost $492 per head to construct. Annual operating and maintenance costs of $6.75 per head include electricity to run pumps, maintenance of pumps and berms, and dredging the wetland cells once every 10 years. Reductions in final disposal costs due to reduced phosphorus content of the final effluent were $20.75 per head and offset the costs of constructing and maintaining the wetland in seven years.

Another study evaluated the use of constructed wetlands for treatment of a 3,520-head swine operation in North Carolina. Waste removal from the swine facility occurs via slatted floors to an underlying pit that is flushed once per week. This new treatment system incorporated a settling basin, constructed wetland, and storage pond treatment system prior to land application or return to the pit for flushing.

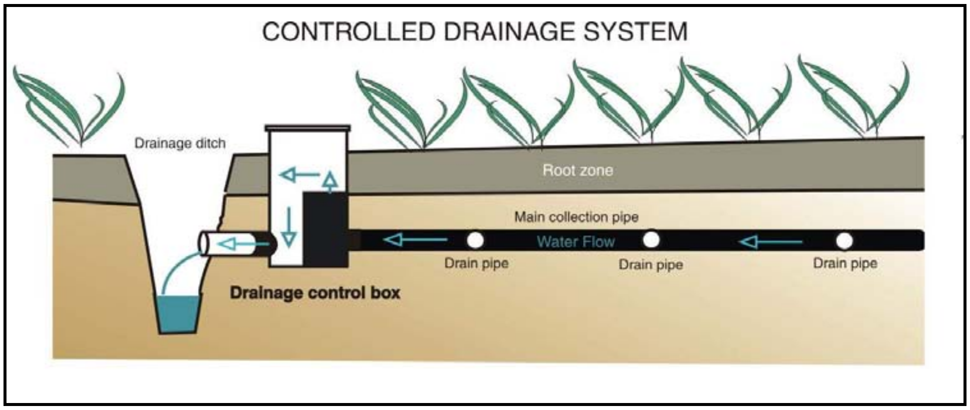
Capital and maintenance costs reported in the literature for dairy and swine operations are summarized per head in Table 5-18. No example studies including costs were available for beef cattle operations, which should generate less liquid waste than the other two operations. It would therefore be expected that constructing a wetland for beef cattle operation would cost less than for a dairy or swine operation.

Table 5-18. Costs Calculations for Constructed Wetlands.

Example	Capital Costs per Head	Annual Operation and Maintenance Costs per Head	Total Annualized Costs per Head
Dairy farm	$492	-$14	$2.50
Swine operation	$103.75	$1.00	$4.50

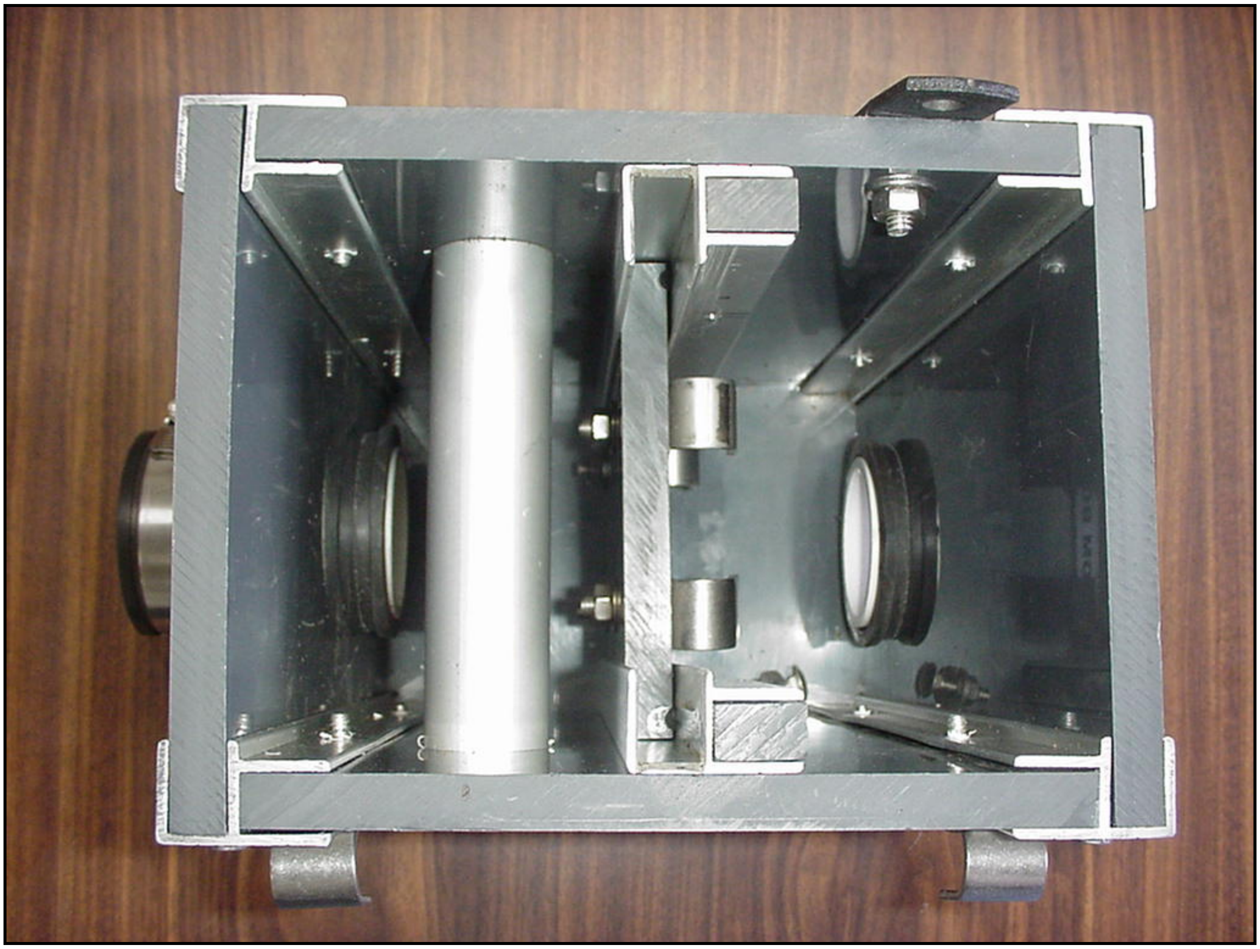
5.11 Controlled Drainage

A conventional tile drain system collects infiltrated water below the root zone and transports the water quickly to a down-gradient surface outlet. Placement of a water-level control structure at the outlet (Figure 5-10 and Figure 5-11) allows for storage of the collected water to a predefined elevation. The stored water becomes a source of moisture for plants during dry conditions and undergoes biological, chemical, and physical processes that result in lower nutrient concentrations in the final effluent.



(Illustration Courtesy of the Agricultural Research Service Information Division)

Figure 5-10. Controlled Drainage Structure for a Tile Drain System.



(Photo Courtesy of CCSWCD)

Figure 5-11. Interior View of a Drainage Control Structure with Adjustable Baffle Height.

The NRCS provides additional information on drainage management at:
http://efotg.nrcs.usda.gov/references/public/IL/554.pdf.

5.11.1 Effectiveness

Use of control structures on conventional tile drain systems in the coastal plains has resulted in reductions of total phosphorus loading of 35 percent (Gilliam et al., 1997). Researchers at the University of Illinois also report reductions in phosphorus loading with tile drainage control structures. Concentrations of phosphate were reduced by 82 percent, although total phosphorus reductions were not quantified in this study (Cooke, 2005). Going from a surface draining system to a tile drain system with outlet control reduces phosphorus loading by 65 percent (Gilliam et al., 1997).

Storage of tiled drained water for later use via subsurface irrigation has shown decreases in dissolved phosphorus loading of approximately 50 percent (Tan et al., 2003). However, accumulated salts in reuse water may eventually exceed plant tolerance and result in reduced crop yields. Mixing stored drain water with fresh water or alternating irrigation with natural precipitation events will reduce the negative impacts of reuse. Salinity thresholds for each crop should be considered and compared to irrigation water concentrations.

5.11.2 Costs

The Champaign County Soil and Water Conservation District currently offers tile mapping services for approximately $2.25/ac using color infrared photography to assist farmers in identifying the exact location of their tile drain lines. Similar services are likely available through local vendors in the South Fork Saline River/Lake of Egypt Watershed. Cooke (2005) estimates that the cost of retrofitting tile drain systems with outlet control structures ranges from $20 to $40 per acre. Construction of new tile drain systems with outlet control is approximately $75/ac. The yield increases associated with installation of tile drain systems are expected to offset the cost of installation (Cooke, 2005). It is assumed that outlet control structures have a system life of 30 years. Cost assumptions for retrofitting and installation of new tile drain systems with outlet control devices are summarized in Table 5-19.

Table 5-19. Costs Calculations for Outlet Control Devices on Tile Drain Systems.

Item	Costs to Retrofit Existing Systems	Costs to Install a New System
Mapping Costs per Acre	$2.25	$0
Construction Costs	$20 to $40/ac	$75/ac
System Life (years)	30	30
Average Annual Costs	**$0.75 to $1.50/ac treated**	**$2.50/ac treated**

5.12 Proper Manure Handling, Collection, and Disposal

Animal operations are typically either pasture-based or confined, or sometimes a combination of the two. The operation type dictates the practices needed to manage manure from the facility. A pasture or open lot system with a relatively low density of animals (1 to 2 head of cattle per acre (USEPA, 2002a)) may not produce manure in quantities that require management for the protection of water quality. If excess manure is produced, then the manure will typically be scraped with a tractor to a storage bin constructed on a concrete surface. Stored manure can then be land applied when the ground is not frozen and precipitation forecasts are low. Rainfall runoff should be diverted around the storage facility with berms or grassed waterways. Runoff from the feedlot area is considered contaminated and is typically treated in a lagoon.

Confined facilities (typically dairy cattle, swine, and poultry operations) often collect manure in storage pits located under slatted floors. Wash water used to clean the floors and remove manure buildup combines with the solid manure to form a liquid or slurry in the pit. The mixture is usually land applied or transported offsite.

Final disposal of waste usually involves land application on the farm or transportation to another site. Manure is typically applied to the land once or twice per year. To maximize the amount of nutrients and organic material retained in the soil, application should not occur on frozen ground or when precipitation is forecast during the next several days.

An example of a waste storage lagoon is shown in Figure 5-12.

(Photo courtesy of USDA NRCS.)

Figure 5-12. Waste Storage Lagoon.

The NRCS provides additional information on waste storage facilities and cover at
http://efotg.nrcs.usda.gov/treemenuFS.aspx
in Section IV B. Conservation Practices Number 313 and 367

and on anaerobic lagoons at
http://efotg.nrcs.usda.gov/references/public/IL/IL-365_2004_09.pdf
http://efotg.nrcs.usda.gov/references/public/IL/IL-366_2004_09.pdf

5.12.1 Effectiveness

Though little change in total phosphorus or organic content has been reported, reductions in fecal coliform as a result of manure storage have been documented in two studies:

- 97 percent reduction in fecal coliform concentrations in runoff when manure is stored for at least 30 days prior to land application (Meals and Braun, 2006).
- 90 percent reduction in fecal coliform loading with the use of waste storage structures, ponds, and lagoons (USEPA, 2003).

5.12.2 Costs

Depending on whether or not the production facility is pasture-based or confined, manure is typically deposited in feedlots, around watering facilities, and within confined spaces such as housing units and milking parlors. Except for feedlots serving a low density of animals, each location will require the collection and transport of manure to a storage structure, holding pond, storage pit, or lagoon prior to final disposal.

Manure collected from open lots and watering areas is typically collected by a tractor equipped with a scraper. This manure is in solid form and is typically stored on a concrete pad surrounded by three walls that allow for stacking of contents. Depending on the climate, a roof may be required to protect the manure from frequent rainfall. Clean water from rooftops or up-grade areas should be diverted around waste stockpiles and heavy use areas with berms, grassed channels, or other means of conveyance (USEPA, 2003). Waste storage lagoons, pits, and above ground tanks are good options for large facilities. Methane gas recovered from anaerobic treatment processes can be used to generate electricity.

The NRCS (2003) has developed cost estimates for the various tasks and facilities typically used to transport, store, and dispose of manure. Table 5-20 summarizes the information contained in the NRCS report and lists the capital and operating/maintenance costs reported per head of animal. Annual maintenance costs were assumed 3 percent of capital costs except for gutter downspouts (assumed 10 percent to account for animals trampling the downspouts) and collection and transfer (assumed 15 percent to account for costs associated with additional fuel and labor). The costs presented as a range were given for various sizes of operations. The lower values reflect the costs per head for the larger operations which are able to spread out costs over more animals.

The full NRCS document can be viewed at
http://www.nrcs.usda.gov/Technical/land/pubs/cnmp1.html

The useful life for practices requiring construction is assumed to be 20 years. The total annualized costs were calculated by dividing the capital costs by 20 and adding the annual operation and maintenance costs. Prices are converted to year 2004 dollars.

Table 5-20. Costs Calculations for Manure Handling, Storage, and Treatment Per Head.

Item	Application	Capital Costs per Head	Annual Operation and Maintenance Costs per Head	Total Annualized Costs per Head
Collection and Transfer of Solid Manure, Liquid/Slurry Manure, and Contaminated Runoff				
Collection and transfer of manure solids (assuming a tractor must be purchased)	All operations with outside access and solid collection systems for layer houses	\$130.50 - dairy cattle \$92.50 - beef cattle \$0 - layer[1] \$37.00 - swine	\$19.50 - dairy cattle \$13.75 - beef cattle \$0.04 - layer \$5.50 - swine	\$26.00 - dairy cattle \$18.25 - beef cattle \$0.04 - layer \$7.25 - swine
Collection and transfer of liquid/slurry manure	Dairy, swine, and layer operations using a flush system	\$160 to \$200 - dairy cattle \$.50 - layer \$5.75 to \$4.50 - swine	\$12.25 - dairy cattle \$0.03 - layer \$0.25 - swine	\$20.25 to 22.25 - dairy cattle \$0.05 - layer \$0.50 - swine
Collection and transfer of contaminated runoff using a berm with pipe outlet	Fattened cattle and confined heifers	\$4 to \$9 - cattle	\$0.12 to 0.25 - cattle	\$0.25 to \$0.75 - cattle
Feedlot Upgrades for Cattle Operations Using Concentrated Feeding Areas				
Grading and installation of a concrete pad	Cattle on feed (fattened cattle and confined heifers)	\$35 - cattle	\$1 - cattle	\$2.75 - cattle
Clean Water Diversions				
Roof runoff management: gutters and downspouts	Dairy and swine operations that allow outside access	\$16 - dairy cattle \$2.25 - swine	\$1.60 - dairy cattle \$0.25 - swine	\$2.50 - dairy cattle \$0.50 - swine
Earthen berm with underground pipe outlet	Fattened cattle and dairy operations	\$25.25 to \$34.50 - cattle	\$0.75 to \$1.00 - cattle	\$2 to \$2.75 - cattle
Earthen berm with surface outlet	Swine operations that allow outside access	\$1 - swine	\$0.03 - swine	\$0.08 - swine
Grassed waterway	Fattened cattle and confined heifer operations: scrape and stack system	\$0.50 to \$1.50 - cattle	\$0.02 to \$0.04 - cattle	\$0.05 to \$0.12 - cattle
Storage				
Liquid storage (contaminated runoff and wastewater)	Swine, dairy, and layer operations using flush systems (costs assume manure primarily managed as liquid)	\$245 to \$267 - dairy cattle \$2 - layer \$78.50 to \$80 - swine	\$7.25 - dairy cattle \$0.06 - layer \$2.50 - swine	\$19.50 to \$20.50 - dairy cattle \$0.16 - layer \$6.50 - swine

Item	Application	Capital Costs per Head	Annual Operation and Maintenance Costs per Head	Total Annualized Costs per Head
Slurry storage	Swine and dairy operations storing manure in pits beneath slatted floors (costs assume manure primarily managed as slurry)	$104 to $127 - dairy cattle $15.50 to $19.50 - swine	$3.25 to $3.75 - dairy cattle $0.50 - swine	$8.25 to $10.25 - dairy cattle $1.25 to $1.50 - swine
Runoff storage ponds (contaminated runoff)	All operations with outside access	$125.50 - dairy cattle $140 - beef cattle $23 - swine	$3.75 - dairy cattle $4.25 - beef cattle $0.75 - swine	$10 - dairy cattle $11.25 - beef cattle $2 - swine
Solid storage	All animal operations managing solid wastes (costs assume 100% of manure handled as solid)	$196 - dairy cattle $129 - beef cattle $1 - layer $14.25 - swine	$5.75 - dairy cattle $3.75 - beef cattle $0.03 - layer $0.50 - swine	$15.50 - dairy cattle $10.25 - beef cattle $0.25 - layer $1.25 - swine
Final Disposal				
Pumping and land application of liquid/slurry	Operations handling manure primarily as liquid or slurry.	Land application costs are listed as capital plus operating for final disposal and are listed as dollars per acre for the application system. The required number of acres per head was calculated for each animal type based on the phosphorus content of manure at the time of application. Pumping costs were added to the land application costs as described in the document.		$19.50 - dairy cattle $0.25 - layer $2.75 - swine
Pumping and land application of contaminated runoff	Operations with outside feedlots and manure handled primarily as solid	Pumping costs and land application costs based on information in NRCS, 2003. Assuming a typical phosphorus concentration in contaminated runoff of 80 mg/L to determine acres of land required for agronomic application (Kizil and Lindley, 2000). Costs for beef cattle listed as range representing variations in number of animals and manure handling systems (NRCS, 2003). Only one type and size of dairy and swine operation were included in the NRCS document.		$4 - dairy cattle $3.75 - beef cattle $4.50 - swine
Land application of solid manure	Operations handling manure primarily as solid	Land application costs are listed as capital plus operating for final disposal and are given as dollars per acre for the application system. The required number of acres per head was calculated for each animal type based on the phosphorus content of manure at the time of application. No pumping costs are required for solid manure.		$11 - dairy cattle $0.25 - layer $1.50 - swine $10.25 - fattened cattle

[1] Costs presented by NRCS (2003) as operating and maintenance only.

5.13 Composting

Composting is the biological decomposition and stabilization of organic material. The process produces heat that, in turn, produces a final product that is stable, free of pathogens and viable plant seeds, and can be beneficially applied to the land. Like manure storage areas, composting facilities should be located on dry, flat, elevated land at least 100 feet from streams. The landowner should coordinate with local NRCS staff to determine the appropriate design for a composting facility based on the amount of manure generated. Extension agents can also help landowners achieve the ideal nutrient ratios, oxygen levels, and moisture conditions for composting on their site.

Composting can be accomplished by simply constructing a heap of the material, forming composting windrows, or by constructing one or more bins to hold the material. Heaps should be 3 feet wide and 5 feet high with the length depending on the amount of manure being composted. Compost does not have to be turned, but turning will facilitate the composting process (University of Missouri, 1993; PSU, 2005). Machinery required for composting includes a tractor, manure spreader, and front-end loader (Davis and Swinker, 2004). Figure 5-13 shows a poultry litter composting facility.

(Photo courtesy of USDA NRCS.)

Figure 5-13. Poultry Litter Composting Facility.

The NRCS provides additional information on composting facilities at
http://efotg.nrcs.usda.gov/references/public/IL/IL-317rev9-04.pdf
and
ftp://ftp.wcc.nrcs.usda.gov/downloads/wastemgmt/neh637c2.pdf

5.13.1 Effectiveness

Composting stabilizes the organic content of manure and reduces the volume that needs to be disposed of. In addition, the following reductions in loading are reported:

- 56 percent reduction in runoff volumes and 68 percent reduction in sediment (and likely manganese) as a result of improved soil infiltration following application of composted manure (HRWCI, 2005).

5.13.2 Costs

The costs for developing a composting system include site development costs (storage sheds, concrete pads, runoff diversions, etc.), purchasing windrow turners if that system is chosen, and labor and fuel required to form and turn the piles. Cost estimates for composting systems have not been well documented and show a wide variation even for the same type of system. The NRCS is in the process of developing cost estimates for composting and other alternative manure applications in Part II of the document discussed in Section 5.12.2. Once published, these estimates should provide a good comparison with the costs summarized for the Midwest region in Table 5-20. For now, costs are presented in Table 5-21 based on studies conducted in Wisconsin, Canada, and Indiana.

Researchers in Wisconsin estimated the costs of a windrow composting system using four combinations of machinery and labor (CIAS, 1996). These costs included collection and transfer of excreted material, formation of the windrow pile, turning the pile, and reloading the compost for final disposal. The Wisconsin study was based on a small dairy operation (60 head). Costs for beef cattle, swine, and layer hens were calculated based on animal units and handling weights of solid manure (NRCS, 2003). Equipment life is assumed 20 years. The costs presented in the Wisconsin study are much higher than those presented in Table 5-21 for collection, transfer, and storage of solid manure. However, the Wisconsin study presented a cost comparison of the windrow system to stacking on a remote concrete slab, and these estimates were approximately four and half times higher than the values summarized by NRCS. It is likely that the single data set used for the Wisconsin study is not representative of typical costs.

Two studies have been conducted in Canada regarding the costs of composting. The University of Alberta summarized the per ton costs of windrow composting with a front end load compared to a windrow turner (University of Alberta, 2000). The Alberta Government presented a per ton estimate for a windrow system with turner: this estimate is quite different than the University of Alberta study. These per ton costs were converted to costs per head of dairy cattle, beef cattle, swine, and layer hens based on the manure generation and handling weights presented by NRCS (2003).

In 2001, the USEPA released a draft report titled “Alternative Technologies/Uses for Manure.” This report summarizes results from a Purdue University research farm operating a 400-cow dairy operation. This farm also utilizes a windrow system with turner.

Table 5-21 summarizes the cost estimates presented in each of the studies for the various composting systems. None of these estimates include the final costs of land application, which should be similar to those listed for disposal of solid manure in Table 5-20, as no phosphorus losses occur during the composting process.

Table 5-21. Costs Calculations for Manure Composting.

Equipment Used	Capital Costs per Head	Annual Operation and Maintenance Costs per Head	Total Annualized Costs per Head
2004 Costs Estimated from CIAS, 1996 – Wisconsin Study			
Windrow composting with front-end loader	$324.25 - dairy cattle $213.50 - beef cattle $1.75 - layer $23.75 - swine	$179.75 - dairy cattle $118.50 - beef cattle $1 - layer $13.25 - swine	$196 - dairy cattle $129.25 - beef cattle $1 - layer $14.25 - swine
Windrow composting with bulldozer	$266 - dairy cattle $175.25 - beef cattle $1.50 - layer $19.50 - swine	$179.75 - dairy cattle $118.50 - beef cattle $1 - layer $13.25 - swine	$193.25 - dairy cattle $127.25 - beef cattle $1 - layer $14.25 - swine
Windrow composting with custom-hire compost turner	$266 - dairy cattle $175.25 - beef cattle $1.50 - layer $19.50 - swine	$215.25 - dairy cattle $141.75 - beef cattle $1.25 - layer $15.75 - swine	$228.75 - dairy cattle $150.50 - beef cattle $1.25 - layer $16.75 - swine
Windrow composting with purchased compost turner	$617 - dairy cattle $406.25 - beef cattle $3.50 - layer $45.25 - swine	$234.25 - dairy cattle $154.25 - beef cattle $1.25 - layer $17.25 - swine	$265.25 - dairy cattle $174.75 - beef cattle $1.50 - layer $19.50 - swine
2004 Costs Estimated from University of Alberta, 2000			
Windrow composting with front-end loader	Study presented annualized costs per ton of manure composted.		$23.75 to $47.50 - dairy cattle $15.75 to $31.25 - beef cattle $0.13 to $0.25 - layer $1.75 to $3.50 - swine
Windrow composting with compost turner	Study presented annualized costs per ton of manure composted.		$71.25 to $142.50 - dairy cattle $47.00 to $94.00 - beef cattle $0.50 to $0.75 - layer $5.25 to $10.50 - swine
2004 Costs Estimated from Alberta Government, 2004			
Windrow composting with compost turner	Study presented annualized costs per ton of manure composted.		$31.50 - dairy cattle $20.75 - beef cattle $0.25 - layer $2.25 - swine
2004 Costs Estimated from USEPA, 2001 Draft			
Windrow composting with compost turner	Study presented annualized costs per dairy cow.		$15.50 - dairy cattle $10.25 - beef cattle $0.09 - layer $1.25 - swine

5.14 Alternative Watering Systems

A primary management tool for pasture-based systems is supplying cattle with watering systems away from streams and riparian areas. Livestock producers who currently rely on streams to provide water for their animals must develop alternative watering systems, or controlled access systems, before they can exclude cattle from streams and riparian areas. One method of providing an alternative water source is the development of off-stream watering using wells with tank or trough systems. These systems are often highly successful, as cattle often prefer spring or well water to surface water sources.

Landowners should work with an agricultural extension agent to properly design and locate watering facilities. One option is to collect rainwater from building roofs (with gutters feeding into cisterns) and use this water for the animal watering system to reduce runoff and conserve water use (Tetra Tech, 2006). Whether or not animals are allowed access to streams, the landowner should provide an alternative shady location and water source so that animals are encouraged to stay away from riparian areas.

Figure 5-14 shows a centralized watering tank allowing access from rotated grazing plots and a barn area.

(Photo courtesy of USDA NRCS.)

Figure 5-14. Centralized Watering Tank.

The NRCS provides additional information on these alternative watering components:

Spring development:
http://efotg.nrcs.usda.gov/references/public/IL/IL-574.pdf,

Well development:
http://efotg.nrcs.usda.gov/references/public/IL/IL-642.pdf,

Pipeline:
http://efotg.nrcs.usda.gov/references/public/IL/516.pdf,

Watering facilities (trough, barrel, etc.):
http://efotg.nrcs.usda.gov/treemenuFS.aspx
in Section IV B. Conservation Practices Number 614

5.14.1 Effectiveness

Some researchers have studied the impacts of providing alternative watering sites without structural exclusions and found that cattle spend 90 percent less time in the stream when alternative drinking water is furnished (USEPA, 2003). Prohibiting access to the stream channels will also prevent streambank trampling, decrease bank erosion, protect bank vegetation, and reduce the loading of organic material to the streams. As a result, dissolved oxygen concentrations will likely increase and manganese loads associated with bank erosion will decrease.

5.14.2 Costs

Alternative drinking water can be supplied by installing a well in the pasture area, pumping water from a nearby stream to a storage tank, developing springs away from the stream corridor, or piping water from an existing water supply. For pasture areas without access to an existing water supply, the most reliable alternative is installation of a well, which ensures continuous flow and water quality for the cattle (NRCS, 2003). Assuming a well depth of 250 ft and a cost of installation of $22.50 per ft, the cost to install a well is approximately, $5,625 per well. The well pump would be sized to deliver adequate water supply for the existing herd size. For a herd of 150 cattle, the price per head for installation was estimated at $37.50.

After installation of the well or extension of the existing water supply, a water storage device is required to provide the cattle access to the water. Storage devices include troughs or tanks. NRCS (2003) lists the costs of storage devices at $23 per head.

Annual operating costs to run the well pump range from $9 to $22 per year for electricity (USEPA, 2003; Marsh, 2001), or up to $0.15 per head. Table 5-22 lists the capital, maintenance, and annualized costs for a well, pump, and storage system assuming a system life of 20 years.

Table 5-22. Costs Calculations for Alternative Watering Facilities.

Item	Capital Costs per Head	Annual Operation and Maintenance Costs per Head	Total Annualized Costs per Head
Installation of well	$37.50	$0	$2
Storage container	$23	$0	$1
Electricity for well pump	$0	$0.15	$0.15
Total system costs	**$60.50**	**$0.15**	**$3.15**

5.15 Cattle Exclusion from Streams

Cattle manure is a source of bacteria loading to streams, particularly where direct access is not restricted and/or where cattle feeding structures are located adjacent to riparian areas. Direct deposition of feces into streams may be a primary mechanism of pollutant loading during baseflow periods. During storm events, overbank and overland flow may entrain manure accumulated in riparian areas resulting in pulsed loads of nutrients, total organic carbon (TOC), and biological oxygen demand (BOD) into streams. In addition, cattle with unrestrained stream access typically cause severe streambank erosion. The impacts of cattle on stream ecosystems are shown in Figure 5-15 and Figure 5-16.

Figure 5-15. Typical Stream Bank Erosion in Pastures with Cattle Access to Stream.

Figure 5-16. Cattle-Induced Streambank Mass Wasting and Deposition of Manure into Stream.

An example of proper exclusion and the positive impacts it has on the stream channel are shown in Figure 5-17.

(Photo courtesy of USDA NRCS.)

Figure 5-17. Stream Protected from Sheep by Fencing.

The NRCS provides additional information on fencing at:
http://efotg.nrcs.usda.gov/treemenuFS.aspx
in Section IV B. Conservation Practices Number 382

Allowing limited or no animal access to streams will provide the greatest water quality protection. On properties where cattle need to cross streams to have access to pasture, stream crossings should be built so that cattle can travel across streams without degrading streambanks and contaminating streams with manure. Figure 5-18 shows an example of a reinforced cattle access point to minimize time spent in the stream and mass wasting of streambanks.

(Photo courtesy of USDA NRCS.)

Figure 5-18. Restricted Cattle Access Point with Reinforced Banks.

The NRCS provides additional information on use exclusion and controlled access at:
http://efotg.nrcs.usda.gov/treemenuFS.aspx
in Section IV B. Conservation Practices Number 472

5.15.1 Effectiveness

Fencing cattle from streams and riparian areas using vegetative or fencing materials will reduce streambank trampling and direct deposition of fecal material in the streams. As a result, manganese (associated with eroded sediment) and BOD_5 loads will decrease.

5.15.2 Costs

The costs of excluding cattle from streams depends more on the length of channel that needs to be protected than the number of animals on site. Fencing may also be used in a grazing land protection operation to control cattle access to individual plots. The system life of wire fences is reported as 20 years; the high tensile fence materials have a reported system life of 25 years (Iowa State University, 2005). NRCS reports that the average operation needs approximately 35 ft of additional fencing per head to protect grazing lands and streams. Table 5-23 presents the capital, maintenance, and annualized costs for four fencing materials based on the NRCS assumptions.

Table 5-23. Installation and Maintenance Costs of Fencing Material.

Material	Capital Costs per Head	Annual Operation and Maintenance Costs per Head	Total Annualized Costs per Head
Woven Wire	$43.50	$3.50	$5.75
Barbed Wire	$33.50	$2.75	$4.50
High Tensile (non-electric) 8-strand	$30.75	$1.75	$3.00
High Tensile (electric) 5-strand	$23.00	$1.50	$2.50

5.16 Grazing Land Management

While erosion rates from pasture areas are generally lower than those from row-crop areas, a poorly managed pasture can approach or exceed a well-managed row-crop area in terms of erosion rates. Grazing land protection is intended to maximize ground cover on pasture, reduce soil compaction resulting from overuse, reduce runoff concentrations of nutrients, and protect streambanks and riparian areas from erosion and fecal deposition. Figure 5-19 shows an example of a pasture managed for land protection. Cows graze the left lot while the right lot is allowed a resting period to revegetate.

(Photo courtesy of USDA NRCS.)

Figure 5-19. Example of a Well Managed Grazing System.

The NRCS provides additional information on prescribed grazing at:
http://efotg.nrcs.usda.gov/treemenuFS.aspx
in Section IV B. Conservation Practices Number 528A

And on grazing practices in general at:
http://www.glti.nrcs.usda.gov/technical/publications/nrph.html

5.16.1 Effectiveness

Maintaining sufficient ground cover on pasture lands requires a proper density of grazing animals and/or a rotational feeding pattern among grazing plots. Increased ground cover will also reduce transport of sediment-bound manganese. Dissolved oxygen concentrations in streams will likely improve as the concentrations of BOD_5 in runoff are reduced proportionally with the change in number of cattle per acre.

5.16.2 Costs

The costs associated with grazing land protection include acquiring additional land if current animal densities are too high (or reducing the number of animals maintained), fencing and seeding costs, and developing alternative water sources. Establishment of vegetation for pasture areas costs from $39/ac to $69/ac based on data presented in the EPA nonpoint source guidance for agriculture (USEPA, 2003). Annual costs for maintaining vegetative cover will likely range from $6/ac to $11/ac (USEPA, 2003). If cattle are not allowed to graze plots to the point of requiring revegetation, the cost of grazing land protection may be covered by the fencing and alternative watering strategies discussed above.

5.17 Inlake Controls

For lakes experiencing high rates of manganese inputs from bottom sediments, several management measures are available to control internal loading. Hypolimnetic (bottom water) aeration involves an aerator air-release that can be positioned at a selected depth or at multiple depths to increase oxygen transfer efficiencies in the water column and reduce internal loading by establishing aerobic conditions at the sediment-water interface.

Hypolimnetic aeration will likely inhibit the release of manganese from bottom sediments in lakes. Artificial circulation is the induced mixing of the lake, usually through the input of compressed air, which forms bubbles that act as airlift pumps. The increased circulation raises the temperature of the whole lake (Cooke et al., 1993) and chemically oxidizes substances throughout the water column (Pastorak et al., 1981 and 1982), reducing the release of manganese from the sediments to the overlying water, and enlarging the suitable habitat for aerobic animals.

5.17.1 Effectiveness

If lake sediments are a significant source of manganese in the Lake of Egypt Watershed, then these inlake controls should reduce the internal loading significantly. Without data to quantify the internal load for, it is difficult to estimate the reduction in loading that may be seen with these controls.

5.17.2 Costs

In general, inlake controls are expensive. For comparison with the agricultural cost estimates, the inlake controls have been converted to year 2004 dollars assuming an average annual inflation rate of 3 percent.

Hypolimnetic aerators may decrease internal loading of both phosphorus and manganese. The number and size of hypolimnetic aerators used in a waterbody depend on lake morphology, bathymetry, and hypolimnetic oxygen demand. Total cost for successful systems has ranged from $170,000 to $1.7

million (Tetra Tech, 2002). USEPA (1993) reports initial costs ranging from $340,000 to $830,000 plus annual operating costs of $60,000. System life is assumed to be 20 years.

Alum treatments are effective on average for approximately 8 years per application and can reduce internal phosphorus loading by 80 percent. Treatment cost ranges from $290/ac to $720/ac (WIDNR, 2003).

Dierberg and Williams (1989) cite mean initial and annual costs for 13 artificial circulation projects in Florida of $440/ac and $190/ac/yr, respectively. The system life is assumed to be 20 years.

Table 5-24 summarizes the cost analyses for the three inlake management measures. The final column lists the annualized cost per lake surface area treated.

Table 5-24. Cost Comparison of Inlake Controls.

Control	Construction or Application Cost	Annual Maintenance Cost	Annualized Costs $/ac/yr
Centralia Lake (254 acres)			
Hypolimnetic Aeration	$340,000 to $830,000	$60,000	$300 to $400
Alum Treatment	$74,000 to $183,000	$0	$36 to $90
Artificial Circulation	$112,000	$48,000	$212
Raccoon Lake (925 acres)			
Hypolimnetic Aeration	$340,000 to $830,000	$60,000	$83 to $110
Alum Treatment	$270,000 to $670,000	$0	$36 to $90
Artificial Circulation	$407,000	$176,000	$212
Salem Lake (74.2 acres)			
Hypolimnetic Aeration	$340,000 to $830,000	$60,000	$1040 to $1400
Alum Treatment	$22,000 to $53,000	$0	$36 to $90
Artificial Circulation	$33,000	$14,000	$212
Nashville City Lake (42 acres)			
Hypolimnetic Aeration	$340,000 to $830,000	$60,000	$1,800 to $2,400
Alum Treatment	$12,000 to $30,000	$0	$36 to $90
Artificial Circulation	$18,000	$8,000	$212

5.18 Streambank and Shoreline Erosion BMPs

Reducing erosion of streambanks and lake shore areas will reduce sediment and manganese loading and improve temperature and dissolved oxygen conditions by allowing vegetation to establish. The filter strips and riparian area BMPs discussed in Sections 5.7 and 5.9 and the agricultural BMPs that reduce the quantity and volume of runoff (Sections 5.5, 5.6, 5.8 5.10, and 5.11) or prevent cattle access (Section 5.15) will all provide some level of streambank and lake shore erosion protection.

In addition, the streambanks and lake shores in the watershed should be inspected for signs of erosion. Banks showing moderate to high erosion rates (indicated by poorly vegetated reaches, exposed tree roots, steep banks, etc.) can be stabilized by engineering controls, vegetative stabilization, and restoration of riparian areas. Peak flows and velocities from runoff areas can be mitigated by infiltration in grassed waterways and passage of runoff through filter strips.

5.18.1 Effectiveness

Because the extent of streambank and lake shore erosion has not yet been quantified, the effectiveness of erosion control BMPs is difficult to estimate. The benefits of BMPs that offer stream bank protection and runoff control are therefore underestimated in this report.

5.18.2 Costs

Costs associated with the BMPs that offer secondary benefits to streambank and lake erosion are discussed separately for each BMP in Sections 5.5, 5.6, 5.7, 5.8, 5.9,5.10, 5.11, and 5.15.

5.19 Stream Restoration

Stream restoration activities usually focus on improving aquatic habitat, but can also be used to increase the amount of reaeration from the atmosphere to the water. A proper restoration effort will involve an upfront design specific to the conditions of the reach being restored. Stagnant, slow moving, and deep waters typically have relatively low rates of reaeration. Restorations aimed at increasing reaeration must balance habitat needs (which include pools of deeper water) with sections of more shallow, faster flowing water. Adding structures to increase turbulence and removing excessive tree fall may be incorporated in the restoration plan.

Stream restoration differs from riparian buffer restoration in that the shape or features within the stream channel are altered, not the land adjacent to the stream channel. Of course, a stream restoration may also include restoration of the riparian corridor as well.

The effectiveness and costs of stream restorations are site specific and highly variable. Watershed planners and water resource engineers should be utilized to determine the reaches where restoration will result in the most benefit for the watershed as a whole.

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6.0 PRIORITIZATION OF IMPLEMENTATION

This section of the plan summarizes the effectiveness of the BMPs discussed in Section 5.0 to help with their prioritization for implementation.

6.1 Summary of BMPs for Abandoned Mine Discharges

Based on the available data, abandoned mine discharges contribute the majority of loading for cadmium, copper, nickel, silver, zinc, iron, sulfates, and TDS in this watershed. The BMPs that are applicable to AMDs are discussed in section 5.1. Passive treatment systems are the recommended BMP for abandoned mine discharges in this watershed. Passive treatment provides low cost treatment methods to treat AMD for acidity and metals. Combining multiple passive treatment technologies can be used to treat a wide range of water quality. The type of systems used should be tailored specifically to specific AMD water quality.

6.2 Summary of BMPs for Agricultural Operations

Based on the available data, crop production and animal operations contribute loading for dissolved oxygen, pH, manganese, and fecal coliform impairments in this watershed. The BMPs that are applicable to agricultural operations are summarized in Table 6-1 and include the percent reductions for each of the five parameters as well as additional information concerning streambank protection and additional impacts on dissolved oxygen. If a BMP is not expected to significantly reduce loading of a specific parameter, then the reduction is labeled not applicable (“na”). If a BMP is expected to reduce pollutant loading, but no studies were found to quantify the reduction, then the reduction is labeled “unknown.”

Table 6-1. Summary of BMPs Reducing Impairments Due to Agricultural Operations.

BMP	BOD_5 Reduction (percent)	Manganese Reduction (percent)	Fecal Coliform Reduction (percent)	Additional Benefits for Stream Health and Dissolved Oxygen Impairments
Nutrient Management Plans	na	na	na	Reducing nutrient loads to streams may reduce algal growth and related dissolved oxygen problems.
Conservation Tillage	na	50 to 90	na	Reduces runoff losses by 69 percent, which may reduce rates of streambank erosion.
Cover Crops	na	90	na	Reduces runoff losses by 50 percent, which may reduce rates of streambank erosion.
Filter Strips	unknown	65	55 to 87	Slows rates of runoff and may reduce volume via infiltration. May reduce rates of streambank erosion.
Grassed Waterways	unknown	68	5	Slows rates of runoff and may reduce volume via infiltration. May reduce rates of streambank erosion.
Riparian Buffers (30 ft wide)	unknown	70 to 90	34 to 74	Slows runoff and may reduce quantity via infiltration. Protects stream channel from erosion and canopy disturbance.
Riparian Buffers (60 to 90 ft wide)	unknown	unknown	unknown	Slows runoff and may reduce quantity via infiltration. Protects stream channel from erosion and canopy disturbance.
Riparian Buffers (200 ft wide)	62	unknown	87	Slows runoff and may reduce quantity via infiltration. Protects stream channel from erosion and canopy disturbance.
Constructed Wetlands	59 to 80	53 to 81	92	Slows runoff and may reduce quantity via infiltration, evaporation, and transpiration.
Controlled Drainage (new tile system)	na	na	na	Reduces peak flow volumes and velocities by storing water; may allow for volume reduction via transpiration.
Controlled Drainage (retrofit tile system)	na	na	na	Reduces peak flow volumes and velocities by storing water; may allow for volume reduction via transpiration.
Proper Manure Handling, Collection, and Disposal	unknown	na	90 to 97	Reduces loads of nutrients and biodegradable organic material entering waterways which may improve dissolved oxygen concentrations.

BMP	BOD_5 Reduction (percent)	Manganese Reduction (percent)	Fecal Coliform Reduction (percent)	Additional Benefits for Stream Health and Dissolved Oxygen Impairments
Manure Composting	unknown	na	99	Stabilized manure that reaches waterbodies will degrade more slowly and not consume oxygen as quickly as conventional manure.
Application of Composted Manure	na	68	na	Application of composted manure improves soil infiltration and may reduce runoff volumes by 56 percent, potentially reducing rates of streambank erosion.
Feeding Strategies	na	na	na	Feeding strategies that reduce the phosphorus content of manure may improve dissolved oxygen conditions by reducing eutrophication in streams and lakes.
Alternative Watering Systems with Cattle Exclusion from Streams	unknown	unknown	29 to 46	Prevents streambank trampling and therefore decreases loads of manganese to the stream. Reduces direct deposition of manure into stream channel, which reduces loads of BOD_5 and nutrients.
Grazing Land Management	unknown	unknown	40 to 90	Increased vegetative ground cover will reduce soil erosion and associated manganese and improve infiltration which should reduce runoff volumes. Improvements in dissolved oxygen concentrations should occur as a result of lower concentrations of BOD_5 in the runoff (reduced proportionally by the change in number of cattle per acre.)
Inlake Controls	unknown	variable	na	May have impacts on dissolved oxygen balances downstream of water release structures.

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7.0 MEASURING AND DOCUMENTING PROGRESS

Managing impairments in the South Fork Saline River/Lake of Egypt Watershed will likely involve multiple passive treatment BMPs for AMDs and multiple agricultural BMPs to be used for crop production and animal operations. Continuing to monitor water quality in the waterbodies will determine whether or not managing the other sources of impairments, which may include failing onsite wastewater systems, point source discharges, and inlake re-suspension, is necessary to bring the watershed into compliance.

Tracking the implementation of BMPs while continuing to monitor water quality parameters will assist stakeholders and public agencies in determining the effectiveness of implementation efforts. If concentrations remain above the water quality standards, further encouragement of the use of BMPs across the watershed through education and incentives will be a priority. It may also be necessary to begin funding efforts for localized BMPs such as riparian buffer restoration.

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8.0 REASONABLE ASSURANCE

USEPA requires that a TMDL provide reasonable assurance that the required load reductions will be achieved and water quality will be restored. For this watershed, use of passive treatment for AMDs and agricultural BMPs for crop production and animal operations are the primary management strategies to reach these goals. Participation of farmers and landowners is essential to improving water quality, but resistance to change and upfront cost may deter participation. Educational efforts and cost share programs will likely increase participation to levels needed to protect water quality.

Two of the incentive programs discussed below were administered under the 2002 Farm Bill, which expired September 30, 2007. The Conservation Reserve Program will continue to pay out existing contracts, but new enrollments will not be allowed until the bill is reinstated; no official date of reinstatement has been announced. Though the Environmental Quality Incentives Program was also part of the 2002 Farm Bill, it was extended beyond fiscal year 2007 by the Deficit Reduction Act of 2005 (Congressional Research Reports for the People, 2007).

8.1 Abandoned Mined Lands Reclamation Division

IDNR, Office of Mines and Minerals, Abandoned Mined Lands Reclamation Division (AMLRD) is the state agency that is primarily responsible for reclamation of pre-law coal mine areas. The AMLRD uses funds from a “reclamation fee” (tax) on every ton of coal mined in Illinois since the implementation of the Surface Mining Control and Reclamation Act of 1977 to contract and oversee the reclamation of pre-law mine sites. Almost all of Illinois pre-law mine site reclamation is funded by this reclamation fee (Muir et al. 1997).

As monies become available abandoned mine sites can be reclaimed through the ALMRD according to a priority list. Safety, and not environmental concerns, was designated first priority for ALMRD projects. No cost estimates were developed for mitigation of AMDs in the South Fork Saline River/Lake of Egypt watershed. If AMDs are shown to contribute to impairments in the watershed, funds from the ALMRD focused on environmental projects should be directed towards water bodies with TMDLs.

8.2 Environmental Quality Incentives Program (EQIP)

Several cost share programs are available to farmers and landowners who voluntarily implement resource conservation practices in the South Fork Saline River/Lake of Egypt Watershed. The most comprehensive is the NRCS Environmental Quality Incentives Program (EQIP) which offers cost sharing and incentives to farmers statewide who utilize approved conservation practices to reduce pollutant loading from agricultural lands.

- The program will pay $10 for one year for each acre of farmland that is managed under a nutrient management plan (up to 400 acres per farmer).
- Use of vegetated filter strips will earn the farmer $100/ac/yr for three years (up to 50 acres per farmer).
- The program will also pay 60 percent of the cost to construct grassed waterways, riparian buffers, and windbreaks.
- Use of residue management will earn the farmer $15/ac for three years (up to 400 acres per farmer).
- Installation of drainage control structures on tile outlets will earn the farmer $5/ac/yr for three years for the effected drainage area as well as 60 percent of the cost of each structure.
- The program will pay 75 percent of the construction cost for a composting facility.

- Sixty percent of the fencing, controlled access points, spring and well development, pipeline, and watering facility costs are covered by the program.
- Waste storage facilities and covers for those facilities have a 50 percent cost share for construction.
- Prescribed grazing practices will earn the farmer $10/ac/yr for three years (up to 200 acres per farmer).

In order to participate in the EQIP cost share program, all BMPs must be constructed according to the specifications listed for each conservation practice.

The specifications and program information can be found online at:
http://www.il.nrcs.usda.gov/programs/eqip/cspractices.html.

8.3 Conservation Reserve Program (CRP)

The Farm Service Agency of the USDA supports the Conservation Reserve Program (CRP) which rents land converted from crop production to grass or forestland for the purposes of reducing erosion and protecting sensitive waters. This program is available to farmers who establish vegetated filter strips or grassed waterways. The program typically provides 50 percent of the upfront cost to establish vegetative cover and $185/ac/yr for up to 15 years.

More information about this program is available online at:
http://www.nrcs.usda.gov/programs/crp/

8.4 Conservation 2000

In 1995 the Illinois General Assembly passed the Conservation 2000 bill providing $100 million in funding over a 6-year period for the promotion of conservation efforts. In 1999, legislation was passed to extend the program through 2009. Conservation 2000 currently funds several programs applicable to the South Fork Saline River/Lake of Egypt Watershed through the Illinois Department of Agriculture.

General information concerning the Conservation 2000 Program can be found online at:
http://www.agr.state.il.us/Environment/conserv/

8.4.1 Conservation Practices Program (CPP)

The Conservation Practices Cost Share Program provides monetary incentives for conservation practices implemented on land eroding at one and one-half times or more the tolerable soil loss rate. Payments of up to 60 percent of initial costs are paid through the local SWCDs. Of the BMPs discussed in this plan, the program will cost share cover crops, filter strips, grassed waterways, no-till systems, and pasture planting. Other sediment control options such as contour farming and installation of stormwater ponds are also covered. Practices funded through this program must be maintained for at least 10 years.

More information concerning the Conservation Practices Program can be found online at:
http://www.agr.state.il.us/Environment/conserv/

8.4.2 Streambank Stabilization Restoration Program

Conservation 2000 also funds a streambank stabilization and restoration program aimed at restoring highly eroding streambanks. Research efforts are also funded to assess the effectiveness of vegetative and bioengineering techniques.

More information about this program is available online at:
http://dnr.state.il.us/orep/c2000/grants/proginfo.asp?id=20

8.4.3 Sustainable Agriculture Grant Program (SARE)

The Sustainable Agricultural Grant Program funds research, education, and outreach efforts for sustainable agricultural practices. Private landowners, organizations, educational, and governmental institutions are all eligible for participation in this program.

More information concerning the Sustainable Agricultural Grant Program can be found online at:
http://www.sare.org/grants/

8.5 Nonpoint Source Management Program (NSMP)

Illinois EPA receives federal funds through Section 319(h) of the Clean Water Act to help implement Illinois' Nonpoint Source (NPS) Pollution Management Program. The purpose of the Program is to work cooperatively with local units of government and other organizations toward the mutual goal of protecting the quality of water in Illinois by controlling NPS pollution. The program emphasizes funding for implementing cost-effective corrective and preventative best management practices (BMPs) on a watershed scale; funding is also available for BMPs on a non-watershed scale and the development of information/education NPS pollution control programs.

The maximum federal funding available is 60 percent, with the remaining 40 percent coming from local match. The program period is two years unless otherwise approved. This is a reimbursement program.

Section 319(h) funds are awarded for the purpose of implementing approved NPS management projects. The funding will be directed toward activities that result in the implementation of appropriate BMPs for the control of NPS pollution or to enhance the public's awareness of NPS pollution. Applications are accepted June 1 through August 1.

More information about this program is available online at:
http://www.epa.state.il.us/water/financial-assistance/non-point.html

8.6 Agricultural Loan Program

The Agricultural Loan Program offered through the Illinois State Treasury office provides low-interest loans to assist farmers who implement soil and water conservation practices. These loans will provide assistance for the construction, equipment, and maintenance costs that are not covered by cost share programs.

More information about this program is available online at:
http://www.state.il.us/TREAS/ProgramsServices.aspx

8.7 Illinois Conservation and Climate Initiative (ICCI)

The Illinois Conservation and Climate Initiative (ICCI) is a joint project of the State of Illinois and the Delta Pollution Prevention and Energy Efficiency (P2/E2) Center that allows farmers and landowners to earn carbon credits when they use conservation practices. These credits are then sold to companies or agencies that are committed to reducing their greenhouse gas emissions. Conservation tillage earns 0.5 metric tons (1.1 US ton) of carbon per acre per year (mt/ac/yr), grass plantings (applicable to filter strips and grassed waterways) earn 0.75 mt/ac/yr, and trees planted at a density of at least 250 stems per acre earn somewhere between 3.5 to 5.4 mt/ac/yr, depending on the species planted and age of the stand.

Carbon credits are currently selling at around $2.50 per mt. Current exchange rates are available online at http://chicagoclimatex.com. Administrative fees of $0.14/mt plus 8 percent are subtracted from the sale price.

Program enrollment occurs through the P2/E2 Center which can be found online at http://p2e2center.org/. The requirements of the program are verified by a third party before credits can be earned.

More information about carbon trading can be found online at:
http://illinoisclimate.org/

Table 8-1 and Table 8-2 summarize the cost share programs available for BMPs in the South Fork Saline River/Lake of Egypt Watershed. Table 8-3 lists the contact information for each local soil and water conservation district (SWCD).

Table 8-1. Summary of Assistance Programs Available for Farmers in the South Fork Saline River/Lake of Egypt Watershed.

Assistance Program	Program Description	Contact Information
AMLRD	Uses reclamation fees to contract and oversee reclamation of pre-law mine sites	Illinois Department of Natural Resources Office of Mines and Minerals 524 South Second Street Springfield, IL 62701-1787 Phone: (217) 782-6791 Southern Illinois Regional Office 503 E. Main Street Benton, Illinois 62812 Phone: (618) 439-9111 AMLRD Phone: (217) 782-0588
NSMP	Provides grant funding for educational programs and implementation of nonpoint source pollution controls.	Illinois Environmental Protection Agency Bureau of Water Watershed Management Section, Nonpoint Source Unit P.O. Box 19276 Springfield, IL 62794-9276 Phone: (217) 782-3362
Agricultural Loan Program	Provides low-interest loans for the construction and implementation of agricultural BMPs. Loans apply to equipment purchase as well.	Office of State Treasurer Agricultural Loan Program 300 West Jefferson Springfield, Illinois 62702 Phone: (217) 782-2072 Fax: (217) 522-1217
NRCS EQIP	Offers cost sharing and rental incentives to farmers statewide who utilize approved conservation practices to reduce pollutant loading from agricultural lands. Applies to nutrient management plans, filter strips, grassed waterways, riparian buffers, and conservation tillage.	Contact local SWCD (Table 8-3)
FSA CRP	Offsets income losses due to land conversion by rental agreements. Targets highly erodible land or land near sensitive waters. Provides up to 50 percent of the upfront cost to establish vegetative cover and $185/ac/yr for up to 15 years for converted land.	
Conservation 2000 CPP	Provides up to 60 percent cost share for several agricultural BMPs: cover crops, filter strips, grassed waterways.	
Conservation 2000 Streambank Stabilization Restoration Program	Provides 75 percent cost share for establishment of riparian corridors along severely eroding stream banks. Also provides technical assistance and educational information for interested parties.	
SARE	Funds educational programs for farmers concerning sustainable agricultural practices.	
Local SWCD	Provides incentives for individual components of nutrient management planning, use of strip tillage, and restoration of riparian buffers.	

Assistance Program	Program Description	Contact Information
ICCI	Allows farmers to earn carbon trading credits for use of conservation tillage, grass, and tree plantings.	

Table 8-2. Assistance Programs Available for Agricultural BMPs.

BMP	Cost Share Programs and Incentives
Education and Outreach	Conservation 2000 Streambank Stabilization Restoration Program SARE NSMP Local SWCD ULWREP
Nutrient Management Plan	EQIP: $10/ac for one year, 400 ac. max. Local SWCD: up to $30/ac for one year ULWREP: contact agency for individual resource allocations
Conservation Tillage	EQIP: $15/ac for three years, 400 ac. max. ICCI: earns 0.5 mt/ac/yr of carbon trading credit ULWREP: contact agency for individual resource allocations
Cover Crops	CPP: cost share of 60 percent ULWREP: contact agency for individual resource allocations
Filter Strips	EQIP: $100/ac for three years, 50 ac. max. CPP: 60 percent of construction costs CRP: 50 percent of the upfront cost to establish vegetative cover and $185/ac/yr for up to 15 years ICCI: earns 0.75 mt/ac/yr of carbon trading credit for each acre planted
Grassed Waterways	EQIP: 60 percent of construction costs CPP: 60 percent of construction costs CRP: 50 percent of the upfront cost to establish vegetative cover and $185/ac/yr for up to 15 years ICCI: earns 0.75 mt/ac/yr of carbon trading credit for each acre planted
Land Retirement of Highly Erodible Land or Land Near Sensitive Waters	CRP: 50 percent of the costs of establishing vegetative cover and cash incentive of $185/ac/yr for 15 years ICCI: earn between 0.75 and 5.4 mt/ac/yr of carbon trading credit depending on species planted ULWREP: contact agency for individual resource allocations
Restoration of Riparian Buffers	EQIP: 60 percent of construction of costs CRP: 50 percent of the costs of establishing vegetative cover and cash incentive of $185/ac/yr for 15 years ICCI: earn between 0.75 and 5.4 mt/ac/yr of carbon trading credit depending on species planted ULWREP: contact agency for individual resource allocations

Note: Cumulative cost shares from multiple programs will not exceed 100 percent of the cost of construction.

Table 8-3. Contact Information for Local Soil and Water Conservation Districts.

Organization Name	Address	Contact Numbers
Johnson County SWCD	807 North 1st Street Vienna, IL 62995	Phone: 618/658-3411 (Ext. 3) Fax: 618/658-9600
Saline County SWCD	912 South Commercial Street Harrisburg, IL 62946	Phone: 618/252-8621 (Ext. 3) Fax: 618/252-2295
Williamson County SWCD	502 Comfort Drive, Suite C Marion, IL 62959	Phone: 618/993-5396 (Ext. 3) Fax: 618/993-3014

9.0 IMPLEMENTATION TIMELINE

This implementation plan for the South Fork Saline River/Lake of Egypt Watershed recommends a phased approach for achieving the water quality standards. Ideally, implementing control measures on nonpoint sources of loading will be based on voluntary participation which will depend on 1) the effectiveness of the educational programs for farmers, landowners, and owners of onsite wastewater systems, and 2) the level of participation in the programs. This section outlines a schedule for implementing the control measures and determining whether or not they are sufficient to meet the water quality standards.

Phase I of this implementation plan should focus on further source identification within the watershed because current data regarding sources of trace metals, sulfates, and TDS in the South Fork Saline River/Lake of Egypt watershed is limited. AMDs should be located and monitoring of water chemistry should be performed to determine appropriate BMP choices for each location. Phase I of this implementation plan should also focus on education of farm owners concerning the benefits of agricultural BMPs on crop yield, soil quality, and water quality as well as cost share programs available in the watershed. It is expected that initial education through public meetings, mass mailings, TV and radio announcements, and newspaper articles could be achieved in less than 6 months. As described in Section 8.0, assistance with educational programs is available through the following agencies: the Illinois Department of Agriculture Conservation 2000 Streambank Stabilization Restoration Program, the Illinois Department of Agriculture Sustainable Agriculture Grant Program (SARE), the Illinois Environmental Protection Agency Nonpoint Source Management Program (NSMP), and the local Soil and Water Conservation Districts.

Phase II of the implementation schedule will involve continued use of BMPs such as passive treatment, active treatment, and mine reclamation. Phase II of the implementation schedule will also involve voluntary participation of farmers in BMPs such as proper management of manure, fertilizers, and pesticides and use of filter strips, composting, constructed wetlands, conservation tillage, and grassed waterways. The local Natural Resources Conservation Service office will be able to provide technical assistance and cost share information for these BMPs. In addition, initial inspections of all onsite wastewater treatment systems and necessary repairs may begin. Continued monitoring of water quality in the watershed should continue throughout this phase, which will likely take one to three years.

If pollutant concentrations measured during Phase II monitoring remain above the water quality standards, Phase III of the implementation plan will be necessary. The load reduction achieved during Phase II should be estimated by 1) summarizing the areas where BMPs are in use, 2) calculating the reductions in loading from BMPs, and 3) determining the impacts on pollutant concentrations measured before and after Phase II implementation. If BMPs are resulting in decreased concentrations, and additional areas could be incorporated, further efforts to include more stakeholders in the voluntary program will be needed. If the Phase II BMPs are not having the desired impacts on pollutant concentrations, or additional areas of incorporation are not available, supplemental BMPs, such as restoration of riparian areas and stream channels will be needed. If required, this phase may last five to ten years.

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