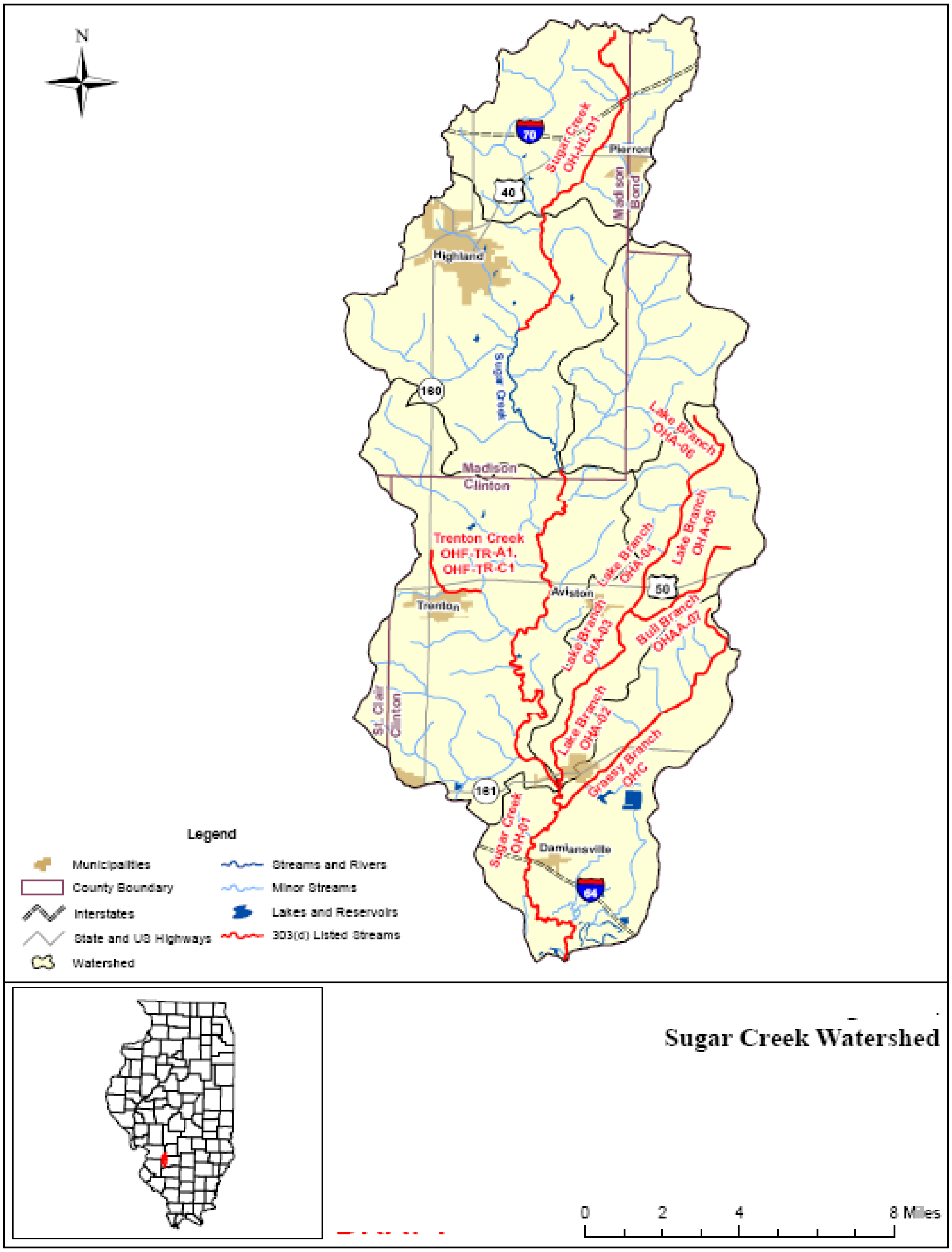
# Sugar Creek/ Lake Branch Watershed TMDL Report

IEPA/BOW/12-002

January 2012




**Illinois Environmental Protection Agency**

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

JAN 31 2012

REPLY TO THE ATTENTION OF:
WW-16J

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

RECEIVED
FEB - 9 2012
BUREAU OF WATER
BUREAU CHIEF'S OFF

Dear Ms. Willhite:

The U.S. Environmental Protection Agency has conducted a complete review of the final Total Maximum Daily Loads (TMDLs) for the Sugar Creek Watershed, including supporting documentation and follow up information. The Sugar Creek Watershed is located in the southern portion of Illinois in Madison and Clinton Counties. The fecal coliform and manganese TMDLs submitted by the Illinois Environmental Protection Agency address the impaired designated Aquatic Life Use and Primary Contact Recreation Use.

These 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 Illinois' three TMDLs for fecal coliform and manganese in the Sugar Creek Watershed. The statutory and regulatory requirements, and EPA's review of Illinois' compliance with each requirement, are described in the enclosed decision document.

We wish to acknowledge Illinois' effort in submitting these TMDLs and look forward to future TMDL submissions by the State of Illinois. If you have any questions, please contact Mr. Peter Swenson, Chief of the Watersheds and Wetlands Branch, at 312-886-0236.

Sincerely,

Tinka G. Hyde
Director, Water Division

Enclosure

cc: Amy Walkenbach, IEPA
Jennifer Clarke, IEPA

# Contents

## Section 6 Approach to Developing TMDL and Identification of Data Needs



## Section 7 Methodology Development for the Sugar Creek Watershed

**Section 10 References**

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# Tables

# Acronyms

| | |
|---|---|
| µg/L | micrograms per liter |
| BMP | best management practice |
| BOD | biochemical oxygen demand |
| CAFOs | concentrated animal feeding operations |
| CBOD | carbonaceous biochemical oxygen demand |
| CCC | Commodity Credit Corporation |
| CCP | Conservation Cost-Share Program |
| CCX® | Chicago Climate Exchange |
| cfs | cubic feet per second |
| CRP | Conservation Reserve Program |
| CRP | Conservation Reserve Program |
| CWA | Clean Water Act |
| DAF | design average flow |
| DEM | Digital Elevation Model |
| DMF | design maximum flows |
| DMR | Discharge Monitoring Reports |
| DO | dissolved oxygen |
| EQIP | Environmental Quality Incentive Program |
| FRSS | Facility Related Stream Survey |
| FSA | Farm Service Agency |
| GIS | geographic information system |
| GWLF | generalized watershed loading function |
| HUC | Hydrologic Unit Code |
| IBI | Index of Biotic Integrity |
| ICCI | Illinois Conservation and Climate Initiative |
| ICLP | Illinois Clean Lakes Program |
| 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 |
| ISGS | Illinois State Geological Survey |

| | |
|---|---|
| ISWS | Illinois State Water Survey |
| LA | load allocation |
| LC | loading capacity |
| mg/L | milligrams per liter |
| MOS | margin of safety |
| MS4s | municipal separate storm sewer systems |
| NASS | National Agricultural Statistics Service |
| NCDC | National Climatic Data Center |
| NED | National Elevation Dataset |
| NOx | nitrogen oxide |
| NPDES | National Pollutant Discharge Elimination System |
| NPS | Nonpoint Source |
| NRCS | National Resource Conservation Service |
| SOD | sediment oxygen demand |
| SSURGO | Soil Survey Geographic Database |
| STATSGO | State Soil Geographic |
| STORET | Storage and Retrieval |
| STP | Sewage Treatment Plant |
| SWCD | Soil and Water Conservation District |
| TMDL | total maximum daily load |
| TP | total phosphorus |
| TSS | total suspended solids |
| USDA | U.S. Department of Agriculture |
| USEPA | U.S. Environmental Protection Agency |
| USGS | U.S. Geological Survey |
| USLE | Universal Soil Loss Equation |
| WHIP | Wildlife Habitat Incentive Plan |
| WLA | waste load allocation |
| WRP | Wetlands Reserve Program |

# Section 1
# Goals and Objectives for Sugar Creek Watershed

## 1.1 Total Maximum Daily Load 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 develops a list known as the "303(d) list" of water bodies not meeting water quality standards every two years, and it is included in the Integrated Water Quality Report. Water bodies on the 303(d) list are then targeted for TMDL development. The Illinois EPA's most recent Integrated Water Quality Report was issued in March 2008. In accordance with U.S. Environmental Protection Agency's (USEPA's) guidance, the report assigns all waters of the state to one of five categories. Category 5 includes water bodies in which data have indicated that a TMDL is needed. Therefore, all waters that appear on the 303(d) list are included in Category 5 of the Integrated Water Quality Report and vice versa.

In general, a TMDL is a quantitative assessment of water quality impairments, contributing sources, and pollutant reductions needed to attain water quality standards. The TMDL specifies the amount of pollutant or other stressor that needs to be reduced to meet water quality standards, allocates pollutant 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 primary contact (swimming), protection of aquatic life, and public and food processing water supply. 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 Sugar Creek 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 Stages 1 and 3 of the TMDL development for the Sugar Creek watershed. Stage 2 involves optional data collection and was performed, to a limited extent, by Illinois EPA in 2008. Additional data collected during Stage 2 is incorporated in the Stage 3 portion of this report (Sections 7-9).

Following this process, the TMDL goals and objectives for the Sugar Creek watershed include development of 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 Sugar Creek watershed for which a TMDL has been developed:

- Sugar Creek (OH-01)
- Lake Branch (OHA-03)
- Bull Branch (OHAA-07)

These impaired water body segments are shown on Figure 1-1. There are 11 impaired water body segments within the Sugar Creek 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 Sugar Creek Watershed**

| Water Body Segment ID | Water Body Name | Size | Impaired Use | Cause of Impairment | Potential Sources |
|---|---|---|---|---|---|
| OH-01 | Sugar Creek | 21.44 miles | Aquatic Life | **Dissolved Oxygen** | Urban Runoff/Storm Sewers, Municipal Point Source Discharges, Animal Feeding Operations |
| | | | | **pH** | Unknown |
| | | | | *Phosphorus (Total)* | *Crop Production, Municipal Point Source Discharges, Urban Runoff/Storm Sewers, Animal Feeding Operations* |
| | | | | *Sedimentation/Siltation* | *Crop Production, Urban Runoff/Storm Sewers, Urban Runoff/Storm Sewers* |
| | | | | *Total Suspended Solids* | *Crop Production, Municipal Point Source Discharges, Urban Runoff/Storm Sewers, Animal Feeding Operations* |
| | | | Primary Contact Recreation | **Fecal Coliform** | Unknown |
| OHA-02 | Lake Branch | 3.98 miles | Aquatic Life | **Dissolved Oxygen** | Livestock, Animal Feeding Operations |
| | | | | *Phosphorus (Total)* | *Crop Production, Livestock, Animal Feeding Operations* |
| | | | | *Sedimentation/Siltation* | *Crop Production, Livestock, Animal Feeding Operations* |
| | | | | *Total Suspended Solids* | *Animal Feeding Operations, Crop Production, Livestock* |
| OHA-03 | Lake Branch | 2.01 miles | Aquatic Life | **Manganese** | Municipal Point Source Discharges, Urban Runoff/Storm Sewers |
| | | | | **Dissolved Oxygen** | Animal Feeding Operations, Urban Runoff/Storm Sewers, Crop Production, Livestock, Municipal Point Source Discharges |
| | | | | *Phosphorus (Total)* | *Urban Runoff/Storm Sewers, Crop Production, Municipal Point Source Discharges, Animal Feedings Operations* |
| | | | | *Sedimentation/Siltation* | *Urban Runoff/Storm Sewers, Livestock, Animal Feeding Operations, Crop Production* |

**Table 1-1 Impaired Water Bodies in Sugar Creek Watershed**

| Water Body Segment ID | Water Body Name | Size | Impaired Use | Cause of Impairment | Potential Sources |
|---|---|---|---|---|---|
| OHA-04 | Lake Branch | 1.93 miles | Aquatic Life | **Dissolved Oxygen** | Animal Feeding Operations, Municipal Point Source Discharges, Livestock |
| | | | | *Phosphorus(Total)* | *Animal Feeing Operations, Livestock, Crop Production, Municipal Point Source Discharges* |
| | | | | *Sedimentation/Siltation* | *Crop Production, Animal Feeding Operations, Livestock, Municipal Point Source Discharges* |
| OHA-05 | Lake Branch | 1.24 miles | Aquatic Life | **Dissolved Oxygen** | Animal Feeding Operations, Livestock |
| | | | | *Phosphorus (Total)* | *Livestock, Animal Feeding Operations, Crop Production* |
| | | | | *Sedimentation/Siltation* | *Livestock, Animal Feeding Operations, Crop Production* |
| | | | | *Total Suspended Solids* | *Livestock, Crop Production, Animal Feeding Operations* |
| OHA-06 | Lake Branch | 3.36 miles | Aquatic Life | **Dissolved Oxygen** | Animal Feeding Operation |
| | | | | *Phosphorus (Total)* | *Crop Production, Animal Feeding Operations* |
| | | | | *Total Suspended Solids* | *Animal Feeding Operations, Crop Production* |
| OHAA-07 | Bull Branch | 3.74 miles | Aquatic Life | *Barium* | *Unknown* |
| | | | | **Manganese** | Unknown |
| | | | | *Nitrogen (Total)* | *Animal Feeding Operations, Crop Production* |
| | | | | **Dissolved Oxygen** | Animal Feeding Operations |
| | | | | *Phosphorus (Total)* | *Animal Feeding Operations, Crop Production* |
| | | | | *Sedimentation/Siltation* | *Animal Feeding Operations, Crop Production* |
| | | | | *Total Suspended Solids* | *Crop Production, Animal Feeding Operations* |
| OHC | Grassy Branch | Aquatic Life | 7.63 miles | *Nitrogen (Total)* | *Crop Production, Municipal Point Source Discharges, Animal Feeding Operations* |
| | | | | **Dissolved Oxygen** | Municipal Point Source Discharges, Animal Feeding Operations |
| | | | | *Phosphorus (Total)* | *Crop Production, Municipal Point Source Discharges, Animal feeding Operations* |
| | | | | *Sedimentation/Siltation* | *Crop Production, Animal Feeding Operations* |
| OHF-TR-A1 | Trenton Creek | 1.21 miles | Aquatic Life | **Dissolved Oxygen** | Animal Feeding Operations |

**Table 1-1 Impaired Water Bodies in Sugar Creek Watershed**

| Water Body Segment ID | Water Body Name | Size | Impaired Use | Cause of Impairment | Potential Sources |
|---|---|---|---|---|---|
| OHF-TR-C1 | Trenton Creek | .91 miles | Aquatic Life | **Dissolved Oxygen** | Urban Runoff/Storm Sewers, Municipal Point Source Discharges, Animal Feeding Operations |
| | | | | *Phosphorus (Total)* | *Animal Feeding Operations, Municipal Point Source Discharges, Urban Runoff/Storm Sewers* |
| OH-HL-D1 | Sugar Creek | 10.41 miles | Aquatic Life | **Dissolved Oxygen** | Unknown |
| | | | | *Phosphorus (Total)* | *Crop Production* |

* **Bold Causes of Impairment do have numeric water quality standard.** *Italicized Causes of Impairment do not have numeric water quality standard.* **TMDLS were developed for causes of impairments shaded in gray.**

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 pH, dissolved oxygen, total fecal coliform, and manganese impairments in the Sugar Creek watershed. After modeling and data analysis, it was determined that TMDLs could not be developed for dissolved oxygen or pH at this time. The results of the modeling and data analysis are discussed in detail in Sections 7 and 8 of this report. 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, some 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:

$$\textbf{TMDL = LC} = \Sigma\textbf{WLA} + \Sigma\textbf{LA} + \textbf{MOS}$$

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 is described in the implementation plan. The implementation plan for the Sugar Creek watershed describes how water quality standards will be attained. This implementation plan includes recommendations for implementing best management practices (BMPs), cost estimates, institutional needs to implement BMPs and controls throughout the watershed, and a timeframe for completion of implementation activities.

## 1.3 Report Overview

The remaining sections of this report contain:

- **Section 2 Sugar Creek 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 Sugar Creek Watershed Water Quality Standards** defines the water quality standards for the impaired water body.
- **Section 5 Sugar Creek Watershed Characterization** presents the available water quality data needed to develop TMDLs, discusses the characteristics of the impaired stream segments 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 are needed for TMDL development and also suggests segments for Stage 2 data collection.
- **Section 7 Methodology Development for the Middle Fork Saline River Watershed** details the development of the TMDLs for each impaired stream segment.
- **Section 8 Total Maximum Daily Load for the Sugar Creek Watershed** provides the results of the TMDL analysis for each impaired stream segment.
- **Section 9 Implementation Plan for the Sugar Creek Watershed** makes recommendations for implementation actions, point source controls, management measures, and BMPs that can be used to address water quality issues in the watershed.

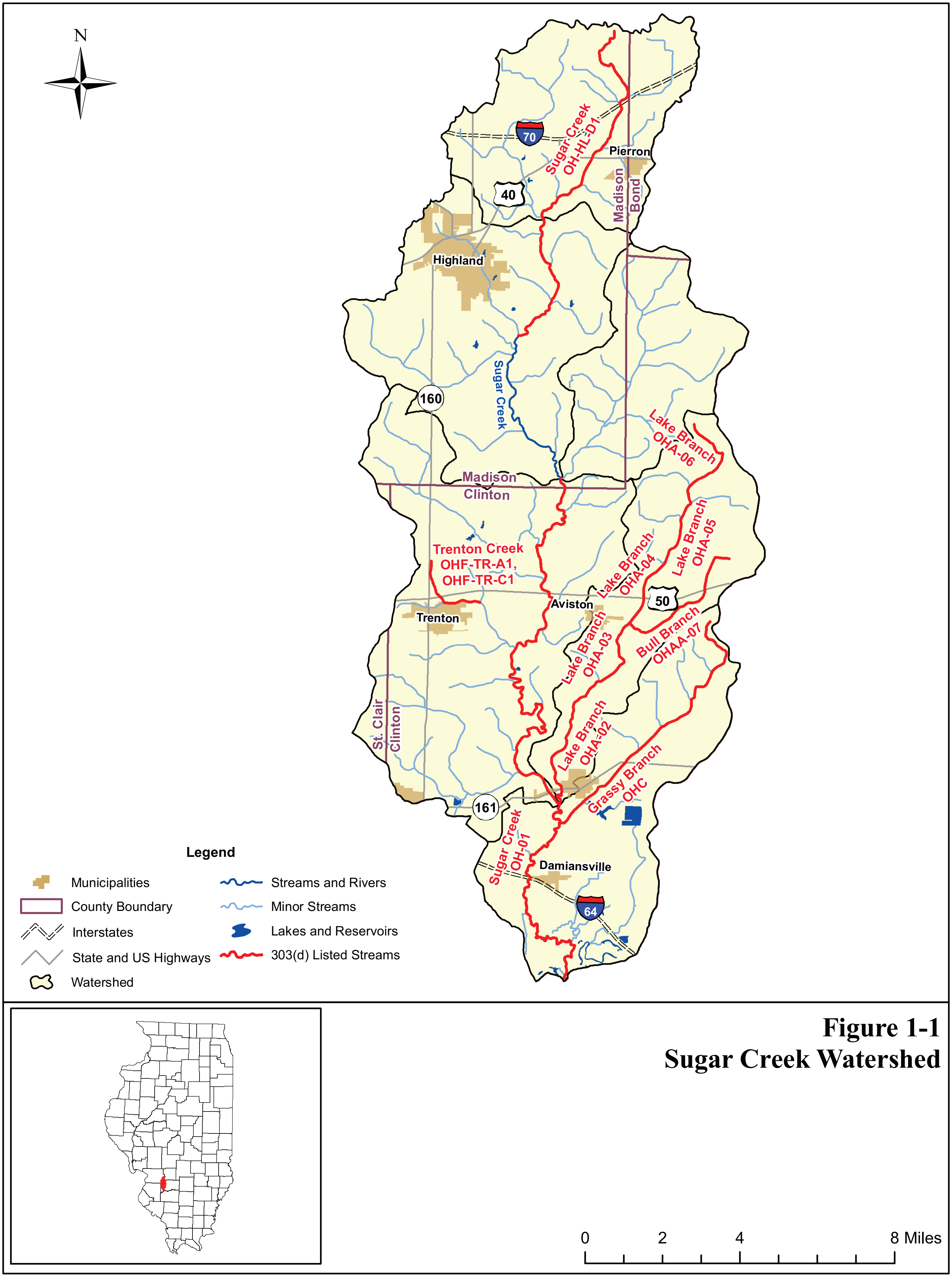


**Figure 1-1**
**Sugar Creek Watershed**

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# Section 2
# Sugar Creek Watershed Description

## 2.1 Sugar Creek Watershed Location

The Sugar Creek watershed (Figure 1-1) is located in southern Illinois, flows in a southerly direction, and drains approximately 112,700 acres. Approximately 41,800 acres (37 percent of the total watershed) lie in southeastern Madison County, 66,000 acres (59 percent of the total watershed) lie in western Clinton County, 3,800 acres (3 percent of the total watershed) lie in southwestern Bond County, and 1,100 acres (less than 1 percent of the watershed) lie in northeastern St. Clair County.

## 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 U.S. Geological Survey (USGS) for each 1:24,000-topographic quadrangle in the United States. Elevation data for the Sugar Creek watershed were obtained by overlaying the NED grid onto the geographic information system (GIS)-delineated watershed. Figure 2-1 shows the elevations found within the watershed.

Elevation in the Sugar Creek watershed ranges from 630 feet above sea level in the northern portion of the watershed at the headwaters of Sugar Creek to 394 feet at its most downstream point near Damiansville in the southern end of the watershed. The absolute elevation change of Sugar Creek is 162 feet over the approximately 78-mile stream length, which yields a stream gradient of approximately 2.1 feet per mile.

## 2.3 Land Use

Land use data for the Sugar Creek 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 (USDA) National Agricultural Statistics Service (NASS), the Illinois Department of Agriculture (IDA), and the Illinois Department of Natural Resources (IDNR). The land cover data was 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 Sugar Creek 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 Sugar Creek 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 95,037 acres, representing nearly 84 percent of the total watershed area, are devoted to agricultural activities. Corn and soybean farming account for 31 percent and 25 percent of the watershed area, respectively, winter wheat/soybeans account for 11 percent, and rural grassland accounts for an additional 9 percent of the total area. Other land cover types each represent 4 percent or less of the watershed area.

**Table 2-1 Land Cover and Land Use in Sugar Creek Watershed**

| Land Cover Category | Area (Acres) | Percentage |
|---|---|---|
| Corn | 34,976 | 31.0 |
| Soybeans | 28,123 | 25.0 |
| Winter Wheat/Soybeans | 12,236 | 10.9 |
| Rural Grassland | 10,458 | 9.3 |
| Other Small Grains & Hay | 4,848 | 4.3 |
| Floodplain Forest | 4,453 | 4.0 |
| Upland Forest | 3,869 | 3.4 |
| Winter Wheat | 3,757 | 3.3 |
| Low/Medium Density | 2,888 | 2.6 |
| High Density | 2,149 | 1.9 |
| Partial Canopy/Savannah Upland | 1,711 | 1.5 |
| Urban Open Space | 869 | 0.8 |
| Other Agriculture | 637 | 0.6 |
| Surface Water | 517 | 0.5 |
| Seasonally/Temporarily Flooded | 349 | 0.3 |
| Deep Marsh | 286 | 0.3 |
| Shallow Marsh/Wet Meadow | 255 | 0.2 |
| Barren & Exposed Land | 202 | 0.2 |
| Shallow Water | 108 | 0.1 |
| **Total** | **112,691** | **100.0** |

## 2.4 Soils

Soils data are available through the Soil Survey Geographic (SSURGO) database. 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 soil mapping done by the NRCS.

Attributes of the spatial coverage can be linked to the SSURGO databases, which provide information on various chemical and physical soil characteristics for each map unit and soil series. Of particular interest for TMDL development are the hydrologic soil groups as well as the K-factor of the Universal Soil Loss Equation (USLE). The following sections describe and summarize the specified soil characteristics for the Sugar Creek watershed.

### 2.4.1 Sugar Creek Watershed Soil Characteristics

Appendix B contains a table of the SSURGO soil series for the Sugar Creek watershed. Various soil types exist in the watershed, but no single type covers more than 2 percent of the watershed. The table also contains the area, dominant hydrologic soil group, and k-factor range. Each of these characteristics is described in more detail in the following paragraphs.

Figure 2-3 shows the hydrologic soils groups found within the Sugar Creek watershed. Hydrologic soil groups are used to estimate runoff from precipitation. Soils are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms. Hydrologic soil groups A, B, C, D, B/D, and C/D are found within the Sugar Creek watershed. Groups B and C cover 27 and 38 percent of the watershed, respectively. Group D and B/D cover 15 and 17 percent of the watershed, respectively. The other groups cover small percentages of the watershed. Group B soils are defined as having "moderately low runoff potential when thoroughly wet." These soils have a moderate rate of water transmission. Group C soils are defined as having "moderately high runoff potential when thoroughly wet." These soils have a low rate of water transmission. Group D soils are defined as having "high runoff potential when thoroughly wet." These soils have a very low or non-existent rate of water transmission. Group B/D soils are "placed in group D based solely on the presence of a water table within 24 inches of the surface," however these soils have a moderate rate of water transmission (NRCS 2007).

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 Sugar Creek watershed range from 0.15 to 0.43.

## 2.5 Population

The Census 2000 TIGER/Line data from the U.S. Census Bureau were retrieved. Geographic shapefiles of census blocks were downloaded for Bond, Clinton, Madison, and St. Clair Counties. The census block shapefiles were clipped to each watershed so that only block populations directly associated with the watershed would be counted. City populations were taken from the U.S. Census Bureau. For municipalities located along a watershed boarder, population was estimated based on the percentage of the municipalities' area within the watershed boundary. Approximately 31,000 people reside in the Sugar Creek watershed. The major municipalities in the watershed are shown in Figure 1-1. The largest urban development in the watershed is the city of Highland, which is located in the northwestern corner of the Sugar Creek watershed.

## 2.6 Climate and Streamflow

### 2.6.1 Climate

Southwestern Illinois has a temperate climate with hot summers and cold, snowy winters. Monthly precipitation data from Greenville, Illinois (station id. 3693) in Bond County were extracted from the NCDC database for the years of 1901 through 2006. Temperature data were available from 1901 to 1959. The data station in Greenville, Illinois was chosen to be representative of precipitation throughout the Sugar Creek watershed.

Table 2-2 contains the average monthly precipitation along with average high and low temperatures for the period of record. The average annual precipitation is approximately 36.2 inches.

**Table 2-2 Average Monthly Climate Data in Greenville, IL**

| Month | Total Precipitation (inches) | Maximum Temperature (degrees F) | Minimum Temperature (degrees F) |
|---|---|---|---|
| January | 1.6 | 40 | 22 |
| February | 1.5 | 42 | 24 |
| March | 2.6 | 54 | 33 |
| April | 3.8 | 66 | 44 |
| May | 3.8 | 75 | 53 |
| June | 4.3 | 83 | 62 |
| July | 4.3 | 88 | 66 |
| August | 3.8 | 83 | 62 |
| September | 3.3 | 77 | 55 |
| October | 2.7 | 66 | 44 |
| November | 2.4 | 54 | 34 |
| December | 2.1 | 42 | 25 |
| **Total** | **36.2** | **64** | **43** |

### 2.6.2 Streamflow

Analysis of the Sugar Creek watershed requires an understanding of flow throughout the drainage area. One USGS gage within the watershed has historic data available which is shown in Table 2-3.

**Table 2-3 Streamflow Gages in the Sugar Creek Watershed**

| Gage Number | Name | POR |
|---|---|---|
| 05594090 | Sugar Creek at Albers, Illinois | 1972-1982 |

Because there are no gages within the watershed that have data available within the past 20 years, flow data will be estimated and compared to historic values during Stage 3 using the drainage area ratio method, represented by the following equation.

$$\mathbf{Q_{gaged}}\left(\frac{\mathbf{Area_{ungaged}}}{\mathbf{Area_{gaged}}}\right) = \mathbf{Q_{ungaged}}$$

| | | | |
|---|---|---|---|
| where | $Q_{gaged}$ | = | Streamflow of the gaged basin |
| | $Q_{ungaged}$ | = | Streamflow of the ungaged basin |
| | $Area_{gaged}$ | = | Area of the gaged basin |
| | $Area_{ungaged}$ | = | Area of the ungaged basin |

The assumption behind the equation is that the flow per unit area is equivalent in watersheds with similar characteristics. Therefore, the flow per unit area in the gaged watershed multiplied by the area of the ungaged watershed estimates the flow for the ungaged watershed.

USGS gage 05595200 (Richland Creek near Hecker, Illinois) was chosen as an appropriate gage from which to estimate flows for all impaired stream segments in the Sugar Creek watershed. The Richland Creek watershed is approximately 21 miles southwest of the Sugar Creek watershed. The gage drains an area of 129 square miles, which is the smallest and most similar watershed area of any of the USGS gages in the region of the state to the impaired segment watershed areas. The contributing watershed areas for stations OH-01, OHA-03, and OHAA-07 are 124.2 square miles, 14.9 square miles, and 2.9 square miles, respectively. GIS analysis shows that the surrogate gage watershed has similar land use, soils, and topography as the Sugar Creek watershed and also receives comparable precipitation throughout the year. Figure 2-4 shows estimated flows in Sugar Creek. Flows are highest in the basin mid-spring and lowest during mid-fall.

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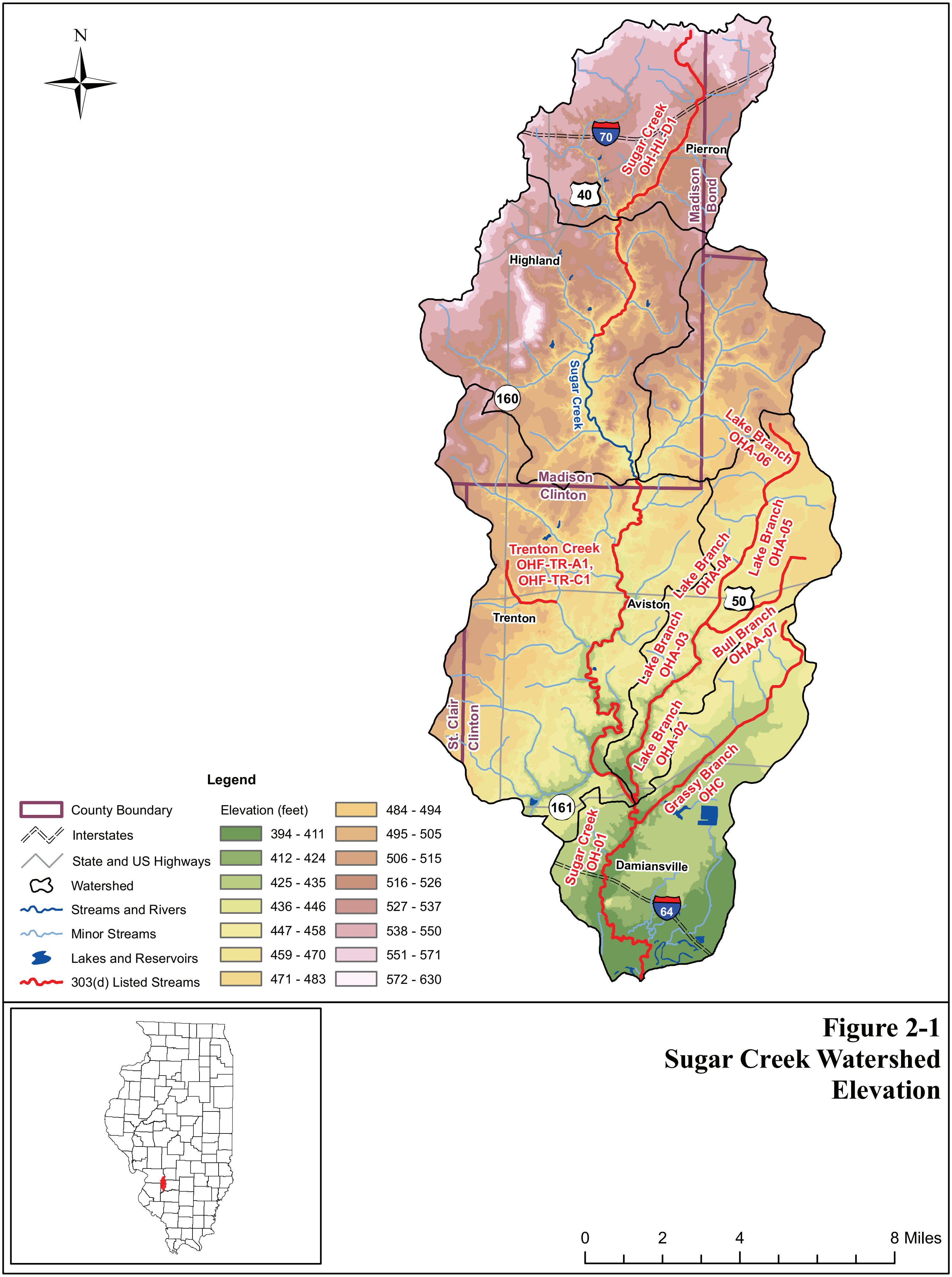


**Figure 2-1**
**Sugar Creek Watershed**
**Elevation**

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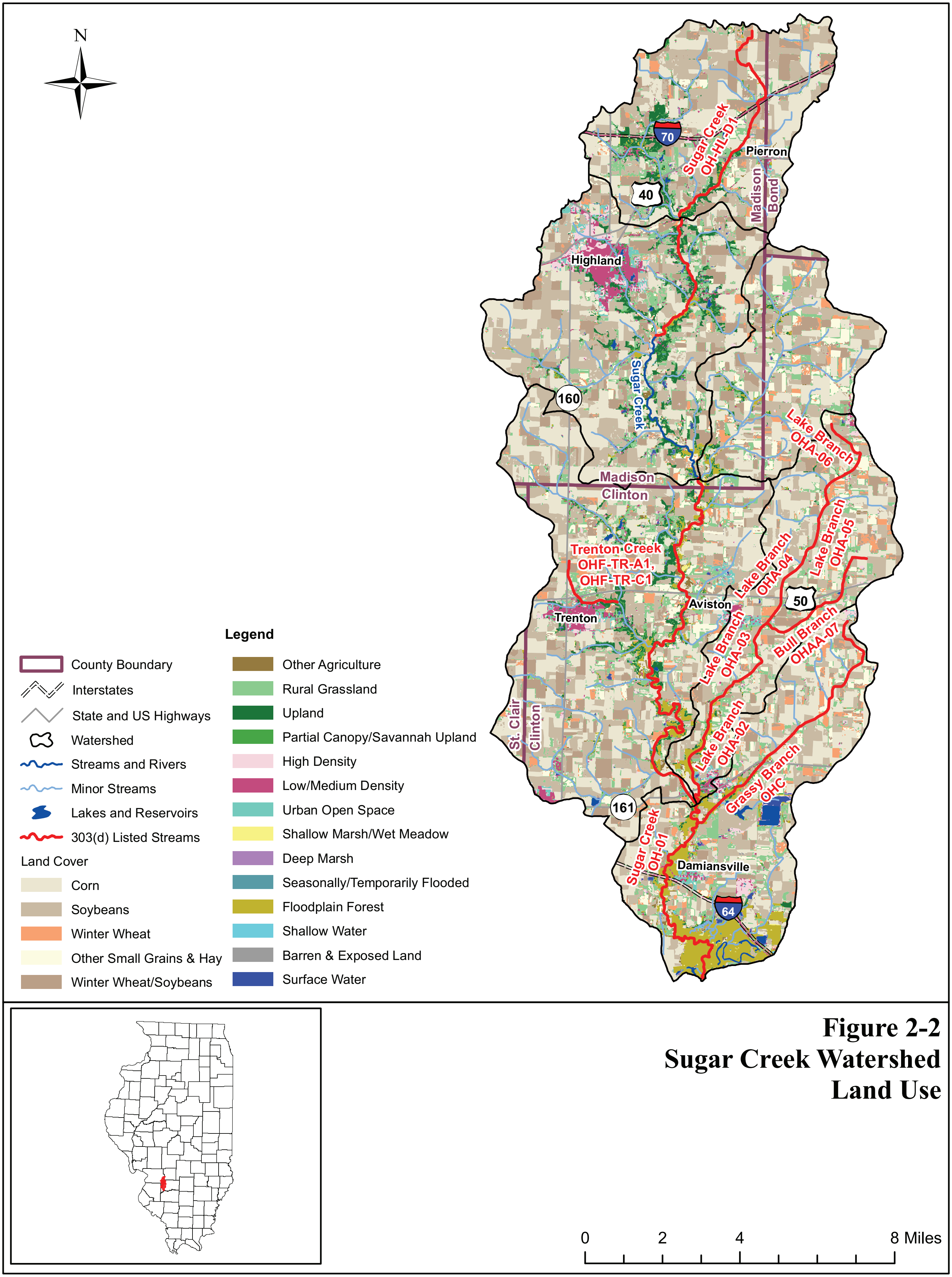


**Figure 2-2**
**Sugar Creek Watershed**
**Land Use**

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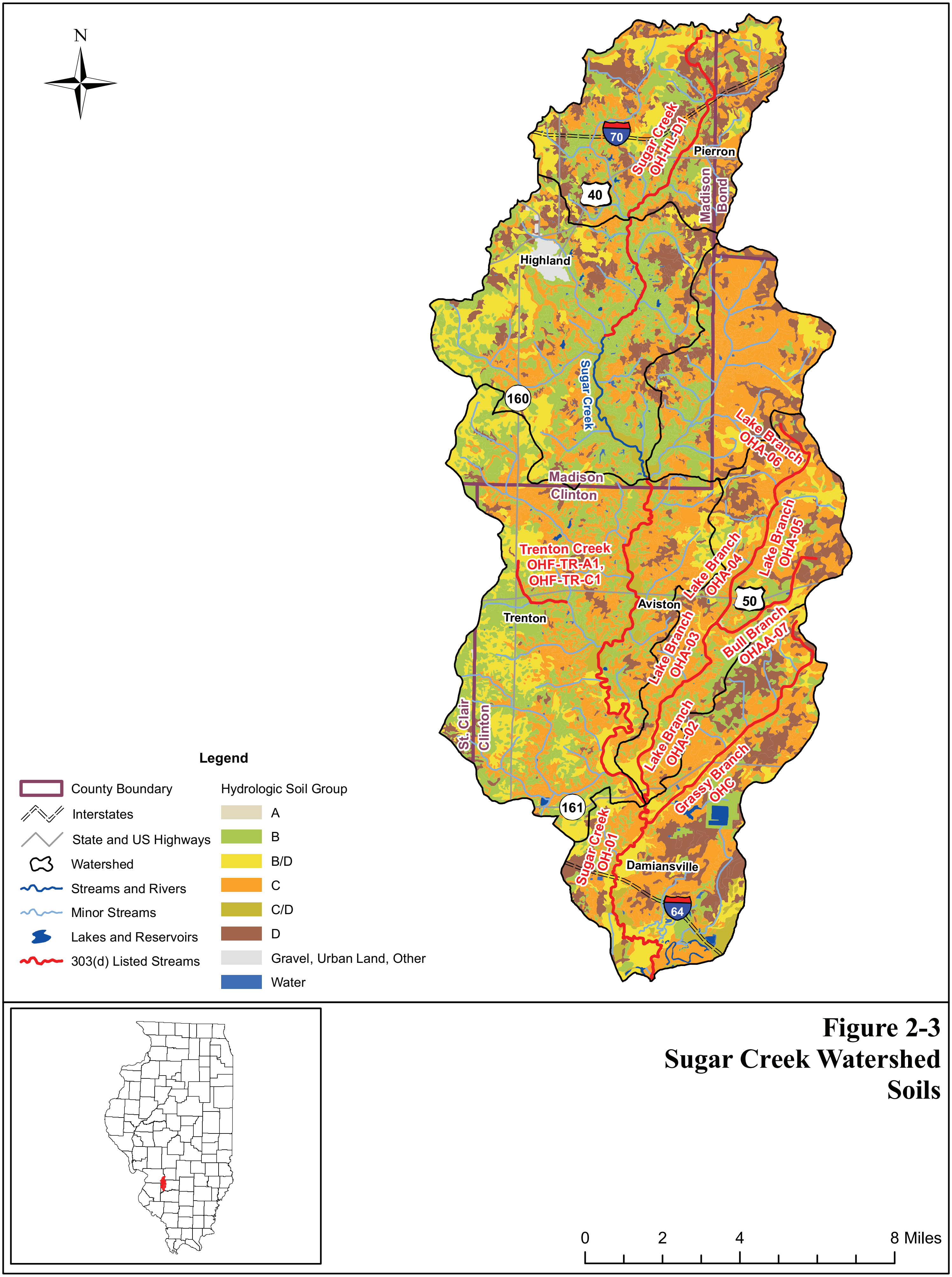


**Figure 2-3**
**Sugar Creek Watershed**
**Soils**

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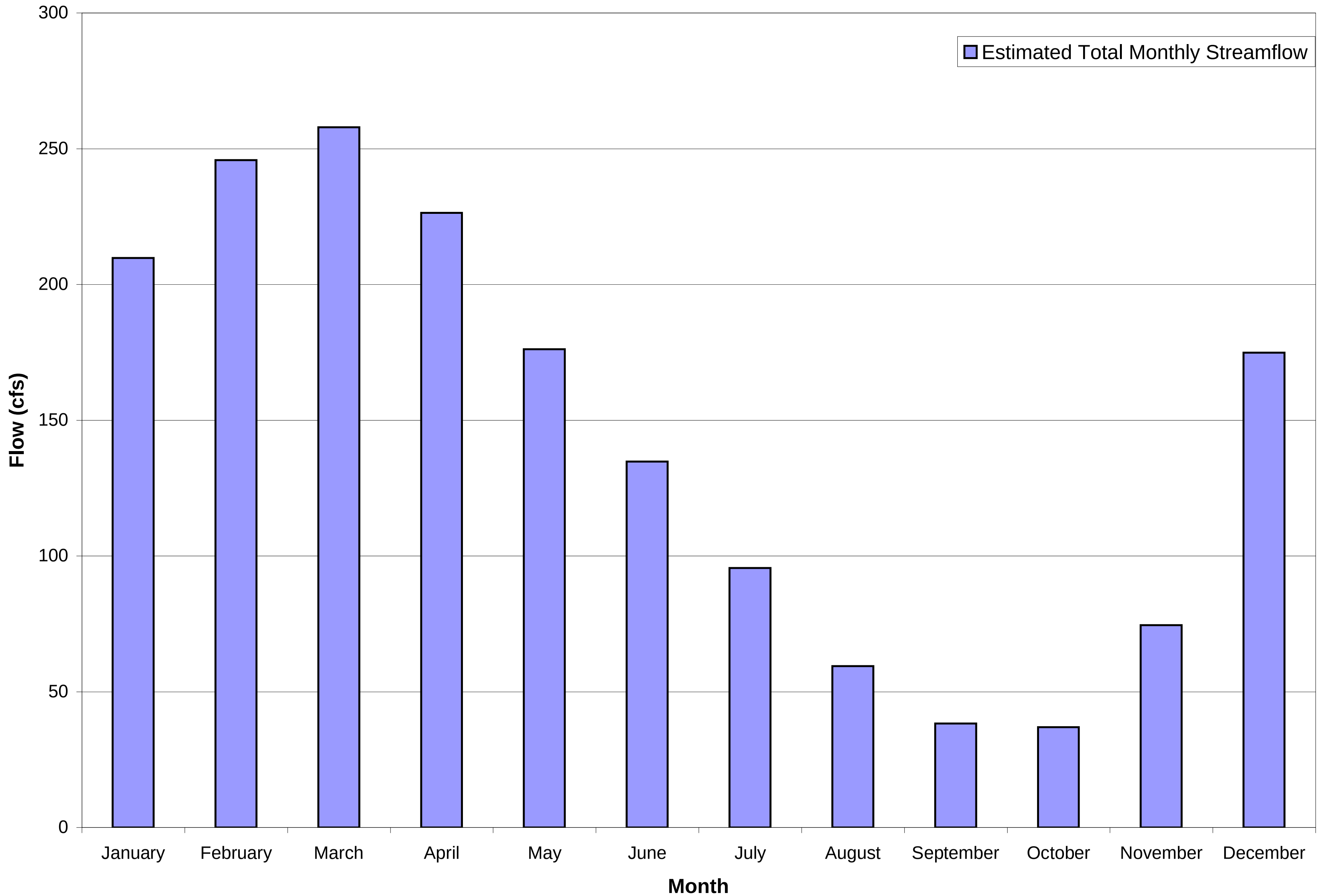


CDM
T:\Stage1Data\USGS Gage Stations\Sugar_Gage_Data.xls

Figure 2-4:
Estimated Total Monthly Streamflow
in Sugar Creek

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# Section 3
# Public Participation and Involvement

## 3.1 Sugar Creek 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, has held one public meeting and will hold one more public meeting within the watershed throughout the course of the TMDL development. Following the completion of Stage 1 of the TMDL process, a public meeting was held in Highland, Illinois on May 13, 2009. No public response comments were submitted to Illinois EPA as a result of this meeting. A similar meeting will be held following completion of the draft Stage 3 report. This section will be updated after the Stage 3 public meetings occur.

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# Section 4
# Sugar Creek 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 2008). The General Use designated use is applicable to the Sugar Creek watershed.

### 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.

## 4.3 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. Table 4-1 presents the water quality standards of the potential causes of impairment the stream segments in the Sugar Creek 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 Sugar Creek Watershed Causes of Stream Impairments**

| Parameter | Units | General Use Water Quality Standard | Regulatory Reference |
|---|---|---|---|
| Manganese (total) | µg/L | 1000 | 302.208(g) |
| Dissolved Oxygen | mg/L | *March through July*<br>≥5.0 minimum & ≥6.0 7-day daily mean averaged over 7 days;<br><br>*August through February*<br>≥3.5 minimum, ≥4.0 7-day minimum averaged over 7 days & ≥5.5 30-day daily mean | 302.206(b) |
| Total Fecal Coliform | Count/100 mL | *May through October*<br>200(1), 400(2) | 302.209 |
| pH | | 6.5-9 | 302.204 |

µg/L = micrograms per liter
mg/L = milligrams per liter
(1) Geometric mean based on a minimum of five samples taken over not more than a 30-day period.
(2) Standard shall not be exceeded by more than 10 percent of the samples collected during any 30-day period.

## 4.4 Potential Pollutant Sources

In order to properly address the conditions within the Sugar Creek 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 potential causes for the 303(d) listed segments in this watershed. They are summarized in Table 4-2.

**Table 4-2 Summary of Potential Pollutant Sources in the Sugar Creek Watershed**

| Segment ID | Segment Name | Potential Causes of Impairment | Potential Sources (as identified by the 2006 303(d) list) |
|---|---|---|---|
| OH-01 | Sugar Creek | **Dissolved Oxygen**, **pH**, Phosphorus(Total), Sedimentation/Siltation, Total Suspended Solids, **Fecal Coliform** | Urban Runoff/Storm Sewers, Municipal Point Source Discharges, Animal Feeding Operations, Unknown, Crop Production |
| OHA-02 | Lake Branch | **Dissolved Oxygen**, Phosphorus(Total), Sedimentation/Siltation, Total Suspended Solids | Livestock, Animal feeding Operations, Crop Production |
| OHA-03 | Lake Branch | **Manganese**, **Dissolved Oxygen**, Phosphorus (Total), Sedimentation/Siltation | Municipal Point Source Discharges, Urban Runoff/Storm Sewers, Animal Feeding Operations, Crop Production, Livestock |
| OHA-04 | Lake Branch | **Dissolved Oxygen**, Phosphorus (Total), Sedimentation/Siltation | Animal Feeding Operations, Municipal Point Source Discharges, Livestock, Crop Production |
| OHA-05 | Lake Branch | **Dissolved Oxygen**, Phosphorus (Total), Sedimentation/Siltation, Total Suspended Solids | Animal Feeding Operations, Livestock, Crop Production |

**Table 4-2 Summary of Potential Pollutant Sources in the Sugar Creek Watershed (cont.)**

| Segment ID | Segment Name | Potential Causes of Impairment | Potential Sources (as identified by the 2006 303(d) list) |
|---|---|---|---|
| OHA-06 | Lake Branch | **Dissolved Oxygen**, Phosphorus (Total), Total Suspended Solids | Animal Feedings Operations, Crop Production |
| OHAA-07 | Bull Branch | Barium, **Manganese**, Nitrogen (Total), **Dissolved Oxygen**, Phosphorus (Total), Sedimentation/Siltation, Total Suspended Solids | Unknown, Animal Feeding Operations, Crop Production |
| OHC | Grassy Branch | Nitrogen (Total), **Dissolved Oxygen**, Phosphorus (Total), Sedimentation/Siltation | Crop Production, Municipal Point Source Discharges, Animal Feeding Operations |
| OHF-TR-A1 | Trenton Creek | **Dissolved Oxygen** | Animal Feeding Operations |
| OHF-TR-C1 | Trenton Creek | **Dissolved Oxygen**, Phosphorus (Total) | Urban Runoff/Storm Sewers, Municipal Point Source Discharges |
| OH-HL-D1 | Sugar Creek | **Dissolved Oxygen**, Phosphorus (Total) | Unknown, Crop Production |

***Bold Potential Causes of Impairment have numeric water quality standard and TMDLs will be developed.**

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# Section 5
# Sugar Creek Watershed Characterization

Data were collected and reviewed from many sources in order to further characterize the Sugar Creek 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 17 historic water quality stations within the Sugar Creek 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 Sugar Creek 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 are available for stations sampled after that date. Illinois EPA collected additional data for various causes of impairment on some segments in 2008 and 2009 which has been incorporated into this report. The following sections will first discuss Sugar Creek watershed stream data followed by Sugar Creek watershed lake data.

### 5.1.1 Stream Water Quality Data

The Sugar Creek watershed has 11 impaired stream segments within its drainage area that are addressed in this report. There is one active water quality station on each of the following impaired stream segments: OH-01, OHA-04, OHA-05, OHA-06, OHF-TR-A1, OHF-TR-C1, OH-HL-D1. There are two water quality stations on segments OHA-02 and OHAA-07. In addition, there are three water quality monitoring stations associated with a Facility Related Stream Survey (FRSS) on Grassy Branch segment OHC and two water quality monitoring stations associated with a FRSS on Sugar Creek on each of the Lake Branch segments OHA-03 and OHA-04. All historic water quality data are available in Appendix C.

#### 5.1.1.1 Fecal Coliform

Sugar Creek segment OH-01 is listed as impaired by total fecal coliform. Table 5-1 summarizes available historic fecal coliform data on the segment. The general use water quality standard for fecal coliform states that the standard of 200 per 100 mL is not to be exceeded by the geometric mean of at least five samples, nor can 10 percent of the samples collected exceed 400 per 100 mL in protected waters, except as provided in 35 Ill. Adm. Code 302.209(b). Samples must be collected within a 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 5-1 reflects single samples compared to the standards during the appropriate months. Figure 5-2 shows the total fecal coliform samples collected over time at Sugar Creek segment OH-01.

**Table 5-1 Existing Fecal Coliform Data for Sugar Creek 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)] |
|---|---|---|---|---|---|---|
| **Sugar Creek Segment OH-01; Sample Location OH-01** | | | | | | |
| Total Fecal Coliform (cfu/100 mL) | 1990-2005; 61 | 789 | 77,000 | 10 | 56 | 43 |

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

### 5.1.1.2 pH

Sugar Creek segment OH-01 is listed for impairment caused by pH. A sample is considered a violation if it falls below 6.5 or above 9.0 standard units at any time. A total of 141 samples have been collected since 1990 from the impaired segment. As shown in Table 5-3, three of the samples collected at OH-01during this time period were in violation of the standard. Figure 5-3 shows the pH samples collected over time at segment OH-01.

**Table 5-2 Existing pH Data for Sugar Creek 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 |
|---|---|---|---|---|---|---|
| **Sugar Creek Segment OH-01; Sample Location OH-01** | | | | | | |
| pH | 6.5-9.0 | 1990-2005;141 | 7.38 | 8.6 | 6.3 | 3 |

### 5.1.1.3 Manganese

Lake Branch segment OHA-03 and Bull Branch segment OHAA-07 are listed for impairment caused by manganese. The applicable water quality standard is a maximum total manganese concentration of 1,000 µg/L for general use and indigenous aquatic life standards. Table 5-3 summarizes the available historic manganese data since 1990 for the impaired stream segments. This table includes data collected by Illinois EPA in 2008. The table also shows the number of violations for each segment. Total manganese samples collected over time for the impaired segments OHA-03 and OHAA-07 are shown in Figure 5-4.

**Table 5-3 Existing Manganese Data for Sugar Creek Watershed Impaired Stream Segments**

| Sample Location and Parameter | Aquatic Life WQ Standard (µg/L) | Period of Record and Number of Data Points | Mean | Maximum | Minimum | Number of Violations |
|---|---|---|---|---|---|---|
| **Lake Branch Segment OHA-03; Sample Locations OHA-03, OHA-AV-A1, OHA-AV-C1, OHA-AV-C3, and OHA-AV-D1** | | | | | | |
| Manganese (total) | 1000 | 1991-2008; 11 | 399.03 | 1600 | 83 | 1 |
| **Bull Branch Segment OHAA-07; Sample Location OHAA-07** | | | | | | |
| Manganese (total) | 1000 | 1991-2008; 10 | 345.8 | 1006 | 83 | 1 |

### 5.1.1.4 Dissolved Oxygen

All of the impaired stream segments in the Sugar Creek watershed are listed as impaired for dissolved oxygen (DO). While there is a large number of available DO data points for Sugar Creek segment OH-01 (147) and Lake Branch segments OHA-03 (341) and OHA-04 (677), only one data point was available for each of the segments on Trenton Creek (OHF-TR-A1 and OHF-TR-C1) and at Sugar Creek segment OH-HL-D1. Likewise, only 3 to 6 data points were available for each of the remaining impaired segments in this watershed. The available data for each stream segment are summarized in Table 5-4. A sample was considered a violation if it was below 5.0 mg/L during the months of March through July and 3.5 mg/L during the months of August through February.

A majority of the DO data points now available for Lake Branch segments OHA-03 and OHA-04 were collected during week-long continuous DO monitoring events conducted by Illinois EPA in 2008. Illinois EPA installed continuous DO monitors at these stations to record in-stream DO concentrations at 30-minute intervals for periods of approximately 7 days. A continuous DO monitors was installed at station OHA-03 for 1 week beginning September 8, 2008. Continuous DO monitors were also installed at station OHA-04 for 1 week beginning July 22, 2008 and again for 1 week beginning September 8, 2008. The data points associated with these continuous DO measurements were utilized in model development and are included in Table 5-4.

Instantaneous DO values for all samples collected from Sugar Creek segment OH-01 are shown in Figure 5-5. The week-long, continuous dissolved oxygen monitoring data collected at OHA-03 and OHA-04 are shown in Figures 5-6 through 5-8. Figure 5-9 shows the additional historical instantaneous DO values for the impaired Lake Branch stream segments OHA-03 and OHA-04 as well as all instantaneous DO data for Lake Branch segments OHA-02, OHA-05, and OHA-06. Figure 5-10 shows the instantaneous DO values for the remaining impaired stream segments in the Sugar Creek Watershed (OHAA-07, OHC, OHF-TR-A1, and OHF-TR-C1).

**Table 5-4 Existing Dissolved Oxygen Data for Sugar Creek Watershed Impaired Stream Segments**

| Sample Location and Parameter | WQ Standard (mg/L) | Period of Record and Number of Data Points | Mean | Maximum | Minimum | Number of Violations |
|---|---|---|---|---|---|---|
| **Sugar Creek Segment OH-01; Sample Location OH-01** | | | | | | |
| Dissolved Oxygen | 5.0(1), 3.5(2) | 1990-2005; 147 | 6.88 | 16 | 0.9 | 44 |
| **Lake Branch Segment OHA-02; Sample Locations OHA-01, OHA-02** | | | | | | |
| Dissolved Oxygen | 5.0(1), 3.5(2) | 1991; 6 | 3.27 | 6.9 | 0.8 | 4 |
| **Lake Branch Segment OHA-03; Sample Locations OHA-03, OHA-AV-C3, and OHA-AV-D1** | | | | | | |
| Dissolved Oxygen | 5.0(1), 3.5(2) | 1991-2008; 341 | 3.71 | 7.3 | 0.6 | 303 |
| **Lake Branch Segment OHA-04; Sample Location OHA-04, OHA-AV-A1, OHA-AV-C1** | | | | | | |
| Dissolved Oxygen | 5.0(1), 3.5(2) | 1991, 2008; 677 | 2.66 | 7.2 | 0.03 | 500 |
| **Lake Branch Segment OHA-05; Sample Location OHA-05** | | | | | | |
| Dissolved Oxygen | 5.0(1), 3.5(2) | 1991; 3 | 4.03 | 8.4 | 0.4 | 2 |
| **Lake Branch Segment OHA-06; Sample Location OHA-06** | | | | | | |
| Dissolved Oxygen | 5.0(1), 3.5(2) | 1991; 3 | 5.3 | 8.5 | 0.7 | 1 |
| **Bull Branch Segment OHAA-07; Sample Locations OHAA-07, OHAA-08** | | | | | | |
| Dissolved Oxygen | 5.0(1), 3.5(2) | 1991; 6 | 3.08 | 7.5 | 0.2 | 4 |
| **Grassy Branch Segment OHC; Sample Locations OHC-AL-C2, OHC-AL-C3, OHC-AL-D1** | | | | | | |
| Dissolved Oxygen | 5.0(1), 3.5(2) | 1994; 3 | 3.77 | 4.5 | 2.6 | 3 |
| **Trenton Creek Segment OHF-TR-A1; Sample Location OHF-TR-A1** | | | | | | |
| Dissolved Oxygen | 5.0(1), 3.5(2) | 1998; 1 | 2.2 | 2.2 | 2.2 | 1 |
| **Trenton Creek Segment OHF-TR-C1; Sample Location OHF-TR-C1** | | | | | | |
| Dissolved Oxygen | 5.0(1), 3.5(2) | 1998; 1 | 3.7 | 3.7 | 3.7 | 1 |
| **Sugar Creek Segment OH-HL-D1; Sample Location OH-HL-D1** | | | | | | |
| Dissolved Oxygen | 5.0(1), 3.5(2) | 2002; 1 | 3.1 | 3.1 | 3.1 | 1 |

(1) Instantaneous Minimum *March –July*
(2) Instantaneous Minimum *August - February*

### 5.1.2 Lake Water Quality Data

There are no impaired lakes within the Sugar Creek watershed.

## 5.2 Point Sources

There are 14 active point sources located within the Sugar Creek watershed that discharge to or upstream of impaired segments. Table 5-5 contains permit information for these point sources while Figure 5-11 shows the locations of outfalls for each facility. Permit limits and discharge monitoring reports were analyzed and further detailed during Stage 3 TMDL development.

**Table 5-5 Permitted Facilities Discharging to or Upstream of Impaired Segments in the Sugar Creek Watershed**

| Facility ID | Facility Name |
|---|---|
| ILG551011 | Wesclin High School Dist 3 |
| ILG551027 | IL DOT 1-70 Rest Area |
| ILG580002 | Saint Rose SD STP |
| ILG580017 | Albers STP |
| ILG580137 | Pierron West STP |
| ILG640060 | Aviston WTP |
| ILG640083 | Saint Rose Public Water District |
| IL0020001 | Aviston STP |
| IL0026701 | Trenton STP |
| IL0029173 | Highland STP |
| IL0032603 | New Baden STP |
| IL0070238 | Home Nursery Apartment Complex |
| IL0048691 | Monterey Coal – Monterey Mine #2 |
| IL0063762 | Damiansville STP |
| IL0075388 | Castle Ridge Estates Subdivision |

Underground mining operations exist in the Sugar Creek watershed. There is one National Pollution Discharge Elimination System (NPDES)-permitted discharge from the Monterey Coal Montery Mine #2 mining operation in the watershed. Mining operations may also have potential to contribute to impairments through overland runoff. Municipal separate storm sewer systems (MS4s) permits are another potential point source of contamination, however, there are no MS4 permits issued for municipalities in the Sugar Creek Watershed.

## 5.3 Nonpoint Sources

There are many potential nonpoint sources of pollutant loading to the impaired segments in the Sugar Creek watershed. This section will discuss site-specific cropping practices, animal operations, and area septic systems. Data were collected through communication with the local NRCS, Soil and Water Conservation District (SWCD), public health departments, and county tax department officials.

### 5.3.1 Crop Information

The majority of the land found within the Sugar Creek watershed is devoted to crops. Corn and soybean farming account for approximately 27 percent and 24 percent of the watershed respectively. The amount of cropland within the watershed is relevant because it can be a source of bacteria, oxygen demanding materials, and manganese to area waterways. This type of land use can contribute these constituents through general runoff caused by precipitation but can also increase loading by practices in place by the landowners. For instance, manure fertilizers can add significant loads of bacteria and nutrients to receiving waters if not applied correctly. Tillage practices can affect runoff; for instance, conservation tillage can significant reduce the amount of water and sediment that enters streams. Tile drains are also a practice employed on farmland in southern Illinois. Tile drains allow faster transmission of pollutant-laden runoff and may even encourage bacteria growth within the drains.

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 IDA from County Transect Surveys. The most recent survey was conducted in 2006. Data specific to the Sugar Creek watershed were not available; however, Bond, Clinton, Madison, and St Clair County practices were available and are shown in the following tables.

**Table 5-6 Tillage Practices in Bond County**

| Tillage System | Corn | Soybean | Small Grain |
|---|---|---|---|
| Conventional | 99% | 55% | 45% |
| Reduced - Till | 0% | 5% | 0% |
| Mulch - Till | 0% | 0% | 0% |
| No - Till | 1% | 40% | 55% |

**Table 5-7 Tillage Practices in Clinton County**

| Tillage System | Corn | Soybean | Small Grain |
|---|---|---|---|
| Conventional | 67% | 29% | 15% |
| Reduced - Till | 5% | 5% | 0% |
| Mulch - Till | 19% | 26% | 62% |
| No - Till | 9% | 40% | 23% |

**Table 5-8 Tillage Practices in Madison County**

| Tillage System | Corn | Soybean | Small Grain |
|---|---|---|---|
| Conventional | 66% | 12% | 0% |
| Reduced - Till | 21% | 41% | 5% |
| Mulch - Till | 3% | 15% | 77% |
| No - Till | 10% | 32% | 18% |

**Table 5-9 Tillage Practices in St Clair County**

| Tillage System | Corn | Soybean | Small Grain |
|---|---|---|---|
| Conventional | 97% | 29% | 89% |
| Reduced - Till | 1% | 23% | 7% |
| Mulch - Till | 1% | 7% | 2% |
| No - Till | 1% | 41% | 2% |

Estimates on tile drainage were provided by the Madison, Clinton, and Bond County NRCS offices. It is estimated that in Madison County, within the Sugar Creek watershed, approximately 50 percent of the farms are drained by field tiles. Madison County NRCS officials state that the amount of tiling on these farms is minimal and the majority of fields are not extensively tiled. In Clinton County, NRCS officials provided that approximately 5 to 10 percent of farms are drained by field tiles. Bond County NRCS officials state that soils within the Bond County portion of Sugar Creek watershed are gently sloping. Due to this slope, farms drain adequately without the use of field tiles. As a result, there is only minimal tiling within this portion of the watershed. Information on tile drainage was not available from St. Clair County, which represents a very small portion of the watershed. More detailed site-specific data will be incorporated if it becomes available.

## 5.3.2 Animal Operations

Animal populations are available from the National Agricultural Statistics Service. Data specific to Sugar Creek watershed were not available; however, the Bond, Clinton, Madison, and St Clair County animal populations were reviewed and are presented in the following tables (5-10 through 5-13). Data on animal operations within the watershed is relevant as these operations are a potential source of pollutants to area waterbodies. Livestock are a source of bacteria and nutrients while their grazing can increase erosion introducing sediments (that may contain manganese) to area streams and increasing sediment oxygen demand (SOD) within the segments which can deplete DO.

**Table 5-10 Bond County Animal Population (2002 Census of Agriculture)**

| | 1997 | 2002 | Percent Change |
|---|---|---|---|
| Cattle and Calves | 10,413 | 11,378 | 9% |
| Beef | 2,885 | 2,930 | 2% |
| Dairy | 2,534 | 3,284 | 30% |
| Hogs and Pigs | 18,334 | 10,810 | -41% |
| Poultry | 668 | 597 | -11% |
| Sheep and Lambs | 409 | 521 | 27% |
| Horses and Ponies | NA | 294 | NA |

**Table 5-11 Clinton County Animal Population (2002 Census of Agriculture)**

| | 1997 | 2002 | Percent Change |
|---|---|---|---|
| Cattle and Calves | 37,735 | 36,849 | -2% |
| Beef | 5,095 | 2,242 | -56% |
| Dairy | 14,830 | 15,080 | 2% |
| Hogs and Pigs | 93,190 | 177,880 | 91% |
| Poultry | 552,992 | 514,945 | -7% |
| Sheep and Lambs | 473 | 430 | -9% |
| Horses and Ponies | NA | 402 | NA |

**Table 5-12 Madison County Animal Population (2002 Census of Agriculture)**

| | 1997 | 2002 | Percent Change |
|---|---|---|---|
| Cattle and Calves | 17,690 | 15,809 | -11% |
| Beef | 5,890 | 5,931 | 1% |
| Dairy | 1,683 | 1,774 | 5% |
| Hogs and Pigs | 46,331 | 29,844 | -36% |
| Poultry | 1,517 | NA | NA |
| Sheep and Lambs | 1,047 | 1,013 | -3% |
| Horses and Ponies | NA | 1,226 | NA |

**Table 5-13 St Clair County Animal Population (2002 Census of Agriculture)**

| | 1997 | 2002 | Percent Change |
|---|---|---|---|
| Cattle and Calves | 8,362 | 6,985 | -16% |
| Beef | 1,888 | 1,656 | -12% |
| Dairy | 1,096 | 1,039 | -5% |
| Hogs and Pigs | 39,433 | 30,188 | -23% |
| Poultry | 1,426 | 790 | -45% |
| Sheep and Lambs | 449 | 374 | -17% |
| Horses and Ponies | NA | 879 | NA |

Communications with local NRCS officials have provided more watershed-specific animal information. Madison County NRCS officials stated that due to major urbanization within the county during the past ten years, the number of animal operations has declined considerably. They estimate that a few small operations exist within the watershed, but no issues have been reported with any of the operations, leading officials to believe that they are not contributing to water body use impairment. Clinton County NRCS officials estimate that 100 animal operations exist within the Clinton County portion of the Sugar Creek watershed. Bond County NRCS officials provided that there are 8 animal feeding operations within their county in the watershed. Of these 8, a few are thought to be dairy concentrated animal feeding operations (CAFOs) and the remaining operations are grazing animal operations. None of the NRCS offices had detailed information regarding the number of animals on each farm. Information on animal operations was not available from other county offices in the watershed.

### 5.3.3 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 many 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.

Across the U.S., septic systems have been found to be a potential and sometimes significant source of phosphorus and fecal coliform pollution. Septic systems that are not functioning properly or that are failing do not adequately treat sewage which can then seep into area waterways. Information on septic systems within the Sugar Creek watershed was obtained specifically for the areas surrounding and upstream of Sugar Creek segment OH-01, where the water body use is impaired for fecal coliform. Information on sewered and septic municipalities was obtained from the Clinton County Health Department. Health department officials provided that the cities of Damiansville, Albers, Trenton, Breese, Germantown, and Aviston are all served by city sewers within the city limits. Each of these towns is located near the impaired segment or near tributaries leading to the impaired segment. Health officials also provided that land beyond the city limits of these towns is generally used for agricultural purposes; however, the towns of Aviston and Trenton are expanding quickly and several subdivisions have been developed beyond the city limits. Health department officials provided that these subdivisions would be served by private septic systems, as would any other homes located outside of city limits. According to health department officials, there have been no complaints received regarding failing septic systems in this area. The Clinton County Tax Assessor was able to provide estimates on the number of homes in the areas of concern. According to the office of the assessor, there are approximately 1,500 homes located outside city limits in the Clinton County portion of Sugar Creek watershed. The condition of the septic systems serving these homes is unknown.

### 5.3.4 Historic Mining Operations

Overland runoff from current and former mining operations can contribute to pollutant loads in the waterways. Runoff from surface mines and from mine spoils and waste can contain elevated concentrations of metals and runoff waters may have low pH levels which can further facilitate the suspension of dissolved metals into the water column.

Data from the Illinois State Geological Survey (ISGS) indicate that there are a number of underground mines in the Sugar Creek watershed, as shown in Figure 5-12. The underground mining operations that exist in the watershed are targeting the Herrin coal seams. One of the underground mining operations in the watershed has an NPDES permitted outfall. However, the mining operation's discharge is not upstream of any segments impaired for metals (OHA-03 and OHAA-07). There are also no reported historical mining operations upstream of segment OHA-03 or OHAA-07. Additional information on the mining operations within the Sugar Creek River Watershed and throughout Illinois can be found at the ISGS Coal Section website at: http://www.isgs.illinois.edu/maps-data-pub/coal-maps/coalshapefiles.shtml.

## 5.4 Watershed Studies and Other Watershed Information

The extent of previous planning efforts within the Sugar Creek watershed is not known. No additional information became available through public meetings within the watershed community.

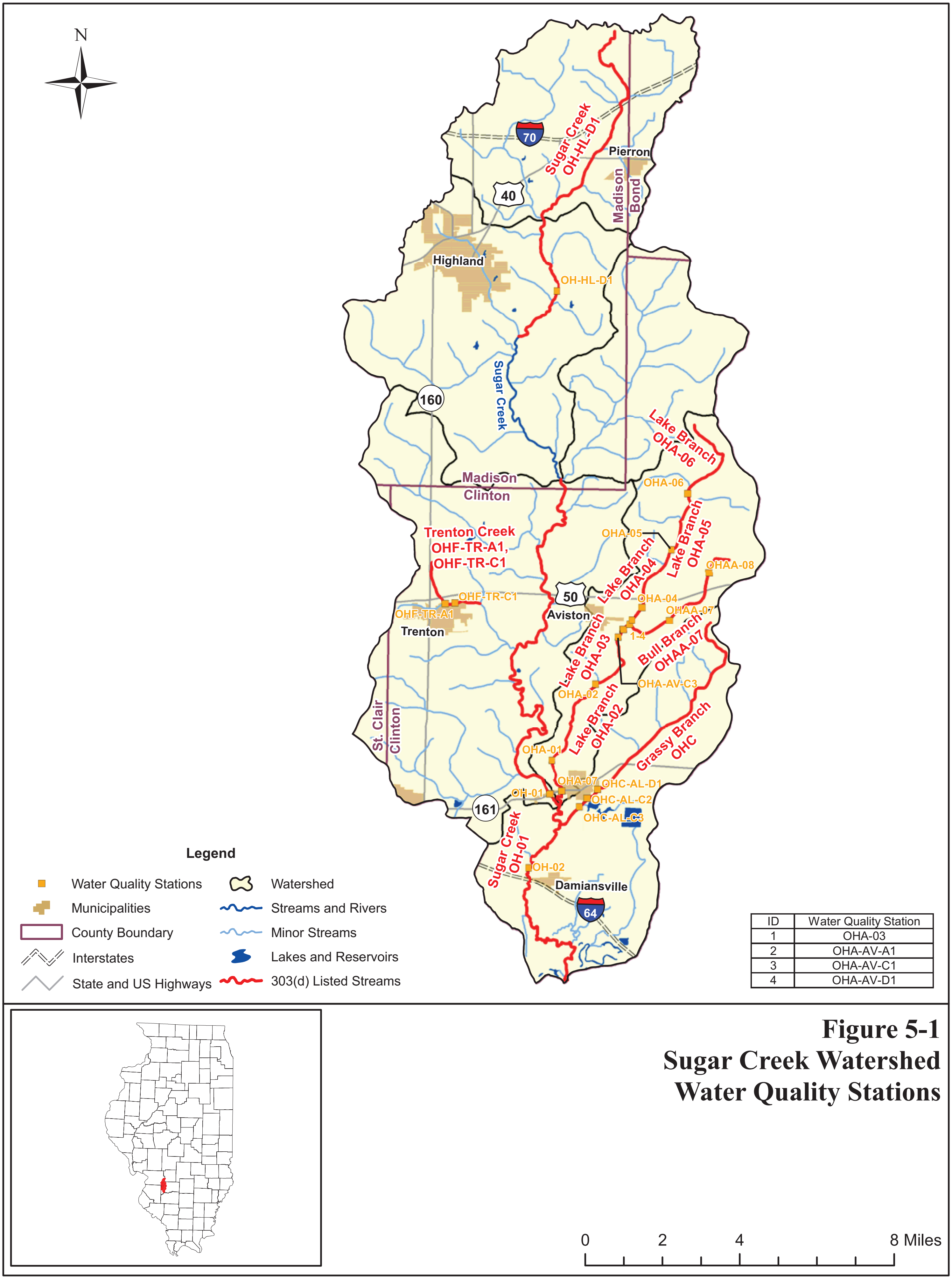


**Figure 5-1**
**Sugar Creek Watershed**
**Water Quality Stations**

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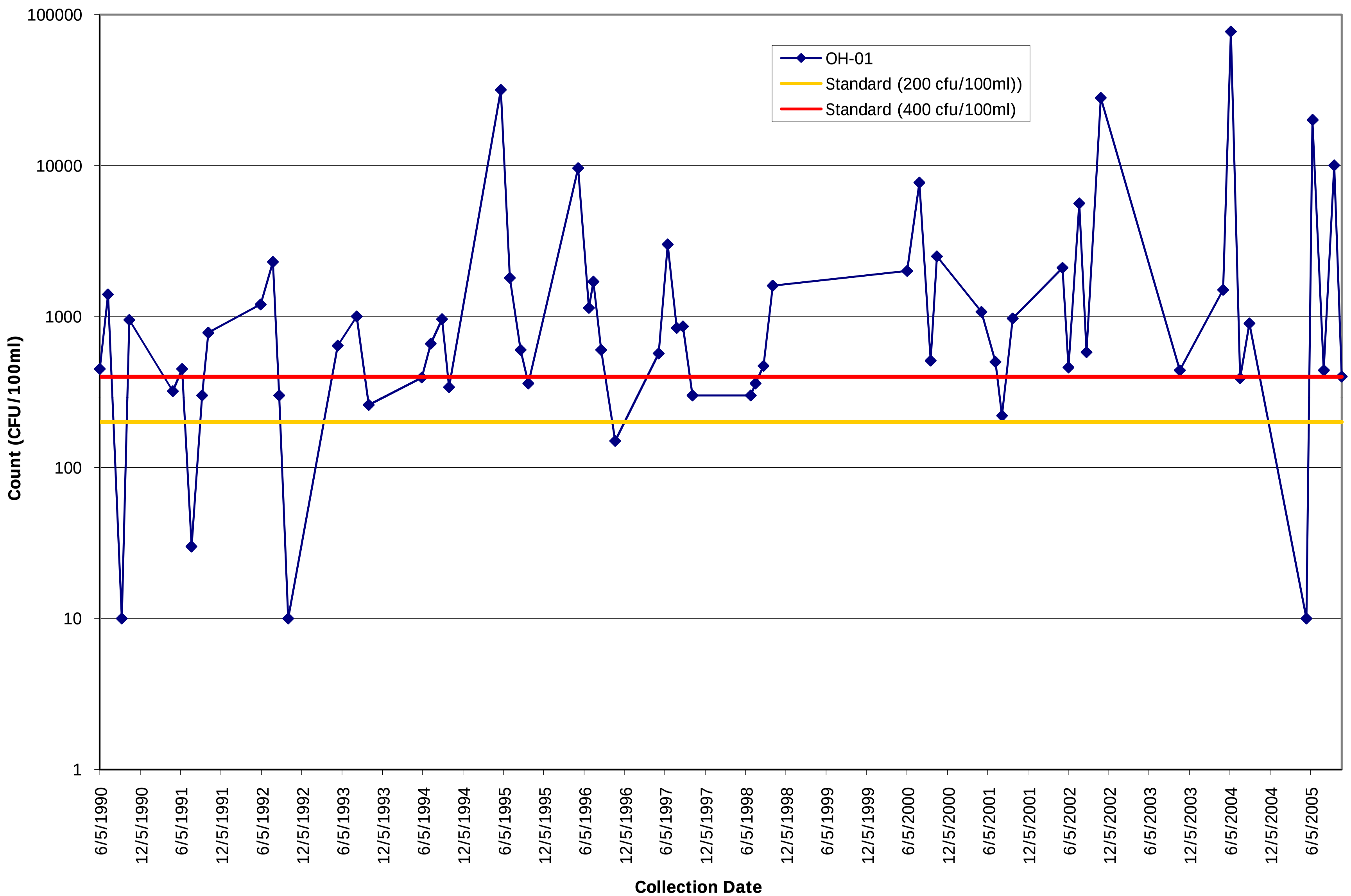


**Figure 5-2:**
**Fecal Coliform Data**
**Sugar Creek Segment OH-01**

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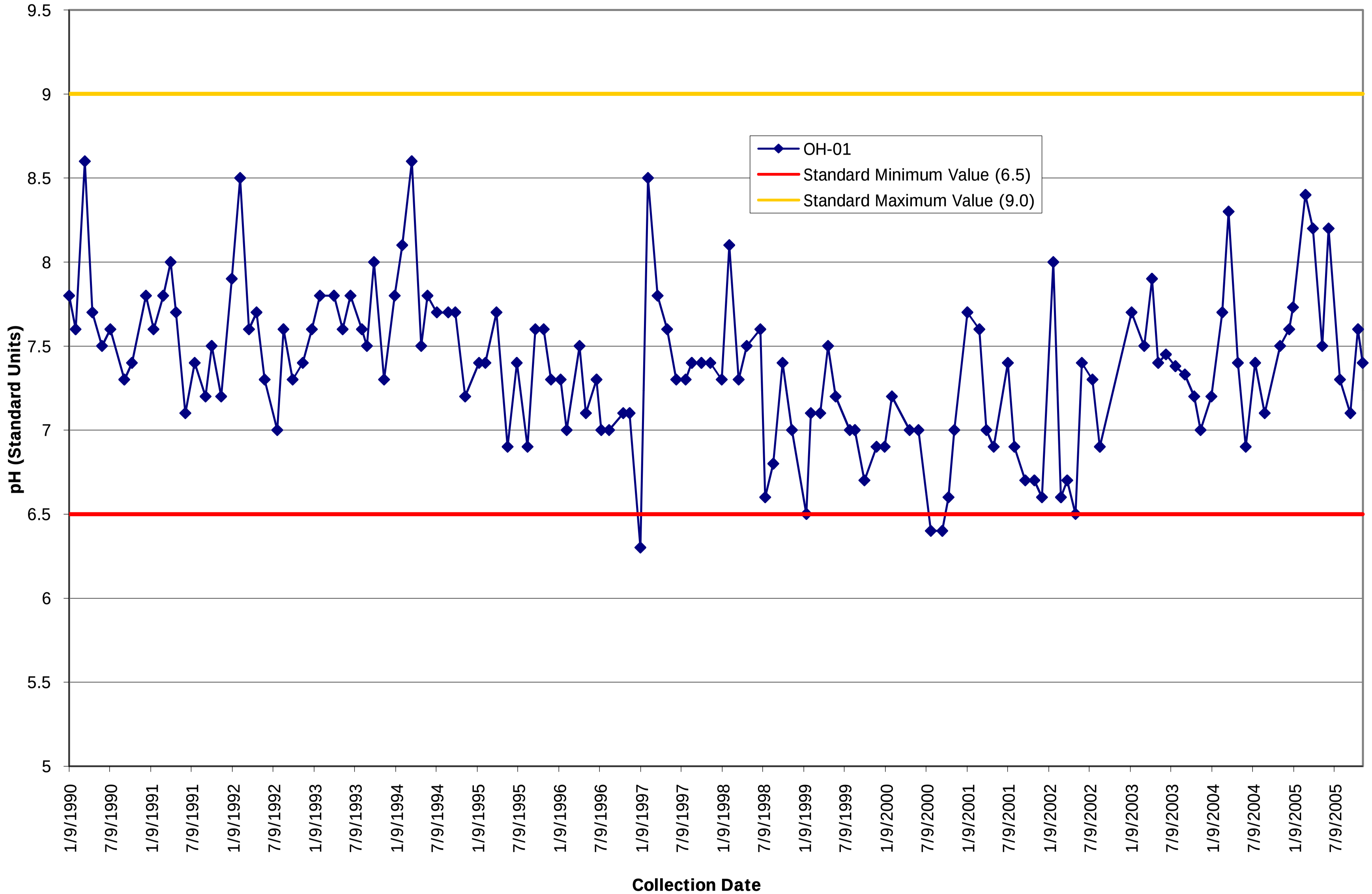


**Figure 5-3:**
**pH Vales**
**Sugar Creek Segment OH-01**

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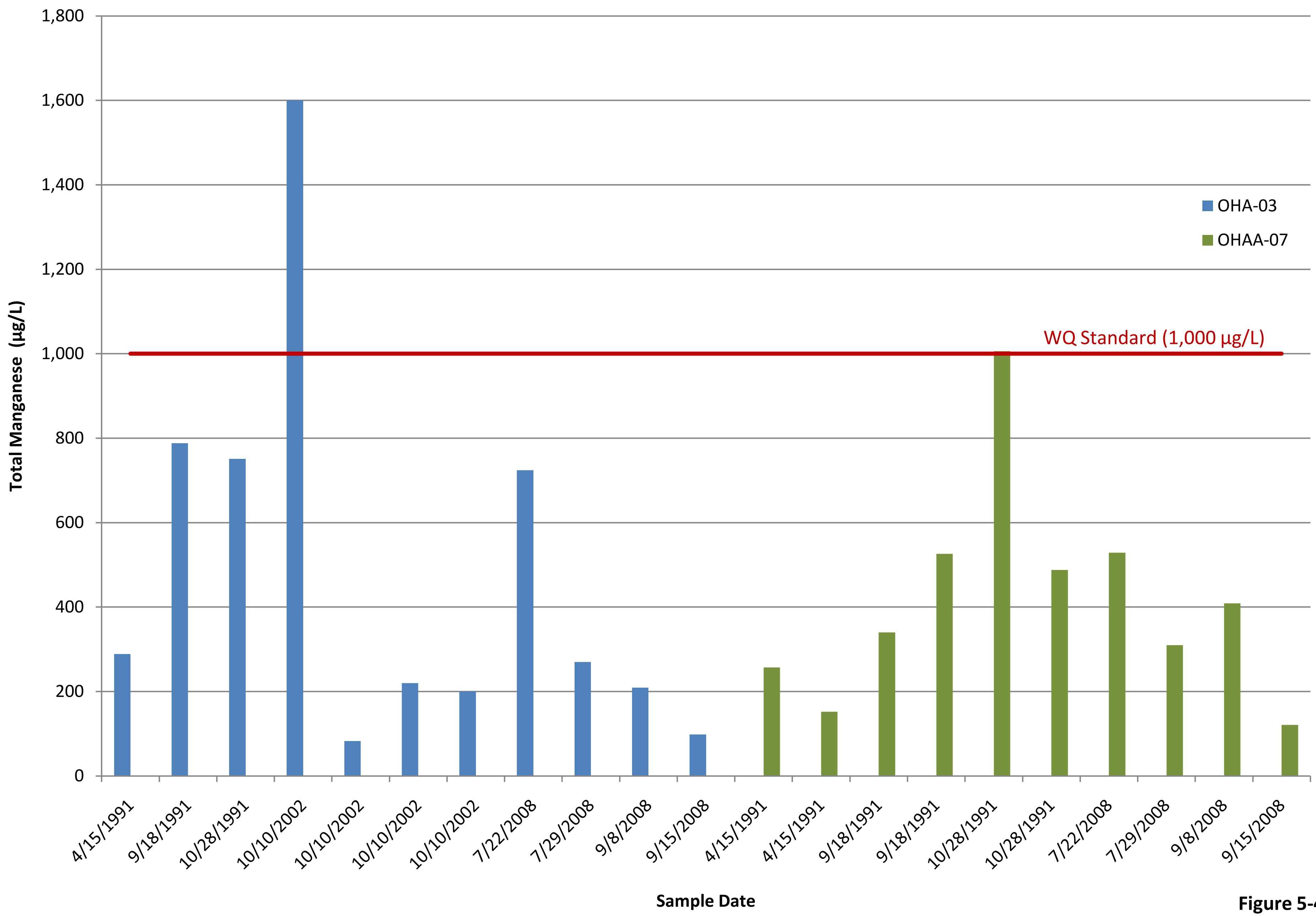


**Figure 5-4**
**Manganese Concentrations**
**Lake Branch Segment OHA-03 and**
**Bull Branch Segment OHAA-07**

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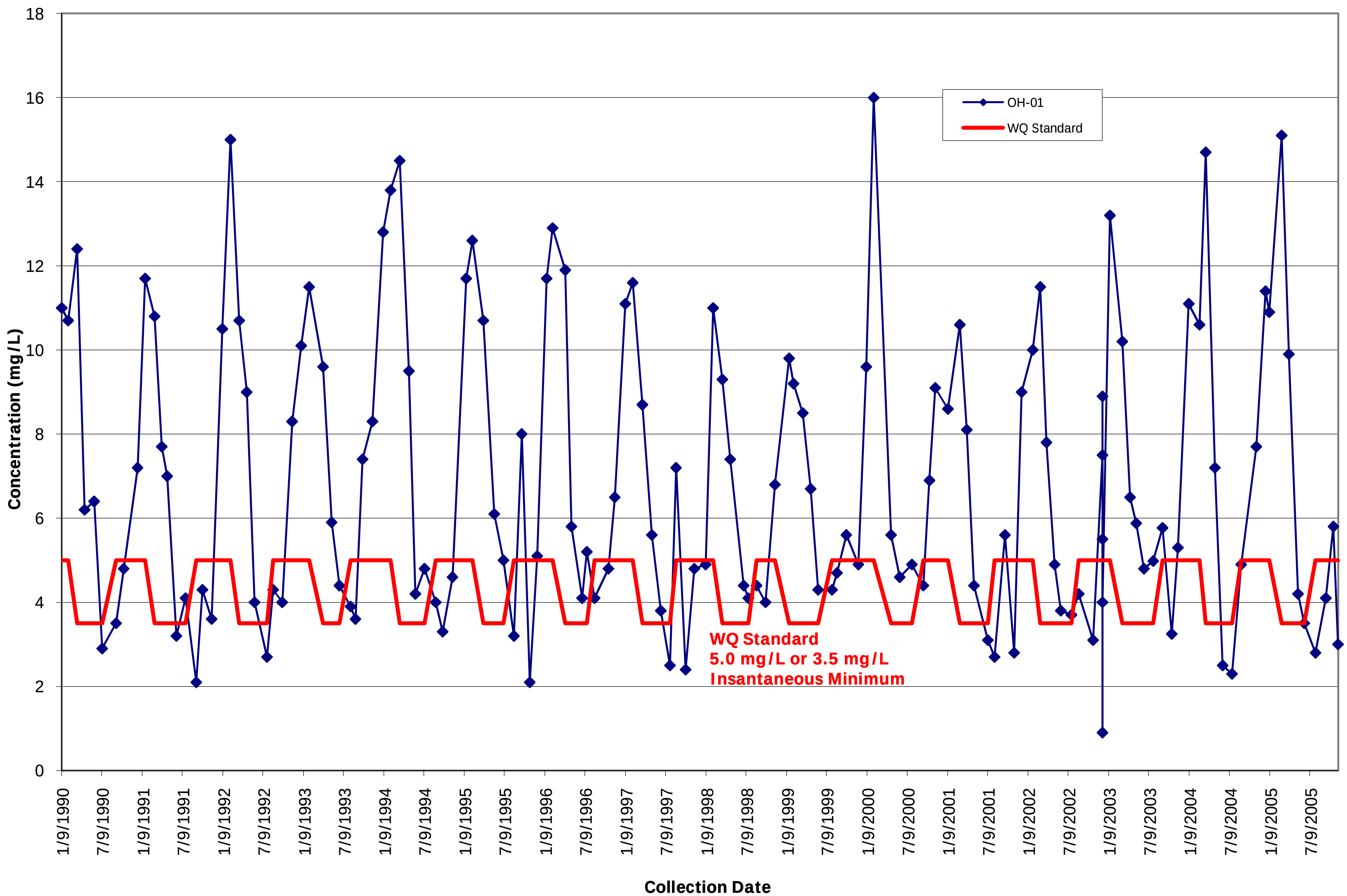


**Figure 5-5:**
**Dissolved Oxygen Concentrations**
**Sugar Creek Segment OH-01**

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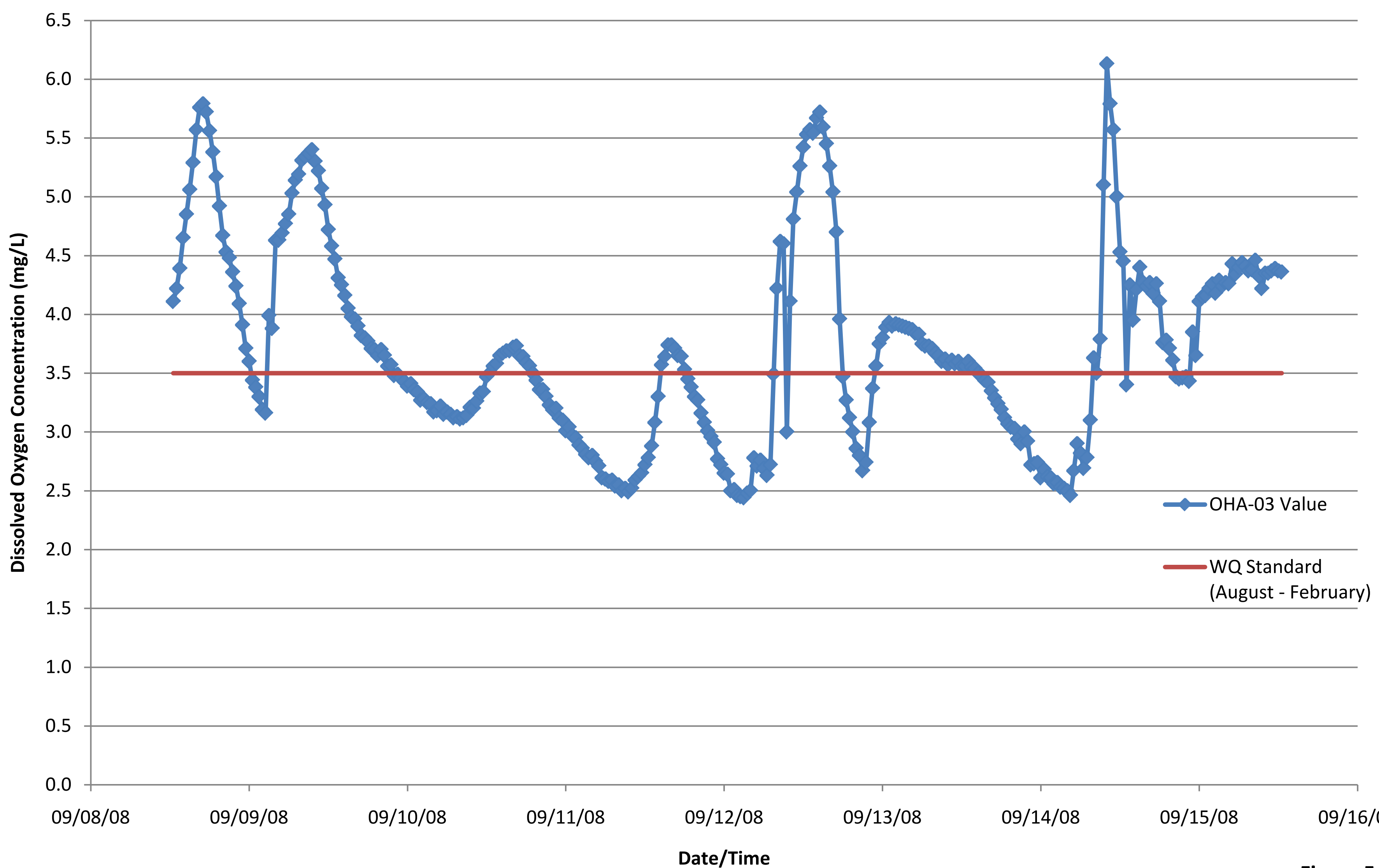


**Figure 5-6**
**Continuous Dissolved Oxygen Data**
**OHA-03 (September 2008)**

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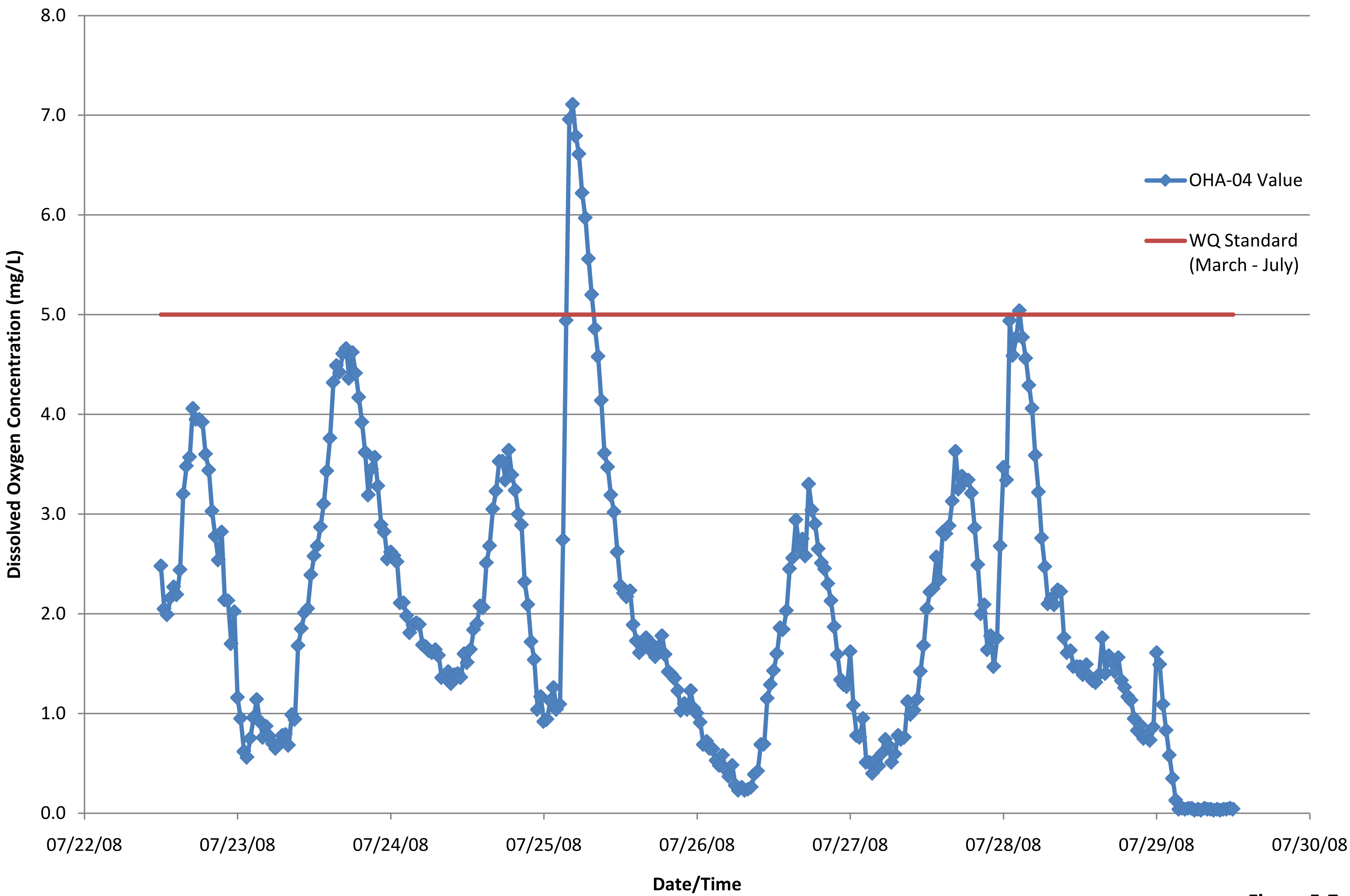


**Figure 5-7**
**Continuous Dissolved Oxygen Data**
**OHA-04 (July 2008)**

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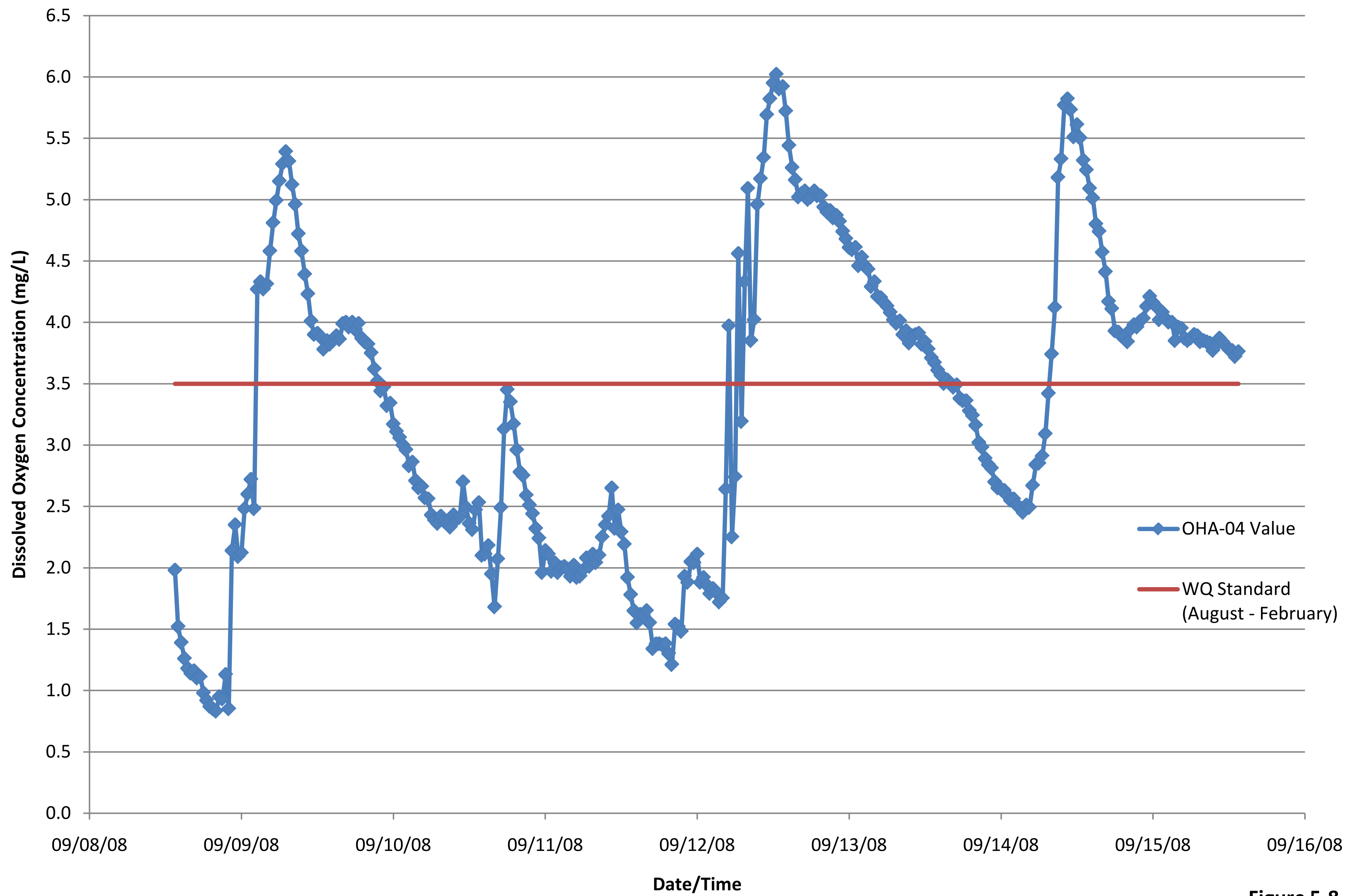


**Figure 5-8**
**Continuous Dissolved Oxygen Data**
**OHA-04 (September 2008)**

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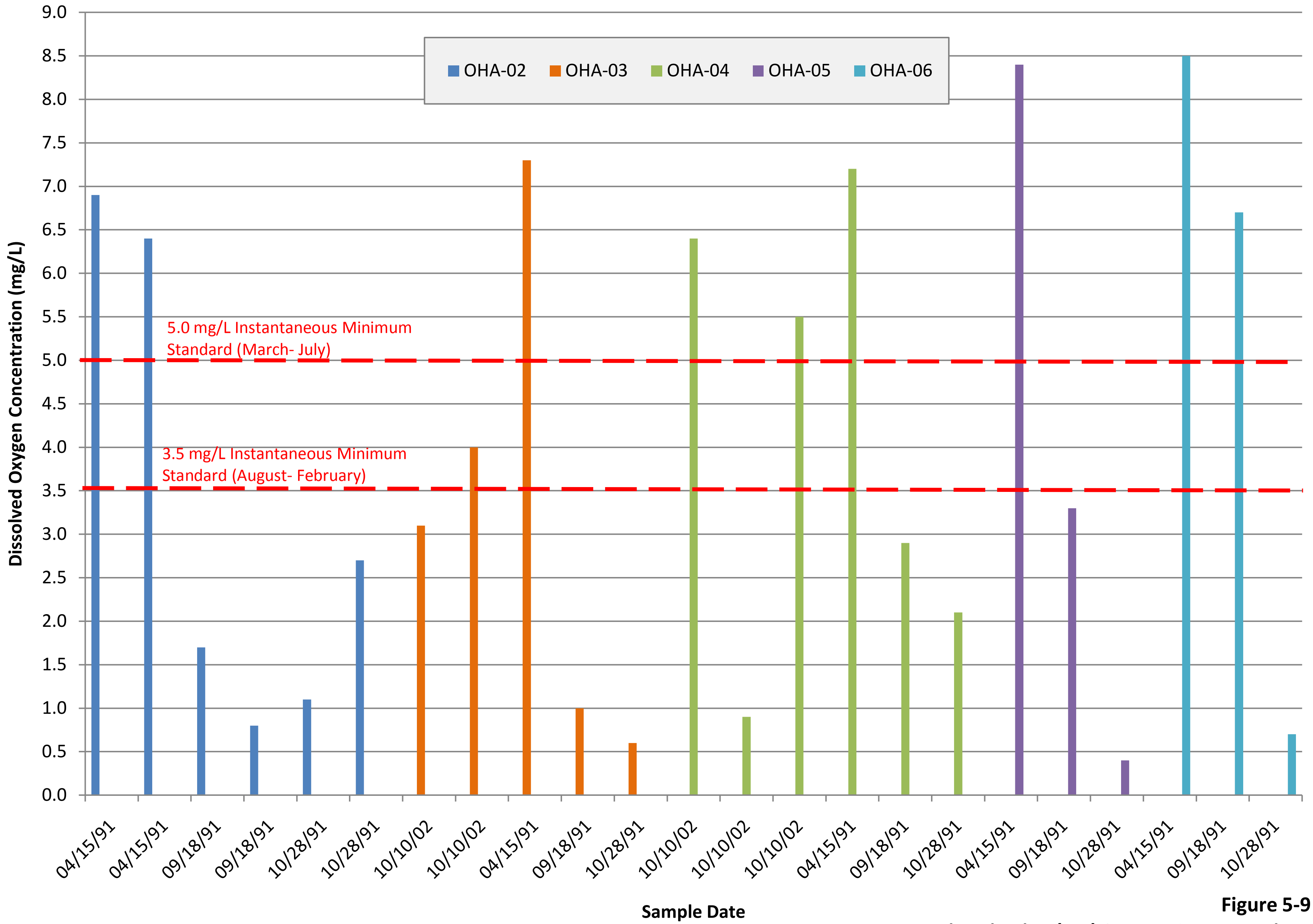


**Figure 5-9**
**Historic Dissolved Oxygen Concentrations**
**Lake Branch**

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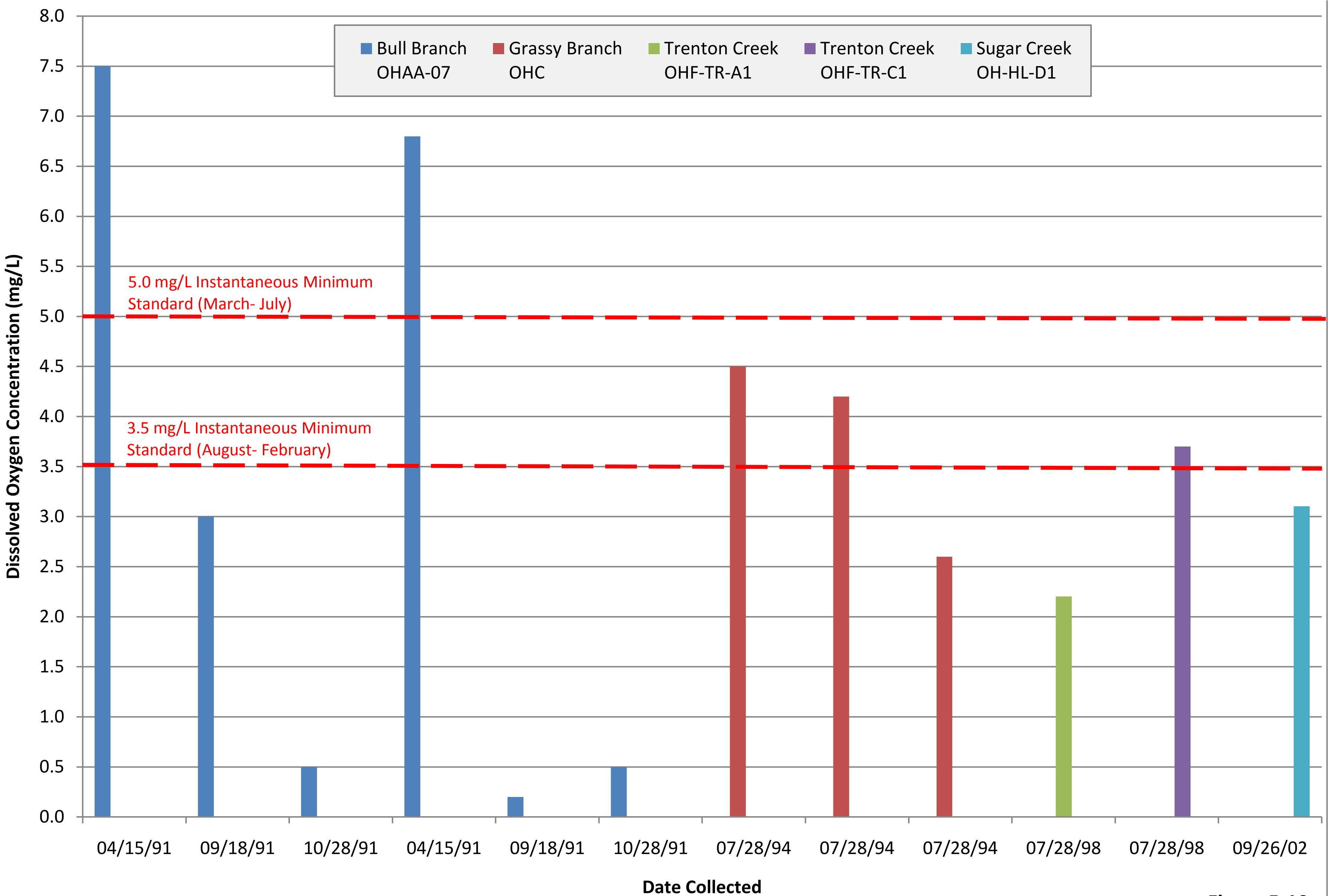


**Figure 5-10**
**Historic Dissolved Oxygen Concentrations**
**Additional Impaired Segments**

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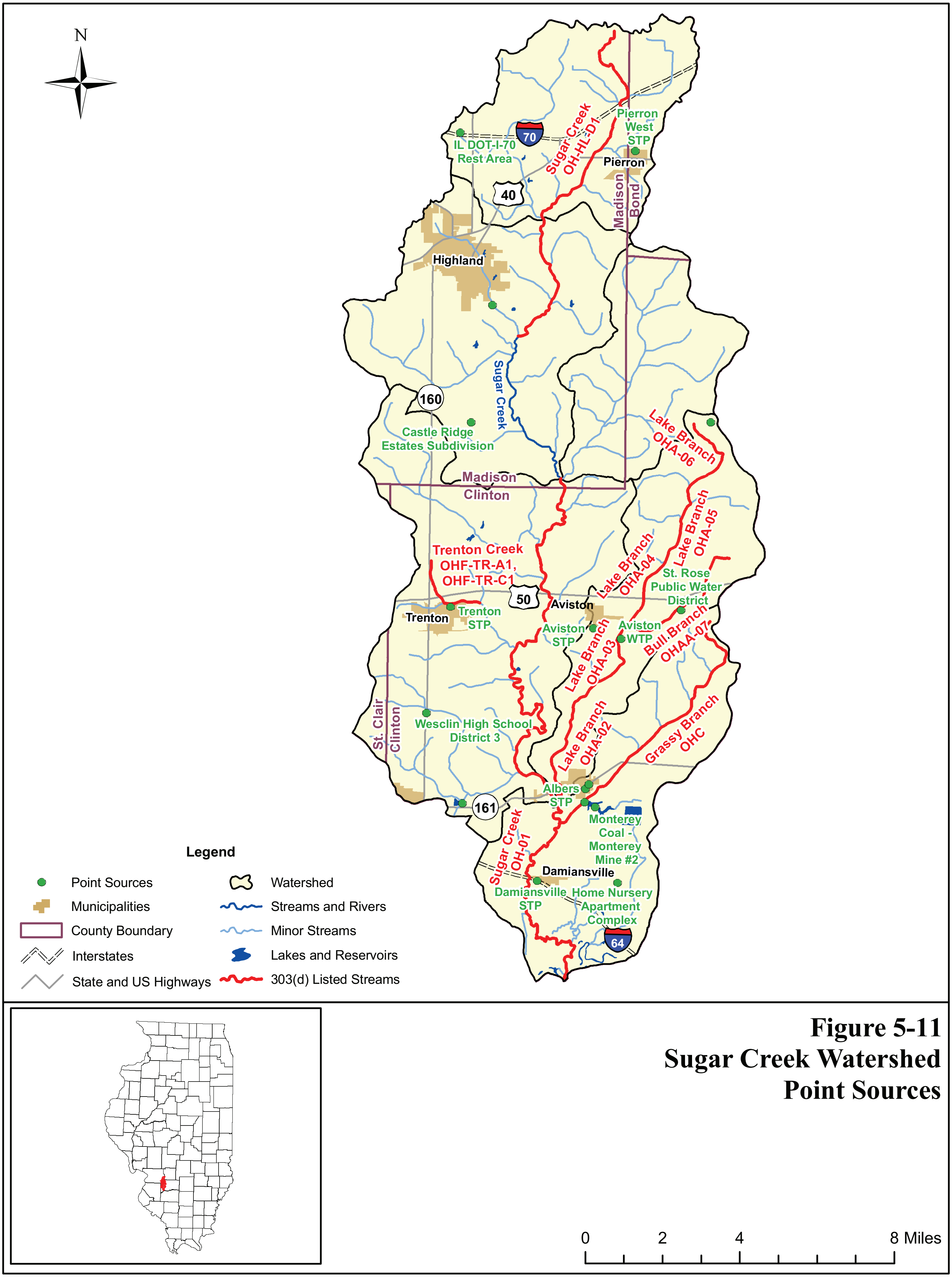


# Figure 5-11
# Sugar Creek Watershed
# Point Sources

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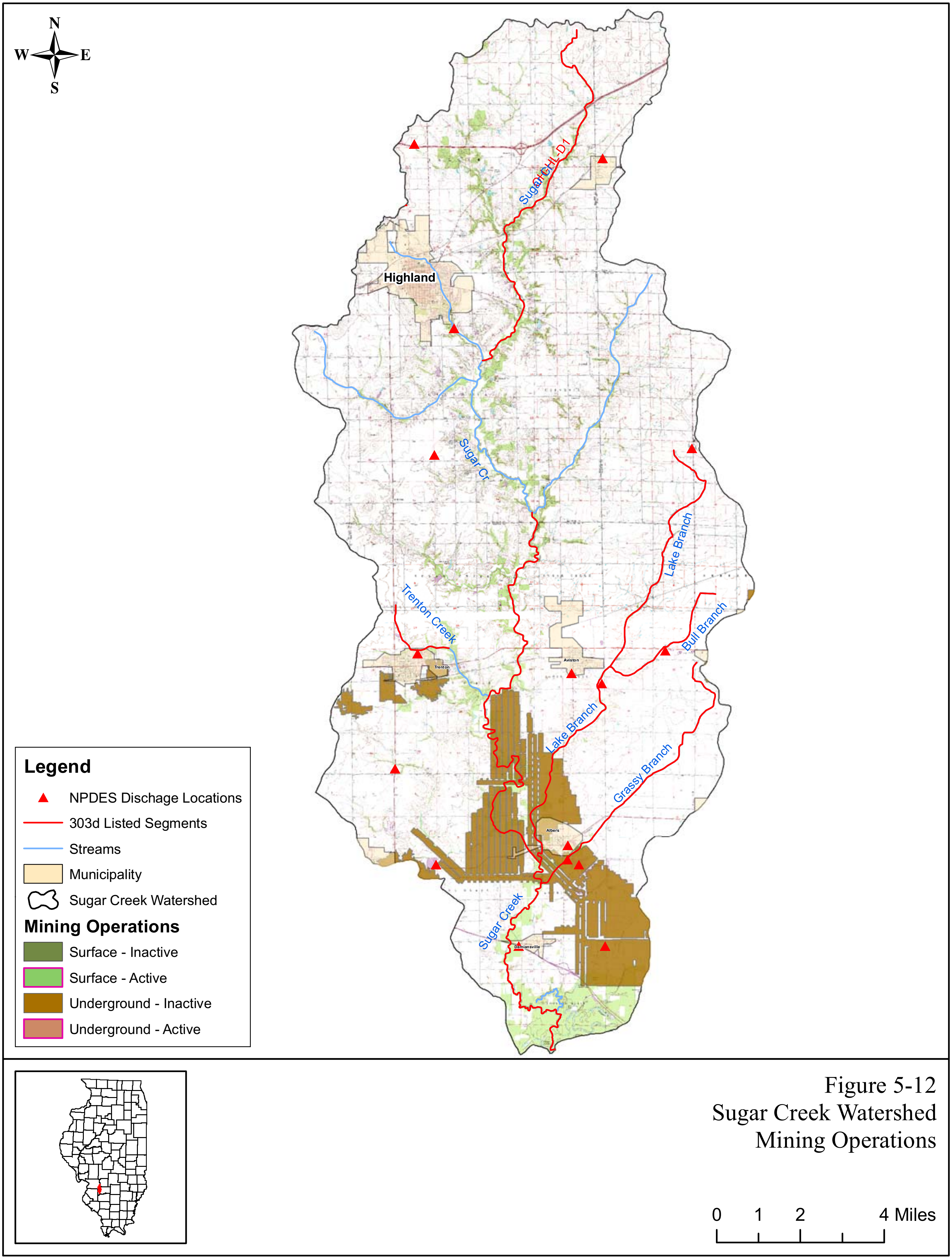


Figure 5-12
Sugar Creek Watershed
Mining Operations

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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 causing impairment to stream segments in the Sugar Creek watershed; manganese, pH, DO, and total fecal coliform are all of the parameters with numeric water quality standards. Refer to Table 1-1 for a full list of potential causes of impairment. Illinois EPA believes that addressing the parameters with numeric standards 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 Sugar Creek watershed except for stream segments where there are 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 Sugar Creek watershed.

## 6.2 Approaches for Developing TMDLs for Stream Segments in Sugar Creek Watershed

### 6.2.1 Recommended Approach for DO TMDLs for Stream Segments

Table 6-1 contains information on the stream segments within the Sugar Creek watershed that are 303(d) listed for impairment caused by low DO.

**Table 6-1 Dissolved Oxygen Data for Impaired Stream Segments**

| Segment | Data Count | Period Of Record |
|---|---|---|
| Sugar Creek Segment OH-01 | 147 | 1990-2005 |
| Lake Branch Segment OHA-02 | 8 | 1991 |
| Lake Branch Segment OHA-03 | 341 | 1991-2008 |
| Lake Branch Segment OHA-04 | 677 | 1991-2008 |
| Lake Branch Segment OHA-05 | 3 | 1991 |
| Lake Branch Segment OHA-06 | 3 | 1991 |
| Bull Branch Segment OHAA-07 | 6 | 1991 |
| Grassy Branch Segment OHC | 3 | 1994 |
| Trenton Creek Segment OHF-TR-A1 | 1 | 1998 |
| Trenton Creek Segment OHF-TR-C1 | 1 | 1998 |
| Sugar Creek Segment OH-HL-D1 | 1 | 2002 |

The data for these segments do suggest impairment of the DO standard. However, spatial data are limited and therefore, additional data collection was recommended to support model development. Specific data requirements include a synoptic (snapshot in time) water quality survey of each reach with careful attention to the location of the point source dischargers. The survey data requirements included measurements of flow, hydraulics, DO, temperature, nutrients, and carbonaceous biochemical oxygen demand (CBOD). Illinois EPA collected some additional data on stream segments OHA-03 and OHA-04 in the Sugar Creek watershed in 2008. The collected data was used to support the model development and parameterization and contributed confidence to the TMDL conclusions for those stream segments with additional data sets..

This newly collected data was used to support the development and parameterization of the QUAL2K model. QUAL2K is an updated spreadsheet-based version of the well-known and USEPA-supported QUAL2E model. The model 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 biochemical oxygen demand (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 suited to steady-state simulations and is believed to be sufficient for developing DO TMDLs for these streams.

### 6.2.2 Recommended Approach for pH TMDL in Sugar Creek Segment OH-01

Segment OH-01 of Sugar Creek is listed for pH impairments. Segment OH-01 had only three violations of the pH standard out of 141 samples. Potential approaches to developing the pH TMDL for this segment include a spreadsheet approach that would take into account natural conditions in the watershed such as soil buffering capacity. A more detailed procedure to develop the pH TMDL would 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. It is assumed that adequate data is available to develop a pH TMDL and further data collection is not needed. Due to the limited nature of the pH dataset, the limited number of reported violations for pH, and the fact that pH is a measure of acidity and/or alkalinity in the stream and not associated with a pollutant load but rather the amount of $H^+$ ion in the solution a TMDL was not calculated for pH. However, it is anticipated that pH issues will be addressed by implementing load reduction strategies for the TMDL pollutants associated with the segment, as outlined in Section 9 of this document.

### 6.2.3 Recommended Approach for Fecal Coliform and Manganese TMDLs

Segment OH-01 of Sugar Creek is listed as impaired by total fecal coliform. Lake Branch segment OHA-03 and Bull Branch segment OHAA-07 are listed for impairment caused by manganese. The recommended approach for developing TMDLs for these segments and parameters was 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. In July and September of 2008, IEPA collected additional samples for manganese at stations OHA-03 and OHAA-07. This data was incorporated into the load duration models for manganese at these segments. No additional fecal coliform data was collected by IEPA at segment OH-01.

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# Section 7
# Methodology Development for the Sugar Creek Watershed

## 7.1 Methodology Overview

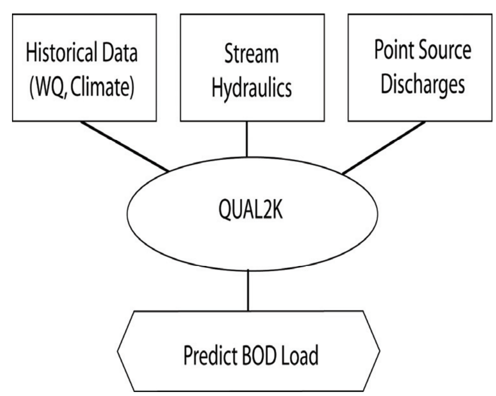
Table 7-1 contains information on the methodologies selected and used to develop TMDLs for impaired segments within the Sugar Creek watershed.

**Table 7-1 Methodologies Used to Develop TMDLs in the Sugar Creek Watershed**

| Segment Name/ID | Causes of Impairment | Methodology |
|---|---|---|
| Sugar Creek - OH-01 | Fecal Coliform | Load Duration Curve |
| Sugar Creek - OH-01 | Dissolved Oxygen | Qual2K |
| Sugar Creek - OH-HL-D1 | Dissolved Oxygen | Qual2K |
| Lake Branch - OHA-02 | Dissolved Oxygen | Qual2K |
| Lake Branch - OHA-03 | Dissolved Oxygen | Qual2K |
| Lake Branch - OHA-03 | Manganese | Load Duration Curve |
| Lake Branch - OHA-04 | Dissolved Oxygen | Qual2K |
| Lake Branch - OHA-05 | Dissolved Oxygen | Qual2K |
| Lake Branch - OHA-06 | Dissolved Oxygen | Qual2K |
| Bull Branch - OHAA-07 | Dissolved Oxygen | Qual2K |
| Bull Branch - OHAA-07 | Manganese | Load Duration Curve |
| Grassy Branch - OHC | Dissolved Oxygen | Qual2K |
| Trenton Creek - (OHC-TR-A1) | Dissolved Oxygen | Qual2K |
| Trenton Creek - (OHC-TR-C1) | Dissolved Oxygen | Qual2K |

### 7.1.1 QUAL2K Overview

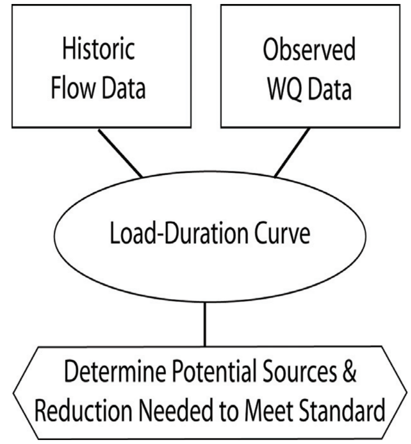
The QUAL2K model was used to develop the dissolved oxygen (DO) TMDL for each of the impaired segments in the Sugar Creek watershed (OH-01, OH-HL-D1, OHA-02, OHA-03, OHA-04, OHA-05, OHA-06, OHAA-07, OHC, OHF-TR-A1, OHF-TR-C1). QUAL2K is a stream water quality model that is one-dimensional and applicable to well-mixed streams. The model assumes steady state hydraulics and allows for point source inputs, diffuse loading and tributary flows. Historic water quality data, observed hydraulic information, and point source discharge data were coupled with model defaults to predict the resulting instream DO concentrations (see Schematic 1).




*Schematic 1*

### 7.1.2 Load-Duration Curve Overview

Loading capacity analyses were performed for each of the stream segments in this watershed impaired by manganese or fecal coliform bacteria (OHA-03, OHAA-07, and OH-01). A load-duration curve is a graphical representation of the maximum load of a pollutant that a stream segment can assimilate over a range of flow scenarios while still meeting the instream water quality standard. The load-duration curve approach utilizes historic flow data and observed water quality data to provide useful information regarding the magnitude and frequency of exceedences as well as the flow scenarios when exceedences occur most often (see Schematic 2). In the Sugar Creek watershed, load duration curves were constructed for manganese and fecal coliform.




*Schematic 2*

## 7.2 Methodology Development

The following sections further discuss and describe the methodologies utilized to examine pH, fecal coliform, manganese, and dissolved oxygen levels in the impaired waterbodies in the Sugar Creek watershed.

### 7.2.1 pH

Sugar Creek segment OH-01 is listed for impairment caused by pH. pH is a measure of acidity and/or alkalinity in the stream and not associated with a pollutant load but rather the amount of $H^+$ ion in the solution. Changes in pH can impact the concentrations of certain metal ions found in the water by altering the solubility of those metals in water. Acidic waters (pH<7.0) are associated with increased capacity to contain dissolved metals and therefore, pH levels and metal concentrations in waters are often closely interrelated. It is anticipated that pH issues will be addressed by implementing load reduction strategies for the TMDL pollutants associated with the segment, as outlined in Section 9 of this document. In addition, the evidence for impairment by pH at Sugar Creek segment OH-01 is minimal with only 1 violation (pH =6.3) reported on January 8, 1997. More recent data has not shown any violations of the pH standard on this segment. Therefore, a specific TMDL calculation for pH on Sugar Creek segment OH-01 will not be developed at this time.

### 7.2.2 QUAL2K Model Development

QUAL2K (Q2K) is a river and stream water quality model that is intended to represent a modernized version of the QUAL2E (Q2E) model (Brown and Barnwell 1987). The original Q2E model is well-known and USEPA-supported. The modernized version has been updated to use Microsoft Excel as the user interface and has expanded the options for stream segmentation as well as a number of other model inputs. Q2K simulates DO dynamics as a function of nitrogenous and carbonaceous oxygen demand, atmospheric reaeration, SOD, and plant photosynthesis and respiration. The model also simulates the fate and transport of nutrients and BOD and the growth and abundance of floating (phytoplankton) and attached (periphyton) algae (as chlorophyll-a). Stream hydrodynamics and temperature are important controlling parameters in the model. Headwater, point source, and non-point source loadings and flows are explicitly input by the user. The model simulates steady-state diurnal cycles.

Model parameter default values are provided in the model based on past studies and are recommended in the absence of site-specific information.

Several separate Q2K models were developed for the DO impaired segments in the Sugar Creek watershed. Lake Branch segments OHA-02, OHA-03, OHA-04, OHA-05, OHA-06 and Bull Branch segment OHAA-07 are contiguous segments with synoptic datasets and where therefore combined into a single QUAL2K model. Likewise, Trenton Creek segments OHF-TR-A1 and OHF-TR-C1 are contiguous segments with synoptic datasets and were both included in the same QUAL2K model setup. The remaining segments (OHC, OH-01, OH-HL-D1) did not include contiguous stream segments and therefore, each segment required an individual Q2K model. A total of five separate Q2K models were developed for the impaired segments in the Sugar Creek watershed.

Because Q2K models simulate steady-state diurnal cycles the TMDL endpoints used for TMDL analysis at each segment were the 7-day average daily minimum water quality standards of 6.0 milligrams per liter (mg/L) (March-July) and 4.0 mg/L (August-February). The use of these standards as a TMDL endpoint, as opposed to the 5.0 mg/L (March-July) and 3.5 mg/L (August-February) instantaneous minimum standards also serves as a conservative measure adding to the implicit MOS included in the final TMDL calculations for each impaired segment (see further discussion in Section 8).

### 7.2.2.1 QUAL2K Inputs

Table 7-2 contains the categories of data required for the Q2K models along with the sources of data used to analyze each of the impaired stream segments in the Sugar Creek watershed.

**Table 7-2 Q2K Data Inputs**

| Input Category | Data Source |
|---|---|
| Stream Segmentation | GIS data |
| Hydraulic characteristics | Aerial photographs; GIS; Illinois EPA field data |
| Headwater conditions | Historic water quality data collected by Illinois EPA |
| Meteorological conditions | National Climatic Data Center |
| Point Source contributions | Illinois EPA, EPA ICIS |

Empirical data amassed during Stage 1 of TMDL development were used to build the Q2K models. In addition to the Stage 1 data, aerial photographs, GIS data and stream cross-section and flow measurements from additional Illinois EPA field data collected in 2008 were used for the Q2K models, where available.

### 7.2.2.2 Lake Branch and Bull Branch Model

Bull Branch (OHAA-07) is a tributary to Lake Branch (OHA-02, OHA-03, OHA-04, OHA-05 and OHA-06) and the impaired segments of each stream are contiguous. The Lake and Bull Branch segments also shared a synoptic dataset, wherein all segments where sampled on the same day (September 18, 1991) during a time of year where low flow and low DO conditions are likely to occur. Therefore, a single Q2K model was developed to encompass all of the impaired segments of Lake Branch and included Bull Branch as a primary tributary in the system.

***7.2.2.2.1 Stream Segmentation - Lake Branch/Bull Branch Model***

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. Lake Branch was divided into six reaches and Bull Branch was added as a tributary consisting of two reaches. The modeled Lake Branch segment extended from Illinois EPA sampling station OHA-06 (approximately 16 km upstream of confluence) to the confluence of Lake Branch with Sugar Creek. The modeled segment of Bull Branch extended from sampling station OHAA-08 (approximately 6 km upstream of Lake Branch) to the confluence of Bull Branch and Lake Branch. Figure 7-2 shows the stream segmentation used for the Lake Branch/Bull Branch Q2K model.

***7.2.2.2.2 Hydraulic Characteristics - Lake Branch/Bull Branch Model***

The majority of stream hydraulics were specified in the model based on an Illinois EPA field survey conducted during Stage 2 sampling conducted in September 2008 under low-flow conditions. Three wetted cross-sections were surveyed by measuring depths, velocities, and widths at multiple points across a transect. The three cross section measurements were conducted at Illinois EPA stations OHA-03, OHA-04, and OHAA-07 (Figure 7-2). Appendix E contains the cross section measurement data supplied by Illinois EPA.

***7.2.2.2.3 Headwater Conditions - Lake Branch/Bull Branch Model***

The model was set up with two headwaters; Lake Branch station OHA-06 and Bull Branch station OHAA-08. The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary condition. Measured concentration data at stations OHA-06 and OHAA-08 on September 18, 1991 were used for the modeled headwater segment. These historic water quality data were used because they were collected during the only large-scale synoptic sampling event on Lake Branch and Bull Branch in the past 20 years and provide an accurate representation of the headwater conditions for each stream at the time of sampling.

The stream flow at the headwaters was estimated for the synoptic sampling data using the area ratio method described in Section 2.6 of this report. Headwater stream flows during the synoptic sampling date were estimated to be 0.409 cubic feet per second (cfs) at OHA-06 and 0.204 cfs at station OHAA-08. These flow rates are representative of the low flow conditions present at the time of synoptic sampling and were entered into the Q2K model.

***7.2.2.2.4 Diffuse Flow - Lake Branch/Bull Branch Model***

Diffuse flow gains were assumed in the system based on surrogate flow gage calculations. The following USGS flow gage was used for these calculations: USGS 05595200 RICHLAND CREEK NEAR HECKER, IL. This gage is regional with watershed landuse and land cover characteristics similar to that of the Sugar Creek watershed. As with the headwater flow calculations, area-weighting calculations were used to estimate flow gains, exclusive of point sources, through the system. These flows were included in the model as diffuse inputs to the system.

***7.2.2.2.5 Climate - Lake Branch/Bull Branch Model***

Q2K requires inputs for climate. Temperature and wind speed data for the synoptic sampling date were obtained from the National Climate Data Center (NCDC). Data from the nearest available weather station (Scott Air Force Base near Belleville, Illinois) were used for the model.

***7.2.2.2.6 Point Sources - Lake Branch/Bull Branch Model***

A total of 4 NPDES permitted point sources discharge within the Lake Branch watershed. Q2K allows user input of point source locations, flow and water quality data. Permit records were reviewed and permitted discharge data were used for model input. Table 7-3 contains information for each facility while the locations of each facility are shown in Figure 7-2. Flow information was available for each discharger; however, permit limit concentration data are available only for parameters that are sampled per permit requirements.

**Table 7-3 Point Source Discharges within the Lake Branch Watershed**

| Facility Name | Permit Number | Permitted Facility Flows | Segment Number |
|---|---|---|---|
| Saint Rose SD STP | ILG580002 | 0.039 mgd | 1 |
| St. Rose Public Water District | ILG640083 | No Discharge | 5 |
| Aviston WTP | ILG640060 | No Discharge | 6 |
| Aviston STP | IL0020001 | 0.167 mgd | 6 |

***7.2.2.2.7 QUAL2K Calibration - Lake Branch/Bull Branch Model***

Sufficient water quality data were available to perform a rudimentary calibration of model kinetic and transport rates. A synoptic data set, spatially distributed data obtained on the same day, were available for a low flow period (September, 1991).This data set was used to calibrate key model kinetic parameters and reach hydraulics. All model kinetic parameters were maintained within the model-recommended ranges during this process (Appendix G). Due to a lack of representative reach hydraulic (cross-section) data for the sampling period, hydraulic parameters (mean velocities and depths) were also treated as calibration parameters. These parameters were varied from the initial values described above in order to achieve the reaeration rates implied by the data and ultimately replicate measured dissolved oxygen profiles. Finally, diffuse flow input concentrations of nutrients and CBOD, as implied by the synoptic data set, were set as part of the calibration process. Final measured versus modeled calibration profiles and simulated reaeration rates are provided in Appendix G.

### 7.2.2.3 Trenton Creek Q2K Model

Trenton Creek has two contiguous segments that are impaired by DO; OHF-TR-A1 and OHF-TR-C1. These segments were sampled by Illinois EPA during a FRSS of the Trenton Sewage Treatment Plant (STP) and therefore, shared a synoptic dataset. Both segments where sampled on the same day (July 29, 1998) during a time of year where low flow and low DO conditions are likely to occur. Therefore, a single Q2K model was developed to encompass both of the impaired segments of Trenton Creek.

***7.2.2.3.1 Stream Segmentation - Trenton Creek Model***

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. In this model, Trenton Creek was divided into 4 reaches. The modeled Trenton Creek segment extended from the upper most point in segment OHF-TR-A1 (approximately 6 km upstream of confluence with Sugar Creek) the lower extent of segment OHF-TR-C3 (approximately 0.5 km upstream of confluence with Sugar Creek). Figure 7-3 shows the stream segmentation used for the Trenton Creek Q2K model.

***7.2.2.3.2 Hydraulic Characteristics - Trenton Creek Model***

No hydraulic data were available for the modeled portion of Trenton Creek. Manning's Equation was used to set initial hydraulic parameters for this segment based on estimated channel width from aerial photographs, channel slope from the NED, and an estimated Manning's roughness coefficient.

***7.2.2.3.3 Diffuse Flow - Trenton Creek Model***

Diffuse flow gains were assumed in the system based on surrogate flow gage calculations. The following USGS flow gage was used for these calculations: USGS 05595200 RICHLAND CREEK NEAR HECKER, IL. This gage is regional with watershed landuse and land cover characteristics similar to that of the Sugar Creek watershed. As with the headwater flow calculations, area-weighting calculations were used to estimate flow gains, exclusive of point sources, through the system. These flows were included in the model as diffuse inputs to the system.

***7.2.2.3.4 Headwater Conditions - Trenton Creek Model***

The model was set up with a single headwater at the upper most extent of the impaired segment OHF-TR-A1. The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary condition. Measured concentration data were not specifically available for the modeled headwater segment. However, historical water quality data collected at sampling site OHA-06 (the headwater station for Lake Branch, approximately 7.5 miles away) were available and were used as a surrogate headwater concentration data set. Only water quality data collected in the months of July, August, September, and October were used for this model. Due to the relative proximity of the surrogate headwater location, along with the similar land use and flow regime characteristics in both headwaters, it was assumed that data collected at the sampling location were representative of conditions at the headwaters.

The stream flow at the headwaters was estimated for the synoptic sampling date using the area ratio method described in Section 2.6 of this report. Headwater stream flow during the synoptic sampling date was estimated to be 0.06 cfs. This flow rate is deemed representative of the low flow conditions present at the time of synoptic sampling were entered into the Q2K model.

#### *7.2.2.3.5 Climate - Trenton Creek Model*

Q2K requires inputs for climate. Temperature and wind speed data for the synoptic sampling date were obtained from the NCDC. Data from the nearest available weather station (Scott Air Force Base near Belleville, Illinois) were used for the model.

#### *7.2.2.3.6 Point Sources - Trenton Creek Model*

Trenton STP (permit number IL0026701) is the only NPDES permitted point source discharges within the Trenton Creek watershed. Permit records were reviewed and permitted discharge data were used for model input. The location of the Trenton STP facility is shown in Figure 7-3. The facility has a permitted flow of 0.5 mgd, which enters Trenton Creek at reach 3 of the Q2K model. Permit limit concentration data were available only for parameters that are sampled per permit requirements.

#### *7.2.2.3.7 QUAL2K Calibration - Trenton Creek Model*

Sufficient water quality data were available to perform a rudimentary calibration of model kinetic and transport rates. A synoptic data set, spatially distributed data obtained on the same day, were available for a low flow period (July, 1998).This data set was used to calibrate key model kinetic parameters and reach hydraulics. All model kinetic parameters were maintained within model recommended ranges during this process (Appendix G). Due to a lack of representative reach hydraulic (cross-section) data for the sampling period, hydraulic parameters (mean velocities and depths) were also treated as calibration parameters. These parameters were varied from the initial values described above in order to achieve the reaeration rates implied by the data and ultimately replicate measured dissolved oxygen profiles. Finally, diffuse flow input concentrations of nutrients and CBOD, as implied by the synoptic data set, were set as part of the calibration process. Final measured vs. modeled calibration profiles, and simulated reaeration rates, are provided in Appendix G.

### 7.2.2.4 Grassy Branch Q2K Model

Grassy Branch consists of a single segment (OHC) which is impaired for dissolved oxygen. This segment was sampled by Illinois EPA during a FRSS of the Albers STP and a synoptic dataset consisting of five sampling locations on the OHC segment was available. All 5 stations were sampled on the same day (July 28, 1994) during a time of year where low flow and low DO conditions are likely to occur. This FRSS data was used to setup and calibrate the Q2K model for Grassy Branch.

#### *7.2.2.4.1 Stream Segmentation - Grassy Branch Model*

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. In this model, Grassy Branch was divided into four reaches, as shown in Figure 7-4. The modeled portion of Grassy Branch extends from upstream end of the impaired OHC segment (approximately 12.5 km upstream of confluence) to the confluence of Grassy Branch with Sugar Creek.

***7.2.2.4.2 Hydraulic Characteristics - Grassy Branch Model***

No hydraulic data were available for Grassy Branch. Manning's Equation was used to set initial hydraulic parameters for this segment based on estimated channel width from aerial photographs, channel slope from the NED, and an estimated Manning's roughness coefficient.

***7.2.2.4.3 Headwater Conditions - Grassy Branch Model***

The model was set up with a single headwater at the upper most extent of the impaired segment OHC. The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary condition. Measured concentration data were not specifically available for the modeled headwater segment. However, historic water quality data collected at sampling site OHC-AL-A1 (Grassy Branch upstream of Albers STP) were available and were used as a surrogate headwater concentration data set. Only water quality data collected in the months of July, August, September, and October were used for this model.

The stream flow at the headwaters was estimated for the synoptic sampling date using the area ratio method described in Section 2.6 of this report. Headwater stream flow during the synoptic sampling date was estimated to be 0.14 cfs. This flow rate is representative of the low flow conditions present at the time of synoptic sampling were entered into the Q2K model.

***7.2.2.4.4 Diffuse Flow - Grassy Branch Model***

Diffuse flow gains were assumed in the system based on surrogate flow gage calculations. The following USGS flow gage was used for these calculations: USGS 05595200 RICHLAND CREEK NEAR HECKER, IL. This gage is regional with watershed land-use and land cover characteristics similar to that of the Sugar Creek watershed. As with the headwater flow calculations, area-weighting calculations were used to estimate flow gains, exclusive of point sources, through the system. These flow were included in the model as diffuse inputs to the system.

***7.2.2.4.5 Climate- Grassy Branch Model***

Q2K requires inputs for climate. Temperature and wind speed data for the synoptic sampling date were obtained from the NCDC. Data from the nearest available weather station (Scott Air Force Base near Belleville, Illinois) were used for the model.

***7.2.2.4.6 Point Sources - Grassy Branch Model***

Albers STP (permit number ILG580017) and Monterey Coal Company Mine #2 (permit number IL0048691) are the only NPDES permitted point sources within the Trenton Creek watershed. Permit records were reviewed and permitted discharge data were used for model input. Albers STP has an average discharge of 0.0907 mgd and Monterey Coal Company is a stormwater discharge permit with a 0 mgd average discharge. Figure 7-4 shows the locations of the NPDES discharges. Permit limit concentration data were available only for parameters that are sampled per permit requirements.

#### *7.2.2.4.7 QUAL2K Calibration - Grassy Branch Model*

Sufficient water quality data were available to perform a rudimentary calibration of model kinetic and transport rates. A synoptic data set, spatially distributed data obtained on the same day, were available for a low flow period (July, 1994).This data set was used to calibrate key model kinetic parameters and reach hydraulics. All model kinetic parameters were maintained within model recommended ranges during this process (Appendix G). Calibrated kinetic parameters are in close agreement with those calibrated for other reaches in this watershed (described above). Due to a lack of representative reach hydraulic (cross-section) data for the sampling period, hydraulic parameters (mean velocities and depths) were also treated as calibration parameters. These parameters were varied from the initial values described above in order to achieve the reaeration rates implied by the data and ultimately replicate measured dissolved oxygen profiles. Finally, diffuse flow input concentrations of nutrients and CBOD, as implied by the synoptic data set, were set as part of the calibration process. Final measured vs. modeled calibration profiles, and simulated reaeration rates, are provided in Appendix G.

### 7.2.2.5 Upper Sugar Creek Q2K Model

The main stem of Sugar Creek has two impaired segments (OH-HL-D1 and OH-01) that are impaired for dissolved oxygen; however, these segments are not contiguous and did not have a synoptic dataset. Therefore, two separate Q2K models were developed for the main stem of Sugar Creek termed “Upper Sugar Creek” and “Lower Sugar Creek” for the purposes of this report. Upper Sugar Creek segment OH-HL-D1has a very limited data set that consists of a single sample collected as part of a Facility Related Stream Study (FRSS) of the Highland STP. The station was sampled on September 26, 2002; a time of year where low flow and low DO conditions are likely to occur.

#### *7.2.2.5.1 Stream Segmentation - Upper Sugar Creek Model*

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. In this model, segment OH-HL-D1 was divided into 3 reaches. The modeled segment of Upper Sugar Creek extends from the downstream extent of segment OH-HL-D1 at the confluence with Sewer Creek to the upstream extent of segment OH-HL-D1, approximately 16.8 km upstream of the confluence with Sewer Creek. Figure 7-5 shows the stream segmentation used for the OH-HL-D1 model.

#### *7.2.2.5.2 Hydraulic Characteristics - Upper Sugar Creek Model*

The majority of stream hydraulics were initially specified in the model based on an Illinois EPA field survey conducted in September 2002 under low-flow conditions. One wetted cross-section was surveyed by measuring depths, velocities, and widths at multiple points across the transect. The cross section measurements were conducted at Illinois EPA stations OH-HL-D1 (Figure 7-5). Appendix E contains the cross section measurement data supplied by Illinois EPA.

### *7.2.2.5.3 Headwater Conditions - Upper Sugar Creek Model*

The model was set up with a single headwater at the upper most extent of the impaired segment OH-HL-D1. The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary condition. Measured concentration data were not specifically available for the modeled headwater segment. However, historical water quality data collected at sampling site OHA-06 (the headwater station for Lake Branch, approximately 12 miles away) were available and were used as a surrogate headwater concentration data set. Only water quality data collected in the months of July, August, September, and October were used for this model. Due to the relative proximity of the surrogate headwater location, along with the similar land use and flow regime characteristics in both headwaters, it was assumed that data collected at the sampling location were representative of conditions at the headwaters.

The stream flow at the headwaters was estimated for the sampling date using the area ratio method described in Section 2.6 of this report. Headwater stream flow during the synoptic sampling date was estimated to be 0.0004 cfs based on the measured flow rate of 0.301 cfs at station OH-HL-D1. This flow rate is essentially zero flow and is expected to be representative of the low flow conditions present at the time of synoptic sampling were entered into the Q2K model.

### *7.2.2.5.4 Diffuse Flow - Upper Sugar Creek Model*

No significant diffuse flow gains were assumed in this short reach model.

### *7.2.2.5.5 Climate - Upper Sugar Creek Model*

Q2K requires inputs for climate. Temperature and wind speed data for the synoptic sampling date were obtained from the NCDC. Data from the nearest available weather station (Scott Air Force Base near Belleville, Illinois) were used for the model.

### *7.2.2.5.6 Point Sources - Upper Sugar Creek Model*

A total of 2 NPDES permitted point sources discharge within the OH-HL-D1 watershed. Q2K allows user input of point source locations, flow and water quality data. Permit records were reviewed and permitted discharge data were used for model input. Table 7-4 contains information for each facility while Figure 7-5 shows the locations of each facility. Flow information was available for each discharger; however, permit limit concentration data are available only for parameters that are sampled per permit requirements.

**Table 7-4 Point Source Discharges within the OH-HL-D1 Watershed**

| Facility Name | Permit Number | Permitted Facility Flows | Segment Number |
|---|---|---|---|
| Pierron West STP | ILG580137 | 0.0429 mgd | 2 |
| IL DOT I-70 Rest Area | ILG551027 | 0.0280 mgd | 3 |

### *7.2.2.5.7 QUAL2K Calibration - Upper Sugar Creek Model*

The limited water quality data available for this segment were sufficient to perform a rudimentary calibration of model kinetic and transport rates. The available data set was collected during a period of low flow on September 26, 2002.This data set was used to calibrate key model kinetic parameters and reach hydraulics. All model kinetic parameters were maintained within model recommended ranges during this process (Appendix G). Calibrated kinetic parameters are in close agreement with those calibrated for other reaches in this watershed (described above). Due to the limited representative reach hydraulic (cross-section) data for the sampling period, hydraulic parameters (mean velocities and depths) were also treated as calibration parameters. These parameters were varied from the initial values described above in order to achieve the reaeration rates implied by the data and ultimately replicate measured dissolved oxygen profiles. Final measured vs. modeled calibration profiles, and simulated reaeration rates, are provided in Appendix G.

### 7.2.2.6 Lower Sugar Creek Q2K Model

The main stem of Sugar Creek has two impaired segments (OH-HL-D1 and OH-01) that are impaired for dissolved oxygen; however, these segments are not contiguous and did not have a synoptic dataset. The separate Q2K model developed for Lower Sugar Creek is discussed in this section of the report. Lower Sugar Creek segment OH-01 has a more robust data set that consists of a multiple sample dates at the single station within the impaired segment as well as synoptic data for an upstream point (OH-05) that served as a headwater condition. The Q2K model was setup and calibrated using data from July 24, 2002. This represents the most recent date in which both stations were sampled at time of year where low flow and low DO conditions are likely to occur.

#### *7.2.2.6.1 Stream Segmentation - Lower Sugar Creek Model*

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. In this model, Lower Sugar Creek was divided into 3 reaches. The modeled segments of Lower Sugar Creek extend from the confluence of Sugar Creek with the Kaskaskia River to the headwater station OH-05, approximately 40 km upstream. Figure 7-6 shows the stream segmentation used for the Lower Sugar Creek Q2K model. Three major tributaries to this reach, Trenton Creek, Lake Branch, and Grassy Branch were explicitly modeled in separated Q2K files (described above). Simulated flows and concentrations from the termini of these tributary models were included as steady point sources to the Lower Sugar Creek model.

#### *7.2.2.6.2 Hydraulic Characteristics - Lower Sugar Creek Model*

No hydraulic data were available for the modeled portion Lower Sugar Creek. The Manning's Equation was used to drive hydraulics for this segment based on estimated channel width from aerial photographs, channel slope from the National Elevation Dataset, and an estimated Manning's roughness coefficient.

#### *7.2.2.6.3 Headwater Conditions - Lower Sugar Creek Model*

The model was set up with one headwater station (OH-05) upstream of the impaired OH-01segment of Sugar Creek. The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary condition. Measured concentration data at station OH-05 on July 24, 2002 were used for the modeled headwater segment. These historical water quality data were used because they represent the most recent date where synoptic sampling occurred on the modeled segment of Lower Sugar Creek.

The stream flow at the headwaters was estimated for the synoptic sampling data using the area ratio method described in Section 2.6 of this report. Headwater stream flows during the synoptic sampling date were estimated to be 4.3 cfs at OH-05. This flow rate is representative of the low flow conditions present at the time of synoptic sampling were entered into the Q2K model.

***7.2.2.6.4 Diffuse Flow - Lower Sugar Creek***

Diffuse flow gains were indirectly incorporated into the Lower Sugar Creek model though the inclusion of all major tributary inputs to the Sugar Creek mainstem. As described above, these tributaries were modeled separately and included diffusive flow gains calculated using surrogate flow gage data and drainage area ratios.

***7.2.2.6.5 Climate - Lower Sugar Creek Model***

Q2K requires inputs for climate. Temperature and wind speed data for the synoptic sampling date were obtained from the NCDC. Data from the nearest available weather station (Scott Air Force Base near Belleville, Illinois) were used for the model.

***7.2.2.6.6 Point Sources- Lower Sugar Creek Model***

A total of 14 NPDES permitted point sources discharge within the Sugar Creek watershed. Q2K allows user input of point source locations, flow and water quality data. Permit records were reviewed and permitted discharge data were used for model input. Table 7-5 contains information for each facility while Figure 7-6 shows the locations of each facility. Flow information was available for each discharger; however, permit limit concentration data are available only for parameters that are sampled per permit requirements. Additionally, as described above, major tributary inputs, simulated separately, were included as point sources in this model.

**Table 7-5 Point Source Discharges within the Sugar Creek Watershed**

| Facility Name | Permit Number | Average Facility Flows | Segment Number |
|---|---|---|---|
| ALBERS STP | ILG580017 | 0.091 mgd | 3 |
| AVISTON STP | IL0020001 | 0.167 mgd | 3 |
| CASTLE RIDGE ESTATES SUBDIVSN | IL0075388 | 0.018 mgd | 1 |
| DAMIANSVILLE STP | IL0063762 | 0.060 mgd | 3 |
| HIGHLAND STP | IL0029173 | 1.6 mgd | 1 |
| HOME NURSERY APARTMENT COMPLEX | IL0070238 | No discharge | 3 |
| IL DOT-I-70 REST AREA | ILG551027 | 0.028 mgd | 1 |
| MONTEREY COAL-MONTEREY MINE #2 | IL0048691 | No discharge | 3 |
| NEW BADEN STP | IL0032603 | 0.780 mgd | 3 |
| PIERRON WEST STP | ILG580137 | 0.043 mgd | 1 |
| SAINT ROSE SD STP | ILG580002 | 0.039 mgd | 3 |
| ST. ROSE PUBLIC WATER DISTRICT | ILG640083 | 0.004 mgd | 3 |
| TRENTON STP | IL0026701 | 0.500 mgd | 3 |
| WESCLIN HIGH SCHOOL DIST 3 | ILG551011 | 0.020 mgd | 3 |

#### *7.2.2.6.7 QUAL2K Calibration - Lower Sugar Creek Model*

Sufficient water quality data were available to perform a rudimentary calibration of model kinetic and transport rates. A synoptic data set, spatially distributed data obtained on the same day, were available for a low flow period (July, 2002).This data set was used to calibrate key model kinetic parameters and reach hydraulics. All model kinetic parameters were maintained within model recommended ranges during this process (Appendix G). Calibrated kinetic parameters are in close agreement with those calibrated for other reaches in this watershed (described above). Due to a lack of representative reach hydraulic (cross-section) data for the sampling period, hydraulic parameters (mean velocities and depths) were also treated as calibration parameters. These parameters were varied from the initial values described above in order to achieve the reaeration rates implied by the data and ultimately replicate measured dissolved oxygen profiles. Final measured vs. modeled calibration profiles, and simulated reaeration rates, are provided in Appendix G.

## 7.2.3 Load Duration Curve Development

Load duration curves are used to gain understanding of the range of loads allowable throughout the flow regime of a stream. This approach was used to characterize the current loading of fecal coliform bacteria to impaired segment OH-01 of Sugar Creek and to characterize the loading of manganese to impaired segments OHA-03 of Lake Branch and OHAA-07 of Bull Branch.

### 7.2.3.1 Watershed Delineation and Flow Estimation

Watersheds for the areas contributing directly to the impaired stream segments at the Illinois EPA data collection stations were delineated with GIS analyses through use of the NED as discussed in Section 2.2 of this report. The delineation determined that Sugar Creek segment OH-01 captures flows from a directly contributing watershed of approximately 124 square miles. Lake Branch segment OHA-03 captures flows from a directly contributing watershed of 14.8 square miles and the watershed for Bull Branch segment OHAA-07 is 2.9 square miles. Figure 7-7 shows the location of the water quality stations on each segment as well as the boundary of the GIS-delineated watersheds.

In order to create a load duration curve, it is necessary to obtain flow data corresponding to each water quality sample. As discussed in Section 2.6.3 of this report, there are no USGS stream gages within the watershed that have current, or even recent, streamflow data. Therefore, the drainage area ratio method, represented by the following equation, was used to estimate flows.

$$Q_{gaged}\left(\frac{Area_{ungaged}}{Area_{gaged}}\right) = Q_{ungaged}$$

where $Q_{gaged}$ = Streamflow of the gaged basin
$Q_{ungaged}$ = Streamflow of the ungaged basin
$Area_{gaged}$ = Area of the gaged basin
$Area_{ungaged}$ = Area of the ungaged basin

The assumption behind the equation is that the flow per unit area is equivalent in watersheds with similar characteristics. Therefore, the flow per unit area in the gaged watershed multiplied by the area of the ungaged watershed estimates the flow for the ungaged watershed.

USGS gage 05595200 (Richland Creek near Hecker, Illinois) was chosen as an appropriate gage from which to estimate flows for all impaired stream segments in the Sugar Creek watershed. The Richland Creek watershed is approximately 21 miles southwest of the Sugar Creek watershed. The gage drains an area of 129 square miles, which is the smallest and most similar watershed area of any of the USGS gages in the region of the state to the impaired segment watershed areas. The contributing watershed areas for stations OH-01, OHA-03, and OHAA-07 are 124.2 square miles, 14.9 square miles, and 2.9 square miles, respectively. GIS analysis shows that the surrogate gage watershed has similar land use, soils, and topography as the Sugar Creek watershed and also receives comparable precipitation throughout the year.

Data were downloaded through the USGS for the Richland Creek gage and multiplied by the area ratio method discussed above to estimate flows for each watershed. Eight of the nine NPDES permitted facilities in the Richland Creek watershed have measureable average permitted discharge flow rates. The total average discharge from the NPDES permitted facilities in the Richland Creek watershed is approximately 12.1 mgd. These flows were subtracted from the gage to account for point source influence. There are 2 NPDES permitted discharges in the OHA-03 watershed, producing a total average discharge of 0.17 mgd. One permitted outfall exists in the OHAA-07 watershed, contributing a average of 0.004 mgd to the stream flow. Segment OH-01 has 6 NPDES permitted discharges contributing an average of 1.67 mgd of effluent discharge. These flows are added to the estimate flows from surrogate gage calculations for each watershed to account for the influence of NPDES discharge volumes on stream flow in the impaired segments. Spreadsheets used for the area ratio flow calculations are provided in Appendix D.

#### 7.2.3.2 Manganese: Lake Branch OHA-03 and Bull Branch OHAA-07

Flow duration curves for each impaired segment were generated by ranking the estimated daily flow data generated through the area ratio method discussed above, determining the percent of days these flows were exceeded, and then graphically plotting the results. The flows in the duration curve were then multiplied by the water quality standard for manganese to generate a load duration curve. The general use water quality standard for manganese is 1.0 mg/L (302.208(g)).

Data collected from USEPA STORET and Illinois EPA databases during Stage 1 of TMDL development and additional data collected by Illinois EPA in 2008 and 2009 were paired with the corresponding flow for the sampling dates and plotted against the load duration curves. Figures 7-8 and 7-9 show the load duration curves as solid lines and the historically observed pollutant loads for manganese as points on each graph. In addition, zones are shown on each figure to provide information on flow regimes. Both stream segments have annual periods of zero-flow, therefore, the flow regime categories were shifted from the typical $25^{th}$, $50^{th}$, and $75^{th}$ percentile brackets to represent only periods of the year with measurable flow.

Although 4 additional samples were collected; one sample on each of the manganese-impaired segments in 2008-2009, the available datasets remain somewhat limited within the watershed. Segment OHA-03 has had a total of only 11 samples for manganese collected since 1990 and a total of only 10 samples have been collected in that time period on segment OHAA-07. The load duration curve for manganese on segment OHA-03 shows that, out of the 11 total samples collected since 1990, only 1 sample exceeded the total manganese standard of 1.0 mg/L (or 1,000 micrograms per liter [µg/L]). The single exceedence reported on segment OHA-03 occurred under minimal-flow conditions. One exceedence of the manganese standard has been reported at OHAA-07 since 1990. This exceedence occurred under moist conditions, at relatively high flow estimates. Spreadsheets used for the calculation of manganese load duration curves are provided in Appendix G.

#### 7.2.3.3 Fecal Coliform: Sugar Creek OH-01

A flow duration curve for fecal coliform was developed for Sugar Creek segment OH-01 by determining the percent of days each estimated flow was exceeded, and then graphically plotting the results. Because the fecal coliform standard is seasonal and is only applicable between the months of May and October, only flows during this time period were used in the analysis. The flows in the duration curve were then multiplied by the water quality standard of 200 cfu/100mL to generate a load duration curve. Fecal coliform data collected between May and October were compiled from data amassed during Stage 1 of TMDL development. These data were then paired with the corresponding flows for the sampling dates and plotted against the load duration curve. Figure 7-10 shows the load duration curve for the segment as a solid line and the observed pollutant loads as points on the graphs. The flow regime categories shown on these figures were shifted from the typical 25th, 50th, and 75th percentile brackets to represent only periods of the year with measurable flow.

The load duration curve for fecal coliform indicates, since 1990, 56 of the 60 samples collected between the months of May and October have exceeded the geometric mean standard of 200 cfu/100mL. Exceedences of the fecal coliform standard at OH-01 occurred at all flow levels. Appendix F contains spreadsheets used for the calculation of the load duration curves for fecal coliform at Sugar Creek segment OH-01.

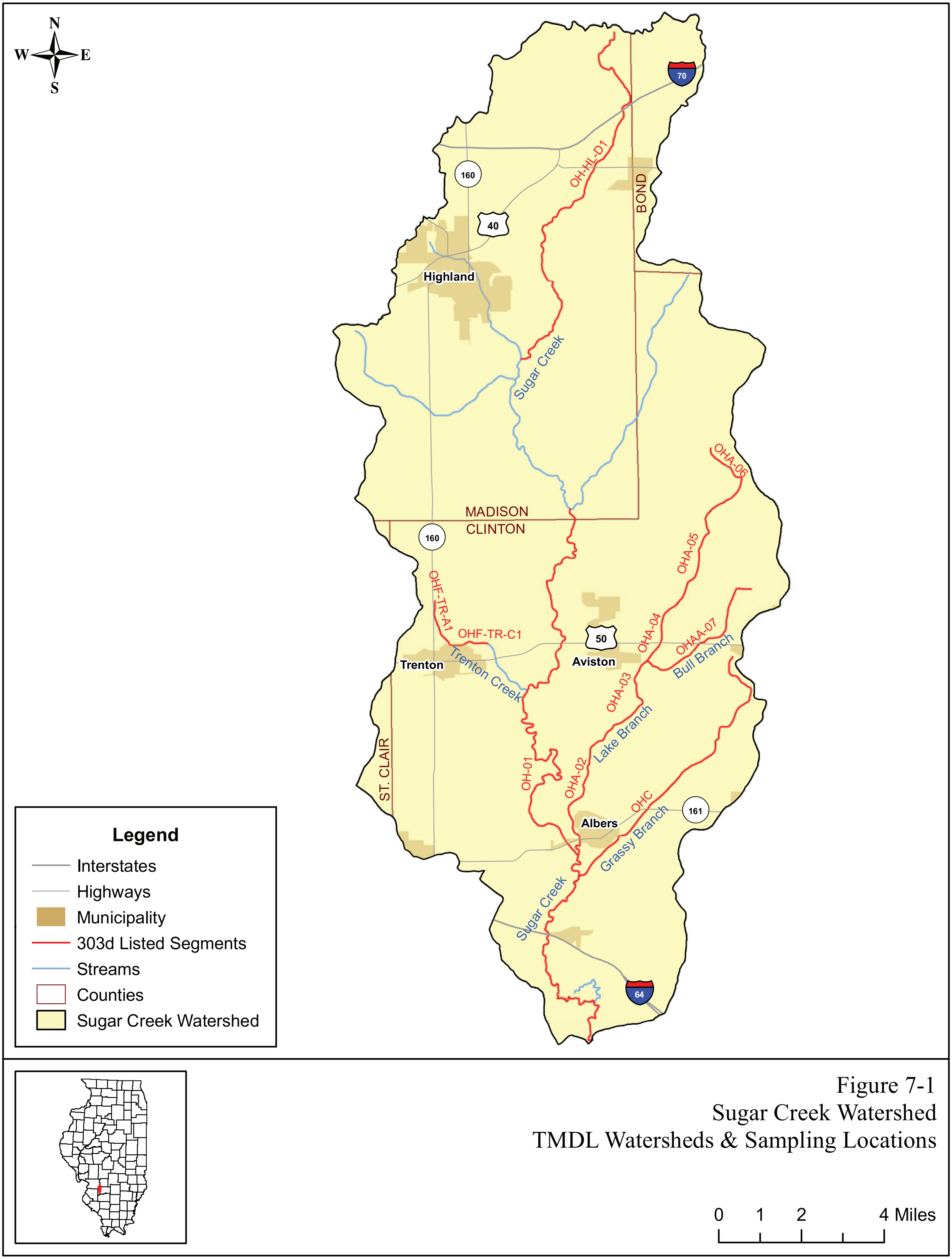



Figure 7-1
Sugar Creek Watershed
TMDL Watersheds & Sampling Locations

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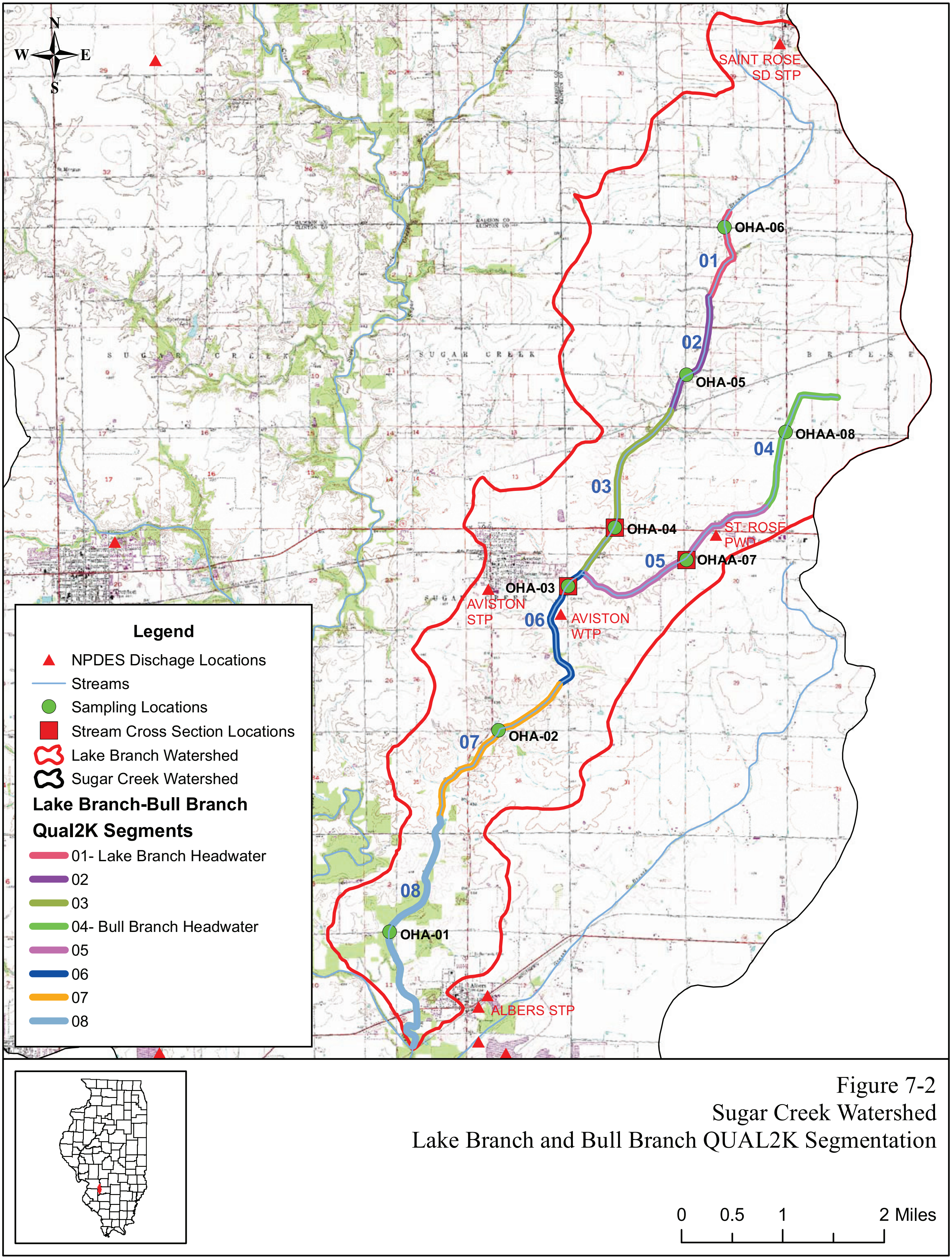


Figure 7-2
Sugar Creek Watershed
Lake Branch and Bull Branch QUAL2K Segmentation

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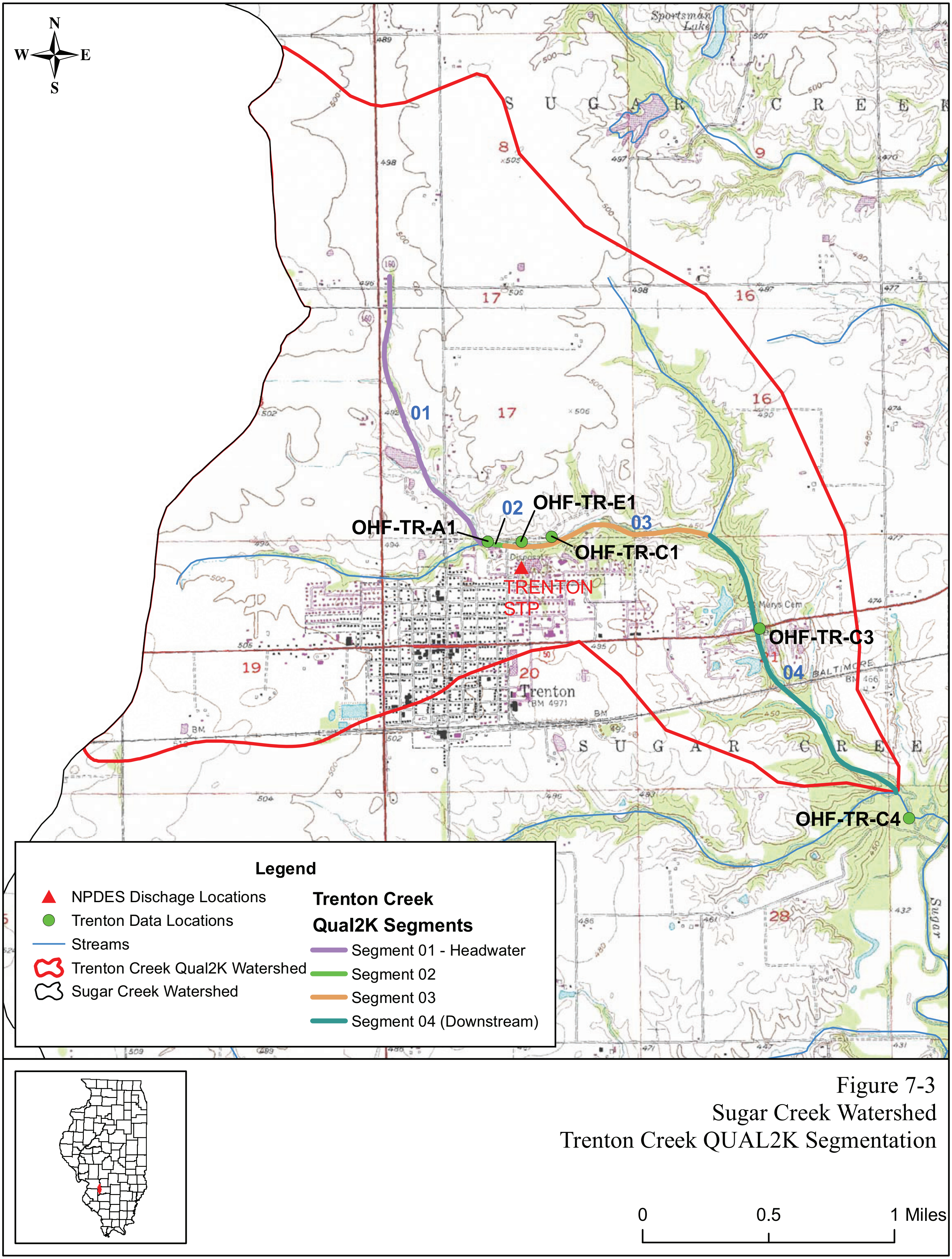


Figure 7-3
Sugar Creek Watershed
Trenton Creek QUAL2K Segmentation

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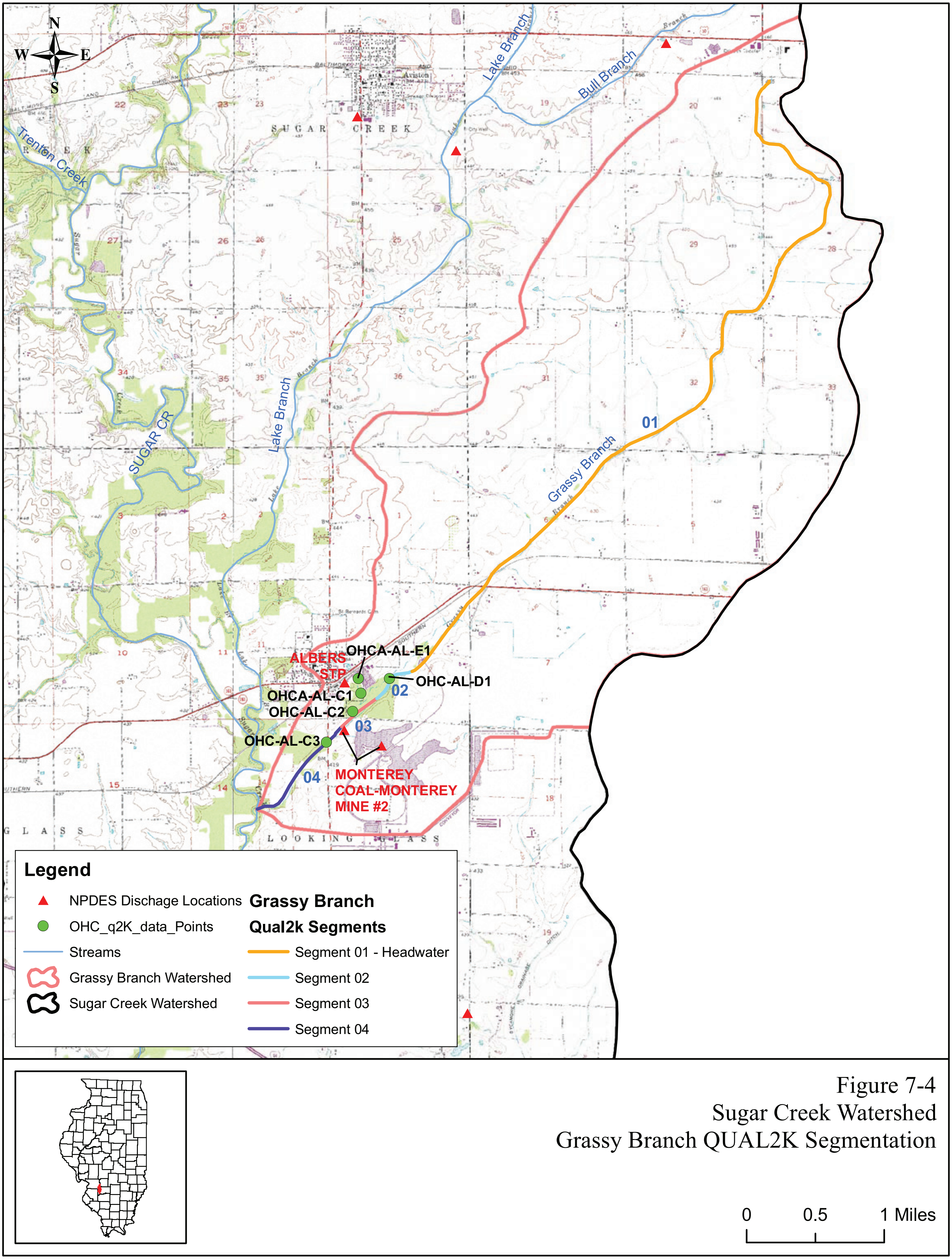


Figure 7-4
Sugar Creek Watershed
Grassy Branch QUAL2K Segmentation

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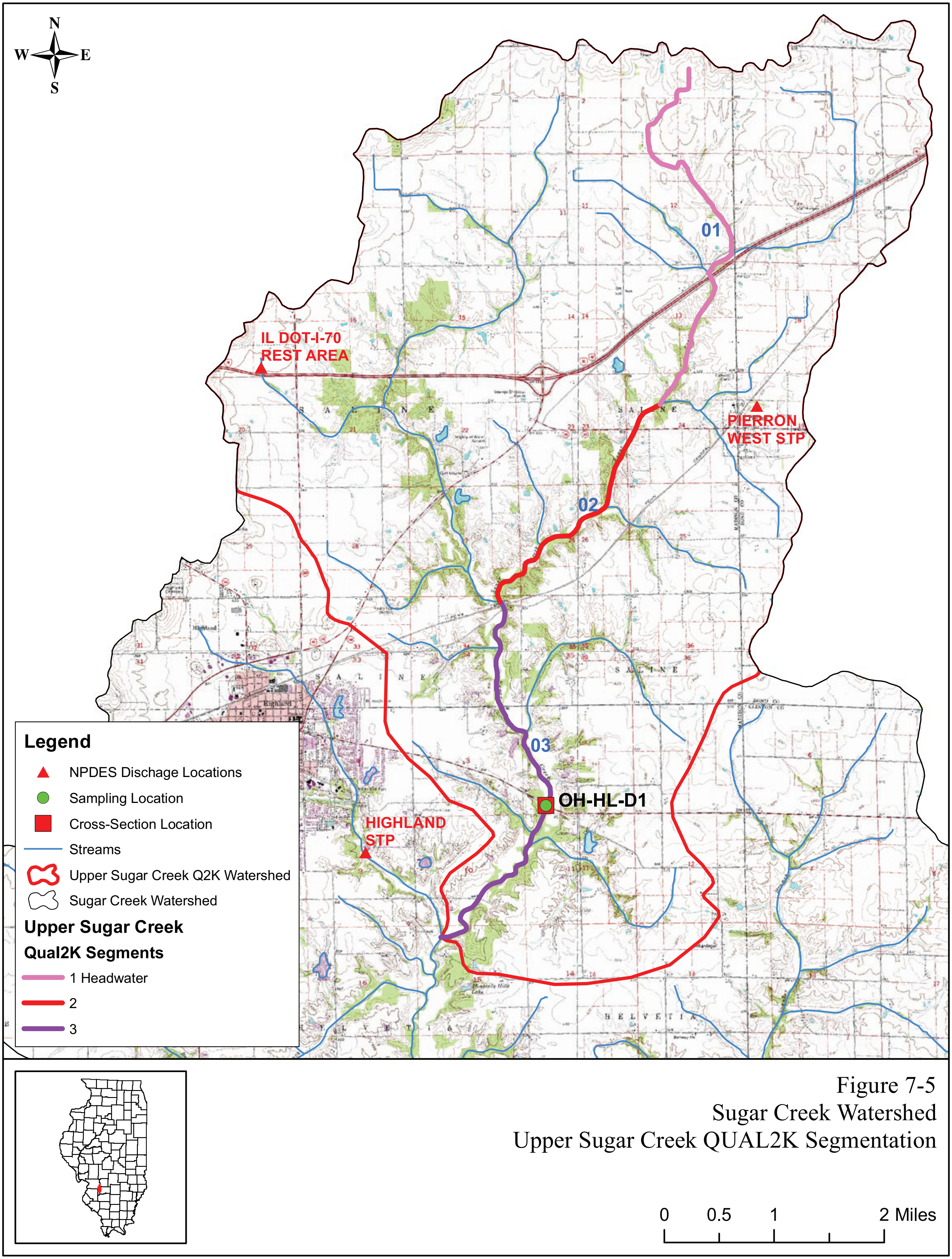


Figure 7-5
Sugar Creek Watershed
Upper Sugar Creek QUAL2K Segmentation

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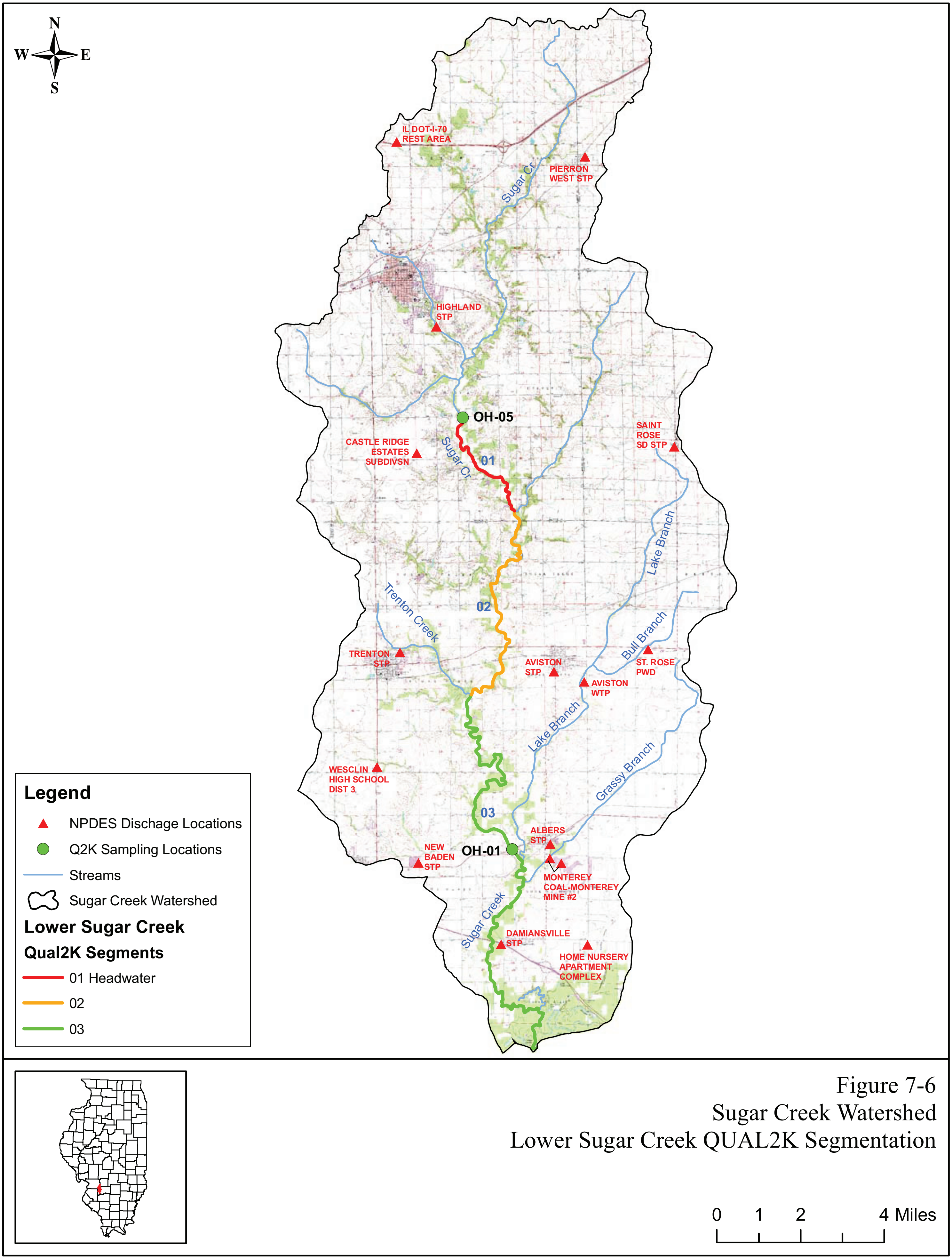


Figure 7-6
Sugar Creek Watershed
Lower Sugar Creek QUAL2K Segmentation

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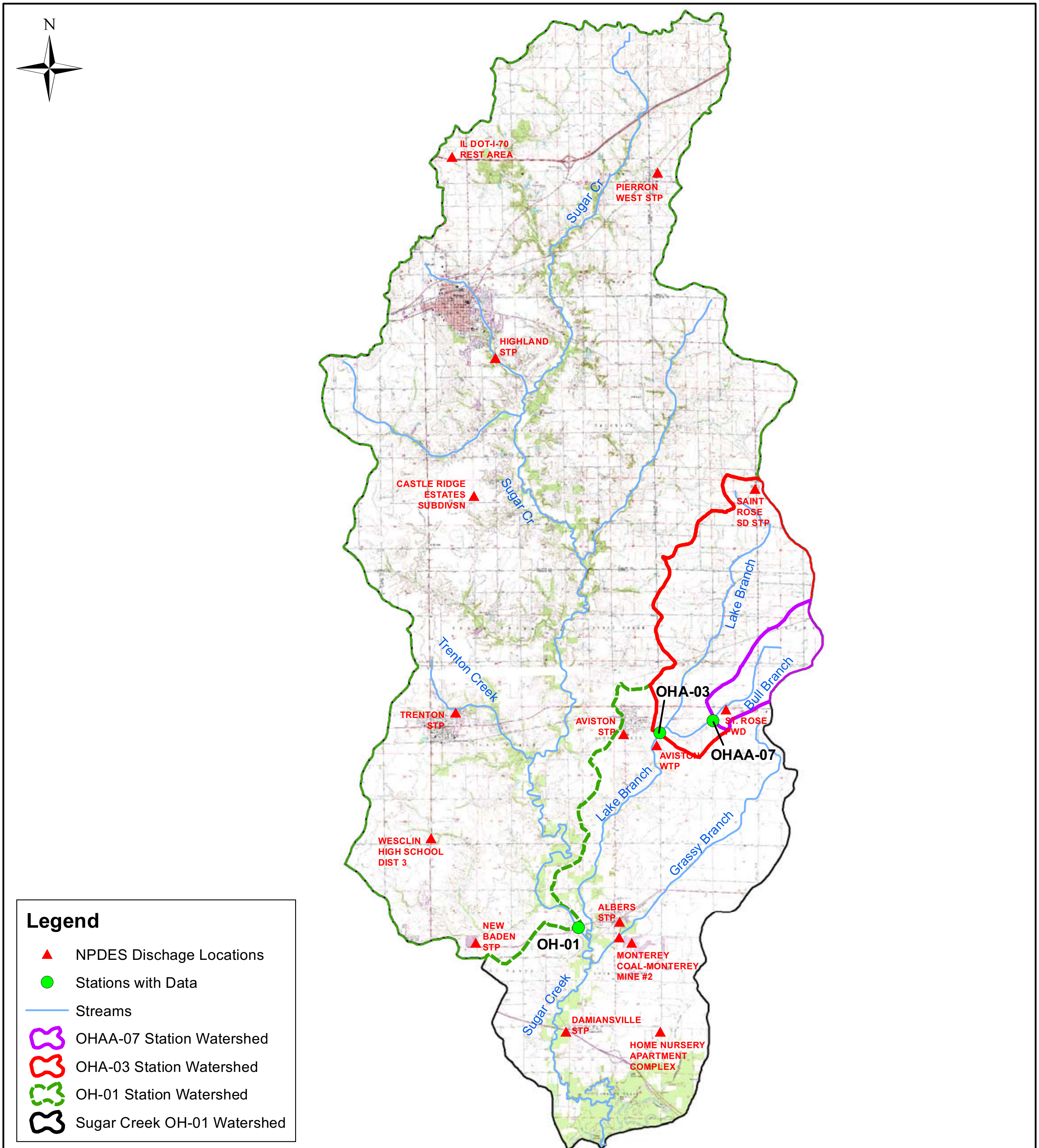


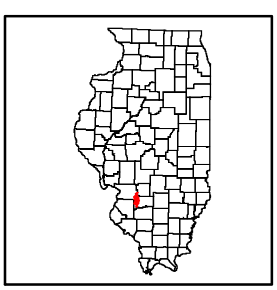

Figure 7-7
Sugar Creek Watershed
Load Duration Curve Watersheds and Sampling Locations

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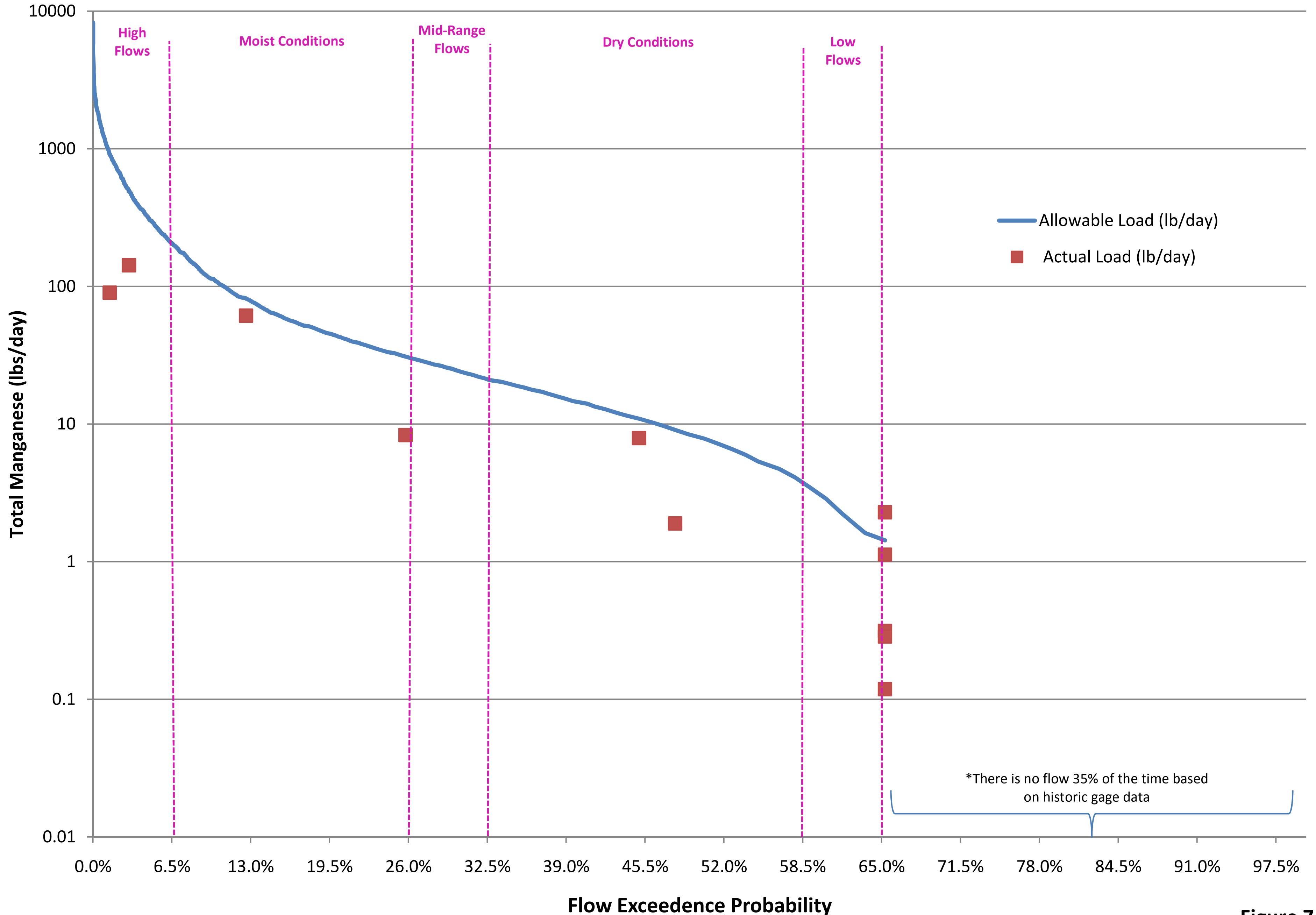


**Figure 7-8**
Lake Branch Segment OHA-03
Manganese Load Duration Curve

CDM

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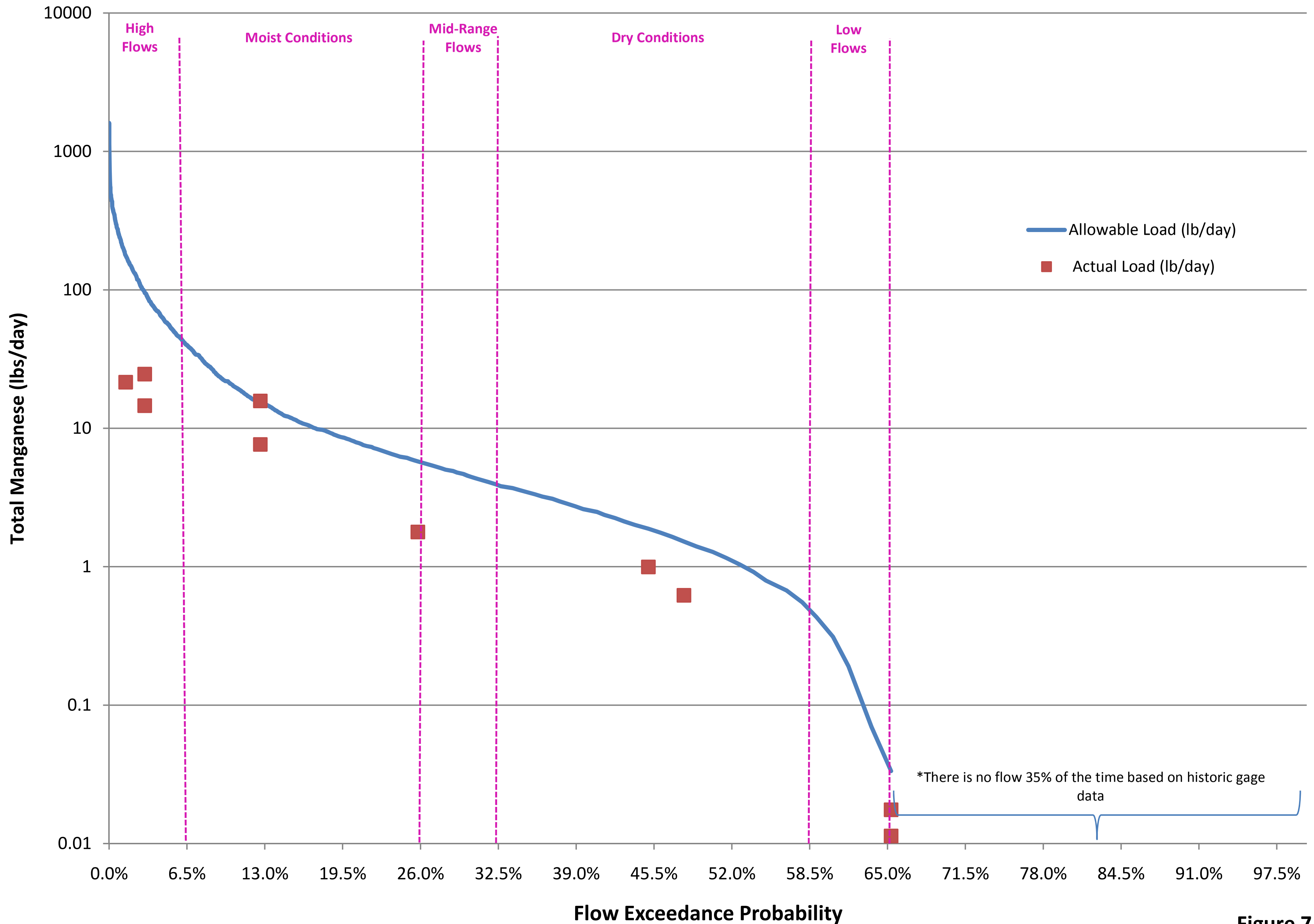


**Figure 7-9**
Bull Branch Segment OHAA-07
Manganese Load Duration Curve

CDM

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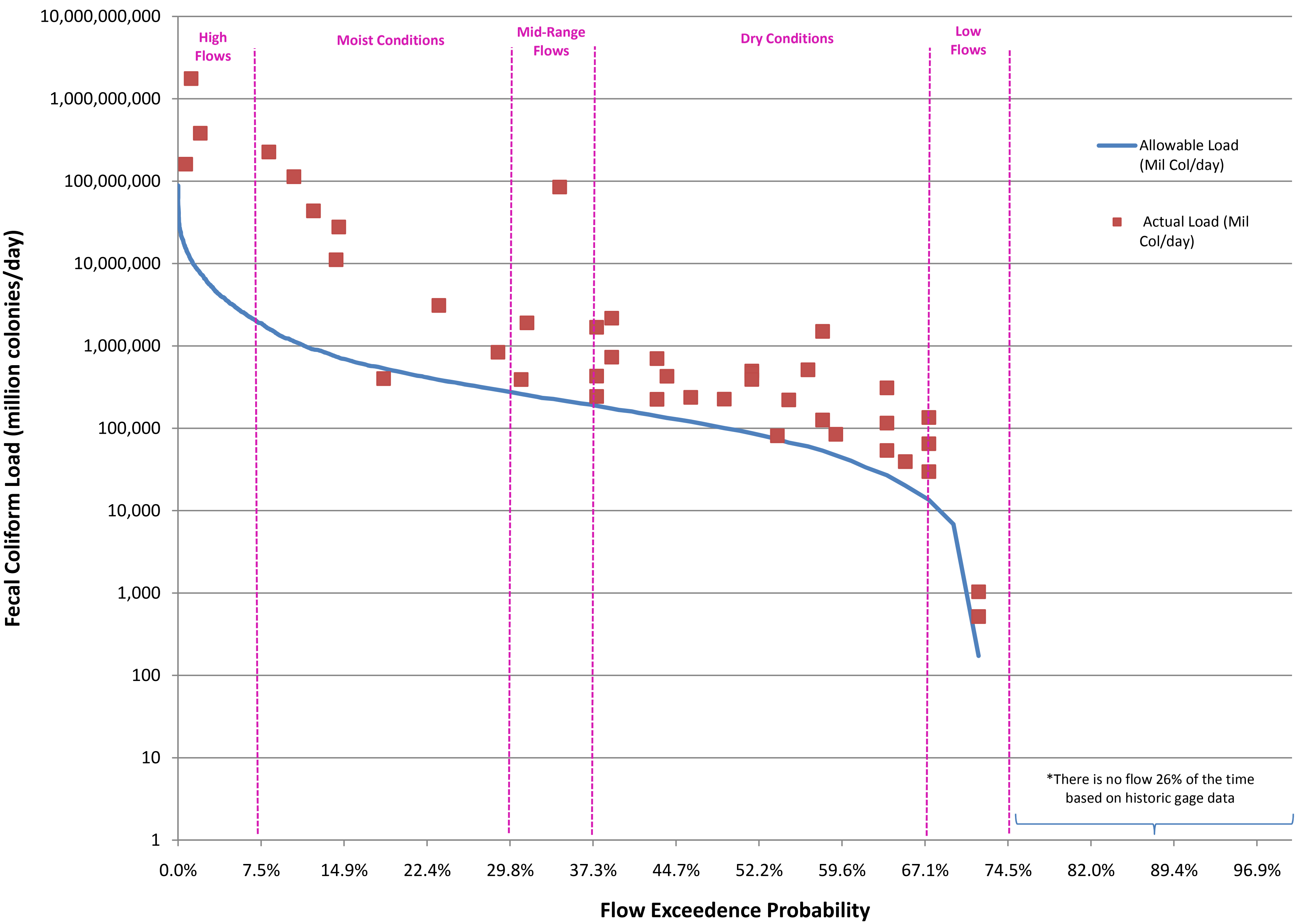


**Figure 7-10**
Sugar Creek Segment OH-01
Fecal Coliform Load Duration Curve

CDM

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# Section 8
# Total Maximum Daily Loads for the Sugar Creek Watershed

## 8.1 TMDL Endpoints for the Sugar Creek Watershed

The TMDL endpoints for fecal coliform, manganese, and dissolved oxygen are summarized in Table 8-1. For fecal coliform and manganese, the concentrations must be below the TMDL endpoint. For dissolved oxygen, the concentrations must be greater than the TMDL endpoint. The TMDL endpoints for fecal coliform and dissolved oxygen vary seasonally while the endpoints for manganese are consistent throughout the year. All of these endpoints, except for the endpoints established for fecal coliform, are based on protection of aquatic life in the impaired segments in the Sugar Creek watershed. TMDL endpoints for fecal coliform on segment OH-01 of Sugar Creek are based on protection of the primary body contact recreational use.

Some of the average concentrations presented in Table 8-1 meet the desired endpoints. However, the data sets have maximum or minimum values, presented earlier in this report, which do not meet the desired endpoints and this was the basis for TMDL analysis. Further monitoring, as outlined in the monitoring plan presented in Section 9, will help define when impairments are occurring in the watershed and support the TMDL allocations outlined in the remainder of this section.

**Table 8-1 TMDL Endpoints and Average Observed Concentrations for Impaired Constituents in the Sugar Creek Watershed**

<table>
<tr><th>Segment Name/ID</th><th>Parameter</th><th>TMDL Endpoint</th><th>Average Observed Value</th></tr>
<tr><td rowspan="3">Sugar Creek - OH-01</td><td>pH</td><td>6.5 – 9.0</td><td>7.38</td></tr>
<tr><td>DO</td><td>7-day average daily minimum:<br>6.0 mg/L (Mar. - Jul.)<br>4.0 mg/L (Aug. - Feb.)</td><td>6.88 mg/L</td></tr>
<tr><td>Fecal Coliform</td><td>400 cfu/100 mL<br>(Oct. - May)</td><td>789 cfu/100 mL</td></tr>
<tr><td>Sugar Creek - OH-HL-D1</td><td>DO</td><td>7-day average daily minimum:<br>6.0 mg/L (Mar. - Jul.)<br>4.0 mg/L (Aug. - Feb.)</td><td>3.1 mg/L</td></tr>
<tr><td>Lake Branch - OHA-02</td><td>DO</td><td>7-day average daily minimum:<br>6.0 mg/L (Mar. - Jul.)<br>4.0 mg/L (Aug. - Feb.)</td><td>3.27 mg/L</td></tr>
<tr><td rowspan="2">Lake Branch - OHA-03</td><td>DO</td><td>7-day average daily minimum:<br>6.0 mg/L (Mar. - Jul.)<br>4.0 mg/L (Aug. - Feb.)</td><td>3.71 mg/L</td></tr>
<tr><td>Manganese</td><td>1,000 µg/L</td><td>399.3 µg/L</td></tr>
</table>

**Table 8-1 TMDL Endpoints and Average Observed Concentrations for Impaired Constituents in the Sugar Creek Watershed (cont.)**

| Segment Name/ID | Parameter | TMDL Endpoint | Average Observed Value |
|---|---|---|---|
| Lake Branch - OHA-04 | DO | *7-day average daily minimum:* 6.0 mg/L (*Mar. - Jul.*) 4.0 mg/L (*Aug. - Feb.*) | 2.66 mg/L |
| Lake Branch - OHA-05 | DO | *7-day average daily minimum:* 6.0 mg/L (*Mar. - Jul.*) 4.0 mg/L (*Aug. - Feb.*) | 4.03 mg/L |
| Lake Branch - OHA-06 | DO | *7-day average daily minimum:* 6.0 mg/L (*Mar. - Jul.*) 4.0 mg/L (*Aug. - Feb.*) | 5.3 mg/L |
| Bull Branch - OHAA-07 | DO | *7-day average daily minimum:* 6.0 mg/L (*Mar. - Jul.*) 4.0 mg/L (*Aug. - Feb.*) | 3.08 mg/L |
| | Manganese | 1,000 µg/L | 345.8 µg/L |
| Grassy Branch - OHC | DO | *7-day average daily minimum:* 6.0 mg/L (*Mar. - Jul.*) 4.0 mg/L (*Aug. - Feb.*) | 3.77 mg/L |
| Trenton Creek - OHF-TR-A1 | DO | *7-day average daily minimum:* 6.0 mg/L (*Mar. - Jul.*) 4.0 mg/L (*Aug. - Feb.*) | 2.2 mg/L |
| Trenton Creek - OHF-TR-C1 | DO | *7-day average daily minimum:* 6.0 mg/L (*Mar. - Jul.*) 4.0 mg/L (*Aug. - Feb.*) | 3.7 mg/L |

## 8.2 Pollutant Source and Linkages

Potential pollutant sources for the Sugar Creek watershed include both point and nonpoint sources as described in Section 5 of this report. Load duration curves were developed for the manganese and fecal coliform TMDLs and are described in this section. Load duration curves are useful in that they provide a link between historic sampling values and hydraulic condition. Table 8-2 shows the example source area/ hydrologic condition consideration developed by EPA.

**Table 8-2 Example Source Area/Hydrologic Condition Considerations (EPA, 2007)**

| Contributing Source Area | Duration Curve Zone | | | | |
|---|---|---|---|---|---|
| | **High Flow** | **Moist** | **Mid-Range** | **Dry** | **Low Flow** |
| Point Source | | | | M | H |
| Onsite Wastewater System | | | H | M | |
| Riparian Areas | | H | H | H | |
| Stormwater: Impervious Areas | | H | H | H | |
| Combined sewer overflows | H | H | H | | |
| Stormwater: Upland | H | H | M | | |
| Bank Erosion | H | M | | | |

Note: potential relative importance of source area to contribute loads under given hydrologic conditions (H: High; M: Medium)

Further pollutant source discussion is provided throughout this section and implementation activities to reduce loading from the potential sources are outlined in Section 9.

## 8.3 Allocation

As explained in the Section 1of this report, the TMDLs for impaired segments in the Sugar Creek watershed will address the following equation:

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

where:
- LC = Maximum amount of pollutant loading a water body can receive without violating water quality standards
- WLA = The portion of the TMDL allocated to existing or future point sources
- LA = Portion of the TMDL allocated to existing or future nonpoint sources and natural background
- MOS = An accounting of uncertainty about the relationship between pollutant loads and receiving water quality

Each of these elements will be discussed in this section as well as consideration of seasonal variation in the TMDL calculation.

### 8.3.1 Fecal Coliform TMDL

Sugar Creek segment OH-01 in the Sugar Creek watershed is listed for impairment of the recreational use caused by fecal coliform. A load duration curve was developed (see Section 7) to determine load reductions needed to meet the instream water quality standards at the base of the stream under varying flow scenarios. The OH-01 sampling station is located approximately 5 miles upstream of the base of the segment, however, the station sampling results were assumed to be representative of the entire reach for the purpose of this fecal coliform load duration curve development.

#### 8.3.1.1 Loading Capacity

The LC is the maximum amount of fecal coliform that Sugar Creek segment OH-01 can receive and still maintain compliance with the water quality standards. The allowable fecal coliform loads that can be generated in the watershed and still maintain the geometric mean standard of 200 cfu/100mL were determined with the methodology discussed in Section 7. The fecal coliform loading capacity according to flow is presented in Table 8-3.

**Table 8-3 Fecal Coliform Loading Capacity for Sugar Creek Segment OH-01**

| Estimated Mean Daily Flow (cfs) | Load Capacity (mil col/day) |
|---|---|
| 5 | 24,468 |
| 10 | 48,937 |
| 50 | 244,685 |
| 100 | 489,370 |
| 500 | 2,446,848 |
| 1,000 | 4,893,696 |
| 5,000 | 24,468,480 |
| 10,000 | 48,936,960 |
| 15,000 | 73,405,440 |

#### 8.3.1.2 Seasonal Variation

Consideration of seasonality is inherent in the load duration analysis. Because the load duration analysis represents the range of expected stream flows, the TMDL has been calculated to meet the standard during all flow conditions. In addition, seasonality is addressed because the TMDL has been calculated to address loading only when the seasonal standard is applicable (May through October).

For this TMDL, the critical period for fecal coliform is the primary contact recreation season which is May through October each year. There is no one critical flow condition during the recreation season. The fecal coliform standard must be met under all flow scenarios and standard exceedences have occurred during the majority of flow scenarios. By using the load duration curve method, all of these "critical conditions" are accounted for in the loading allocations.

### 8.3.1.3 Margin of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The MOS for the OH-01 TMDL is implicit as the analysis compared individual sample results to the 200 cfu/100 ml geometric mean component of the WQS. Illinois EPA considered this conservative as the standard is based upon a geometric mean of 5 samples taken over a 30 day period. This, in effect, increases the reductions needed to meet the standard. Illinois EPA also included additional MOS in the TMDL because no rate of decay was used in calculations or in load duration curves for the fecal coliform. Because bacteria have a limited capability of surviving outside their hosts, a rate of decay would normally be used. Thus, it was determined by Illinois EPA that it is more conservative to use the water quality standard of 200 cfu/100ml fecal coliform, and not to apply a rate of decay which could result in a discharge limit greater than the water quality standard.

### 8.3.1.4 Waste Load Allocation

There are 11 small municipal treatment facilities with NPDES permitted discharges within the Sugar Creek segment OH-01 watershed. Specific fecal coliform data were not available for all of these facilities; therefore the fecal coliform standard (200 cfu/100ml) and each facilities' design average flow (DAF) values were used to set the WLA for low and moderate flow levels. At high flow levels, the facilities' design maximum flows (DMF) were used to calculate the WLA allocations. Using the conservative fecal coliform standard to calculate the WLA for the watershed ensures that point sources will not be contributing to fecal coliform exceedances instream. The WLA for the small STPs was determined to be 24,526 million colonies/day using the DAFs and 59,108 million colonies/day when calculated for higher flow levels using the facilities' DMFs. WLAs for each facility are shown in Table 8-4.

Under certain low stream flow conditions, the effluent discharge from the treatment facilities may represent the only source of flow in the receiving stream. Under these low flow conditions, large proportions of the discharge will be lost to evaporation and infiltration into the stream bed, limiting the potential for conveyance of discharged materials into downstream reaches. Because WLA calculations are based on the DAFs for each facility, at very low flow conditions the WLA can be overestimated and the resulting calculations will show WLA exceeding the LC for the receiving stream. In the case of OH-01, the WLA at the lowest flow level was set equal to the calculated loading capacity (6,859 million colonies/day) at that flow level and the resulting non-point source load percent reduction needed is calculated at 100 percent. The WLA is a combination of facility flows and the water quality standard. The TMDL does not suggest limiting effluent concentrations below the water quality standard.

**Table 8-4: WLAs for Permitted Discharges in the Sugar Creek OH-01 watershed**

| Facility | NPDES Permit Number | Design Average Flow (MGD) | WLA - low to moderate flows (mil. col/Day) | Design Maximum Flow (MGD)* | WLA - moderate to high flows (mil. col/Day) |
|---|---|---|---|---|---|
| TRENTON STP | IL0026701 | 0.5 | 3,785 | 1.25 | 9,464 |
| HIGHLAND STP | IL0029173 | 1.6 | 12,113 | 4 | 30,283 |
| NEW BADEN STP | IL0032603 | 0.6745 | 5,107 | 1.349 | 10,213 |
| CASTLE RIDGE ESTATES SUBDIVSN | IL0075388 | 0.0175 | 132 | 0.0735 | 556 |
| WESCLIN HIGH SCHOOL DIST 3 | ILG551011 | 0.02 | 151 | 0.05 | 379 |
| IL DOT-I-70 REST AREA | ILG551027 | 0.028 | 212 | 0.072 | 545 |
| PIERRON WEST STP | ILG580137 | 0.0429 | 325 | 0.172 | 1,302 |
| DAMIANSVILLE STP | IL0063762 | 0.060 | 454 | 0.100 | 757 |
| AVISTON STP | IL0020001 | 0.167 | 1,264 | 0.350 | 2,650 |
| SAINT ROSE SD STP | ILG580002 | 0.039 | 295 | 0.039 | 295 |
| ALBERS STP | ILG580017 | 0.091 | 687 | 0.352 | 2,665 |
| | | | **24,526** | | **59,108** |

In addition to the facilities listed in Table 8-4, the Damiansville STP discharges to segment OH-01 downstream of the monitoring point used to develop the load duration curve analysis. Additional NPDES discharges occur in the watershed but discharge to Lake Branch and Grassy Branch, which flow into the impaired segment (OH-01) at a location below the monitoring station and were therefore not include as WLA for the load duration curve calculations. Further discussion of all the point sources within this watershed is provided in Section 9.

### 8.3.1.5 Load Allocation and TMDL Summary

Table 8-5 shows a summary of the TMDL for Sugar Creek segment OH-01. The flow regime zones were shifted from the typical 25$^{th}$, 50$^{th}$, and 75$^{th}$ percentile brackets to represent only periods of the recreation season with measurable flow. The WLA was calculated using DAFs for each facility and the 200cfu/100ml water quality standard. Under low flow conditions, the calculated WLA is greater than the calculated LC, which is a product of the disproportionally high discharge flows associated with using DAF under such low flow conditions. In order to reconcile this and provide more accurate load allocation numbers, the WLA was set equal to the LC for the lowest flow category.

**Table 8-5 Fecal Coliform TMDL for Sugar Creek Segment OH-01**

| Zone | Flow Exceedance Range (%) | LC (mil. col/day) | LA (mil. col/day) | WLA (mil. col/day) | MOS | Actual Load[1] (mil. col/day) | Percent Reduction Needed (%) |
|---|---|---|---|---|---|---|---|
| High | 0 - 7.4 | 45,357,784 | 45,298,676 | 59,108 | implicit | 1,488,133,034 | 97.0% |
| Moist | 7.4 - 14.8 | 1,293,908 | 1,234,800 | 59,108 | implicit | 181,398,367 | 99.3% |
| | 14.8 - 22.2 | 561,794 | 502,686 | 59,108 | implicit | 401,288 | 0.0% |
| | 22.2 - 29.6 | 351,186 | 292,078 | 59,108 | implicit | 2,877,195 | 89.8% |
| Mid-Range | 29.6 - 37.0 | 237,525 | 212,999 | 24,526 | implicit | 68,390,723 | 99.7% |
| Dry | 37.0 - 44.4 | 163,979 | 139,453 | 24,526 | implicit | 1,833,022 | 92.4% |
| | 44.4 - 51.8 | 107,148 | 82,622 | 24,526 | implicit | 484,744 | 83.0% |
| | 51.8 - 59.2 | 67,032 | 42,506 | 24,526 | implicit | 1,007,718 | 95.8% |
| | 59.2 - 66.6 | 26,917 | 2,391 | 24,526 | implicit | 251,400 | 99.0% |
| Low Flow | 66.6 - 74.0 | 6,859 | 0 | 6,859 | implicit | 121,360 | 100.0% |

1 Actual Load was calculated using the 90th percentile of observed fecal coliform concentrations in a given flow range (EPA 2007)
2 WLA calculated greater than LC due to very low flow conditions. WLA set equal to the LC.

## 8.3.2 Manganese TMDLs

Two segments within the Sugar Creek watershed are listed for impairment caused by manganese: Lake Branch OHA-03 and Bull Branch OHAA-07. Load duration curves were developed (see Section 7) to determine load reductions needed to meet the instream water quality standard of 1,000 μg/L total manganese at varying flow levels.

### 8.3.2.1 Loading Capacities

The LC is the maximum amount of manganese that the impaired segments can receive and still maintain compliance with the water quality standard. In order to determine the loading capacity at various flow conditions, a range of flows were multiplied by the water quality standard. Table 8-6 contains the loading capacity for manganese.

**Table 8-6 Manganese Loading Capacity for Impaired Segments in the Sugar Creek Watershed**

| Estimated Mean Daily Flow (cfs) | Load Capacity (lbs/day) |
|---|---|
| 5 | 27 |
| 10 | 54 |
| 50 | 270 |
| 100 | 539 |
| 500 | 2,697 |
| 1,000 | 5,394 |
| 5,000 | 26,969 |
| 10,000 | 53,938 |
| 15,000 | 80,907 |

### 8.3.2.2 Seasonal Variations

Consideration to seasonality is inherent in the load duration analysis described above. The standard is not seasonal and the full range of expected flows is represented in the loading capacity table (Table 8-6). Therefore, the loading capacity represents conditions throughout the year. Load duration curve development and analysis (Section 7) showed that few manganese violations have occurred in the impaired segments (1 exceedance on each segment). The single exceedance on Lake Branch occurred under minimal flow conditions while the single exceedance on Bull Branch occurred under moist conditions. By considering and addressing all flow scenarios, these critical conditions when the stream segments are most vulnerable to water quality exceedences were addressed.

### 8.3.2.3 Margins of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The manganese TMDLs developed for the impaired segments within the Sugar Creek watershed contain an explicit MOS of 10 percent. Ten percent is considered adequate to compensate for any uncertainty in the manganese TMDLs developed for these watersheds because the use of the load duration curve approach minimizes a great deal of uncertainty because the calculation of the loading capacity is simply a function of flow multiplied by the target value. Most of the uncertainty is therefore associated with the estimated flows in each assessed segment which were based on extrapolating flows from the downstream USGS gage. The methodology employed in estimating watershed flows is discussed in Section 7.4 of this document.

### 8.3.2.4 Waste Load Allocations

There are four permitted facilities in the Lake Branch segment OHA-03 watershed and one permitted facility in the Bull Branch segment OHAA-07 watershed. The Aviston STP (NPDES Permit No. IL0060402) is a small municipal sewage treatment facility that discharges to an unnamed tributary which flows into Lake Branch downstream of the sampling location on the OHA-03 segment and is therefore not included in the OHA-03 load duration curve calculations. Likewise, the Aviston WTP (NPDES Permit No. ILG640060) discharge is for a filter backwash processes at a drinking water facility which also discharges below the sampling location in OHA-03 and is not included in the load duration curve calculations. The St. Rose Sewer District STP (NPDES Permit No. IL580002) is a small municipal sewage treatment facility that discharges upstream of the OHA-03 sampling location and is included in the load duration curve calculations for that segment. The St. Rose Public Water District (NPDES Permit No. ILG640083) discharge is for filter backwash processes at drinking water facilities located along segment OHAA-07 and is included in both OHA-03 and OHAA-07 load duration calculations. None of these facilities are required to monitor for manganese and therefore DMR data does not include concentrations of manganese. Due to the nature of these facilities' operations, manganese loading from these discharges is not expected to be an issue. Therefore, no WLAs were developed for segments OHA-03 and OHAA-07s.

### 8.3.2.5 Load Allocations and TMDL Summaries

The manganese loads have been allocated between the LAs (nonpoint sources) and the MOSs. Tables 8-7 and 8-8 show the summary of the manganese TMDLs for the impaired segments along with the percent reductions required at various flow levels. Both stream segments have annual periods of zero-flow, so the flow regime zones were shifted from the typical $25^{th}$, $50^{th}$, and $75^{th}$ percentile brackets to represent only periods of the year with measurable flow.

**Table 8-7 Total Manganese TMDL for Lake Branch Segment OHA-03**

| Zone | Flow Exceedence Range (%) | LC (lbs/day) | LA (lbs/day) | WLA (lbs/day) | MOS | Actual Load[1] (lbs/day) | Percent Reduction Needed (%) |
|---|---|---|---|---|---|---|---|
| High | 0-6.5 | 445.22 | 400.70 | n/a | 44.52 | 129.22 | 0% |
| Moist | 6.5- 13.0 | 113.91 | 102.52 | n/a | 11.39 | 61.35 | 0% |
| | 13.0-19.5 | 56.21 | 50.59 | n/a | 5.62 | - | - |
| | 19.5-26.0 | 36.98 | 33.28 | n/a | 3.70 | 8.31 | 0% |
| Mid-Range | 26.0-32.5 | 25.81 | 23.23 | n/a | 2.58 | - | - |
| Dry | 32.5-39.0 | 18.37 | 16.53 | n/a | 1.84 | - | - |
| | 39.0-45.5 | 12.78 | 11.50 | n/a | 1.28 | 7.92 | 0% |
| | 45.5-52.0 | 8.44 | 7.59 | n/a | 0.84 | 1.89 | 0% |
| | 52.0-58.5 | 5.34 | 4.80 | n/a | 0.53 | - | - |
| Low Flow | 58.5-65.0 | 1.43 | 1.28 | n/a | 0.14 | 2.28 | 43.8% |

[1] *Actual Load was calculated using the 90th percentile of observed Total Manganese concentrations in a given flow range (EPA 2007)*

**Table 8-8 Total Manganese TMDL for Bull Branch Segment OHAA-07**

| Zone | Flow Exceedence Range (%) | LC (lbs/day) | LA (lbs/day) | WLA (lbs/day) | MOS | Actual Load[1] (lbs/day) | Percent Reduction Needed (%) |
|---|---|---|---|---|---|---|---|
| High | 0-6.5 | 86.38 | 86.38 | n/a | implicit | 24.61 | 0% |
| Moist | 6.5-13 | 21.93 | 21.93 | n/a | implicit | 15.72 | 0% |
| | 13-19.5 | 10.70 | 10.70 | n/a | implicit | - | - |
| | 19.5-26 | 6.96 | 6.96 | n/a | implicit | 1.77 | 0% |
| Mid-Range | 26-32.5 | 4.78 | 4.78 | n/a | implicit | - | - |
| Dry | 32.5-39 | 3.33 | 3.33 | n/a | implicit | - | - |
| | 39-45.5 | 2.24 | 2.24 | n/a | implicit | 0.98 | 0% |
| | 45.5-52 | 1.40 | 1.40 | n/a | implicit | 0.61 | 0% |
| | 52-58.5 | 0.79 | 0.79 | n/a | implicit | - | - |
| Low Flow | 58.5-65 | 0.19 | 0.19 | n/a | implicit | - | - |

[1] *Actual Load was calculated using the 90th percentile of observed Total Manganese concentrations in a given flow range (EPA 2007)*

One violation of the manganese standard was reported for segment OHAA-07 and occurred under moist (6.5-13 percent flow exceedence) conditions. The violation was reported at a concentration of 1,006 µg/L, which is only slightly above the applicable standard of 1,000 µg/L. The 90$^{th}$ percentile of the values across a given flow range were used in the actual load calculations. The single exceedance was not great enough to require a reduction; therefore, a 0 percent reduction is shown for the 6.5-13 percent flow exceedence range at OHAA-07. The single sample would require a 0.6 percent reduction to meet the instream standard. Recommendations for reducing in-stream manganese concentrations on these segments are discussed in Section 9 of this report.

## 8.3.3 Dissolved Oxygen TMDLs

All of the 11 impaired stream segments within the Sugar Creek watershed are listed for impairment caused by low DO. As discussed in Section 7 of this report, QUAL2K water quality models were developed for each impaired segment. Lake Branch segments OHA-03, OHA-04, OHA-05, OHA-06 and Bull Branch segment OHAA-07 are contiguous segments and were combined into a single QUAL2K model. Likewise, Trenton Creek segments OHF-TR-A1 and OHF-TR-C1 were contiguous and modeled together. Grassy Branch segment OHC is not contiguous with any other impaired segments and was modeled separately, as was the upper Sugar Creek segment OH-HL-D1. An individual QUAL2K model was developed for the lower portion of Sugar Creek (segment OH-01) that included the modeled outputs from the Trenton Creek and Lake-Bull Branch models as point sources along the modeled segment.

All QUAL2K models were developed (see Section 7) to determine load reductions of oxygen demanding materials needed to meet the instream water quality standard of 6.0 mg/L during the months of March through July and 4.0 mg/L for the months of August through February at varying flow levels. These seasonal minimum DO standards are based on a 7-day daily mean averaged over 7 days and were used as endpoints for the QUAL2K models in order to provide a conservative endpoint that will provide some implicit margin of safety for TMDL calculations derived from the model outputs.

#### 8.3.3.1 Loading Capacity

The LC is the maximum amount of oxygen-demanding material that a given water body can receive and still maintain compliance with the water quality standards. The allowable loads of oxygen-demanding material that can be generated in the Sugar Creek watershed and still maintain water quality standards were analyzed using the calibrated models described in Section 7. Modeling analysis revealed that, for each of the modeled reaches in the watershed, the DO standards could not be met with reductions in oxygen-demanding material loads alone. This analysis indicates that, given the best available data and constructed model, low DO levels in this watershed are driven primarily by a combination of low reaeration and high SOD. SOD is the sum of all chemical and biological processes in the sediment that take up oxygen. SOD generally consists of a combination of biological respiration from benthic organisms and the biochemical decay processes in the top layer of deposited sediments, together with the release of oxygen-demanding (reduced) anaerobic chemicals such as iron, manganese, sulfide, and ammonia.

Because low DO levels in this watershed are driven primarily by a combination of low reaeration and high SOD, loading capacities were not explicitly calculated for any of the study reaches. Rather, the constructed models were used to estimate levels of stream channel hydraulic alteration and/or SOD reduction needed to achieve DO targets. Model internal rates were maintained at calibrated values for this exercise. Results are summarized in Table 8-9. These results are intended to provide guidance for future implementation projects.

Because a TMDL cannot be developed for reaeration or SOD, no TMDL allocations were developed at this time. Potential further monitoring and implementation measures to increase aeration or reduce SOD in the system are discussed in Section 9. Further monitoring is also recommended to confirm the preliminary conclusions outlined above.

**Table 8-9 Summary of Dissolved Oxygen TMDL Modeling**[1]

| | DO Standard (mg/L)[2] | Current Critical Period DO (mg/L) | Required % Reduction in SOD | Required Factor Increase in Reaeration |
|---|---|---|---|---|
| ***Lake Branch and Bull Branch Segments OHA-03, OHA-04, OHA-05, OHA-06, OHAA-07*** | | | | |
| March - July | 6.0 | 1.6 | 90% | 0 |
| August - February | 4.0 | 1.6 | 70% | 0 |
| ***Trenton Creek Segments OHF-TR-A1, OHF-TR-C1*** | | | | |
| March - July | 6.0 | 1.8 | 100% | 13 |
| August - February | 4.0 | 1.8 | 100% | 3 |
| ***Grassy Branch Segment OHC*** | | | | |
| March - July | 6.0 | 2.2 | 80% | 0 |
| August - February | 4.0 | 2.2 | 40% | 0 |
| ***Upper Sugar Creek Segment OH-HL-D1*** | | | | |
| March - July | 6.0 | 2.0 | 95% | 0 |
| August - February | 4.0 | 2.0 | 60% | 0 |
| ***Lower Sugar Creek Segment OH-01*** | | | | |
| March - July | 6.0 | 3.7 | 80% | 0 |
| August - February | 4.0 | 3.7 | 10% | 0 |

[1] Assuming design average flow (DAF) for all point sources
[2] Based on 7-day daily mean averaged over 7 days

# Section 9
# Implementation Plan for the Sugar Creek Watershed

## 9.1 Adaptive Management

An adaptive management or phased approach is recommended for the TMDLs developed for the Sugar Creek watershed due to the limited amount of data available for the TMDL analysis. Adaptive management is a systematic process for continually improving management policies and practices through learning from the outcomes of operational programs. Some of the differentiating characteristics of adaptive management are:

- Acknowledgement of uncertainty about what policy or practice is "best" for the particular management issue
- Thoughtful selection of the policies or practices to be applied (the assessment and design stages of the cycle)
- Careful implementation of a plan of action designed to reveal the critical knowledge that is currently lacking
- Monitoring of key response indicators
- Analysis of the management outcomes in consideration of the original objectives and incorporation of the results into future decisions (British Columbia Ministry of Forests 2000)

Implementation actions, point source controls, management measures, or BMPs are used to control the generation or distribution of pollutants. BMPs are either structural, such as wetlands, sediment basins, fencing, or filter strips; or managerial, such as conservation tillage, nutrient management plans, or crop rotation. Both types require good management to be effective in reducing pollutant loading to water resources (Osmond et al. 1995).

It is generally more effective to install a combination of point source controls and BMPs or a BMP system. A BMP system is a combination of two or more individual BMPs that are used to control a pollutant from the same critical source. In other words, if the watershed has more than one identified pollutant, but the transport mechanism is the same, then a BMP system that establishes controls for the transport mechanism can be employed (Osmond et al. 1995).

To assist in adaptive management, implementation actions, management measures, available assistance programs, and recommended continued monitoring are all discussed throughout the remainder of this section.

## 9.2 Implementation Actions and Management Measures for Manganese in Lake Branch and Bull Branch

Since 1990, one violation of the manganese standard has been reported on Lake Branch segment OHA-03 and one violation has been reported on Bull Branch segment OHAA-07. The only known sources of manganese to the creek are natural sources including overland runoff, soil erosion, and groundwater.

### 9.2.1 Nonpoint Sources of Manganese

It is likely that the main contributors to elevated manganese in segments OHA-03 and OHAA-07 are natural background levels. As such, nonpoint source controls that are designed to reduce erosion are expected to provide a secondary benefit of reducing manganese that may be attached to the soil.

Following are examples of potentially applicable erosion control measures:

- Filter Strips
- Sediment Control Basins
- Streambank Stabilization/Erosion Control

The remainder of this section discusses these management options.

#### 9.2.1.1 Filter Strips

Filter strips can be used as a control to reduce pollutant loads from runoff and sedimentation to impaired stream segments in the Sugar Creek watershed. Filter strips implemented along stream segments slow and filter runoff and provide bank stabilization decreasing erosion and deposition. The following paragraphs focus on the implementation of filter strips in the watershed.

Filter strips may help control contaminant levels by removing loads associated with sediment from runoff; however, no studies were identified as providing an estimate of removal efficiency. Grass filter strips have been shown to remove as much as 75 percent of sediment and 45 percent of total phosphorus from runoff, so it is assumed that the removal of other contaminants such as metals and sulfates from runoff may fall within this range (NCSU 2000). Riparian vegetation also provides bank stability that further reduces sediment loading to the stream and therefore reduces the loading of silver and manganese found in soils.

Filter strip widths for the impaired stream segments TMDLs were estimated based on the land slope. According to the NRCS Planning and Design Manual, the majority of sediment is removed in the first 25 percent of the width (NRCS 1994). Table 9-1 outlines the guidance for filter strip flow length by slope (NRCS 1999).

**Table 9-1 Filter Strip Flow Lengths Based on Land Slope**

| Percent Slope | 0.5% | 1.0% | 2.0% | 3.0% | 4.0% | 5.0% or greater |
|---|---|---|---|---|---|---|
| **Minimum** | 36 | 54 | 72 | 90 | 108 | 117 |
| **Maximum** | 72 | 108 | 144 | 180 | 216 | 234 |

GIS land use data described in Section 5 were used in conjunction with soil slope data to provide an estimate of acreage where filter strips could be installed. As discussed in Section 2.4.1 of this report, there is a wide diversity of soil types in the watershed with no single soil type accounting for more than 8 percent of the watershed. Because soil type and corresponding slope values vary so widely across the watershed, maximum values associated with 5 percent or greater slopes were used for this analysis. Based on this slope value, filter strip widths of 234 feet could be incorporated into agricultural lands adjacent to the ditch and its tributaries.

Mapping software was then used to buffer impaired stream segments and their major tributaries to determine the total area found within 234 feet the stream channels. There are approximately 4,656 total acres within this buffer distance throughout the watershed. The land use data were then clipped to the buffer area to determine the amount of this land that is agricultural. There are an estimated 2,250 acres of agricultural land surrounding tributaries of the Sugar Creek watershed where filter strips and riparian buffers could potentially be installed. The relative areas within the buffer distance for each impaired stream segment and its tributaries are provided in Table 9-2. Landowners should evaluate their land near the stream and its tributaries and install or extend filter strips according to the NRCS guidance provided in Table 9-1. Programs available to fund the construction of these buffer strips are discussed in Section 9.5.

**Table 9-2 Total Area and Area of Agricultural Land Within 234-feet Buffer by Segment**

| Stream Name | Segment ID | Area in 234 ft Buffer (Acres) | Agricultural Land In 234 ft Buffer (Acres) |
|---|---|---|---|
| Sugar Creek | OH-01 | 4656.5 | 2250.1 |
| | OH-HL-D1 | 588.3 | 285.5 |
| Lake Branch | OHA-02 | 920.3 | 657.1 |
| | OHA-03 | 695.8 | 586.4 |
| | OHA-04 | 369.9 | 335.4 |
| | OHA-05 | 260.3 | 231.0 |
| | OHA-06 | 189.9 | 165.8 |
| Bull Branch | OHAA-07 | 212.0 | 161.0 |
| Grassy Branch | OHC | 432.4 | 307.3 |
| Trenton Creek | OHF-TR-A1 | 68.4 | 38.0 |
| | OHF-TR-C1 | 120.0 | 48.5 |

## 9.2.1.2 Sediment Control Basins

Sediment control basins are designed to trap sediments (and the pollutants bound to the sediment) prior to reaching a receiving water. Sediment control basins are typically earthen embankments that act similarly to a terrace. The basin traps water and sediment running off cropland upslope from the structure, and reduces gully erosion by controlling flow within the drainage area. The basin then releases water slowly, which also helps to decrease streambank erosion in the receiving water.

Sediment control basins are usually designed to drain an area of 30 acres or less and should be large enough to control runoff form a 10-year, 24-hour storm. Locations are determined based on slopes, tillage and crop management, and local NRCS can often provide information and advice for design and installation. Maintenance includes reseeding and fertilizing the basins in order to maintain vegetation and periodic checking, especially after large storms to determine the need for embankment repairs or excess sediment removal.

### 9.2.1.3 Streambank Stabilization/Erosion Control

Soil erosion is the process of moving soil particles or sediment by flowing water or wind. Eroding soil transports pollutants, such as manganese, that can potentially degrade water quality.

Following are three available approaches to stabilizing eroding banks that could, in turn, decrease nonpoint source manganese and silver loads:

- Stone Toe Protection
- Rock Riffle Grade Control (RR)
- Floodplain Excavation

Stone Toe Protection uses non-erodible materials to protect the eroding banks. Meandering bends found in the watershed could possibly be stabilized by placing the hard armor only on the toe of the bank. Stone Toe Protection is most commonly implemented "using stone quarry stone that is sized to resist movement and is placed on the lower one third of the bank in a windrow fashion" (STREAMS 2005).

Naturally stable stream systems typically have an alternating riffle-pool sequence that helps to dissipate stream energy. Rock Riffle Grade Control places loose rock grade control structures at locations where natural riffles would occur to create and enhance the riffle-pool flow sequence of stable streams. By installing RR in an incised channel, the riffles will raise the water surface elevation resulting in lower effective bank heights, which increases the bank stability by reducing the tractive force on the banks (STREAMS 2005).

Rather than raising the water level, Floodplain Excavation lowers the floodplain to create a more stable stream. Floodplain Excavation uses mechanical means to restore the floodplain by excavating and utilizing the soil that would eventually be eroded away and deposited in the stream (STREAMS 2005).

The extent of streambank erosion in the Sugar Creek watershed is unknown. It is recommended that further investigation be performed to determine the extent that erosion control measures could help manage nonpoint source manganese loads to the creek.

# 9.3 Implementation Actions and Management Measures for Fecal Coliform in Sugar Creek Segment OH-01

The TMDL analysis performed for fecal coliform in OH-01 showed that although exceedences were reported over the full range of flow conditions. Exceedences of the standard collected during higher flow conditions are likely a result of stormwater runoff and re-suspension of instream fecal material. Exceedences of the fecal coliform standard that occur under low flow conditions are likely a result of point source contributions, failed septic systems, livestock, and/or groundwater inputs.

## 9.3.1 Point Sources of Fecal Coliform

### 9.3.1.1 NPDES Permitted Municipal Point Sources

There are a number of active point sources located within the Sugar Creek watershed. The facilities are all located on tributaries of the impaired segment. All permitted facilities are relatively minor with low permitted flows generally less than 1 MGD (the exception being the Highland STP which has a slightly higher permitted flow rate of 1.6 MGD but is located well upstream of the impaired segment), as shown in Table 9-3. Model input parameters for fecal coliform were calculated for each facility during TMDL development and are also shown Table 9-3. All of the municipal NPDES discharges in the watershed currently have disinfection exemptions which require that the applicable water quality standards for fecal coliform be met at the downstream extent of the exempted stream reach. All of the exempted reaches are on tributaries to the impaired segment of Sugar Creek (OH-01). Therefore, waters entering the impaired segment from the tributaries are all required to be in compliance with the standard and so the model input parameter calculations were accomplished using the 200 cfu/100ml standard.

Many of the exempted facilities in the watershed will be required to reapply for their chlorination exemption by their next permit renewal. These facilities include: Albers STP (ILG580017), Aviston STP (IL0020001), Castle Ridge Estates Subdivision (IL0075388), Damiansville STP (IL0063762), Highland STP (IL0029173), New Baden STP (IL0032603), Pierron West STP (ILG580137), Saint Rose STP (ILG640083), Trenton STP (IL0026701) and Wesclin High School District 3 (ILG551011). Descriptions of each discharge's disinfection exemption and the resulting exempted receiving stream reaches are provided in Appendix F.

**Table 9-3 Point Source Discharges and Fecal Coliform Model Input Parameters in the Sugar Creek Watershed**

| Facility - Point Source | NPDES Permit Number | Receiving Water | Segment ID | Permitted Flow (MGD) | WLA- Fecal Coliform (mil. Col./Day) |
|---|---|---|---|---|---|
| Albers STP | ILG580017 | Grassy Branch | OH-01 | 0.0907 | 687 |
| Aviston STP | ILG640060 (IL0020001) | Lake Branch | OH-01 | 0.0167 | 1,264 |
| Castle Ridge Estates Subdivision | IL0075388 | Unnamed Tributary to Mill Creek | OH-01 | 0.0175 | 132 |
| Damiansville STP | IL0063762 | Unnamed Tributary of Sugar Creek | OH-01 | 0.06 | 454 |
| Highland STP | IL0029173 | Lindenthal Creek (Tributary to Sugar Creek) | OH-01 | 1.6 | 12,113 |
| Home Nuresery Apartment Complex | IL0070238 | not listed | OH-01 | | |
| IL DOT I-70 Rest Area | ILG551027 | Unnamed Tributary of Sugar Creek | OH-01 | 0.0280 | 212 |
| Monterey Coal-Monterey Mine # 2 | IL0048691 | Grassy Branch | OH-01 | | |
| New Baden STP | IL0032603 | Unnamed Tributary of Sugar Creek | OH-01 | 0.78 | 5,107 |
| Pierron West STP | ILG580137 | Sugar Creek | OH-01 | 0.0429 | 325 |
| Saint Rose SD STP | ILG580002 | Lake Branch | OH-01 | 0.039 | 295 |
| St. Rose Public Water District | ILG640083 | Lake Branch | OH-01 | 0.004 | 30 |
| Trenton STP | IL0026701 | Trenton Creek | OH-01 | 0.5 | 3,785 |
| Wesclin High School Dist. 3 | ILG551011 | Sugar Creek | OH-01 | 0.02 | 151 |

Illinois EPA will evaluate the need for point source controls through the NPDES permitting program as each permit is due for renewal. The facilities are not believed to be a significant source of fecal coliform to the impaired segment (OH-01). The existing permit limits are thought to be adequately protective of aquatic life uses within the impaired segments.

### 9.3.1.2 Stormwater Sources

A portion of the Sugar Creek segment OH-01 watershed is urban in nature (approximately 6 percent of the watershed area). However, none of the municipalities within the watershed are required to have stormwater permits. Therefore, little information is available regarding stormwater runoff in the watershed. It is recommended that a storm sewer survey be performed to determine the amount of fecal coliform that may be contributed to the stream via urban stormwater sources.

### 9.3.2 Nonpoint Sources of Fecal Coliform

Several management options have been identified to help reduce fecal coliform counts in Sugar Creek segment OH-01. These management options focus on the most likely sources of fecal coliform within the basin, such as agricultural runoff, septic systems, and livestock. The alternatives that were identified are:

- Filter Strips
- Private Septic System Inspection and Maintenance Program
- Restrict Livestock Access to Harding Ditch and Tributaries

Each alternative is discussed briefly in this section.

#### 9.3.2.1 Filter Strips

Filter strips were discussed in Section 9.2.2.8 for control of manganese loadings into impaired waterbodies. Filter strips will have a similar impact in reducing loads of fecal coliform from overland runoff in the watershed. Therefore the same technique for evaluating available land can be applied to fecal coliform controls. As described in Section 9.2.2.8, there are approximately 4,656 acres of land within 234 feet of OH-01 and its major tributaries. Nearly half of this area, approximately 2,250 acres, are categorized as agricultural and could potentially be converted into filter strips.

#### 9.3.2.2 Private Septic System Inspection and Maintenance Program

Given the largely rural nature of much of the Sugar Creek watershed, a number of septic systems are likely to exist in the OH-01 watershed associated with the rural residences in the area. Failing or leaking septic systems can be a significant source of fecal coliform pollution. A program that actively manages functioning systems and addresses non-functioning systems could be put in place. The USEPA has developed guidance for managing septic systems, which includes assessing the functionality of systems, public health, and environmental risks (EPA 2005). It also introduces procedures for selecting and implementing a management plan.

To reduce the excessive amounts of contaminants from a faulty septic system, a regular maintenance plan that includes regular pumping and maintenance of the septic system should be followed. The majority of failures originate from excessive suspended solids, nutrients, and BOD loading to the septic system. Reduction of solids to the tank can be achieved via limiting garbage disposals use and water conservation.

Septic system management activities can extend the life and maintain the efficiency of a septic system. Water conservation practices, such as limiting daily water use or using low flow toilets and faucets, are the most effective methods to maintain a properly functioning septic system. Additionally, the system should not be used for the disposal of solids, such as cigarette butts, cat litter, cotton swabs, coffee grounds, disposable diapers, etc. Finally, physical damage to the drainfield can be prevented by:

- Maintaining a vegetative cover over the drainfield to prevent erosion
- Avoiding construction over the system

- Protecting the area down slope of the system from excavation
- Landscape the area to divert surface flow away from the drainfield (Johnson 1998)

The cost of each management measure is site specific and there is not specific data on septic systems and management practices for the watershed; therefore, costs for these practices were not outlined in Section 9.5.

Alternatively, a long-range solution to failing septic systems is a connection to a municipal sanitary sewer system. Installation of a sanitary sewer would reduce existing fecal coliform sources by replacing failing septic systems and will allow communities to develop without further contribution of fecal material to Sugar Creek. Costs for the installation are generally paid over a period of several years (average of 20 years) instead of forcing homeowners to shoulder the entire cost of installing a new septic system. In addition, costs are sometimes shared between the community and the utility responsible for treating the wastewater generated from replacing the septic tanks. The planning process is involved and requires participation from townships, cities, counties, and citizens.

#### 9.3.2.3 Restrict Livestock Access to Sugar Creek and Tributaries

As discussed previously in this report, livestock are present in the OH-01 watershed. St. Clair, Bond, Madison, and Clinton Counties' NRCS reported over 100 cattle operations and a small number of CAFOs exist within the watershed, but no definite numbers of livestock were available. It is unknown to what extent these animals have access to the Sugar Creek or its tributaries. Reduction of livestock access to streams, however, is recommended to reduce bacteria loads. The USEPA found that livestock exclusion from waterways and other grazing management measures were successful in reducing fecal coliform counts by 29 to 46 percent (2003). Fencing and alternate watering systems are effective ways to restrict livestock from streams.

## 9.4 Implementation Actions and Management Measures for DO in the Sugar Creek Watershed

DO impairments are generally addressed by focusing on organic loads that consume oxygen through decomposition and nutrient loads that can cause algal growth, which can also deplete DO. Analysis discussed in Section 8 established a relationship between low flows, oxygen-demanding materials ($BOD_5$, ammonia-nitrogen and organic nitrogen), and DO concentrations in the impaired segments; therefore, management measures for these segments will focus on increasing reaeration and decreasing loads of oxygen-demanding materials to increase DO concentrations.

DO impairments in the impaired segments are mostly attributed to low flow or stagnant conditions, which also allows for greater sedimentation. Runoff from nonpoint sources may also contribute loading of oxygen-demanding materials in the segment. An additional contributor to low DO is increased water temperatures. Therefore, management measures for the segments will focus on reducing nonpoint source loading through sediment and surface runoff controls, reducing stream temperatures, and reducing stagnant conditions through reaeration.

## 9.4.1 Point Sources of Oxygen-Demanding Materials

Point sources within the Sugar Creek watershed include municipal sources. This section discusses the sources and their potential to contribute oxygen-demanding materials.

### 9.4.1.1 Municipal/Industrial Sources

A number of small STPs discharge oxygen-demanding materials within the watersheds of each impaired segment. The facilities are located both on tributaries of the impaired segments and, in some cases, directly discharge effluent to the impaired stream segments. Table 9-4 contains permit information on each of these facilities as well as model input parameters for available parameters used in the QUAL2K modeling discussed in Section 8 of this report.

Illinois EPA will evaluate the need for point source controls through the NPDES permitting program as each permit is due for renewal. Violations of discharge limits for some QUAL2K model input parameters such as DO, BOD, TSS, and ammonia have been reported from several of the municipal discharges at various intervals in the past decade. However, reported violations have not been ongoing and the facilities are not believed to be a significant source of oxygen-demanding materials to the impaired segments. The existing permit limits are thought to be adequately protective of aquatic life uses within the impaired segments. The NPDES permitted facilities discharge monitoring reports (DMRs) continue to be monitored and ongoing violations of the effluent limits at any of the permitted facilities may prompt further regulatory action.

## 9.4.2 Nonpoint Sources of Oxygen-Demanding Materials

In addition to point sources of oxygen-demanding materials within the watershed, there are a number or potential nonpoint sources. The potential sources of nonpoint pollution to the impaired segments of the Sugar Creek watershed include over-fertilization (associated with both agricultural and urban land uses), streambank erosion, low flows, and high temperatures. BMPs evaluated for treatment of these nonpoint sources are:

- Conservation tillage practices
- Filter strips
- Riparian Buffers
- Nutrient management
- Reaeration/Streambank Stabilization

**Table 9-4 Point Source Discharges and Oxygen Demanding Materials in the Sugar Creek Watershed**

| ***Name*** | ***NPDES Permit ID*** | ***Receiving Water*** | ***Segments*** | ***Design Average Flow (MGD)*** | ***DO (lbs/day)*** | ***Fast CBOD (lbs/day)*** | ***Ammonia N (lbs/day)*** | ***Nitrate + NItrite (lbs/day)*** | ***Organic P (lbs/day)*** | ***Inorganic P (lbs/day)*** |
|---|---|---|---|---|---|---|---|---|---|---|
| Albers STP | ILG580017 | Grassy Branch | OH-01, OHC | 0.0907 | 3.6 | 7.6 | 5.07 | 10.59 | 1.17 | 2.2 |
| Aviston STP | ILG640060 (IL0020001) | Lake Branch | OH-01, OHA-02, OHA-03 | 0.167 | 0.9 | 1.0 | | | | |
| Castle Ridge Estates Subdivision | IL0075388 | Unnamed Tributary to Mill Creek | OH-01 | 0.0175 | 0.0 | 0.3 | 0.03 | | | |
| Damiansville STP | IL0063762 | Unnamed Tributary of Sugar Creek | OH-01 | 0.06 | 2.9 | 2.3 | 3.60 | | | |
| Highland STP | IL0029173 | Lindenthal Creek (Tributary to Sugar Creek) | OH-01 | 1.6 | 102.0 | 37.3 | 2.67 | | | |
| Home Nuresery Apartment Complex | IL0070238 | not listed | OH-01 | n/a | | | | | | |
| IL DOT I-70 Rest Area | ILG551027 | Unnamed Tributary of Sugar Creek | OH-01, OH-HL-D1 | 0.0280 | | 3.8 | | | | |
| Monterey Coal-Monterey Mine # 2 | IL0048691 | Grassy Branch | OH-01 | n/a | | | | | | |

**Table 9-4 Point Source Discharges and Oxygen Demanding Materials in the Sugar Creek Watershed, continued**

| *Name* | *NPDES Permit ID* | *Receiving Water* | *Segments* | *Design Average Flow (MGD)* | *DO (lbs/day)* | *Fast CBOD (lbs/day)* | *Ammonia N (lbs/day)* | *Nitrate + NItrite (lbs/day)* | *Organic P (lbs/day)* | *Inorganic P (lbs/day)* |
|---|---|---|---|---|---|---|---|---|---|---|
| New Baden STP | IL0032603 | Unnamed Tributary of Sugar Creek | OH-01 | 0.78 | 49.6 | 139.8 | | | | |
| Pierron West STP | ILG580137 | Sugar Creek | OH-01, OH-HL-D1 | 0.0429 | | 1.9 | | | | |
| Saint Rose STP | ILG580002 | Lake Branch | OH-01, OHA-03, OHA-02, OHA-04, OHA-05, OHA-06 | 0.0390 | | 1.0 | | | | |
| St. Rose Public Water District | ILG640083 | Lake Branch | OH-01, OHA-02, OHA-03, OHAA-07 | 0.004 | | | | | | |
| Trenton STP | IL0026701 | Trenton Creek | OH-01, OHF-TR-C1 | 0.5000 | 19.2 | 4.2 | 8.76 | 2.71 | 4.04 | 7.6 |
| Wesclin High School Dist. 3 | ILG551011 | Sugar Creek | OH-01 | 0.02 | | 0.5 | | | | |

Organic and nutrient loads originating from cropland can be treated with a combination of riparian buffer or grass filter strips. Streambank stabilization and erosion control can limit the oxygen-demanding material entering the stream. A reduction in nutrient loads will decrease the biological productivity and, along with the decreased inputs of oxygen-demanding materials, will lead to a reduction in the levels of SOD present in the stream. Instream management measures for DO focus on reaeration techniques. The Q2K models used to develop the TMDLs utilize reaeration coefficients. Increasing the reaeration coefficient by physical means will increase DO in the impaired segments.

### 9.4.2.1 Conservation Tillage Practices

For the Sugar Creek watershed, conservation tillage practices could help reduce nutrient and sediment loads into the stream segments Approximately 75,335 acres in the watershed are under cultivation, which accounts for 67 percent of the total watershed area. Nutrient and sediment loading from cropland can be controlled through management BMPs, such as conservation tillage. Conservation tillage maintains at least 30 percent of the soil surface covered by residue after planting. Crop residuals or living vegetation cover on the soil surface protect against soil detachment from water and wind erosion. Conservation tillage practices can remove up to 45 percent of the dissolved and total phosphorus from runoff and approximately 75 percent of the sediment. Additionally, studies have found around 93 percent less erosion occurred from no-till acreage compared to acreage subject to moldboard plowing (USEPA 2003). The 2006 Illinois Department of Agriculture's Soil Transect Survey estimated that conventional till currently accounts for 99 percent of corn, 55 percent of soybean, and 45 percent of small grain tillage practices in Bond County; 67 percent of corn, 29 percent of soybean, and 15 percent of small grain tillage practices in Clinton County; 66 percent of corn, 12 percent of soybean, and 0 percent of small grain tillage practices in Madison County; and 97 percent of corn, 29 percent of soybean, and 89 percent of small grain tillage practices in St. Clair County. To achieve TMDL load allocations, tillage practices already in place should be continued, and practices should be assessed and improved upon for all agricultural areas in Sugar Creek watershed.

### 9.4.2.2 Filter Strips

Filter strips were discussed in Section 9.2.2.8 for control of manganese loadings and in Section 9.3.2.1 for control of fecal coliform loadings into impaired waterbodies. Filter strips will have a similar impact in reducing loads of nutrients and sediments from overland runoff in the watershed. Therefore the same technique for evaluating available land can be applied to controls designed to reduce oxygen-demanding materials. Filter strips implemented along stream segments slow and filter nutrients and sediment out of runoff, help reduce stream water temperatures thereby increasing the water body DO saturation level, and provide bank stabilization decreasing erosion and deposition. The following paragraphs focus on the implementation of filter strips to control oxygen demanding materials entering waterbodies in the Sugar Creek watershed.

Organic debris in topsoil contributes to the $BOD_5$ load to water bodies (USEPA 1997). Increasing the length of stream bordered by grass and riparian buffer strips will decrease the amount of $BOD_5$ and nutrient load associated with sediment loads to the impaired segments of the Sugar Creek watershed. Nutrient criteria, currently being developed and expected to be adopted in the near future by the Illinois EPA, will assess the instream nutrient concentrations required for the watershed. Excess nutrients in streams can cause excessive algal growth, which can deplete DO in streams. Adoption of nutrient criteria will potentially affect this DO TMDL and help control exceedences of DO water quality criteria in the Sugar Creek watershed.

Filter strips will help control $BOD_5$ levels by removing organic loads associated with sediment from runoff; however, no studies were identified as providing an estimate of removal efficiency. Grass filter strips can remove as much as 75 percent of sediment and 45 percent of total phosphorus from runoff, so it is assumed that the removal of $BOD_5$ falls within this range (NCSU 2000). Riparian buffer strips also help reduce water temperatures which can in turn increase the water body DO saturation level.

Riparian vegetation, specifically shade, plays a significant role in controlling stream temperature change. The shade provided will reduce solar radiation loading to the stream. Furthermore, riparian vegetation provides bank stability that reduces sediment loading to the stream and the stream width-to-depth ratio. Research in California (Ledwith 1996), Washington (Dong et al. 1998), and Maine (Hagan and Whitman 2000) has shown that riparian buffers effect microclimate factors such as air temperature and relative humidity proximal to the stream. Ledwith (1996) found that a 500-foot buffer had an air temperature decrease of 12°F at the stream over a zero-foot buffer. The greatest change occurred in the first 100 feet of the 500-foot buffer where the temperature decreased 2°F per 30 feet from the stream bank. A decrease in the air temperature proximal to the stream would result in a smaller convective flux to the stream during the day.

The relative areas within the buffer distance for each impaired stream segment and its tributaries are provided in Table 9-2.

### 9.4.2.3 Riparian Buffers

Riparian corridors, including both the stream channel and adjacent land areas, are important components of watershed ecology. Tree canopies of riparian forests cool the water in streams which can affect the composition of the fish species in the stream, as well as the rate of biological reactions. Channelization or widening of streams moves the canopy farther apart, decreasing the amount of shaded water surface and increasing water temperature which can increase DO problems.

Preserving natural vegetation along stream corridors can effectively reduce water quality degradation associated with development. 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. 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 passes through the buffer.

Converting land adjacent to streams for the creation of riparian buffers will provide stream bank stabilization, stream shading, and nutrient uptake and trapping from adjacent areas. Minimum buffer widths of 25 feet are required for water quality benefits. Higher removal rates are provided with greater buffer widths. NCSU (2002) reports phosphorus removal rates of approximately 25 to 30 percent for 30 foot wide buffers and 70 to 80 percent for 60 to 90 foot wide buffers. Land use data were clipped to 25 feet buffer zones created around the impaired segments in the Sugar Creek watershed. There are 351 acres within 25 feet of the impaired segments. Approximately 212 of these acres are existing grassland or forest while 128 acres are currently classified as agricultural. Landowners should assess parcels adjacent to the stream channel and maintain or improve existing riparian areas or potentially convert cultivated lands.

Riparian corridors typically treat a maximum of 300 feet of adjacent land before runoff forms small channels that short circuit treatment. In addition to the treated area, the land converted from agricultural land to buffer will generate 90 percent less nutrients based on data presented in Haith et al. (1992).

#### 9.4.2.4 Nutrient Management

Nutrient management could result in reduced nutrient loads to the DO impaired stream segments in the Sugar Creek watershed. Crop management of nitrogen and phosphorus originating in the agricultural portions of the watershed can be accomplished through Nutrient Management Plans, which focus on increasing the efficiency with which applied nutrients are used by crops, thereby reducing the amount available to be transported to both surface and groundwater. In the past, nutrient management focused on application rates designed to meet crop nitrogen requirements but avoid groundwater quality problems created by excess nitrogen leaching. This results in buildup of soil phosphorus above amounts sufficient for optimal crop yields. Illinois, along with most Midwestern states, demonstrates high soil test phosphorus in greater than 50 percent of soil samples analyzed (Sharpley et al. 1999).

The overall goal of nutrient reduction from agriculture should increase the efficiency of nutrient use by balancing nutrient inputs in feed and fertilizer with outputs in crops and animal produce as well as managing the level of nutrients in the soil. Reducing nutrient loss in agricultural runoff may be brought about by source and transport control measures, such as filter strips or grassed waterways. The Nutrient Management Plans account for all inputs and outputs of nutrients to determine reductions. Nutrient Management Plans include:

- Review of aerial photography and soil maps
- Regular soil testing
- Review of current and/or planned crop rotation practices
- Yield goals and associated nutrient application rates
- Nutrient budgets with planned rates, methods, timing and form of application
- Identification of sensitive areas and restrictions on application when land is snow covered, frozen or saturated

In Illinois, Nutrient Management Plans have successfully reduced phosphorus application to agricultural lands by 36-lb/acre. National reductions range from 11 to 106-lb/acre, with an average reduction of 35-lb/acre (USEPA 2003).

### 9.4.2.5 Reaeration

The purpose of reaeration is to increase DO concentrations in streams. Physical measures that will assist in increasing reaeration of a stream include bank stabilization, channel modifications, and the addition of riprap or pool and riffle sequences. Bank stabilization reduces erosion by planting vegetation along the bank or modification of the channel to decrease the slope of the bank. Riprap or pool and riffle sequences would increase reaeration by increasing turbulence. Turbulence creates an increase in the interaction between air and water, which draws air into the river increasing aeration. Expanding monitoring to several locations along the impaired segments could help identify reaches that would benefit the most from an increase of turbulence.

### 9.4.2.6 Streambank Stabilization

Soil erosion is the process of moving soil particles or sediment by flowing water or wind. Eroding soil transports pollutants, such as oxygen-demanding materials, that can potentially degrade water quality. Following are two available approaches to stabilizing eroding banks that could, in turn, decrease nonpoint source oxygen demanding loads which can increase sediment oxygen demand in the stream:

- Stone Toe Protection
- Rock Riffle Grade Control (RR)

Stone Toe Protection uses non-erodible materials to protect the eroding banks. Meandering bends found in the Sugar Creek watershed could possibly be stabilized by placing the hard armor only on the toe of the bank. Stone Toe Protection is most commonly implemented "using stone quarry stone that is sized to resist movement and is placed on the lower one third of the bank in a windrow fashion" (STREAMS 2005).

Naturally stable stream systems typically have an alternating riffle-pool sequence that helps to dissipate stream energy. Rock Riffle Grade Control places loose rock grade control structures at locations where natural riffles would occur to create and enhance the riffle-pool flow sequence of stable streams. By installing RR in an incised channel, the riffles will raise the water surface elevation resulting in lower effective bank heights, which increases the bank stability by reducing the tractive force on the banks (STREAMS 2005).

## 9.5 Reasonable Assurance

Reasonable assurance means that a demonstration is given that nonpoint source reductions in this watershed will be implemented. It should be noted that all programs discussed in this section are voluntary and some may currently be in practice in the watershed. The discussion in Sections 9.2 through 9.4 provided information on available BMPs for reducing pollutant loads from point and nonpoint sources. The remainder of this section discusses an estimate of costs to the watershed for implementing nonpoint source management practices and programs available to assist with funding.

### 9.5.1 Available Programs for Nonpoint Source Management

There are several voluntary conservation programs established through the 2008 U.S. Farm Bill, which encourage landowners to implement resource-conserving practices for water quality and erosion control purposes. These programs would apply to crop fields and rural grasslands that are presently used as pasture land. Each program is discussed separately in the following paragraphs.

#### 9.5.1.1 Illinois Department of Agriculture and Illinois EPA Nutrient Management Plan Project

The IDA and Illinois EPA are presently co-sponsoring a cropland Nutrient Management Plan project in watersheds that have or are developing a TMDL. This voluntary project supplies incentive payments to producers to have Nutrient Management Plans developed and implemented. Additionally, watersheds that have sediments or phosphorus identified as a cause for impairment (as is the case in this watershed), are eligible for cost-share assistance in implementing traditional erosion control practices through the Nutrient Management Plan project.

#### 9.5.1.2 Conservation Reserve Program

This voluntary program encourages landowners to plant long-term resource-conserving cover to improve soils, water, and wildlife resources. The Conservation Reserve Program (CRP) is the USDA's single largest environmental improvement program and one of its most productive and cost-efficient. It is administered through the Farm Service Agency (FSA) by USDA's Commodity Credit Corporation (CCC). The program was initially established in the Food & Security Act of 1985. The duration of the contracts under CRP range from 10 to 15 years.

Eligible land must be one of the following:

1. Cropland that is planted or considered planted to an agricultural commodity four of the six most recent crop years (including field margins) and must be physically and legally capable of being planted in a normal manner to an agricultural commodity.

2. Certain marginal pastureland enrolled in the Water Bank Program.

In addition to the eligible land requirements, cropland must meet one of the following criteria:

- Have a weighted average erosion index of 8 or higher;
- Be expiring CRP acreage; or
- Be located in a national or state CRP conservation priority area.

The CCC bases rental rates on the relative productivity of soils within each county and the average of the past three years of local dry land cash rent or cash-rent equivalent. The maximum rental rate is calculated in advance of enrollment. Producers may offer land at the maximum rate or at a lower rental rate to increase likelihood of offer acceptance. In addition, the CCC provides cost-share assistance for up to 50 percent of the participant's costs in establishing approved conservation practices (USDA 2006).

Finally, CCC offers additional financial incentives of up to 20 percent of the annual payment for certain continuous sign-up practices (USDA 2006). Continuous sign-up provides management flexibility to farmers and ranchers to implement certain high-priority conservation practices on eligible land. The land must be determined by NRCS to be eligible and suitable for any of the following practices:

- Riparian buffers
- Filter strips
- Grass waterways
- Shelter belts
- Field windbreaks
- Living snow fences
- Contour grass strips
- Salt tolerant vegetation
- Shallow water areas for wildlife
- Eligible acreage within an EPA-designated wellhead protection area (FSA 1997)

The current extent of land enrolled in CRP within the Sugar Creek watershed is unknown.

#### 9.5.1.3 Clean Water Act Section 319 Grants

Section 319 was added to the CWA to establish a national program to address nonpoint sources of water pollution. Through this program, each state is allocated Section 319 funds on an annual basis according to a national allocation formula based on the total annual appropriation for the section 319 grant program. The total award consists of two categories of funding: incremental funds and base funds. A state is eligible to receive EPA 319(b) grants upon USEPA's approval of the state's Nonpoint Source Assessment Report and Nonpoint Source Management Program. States may reallocate funds through subawards (e.g., contracts, subgrants) to both public and private entities, including local governments, tribal authorities, cities, counties, regional development centers, local school systems, colleges and universities, local nonprofit organizations, state agencies, federal agencies, watershed groups, for-profit groups, and individuals.

USEPA designates incremental funds, a $100-million award, for the restoration of impaired water through the development and implementation of watershed-based plans and TMDLs for impaired waters. Base funds, funds other than incremental funds, are used to provide staffing and support to manage and implement the state Nonpoint Source Management Program. Section 319 funding can be used to implement activities which improve water quality, such as filter strips, streambank stabilization, etc. (USEPA 2003).

Illinois EPA receives federal funds through Section 319(h) of the CWA 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 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.

#### 9.5.1.4 Wetlands Reserve Program

The Wetlands Reserve Program (WRP) is a voluntary program that provides technical and financial assistance to eligible landowners to restore, enhance, and protect wetlands. The goal of WRP is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection.

The program offers three enrollment options:

1. *Permanent Easement* is a conservation easement in perpetuity. USDA pays 100 percent of the easement value and up to 100 percent of the restoration costs.

2. *30-Year Easement* is an easement that expires after 30 years. USDA pays up to 75 percent of the easement value and up to 75 percent of the restoration costs. For both permanent and 30-year easements, USDA pays all costs associated with recording the easement in the local land records office, including recording fees, charges for abstracts, survey and appraisal fees, and title insurance.

3. *Restoration Cost-Share Agreement* is an agreement to restore or enhance the wetland functions and values without placing an easement on the enrolled acres. USDA pays up to 75 percent of the restoration costs.

The total number of acres that can be enrolled in the program is 3,041,200 – an increase of 766,200 additional acres over the previous Farm Bill.

- Payments for easements valued at $500,000 or more will be made in at least five annual payments.

- For restoration cost-share agreements, annual payments may not exceed $50,000 per year.

- No easement shall be created on land that has changed ownership during the preceding 7 years.

- Eligible acres are limited to private and Tribal lands.

### 9.5.1.5 Environmental Quality Incentive Program

The Environmental Quality Incentive Program (EQIP) is a voluntary USDA conservation program for farmers and private landowners engaged in livestock or agricultural production who are faced with serious threats to soil, water, and related natural resources. Through EQIP, the NRCS develops contracts with agricultural producers to implement conservation practices to address environmental natural resource problems. Payments are made to producers once conservation practices are completed according to NRCS requirements.

Persons engaged in livestock or agricultural production and owners of non-industrial private forestland are eligible for the program. Eligible land includes cropland, rangeland, pastureland, private non-industrial forestland, and other farm or ranch lands. Persons interested in entering into a cost-share agreement with the USDA for EQIP assistance may file an application at any time.

NRCS works with the participant to develop the EQIP plan of operations. This plan becomes the basis of the EQIP contract between NRCS and the participant. NRCS provides conservation practice payments to landowners under these contracts that can be up to 10 years in duration.

The EQIP objective to optimize environmental benefits is achieved through a process that begins with National priorities that address: impaired water quality, conservation of ground and surface water resources improvement of air quality reduction of soil erosion and sedimentation, and improvement or creation of wildlife habitat for at-risk species. National priorities include: reductions of nonpoint source pollution, such as nutrients, sediment, pesticides, or excess salinity in impaired watersheds consistent with TMDLs where available as well as the reduction of groundwater contamination and reduction of point sources such as contamination from confined animal feeding operations; conservation of ground and surface water resources; reduction of emissions, such as particulate matter, nitrogen oxides (NOx), volatile organic compounds, and ozone precursors and depleters that contribute to air quality impairment violations of National Ambient Air Quality Standards reduction in soil erosion and sedimentation from unacceptable levels on agricultural land; and promotion of at-risk species habitat conservation.

EQIP provides payments up to 75 percent of the incurred costs and income foregone of certain conservation practices and activities. The overall payment limitation is $300,000 per person or legal entity over a 6-year period. The Secretary of Agriculture may raise the limitation to $450,000 for projects of special environmental significance. Payment limitations for organic production may not exceed an aggregate $20,000 per year or $80,000 during any 6-year period for installing conservation practices.

Conservation practices eligible for EQIP funding which are recommended BMPs for this watershed TMDL include field borders, filter strips, cover crops, grade stabilization structures, grass waterways, riparian buffers, streambank shoreline protection, terraces, and wetland restoration.

The selection of eligible conservation practices and the development of a ranking process to evaluate applications are the final steps in the optimization process. Applications will be ranked based on a number of factors, including the environmental benefits and cost effectiveness of the proposal. More information regarding State and local EQIP implementation can be found at www.nrcs.usda.gov/programs/eqip.

### 9.5.1.6 Wildlife Habitat Incentives Program

The Wildlife Habitat Incentive Plan (WHIP) is a voluntary program administered by NRCS which is designed to assist those who want to develop and improve wildlife habitat primarily on private lands and nonindustrial private forest land. It provides both technical assistance and cost share payments to help:

- Promote the restoration of declining or important native fish and wildlife species.
- Protect, restore, develop, or enhance fish and wildlife habitat to benefit at-risk species.
- Reduce the impacts of invasive species in fish and wildlife habitat.

- Protect, restore, develop, or enhance declining or impaired aquatic wildlife species habitat.

Participants who own or control land agree to prepare and implement a wildlife habitat development plan. The NRCS provides technical and financial assistance for the establishment of wildlife habitat development practices. In addition, if the landowner agrees, cooperating State wildlife agencies and nonprofit or private organizations may provide expertise or additional funding to help complete a project.

Participants work with the NRCS to prepare a wildlife habitat development plan in consultation with the local conservation district. The plan describes the participant's goals for improving wildlife habitat, includes a list of practices and a schedule for installing them, and details the steps necessary to maintain the habitat for the life of the agreement. This plan may or may not be part of a larger conservation plan that addresses other resource needs such as water quality and soil erosion.

The NRCS and the participant enter into a cost-share agreement for wildlife habitat development. This agreement generally lasts from 5 to 10 years from the date the agreement is signed for general applications and up to 15 years for essential habitat applications. Cost-share payments may be used to establish new practices or replace practices that fail for reasons beyond the participant's control.

WHIP has a continuous sign-up process. Applicants can sign up anytime of the year at their local NRCS field office. Conservation practices eligible for WHIP funding which are recommended BMPs for this watershed TMDL include but are not limited to filter strips, field borders, riparian buffers, streambank and shoreline protection, and wetland restoration.

#### 9.5.1.7 Illinois Conservation and Climate Initiative

The Illinois Conservation and Climate Initiative (ICCI) is a joint project of the State of Illinois and the Delta Institute that allows farmers and landowners to earn revenue through the sale of greenhouse gas emissions credits when they use conservation practices such as no-till, grass plantings, reforestation, or manure digesters.

The Chicago Climate Exchange (CCX®) quantifies, credits, and sells greenhouse gas credits from conservation practices. The credits are aggregated, or pooled, from farmers and landowners in order to sell them to CCX® members that have made voluntary commitments to reduce their greenhouse gas contributions.

ICCI provides an additional financial incentive for farmers and landowners to use conservation practices that also benefit the environment by creating wildlife habitat and limiting soil and nutrient run-off to streams and lakes.

Many farmers and landowners are already using conservation practices eligible for carbon credits on the CCX® such as no-till farming, strip-till farming, grass plantings, afforestation/reforestation, and the use of methane digesters. To be eligible, the producer or landowner must make a contractual commitment to maintain the eligible practice through 2010. CREP and CRP land is eligible for enrollment in the ICCI as long as it meets CCX® eligibility requirements for the practice (www.illinoisclimate.org).

#### 9.5.1.8 Local Program Information

The FSA administers the CRP. NRCS administers the EQIP, WRP, and WHIP. Local NRCS contact information in Clinton, Bond, Madison, and St. Clair counties are listed in the Table 9-4 below.

**Table 9-5 Local NRCS and FSA Contact Information**

| County | Contact | Address | Phone |
|---|---|---|---|
| **Local SWCD Office** | | | |
| Bond County | Emily Hartmann | 111 East Harris Avenue<br>Greenville, IL 62246 | (618) 664-0555 |
| Clinton County | Jill Brammeier | 1780 North 4th Street<br>Breese, IL 62230 | (618) 526-7919 |
| Madison County | Norma Kuethe | 7205 Marine Road<br>Edwardsville, IL 62025 | (618) 656-7300 |
| St. Clair County | Bonita Rubach | 2031 Mascoutah Avenue<br>Belleville, IL 62220 | (618) 233-5383 |
| **Local FSA Office** | | | |
| Bond County | Caryl Hickerson | 111 East Harris Avenue<br>Greenville, IL 62246 | (618) 664-0555 ext. 2 |
| Clinton County | Mike Eggerman | 1780 North 4th Street<br>Breese, IL 62230 | (618) 526-7919 ext. 2 |
| Madison County | Brad Grotefendt | 7205 Marine Road<br>Edwardsville, IL 62025 | (618) 656-4710 ext. 2 |
| St. Clair County | Barb Burns | 2031 Mascoutah Avenue<br>Belleville, IL 62220 | (618) 235-2500 ext. 2 |
| **Local NRCS Office** | | | |
| Bond County | Justin E. King | 111 East Harris Avenue<br>Greenville, IL 62246 | (618) 664-0555 ext. 3 |
| Clinton County | Howard E. Zenner | 1780 North 4th Street<br>Breese, IL 62230 | (618) 526-7919 ext. 3 |
| Madison County | Denny Steinmann | 7205 Marine Road<br>Edwardsville, IL 62025 | (618) 656-4710 ext. 3 |
| St. Clair County | John F. Harryman | 2031 Mascoutah Avenue<br>Belleville, IL 62220 | (618) 235-2500 ext. 3 |

### 9.5.2 Cost Estimates of BMPs

Cost estimates for different BMPs and individual practice prices such as filter strip installation are detailed in the following sections. Finally, an estimate of the total order of magnitude costs for implementation measures in the Sugar Creek watershed are presented in Section 9.5.2.6 and Table 9-6.

#### 9.5.2.1 Filter Strips and Riparian Buffers

The Illinois EQIP document used for wetland pricing also provides filter strip and riparian buffer cost estimates. Filter strip implementation that includes seedbed preparation and native seed was estimated at $88/acre while riparian buffers ranged from $130/acre for herbaceous cover up to $800/acre for forested buffers

### 9.5.2.2 Nutrient Management Plan – NRCS

A significant portion of the agricultural land in the Sugar Creek watershed is comprised of cropland. The service for developing a nutrient management plan averages $6 to $18/acre. This includes soil testing, manure analysis, scaled maps, and site specific recommendations for fertilizer management.

### 9.5.2.3 Nutrient Management Plan – IDA and Illinois EPA

The costs associated with development of Nutrient Management Plans co-sponsored by the IDA and the Illinois EPA is estimated at $10/acre paid to the producer and $3/acre for a third party vendor who develops the plans. There is a 200 acre cap per producer. The total plan development cost is estimated at $13/acre.

### 9.5.2.4 Conservation Tillage

Conservation tillage is assumed to include tillage practices that preserve at least 30 percent residue cover of the soil after crops are planted. Costs associated with converting to conservation tillage will depend on the degree of conservation tillage practices implemented. The University of Iowa has estimated a cost for conversion to no-till practices. The study acknowledged that some equipment conversion is needed, but converting to no-till only means (for most producers) the addition of heavier down-pressure springs, row cleaners, and possibly a coulter on each planter row unit. The cost of converting existing equipment ranges between $300 and $400 per planter row, which for many producers, amounts to a nominal additional production cost of approximately $1 or $2 per acre per year (Al-Kaisi 2002).

### 9.5.2.5 Septic System Maintenance

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 back-ups. In addition, septic systems should not be connected to field tile lines.

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.

The cost of developing and maintaining a watershed-wide database of the onsite wastewater treatment systems in the Sugar Creek watershed depends on the number of systems that 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.

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.

### 9.5.2.6 Planning Level Cost Estimates for Implementation Measures

Cost estimates for different implementation measures are presented in Table 9-5. The column labeled "Program" or "Sponsor" lists the financial assistance program or sponsor available for various BMPs. The programs and sponsors represented in the table are the WRP, the CRP, National Resource Conservation Service (NRCS), Conservation Cost-Share Program (CCP), Illinois EPA, and IDA. It should be noted that IEPA 319 Grants are applicable to all of these practices.

**Table 9-5 Cost Estimate of Various BMP Measures**

| Source | Program | Sponsor | BMP | Installation Mean $ |
|---|---|---|---|---|
| Nonpoint | CRP | NRCS and IDA | Filter strip (seeded) | $88/acre |
| | CRP | NRCS and IDA | Riparian Buffer | $130-$800/acre |
| | EQIP | NRCS | Livestock Fencing – Woven Wire | $1.55/ft |
| | | | Livestock Fencing – Barbed Wire | $1.22/ft |
| | WRP | NRCS | Nutrient Management Plan | $6-18/acre |
| | | IDA and Illinois EPA | Nutrient Management Plan | $13/acre |
| | SSRP | IDA | Bank Stabilization | $25/ft |
| | | | Rock Riffle Grade Control | $7,500/riffle |
| | CRP | NRCS and IDA | Conservation Tillage | varies |

Total watershed costs will depend on the combination of BMPs selected to target non-point sources within the watershed. Regular monitoring will support adaptive management of implementation activities to most efficiently reach the TMDL goals.

## 9.6 Monitoring Plan

The purpose of the monitoring plan for the Sugar Creek watershed is to assess the overall implementation of management actions outlined in this section. This can be accomplished by conducting the following monitoring programs:

- Track implementation of management measures in the watershed
- Estimate effectiveness of management measures
- Further monitoring of point source discharges in the watershed
- Continued monitoring of impaired stream segments
- Storm-based monitoring of high flow events
- Low flow monitoring of dissolved oxygen in impaired streams
- Livestock survey within watershed to assess livestock access to stream channels
- Tributary monitoring

Tracking the implementation of management measures can be used to address the following goals:

- Determine the extent to which management measures and practices have been implemented compared to action needed to meet TMDL endpoints
- Establish a baseline from which decisions can be made regarding the need for additional incentives for implementation efforts
- Measure the extent of voluntary implementation efforts
- Support work-load and costing analysis for assistance or regulatory programs
- Determine the extent to which management measures are properly maintained and operated

Estimating the effectiveness of the BMPs implemented in the watershed could be completed by monitoring before and after the BMP is incorporated into the watershed. Additional monitoring could be conducted on specific structural systems such as a constructed wetland. Inflow and outflow measurements could be conducted to determine site-specific removal efficiency.

IEPA conducts Intensive Basin Surveys every 5 years. Additionally, ambient sites are monitored nine times a year. Continuation of this state monitoring program will assess lake and stream water quality as improvements in the watershed are completed. This data will also be used to assess whether water quality standards in the impaired segments are being attained.

## 9.7 Implementation Time Line

Implementing the actions outlined in this section for the Sugar Creek watershed should occur in phases and assess effectiveness of the management actions as improvements are made. It is assumed that it may take up to 5 years to secure funding for actions needed in the watershed and five to seven years after funding to implement the measures. Once improvements are implemented, it may take 10 years or more for impaired waters to reach water quality standard targets. In summary, it may take up to 20 years for the impaired waterbodies to meet the applicable water quality standards.

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# Section 10
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