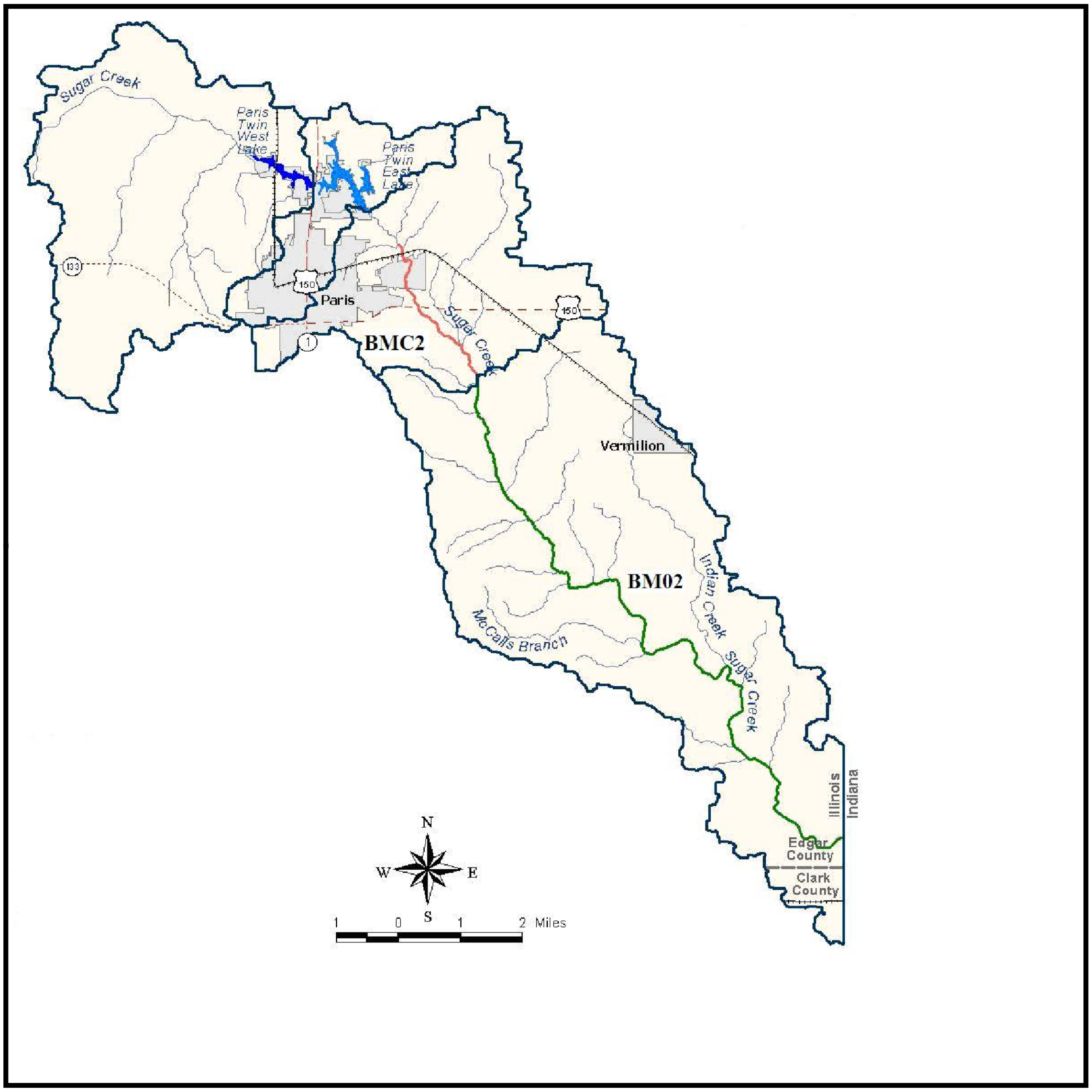
Illinois
Environmental
Protection Agency

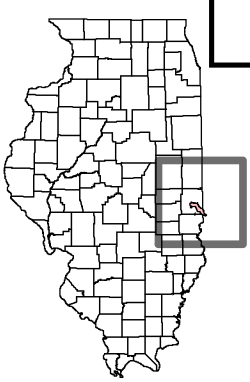
Bureau of Water
P.O. Box 19276
Springfield, IL 62794-9276

May 2008

IEPA/BOW/08-004

# SUGAR CREEK WATERSHED TMDL REPORT



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

APR 24 2008

REPLY TO THE ATTENTION OF
WW-16J



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

Dear Ms. Willhite:

The United States Environmental Protection Agency (U.S. EPA) has reviewed the final Total Maximum Daily Loads (TMDL) from the Illinois Environmental Protection Agency (IEPA) for the Sugar Creek Watershed in Illinois. The TMDL is for fecal coliform, and addresses the recreational use impairment in this waterbody.

Based on this review, U.S. EPA has determined that Illinois' TMDL for fecal coliform meets the requirements of Section 303(d) of the Clean Water Act and U.S. EPA's implementing regulations at 40 C.F.R. Part 130. Therefore, U.S. EPA hereby approves one TMDL for one impairment in the Sugar Creek watershed (BM02) in Illinois. The statutory and regulatory requirements, and U.S. EPA's review of Illinois' compliance with each requirement, are described in the enclosed decision document.

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

Sincerely yours,

Tinka G. Hyde
Acting Director, Water Division

Enclosure

cc: Trevor Sample, IEPA

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# Contents

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# Attachment 1
# Stage One Report
# Tetra Tech, 2005

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# TMDL Development for the Sugar Creek Watershed

# Stage One Report: Watershed Characterization and Water Quality Analysis

***FINAL REPORT***

April 8, 2005

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

Submitted by:
Tetra Tech, Inc.
Water Resources TMDL Center

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**Key Findings**

As part of the Section 303(d) listing process, the Illinois Environmental Protection Agency has identified four waterbodies in the Sugar Creek watershed as impaired:

- Paris Twin West Lake (segment RBX)
- Paris Twin East Lake (segment RBL)
- Sugar Creek (segment BMC2)
- Sugar Creek (segment BM02)

The purpose of this report is to describe the watershed in which these waters are located and review the available water quality data to confirm the impairments. This report also identifies several potential options for proceeding with developing total maximum daily loads (TMDLs) for these waters.

A review of the available water quality data confirms most of these impairments. However, insufficient data have been collected with which to make a direct comparison of the fecal coliform criteria as it applies to Sugar Creek segment BM02.

Other key findings described in this report include:

- Mean total phosphorus concentrations exceed State water quality criteria for several months in both Paris West and Paris East Twin Lakes. Furthermore, dissolved phosphorus appears to comprise a significant proportion of the total phosphorus loading. On a monthly average basis, dissolved phosphorus comprises 20 to 40 percent of total phosphorus in the Paris West Twin Lake, and 30 to 40 percent of the total phosphorus load in the Paris East Twin Lake.

- There does not appear to be any significant improving or degrading trend over time for the assessed water quality parameters. Nutrient levels in the Twin Lakes, particularly total phosphorus, have remained relatively constant over the period of record. Similarly, dissolved oxygen and fecal coliform collected in Sugar Creek have remained at nearly the same levels over their respective periods of record.

- A lack of continuous streamflow data for Sugar Creek poses a challenge for developing the TMDLs, as does the significant area of the watershed that is tile drained.

- It is recommended that water quality sampling be performed on Sugar Creek upstream of the Paris West Twin Lake to better estimate loadings to the lake from upland areas. Few data are currently available for this location.

- Water quality sampling is recommended on Sugar Creek BMC2. Such data would be useful to assess sediment transport and nutrient transformation and transport between the lake and the downstream portion of the Sugar Creek.

- Fecal coliform sampling is recommended for Sugar Creek segment BM02 to gather five samples within 30 days to allow for a direct comparison with the state's water quality standard.

- Additional information on the potential for shoreline erosion of the Twin Lakes' is needed.

# 1 Introduction

The Sugar Creek watershed (ILBM02) is located in east-central Illinois and trends in a southeasterly direction. The watershed drains approximately 65 square miles within the State of Illinois and an additional 27 square miles lie within the State of Indiana. Within Illinois, most of the watershed is in southeastern Edgar County, and a smaller portion of the basin is located in northeastern Clark County.

The Paris Twin West Lake and Paris Twin East Lake are located within the Sugar Creek watershed. The Twin Lakes were created in 1894 by damming and flooding a portion of Sugar Creek. The lakes have a combined surface area of 222 acres and drain approximately 14,284 acres of primarily agricultural land. Paris West Twin Lake serves as a sedimentation basin to protect East Lake (Bogner, 1992). The Twin Lakes serve as the community drinking water supply for Paris, Illinois. Water is obtained from one surface water intake in the lakes with average pumpage of 1.5 million gallons per day to approximately 4,115 service connections and an estimated population of 8,990 people.

As part of the Section 303(d) listing process, the Illinois Environmental Protection Agency (IEPA) has identified four waterbodies in the ILBM02 watershed as impaired (Table 1-1):

- Paris Twin West Lake (RBX)
- Paris Twin East Lake (RBL)
- Sugar Creek (BMC2)
- Sugar Creek (BM02)

The potential causes of impairment for segments RBX and RBL are phosphorus, total suspended solids (TSS), excessive algal growth/chlorophyll *a*. Dissolved oxygen, sedimentation/siltation, unspecified nutrients, and other flow alterations are the impairments for segment BMC2. Segment BM02 is impaired for pathogens (Illinois EPA, 2002). These impairments result in partial support of primary contact (swimming), secondary contact (recreation), and aquatic life designated uses.

The Clean Water Act and USEPA regulations require that states develop TMDLs for waters on the Section 303(d) lists. Illinois EPA is currently developing TMDLs for pollutants that have numeric water quality standards. Of the pollutants impairing Paris Twin West Lake and Paris Twin East Lake, phosphorus is the only parameter with a water quality standard for lakes. Illinois EPA believes that addressing the phosphorus impairment should lead to an overall improvement in water quality due to the interrelated nature of the other listed pollutants. For example, reducing loads of phosphorus should result in less algal growth and some of the management measures taken to reduce phosphorus loads (e.g., reducing shoreline erosion) should also reduce loads of suspended solids.

A TMDL is defined as "the sum of the individual wasteload allocations for point sources and load allocations for nonpoint sources and natural background" such that the capacity of the waterbody to assimilate pollutant loadings is not exceeded. A TMDL is also required to be developed with seasonal variations and must include a margin of safety that addresses the uncertainty in the analysis. The overall goals and objectives in developing the ILBM02 TMDLs include:

- Assess the water quality of the impaired waterbodies and identify key issues associated with the impairments and potential pollutant sources.

- Use the best available science and available data to determine the maximum load the waterbodies can receive and fully support all of their designated uses.

- Use the best available science and available data to determine current loads of pollutants to the impaired waterbodies.
- If current loads exceed the maximum allowable load, determine the load reduction that is needed.
- Identify feasible and cost-effective actions that can be taken to reduce loads.
- Inform and involve the public throughout the project to ensure that key concerns are addressed and the best available information is used.
- Submit a final TMDL report to USEPA for review and approval.

**Table 1-1. 2002 303(d) List Information for the Sugar Creek Watershed (ILBM02)**

| Segment (Area) | Name | Designated Uses and Support Status | Causes of Impairment | Potential Sources of Impairment |
|---|---|---|---|---|
| **RBX (56.7 acres)** | Paris Twin West Lake | Overall Use (Not Assessed), Aquatic Life Support (Partial), Primary Contact /swimming (Partial), Secondary Contact/ recreation (Partial), Fish Consumption (Full), Drinking Water Supply (Full) | Total Phosphorus, Excessive Algal Growth, TSS | Agriculture (crop related sources, non–irrigated crop production), Habitat modification (Streambank Modification/destabilization, Highway Maintenance and Runoff), Waterfowl, Forest/grassland/parkland |
| **RBL (162.8 acres)** | Paris Twin East Lake | Overall Use (Full), Aquatic Life Support (Full), Primary Contact /swimming (Partial), Secondary Contact/recreation (Partial), Fish Consumption (Full), Drinking Water Supply (Full) | Total Phosphorus, Excessive Algal Growth, TSS | Agriculture (crop related sources, non–irrigated crop production), Habitat modification (Streambank Modification/destabilization, Highway Maintenance and Runoff), Waterfowl, Forest/grassland/parkland |
| **BMC2 (2.9 miles)** | Sugar Creek | Aquatic Life Support (Partial) | Dissolved Oxygen, Sedimentation/ Siltation, Unspecified Nutrients, Other Flow Alterations | Municipal Point Source, Hydrologic/Habitat Modification (flow regulation/modification) |
| **BM02 (12.9 miles)** | Sugar Creek | Aquatic Life Support (Full) Primary Contact/Swimming (Partial) | Pathogens | Source Unknown |

Source: Illinois EPA, 2002.

The project is being initiated in three stages. Stage One involves the characterization of the watershed, an assessment of the available water quality data, and identification of potential technical approaches. Stage Two will involve additional data collection, if necessary. Stage Three will involve model development and calibration, TMDL scenarios, and implementation planning. This report documents the results of Stage One.

# 2 Watershed Characteristics

The physical characteristics of the Sugar Creek watershed are described in the following sections. For the purposes of this characterization, the watershed was subdivided into four subwatersheds according to their respective Illinois water body segment identification. These subwatersheds correspond to the upstream contributing areas of Paris Twin West Lake (RBX), Paris Twin East Lake (RBL), Sugar Creek (BMC2), and Sugar Creek (BM02). The subwatersheds were defined using digital elevation data, and the delineation process is discussed in section 3.2.3. This type of watershed subdivision allows for a more pertinent discussion of land use and soils information for each of the water body segments.

## 2.1 Location

The Sugar Creek watershed (Figure 2-1) is located in east-central Illinois, trends in a southeasterly direction, and drains approximately 42,041 acres within the State of Illinois. An additional 17,196 acres lie within the State of Indiana. Approximately 41,443 acres lie in southeastern Edgar County. A smaller portion of the watershed, approximately 598 acres, is located in northeastern Clark County.

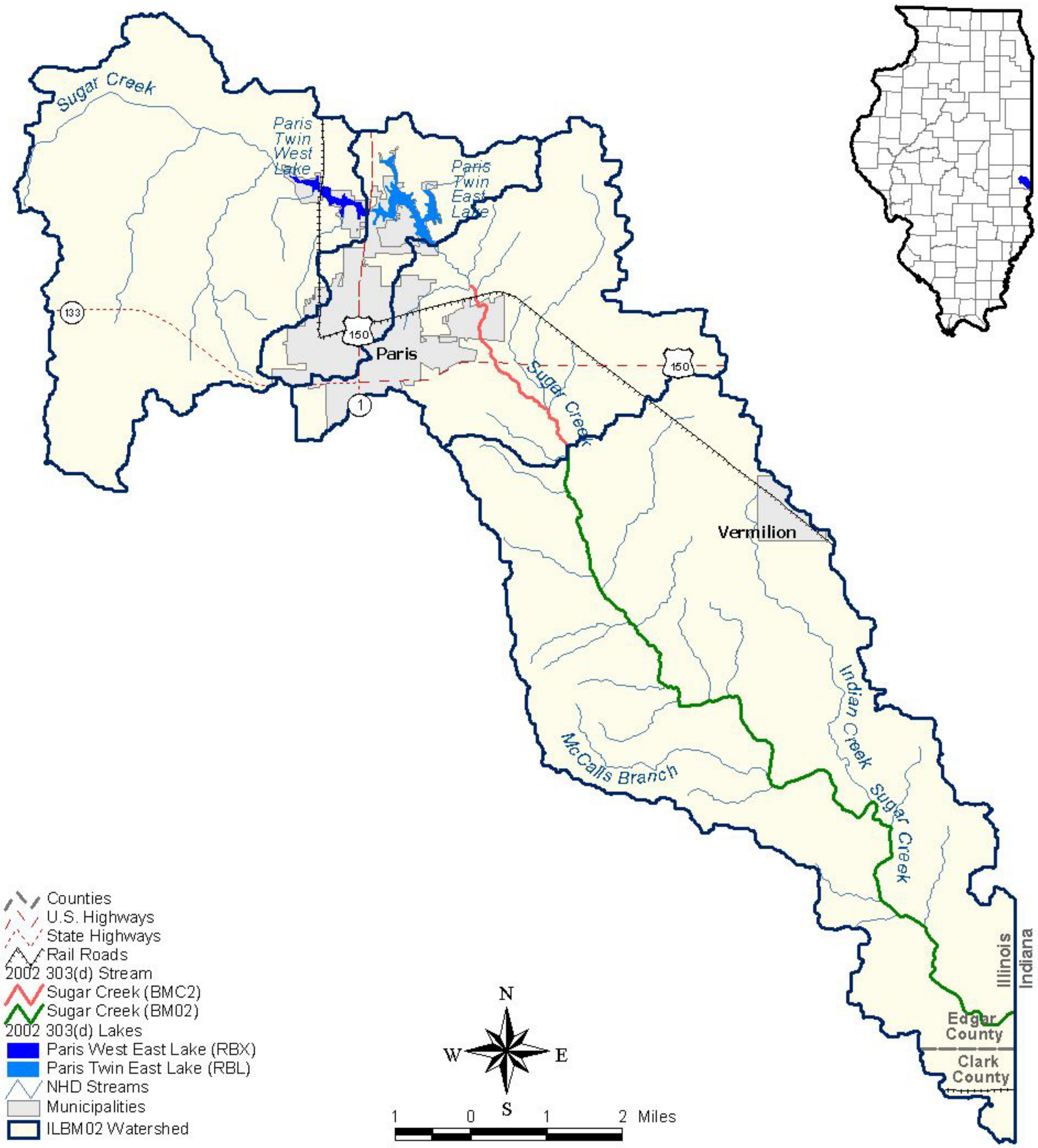


**Figure 2-1. Location of the Sugar Creek watershed.**

## 2.2 Topography

Topography is an important factor in watershed management because stream types, precipitation, and soil types can vary dramatically by elevation. Digital elevation models (DEM) containing 30-meter grid resolution elevation data are available from the USGS for each 1:24,000-topographic quadrangle in the

United States. Elevation in the Sugar Creek watershed ranges from 755 feet above sea level in the headwaters to 511 feet at the most downstream point of the segment (Figure 2-2). The absolute elevation change is 186 feet over the 25.2-mile stream length of Sugar Creek, which yields a stream gradient of 7.5 feet per mile.

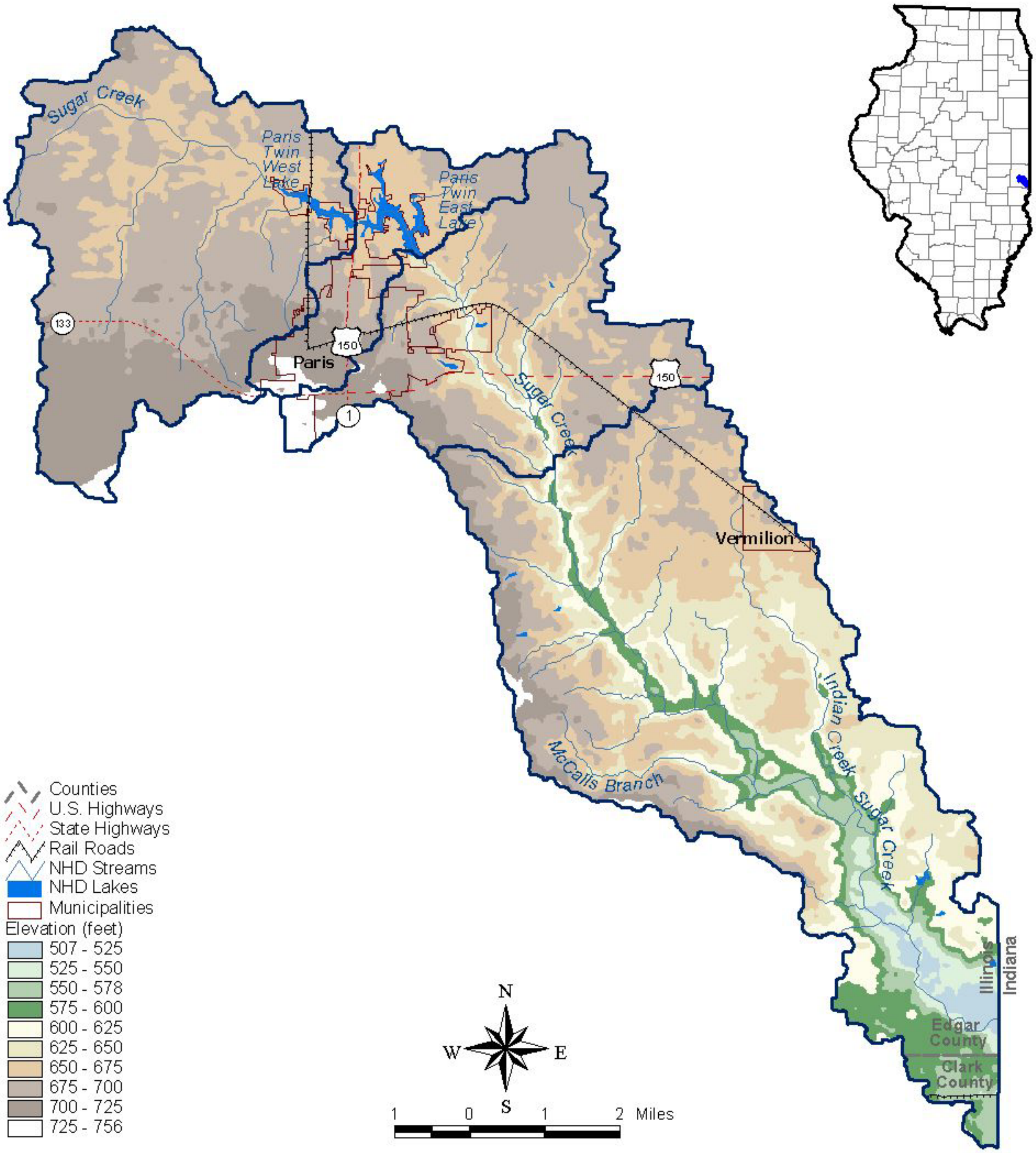


**Figure 2-2. Elevation in the Sugar Creek watershed.**

## 2.3 Land Use and Land Cover

General land cover data for the Sugar Creek watershed were extracted from the Illinois Natural History Survey's GAP Analysis Land cover database (INHS, 2003). This database was derived from satellite imagery taken during 1999 and 2000 and is the most current detailed land cover data known to be available. Each 98-foot by 98-foot pixel contained within the satellite image is classified according to its reflective characteristics. Figure 2-3 displays land use and land cover in the Sugar Creek watershed. A complete listing of the Illinois GAP land cover categories is given in Table A-1 in Appendix A.

The land cover data reveal that approximately 29,276 acres, representing nearly 70 percent of the total watershed area, are devoted to agricultural activities. Approximately 21 percent of the watershed is forested, and nearly seven percent is devoted to urban land uses. Tillage system practices are not available specifically for the Sugar Creek watershed, however, county-wide tillage system surveys have been undertaken by the Illinois Department of Agriculture (2000; 2002). It is assumed that the general tillage practice trends evidenced throughout the county are applicable to the Sugar Creek watershed. The results of these surveys for Edgar County are presented in Table 2-1. The table shows that the percentage of surveyed cornfields employing conventional tillage in Edgar County decreased from 2000 to 2002, and that no-till practices dramatically increased during the same time frame. For soybean production within the county, conventional tillage practices increased while conservation tillage practices remained roughly the same from 2000 to 2002. In 2002, all small grain production involved reduced-till practices through the county.

**Table 2-1. Percentage of Agricultural Fields Surveyed with Indicated Tillage System in Edgar County, Illinois, in 2000 and 2002.**

| ***2000 Transect Survey*** | | | | |
|---|---|---|---|---|
| | Tillage Practice | | | |
| **Crop Field Type** | **Conventional** | **Reduced-till** | **Mulch-till** | **No-till** |
| Corn | 70 | 12 | 6 | 12 |
| Soybean | 13 | 21 | 19 | 48 |
| Small Grain | 0 | 0 | 0 | 0 |
| ***2002 Transect Survey*** | | | | |
| | Tillage Practice | | | |
| **Crop Field Type** | **Conventional** | **Reduced-till** | **Mulch-till** | **No-till** |
| Corn | 59 | 9 | 2 | 30 |
| Soybean | 21 | 24 | 10 | 45 |
| Small Grain | 0 | 100 | 0 | 0 |

Source: Illinois Dept. of Agriculture, 2000; 2002.

In the following sections, land use and land cover are described and summarized for each of the listed water bodies, and their respective subwatershed areas.

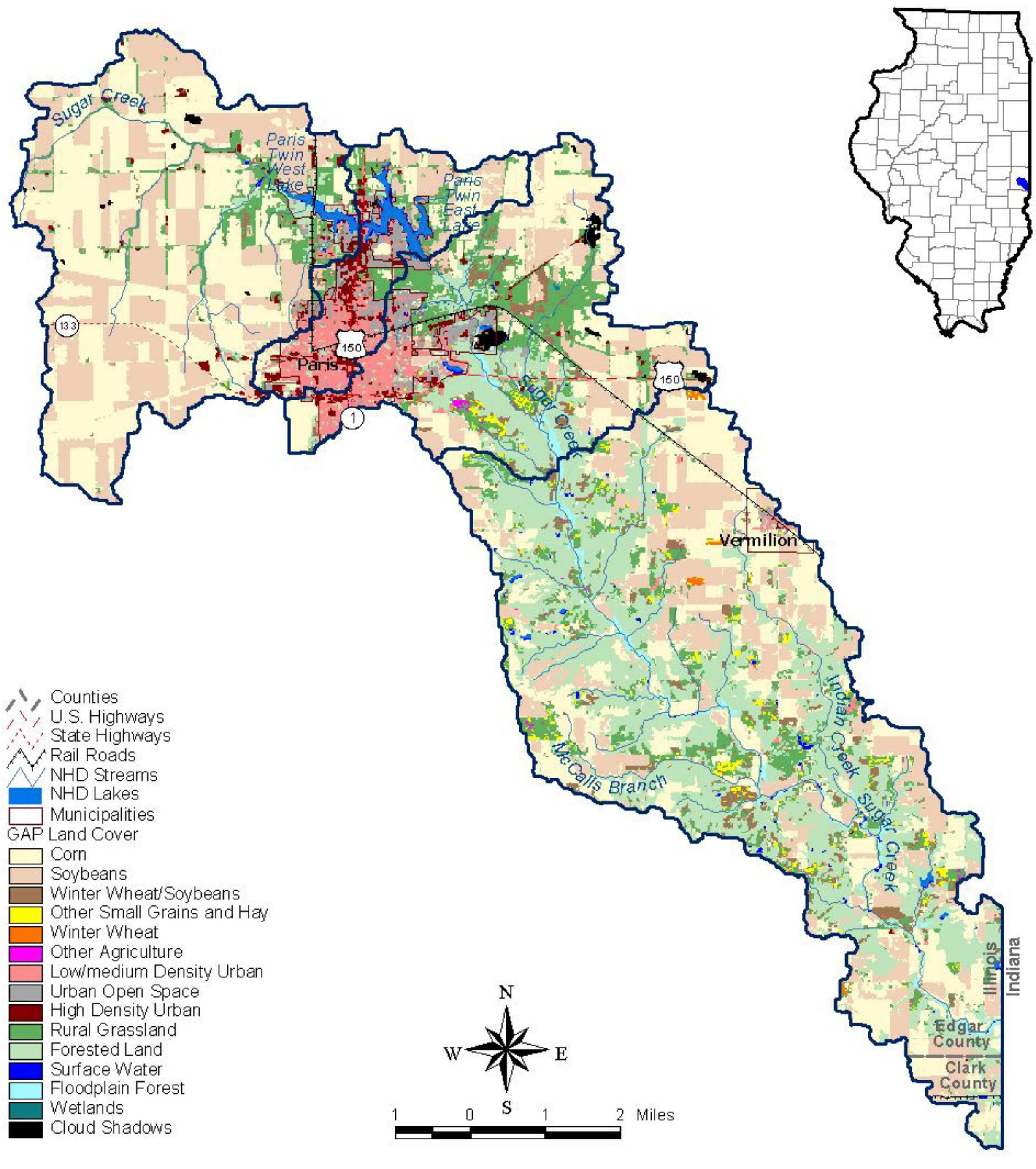


**Figure 2-3. GAP land use/land cover in the Sugar Creek watershed.**

### 2.3.1 Paris Twin West Lake (Illinois Water Body Segment RBX)

Land use and land cover in the Paris Twin West Lake subwatershed is summarized in Table 2-2. The table shows that agricultural land uses account for 10,585 acres, representing nearly 94 percent of the subwatershed area. Corn and soybeans dominate land cover, accounting for 47 and 39 percent of subwatershed area, respectively. Rural grassland, urban land uses, and forested lands represent seven, three, and two percent of the subwatershed area, respectively. All other cover types represent less that one percent of the subwatershed area.

**Table 2-2. Land Use and Land Cover in the Paris Twin West Lake Subwatershed**

| Land Use / Land Cover Description | Area | | Percent of Watershed Area |
|---|---|---|---|
| | Acres | Square Miles | |
| Corn | 5,310.8 | 8.3 | 47.1 |
| Soybeans | 4,398.5 | 6.9 | 39.0 |
| Rural Grassland | 828.6 | 1.3 | 7.3 |
| Urban | 347.2 | 0.5 | 3.1 |
| Forested | 231.5 | 0.4 | 2.1 |
| Water | 83.6 | 0.1 | 0.7 |
| Winter Wheat/Soybeans | 46.0 | 0.1 | 0.4 |
| Other | 34.0 | 0.1 | 0.3 |
| Other Small Grains And Hay | 1.1 | <0.1 | 0.0 |
| Wetland | 0.4 | <0.1 | 0.0 |
| **Total** | **11,281.7** | **17.7** | **100.0** |

### 2.3.2 Paris Twin East Lake (Illinois Water Body Segment RBL)

Agricultural land use is the dominant land use type in the Paris Twin East Lake subwatershed and accounts for 84 percent (12,044 acres) of the total subwatershed area. As shown in Table 2-3, corn and soybeans are the dominant crops, representing 41 percent and 34 percent, respectively, of all subwatershed land use and land cover types. Approximately 1,592 acres are devoted to urban land uses, representing slightly over 11 percent of the subwatershed area. Rural grassland, forested lands and surface water represent approximately 8 percent, 2.5 percent and 1.8 percent, respectively, of the subwatershed area. Other land cover types represent less than one percent of the subwatershed area.

**Table 2-3. Land Use and Land Cover in the Paris Twin East Lake Subwatershed**

| Land Use / Land Cover Description | Watershed Area | | Percent of Watershed Area |
|---|---|---|---|
| | Acres | Square Miles | |
| Corn | 5,899.2 | 9.2 | 41.3 |
| Soybeans | 4,880.4 | 7.6 | 34.1 |
| Urban | 1,592.3 | 2.5 | 11.1 |
| Rural Grassland | 1,170.9 | 1.8 | 8.2 |
| Forested | 353.2 | 0.6 | 2.5 |
| Water | 254.2 | 0.4 | 1.8 |
| Winter Wheat/Soybeans | 92.7 | 0.1 | 0.6 |
| Other | 48.7 | 0.1 | 0.3 |
| Other Small Grains And Hay | 1.1 | 0.0 | 0.1 |
| Wetland | 0.9 | 0.0 | 0.0 |
| **Total** | **14,293.6** | **22.3** | **100.0** |

### 2.3.3 Upper Sugar Creek (Illinois Water Body Segment BMC2)

Of the 21,932 acres draining the upper Sugar Creek subwatershed, 14,565 acres, slightly greater than 66 percent of the subwatershed area, is dedicated to agricultural activities. The dominant crop types are corn and soybeans (see Table 2-4), which represent 35 percent and 29 percent of the total subwatershed acreage, respectively. Urban lands account for 12 percent of the subwatershed area, while rural grassland, forested land uses, and winter wheat/soybeans account for approximately 11 percent, 8 percent, and 2 percent of the subwatershed area, respectively.

**Table 2-4. Land Use and Land Cover in the Upper Sugar Creek Subwatershed**

| Land Use / Land Cover Description | Watershed Area | | Percent of Watershed Area |
|---|---|---|---|
| | Acres | Square Miles | |
| Corn | 7,763.6 | 12.1 | 35.40 |
| Soy | 6,259.7 | 9.8 | 28.54 |
| Urban | 2,665.4 | 4.2 | 12.15 |
| Rural Grassland | 2,496.4 | 3.9 | 11.38 |
| Forested | 1,721.1 | 2.7 | 7.85 |
| Winter Wheat/Soybeans | 456.1 | 0.7 | 2.08 |
| Surface Water | 278.4 | 0.4 | 1.27 |
| Other | 188.1 | 0.3 | 0.86 |
| Other Small Grains and Hay | 68.5 | 0.1 | 0.31 |
| Wetlands | 17.3 | 0.0 | 0.08 |
| Other Agriculture | 15.6 | 0.0 | 0.07 |
| Winter Wheat | 1.8 | 0.0 | 0.01 |
| Total | 21,932.0 | 34.2 | 100.00 |

### 2.3.4 Lower Sugar Creek (Illinois Water Body Segment BM02)

The lower Sugar Creek subwatershed represents the entire Sugar Creek watershed within Illinois, and drains approximately 42,041 acres (Table 2-5). Of this area, approximately 29,276 acres is dedicated to agricultural land use, representing nearly 70 percent of the total watershed area. Corn and soybean are the dominant crop types, accounting for 31 percent and 25 percent, respectively, of all land use and land cover within the watershed. Forested lands account for slightly more than 21 percent of the watershed area, while rural grassland, urban land uses, and winter wheat account for approximately 10 percent, 7 percent, and 3 percent of the watershed area.

**Table 2-5. Land Use and Land Cover in the Lower Sugar Creek Subwatershed within Illinois**

| Land Use / Land Cover Description | Watershed Area | | Percent of Watershed Area |
|---|---|---|---|
| | Acres | Square Miles | |
| Corn | 13,093.9 | 20.5 | 31.1 |
| Soybeans | 10,503.7 | 16.4 | 25.0 |
| Forested | 9,058.6 | 14.2 | 21.5 |
| Rural Grassland | 4,084.7 | 6.4 | 9.7 |
| Urban | 2,783.3 | 4.3 | 6.6 |
| Winter Wheat/Soybeans | 1,198.7 | 1.9 | 2.9 |
| Water | 366.7 | 0.6 | 0.9 |
| Wetland | 366.7 | 0.6 | 0.9 |
| Other Small Grains And Hay | 323.8 | 0.5 | 0.8 |
| Other | 190.1 | 0.3 | 0.5 |
| Winter Wheat | 44.9 | 0.1 | 0.1 |
| Other Agriculture | 25.8 | 0.0 | 0.1 |
| **Total** | **42,040.9** | **65.7** | **100.0** |

## 2.4 Soils

Soils data and GIS coverages from the Natural Resources Conservation Service (NRCS) were used to characterize soils in the Sugar Creek watershed. General soils data and map unit delineations for the country are provided as part of the State Soil Geographic (STATSGO) database. GIS coverages provide locations for the soil map units at a scale of 1:250,000 (USDA, 1995). A map unit is composed of several soil series having similar properties. It should be noted that map units can be highly variable and the following maps are meant as general representations. Figure 2-4 displays the STATSGO soil map units in the Sugar Creek watershed. Identification fields in the GIS coverage can be linked to a database that provides information on chemical and physical soil characteristics for each map unit. Of particular interest for water resource studies are the hydrologic soil group, the K-factor of the Universal Soil Loss Equation, and depth to water table. The following sections describe and summarize the specified soil characteristics for each of the listed water bodies, and their respective subbasins, in the Sugar Creek watershed.

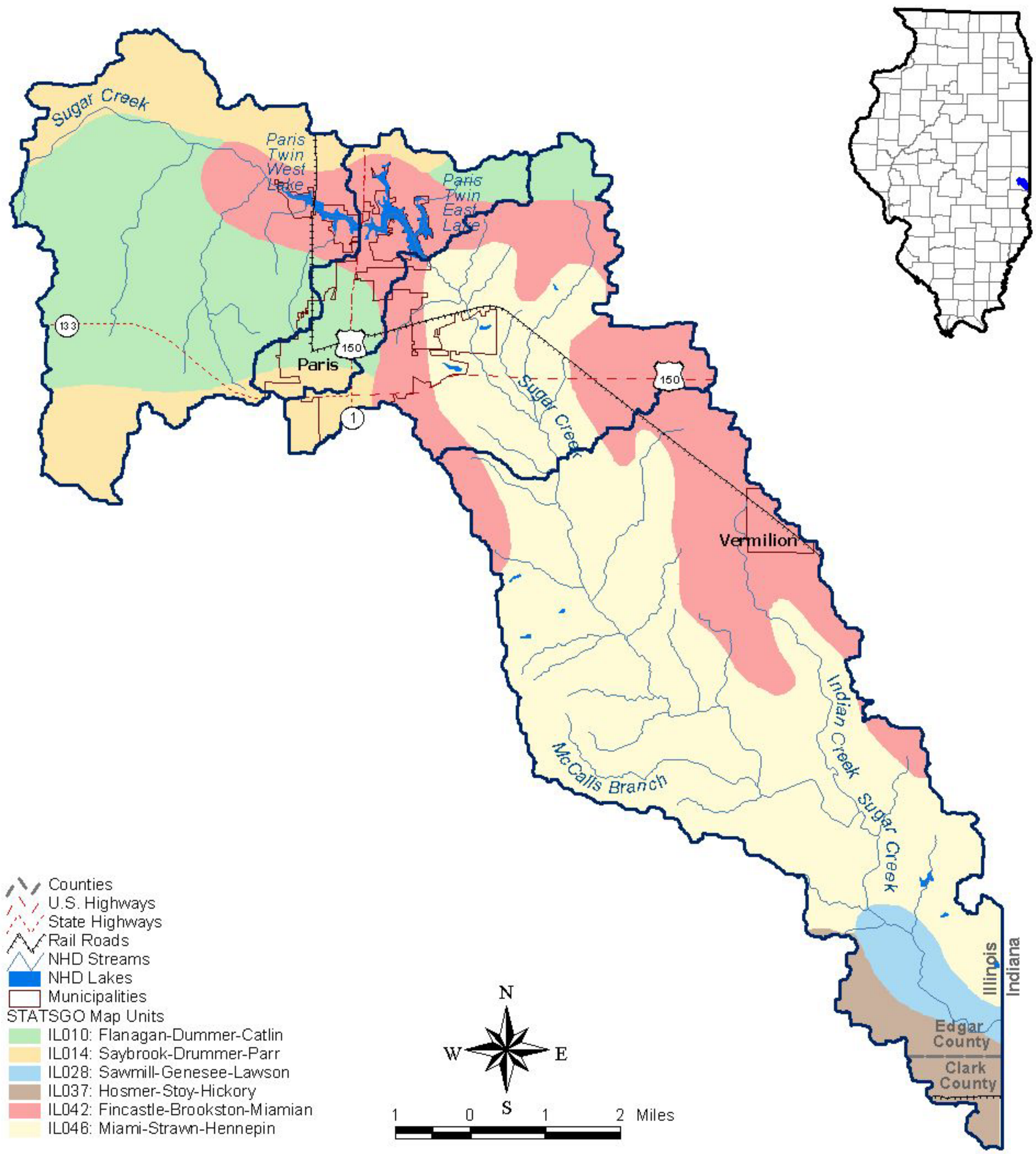


**Figure 2-4. Distribution of STATSGO Map Units in the Sugar Creek watershed.**

### 2.4.1 Hydrologic Soil Group

The hydrologic soil group classification is a means for grouping soils by similar infiltration and runoff characteristics during periods of prolonged wetting. Typically, clay soils that are poorly drained have lower infiltration rates, while well-drained sandy soils have the greatest infiltration rates. NRCS (2001) has defined four hydrologic groups for soils as listed in Table 2-6. In addition, soils with tile drainage in Illinois should be designated as Class B soils (i.e., due to the presence of tile drainage the soil takes on the attribute of a Class B soil ((McKenna, personal communications, December 15, 2004)). Figure 2-5 presents the general distribution of hydrologic soil groups in the Sugar Creek watershed. The figure shows the dominant hydrologic groups in the basin are B and C. Hydrologic soil group B composes soils in the lower and middle reaches of the basin, which includes Sugar Creek below Paris Twin East Lake. The headwaters region also contains soils classified as hydrologic soil group B. Hydrologic group C accounts for soils in the areas adjacent to Paris Twin East Lake and Paris Twin West Lake as well as areas near Vermilion village and the Clark County line.

**Table 2-6. NRCS Hydrologic Soil Groups**

| Hydrologic Soil Group | Description |
|---|---|
| A | Soils with high infiltrations rates. Usually deep, well drained sands or gravels. Little runoff. |
| B | Soils with moderate infiltration rates. Usually moderately deep, moderately well drained soils. |
| C | Soils with slow infiltration rates. Soils with finer textures and slow water movement. |
| D | Soils with very slow infiltration rates. Soils with high clay content and poor drainage. High amounts of runoff. |

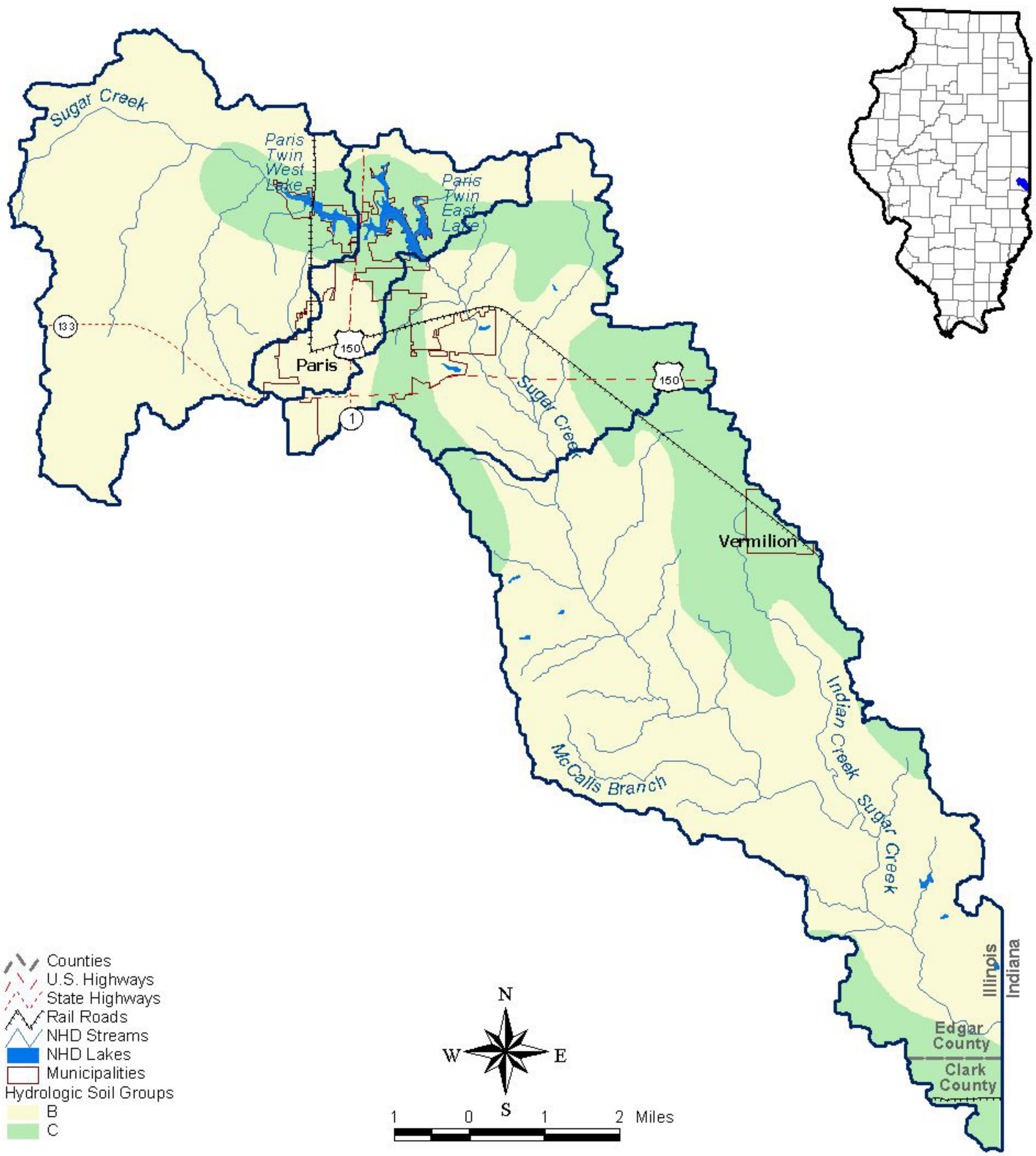


**Figure 2-5. Hydrologic soil group distribution in the Sugar Creek watershed.**

### 2.4.2 K-Factor

A commonly used soil attribute is the K-factor, a component of the USLE (Wischmeier and Smith, 1978). The K-factor is a dimensionless measure of a soil's natural susceptibility to erosion, and factor values may range from 0 for water surfaces, to 1.00 (although in practice, maximum factor values do not generally exceed 0.67). Large K-factor values reflect greater inherent soil erodibility. The distribution of K-factor values in the Sugar Creek watershed is shown in Figure 2-6. The figure indicates that soils with moderate erosion potential (e.g. K-factors that range in value from 0.20 to 0.37) are widely distributed throughout the watershed, and comprise approximately 66.83 percent of the soils in the basin. The figure also shows that only a small area contains soils where K-factor values exceed 0.37, suggesting that inherent erodibility does not exceed the moderate classification in the majority of the basin. Interestingly, low and low-to-moderate K-factor values share equal proportions of the watershed, each occupying approximately 16 percent of the watersheds soils. These low erosion susceptibility areas occur throughout the watershed and are typically associated with sandy soils with high infiltration rates.

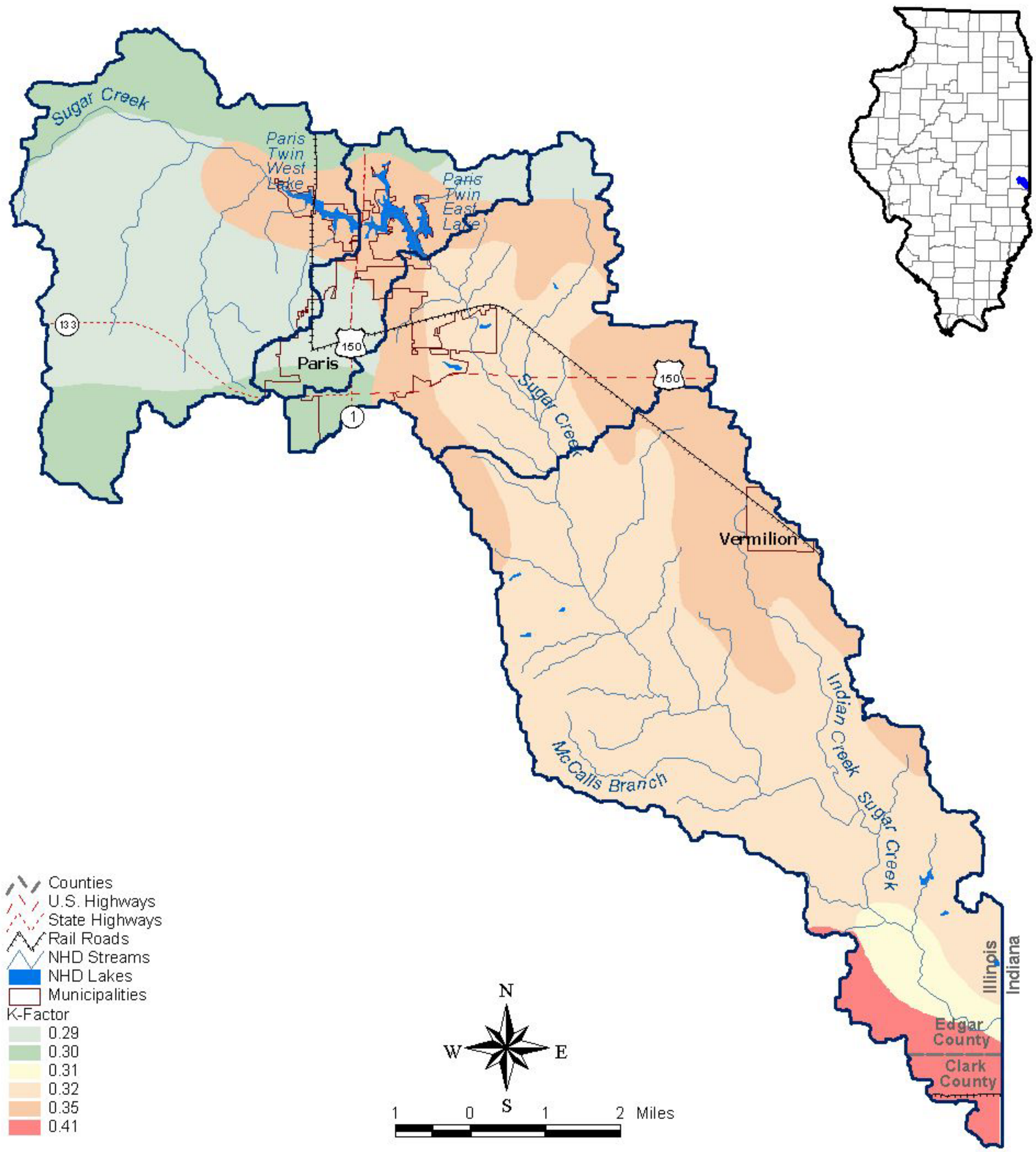


**Figure 2-6. USLE K-Factor distribution in the Sugar Creek watershed.**

### 2.4.3 Depth to Water Table

Water table depth as described in the STATSGO database is the range in depth to the seasonally high water table level for a specified month. The STATSGO database reports depth to water table as both a minimum and maximum depth. Values were summarized to reflect the weighted sum of the minimum depth to water table for the surface layer of all soil sequences composing a single STATSGO map unit. Figure 2-7 displays the distribution of depth to water table for the basin and shows that depths range from 1.0 foot to 5.0 feet. Minimum depths occur along the northwest margin of the watershed maximum depths occur in two along the middle reaches of Sugar Creek.

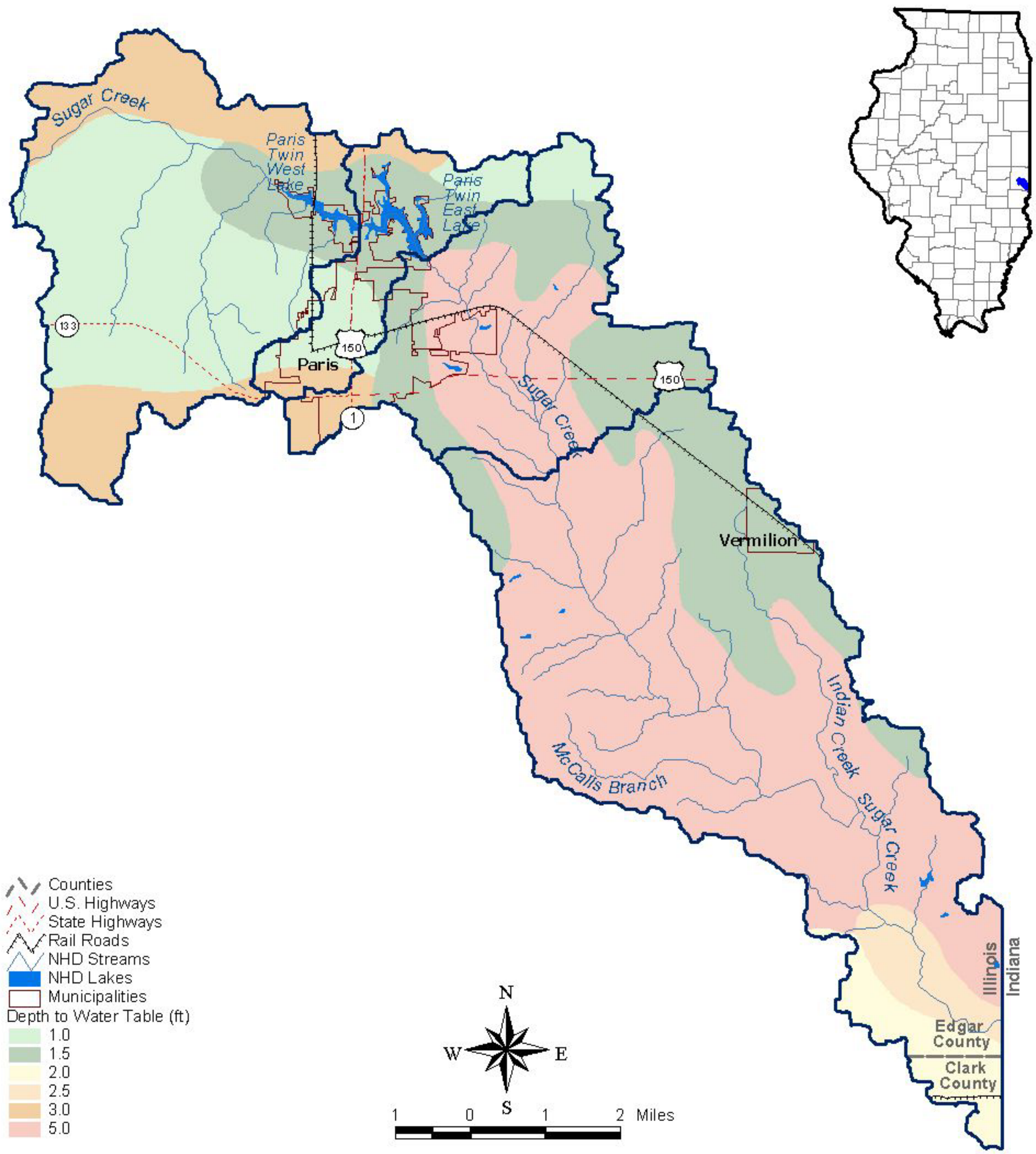


**Figure 2-7. Depth to water table in the Sugar Creek watershed**

## 2.5 Population

Total watershed population is not directly available but may be calculated from the 2000 U.S. Census data. The 2000 U.S. Census data were downloaded for all towns, cities, and counties whose boundaries lie wholly or partially in the watershed (Census, 2000). Urban and nonurban populations were estimated for the watershed area and were summed to obtain an estimate of total watershed population. The following paragraphs describe how urban and nonurban population estimates were determined from town, city, and county Census data.

Urban watershed population is the sum of population for all towns and cities located entirely in the watershed. In the instance where a city or town is located partially in the watershed, a population weighting method was used to estimate a place's contribution to urban watershed population. First, the proportion of the place's area in the watershed was determined using spatial overlay of the town and city boundaries with the watershed boundary in a geographic information system (GIS). Assuming an even distribution of population throughout each place, the city and town populations were multiplied by the proportion of the place encompassed by the watershed. The product was assumed to reflect an urban area's contribution to total watershed population. Finally, contributing population for each place was summed to obtain total urban watershed population.

Nonurban watershed population is defined as the portion of watershed population excluding urban population. Nonurban population for each county was determined by first subtracting the total county urban population from the total county population. Some cities and towns are not entirely included in a single county and their contribution to total county urban population was estimated using the same method described in the previous paragraph. Since only portions of counties are found in the watershed, a nonurban population weighting method was also used to estimate each county's contribution of nonurban population to the total watershed population. The proportion of county to watershed nonurban area was determined from spatial overlay of county boundaries and the watershed boundary in a GIS. Nonurban area for each county and watershed were calculated by subtracting the total urban area from the total area, respectively. It is assumed that the nonurban population for each county is uniformly distributed throughout the nonurban portion of the county. The nonurban county population was multiplied by the county's nonurban proportional watershed area and the product was assumed to reflect the county's contribution to the nonurban watershed population.

### 2.5.1 Watershed Population

Watershed population is summarized in Table 2-7 for the ILBM02 watershed. Approximately 9,202 people reside in the ILBM02 watershed. The watershed's urban and nonurban population totals are given for each county in Table 2-7. Figure 2-1 displays the locations of counties, cities, and towns. Table 2-7 indicates that 717 people, or 7.79 percent of the population, live in nonurban areas, while 8,486 people (92.21 percent) reside in urban areas.

**Table 2-7. ILBM02 Watershed Population Summarized by County**

| County | Watershed Population | Percent Watershed Population [a] | Nonurban Population | Percent Nonurban Population [a] | Urban Population | Percent Urban Population [a] |
|---|---|---|---|---|---|---|
| Edgar County | 9,187 | 99.83 | 701 | 7.62 | 8,486 | 92.21 |
| Clark County | 16 | 0.17 | 16 | 0.17 | 0 | 0.00 |
| **Total** | **9,202** | **100.00** | **717** | **7.79** | **8,486** | **92.21** |

[a] Percentages are a proportion of the total watershed population.
Source: U.S. 2000 Census and GIS analysis.

The urban population centers in the ILBMC2 watershed are shown in Figure 2-1 and Table 2-8.

The city of Paris is the only urban population center in the BMC2 watershed and contributes 8,336 people to total watershed population. There are no urban population centers contributing to urban population in Clark County.

**Table 2-8. Urban Population Centers in the ILBM02 Watershed**

| Waterbody Segment/ County | Municipality | Total Urban Population |
|---|---|---|
| Edgar County | City of Paris | 8,336 |
| | Village of Vermilion | 150 |
| Clark County | NA | NA |
| | **Total** | **8,486** |

Source: U.S. 2000 Census and GIS analysis.

### 2.5.2 Population Growth

Table 2-9 demonstrates population change, calculated for the ten-year period between 1990 and 2000, for nonurban and urban populations in the Sugar Creek watershed. The population remained fairly stable during this period.

**Table 2-9. Population Change in the Sugar Creek Watershed**

| County | Municipality | 1990 Population | 2000 Population | Absolute Change | Percent Change |
|---|---|---|---|---|---|
| Edgar County | Nonurban | 705 | 701 | -4 | -0.57 |
| | City of Paris | 8,253 | 8,336 | 83 | 1.00 |
| | Village of Vermilion | 177 | 150 | -27 | -18.00 |
| Clark County | Nonurban | 14 | 16 | 2 | 12.50 |
| | **Total** | **9,149** | **9,202** | **53** | **0.58** |

# 3 Climate and Hydrology

## 3.1 Climate

East central Illinois has a temperate climate with hot summers and cold, snowy winters. Average annual precipitation is 41.6 inches. On average there are 124 days with at least 0.01 inches of precipitation. Annual average snowfall is 28.5 inches. Monthly variation of total precipitation, snowfall, and temperature is presented for the Paris Waterworks (Cooperative ID 116610) in Figure 3-1. The figure shows that although precipitation occurs throughout the year, April through August are the months with the most precipitation per month. Much of the annual snowfall occurs in the months of December through February, with the greatest snowfalls occurring in January.

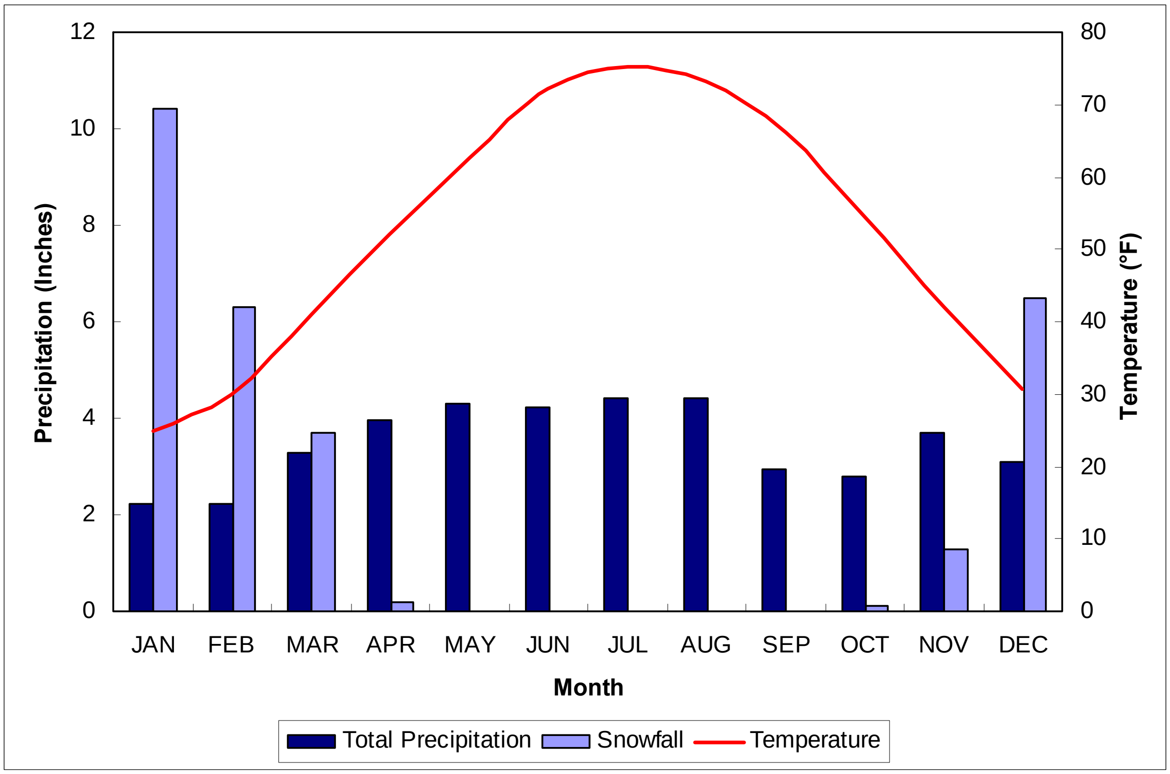


**Figure 3-1. Climate summary for the Paris Waterworks station (116610).**

## 3.2 Hydrology

This section presents information related to the general hydrology, streams types, and subbasins found within the Sugar Creek watershed.

### 3.2.1 Reservoir Hydrology

Two reservoirs, West Lake and East Lake, are located on Sugar Creek. West Lake, built in 1894 has a surface area of 62 acres with an average depth of 3.3 feet. West Lake was supplemented with East Lake, which was built in 1917 and expanded to its present configuration in 1960 following a dam failure in 1957. East Lake has a surface area of 162.8 acres and an average depth of 10.2 feet.

The reservoirs are owned by the City of Paris, Illinois, and serve as the water supply for the City. The lakes also provide recreational opportunities such as fishing, boating, and swimming. An earthen embankment and a dam divide West Lake from East Lake. Consequently, the West Lake has acted as a sedimentation basin, allowing considerable amounts of sediment to accumulate.

Groundwater exchange between the lake and underlying materials is difficult to calculate. However, given the relatively low-impermeable soils and very flat topography, it can be assumed that groundwater flow is not an important component in the overall hydrologic budget of the lakes. In a previous study (Illinois EPA, 1992) groundwater inflows and outflow were calculated and the average difference between the two was found to be 3.8 percent of total outflows. Additionally, the study concluded that the greatest amount of groundwater inflow to the lakes occurred during May and June, and the greatest amount of groundwater outflow occurred during November and January.

### 3.2.2 Stream Types

The National Hydrography Data (NHD) provided by USEPA and USGS identified three different stream types in the Sugar Creek Basin (Figure 3-2) (NHD, 2003). Most streams were classified as intermittent streams (Table 3-1). Intermittent streams have flow only for short periods during the course of a year, which is usually initiated by rainfall. Artificial paths are the NHD line features in the basin that designate the location of a lake.

**Table 3-1. Summary of Stream Type in the Sugar Creek Basin**

| Stream Type | Stream Length (m) | Percent |
|---|---:|---:|
| Intermittent Streams | 90,691.5 | 69.49 |
| Perennial Streams | 33,821.5 | 25.92 |
| Artificial Paths | 5,991.7 | 4.59 |
| **Total** | **130,504.6** | **100.00** |

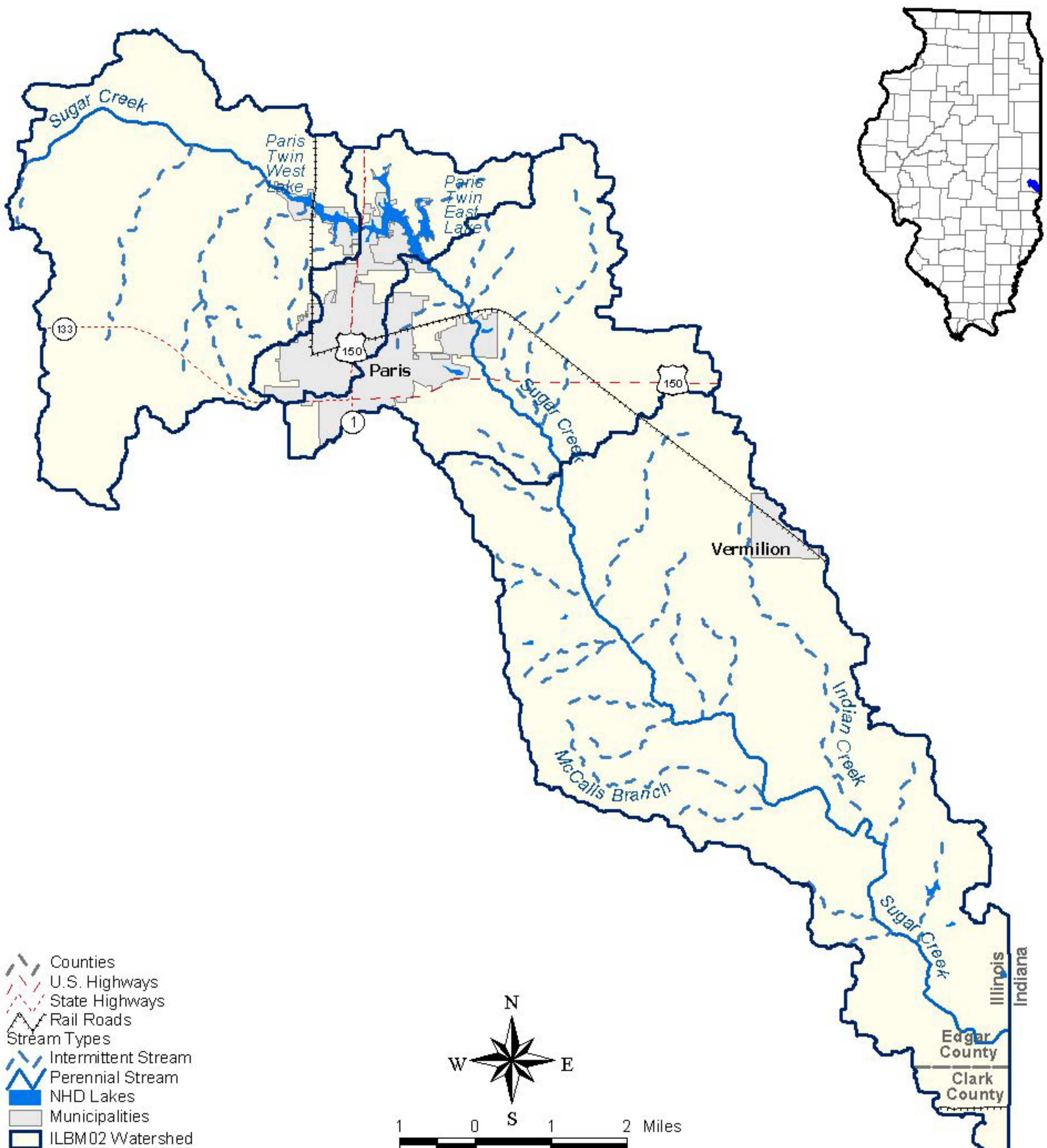


**Figure 3-2. Stream types in the Sugar Creek watershed.**

### 3.2.3 Subbasin Delineation

Subbasins were delineated using the ArcView interface for the Soil Water Assessment Tool (SWAT) model. The interface requires digital elevation data (DEM) covering the entire area of the Sugar Creek watershed. Thirty-meter DEM data, representing 7.5 minute U.S. Geological Survey (USGS) quadrangle maps, were downloaded from the GEOCommunity <www.geocomm.com> web site. Subbasin delineation is based on the DEM data coupled with a "burn-in" of the National Hydrography Data set (NHD) spatial database of stream reaches. This approach ensures that the subbasin boundaries conform to topographic characteristics while requiring that catalogued stream segments connect in the proper order and direction. The delineated subbasins, shown in Figure 2-1 and later watershed figures, conform very well to the drainage divides given by the Illinois 12-digit Hydrologic Unit Codes. These subbasins will be useful for implementation planning.

### 3.2.4 Tile Drainage

The watershed is extensively underlain by drain tile designed to remove standing water from the soil surface. Tile drainage affects the water table by reducing the volume of water entering the soil profile. This type of drainage includes land leveling and smoothing; the construction of surface water inlets to subsurface drains; and the construction of shallow ditches and grass waterways, which empty into open ditches and streams. Subsurface drainage is designed to remove excess water from the soil profile. The water table level is controlled through a series of drainage pipes (tile or tubing) that are installed below the soil surface, usually just below the root zone. In Illinois, subsurface drainage pipes are typically installed at a depth of 3 to 4 feet and at a spacing of 80 to 120 feet. The subsurface drainage network generally outlets to an open ditch or stream.

Researchers at the University of Illinois and elsewhere have studied the impact of tile drainage on hydrology and water quality. Some impacts are relatively well understood while others are not. Zucker and Brown (1998) provided the following summary of the impacts (statements compare agricultural land with subsurface drainage to that without subsurface drainage):

- The percentage of rain that falls on a site with subsurface drainage and leaves the site through the subsurface drainage system can range up to 63 percent.
- The reduction in the total runoff that leaves the site as overland flow ranges from 29 to 65 percent.
- The reduction in the peak runoff rate ranges from 15 to 30 percent.
- Total discharge (total of runoff and subsurface drainage) is similar to flows on land without subsurface drainage, if flows are considered over a sufficient period of time before, during, and after the rainfall/runoff event.
- The reduction in sediment loss by water erosion from a site ranges between 16 to 65 percent. This reduction relates to the reduction in total runoff and peak runoff rate.
- The reduction in loss of phosphorus ranges up to 45 percent, and is related to the reductions in total runoff, peak runoff rate, and soil loss. However, in high phosphorus content soils, dissolved phosphorus levels in tile flow can be high.
- In terms of total nutrient loss, by reducing runoff volume and peak runoff rate, the reduction in soil-bound nutrients is 30 to 50 percent.
- In terms of total nitrogen losses (sum of all N species), there is a reduction. However, nitrate-N, a soluble nitrogen ion, has great potential to move wherever water moves. Numerous studies throughout the Midwest and southeast U.S., and Canada document that the presence of a subsurface drainage system enhances the movement of nitrate-N to surface waters. Proper management of drainage waters along with selected in-field BMPs helps reduce this potential loss.

### 3.2.5 Flow Data

There are no USGS stream flow monitoring stations within the watershed. No other sources of continuous stream flow data have been identified.

# 4 Inventory and Assessment of Water Quality Data

This section presents the 2002 303(d) list information for all listed waterbodies in the ILBM02 watershed. A description of the parameters of concern and the applicable water quality standards is presented. Additionally, an analysis of the available water quality (or other watershed monitoring) data to confirm the impairment and a summary of existing water quality conditions is provided. A complete listing of the water quality data is provided in Appendix B.

## 4.1 Illinois 303(d) List Status

The Illinois 2002 303(d) list for the ILBM02 watershed is given in Table 1-1. The table shows that Paris Twin West Lake and Paris Twin East Lake are listed for impairments related to nutrients. Sugar Creek is listed for impairments related to dissolved oxygen and fecal coliform.

## 4.2 Previous Studies

Previous study in the Sugar Creek watershed has focused on water quality in the Paris Twin Lakes. The Illinois State Water Survey conducted a sedimentation survey of Paris West Twin Lake in the early 1990s (Bogner, 1992). The study found that sedimentation had reduced the original lake storage capacity by 53 percent, which in turn had reduced the sediment trap efficiency of the lake from the designed efficiency of 77 percent to 63 percent. The study recommended that in-lake rehabilitation programs, such as dredging and improved wetland vegetation to enhance sediment filtering, be implemented to improve general water quality in the lake.

A Phase I Diagnostic and Rehabilitation Feasibility study (Illinois EPA, 1992) of the Twin Lakes was completed under the USEPA Clean Lakes Program in 1992. The Phase I study investigated the physical and social characteristics of the Twin Lakes drainage, assessed numerous water quality parameters and biological resources, and examined the feasibility of lake restoration. The study found high rates of sediment delivery from Sugar Creek to West Lake, high suspended solids levels in the lake, and diminished sediment storage capacity of West Lake. Additionally, high levels of nitrogen and phosphorus, particularly in the West Lake, were contributed from Sugar Creek, which caused frequent algal growth. Total phosphorus and dissolved phosphorus concentration tended to decrease from upstream locations (West Lake) to downstream (East Lake). Total phosphorus concentration in the Twin lakes exceeded the State criteria of 0.05 mg/L. The West Lake averaged 0.093 mg/L, while the East Lake averaged 0.060 mg/L. The study also found low dissolved oxygen levels in the lakes, particularly near the bottom of West Lake, and below a depth of eight to nine feet in the East Lake during periods of thermal stratification.

Additional problems identified were shoreline erosion, due to insufficient shoreline vegetation and wave action from wind and boats, and poor fisheries population and habitat. The primary restoration alternative recommended for the project was hydraulically dredging 450,000 cubic yards of sediment from West Lake. Additional recommendations included the enhancement of the upper end of the lake to function as a sediment basin, various shoreline erosion control and protection measures, fisheries management, watershed land treatment practices, and the installation of an aeration system.

A Phase II Implementation study (Illinois EPA, 1998) examined the differences between pre-implementation and post-implementation periods. The study found that shoreline protection and stabilization measures suggested in the Phase I report proved to be successful in reducing shoreline erosion, and that dredging operations increased overall storage capacity by over 200 percent. Additionally, the study found that dredging operations resulted in an estimated 26.5% reduction in sediment load. However, a majority of the chemical parameters have remained approximately the same.

In particular, nitrogen concentrations averaged above 0.30 mg/L and mean phosphorus levels remained above 0.05 mg/L. The levels of these nutrients were sufficient to increase algal biomass and subsequently contribute to low dissolved oxygen levels during summer months.

## 4.3 Parameters of Concern

The following sections provide a summary of the parameters identified on Illinois 2002 303(d) list as causing impairments to the Sugar Creek watershed. The purpose of these sections is to provide an overview of the parameters, units, sampling methods, and potential sources. The relevance of the parameter to the various beneficial uses is also briefly discussed.

### 4.3.1 Nutrients/Organic Enrichment/Low DO/Excessive Algal Growth

The term *nutrients* usually refers to the various forms of nitrogen and phosphorus found in a waterbody. Both nitrogen and phosphorus are necessary for aquatic life, and both elements are needed at some level in a waterbody to sustain life. The natural amount of nutrients in a waterbody varies depending on the type of system. A pristine mountain spring might have little to almost no nutrients, whereas a lowland, mature stream flowing through wetland areas might have naturally high nutrient concentrations. Various forms of nitrogen and phosphorus can exist at one time in a waterbody, although not all forms can be used by aquatic life. Common phosphorus sampling parameters are total phosphorus (TP), dissolved phosphorus, and orthophosphate.

The dissolved phosphorus component of total phosphorus is the form that is most readily available to plants. It consists of soluble phosphorus that is not bound to particulates. In waterbodies with relatively short residence times, such as fast-flowing streams, dissolved phosphorus is of greater interest than TP because it is the only form that is readily available to support algal growth. However, in lakes and reservoirs, where residence times are much longer, particulate phosphorus can be transformed to dissolved phosphorus through microbial action. TP is therefore considered an adequate estimation of bioavailable phosphorus (USEPA, 1999).

Common nitrogen sampling parameters are total nitrogen (TN), nitrite ($NO_2$), nitrate ($NO_3$), total Kjeldahl nitrogen (TKN), and ammonia ($NH_3$). Concentrations are measured in the lab and are typically reported in milligrams per liter.

Nutrients generally do not pose a direct threat to the beneficial uses of a waterbody. However, excess nutrients can cause an undesirable abundance of plant and algae growth. This process is called eutrophication or organic enrichment. Organic enrichment can have many effects on a stream or lake. One possible effect of eutrophication is low dissolved oxygen concentrations. Aquatic organisms need oxygen to live and they can experience lowered reproduction rates and mortality with lowered dissolved oxygen concentrations. Dissolved oxygen concentrations are measured in the field and are typically reported in milligrams per liter. Ammonia, which is toxic to fish at high concentrations, can be released from decaying organic matter when eutrophication occurs. Recreational uses can be impaired because of eutrophication. Nuisance plant and algae growth can interfere with swimming, boating, and fishing. Nutrients generally do not pose a threat to agricultural uses.

Nitrogen and phosphorus exist in rocks and soils and are naturally weathered and transported into waterbodies. Organic matter is also a natural source of nutrients. Systems rich with organic matter (e.g., wetlands and bogs) can have naturally high nutrient concentrations. Phosphorus and nitrogen are potentially released into the environment through different anthropogenic sources including septic systems, wastewater treatment plants, fertilizer application, and animal feeding operations.

### 4.3.2 Sedimentation/Siltation

Extreme sedimentation can impair aquatic life, drinking water, and recreational designated uses. Excessive sediments deposited on the bottom of streams and lakes can choke spawning gravels, thereby reducing fish survival and growth rates, impair fish food sources, and reduce habitat complexity in stream channels. Furthermore, high sediment levels can clog fish gills, causing direct physical harm. Related to drinking water supply, sediments can cause taste and odor problems, block water supply intakes, foul treatment systems, and fill reservoirs. High levels of sediment can impair swimming and boating by altering channel form, creating hazards due to reductions in water clarity, and adversely affecting the general aesthetics of the waterbody.

Sediment is delivered to a receiving waterbody through various erosional processes such as sheetwash, gully and rill erosion, wind, landslides, and human excavation. Additionally, sediments are often produced through the stream channel and stream bank erosion, and by channel disturbance.

### 4.3.3 Fecal Coliform

Fecal coliform is a widely-used indicator organism for the potential contamination from other, more harmful septic-effluent and manure-borne microorganisms. High levels of fecal coliform can impair recreational uses by inducing human illness. Infections due to fecal coliform-contaminated recreational waters include gastrointestinal, respiratory, eye, ear, nose, throat, and skin diseases (USEPA, 1986). Drinking water supplies may become contaminated and unsafe for consumption. Although chlorination or other disinfectants inactivate fecal coliform under normal circumstances, high loadings in the source water may require more expensive treatment techniques, such as ozone, membranes or ultraviolet radiation. In aquatic systems, excessive fecal coliform may contaminate filter-feeding fish, such as clams, oysters, mussels, and other shellfish. Microbial contaminants may concentrate in their tissues and may be harmful to humans when consumed raw or undercooked.

Fecal coliform is generated by point and nonpoint sources and then transported by a pipe, storm water runoff, groundwater, or other mechanisms to receiving water. Typical point sources of fecal coliform include discharges from wastewater treatment plants (WWTP) and combined sewer overflows (CSOs). CSOs occur when wet weather flows exceed the conveyance and storage capacity of the combined stormwater and sanitary sewage system. During a CSO, raw sewage can bypass the WWTP and enter directly into a receiving waterbody. Tetra Tech is not aware of any CSO discharges into Sugar Creek. Other point sources include concentrated animal feeding operations, and slaughterhouses and meat processing facilities.

Nonpoint sources of fecal coliform are dominated by wet weather, and do not enter waterbodies at a single point. Furthermore, nonpoint sources may be from rural or urban areas. Urban and suburban nonpoint sources include surface litter, contaminated refuse, domestic pet and wildlife excrement, and failing sanitary sewer lines. Rural nonpoint source loadings originate from both land use-specific and natural sources. The primary rural nonpoint source for fecal coliform is confined animal operations, such as a feedlot. Other significant sources include leaking septic systems and land application of manure and sewer sludge. Lastly, another significant source of fecal coliform loadings is wildlife. Beaver, deer, and waterfowl, such as ducks, geese, and heron, can contaminate surface water with microbial organisms.

## 4.4 Applicable Water Quality Standards

A description of the designated use support for waters within Illinois and a narrative of IEPA’s water quality standards are presented in this section. Additionally, numerical water quality criteria for the parameters of interest in this TMDL are listed as well.

### 4.4.1 Use Support Guidelines

To assess the designated use support for Illinois waterbodies the Illinois EPA uses rules and regulations adopted by the Illinois Pollution Control Board (IPCB). The following are the use support designations provided by the IPCB for the Paris Twin Lakes:

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

*b.* *Public and Food Processing Water Supply Standards* **-** These standards protect for any water use in which water is withdrawn from surface waters of the state for human consumption or for processing of food products intended for human consumption.

### 4.4.2 Numeric Standards

Numeric water quality standards for the State of Illinois for general use and Public and food processing and water supply are presented in Table 4-2.

**Table 4-2. Illinois Numeric Water Quality Standards**

| Parameter | Units | General Use | Public and Food Processing Water Supply |
|---|---|---|---|
| **Nutrients/Organic Enrichment/Low DO/Excessive Algal Growth** | | | |
| Total Phosphorus[1] | mg/L | 0.05 | 0.05 |
| Dissolved Oxygen | mg/L | 5.0 minimum | 5.0 minimum |
| Chlorophyll-a | µg/L | None | None |
| **Sedimentation/Siltation** | | | |
| Sedimentation/Siltation | | None | None |
| **Total Suspended Solids** | | | |
| Total Suspended Solids | | None | None |
| **Pathogens** | | | |
| Fecal Coliform | #/100 mL | 200 (geometric mean)/400 (instantaneous)[2] | 2000[3] |

[1]The total phosphorus standard only applies to lakes.
[2]The general use fecal coliform standard reads as follows: "During the months May through October, based on a minimum of five samples taken over not more than a 30 day period, fecal coliform shall not exceed a geometric mean of 200 per 100 ml, nor shall more than 10% of the samples during any 30 day period exceed 400 per 100 ml in protected waters." (Source: Illinois Administrative Code. Title 35. Subtitle C. Part 302.209)
[3]The public and food processing water supply fecal coliform standard reads as follows: "Notwithstanding the provisions of Section 302.209, at no time shall the geometric mean, based on a minimum of five samples taken over not more than a 30 day period, of fecal coliform exceed 2000 per 100 mL." (Source: Illinois Administrative Code. Title 35. Subtitle C. Part 302.306).

## 4.5 Water Quality Assessment

Water quality data for Paris Twin West Lake, Paris Twin East Lake, and Sugar Creek were downloaded from the STORET and USGS NWIS databases. Additionally, sampling data from the Paris Waste Water Treatment Plant are available. The location of the monitoring stations located within the watershed is shown in Figure 4-1. Figure 4-2 displays the monitoring stations located in the Paris Twin West Lake and the Paris Twin East Lake. Summary statistics, including the period of record, for all available water quality data are presented in this section, and are organized by impaired waterbody segment. The individual results of each sampling event are provided in Appendix B.

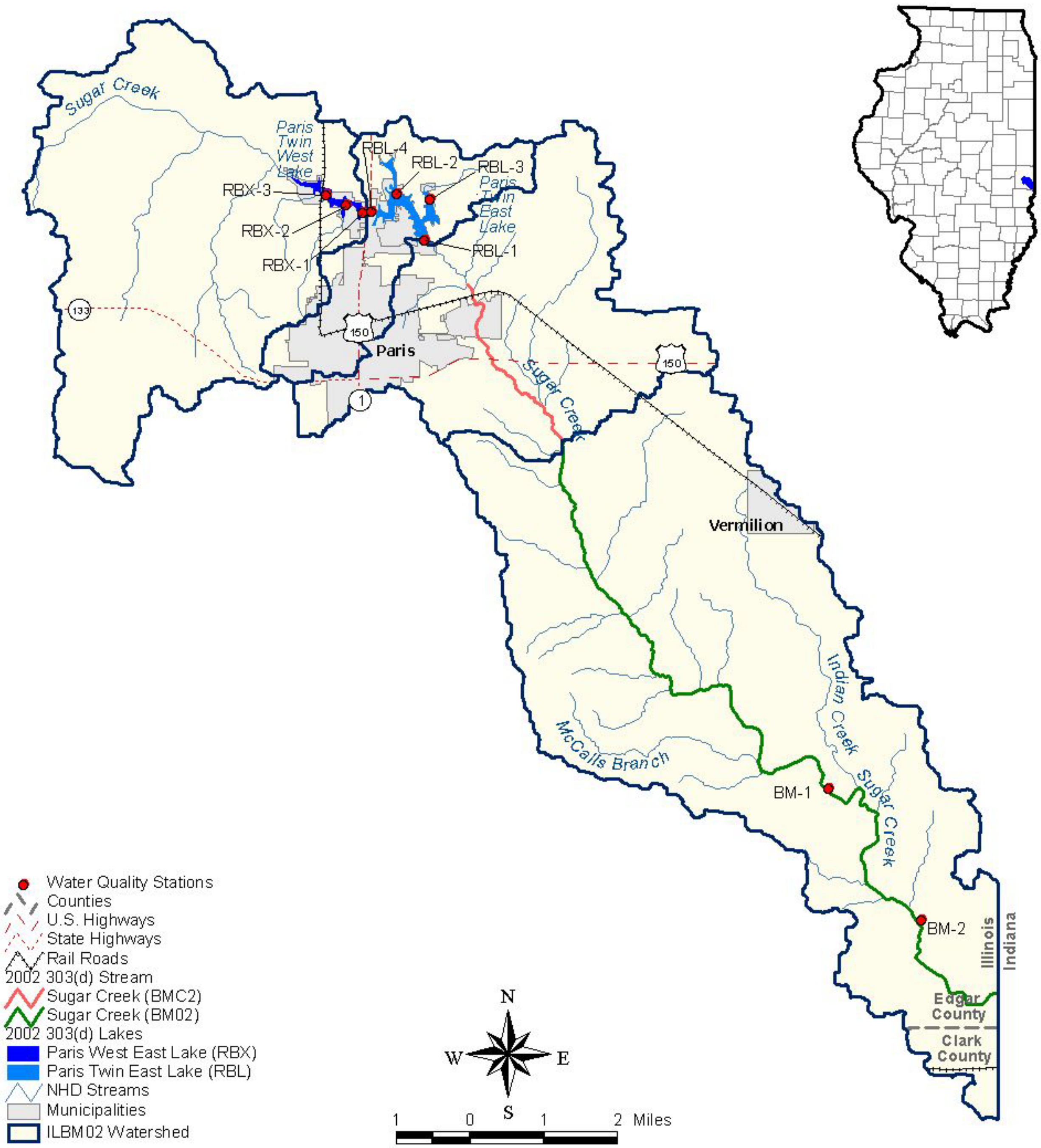


**Figure 4-1. Water quality sampling stations in the Sugar Creek watershed.**

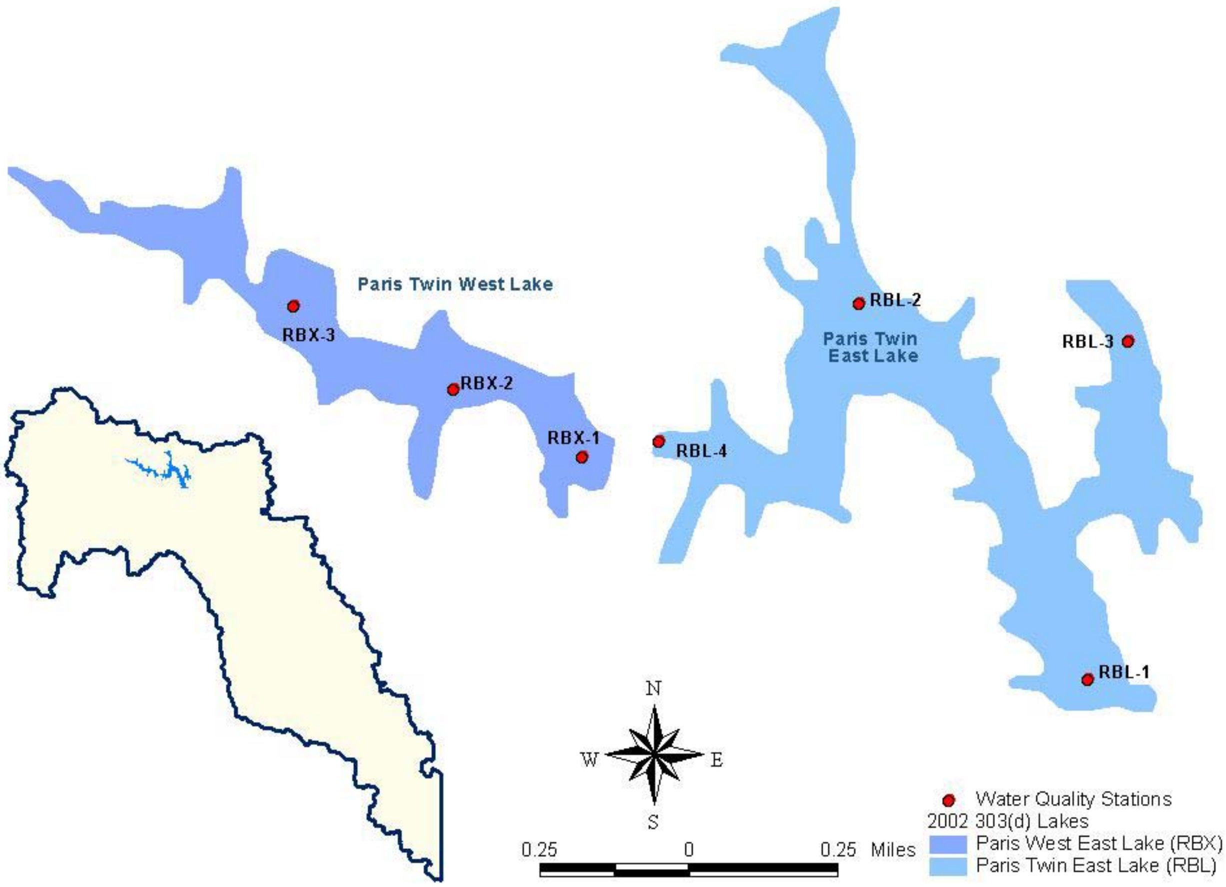


**Figure 4-2. Water quality sampling stations in the Paris Twin Lakes.**

### 4.5.1 Paris Twin West Lake (RBX)

Water quality data collected in the Paris Twin West Lake at IEPA monitoring stations RBL4, RBX, RBX-1, RBX-2, and RBX-3 are available from 1979 to 2002. A summary of these data is presented in the sections below. It should be noted that RBL-4, RBL-5, and RBL-6 are located in Paris Twin West Lake even though they have the "RBL" prefix. Data from these stations are included in Appendix B.

#### 4.5.1.1 Total Phosphorus

The applicable water quality standard for total phosphorus (TP) in Illinois lakes is 0.05 mg/L. Table 4-3 presents the period of record and a statistical summary for all available TP and other nutrient-related parameters. Additionally, Figure 4-3 presents a graphical representation of the TP sampling activity in Paris Twin West Lake. A review of the data reveals that 83 percent of TP samples violated the water quality standard, including 98 percent of recent samples (Table 4-4). TP concentrations at the surface (one foot depth) are typically similar to TP concentrations at deeper samples, probably due to the shallowness of the lake.

**Table 4-3. Summary of total phosphorus parameters for Paris Twin West Lake.**

| Parameter | Samples (Count) | Start | End | Minimum (mg/L) | Average (mg/L) | Maximum (mg/L) | CV* |
|---|---|---|---|---|---|---|---|
| Total Phosphorus | 272 | 6/18/1979 | 10/22/2001 | 0.02 | 0.12 | 1.80 | 1.23 |
| Dissolved Phosphorus | 159 | 6/18/1979 | 10/22/2001 | 0.00 | 0.04 | 0.54 | 1.50 |

*CV = standard deviation/average

**Table 4-4. Violations of the total phosphorus standard in Paris Twin West Lake.**

| Parameter | Samples (Count) | Violations (Count) | Percent Violating | Samples (Count), 1998 to Present | Violations (Count), 1998 to present | Percent Violating, 1998 to Present |
|---|---|---|---|---|---|---|
| Total Phosphorus (All Depths) | 272 | 226 | 83% | 48 | 47 | 98% |
| Total Phosphorus (1-foot Depth) | 234 | 194 | 83% | 32 | 31 | 97% |

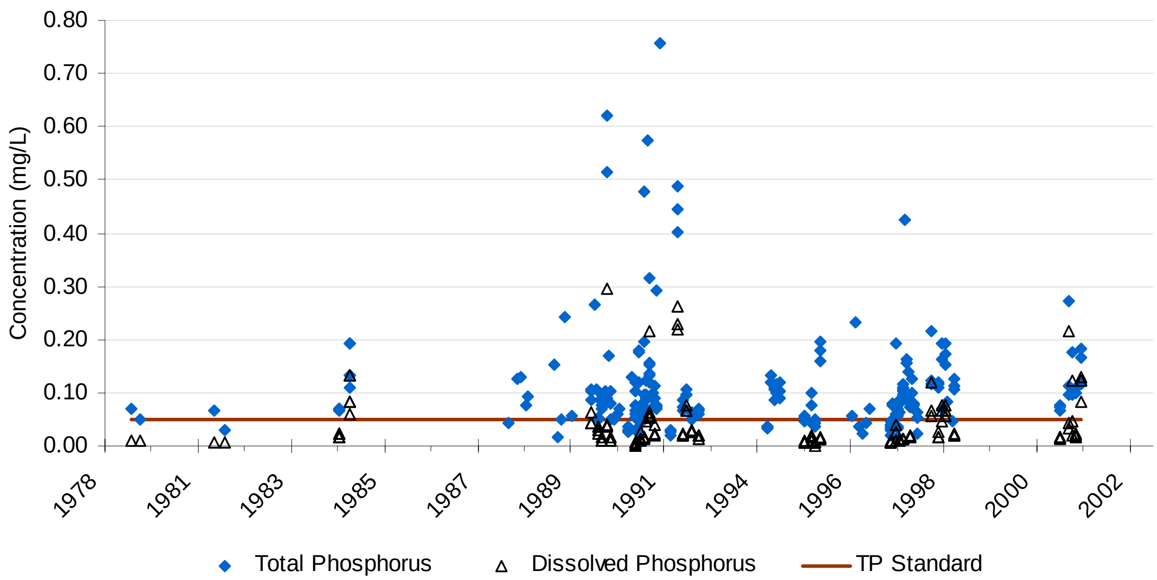


**Figure 4-3. Total phosphorus and dissolved phosphorus sampling observations in the Paris Twin West Lake.**

Monthly median and mean TP concentrations for the period of record are presented in Figure 4-4. Data are not available for the month of January. The figure shows that the water quality standard of 0.05 mg/L is exceeded in all months except February. Additionally, median and mean monthly TP concentrations display seasonal variability. Median and mean monthly TP concentrations are elevated yet fairly steady during late winter (March) through early summer (June). TP concentrations increase in the mid-summer months of July through September, then decrease in the month of October and continue to decrease through December.

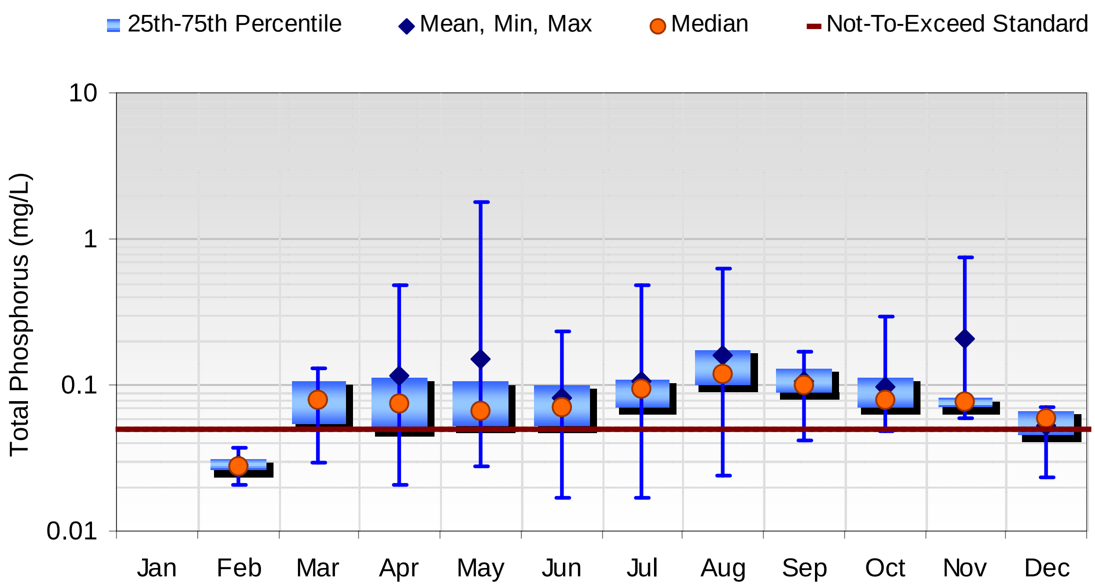


**Figure 4-4. Monthly statistics for total phosphorus in the Paris Twin West Lake, 1978–2002.**

### 4.5.1.2 Dissolved Phosphorus

As stated in section 4.3.1, dissolved phosphorus (DP) is an important component of the total phosphorus (TP) measure. Mean and median dissolved phosphorus concentrations sampled in the Paris West Twin Lake are shown in Figure 4-5. DP data are available from April through August, and October. The figure shows that median DP concentrations are lowest in April, increase in May, reach their maximum in August, and decrease in October to levels comparable to early summer. The median DP concentration exceeds the total phosphorus criteria of 0.05 mg/L in August. Mean DP concentrations are significantly greater for the months of April, July, August and October, which leads to greater variability of dissolved phosphorus concentrations in these months. Furthermore, mean DP concentrations exceed the total phosphorus criteria in April and August.

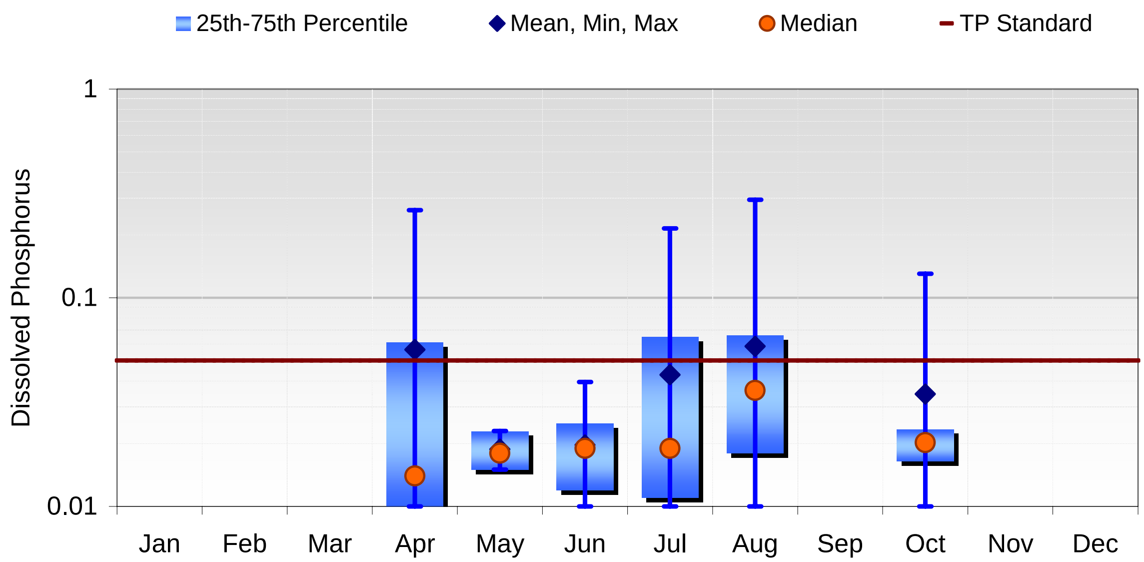


**Figure 4-5. Dissolved phosphorus monthly statistics in the Paris Twin West Lake, 1978–2002.**

The proportion of DP to TP is quite variable over the period of record as shown in Figure 4-6. The percentage of DP ranges from less than five percent to nearly 80 percent. A significant number of observations record dissolved phosphorus contributions greater than 30 percent of TP in Paris West Twin Lake.

The monthly percent contribution of DP to TP is quite variable, yet the greatest monthly contributions occur in April, July and August, as illustrated in Figure 4-7.

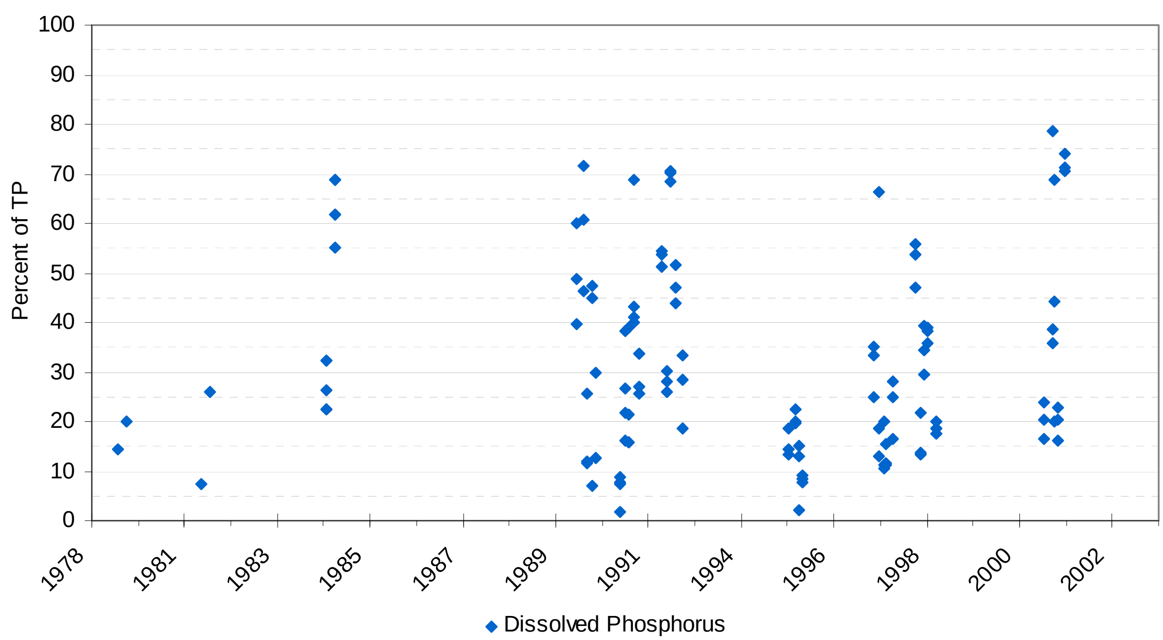


**Figure 4-6. Proportion of dissolved phosphorus in total phosphorus for the Paris Twin West Lake.**

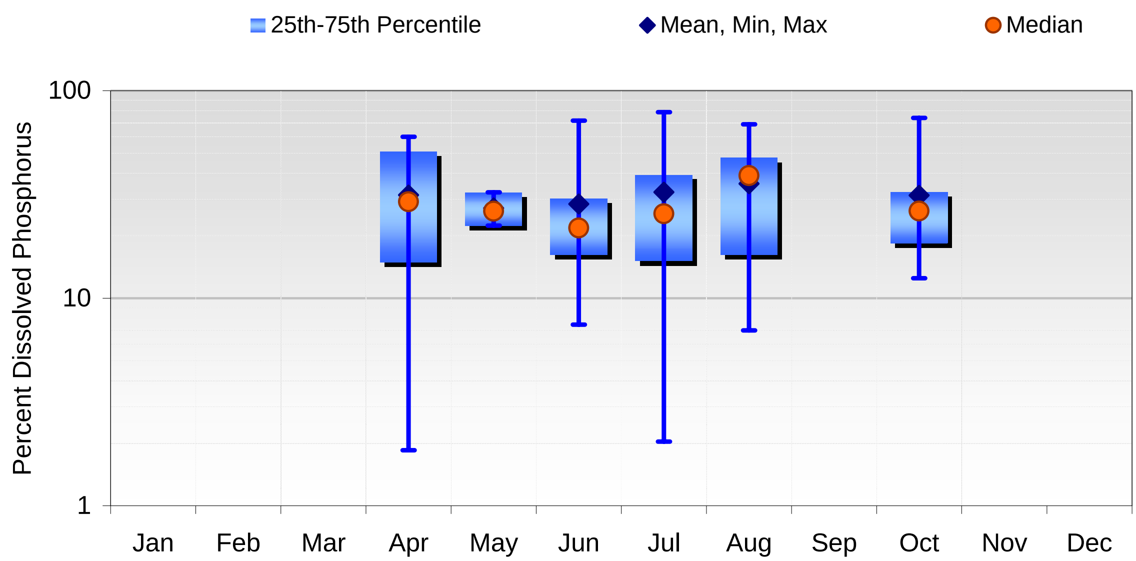


**Figure 4-7. Monthly mean and median percentage of dissolved phosphorus comprising total phosphorus for the Paris Twin West Lake, 1978–2002.**

### 4.5.1.3 Total Nitrogen (TN)-to-Total Phosphorus (TP) Ratio

Eutrophication in freshwater systems is typically controlled by either nitrogen or phosphorus. The limiting nutrient is defined as the nutrient that limits plant growth when it is not available in sufficient quantities. Controlling this nutrient can often slow the rate of eutrophication and improve conditions in the waterbody. An initial identification of the limiting nutrient can be made by comparing the levels of nutrients in the waterbody with the plant stoichiometry. The ratio of nitrogen to phosphorus in biomass is approximately 7.2:1. Therefore, a nitrogen:phosphorus ration in water that is less than 7.2 suggests that nitrogen is limiting. In contrast, a ratio greater than 7.2 suggests that phosphorus is the limiting nutrient (Chapra, 1997).

The variability of the TN:TP ratios in Paris Twin West Lake are presented in Figure 4-8. Figure 4-9 illustrates that TN:TP ratios are quite variable over the period of record, as well as over the course of a year. Most TN:TP ratios are greater than 10, strongly suggesting that phosphorus is the limiting nutrient in the Paris Twin West Lake.

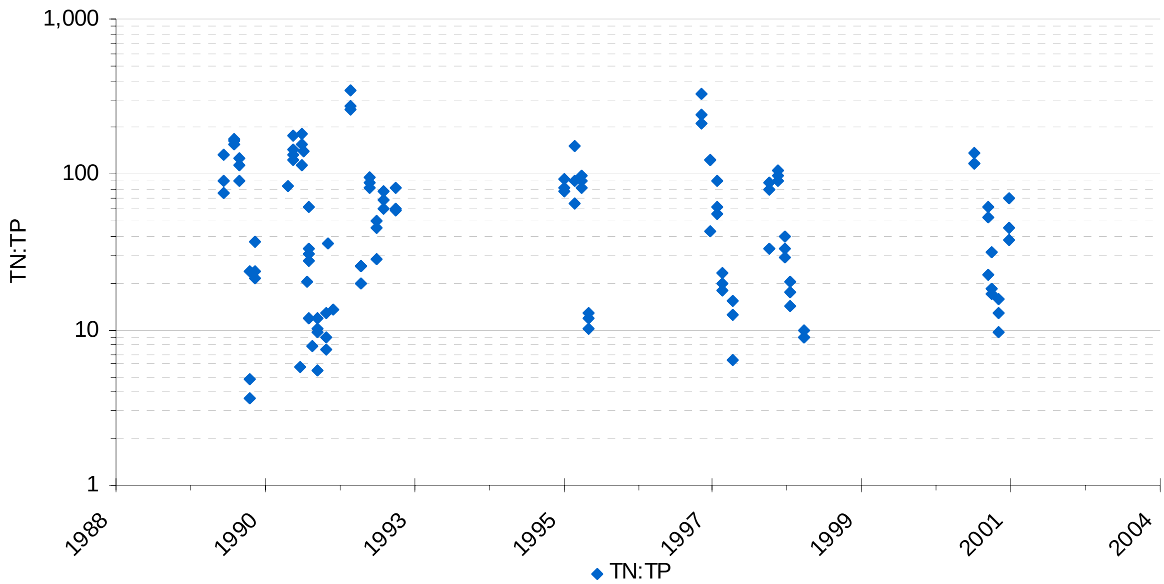


**Figure 4-8. TN:TP ratios over the period of record in the Paris Twin West Lake.**

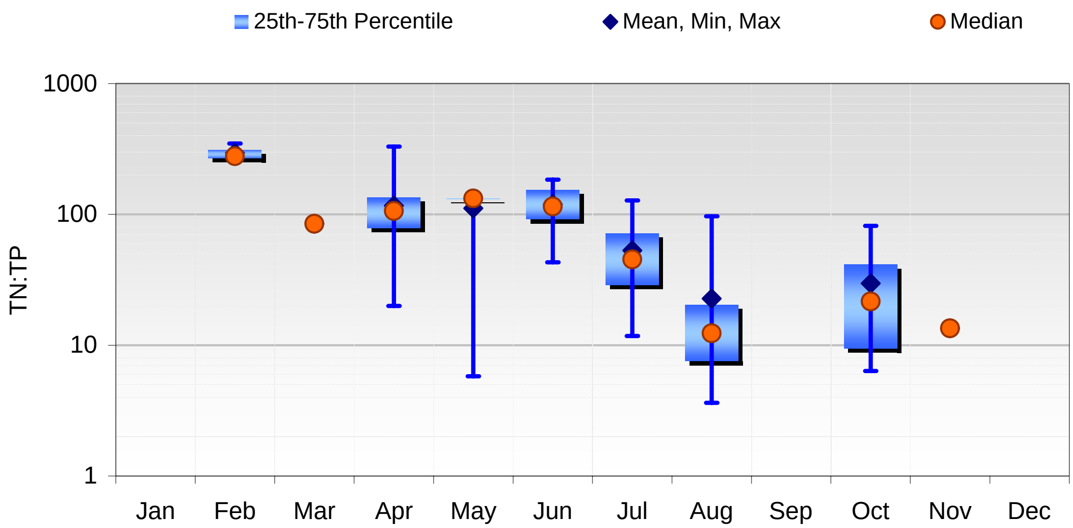


**Figure 4-9. Monthly median and mean TN:TP ratios in the Paris West Twin Lake, 1989–2002.**

### 4.5.1.4 Excessive Algal Growth

The dominant pigment in algal cells is chlorophyll-*a*, which is easy to measure and is a valuable surrogate measure for algal biomass. Chlorophyll-*a* is desirable as an indicator because algae are either the direct (e.g. nuisance algal blooms) or indirect (e.g. high/low dissolved oxygen, pH, and high turbidity) cause of most problems related to excessive nutrient enrichment. Both seasonal mean and instantaneous maximum concentrations can be used to determine impairments. The Illinois water quality standard for general use states that "waters of the state shall be free from algal growth of other than natural origin" (Section 302.203). Table 4-5 presents a summary of the chlorophyll-*a* collected in Paris Twin West Lake. Data are not available for the months of January, February, and March. Figure 4-10 displays the sampling frequency for chlorophyll-*a* in Paris Twin West Lake and indicates an increasing trend over the period of record. Monthly median and mean chlorophyll-*a* concentrations are presented in Figure 4-11, which shows that median and mean chlorophyll-*a* increase in magnitude and variability during the summer months of June through August, remain relatively high in September and August, and then decrease sharply in November through December. The relationship between chlorophyll-*a* and TP is graphically displayed in Figure 4-12. The figure shows that in general, as the concentration of TP increases, the concentration of chlorophyll-*a* correspondingly increases.

**Table 4-5. Summary Statistics for Chlorophyll-*a* in the Paris Twin West Lake.**

| Parameter | Samples (Count) | Start | End | Minimum (µg/L) | Average (µg/L) | Maximum (µg/L) | CV* |
|---|---|---|---|---|---|---|---|
| Chlorophyll-a | 148 | 6/18/1979 | 10/22/2001 | 0.00 | 39.17 | 295.00 | 0.98 |

*CV = standard deviation/average

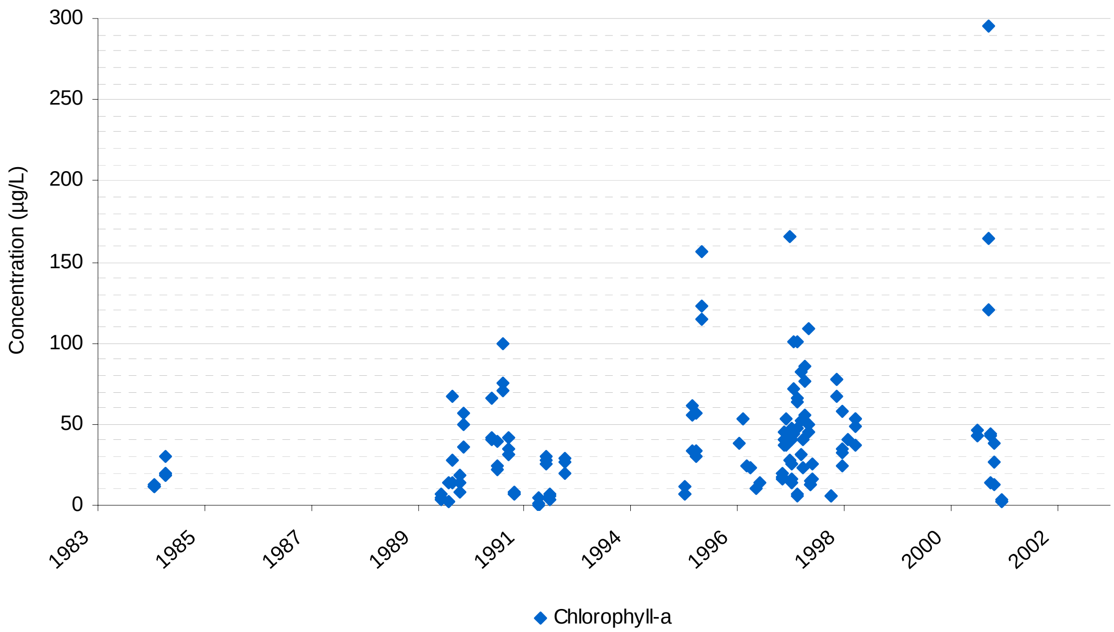


**Figure 4-10. Chlorophyll-*a* sampling observations in the Paris Twin West Lake.**

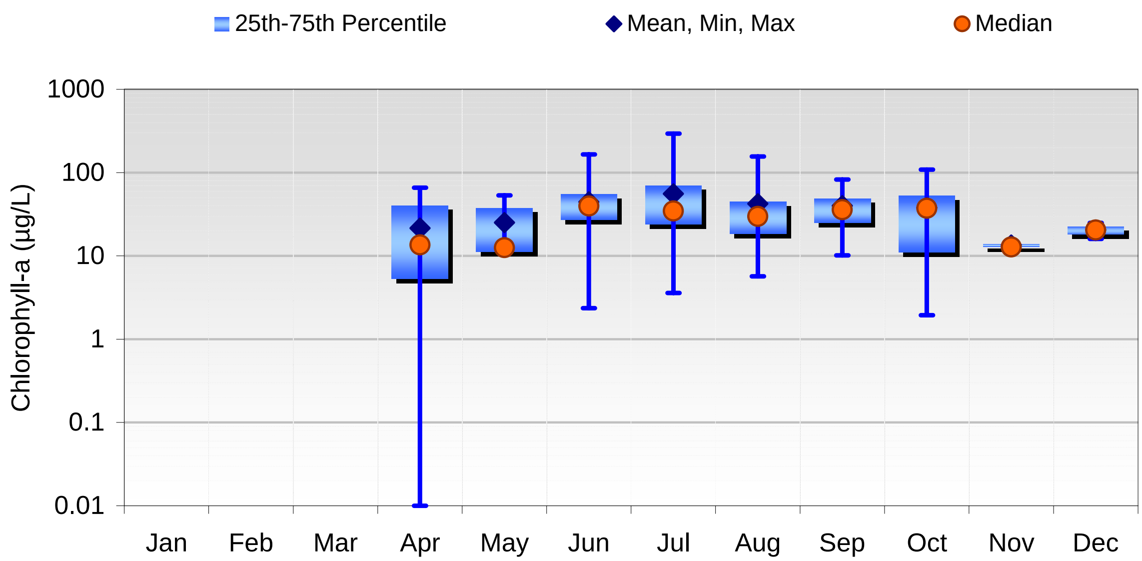


**Figure 4-11. Monthly mean and median chlorophyll-*a* concentrations in the Paris Twin West Lake, 1979–2002.**

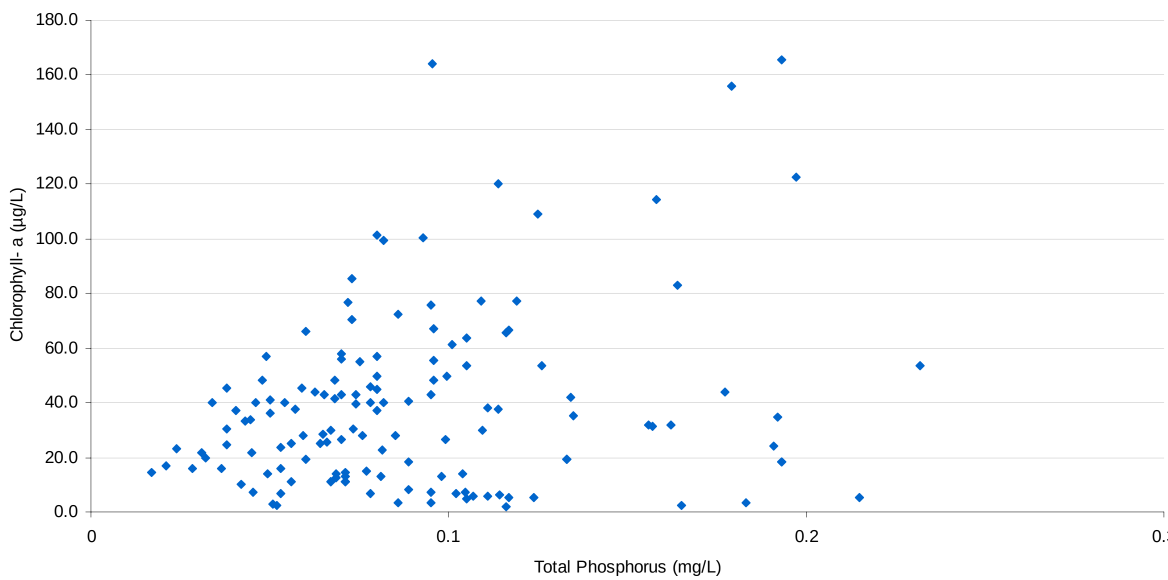


**Figure 4-12. Relationship between chlorophyll-a concentration and TP concentration in the Paris Twin West Lake, 1979–2002.**

### 4.5.1.5 Total Suspended Solids

A summary of the total suspended solids (TSS) data collected in Paris Twin West Lake is given in Table 4-6. Data are not available for the month of January. Figure 4-13 displays the sampling frequency for TSS in Paris Twin West Lake, and indicates that TSS concentrations are highly variable over the period of record. Monthly median and mean TSS concentrations are presented in Figure 4-14. The figure shows that median and mean TSS concentrations are slightly lower in the month of February, then increase in March and remain fairly constant throughout the remaining months of the year.

**Table 4-6. Summary Statistics for Total Suspended Solids in the Paris Twin West Lake.**

| Parameter | Samples (Count) | Start | End | Minimum (mg/L) | Average (mg/L) | Maximum (mg/L) | CV* |
|---|---|---|---|---|---|---|---|
| Suspended Solids | 277 | 6/18/1979 | 10/22/2001 | 1.00 | 21.01 | 124.00 | 0.92 |

*CV = standard deviation/average

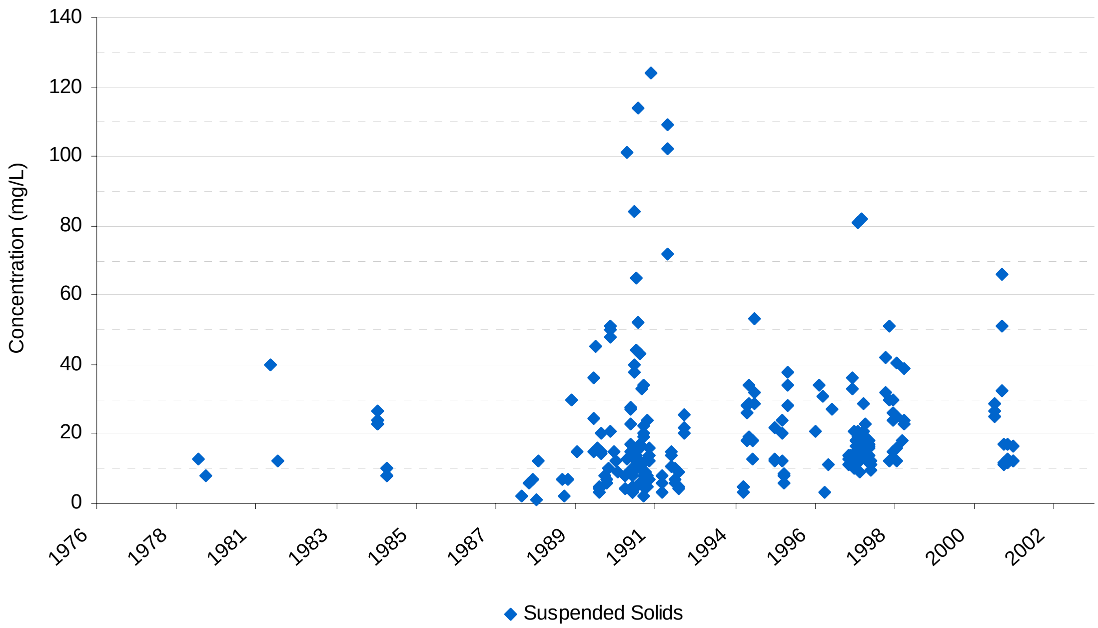


**Figure 4-13. Total suspended solids sampling observations in the Paris Twin West Lake.**

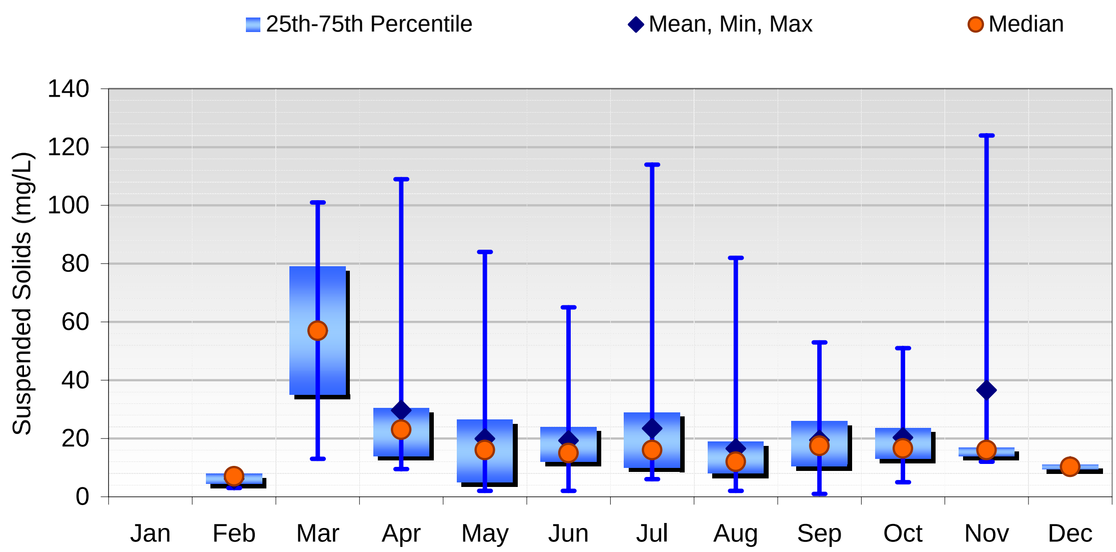


**Figure 4-14. Monthly mean and median total suspended solids concentrations in the Paris Twin West Lake, 1979–2002.**

### 4.5.2 Paris Twin East Lake (RBL)

A summary of the water quality data for Paris Twin East Lake is presented below.

#### 4.5.2.1 Total Phosphorus

The applicable water quality standard for TP in Illinois is 0.05 mg/L. Table 4-7 presents the period of record and a statistical summary for all available TP data. Additionally, Figure 4-15 presents a graphical representation of the TP sampling activity in Paris Twin East Lake. A review of the data reveals that nearly 67 percent of TP samples violated the water quality standard, and all recent samples (data post-1997), exceed the TP water quality standard. There does not appear to be a significant increasing or decreasing trend represented by the data. TP concentrations at the surface (one foot depth) are typically similar to TP concentrations at deeper samples.

**Table 4-7. Summary of total phosphorus parameters in Paris Twin East Lake.**

| Parameter | Samples (Count) | Start | End | Minimum | Average | Maximum | CV* |
|---|---|---|---|---|---|---|---|
| Dissolved Phosphorus | 175 | 6/18/1979 | 10/22/2001 | 0.001 | 0.06 | 0.92 | 1.97 |
| Total Phosphorus | 338 | 6/29/1977 | 10/22/2001 | 0.001 | 0.10 | 1.10 | 1.15 |

*CV = standard deviation/average

**Table 4-8. Violations of the total phosphorus standard in Paris Twin East Lake.**

| Parameter | Samples (Count) | Violations (Count) | Percent Violating | Samples (Count), 1998 to Present | Violations (Count), 1998 to present | Percent Violating, 1998 to Present |
|---|---|---|---|---|---|---|
| Total Phosphorus (All Depths) | 338 | 229 | 68% | 47 | 47 | 100% |
| Total Phosphorus (1-Foot Depth) | 277 | 178 | 64% | 32 | 32 | 100% |

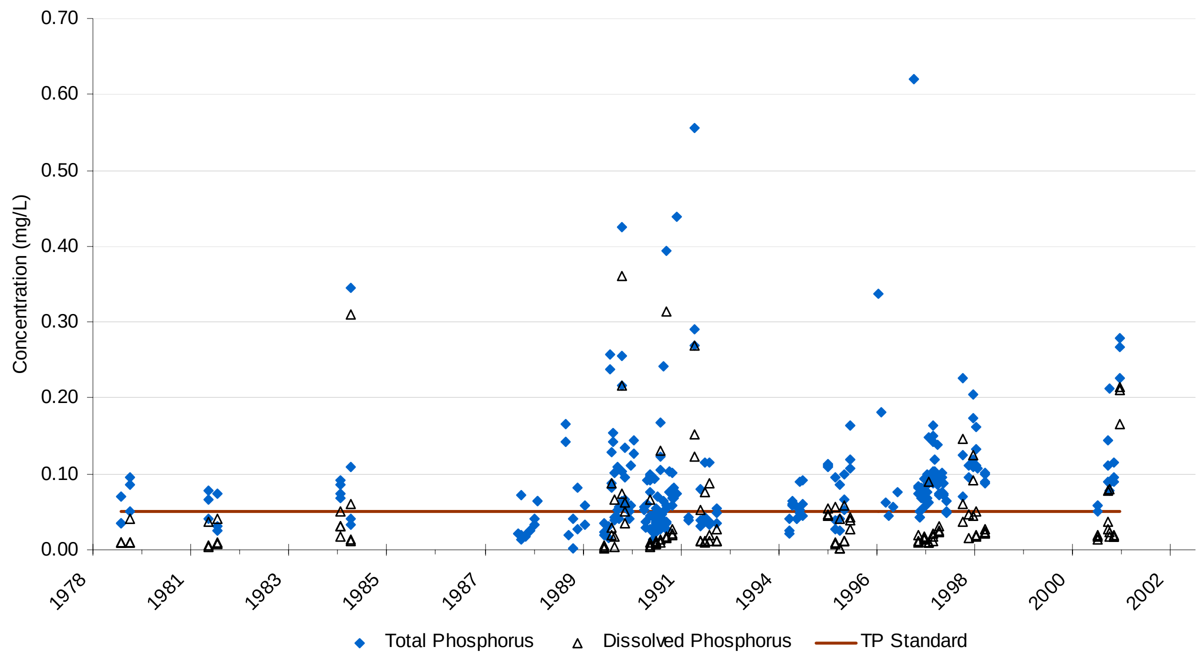


**Figure 4-15. Total phosphorus and dissolved phosphorus sampling observations in the Paris Twin East Lake.**

Monthly median and mean TP concentrations for the period of record are presented in Figure 4-16. Data are not available for the month of January. The figure shows that the water quality standard of 0.05 mg/L is exceeded in all months except February. Additionally, mean monthly TP concentrations display seasonal variability. Mean monthly TP concentrations are greatest in March, and then steadily decrease from April through June. TP concentrations begin to rise in July and reach a secondary peak in August, and afterward decrease in the fall months of September and October. A third peak in mean TP concentration occurs in November, with a decrease in concentration following in the month of December.

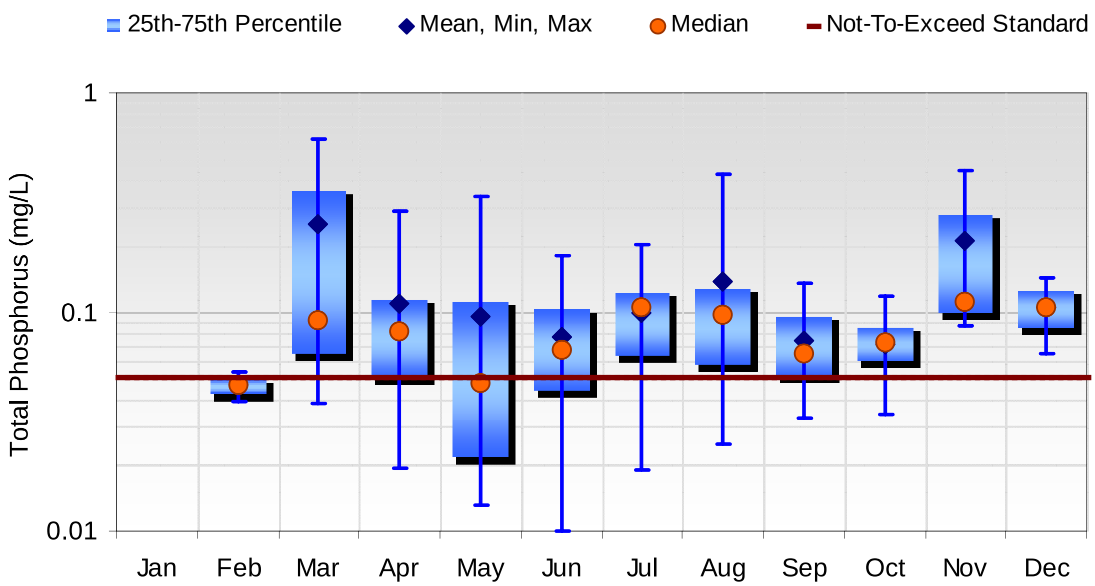


**Figure 4-16. Monthly total phosphorus statistics in the Paris Twin East Lake, 1977–2002.**

#### 4.5.2.2 Dissolved Phosphorus

Dissolved phosphorus (DP) is an important component of the total phosphorus (TP) measure (see section 4.3.1). Mean and median dissolved phosphorus concentrations sampled in the Paris East Twin Lake are shown in Figure 4-17. DP data are available from April through August, and October. The figure shows that mean DP concentrations follow the general seasonal trend as TP presented in the previous section: mean DP concentrations are greatest in April and then decrease through June and reach a secondary peak in August. Mean DP concentrations exceed the total phosphorus criteria of 0.05 mg/L in April, July, August and November. Additionally, DP concentrations are highly variable for each month of available data.

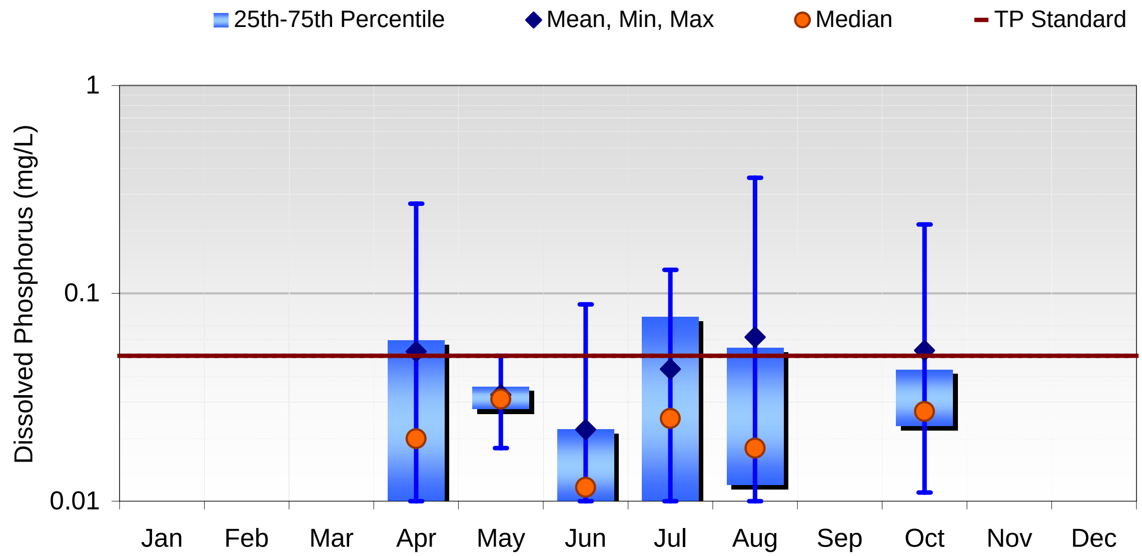


**Figure 4-17. Dissolved phosphorus monthly statistics in the Paris Twin East Lake, 1977–2002.**

The proportion of DP to TP is quite variable over the period of record as shown in Figure 4-18. The percentage of DP comprising the TP load ranges from less than five percent to nearly 90 percent. A significant number of observations record dissolved phosphorus contributions greater than 30 percent of the TP in the Paris West Twin Lake.

The monthly percent contribution of DP to TP varies greatly, yet the greatest monthly contributions occur in April, July, August, and October as illustrated in Figure 4-19. Indeed, the mean DP contribution to TP exceeds 65 percent for the month of August.

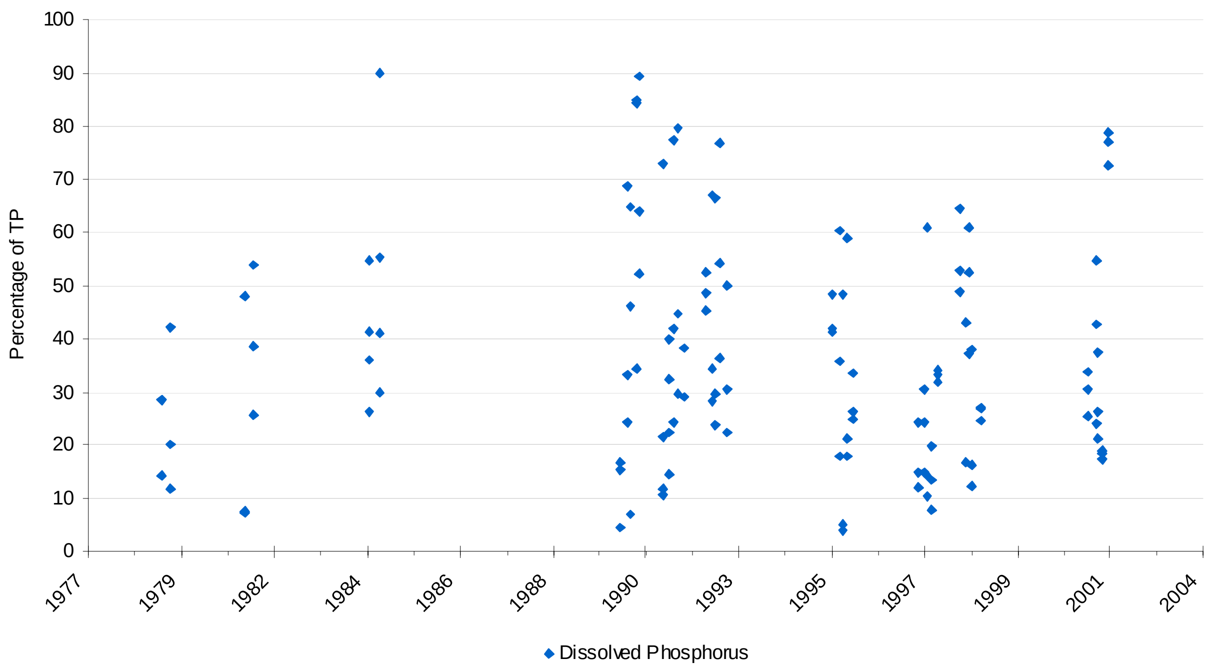


**Figure 4-18. Proportion of dissolved phosphorus in total phosphorus for the Paris Twin East Lake.**

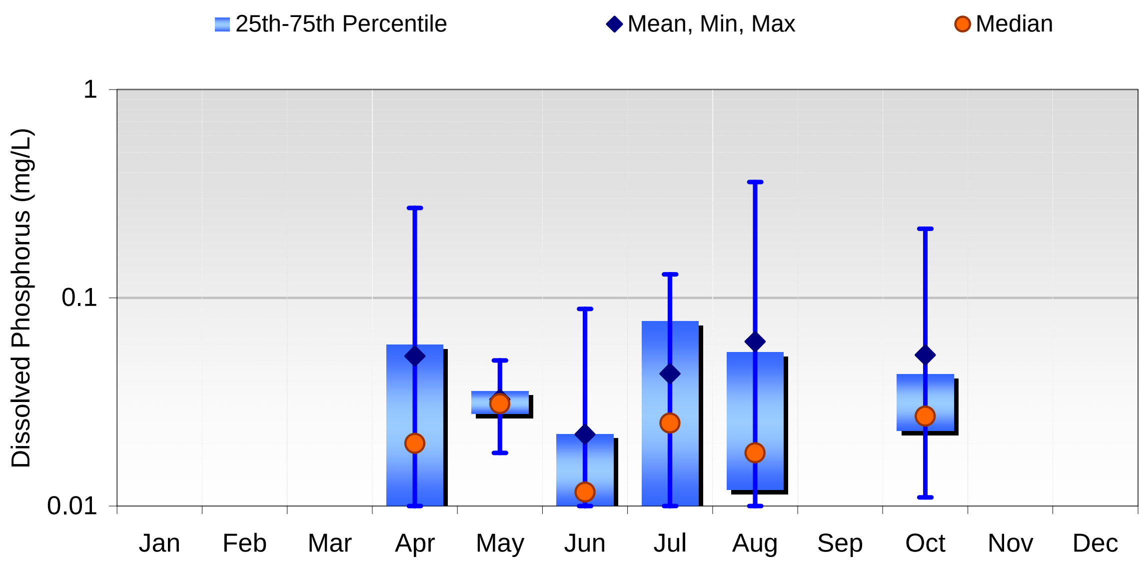


**Figure 4-19. Monthly mean and median percentage of dissolved phosphorus comprising total phosphorus for the Paris Twin East Lake, 1977–2002.**

#### 4.5.2.3 Total Nitrogen (TN)-to-Total Phosphorus (TP) Ratio

The importance of the TN:TP ratio is discussed in section 4.5.1.3. The variability of the TN:TP ratios is presented in Figure 4-20, and monthly median and mean TN:TP ratios are shown in Figure 4-21. These figures illustrate that TN:TP ratios are quite variable over the period of record, as well as over the course of a year. Mean spring and summer TN:TP ratios are greater than 20, strongly suggesting that phosphorus is the limiting nutrient in the Paris Twin East Lake.

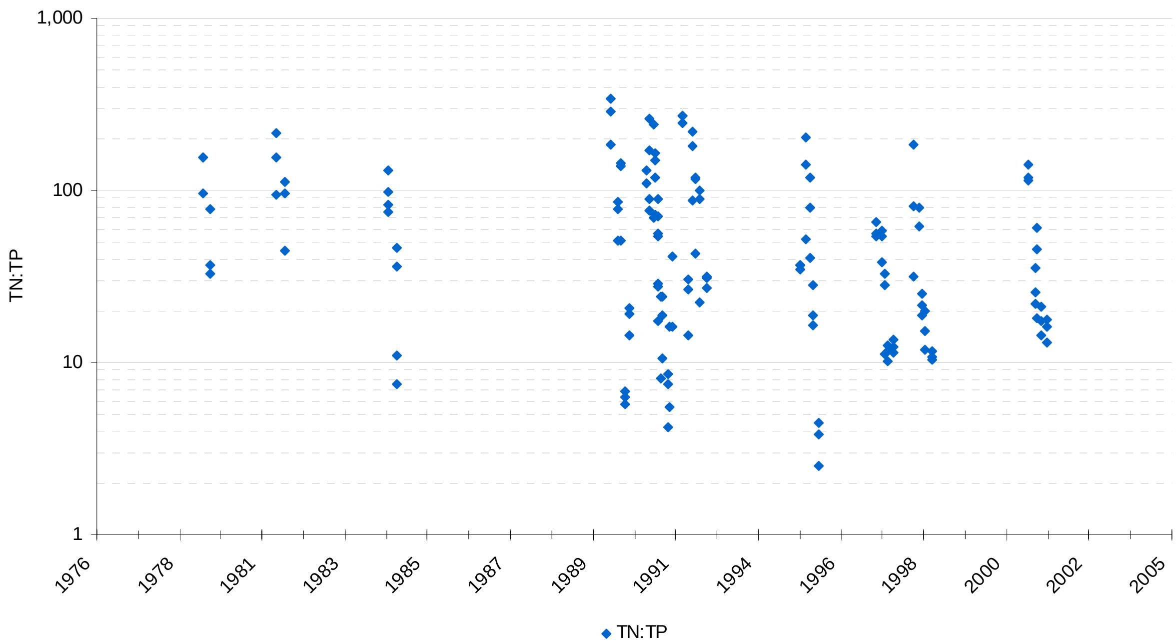


**Figure 4-20. TN:TP ratios over the period of record in the Paris Twin East Lake.**

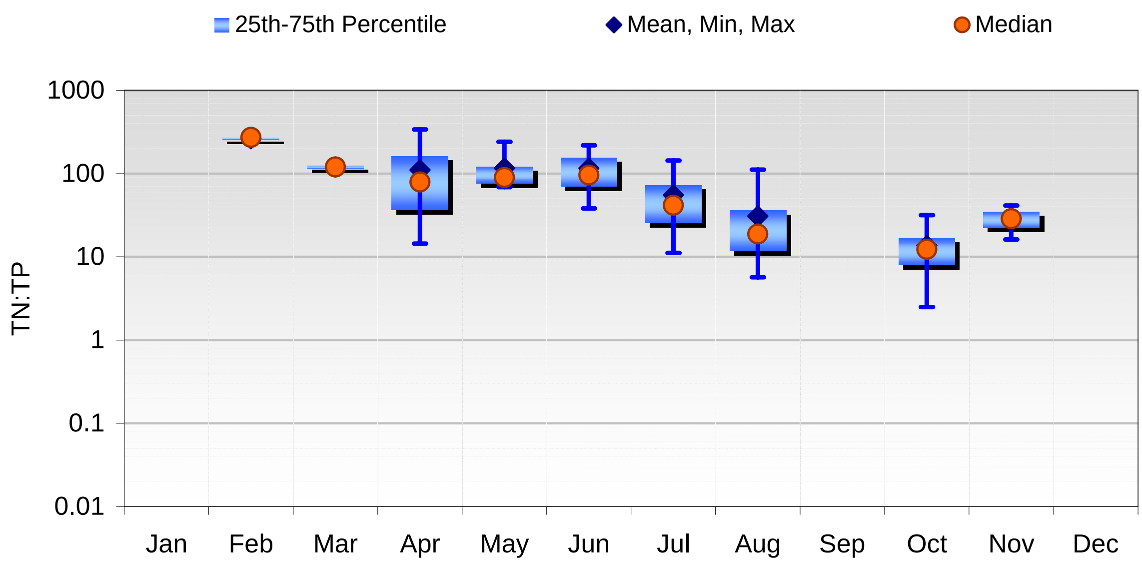


**Figure 4-21. Monthly median and mean TN:TP ratios in the Paris East Twin Lake, 1989–2002.**

### 4.5.2.4 Excessive Algal Growth

The importance of algal growth, and specifically chlorophyll-*a* is discussed in section 4.5.1.4. Table 4-9 presents a summary of the chlorophyll-*a* collected in Paris Twin East Lake. Data are not available for the months of January, February, and March. Figure 4-22 displays the sampling frequency for chlorophyll-*a* in Paris Twin West Lake and indicates a slight increasing trend over the period of record. Monthly median and mean chlorophyll-*a* concentrations are presented in Figure 4-23, which shows that median and mean chlorophyll-*a* concentrations are slightly increased from June through November, relative to spring months. A weak relationship exists between TP concentrations and chlorophyll-a concentrations, as displayed in Figure 4-24. Chlorophyll-*a* is a commonly used surrogate measure of algal biomass.

Typically, as TP concentrations increase, concentrations of chlorophyll-*a* increase as well. Figure 4-23 shows that as TP concentrations increase in the Paris East Twin Lake, chlorophyll-*a* concentrations do not always correspondingly increase. Thus, the relationship between chlorophyll-*a* and TP concentrations is characterized as weak for the Paris East Twin Lake.

**Table 4-9. Summary Statistics for Chlorophyll-*a* in the Paris Twin East Lake.**

| Parameter | Samples (Count) | Start | End | Minimum (µg/L) | Average (µg/L) | Maximum (µg/L) | CV* |
|---|---|---|---|---|---|---|---|
| Chlorophyll-a | 158 | 6/18/1979 | 10/22/2001 | 1 | 43.20 | 450.10 | 1.01 |

*CV = standard deviation/average

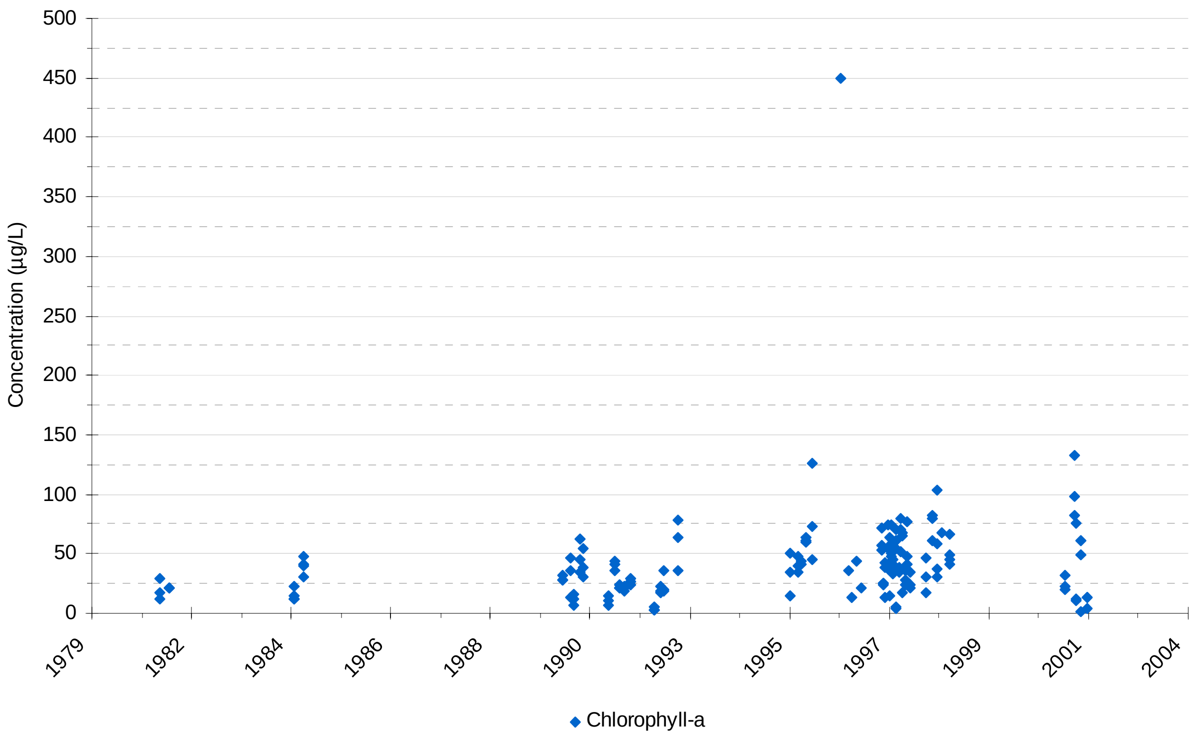


**Figure 4-22. Chlorophyll-*a* sampling observations in the Paris Twin East Lake.**

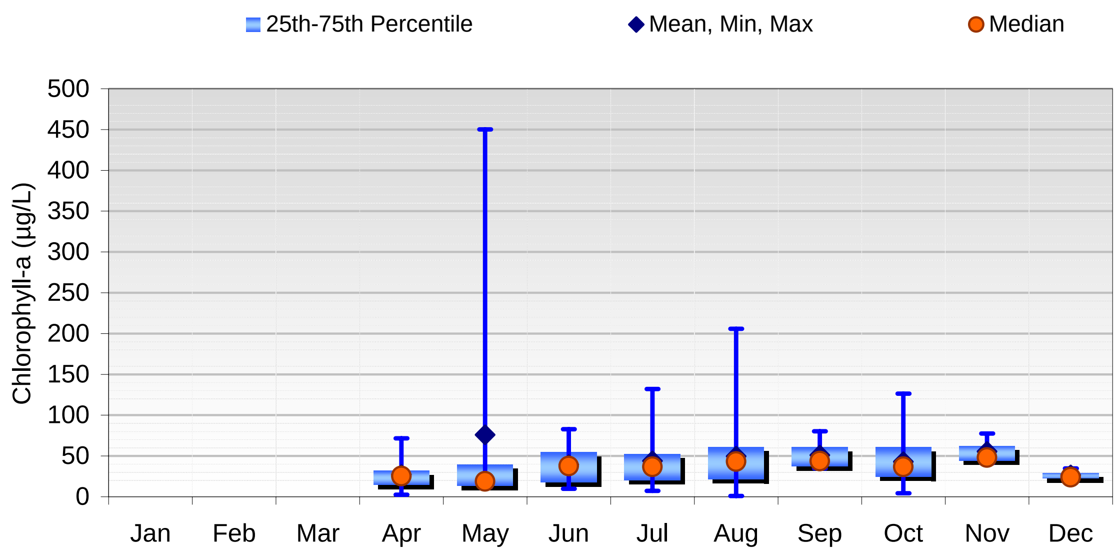


**Figure 4-23. Monthly mean and median chlorophyll-*a* concentrations in the Paris Twin East Lake, 1979–2001.**

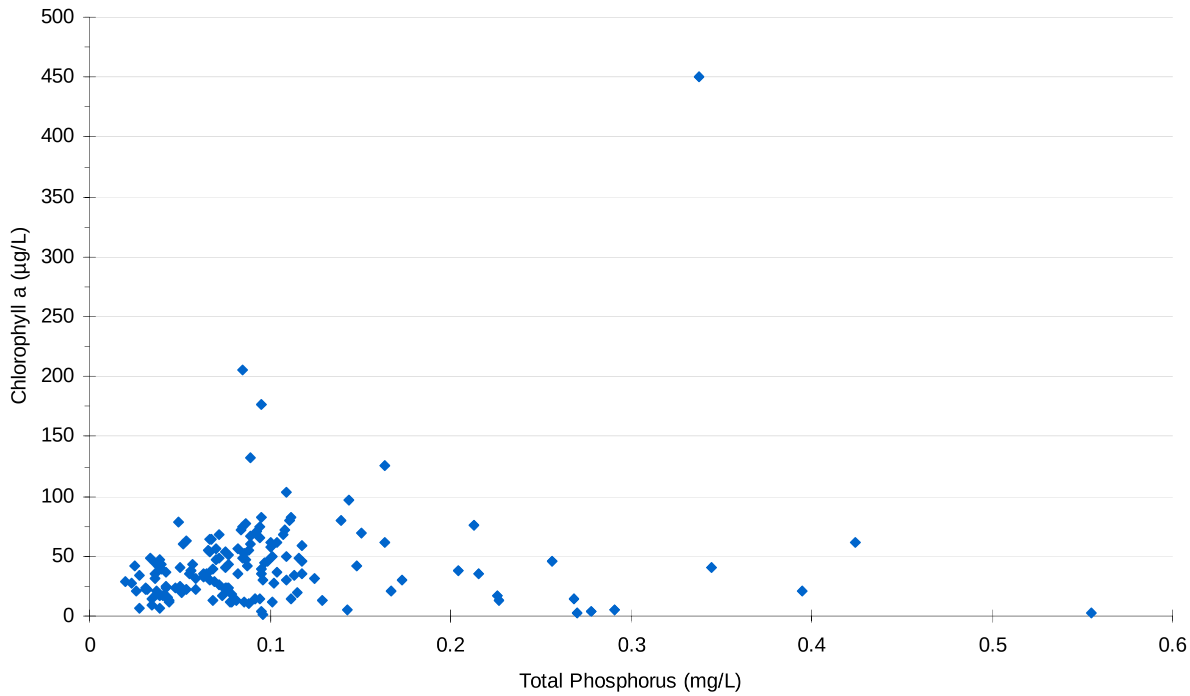


**Figure 4-24. Relationship between chlorophyll-a concentration and TP concentration in the Paris Twin East Lake, 1979-2001.**

### 4.5.2.5 Total Suspended Solids

A summary of the total suspended solids (TSS) data collected in Paris Twin East Lake is given in Table 4-10. Data are not available for the month of January. Figure 4-25 displays the sampling frequency for TSS in Paris Twin East Lake, and indicates that TSS concentrations are highly variable over the period of record. Monthly mean and median TSS concentrations are presented in Figure 4-26. The figure shows that mean and median TSS concentrations are greatest in March and April, then decrease and remain at lower levels from May through February.

**Table 4-10. Summary Statistics for Total Suspended Solids in the Paris Twin East Lake.**

| Parameter | Samples (Count) | Start | End | Minimum (mg/L) | Average (mg/L) | Maximum (mg/L) | CV* |
|---|---|---|---|---|---|---|---|
| Suspended Solids | 335 | 6/29/1977 | 10/22/2001 | 1.00 | 15.67 | 240.00 | 1.22 |
| *CV = standard deviation/average | | | | | | | |

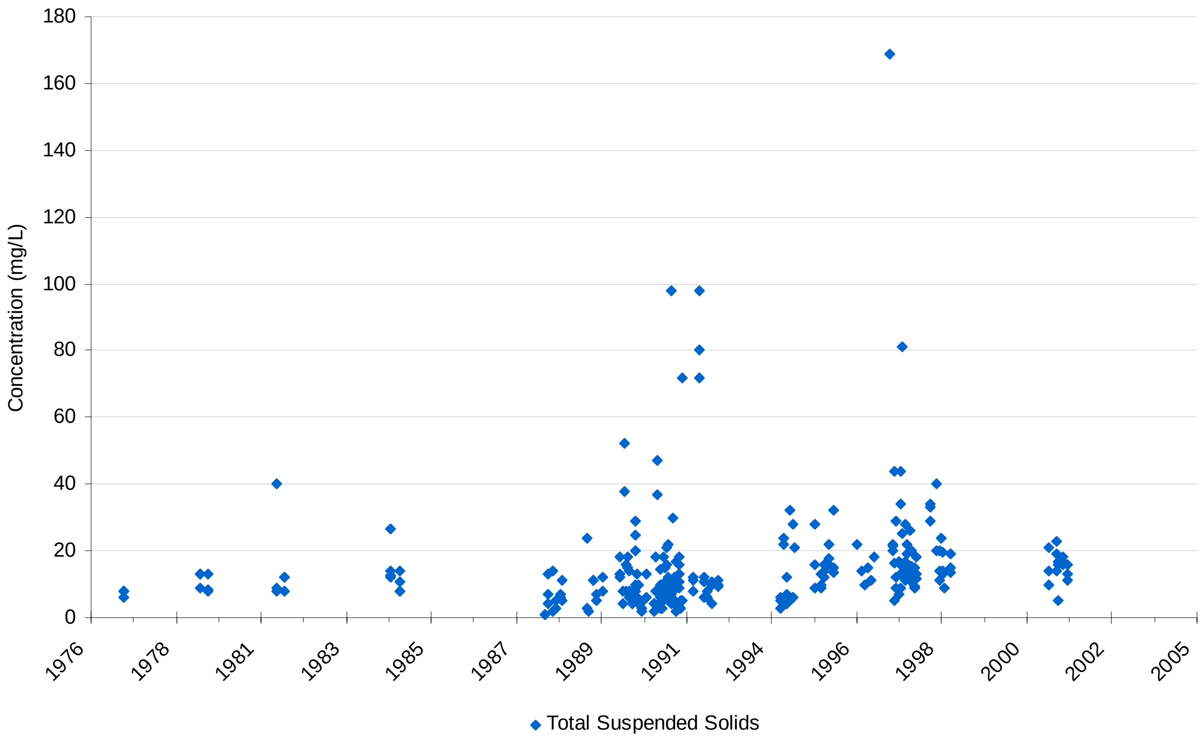


**Figure 4-25. Total suspended solids sampling observations in the Paris Twin East Lake.**

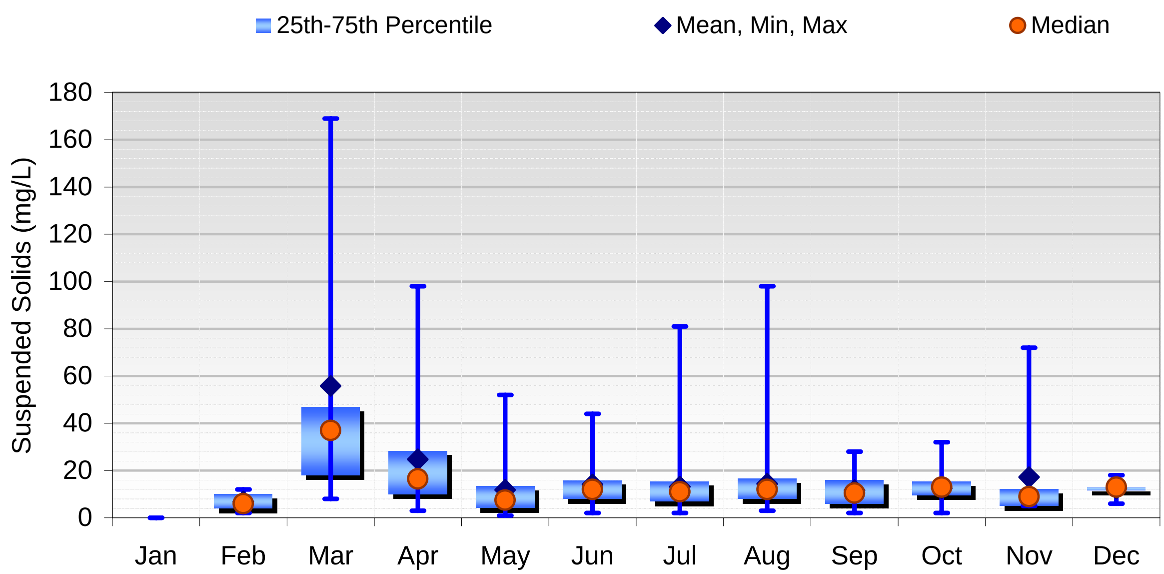


**Figure 4-26. Monthly mean and median suspended solids concentrations in the Paris Twin East Lake, 1979–2002.**

### 4.5.3 Sugar Creek (BMC2)

Water quality data collected in Sugar Creek at IEPA monitoring stations BM-1 and BM-2 are available from 1972 to 2002. Additionally, a Facility-Related Stream Survey (FRSS) was conducted in 1994 on Sugar Creek both upstream and downstream of the Paris-South sewage treatment plant (STP). The FRSS was a longitudinal survey comprised of six sampling locations, where each location was a specified distance from the Paris-South STP. Water quality constituents included sediment, nutrients, dissolved oxygen, and metals. A summary of all the water quality data is presented in the following sections. This stream segment is listed for dissolved oxygen (DO) and unspecified nutrients.

#### 4.5.3.1 Dissolved Oxygen

The applicable water quality standard for DO in Illinois is a minimum concentration of 5.0 mg/L. Table 4-11 and Table 4-12 present the period of record, a statistical summary, and summary of violations for all available DO data in Sugar Creek. Additionally, Figure 4-27 presents a graphical representation of the DO sampling activity in Sugar Creek and Figure 4-28 presents monthly mean and median DO sample concentrations. It should be noted that data from downstream of the listed segment are included in these tables and figures for reference purposes because so few data are available for the impaired segment.

A review of the data and inspection of Figure 4-27 and Figure 4-28 reveals that only one violation of the DO standard occurred in Sugar Creek over the period of record. This single sample occurred during the FRSS sampling in 1994 at a location approximately 75 yards upstream of the Paris-South STP. Biological monitoring also indicated degraded aquatic communities. Low flows might have contributed to the low DO concentration. The monitoring report states that “Negligible flow was observed upstream of the Paris-South facility…” and “…flow over the Paris Twin Lakes spillway was negligible and the Paris-North facility was not discharging during the survey.” Additional DO data are necessary to confirm current DO conditions.

**Table 4-11. Summary Statistics for Dissolved Oxygen in Sugar Creek.**

| Parameter | Samples (Count) | Start | End | Minimum (mg/L) | Average (mg/L) | Maximum (mg/L) | CV* |
|---|---|---|---|---|---|---|---|
| Dissolved Oxygen | 218 | 3/9/1972 | 11/18/2002 | 5.23 | 10.85 | 17.20 | 0.23 |
| Dissolved Oxygen (FRSS Data) | 6 | 8/31/1994 | 8/31/1994 | 3.00 | 6.35 | 8.90 | 0.31 |

*CV = standard deviation/average

**Table 4-12. Dissolved Oxygen Violations**

| Parameter | Samples (Count) | Violations (Count) | Percent Violating | Samples (Count), 1998 to Present | Violations (Count), 1998 to present | Percent Violating, 1998 to Present |
|---|---|---|---|---|---|---|
| Dissolved Oxygen | 218 | 0 | 0% | 25 | 0 | 0% |
| Dissolved Oxygen (FRSS Data) | 6 | 1 | 17% | 0 | 0 | 0% |

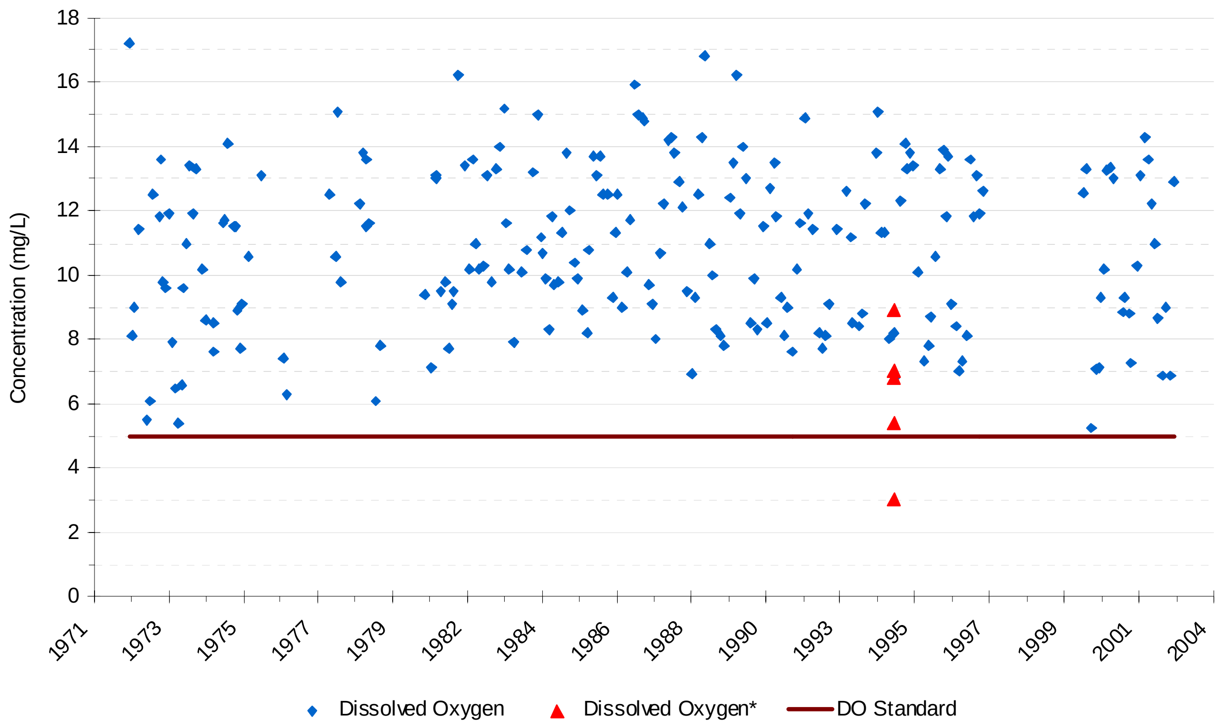


**Figure 4-27. Dissolved oxygen sampling observations in Sugar Creek (* indicates FRSS data).**

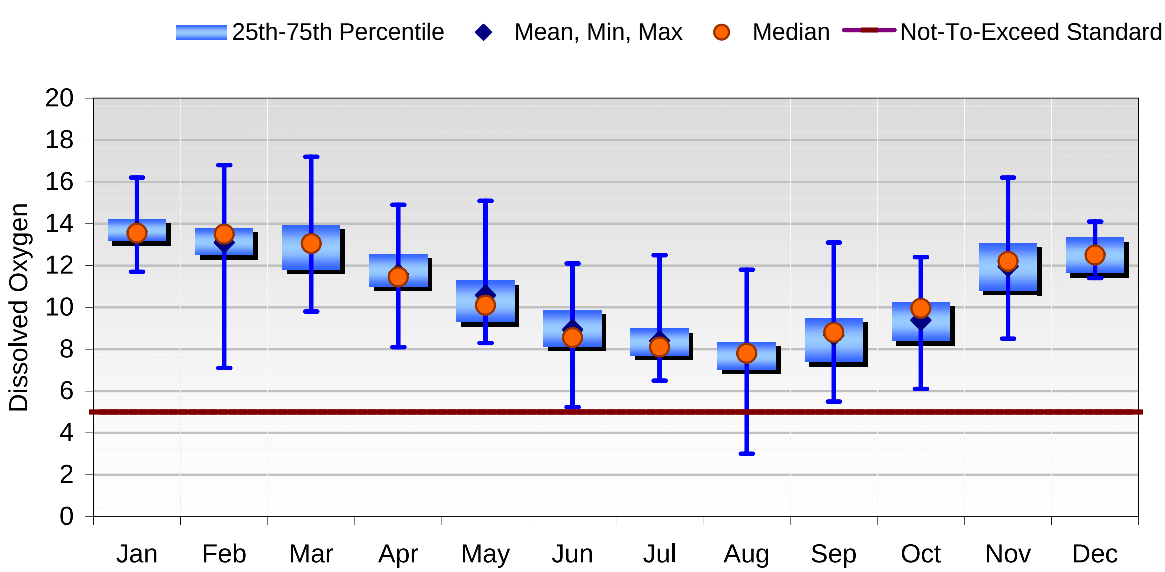


**Figure 4-28. Dissolved oxygen (mg/L) monthly statistics in Sugar Creek, 1977-2002.**

#### 4.5.3.2 Nutrients

Various nutrients can contribute to excessive algal growth and ultimately low dissolved oxygen levels. Table 4-13 summarizes all available nutrient sampling in Sugar Creek. Figure 4-29 displays historic the phosphorus sampling activity for Sugar Creek. It should be noted that the following tables and graphs primarily represent data taken from IEPA monitoring stations BM-1 and BM-2, which are located several miles downstream of the listed segment. However, the FRSS data (six samples on one day in 1994) are the only data available for the listed segment.

**Table 4-13. Summary of Nutrient Data Collected in Sugar Creek.**

| Parameter | Samples (Count) | Start | End | Minimum (mg/L) | Average (mg/L) | Maximum (mg/L) | CV* |
|---|---|---|---|---|---|---|---|
| Total Phosphorus | 201 | 3/9/1972 | 11/18/2002 | 0.01 | 0.40 | 4.80 | 1.69 |
| Total Phosphorus (FRSS Data) | 6 | 8/31/1994 | 8/31/1994 | 0.17 | 0.70 | 1.20 | 0.52 |
| Dissolved Phosphorus | 159 | 9/10/1980 | 11/18/2002 | 0.01 | 0.22 | 3.90 | 1.62 |
| Total Nitrogen | 3 | 10/18/1978 | 12/20/1978 | 2.90 | 3.63 | 4.40 | 0.21 |
| Nitrate + Nitrite | 264 | 3/9/1972 | 11/18/2002 | 0.01 | 3.14 | 14.00 | 0.56 |
| Nitrate + Nitrite (FRSS Data) | 6 | 8/31/1994 | 8/31/1994 | 0.29 | 3.62 | 6.50 | 0.64 |
| TKN | 3 | 10/18/1978 | 12/20/1978 | 0.50 | 0.63 | 0.90 | 0.36 |
| Ammonia | 248 | 10/10/1974 | 11/18/2002 | 0.00 | 0.12 | 1.60 | 1.37 |
| Ammonia (FRSS Data) | 6 | 8/31/1994 | 8/31/1994 | 0.07 | 0.15 | 0.28 | 0.47 |
| Un-ionized Ammonia | 202 | 10/10/1974 | 12/9/1998 | 0.00 | 0.00 | 0.04 | 1.44 |
| Un-ionized Ammonia (FRSS Data) | 6 | 8/31/1994 | 8/31/1994 | 0.001 | 0.0015 | 0.002 | 0.36 |

*CV = standard deviation/average

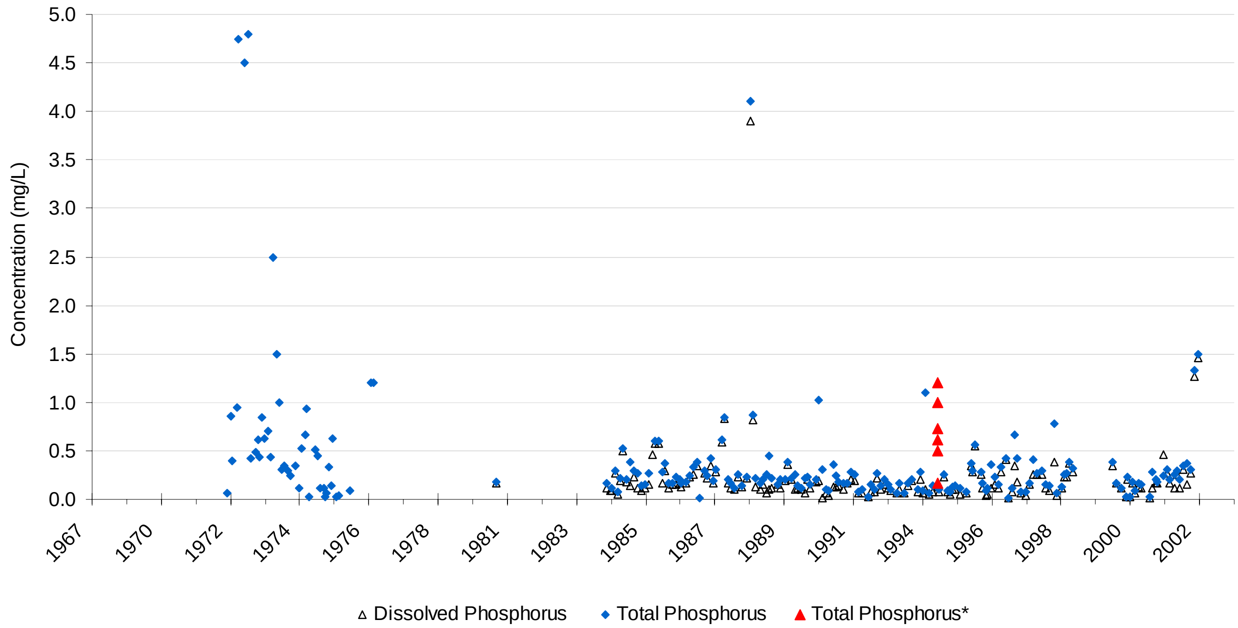


**Figure 4-29. Total phosphorus and dissolved phosphorus sampling observations in Sugar Creek (* indicates FRSS data).**

Monthly mean TP concentrations are presented in Figure 4-30. The figure shows that TP concentrations vary widely and are elevated in summer and fall months. In addition, dissolved phosphorus comprises an extremely large proportion of TP in Sugar Creek (Figure 4-31), with some observations comprising nearly 100 percent of TP. These high dissolved proportions remain relatively constant throughout the year, as presented in Figure 4-32.

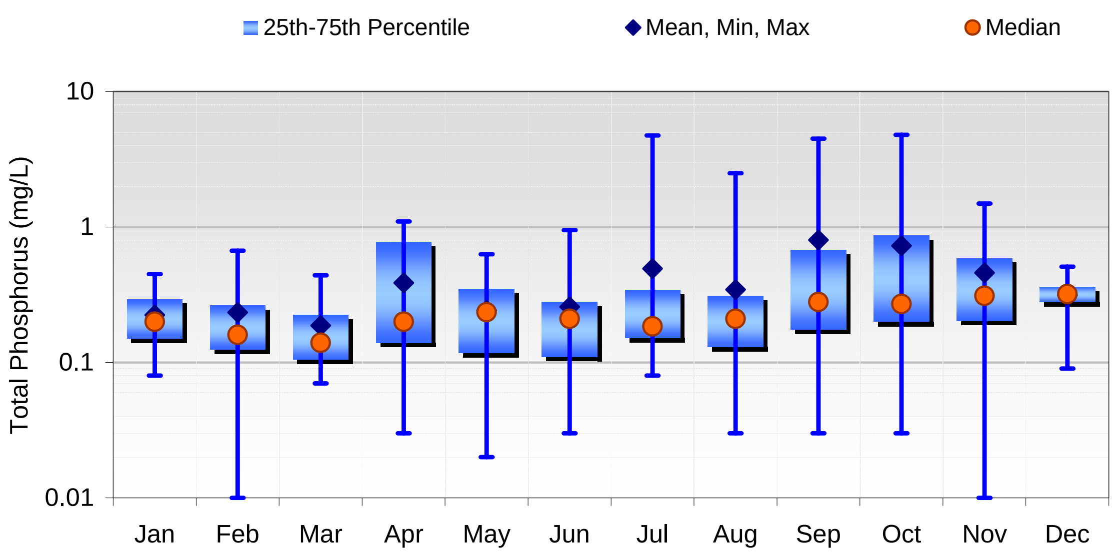


**Figure 4-30. Monthly statistics for total phosphorus in Sugar Creek, 1972–2002.**

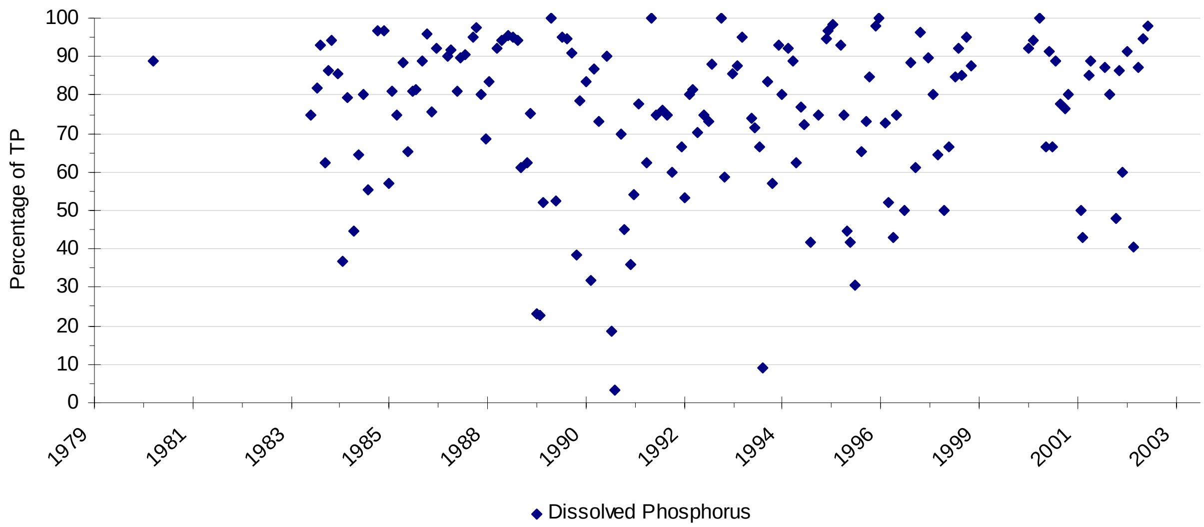


**Figure 4-31. Proportion of dissolved phosphorus in total phosphorus in Sugar Creek.**

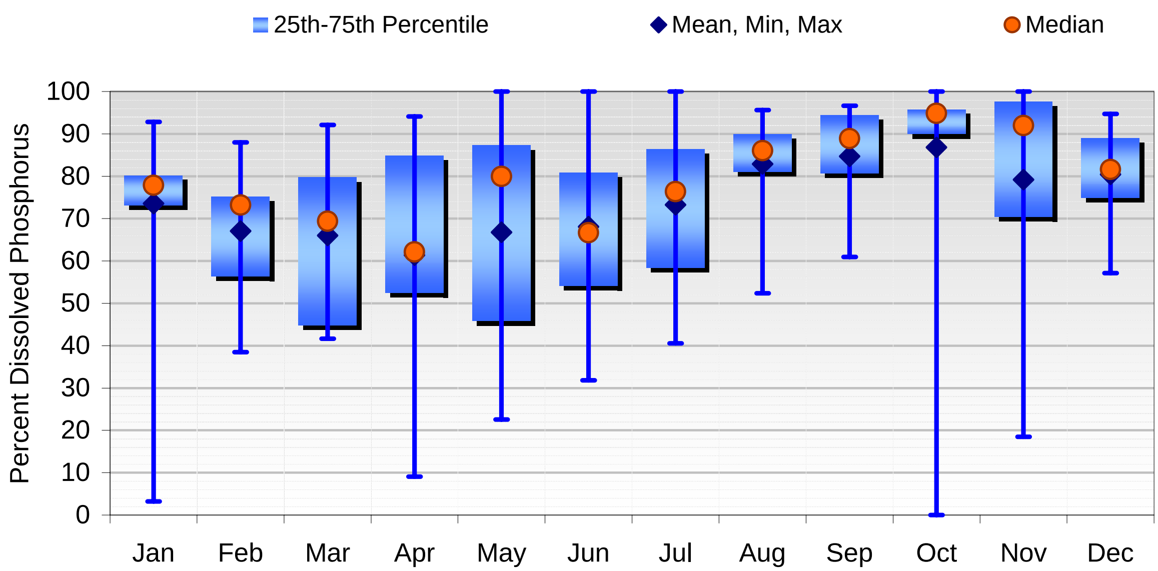


**Figure 4-32. Dissolved phosphorus monthly statistics in Sugar Creek, 1972–2002.**

Another important nutrient is nitrogen. The historic sampling frequency of nitrate plus nitrite in Sugar Creek is given in Figure 4-33, and monthly statistics are presented in Figure 4-34. Figure 4-34 shows that mean and median nitrate plus nitrite concentrations are higher and relatively steady in winter and spring months, with mean concentrations reaching their peak in June. Concentrations then decrease in July to levels less than those in winter and spring, and remain steady through December.

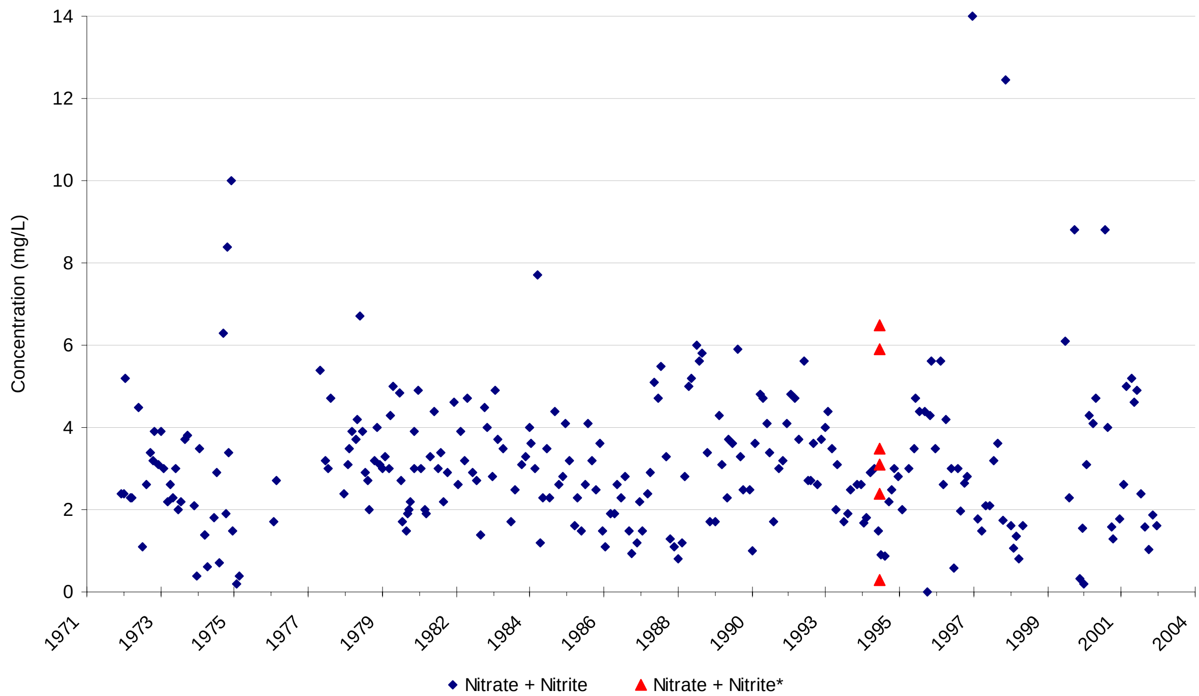


**Figure 4-33. Nitrate + nitrite sampling frequency in Sugar Creek (* indicates FRSS data).**

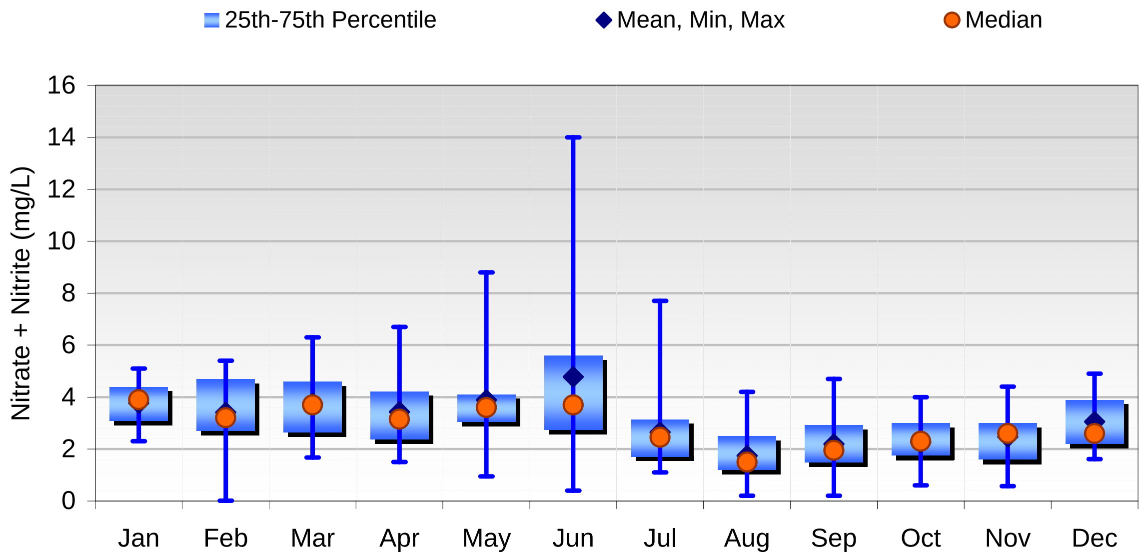


**Figure 4-34. Monthly nitrate + nitrite statistics for Sugar Creek, 1972–2002.**

Historic ammonia sampling data are shown graphically in Figure 4-35. Monthly ammonia concentrations are summarized in Figure 4-36. Figure 4-36 shows that ammonia levels are variable and slightly higher in winter months.

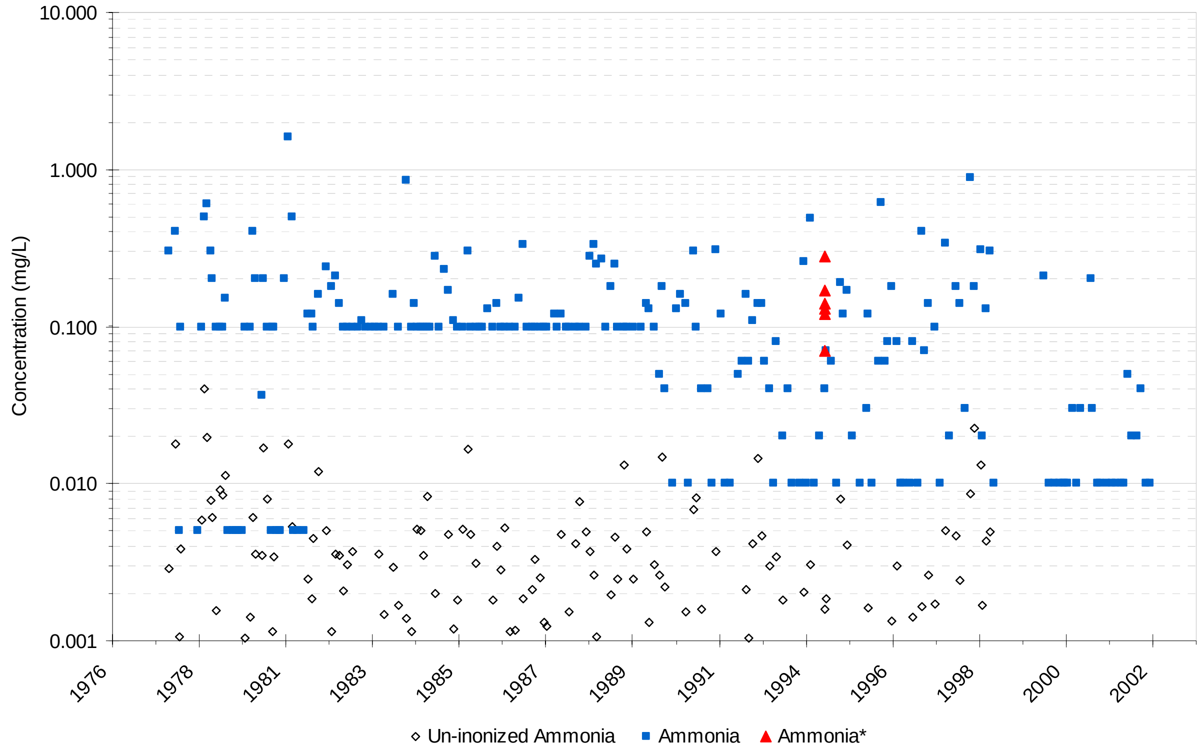


**Figure 4-35. Ammonia sampling observations in Sugar Creek (* indicates FRSS data).**

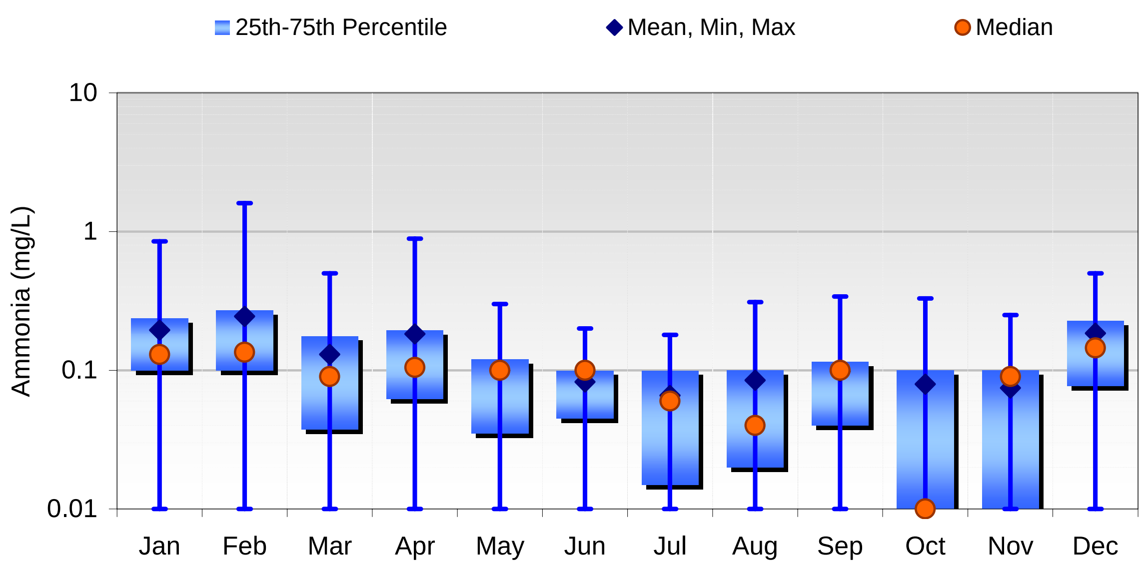


**Figure 4-36. Monthly ammonia statistics in Sugar Creek, 1972-2002.**

#### 4.5.3.3 Sedimentation/Siltation

The sampling frequency of total suspended solids (TSS) for Sugar Creek is presented in Figure 4-37. A summary of monthly TSS data is presented graphically in Figure 4-38. TSS concentrations vary greatly (Figure 4-38) and the greatest mean TSS levels occur in April and September, while the lowest TSS levels occur in October and November.

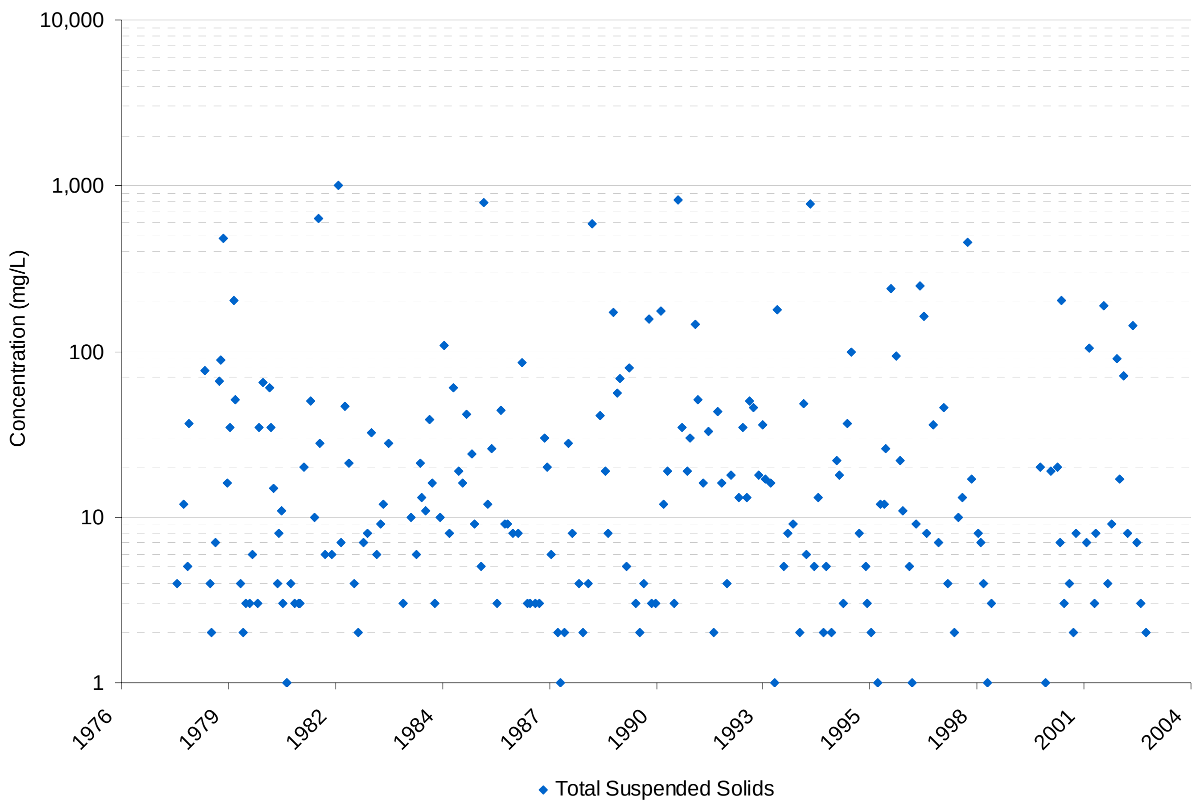


**Figure 4-37. Sampling observations for total suspended solids in Sugar Creek.**

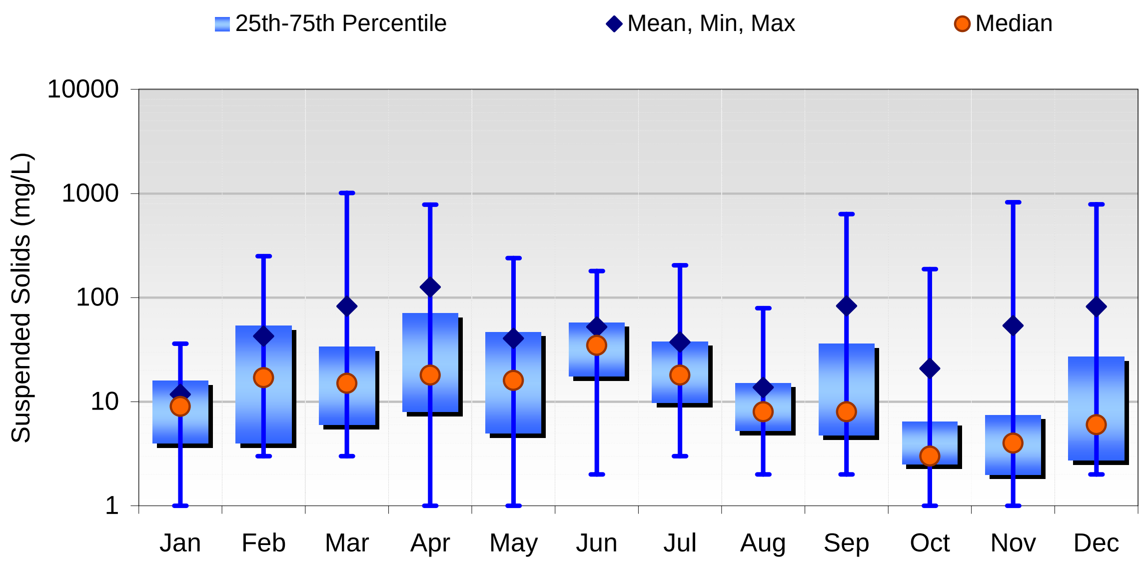


**Figure 4-38. Monthly statistics for total suspended solids in Sugar Creek, 1972–2002.**

### 4.5.4 Sugar Creek (BM02)

Water quality data collected in Sugar Creek at IEPA monitoring stations BM01 and BM02 are available from 1972 to 2002. A summary of these data is presented in Table 4-14. This segment is listed as impaired by fecal coliform.

#### 4.5.4.1 Fecal Coliform

Table 4-14 presents a data summary of fecal coliform data collected in Sugar Creek. The applicable water quality standard for fecal coliform in Illinois is 200 colonies per 100 mL. This is the general use standard and is the more stringent applicable fecal coliform standard. The standard is based on a geometric mean of five samples collected over a 30-day period and only applies from May through October. However, no more than two samples in any month have been collected by IEPA, and most months have only one sample. Therefore it is not possible to evaluate the fecal coliform data against the standard. A significant number of the individual fecal coliform samples exceed 200 colonies/100 mL, however, and the geometric mean for all samples in most months exceeds the standard (Table 4-14).

**Table 4-14. Summary statistics for fecal coliform in Sugar Creek.**

| Fecal Coliform | Samples (Count) | Start | End | Minimum (count/100mL) | Geometric Mean (count/100 mL)[1] | Maximum (count/100mL) |
|---|---|---|---|---|---|---|
| All Data | 253 | 3/9/1972 | 6/21/04 | 0 | 325 | 180,000 |
| May | 27 | 5/3/1972 | 5/26/04 | 10 | 526 | 34,100 |
| June | 22 | 6/20/1972 | 6/20/04 | 10 | 528 | 6,600 |
| July | 20 | 7/13/1972 | 7/21/04 | 30 | 591 | 6,900 |
| August | 20 | 8/23/1973 | 8/26/02 | 0 | 306 | 7,000 |
| September | 25 | 9/20/1972 | 9/10/04 | 40 | 409 | 52,000 |
| October | 19 | 10/31/1972 | 10/15/03 | 10 | 228 | 11,600 |

[1] The reported value reflects the geometric mean calculated from all fecal coliform samples collected within a given month.

Figure 4-39 presents a graphical representation of the fecal coliform sampling activity in Sugar Creek, and Figure 4-40 presents monthly mean and median fecal coliform sample concentrations. Figure 4-40 shows that greater fecal coliform counts occur in the months of April, May, November and December, while lower counts occur in the summer months of June and July. This pattern suggests that fecal coliform loading to Sugar Creek is associated with the typically wetter months. However, an examination of instantaneous flow and fecal coliform counts, shown in Figure 4-41, does not display any general relationship.

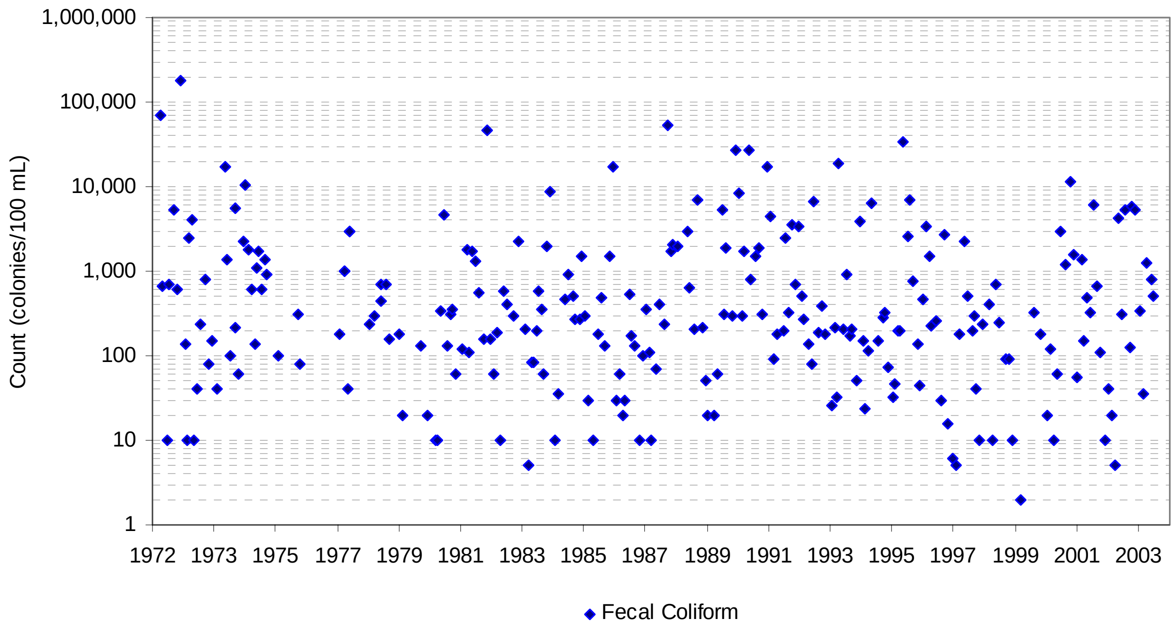


**Figure 4-39. Fecal coliform sampling observations in Sugar Creek.**

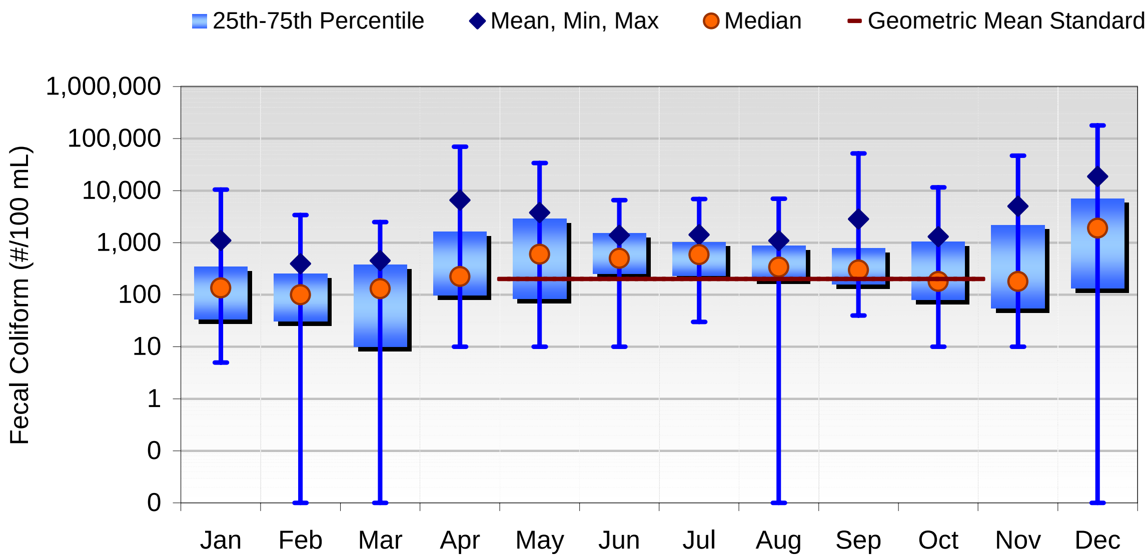


**Figure 4-40. Fecal coliform monthly statistics in Sugar Creek, 1972–2004.**

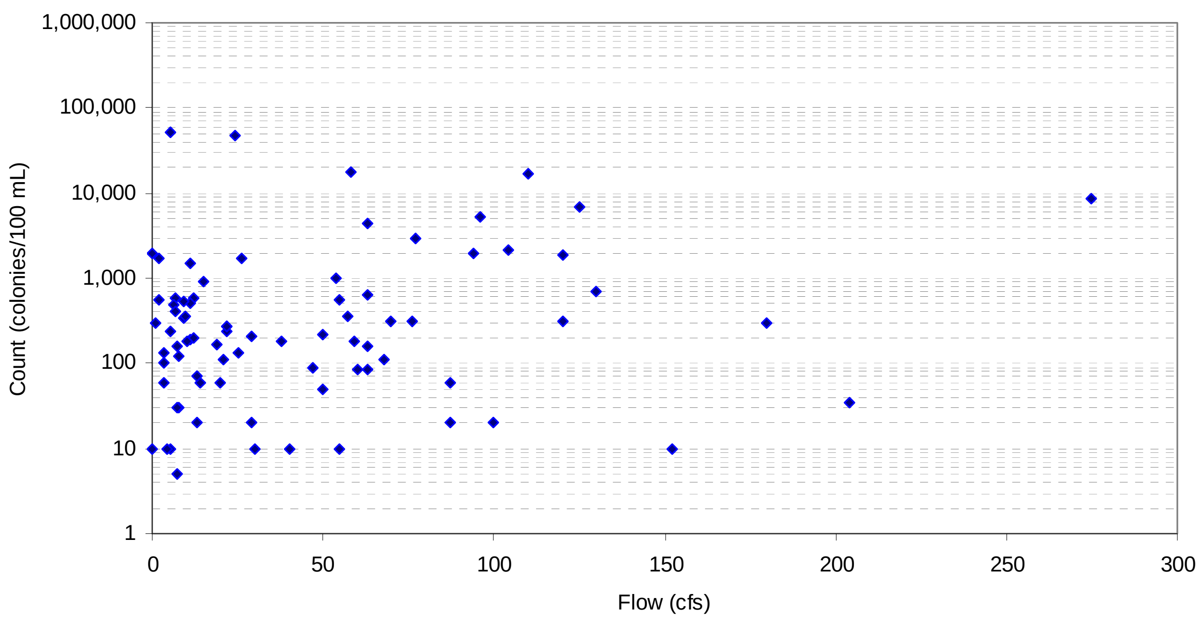


**Figure 4-41. Relationship between fecal coliform concentration and flow.**

### 4.5.5 Potential Pollutant Sources

Both point and nonpoint sources represent potential sources of pollutants in the Sugar Creek watershed and are discussed further below.

#### 4.5.5.1 Point Source Discharges

A query of the National Pollution Discharge Elimination System (NPDES) database revealed three point source dischargers to Sugar Creek, as presented in Table 4-15. The City of Paris has two permitted facilities: a sewage treatment plant and a water treatment plant. The sewage treatment plant has two outfalls and has reported monthly total suspended solids (TSS), ammonia, and flow from 1998 to 2004. The water treatment plant has reported monthly TSS and flow. The locations of the point sources are shown in Figure 4-42.

**Table 4-15. NPDES Discharges in the Sugar Creek Watershed.**

| NPDES ID | Facility Name | Parameter Name | Start Date | End Date | Count | Min | Mean | Max | CV* |
|---|---|---|---|---|---|---|---|---|---|
| IL0021377 | City of Paris Sewage Treatment Plant (STP) | TSS (mg/L) | 1/31/1998 | 6/30/2004 | 231 | 1.10 | 21.84 | 122.00 | 1.12 |
| | | Ammonia (mg/L) | 1/31/1998 | 6/30/2004 | 77 | 0.01 | 0.07 | 0.32 | 0.99 |
| | | Fecal Coliform (#/100 mL) | 1/31/1998 | 6/30/2004 | 154 | N.D. | N.D. | N.D. | N.D. |
| | | Flow (MGD) | 1/31/1998 | 6/30/2004 | 151 | 0.876 | 1.720 | 3.136 | 0.341 |
| ILG640172 | City of Paris Water Treatment Plant (WTP) | TSS (mg/L) | 1/31/1998 | 5/31/2004 | 68 | 2.00 | 7.91 | 15.00 | 0.47 |
| | | Flow (MGD) | 1/31/1998 | 5/31/2004 | 68 | 0.038 | 0.057 | 0.091 | 0.215 |

*CV = standard deviation/average

It should also be noted that the Louis A. Mattingly feedlot operation used to hold an NPDES permit (IL0061123) but ceased operations at least 10 years ago. This feedlot caused a large fish kill in November 1980 during which an estimated 400,000 gallons of cattle manure were spilled and an estimated 62,108 fish were killed.

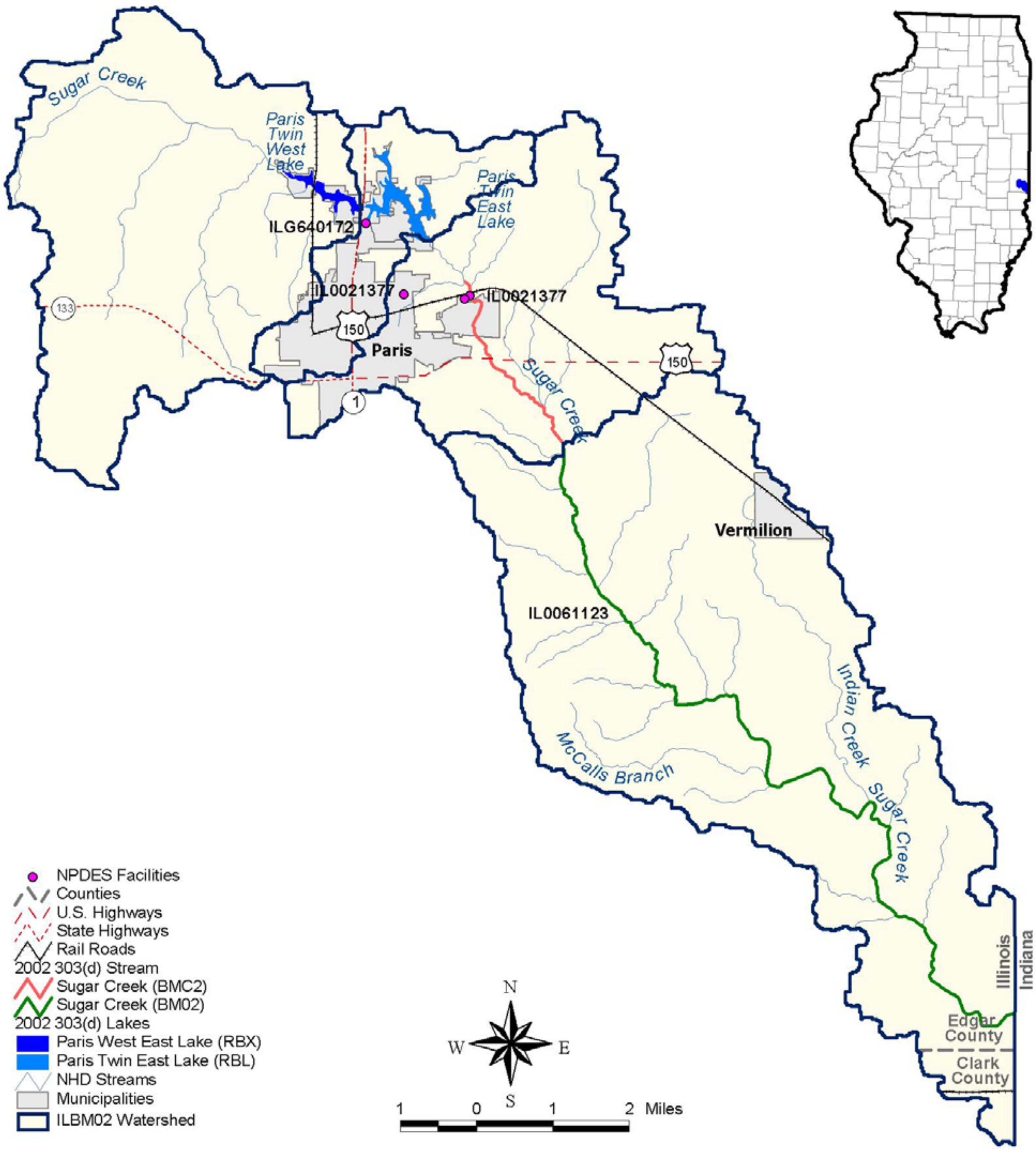


**Figure 4-42. Point sources in the Sugar Creek watershed.**

#### 4.5.5.2 Nonpoint Sources

Potential nonpoint sources of sediments and nutrients in the Sugar Creek watershed include sheet and rill erosion, lake shoreline erosion, stream channel erosion, fertilizer use, failing septic systems, storm water runoff, atmospheric deposition, internal lake recycling, and natural sources. No animal confinements are located in the watershed and the majority of livestock are cattle on pasture (Edgar County Soil and Water Conservation District, personal communications). The relative magnitude of each of these various sources has not yet been estimated and will be the focus of Stage 2 and 3 activities. The Edgar County Soil and Water Conservation District is currently compiling information on livestock numbers and the Edgar County Public Health Department has been contacted regarding information on potentially failing septic systems.

# 5 Identification of Data Gaps and Sampling Plan

Several data gaps have been identified in the Sugar Creek watershed that will have implications for TMDL development. First, no continuous flow data exist. The absence of such data has consequences for the recommended technical approach to TMDL development for the watershed, as discussed in section 6.0 below. Flows should be measured at the mouth of Sugar Creek where it enters Paris Twin West Lake and downstream of Paris Twin East Lake. Flow rates at these locations should be measured every two weeks from April through June. Flow rates should be measured once a month in February, July to October, and December. The USGS method should be used to measure flow using a current meter. Water levels should be measured in conjunction with all flow measurements. For this purpose, water level gages should be installed and water levels at each gage should be monitored and recorded by volunteers. Water levels should be recorded at least weekly; more frequent measurements are desirable during wet weather.

Secondly, additional water quality sampling is recommended for Sugar Creek. Additional DO data are required in segment BMC2 at two to three locations to evaluate current conditions and to confirm whether or not the segment is still impaired. The stations should be located upstream and downstream of the STP outfall location and at the end of segment BMC2. Additional data are also required upstream of Paris Twin West Lake to evaluate loadings to the lake. The streams should be sampled two times a month from April through September, and once in each of March and October. This schedule will capture the expected seasonal variation in water quality parameters related to nutrient loading, eutrophication and oxygen-demanding processes. Water samples should be analyzed to determine concentrations of TP, soluble reactive phosphorus, chlorophyll-a, nitrate/nitrite nitrogen, and total Kjeldahl nitrogen. In the field, measurements should be made using a Hydrolab to obtain pH, temperature and dissolved oxygen. A diel DO survey would also be very useful to determine the extent to which excessive algal growths result in large swings in concentrations.

Additional fecal coliform data are required in segment BM02 to allow for a direct comparison to the water quality standards. Five samples should be collected within a 30-day period during the summer, preferably during a month with critically high historical fecal coliform counts (such as June or July).

Lastly, detailed bathymetric data do not appear to be available for the Paris Twin Lakes. A bathymetric survey was completed in 1992 (IEPA, 1992) as part of a sediment survey for the lakes. However, the survey showed significant sediment accumulation in the lakes over time. Given the large sediment accumulation in the lakes, the bathymetric data from the 1992 survey should be used with caution.

A summary of the sampling plan is provided in Table 5-1. Sampling should be conducted by qualified personnel and might include representatives from Illinois EPA, local government agencies, or private consulting companies. A cost estimate can be made once Illinois EPA has decided on the extent of the sampling effort and the responsible party.

**Table 5-1. Summary of number of sampling events by month for the Sugar Creek watershed.**

| Type of Sampling | March | April | May | June | July | Aug | Sept | Oct |
|---|---|---|---|---|---|---|---|---|
| Sugar Creek Flow Sampling | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Sugar Creek DO, Nutrient, and Algal Sampling | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| Sugar Creek Fecal Coliform Sampling | | | | | 5 | | | |

# 6 Technical Approach

Technical approaches for developing phosphorus TMDLs for the Paris Twin Lakes and dissolved oxygen and fecal coliform TMDLs for Sugar Creek are presented in this section. Both simple and more advanced technical approaches are presented.

## 6.1 Paris Twin Lakes

The following discussion provides a description of two different approaches for developing the Paris Twin Lakes TP and dissolved oxygen TMDLs.

### 6.1.1 Simple Approach

A simple approach to TMDL development would be to use a mass balance analysis to assess the extent to which TP loadings need to be reduced in the lake. Necessary reductions would essentially be calculated based on a comparison of existing concentrations to the standard. For example, if the existing TP concentration is twice the standard, loads would need to be reduced by 50 percent (plus perhaps a margin of safety). Existing loads from the tributaries would be estimated using the available flow and water quality data and other sources (e.g., shoreline erosion) would need to be estimated separately.

The advantages of the simple approach are that it would be easy to apply and therefore could be done quickly. The disadvantages include the fact that loadings and water quality response are not always linearly related (as is assumed with the approach) and limited information would be available on certain other potential sources of the pollutants (e.g., TP from the lake bottom sediments). Dissolved oxygen concentrations would also not be simulated using the simple approach.

### 6.1.2 Detailed Approach

Under a more detailed approach both a watershed and a lake model would be developed and applied for the TMDLs. The Soil Water Assessment Tool (SWAT) model would be used to estimate watershed loadings and conditions in Sugar Creek, and to use either the LAKE2K model would be used to evaluate conditions in the two lakes. A lake model is desirable for the Paris Twin Lakes TMDLs to estimate the extent to which lake bottom sediments contribute phosphorus loads and to assess the potential water quality response of reduced loadings. A watershed model is needed for several reasons:

1) Help estimate existing inflows to the lakes (due to the lack of flow data).
2) Help estimate existing sediment and nutrient loads to the lakes by complementing the available water quality data.
3) Provide additional perspective on the relative magnitude of the various sediment and nutrient sources (in both the lakes and Sugar Creek).
4) Assess the potential benefit of various best management practices.

The SWAT model, version 2000A, is proposed for developing the nutrient and dissolved oxygen TMDLs for the Sugar Creek watershed. The SWAT model was designed specifically to address loadings from rural, agriculture-dominated watersheds. It is able to predict the impact of land management practices, such as vegetative changes, conservation practices, and groundwater withdrawals, on water quality and sediment. SWAT can analyze large watersheds and river basins (greater than 100 square miles) by subdividing the area into subwatersheds. SWAT simulates hydrology, pesticide and nutrient cycling, erosion and sediment transport.

SWAT is proposed for the Sugar Creek watershed TMDLs because it:

- models the constituents of concern (TP, nitrate and nitrite, dissolved oxygen, and sediments)
- is designed for primarily agricultural watersheds
- provides daily output to allow for direct comparison to the water quality targets (daily output can be averaged over a month)
- provides the ability to directly evaluate management practices (such as altering fertilizer application rates, tillage practices, and erosion control structures)
- has been used elsewhere in Illinois for TMDL development
- can incorporate multiple point sources, such as flow from waste water treatment facilities
- has a greater level of acceptance with the agricultural community because it was developed by the U.S. Department of Agriculture, Agricultural Research Service.

Calibrating the hydrologic component of SWAT presents a challenge since there are no flow gauges located within the basin. However, daily mean stream flow and water quality information is available for the Little Vermilion River, located to the north of Sugar Creek. The physical characteristics (e.g. land use, soils, topography, agricultural practices) of the Little Vermilion River watershed are very similar to those of Sugar Creek. Consequently, a SWAT model can be built for the Little Vermilion River, and the calibrated hydrologic and water quality parameters will be used for Sugar Creek. SWAT will be calibrated for water quality using the data collected at the IEPA BM-1 and BM-2 monitoring stations (see Figure 4-1) located on Sugar Creek.

The issue of tile drainage will be addressed in the SWAT model by using the model's tile drainage module and making other parameter adjustments to reflect known hydrologic and water quality impacts.

Establishing the relationship between the in-reservoir water quality targets and source loading is a critical component in the development of a TMDL. It allows for the evaluation of management options that will achieve the desired outcome in terms of water quality. The link can be established through a range of techniques, from simple mass balance analyses to sophisticated computer modeling. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associated certain waterbody responses with flow and loading conditions.

LAKE2K, which was designed to compute seasonal trends of water quality in stratified lakes (Chapra and Martin, 2004), is proposed for evaluating water quality conditions in Paris Twin Lakes. A beta version of the model has recently been released and is supported by the U.S. EPA Office of Research and Development. LAKE2K is implemented within the Microsoft Windows environment and uses Microsoft Excel as the graphical user interface. The model requires information on lake elevation, area, volume, inflows, meteorology, and initial water quality conditions. Daily water quality output is provided for three vertical layers (epilminion, metalimnion, and hypolimnion), including daily predictions of TP, dissolved oxygen, and three phytoplankton groups. LAKE2K also includes a sediment diagenesis model for nutrient release during low dissolved oxygen conditions. LAKE2K falls between the less complex BATHTUB model and the more rigorous and data-intensive CE-QUAL-W2 or Environmental Fluid Dynamics Code (EFDC) models.

### 6.2 Sugar Creek Fecal Coliform TMDLs

The following discussion provides a description of two different approaches for developing the Little Vermilion River fecal coliform TMDL.

### 6.2.1 Simple Approach

Required fecal coliform load reductions for Sugar Creek can be assessed through the use of a load duration curve. The load duration approach involves calculating the desired loadings over the range of flow conditions expected to occur in the impaired stream and is a simple and accurate method to assess existing and allowable loads. The following specific steps are recommended:

1) A flow duration curve for the stream gage site of interest is developed. This is done by generating a flow frequency table and plotting the data points.
2) The flow curve is translated into a load duration (TMDL) curve. To accomplish this, the flow value is multiplied by the water quality standard and by a conversion factor. The resulting points are graphed.
3) A water quality sample is converted to a load by multiplying the water quality sample concentration by the average daily flow on the day the sample was collected. Then, the load is plotted on the TMDL graph.
4) Points plotting above the curve represent deviations from the water quality standard and the permissible loading function. Those plotting below the curve represent compliance with standards and represent adequate quality support for the appropriate designated use.
5) The area beneath the TMDL curve is the loading capacity of the stream. The difference between this area and the area representing the current loading conditions is the load that must be reduced to meet water quality standards.

Tetra Tech is very familiar with the use of the load duration approach and has developed spreadsheet tools to facilitate its use. The approach helps to identify the issues surrounding the impairment and to roughly differentiate between sources. Loads which plot above the curve in the low flow regime are likely indicative of constant discharge sources. Those plotting above the curve in the high flow regime likely reflect wet weather contributions. Some combination of the two source categories lies in the transition zone. Specific sources of fecal coliform would be identified through a non-modeling approach to facilitate implementation activities. Disadvantages of this approach include the fact that estimating the observed and allowable loads would be disconnected from the analysis of the source of the loads. The approach also does not directly address the geometric mean component of the standard.

### 6.2.2 Detailed Approach

A more detailed approach to developing the fecal coliform TMDL would be to rely on the watershed model described above in Section 6.1.2 to estimate existing and allowable loads. The advantages of this approach are that the sources of fecal coliform would be more explicitly addressed and the effectiveness of potential best management practices could be evaluated with the model. The geometric mean component of the standard could also be directly addressed because the model would provide daily output with which to calculate a 30-day geometric mean.

## References

Bogner, W.C., 1992. Sedimentation Survey of Paris West Lake, Edgar County, Illinois. Illinois State Water Survey, SWS Contract Report 527. 47 pp.

Chapra, S. C., 1997. Surface Water Quality Modeling. McGraw Hill. Boston, Massachusetts.

Chapra, S.C. and Martin, J.L. 2004. LAKE2K: A Modeling Framework for Simulating Lake Water Quality (Version 1.2): Documentation and Users Manual. Civil and Environmental Engineering Dept., Tufts University, Medford, MA.

Illinois Department of Agriculture, 2000. 2000 Illinois Soil Conservation Transect Survey Summary, Springfield, Illinois.

Illinois Department of Agriculture, 2002. 2002 Illinois Soil Conservation Transect Survey Summary, Springfield, Illinois, November 2002.

Illinois EPA, 1992. Phase I Diagnostic/Feasibility Study of Paris Twin Lakes, Edgar County, Illinois. Springfield, Illinois.

Illinois EPA, 1998. Phase II Project Report of Paris Twin Lakes, Edgar County, Illinois. Springfield, Illinois.

Illinois EPA, 2002. Illinois 2002 Draft Section 303(d) List. Illinois Environmental Protection Agency. Springfield, Illinois.

INHS, 2003. Illinois Natural History Survey's 1999-2000 1:100 000 Scale Illinois Gap Analysis Land Cover Classification, Raster Digital Data, Version 2.0, September 2003.

Newcombe, C.P., and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: A synthesis for quantitative assessment of risk and impact. *N. Am. J. Fish. Manage.* 16:693–627.

NHD, 2003. National Hydrography Dataset. U.S. Environmental Protection Agency, Washington, DC.

USEPA, 1986. *Ambient Water Quality Criteria for Bacteria–1986.* EPA-A440/5-84-002. U.S. Environmental Protection Agency, Washington, DC.

USEPA, 1999. Protocol for Developing Nutrient TMDLs. 1$^{st}$ edition. EPA-841-B-99-007. U.S. Environmental Protection Agency. Office of Water, Washington, D.C.

Wischmeier, W.H., and Smith, D.D., 1978. Predicting Rainfall Erosion Losses - A Guide to Conservation Planning. Agricultural Handbook No. 537. U.S. Department of Agriculture, Washington, D.C.

Zucker, L.A. and L.C. Brown (Eds.). 1998. Agricultural Drainage: Water Quality Impacts and Subsurface Drainage Studies in the Midwest. Ohio State University Extension Bulletin 871. The Ohio State University.

# Appendix A: Illinois GAP Land Cover Description

**Table A-1. Values and class names in the Illinois Gap Analysis Project Land Cover 1999-2000 Arc/Info GRID coverage.**

| GRID VALUE | LAND COVER CATEGORY |
|---|---|
| | *AGRICULTURAL LAND* |
| 11 | Corn |
| 12 | Soybeans |
| 13 | Winter Wheat |
| 14 | Other Small Grains and Hay |
| 15 | Winter Wheat/Soybeans |
| 16 | Other Agriculture |
| 17 | Rural Grassland |
| | |
| | *FORESTED LAND* |
| 22 | Dry Upland |
| 23 | Dry-Mesic Upland |
| 24 | Mesic Upland |
| 25 | Partial Canopy/Savannah Upland |
| 26 | Coniferous |
| | |
| | *URBAN LAND* |
| 31 | High Density |
| 32 | Low/Medium Density (excluding TM Scene 2331) |
| 33 | Medium Density (TM Scene 2331) |
| 34 | Low Density (TM Scene 2331) |
| 35 | Urban Open Space |
| | |
| | *WETLAND* |
| 41 | Shallow Marsh/Wet Meadow |
| 42 | Deep Marsh |
| 43 | Seasonally/Temporarily Flooded |
| 45 | Mesic Floodplain Forest |
| 46 | Wet-Mesic Floodplain Forest |
| 47 | Wet Floodplain Forest |
| 48 | Swamp |
| 49 | Shallow Water |
| | |
| | *OTHER* |
| 51 | Surface Water |
| 52 | Barren and Exposed Land |
| 53 | Clouds |
| 53 | Cloud Shadows |

# Appendix B: Water Quality Data for the Sugar Creek Watershed

Available upon Request

# Attachment 2
# Stage Two Report
# Tetra Tech, 2007

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# STAGE 2 – WATER QUALITY SAMPLING REPORT

For TMDLs in North Fork Vermilion River, Salt Fork Vermilion River,
Sugar Creek, and Walnut Point Lake

## Final Report

Prepared for

**ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
BUREAU OF WATER**

Prepared by

**TETRA TECH, INC**.

February 22, 2007

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**CONTENTS**

# 1.0 INTRODUCTION

Tetra Tech, Inc (Tetra Tech), has been tasked by the Illinois Environmental Protection Agency (IEPA) to conduct Stage 2 water quality sampling to support the development of total maximum daily loads (TMDL) for the Hoopeston Branch of the North Fork Vermilion River, Salt Fork Vermilion River, Sugar Creek, and Walnut Point Lake watersheds in Champaign, Edgar, Douglas, and Vermilion Counties. This report discusses Stage 2 data collection (Section 2.0), preliminary data analysis of listed impairments (Section 3.0), and recommendations for Stage 3 based on collected water quality data (Section 4.0).

# 2.0 DATA COLLECTION

This section (1) summarizes data collection activities, including the preparation of the quality assurance project plan (QAPP), identification of sampling sites, field sampling procedures, and laboratory sample analysis; (2) presents a data summary, and (3) discusses problems that occurred.

## 2.1 QAPP PREPARATION

Tetra Tech prepared a detailed QAPP, including a sampling analysis plan (SAP), for the Stage 2 water quality sampling in September 2005. The QAPP describes sampling objectives, sampling sites, sampling events and frequency, water quality parameters, and field and laboratory procedures and standards. The QAPP, which was approved by IEPA, has been used as a guideline for both field work and laboratory analysis (see Appendix A). After the approval of the initial QAPP, an addendum to the QAPP added four additional sampling locations to the sampling effort in the Salt Fork Vermilion River in March 2006 (see Appendix B).

## 2.2 SAMPLING SITE IDENTIFICATION

Sampling sites were identified for each watershed based on data needs discussed in the Stage 1 reports and through consultation with IEPA. A total of 15 sites were identified for the Stage 2 sampling effort, four of which were not included in the initial QAPP (see Appendix A). These sites were added in March 2006 as requested by IEPA (see Appendix B). Table 1 summarizes the listed segments, impairment causes, sampling sites, number of events, and field and laboratory parameters. Figures 1 through 4 show the final sampling sites identified in the field. Each site reflects the coordinates and description described in the QAPP or QAPP addendum except BPJ-08, which was relocated to the bridge near the confluence of Salt Fork Vermilion River and Stony Creek (see Figure 2) because of access problems in the field. BPJA-03 was also relocated on Jordan Creek, a tributary to the Salt Fork Vermillion River, because of access problems along the main stream (see Figure 2).

**TABLE 1**
**SUMMARY OF IMPAIRED SEGMENTS, SAMPLING SITES, AND PARAMETERS**

| Watershed | Water Body | Impairment Cause(s) of Concern | Segment | Sampling Sites | No. of Events | Field Parameters | Laboratory Parameters |
|---|---|---|---|---|---|---|---|
| North Fork Vermilion River | Hoopeston Branch | DO | BPGD | BPGD-H-A1, BPGD-H-C1 | 14 | pH, conductivity, DO, turbidity, Secchi disk, temperature, flow | TKN, $NO_2$ + $NO_3$, TP, TDP, chlorophyll- *a*, BOD5 |
| Salt Fork Vermilion River | Salt Fork Vermillion River | pH, Nitrate | BPJ10 | BPJ-10[a], BPJ-16[a] | 14 | pH, conductivity, DO, turbidity, Secchi disk, temperature, flow | TKN, $NO_2$ + $NO_3$, TP, TDP, BOD5, $NH_3$, TSS |
| Salt Fork Vermilion River | Salt Fork Vermillion River | pH, Nitrate | BPJ08 | BPJ-08 | 14 | pH, conductivity, DO, turbidity, Secchi disk, temperature, flow | TKN, $NO_2$ + $NO_3$, TP, TDP, chlorophyll- *a* , BOD5, fecal coliform |
| Salt Fork Vermilion River | Jordan Creek | Fecal Coliform | Tributary to Salt Fork Vermilion River | BPJA-03[a] | 14 | pH, conductivity, DO, turbidity, Secchi disk, temperature, flow | TKN, $NO_2$ + $NO_3$, TP, TDP, BOD5, $NH_3$, TSS, fecal coliform |
| Salt Fork Vermilion River | Salt Fork Vermillion River | Fecal Coliform | BPJ03 | BPJ-03[a] | 14 | pH, conductivity, DO, turbidity, Secchi disk, temperature, flow | TKN, $NO_2$ + $NO_3$, TP, TDP, BOD5, $NH_3$, TSS, fecal coliform |
| Salt Fork Vermilion River | Saline Branch | DO | BPJC08 | BPJC-08, BPJC-UC-A2 | 14 | pH, conductivity, DO, turbidity, Secchi disk, temperature, flow | TKN, $NO_2$ + $NO_3$, TP, TDP, chlorophyll-*a* , BOD5 |
| Salt Fork Vermilion River | Spoon Branch | DO | BPJD02 | BPJD-01, BPJD-02 | 14 | pH, conductivity, DO, turbidity, Secchi disk, temperature, flow | TKN, $NO_2$ + $NO_3$, TP, TDP, chlorophyll- *a* , BOD5 |
| Sugar Creek | Sugar Creek | DO | BMC2 | BMC-2 | 14 | pH, conductivity, DO, turbidity, Secchi disk, temperature, flow | TKN, $NO_2$ + $NO_3$, TP, TDP, chlorophyll- *a* , BOD5 |
| Walnut Point Lake | Walnut Point Lake | TP, DO, $NO_3$ | RBK | RBK-1, RBK-2, RBK-3 | 14 | pH, conductivity, DO, turbidity, Secchi disk, temperature | TKN, $NO_2$ + $NO_3$, TP, TDP, chlorophyll- *a* |
| Walnut Point Lake | Walnut Point Lake | TP, DO, $NO_3$ | BEX1 | BEX-1 | 14 | pH, conductivity, DO, turbidity, Secchi disk, temperature, flow | TP and TDP |

Notes:

BOD5 5-Day biological oxygen demand
DO Dissolved oxygen
$NH_3$ Ammonia
$NO_2$ Nitrate
$NO_3$ Nitrite
a Sampling site added in March 2006
TKN Total Kjehldahl nitrogen
TDP Total dissolved phosphorus
TP Total phosphorus
TSS Total suspended solids

**FIGURE 1**
**HOOPESTON BRANCH SAMPLING SITES**

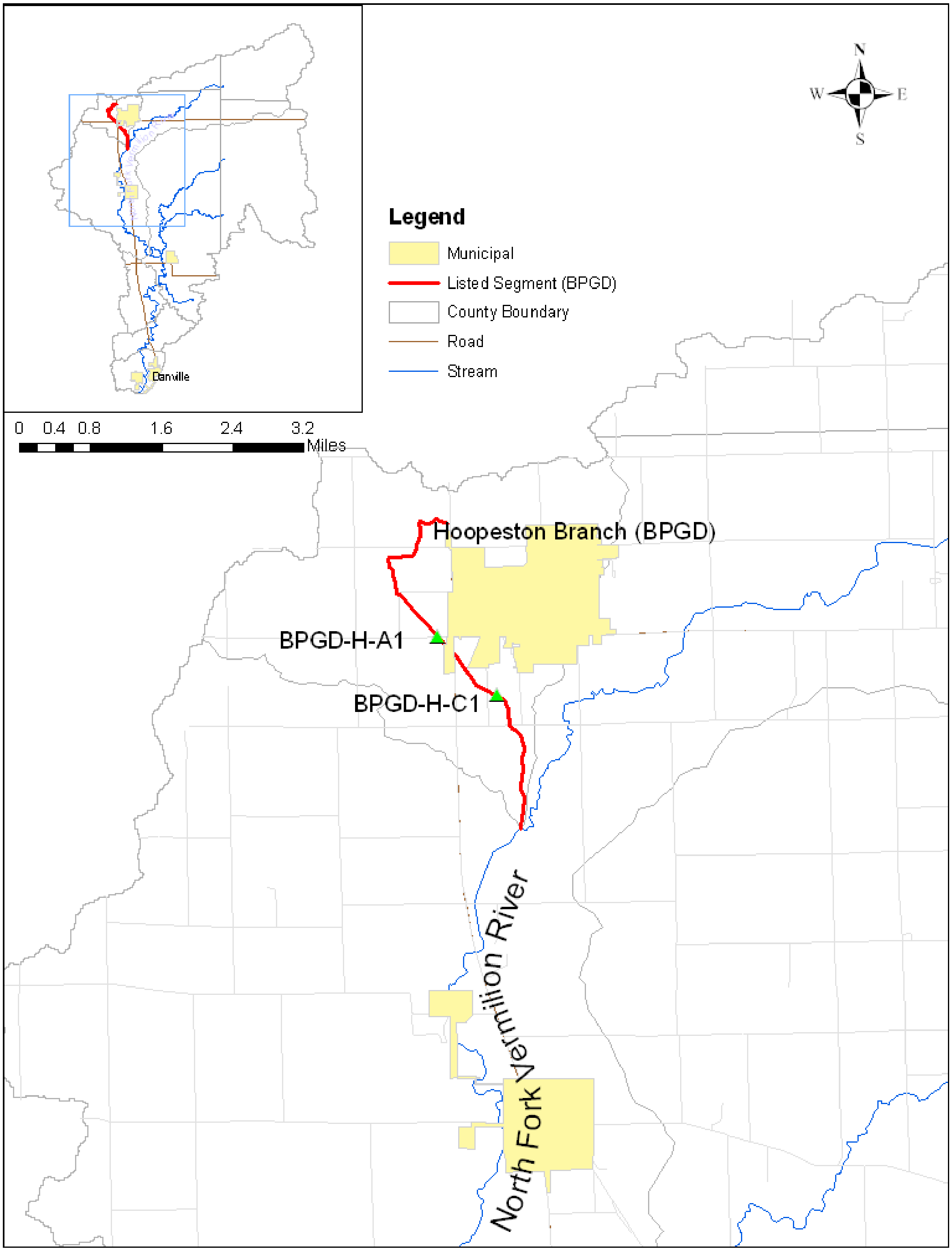


**FIGURE 2**
**SALT FORK VERMILION RIVER AND TRIBUTARY SAMPLING SITES**

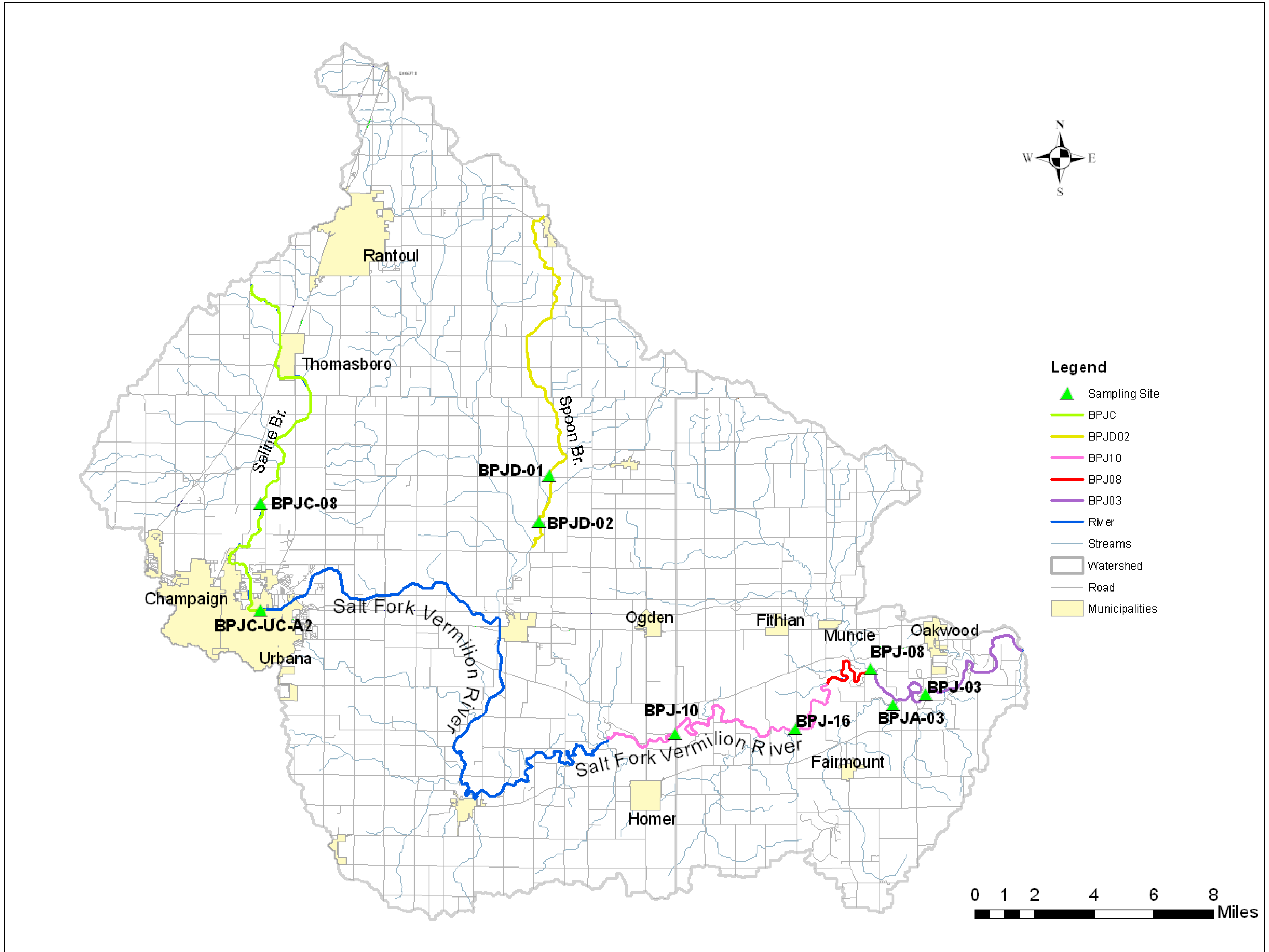


**FIGURE 3**
**SUGAR CREEK SAMPLING SITE**

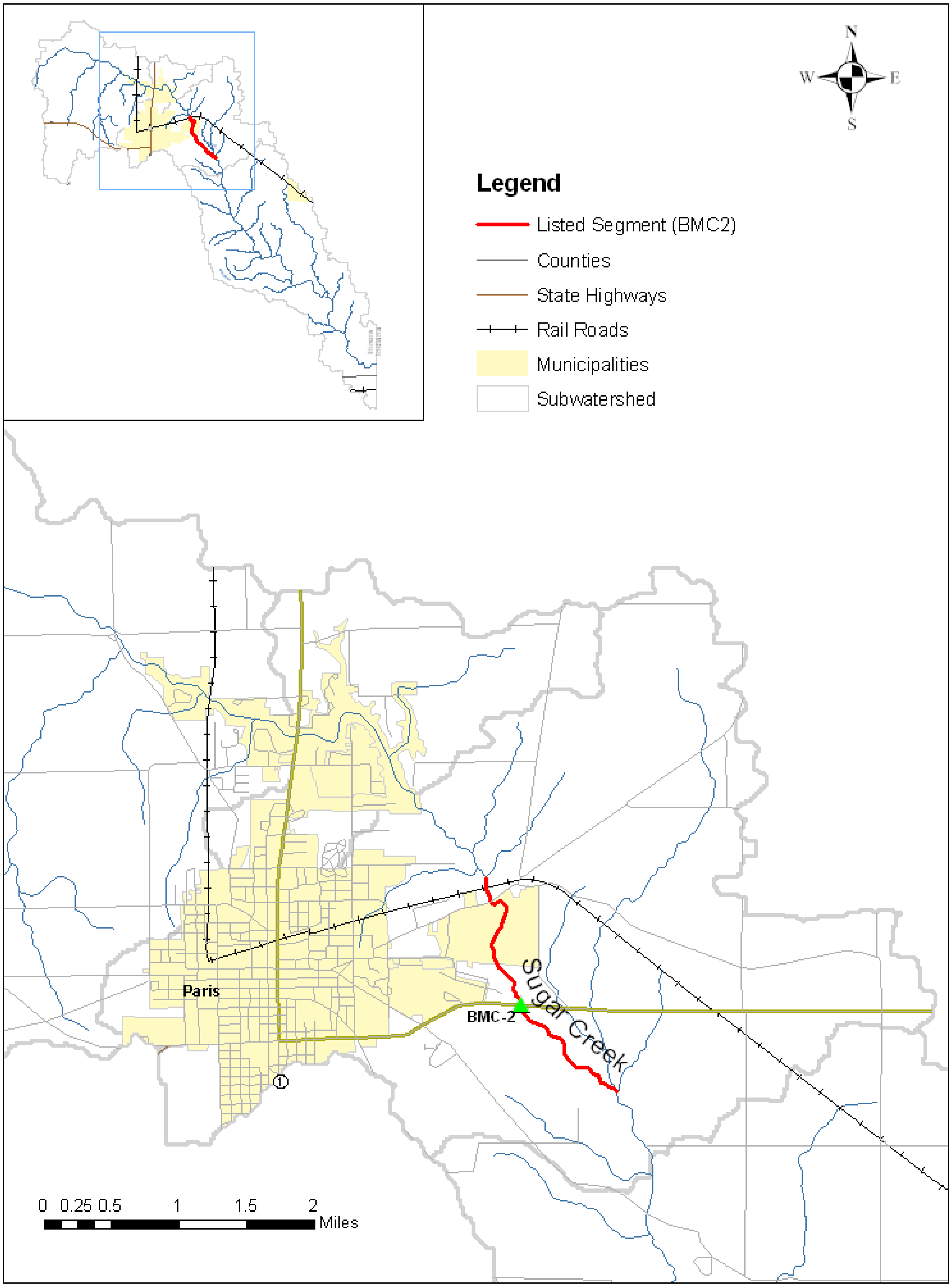
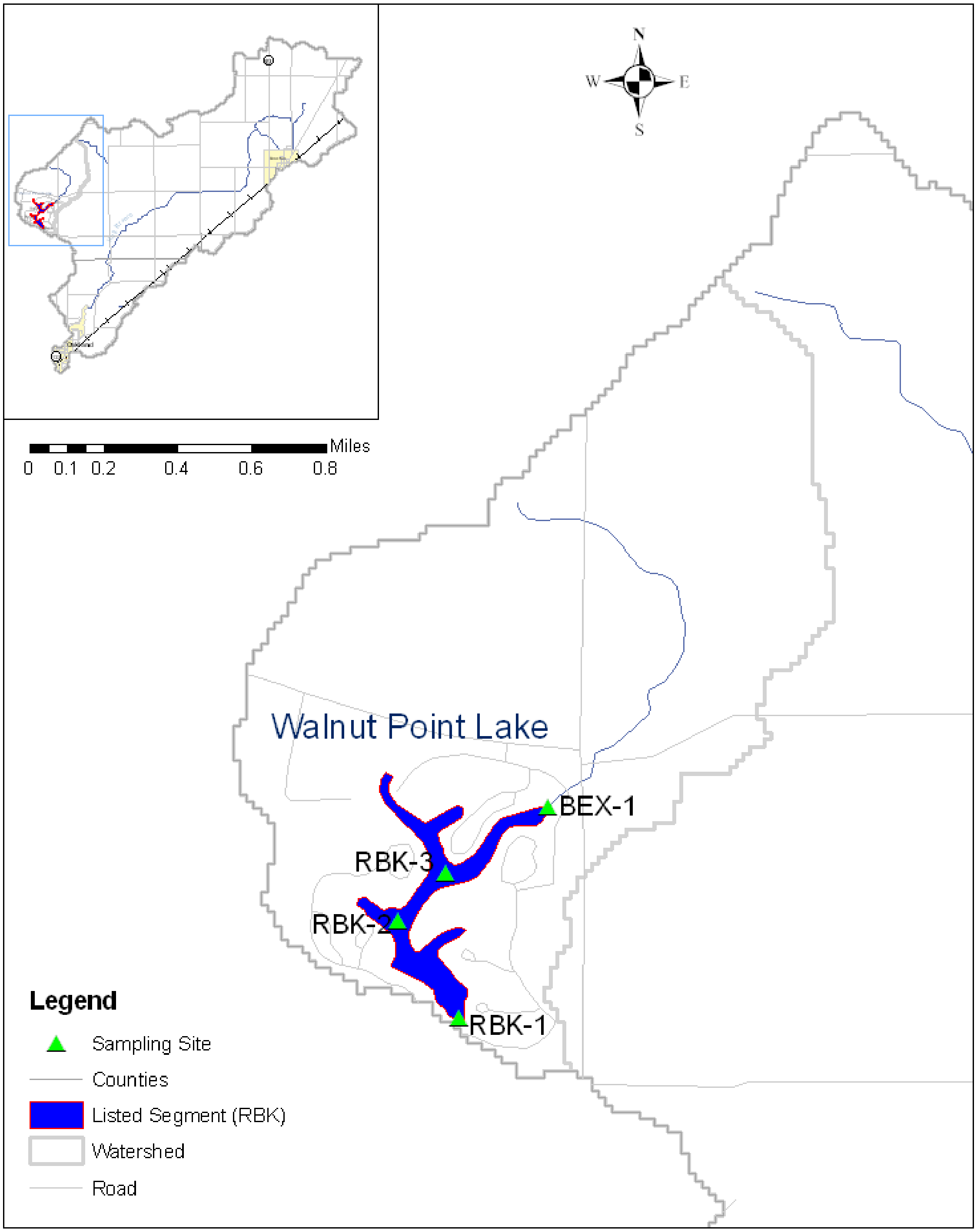


**FIGURE 4**
**WALNUT POINT LAKE SAMPLING SITES**



## 2.3 FIELD SAMPLING PROCEDURES

Water quality sampling was conducted from October 6 through November 1, 2005; resumed on April 11, 2006; and ended on October 27, 2006. Sampling at BPJ-10, BPJ-16, BPJA-03, and BPJ-03 began on April 11, 2006. The samples were collected from each site twice a month, generally 2 weeks apart. The first sampling event approximately occurred during the second week of the month, and the second sampling event occurred during the fourth week of the month.

During each sampling event, two to three field technicians and environmental scientists conducted field measurements and collected grab samples. The staff was required to be familiar with the QAPP and follow the sampling protocol. The sampling usually began in early morning and ended during mid-afternoon to allow enough time to deliver the samples to the laboratory. For each sampling event, field staff implemented standard procedures (as described in QAPP) for field sampling, chain of custody, laboratory analysis, and data reporting to produce well-documented data of known quality. The field staff maintained detailed logbooks and chain-of-custody forms that contain all information pertaining to sample collection. Information recorded for each sample included sample identification number, location (including latitude and longitude), sampling depth, date, time, sampler, and sample matrix.

Duplicate field quality control (QC) samples (one every other sampling event) were collected for laboratory analysis to check sampling and analytical precision, accuracy, and representativeness. Field duplicate samples are independent samples collected as close as possible in space and time to the original investigative sample. Field duplicate samples were collected immediately after collection of the original sample using the same collection method.

At each sampling site within a river or stream, water quality measurements for pH, temperature, dissolved oxygen (DO), conductivity, and turbidity were taken using a Horiba U-10 water quality meter; flow measurements (as field conditions allowed) were recorded using a flow meter; and Secchi depth was recorded using a Secchi disk. Water quality readings were recorded near both banks and in the center of each river or stream.

After water quality readings were taken, composite samples from the three water quality measurement reading locations were collected at the water surface. For samples collected in the streams, laboratory analysis included total Kjehldahl nitrogen (TKN), nitrates + nitrites ($NO_2$ + $NO_3$), total phosphorus (TP), total dissolved phosphorus (TDP), chlorophyll-*a*, and 5-day biological oxygen demand (BOD5). In addition, the samples from BPJ-08, BPJA-03, and BPJ-03 were delivered to the IEPA laboratory in Champaign for total fecal coliform analysis.

In Walnut Point Lake, water quality readings and samples for laboratory analysis were collected from three different depths at each of the three sampling locations so that the vertical profile of the water column could be characterized during Stage 3. At each location, the water depth was recorded. One sampling depth was just above the bottom of the lake, one was between the bottom of the lake and the surface, and one was near the surface. One Secchi disk reading was collected at each sampling location, and conductivity, pH, DO, turbidity, and temperature readings were collected at all three depths at each location. Samples for laboratory analysis were also collected at all three depths at each sampling location and analyzed for TKN, $NO_2$ + $NO_3$, TP, TDP, and chlorophyll-*a*. In addition, one sediment sample was collected using an Eckman dredge from the deepest sampling location and sent to the laboratory for TP and TDP analysis. One water sample was collected from a tributary to Walnut Point Lake during the first sampling event and analyzed for the same water quality parameters as for the other streams sampled; however, the water sample collected for laboratory analysis was analyzed for TP and TDP only as recommended in the Stage 1 report.

Each sampling event was photologged (see Appendix C). After sampling was completed at each location, the sampling location was recorded using global positioning system (GPS).

All samples were packed in coolers on ice immediately after collection from water and hand-delivered to Severn Trent Laboratory (STL) in University Park, Illinois, at the end of each sampling event. STL provided sample analytical results in the form of a Level II data package within a 2-week turnaround time. The Level II data package is provided in Appendix D in an Excel data file in an Illinois EPA water quality data submittal format.

## 2.4 LABORATORY SAMPLE ANALYSIS

STL was subcontracted to conduct all the laboratory analysis except the total fecal coliform analysis, which was conducted by the IEPA laboratory. The laboratories followed their internal QA procedures and any additional QA procedures specific to the analytical methods. All laboratory internal QC checks were conducted in accordance with the laboratories' QA manuals and SOPs and in accordance with the requirements of the QAPP.

During the sampling period, 160 samples were submitted for laboratory analysis, plus QC/quality assurance (QA) samples. A total of 168 water samples collected from rivers and streams were submitted for TKN, $NO_2$ + $NO_3$, TP, TDP, chlorophyll-*a*, and BOD5 analysis. In addition, 126 samples collected from Walnut Point Lake were submitted for TKN, $NO_2$ + $NO_3$, TP, TDP, and chlorophyll-*a* analysis. Seven water samples were collected from the tributary to Walnut Point Lake and submitted for TP and TDP analysis, and fourteen sediment samples collected from Walnut Point Lake were submitted for TP and total organic carbon (TOC) analysis. Seven duplicate samples and seven matrix spike duplicates were submitted for TKN, $NO_2$ + $NO_3$, TP, TDP, chlorophyll-*a*, and BOD5 analysis. The following methods were used by the laboratory to conduct these analyses:

- TKN – Method E 351.3; A 4500NorgC
- $NO_2$ + $NO_3$ – Method E 353.2; A 4500NO3F
- TP – Method E 365.2; A 4500PE
- TDP (ortho) – Method E 365.2; A 4500PE
- Chlorophyll-*a* – Method 10200H
- BOD5 – Method E 405.1; A 5210B
- TP (sediment) – A 4500PB4E; E 365.2M
- TOC – TOC analysis
- TSS – EPA Method 160.2
- $NH_3$ –EPA Method 350.2

In addition, fecal coliform was added to the laboratory analysis for samples collected from BPJ-08 so that the results at BPJ-08 and BPJA-03 can be used to characterize the fecal coliform concentration in the upstream of segment BPJ-03.

## 2.5 DATA SUMMARY

Tetra Tech received the data report from STL in both electronic and hard-copy formats. The data were checked for quality and accuracy and then formatted in an Excel spreadsheet for reporting. Appendix D presents the Excel spreadsheet of water quality data results for the Stage 2 sampling. The spreadsheet includes a total of 3,263 data points for various water quality parameters, including both field measurements and laboratory results.

## 2.6 PROBLEMS

During the shipment of samples collected on October 31, 2005, for chlorophyll-*a* analysis from STL in University Park, Illinois, to Pensacola, Florida, three water samples (RBK-1-Bottom, RBK-3-Bottom, and BPJC-08) were damaged and could not be analyzed by the laboratory.

In addition, the samples from RBK-1 collected from a 26-foot depth on October 31, 2005, and RBK-2 collected from an 11-foot depth on October 7, 2005, contained higher TDP concentrations than TP concentrations. This situation is attributed to the detection error of the standard analysis approach. During Stage 3, these data points should not be used.

# 3.0 DATA ANALYSIS

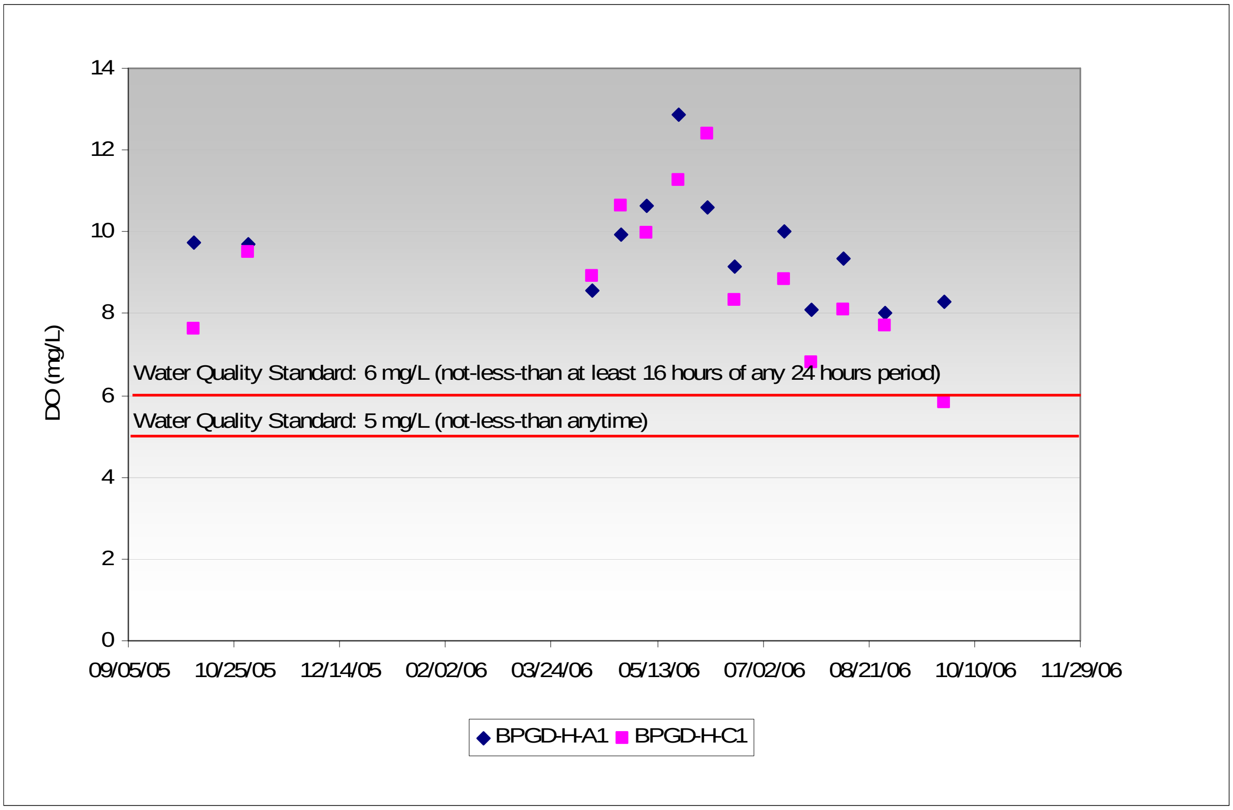
This section discusses the preliminary data analysis for each water body sampled, with a focus on the listed impairments.

## 3.1 HOOPESTON BRANCH IN NORTH FORK VERMILION RIVER

Sampling sites BPGD-H-A1 and BPGD-H-C1 are located on the Hoopeston Branch of North Fork Vermilion River. BPGD-H-A1 is located upstream of the confluence of the Hoopeston Sewage Treatment Plant (STP) outfall ditch with the stream, and BPGD-H-C1 is located downstream from this confluence. BOD and DO data collected from these two locations were analyzed. A detection limit of 2 milligrams per liter (mg/L) was used for data points when the BOD concentration was below the detect limit.

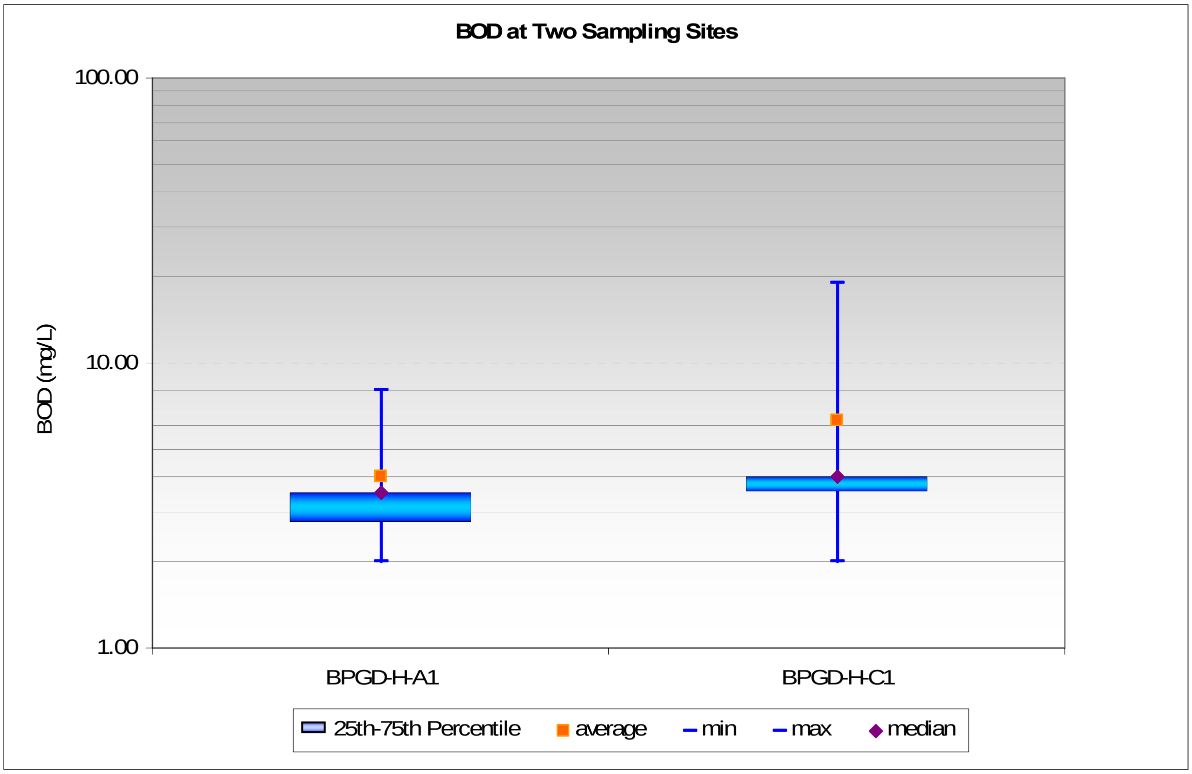
Figure 5 compares the DO measurements at the two sites during the sampling period. All data points met the DO standard of not-less-than 5.0 mg/L at any time. It is evident that BPGD-H-A1 contained higher average DO concentrations than BPGD-H-C1.

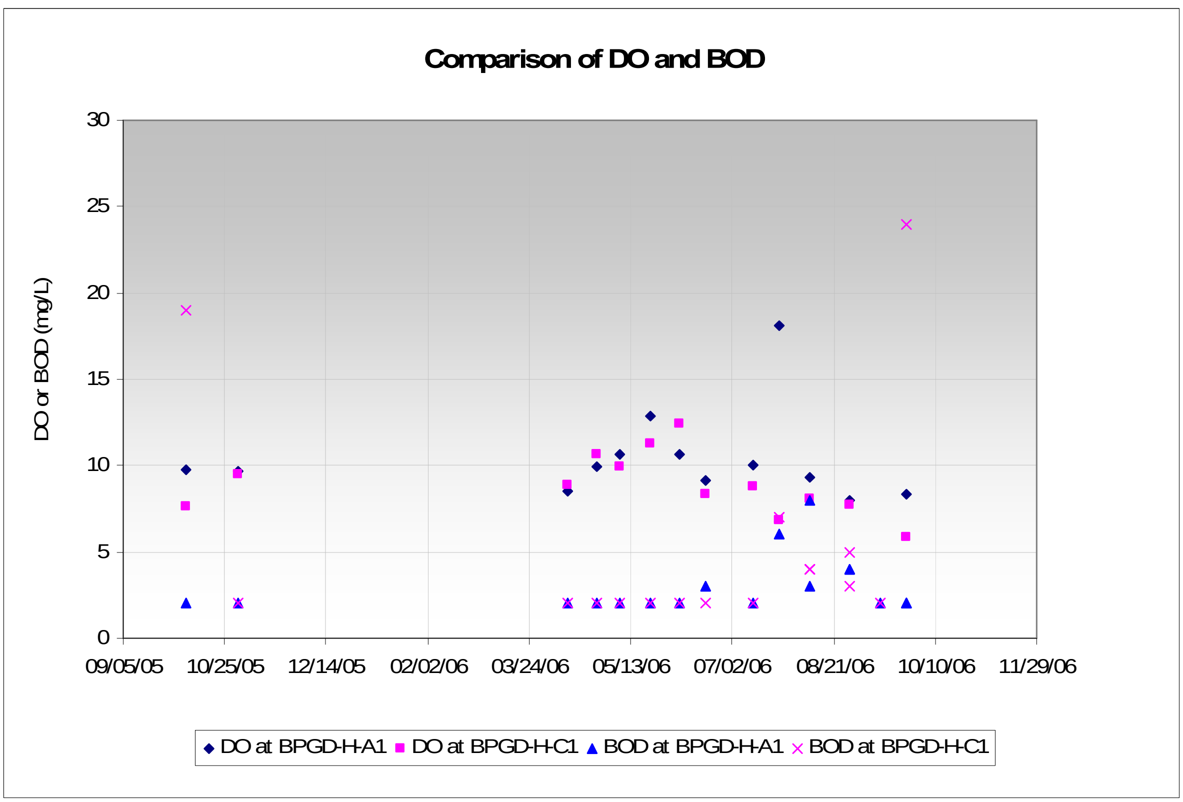
**FIGURE 5**
**DO CONCENTRATIONS IN HOOPESTON BRANCH**




A total of 15 BOD data points (data points below the detective limit were removed) were analyzed for the two sites in Hoopeston Branch. The measured BOD values ranged from 2 to 19 mg/L. For most of the sampling period, BOD concentrations were below 8 mg/L, with highest of 19 mg/L observed in October. In general, BOD concentrations in BPGD-H-C1 were relatively higher than those at BPGD-H-A1, a situation potentially attributable to effluent from the Hoopeston STP (see Figure 6). The comparison of BOD and DO data points in Figure 6 indicates a noticeable correlation between BOD and DO data. Increased BOD concentrations decrease DO concentrations in Hoopeston Branch as shown by the data points for August and September in Figure 6.

**FIGURE 6**
**BOD CONCENTRATIONS IN HOOPESTON BRANCH**

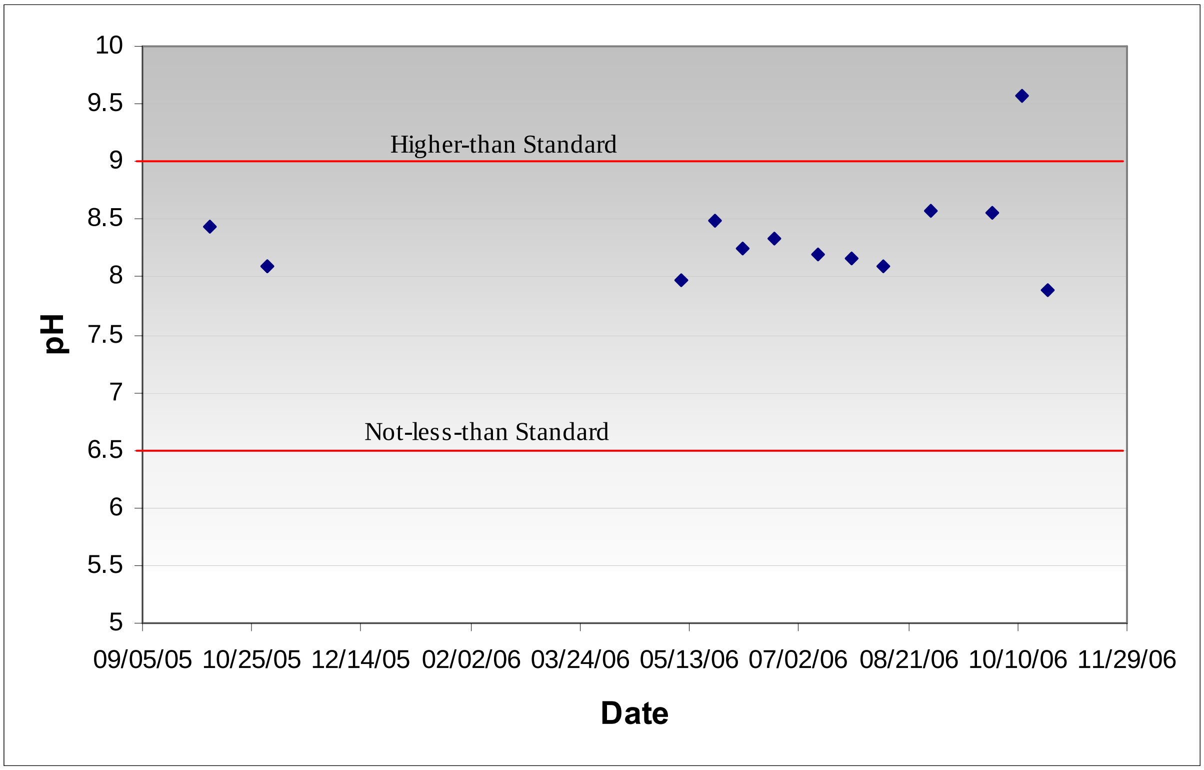


## 3.2 SALT FORK VERMILION RIVER

pH data were recorded at sampling site BPJ-08 between October 2005 and October 2006. A total of 14 measurements were taken at this sampling station and only 1 exceeded the pH water quality standard of 9 (see Figure 7). At BPJ-08, pH values ranged from 7.88 to 9.57, with an average value of 8.34. A pattern is not apparent over the period of time that measurements were taken.

**FIGURE 7**
**pH AT BPJ-08 IN SALT FORK VERMILLION RIVER**




pH data were also recorded at sampling sites BPJ-10 and BPJ-16 between May and October of 2006. A total of 11 measurements were taken at BPJ-10 and one of the measurements exceeded the pH water quality standard of 9 (see Figure 8). At BPJ-10, pH values ranged from 7.85 to 9.90, with an average value of 8.40. A total of 10 measurements were taken at BPJ-16 and one value barely exceeded the pH water quality standard of 9 (see Figure 9). At BPJ-16, pH values ranged from 7.53 to 9.05, with an average value of 8.30.

**FIGURE 8**
**pH AT BPJ-10 IN SALT FORK VERMILLION RIVER**

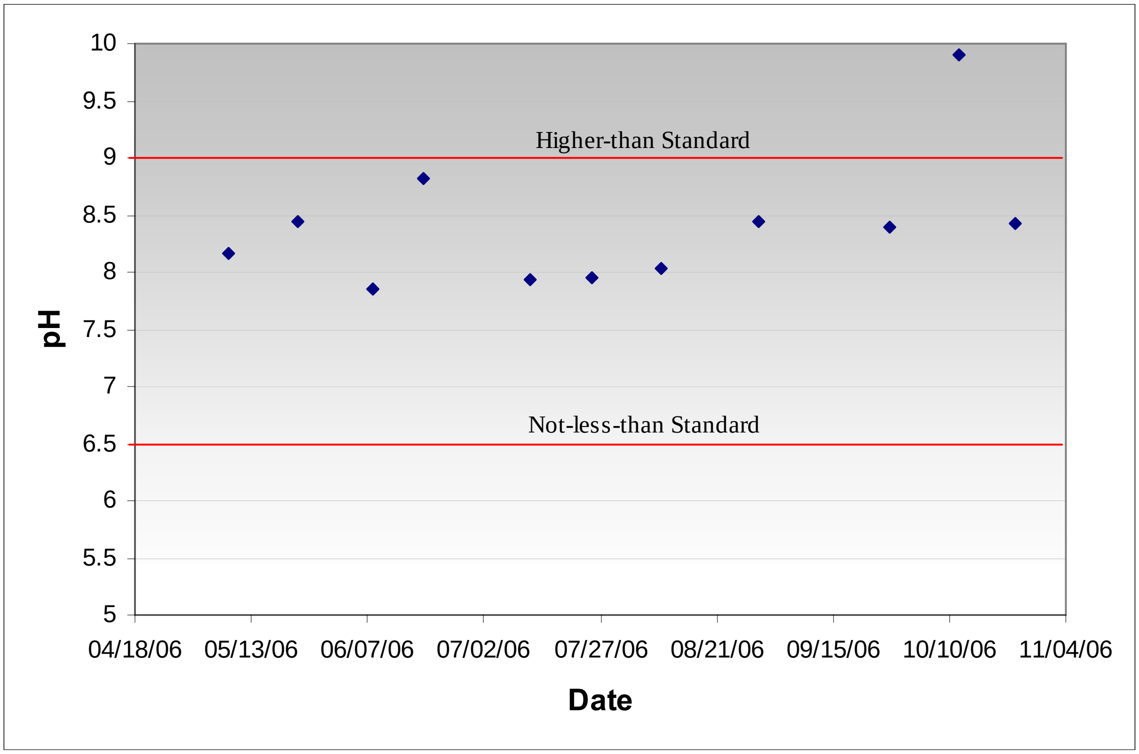
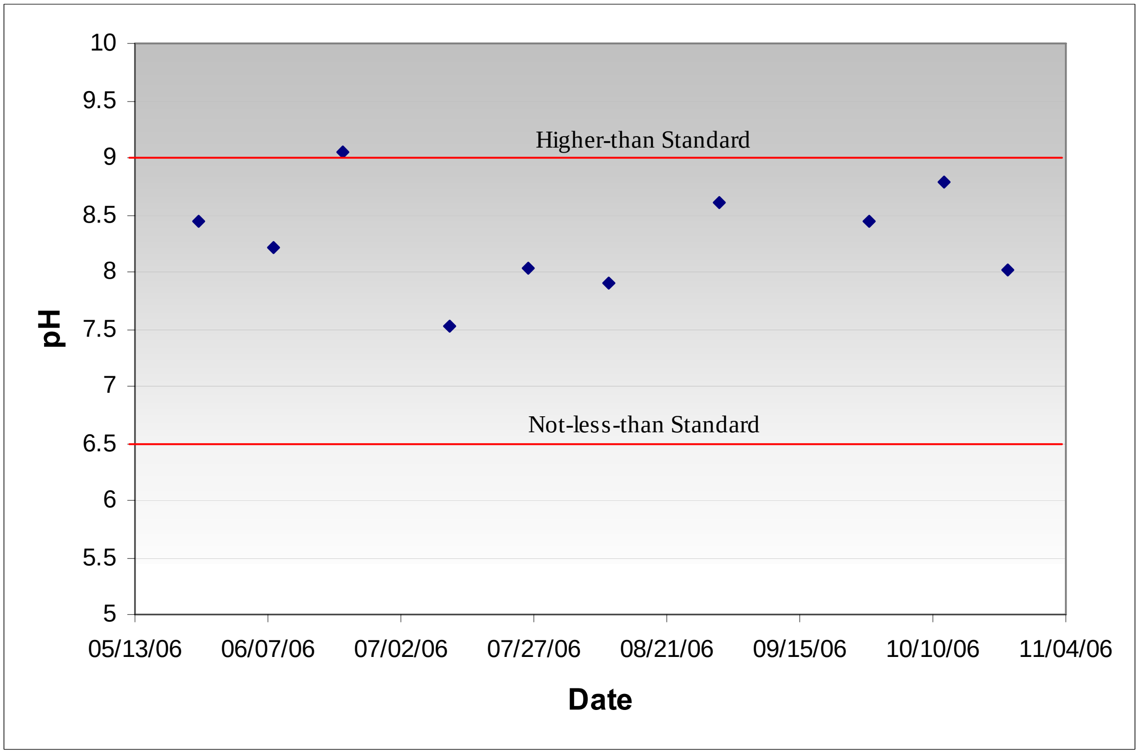
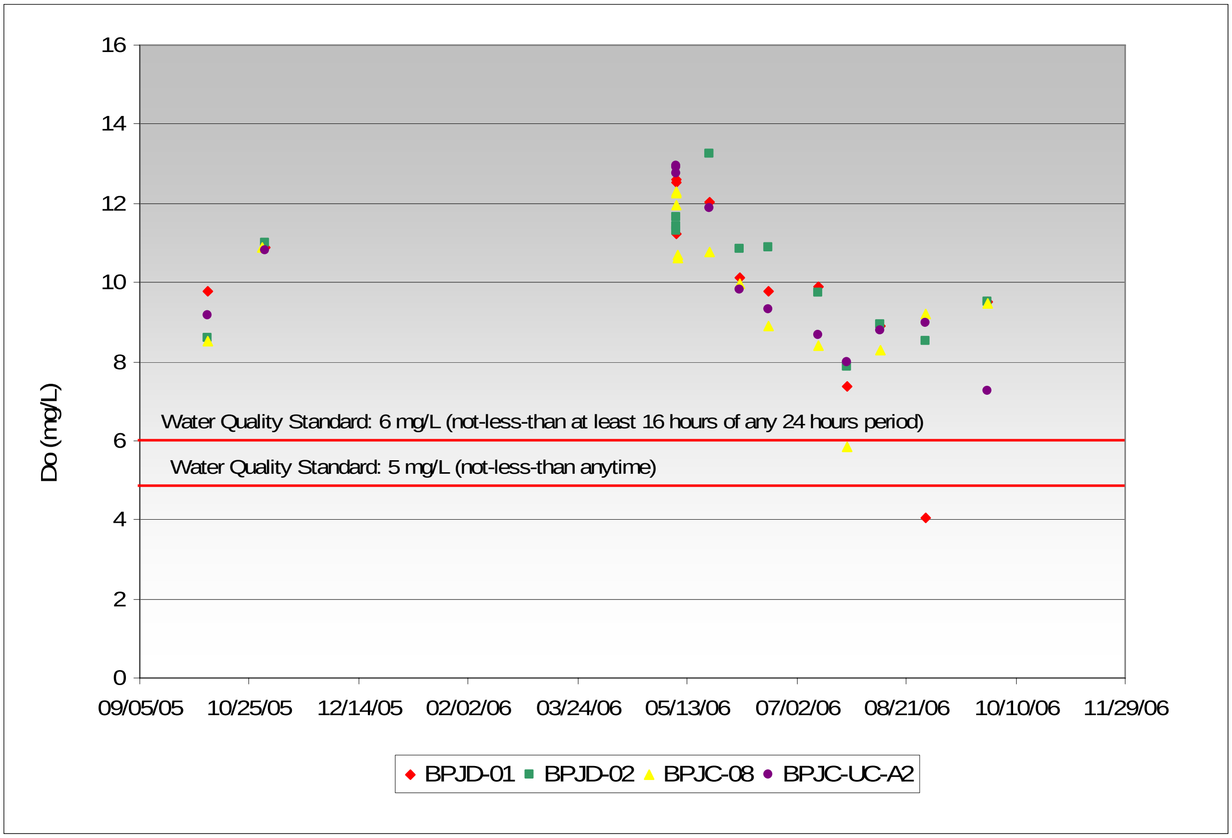



**FIGURE 9**
**pH AT BPJ-16 IN SALT FORK VERMILLION RIVER**



DO data from BPJD-01, BPJD-02, BPJC-08, and BPJC-UC-A2 were analyzed. A total of 54 DO measurements were taken, and only one collected from BPJD-01 fell below the water quality standard of 6 mg/L (see Figure 10). DO measurements at all four sites were similar, with averages ranging from 9.87 to 10.27 mg/L. DO levels are higher in the spring and decrease as the year progresses.

**FIGURE 10**
**DO CONCENTRATIONS AT SEGMENTS BPJC-08 AND BPJD-02**
**IN SALT FORK VERMILLION RIVER**




Fecal coliform data were collected between May and October 2006 from BPJ-03, BPJ-08, and BPJA-03. A total of 36 measurements were taken, and 19 exceeded the water quality standard of 200 colony-forming units per 100 milliliters (cfu/100 mL) (see Figure 11). The geometric mean of fecal coliform concentrations exceeded the water quality standard at all three sites. The fecal coliform concentrations at the upstream side of segment BPJ-03 (as shown by combining BPJ-08 and BPJA-03 data) are similar to those at the downstream end (as shown by BPJ-03 data). The elevated fecal coliform concentrations mostly occurred in July and August (see Figure 12).

**FIGURE 11**
**FECAL COLIFORM CONCENTRATIONS AT BPJ-03, BPJ-08, AND BPJA-03**
**IN SALT FORK VERMILLION RIVER**

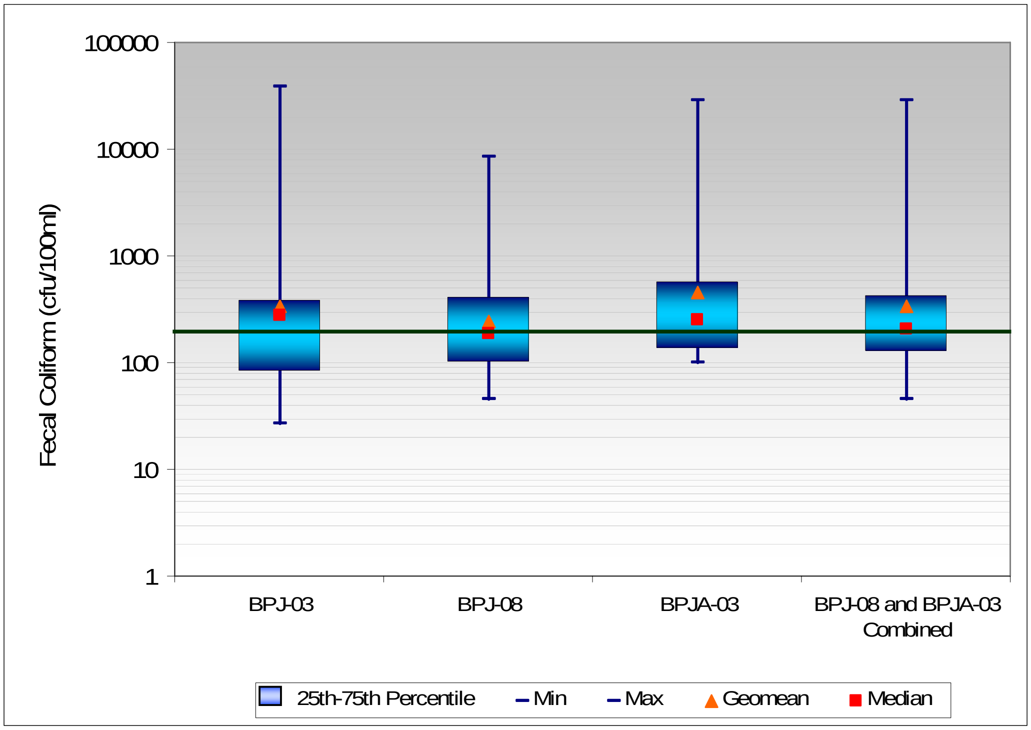
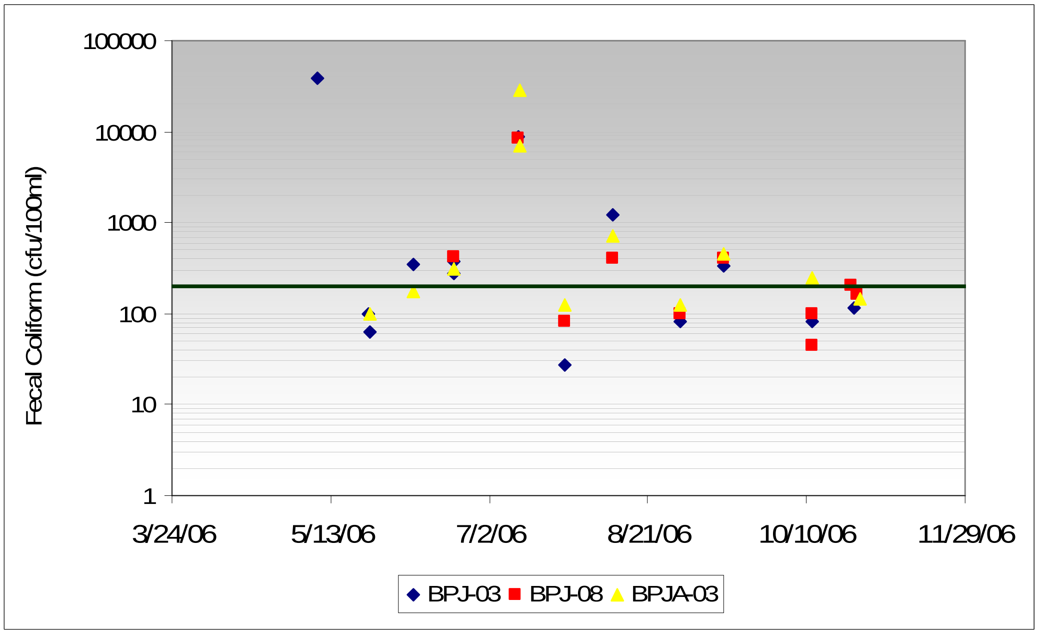



**FIGURE 12**
**MONTHLY VARIATIONS IN FECAL COLIFORM CONCENTRATIONS**
**AT BPJ-03, BPJ-08, AND BPJA-03**
**IN SALT FORK VERMILLION RIVER**



## 3.3 SUGAR CREEK

The bi-weekly DO data collected from Sugar Creek during the sampling period never violated the IEPA DO standard of not less than 5 mg/L at any time. A total of 15 measurements were taken that ranged from 7.48 to 12.92 mg/L (see Figure 13). DO concentrations were highest in May and gradually decreased with time after May. The IEPA surface water section independently conducted continuous DO sampling every 30 minutes in July and September 2006, and data indicate that DO concentrations violated the standard of no less than 5 mg/L DO at any time (see Figure 14). In addition, the DO concentrations violated the standard of not less than 6 mg/L for at least 16 hours out of a 24-hour period.

**FIGURE 13**
**DO CONCENTRATIONS IN SUGAR CREEK**

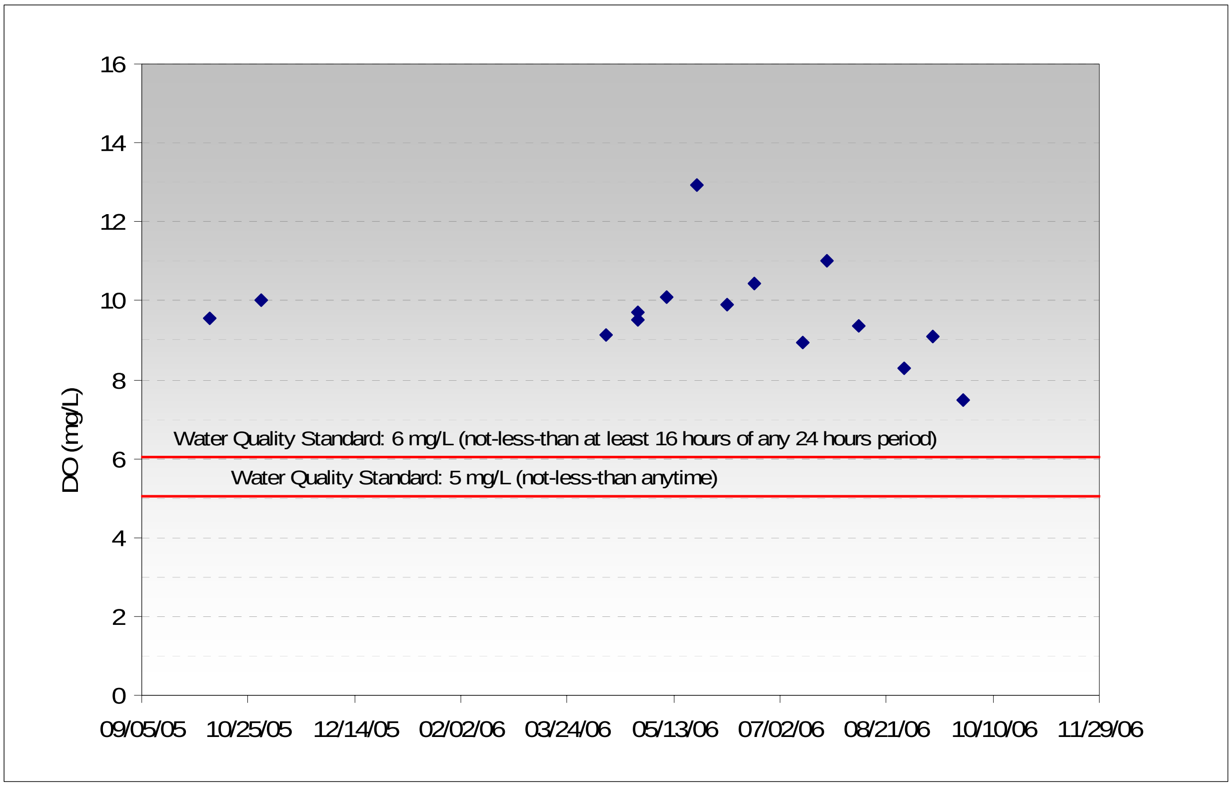
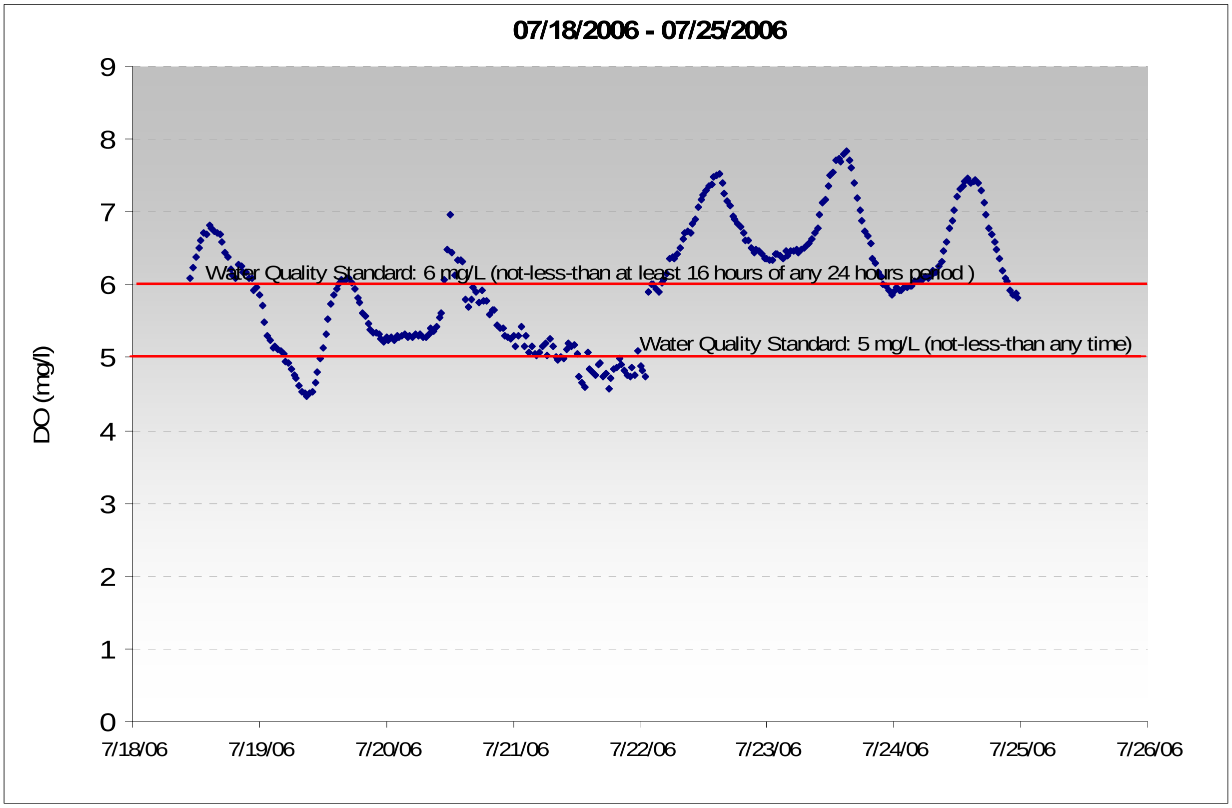
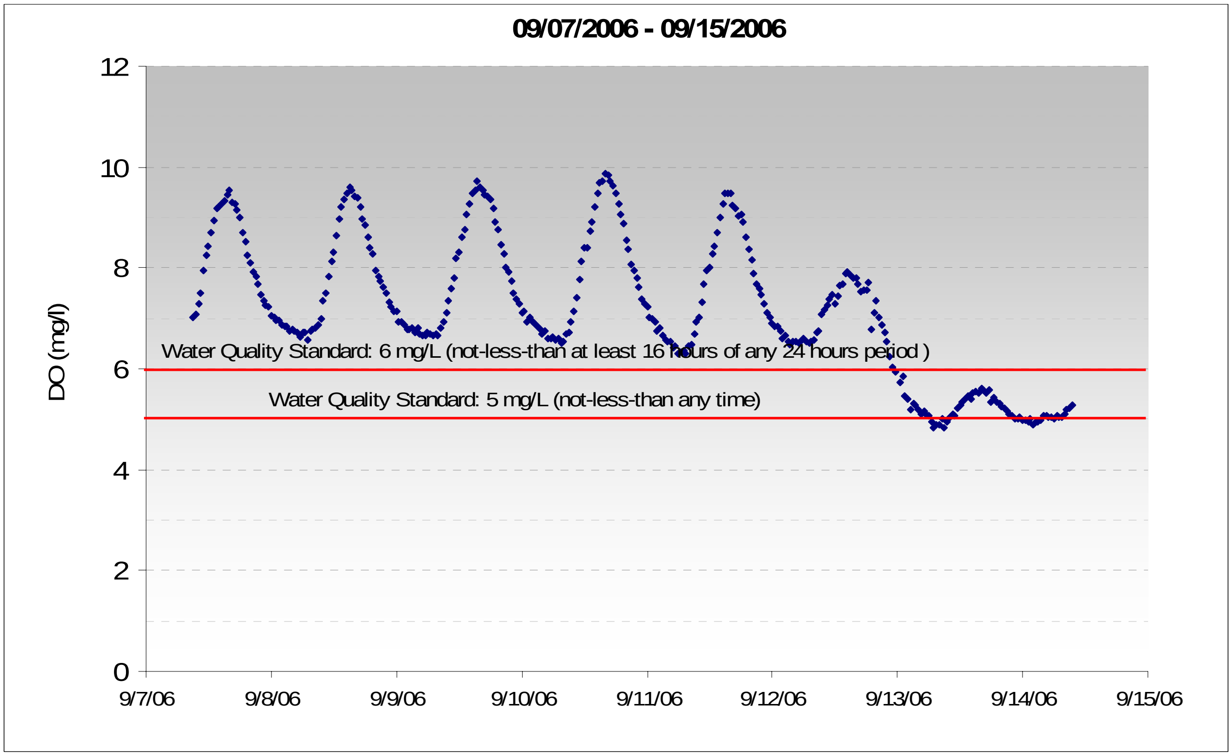


**FIGURE 14**
**CONTINUOUS DO CONCENTRATIONS IN SUGAR CREEK**
**(Collected by IEPA)**



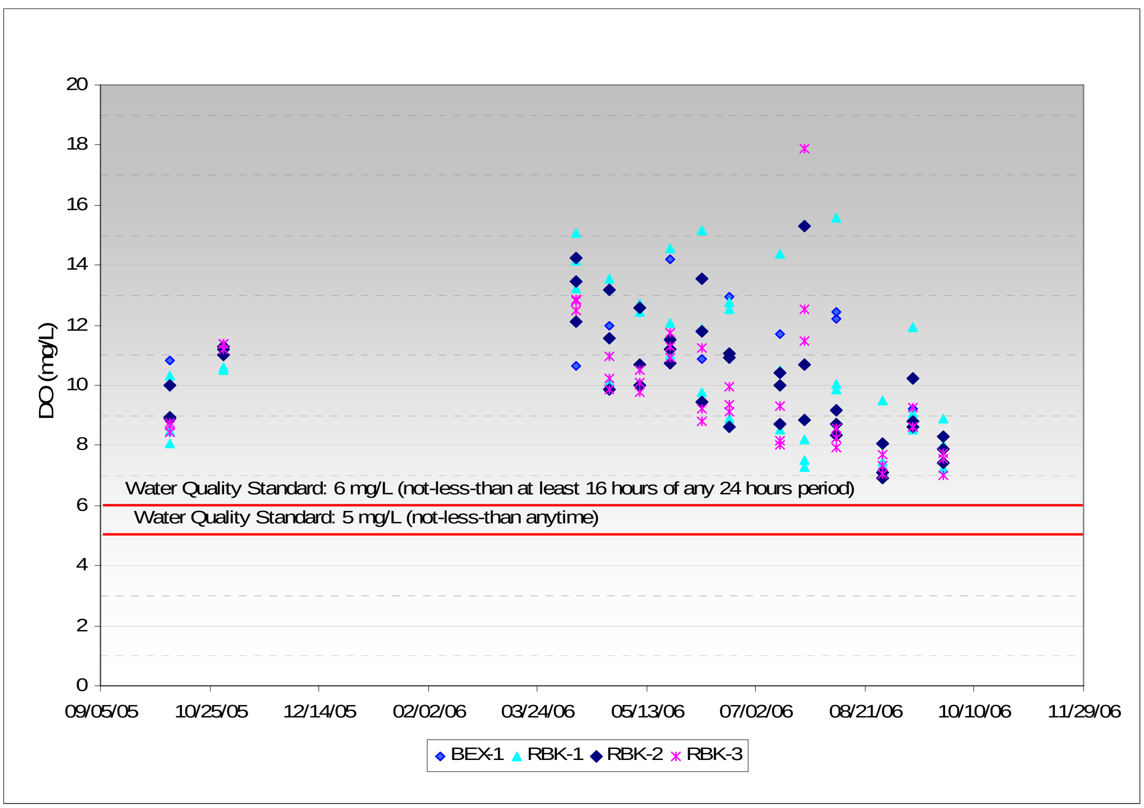
## 3.4 WALNUT POINT LAKE

Walnut Point Lake has four sampling sites: BEX-1, RBK-1, RBK-2, and RBK-3. BEX-1 is located at the inflow point from a tributary to the north end of the lake. The flow path starts from BEX-1 to RBK-3, RBK-2, and finally RBK-1 which is located near the dam at the southern end of the lake. DO, TP, $NO_2$ + $NO_3$, and chlorophyll-*a* measurements were analyzed to characterize the water quality in the lake as discussed below.

### DO

A total of 96 DO data points were collected from BEX-1, RBK-1, RBK-2, and RBK-3 during the sampling period. The average and minimum DO concentrations at all four locations exceeded the water quality standard of not less than 6.0 mg/L (see Figure 15). The average DO concentration at the tributary (12 mg/L) appears higher than concentrations in the lake. In general, DO concentrations are stable in the lake and gradually decrease in August and September. DO concentrations are measured 1 foot below the water surface, 2 feet above the lake bottom, and at a middle point. Figure 15 shows data from all three depths.

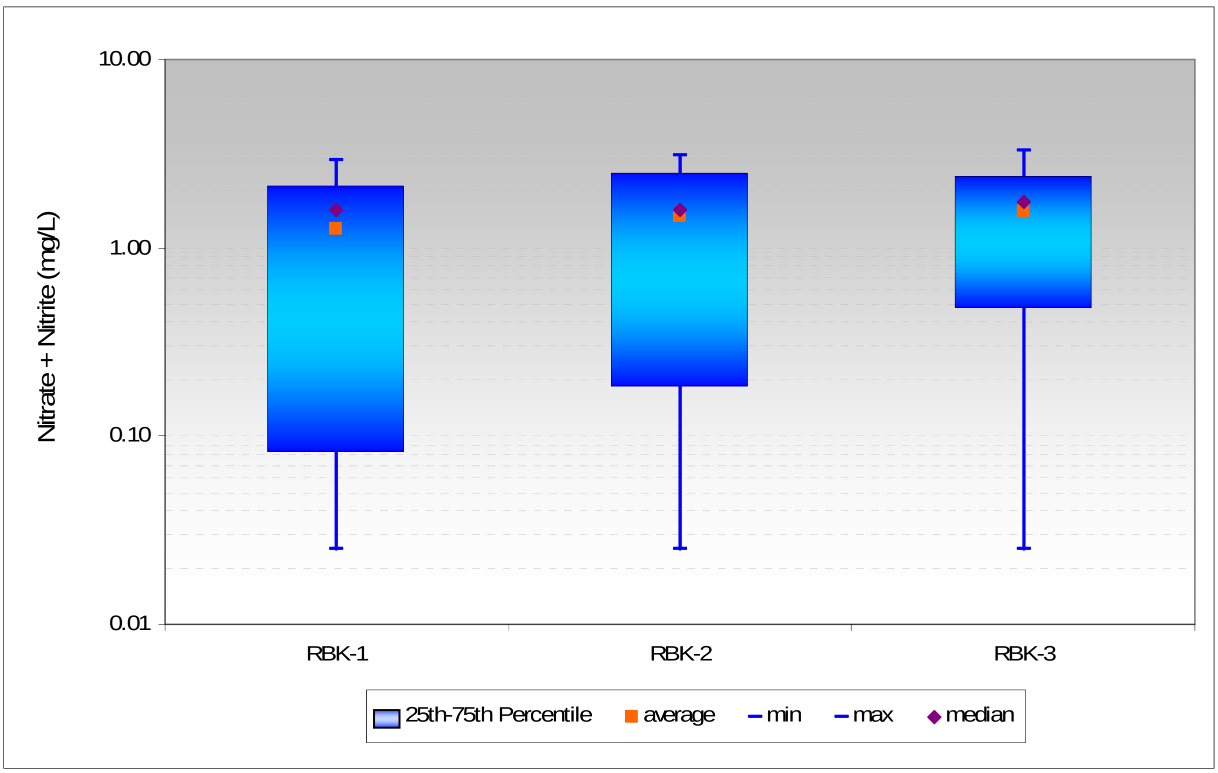
**FIGURE 15**
**DO CONCENTRATIONS IN WALNUT POINT LAKE**



**$NO_2$ + $NO_3$**

A total of 70 $NO_2$ + $NO_3$ data points were collected from RBK-1, RBK-2, and RBK-3 during the sampling period. Concentrations at all three locations are below the IEPA water quality standard of 10 mg/L (see Figure 16). The data range from a minimum concentration of 0.03 mg/L to a maximum concentration of 3.30 mg/L at RBK-3. The average total nitrogen concentration is highest at RBK-3 and lowest at RBK-1. A high range of the 25$^{th}$ to 75$^{th}$ quartile at RBK-1 indicates a diverse range of total nitrogen values.

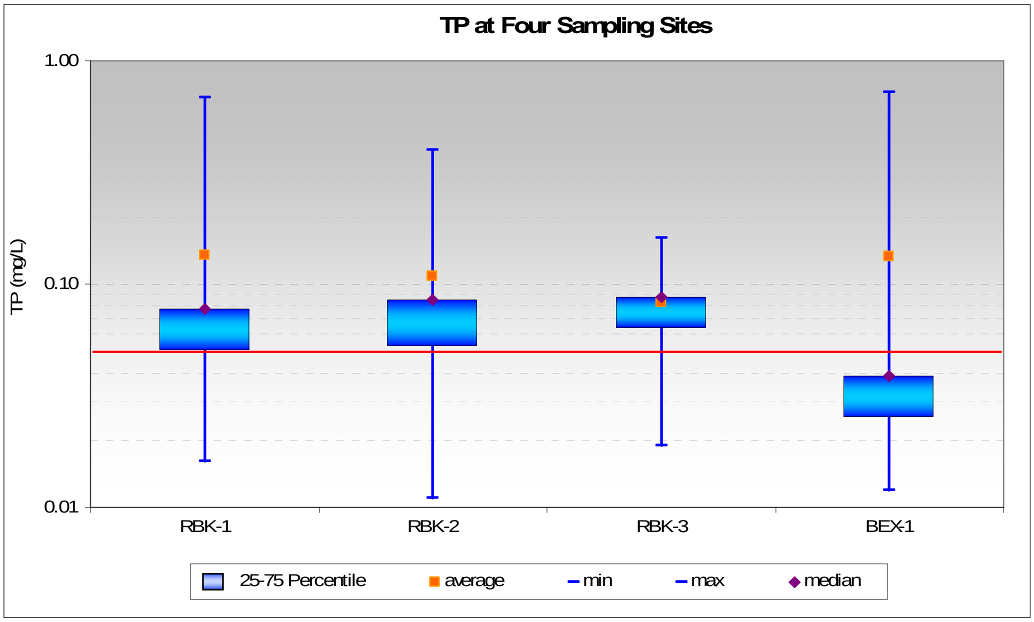
**FIGURE 16**
**$NO_2$ + $NO_3$ CONCENTRATIONS IN WALNUT POINT LAKE**




**TP**

A total of 139 TP data points were collected from all four location Walnut Point Lake sites (RBK-1, RBK-2, RBK-3, and BEX-1). TP values ranged from 0.01 to 0.72 mg/L (see Figure 17). The average TP concentrations at all sites exceeded the IEPA water quality standard of 0.05 mg/L. High concentrations were detected at BEX-1 and RBK-1. Out of the 139 total data points, 106 (76 percent) violated the standard. These low values were mostly seen from April through July. The 25$^{th}$ to 75$^{th}$ quartile of TP concentrations at BEX-1 is below the average concentration, indicating that most values are below the water quality standard. TP concentrations are measured at 1 foot below the water surface, 2 feet above the lake bottom, and at a middle point. The second graph in Figure 17 indicates lower average concentrations at the surface and gradually increasing concentrations with an increase in depth. High concentrations at the bottom indicate historic TP accumulation at RBK-1.

**FIGURE 17**
**TP CONCENTRATIONS IN WALNUT POINT LAKE**



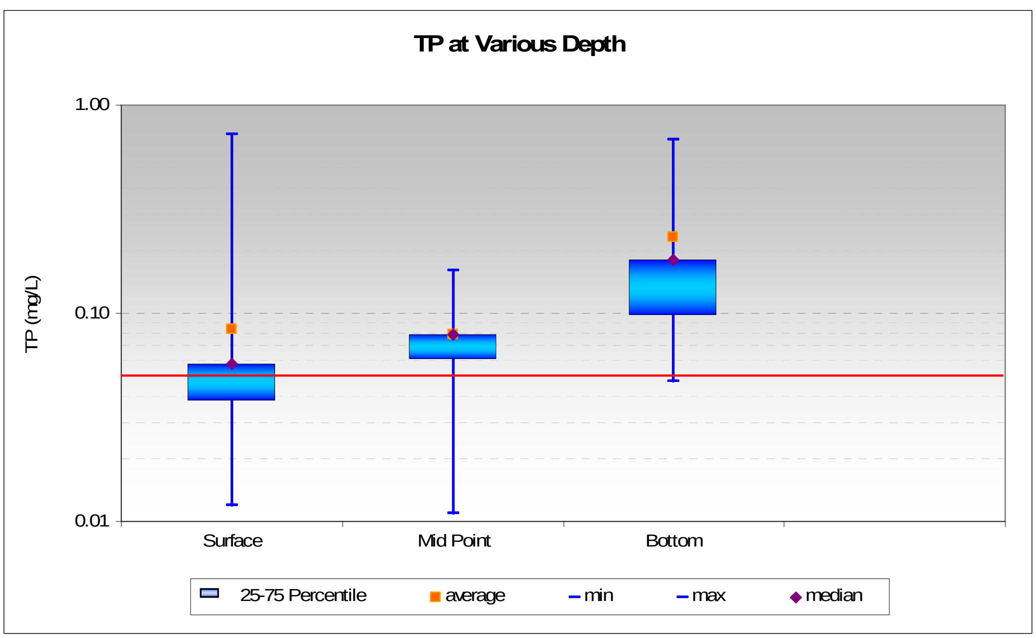
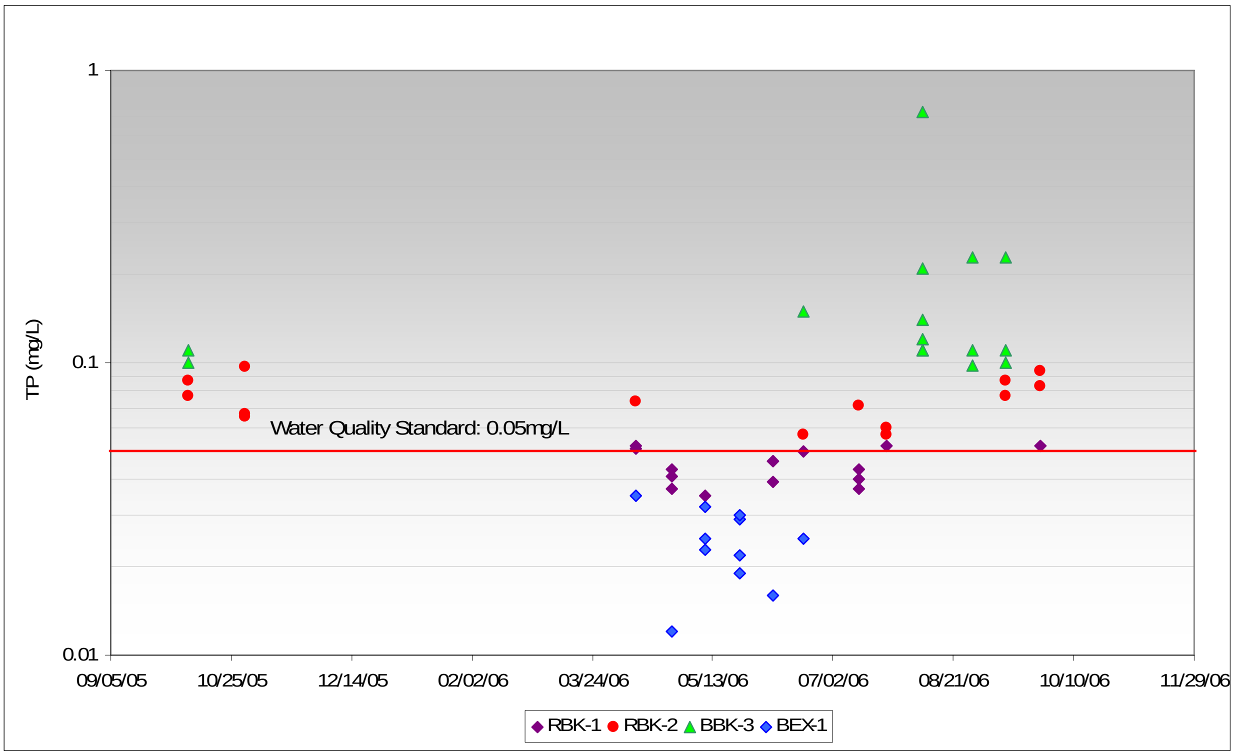



Figure 18 presents the TP data points for 1 foot below the water surface in Walnut Point Lake at all four sampling sites. Out of the 55 data points, 34 violated the 0.05-mg/L standard. The highest TP concentrations occurred in August and September.

**FIGURE 18**
**SCATTER PLOT OF TP CONCENTRATIONS WITHIN 1 FOOT OF WATER SURFACE IN WALNUT POINT LAKE**




## Chlorophyll-*a*

A total of 111 chlorophyll-*a* measurements were taken at RBK-1, RBK-2, and RBK-3. The minimum concentration of 0.53 milligrams per cubic meter (mg/m$^3$) was detected at RBK-1, and the maximum concentration of 170 mg/m$^3$ was detected at RBK-3 (see Figure 19). The average concentration ranges from 21.27 to 29.74 mg/m$^3$. The chlorophyll-*a* concentration at RBK-3 varied from 0.8 to 170 mg/m$^3$. Higher chlorophyll-*a* concentrations were detected at the surface and gradually decreased with depth. The elevated chlorophyll-*a* concentrations are apparently closely related to high TP concentrations (see Figure 20).

**FIGURE 19**
**CHLOROPHYLL-*a* CONCENTRATIONS IN WALNUT POINT LAKE**

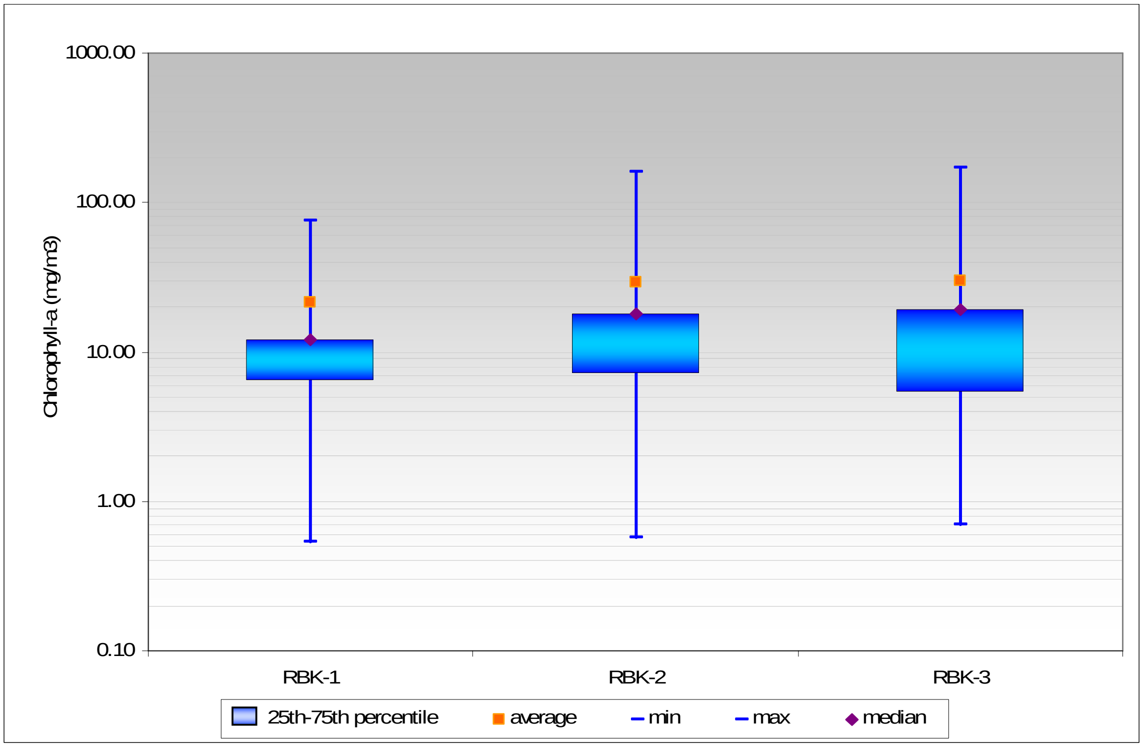
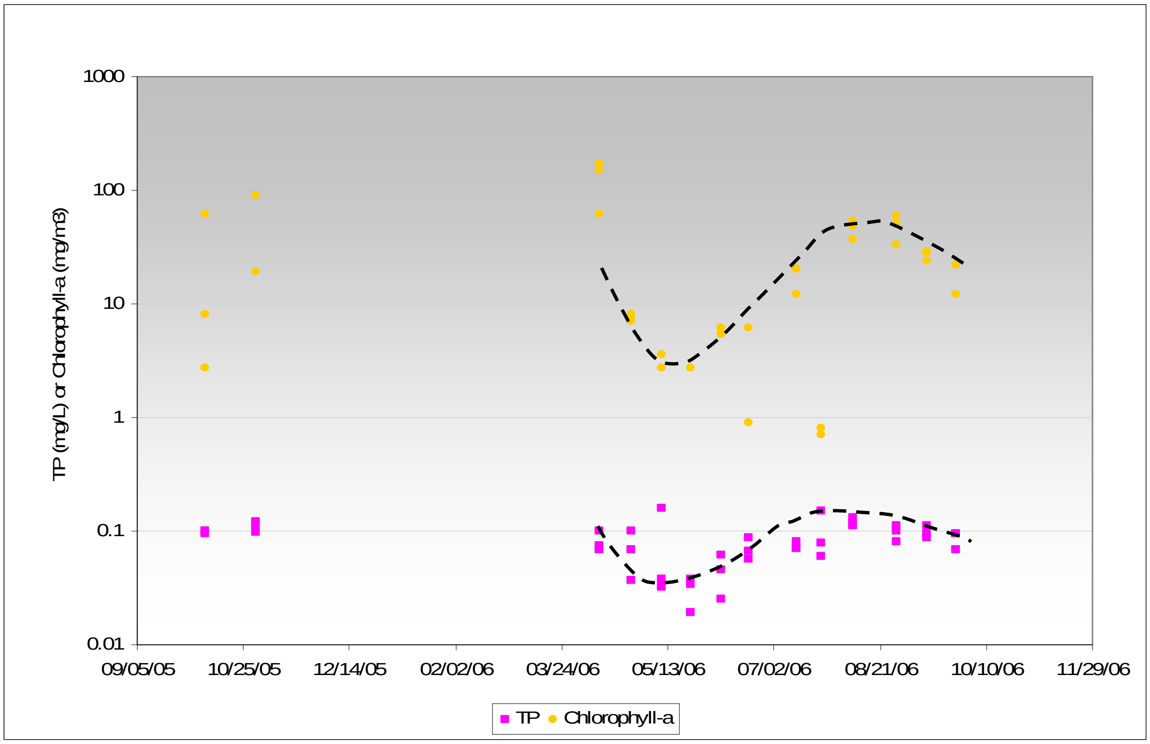



**FIGURE 20**
**TP AND CHLOROPHYLL-*a* CONCENTRATIONS AT RBK-3**
**IN WALNUT POINT LAKE**



# 4.0 RECOMMENDATIONS

Based on the data analysis, the recommendations below should be considered.

## NORTH FORK VERMILLION RIVER WATERSHED

- Segment BPGD (Hoopeston Branch): Previously, the BPGD segment was assessed based on 2002 facility-related stream survey (FRSS) data, when a DO concentration of 4.7 mg/L was recorded, which violated the standard of not less than 5 mg/L at any time. This standard was never violated based on Stage 2 sampling data. It is recommended that DO be delisted from 2006 303(d) list.

## SALT FORK VERMILION RIVER WATERSHED

- Segment BPJ10 (Salt Fork Vermilion River): It is recommended that the segment be listed for pH impairment because two violations of the pH water quality standard of no more than 9 were recorded during the sampling period. These violations occurred on October 12, 2006 with a pH value of 9.90 and June 21, 2006 with a pH value of 9.05. In addition, BPJ10 should also be listed for nitrate impairment because eight violations were recorded during the sampling period.

- Segment BPJ08 (Salt Fork Vermilion River): It is recommended that the segment be listed for pH impairment because one violation of the pH water quality standard of no more than 9 was recorded during the sampling period. The violation occurred on October 12, 2006 with a pH value of 9.57. It is also recommended that BPJ08 be listed for nitrates because three violations were recorded during the sampling period. In addition, BPJ08 should also be listed for fecal coliform impairment.

- Segment BPJ03 (Salt Fork Vermilion River and Jordan Creek): It is recommended that the segment be listed for fecal coliform impairment because 6 violations on Jordan Creek and 7 violations on Salt Fork Vermilion River of fecal coliform water quality standard of 200 colony-forming units per 100 milliliters (cfu/100 mL) were recorded during the sampling period.

- Segment BPJC08 (Saline Brach): The DO standard of not less than 5 mg/L at any time was not violated based on Stage 2 sampling data. It is recommended that the segment be delisted for DO impairment.

- Segment BPJD02 (Spoon Branch): One DO data point, 4.04 mg/L on August 30, 2006, was below the IEPA standard of no less than 5 mg/L at any time. It is recommended that a DO TMDL be developed for the segment.

**SUGAR CREEK WATERSHED**

- Segment BMC2: Based on DO data that violated the IEPA standard of no less than 5 mg/L at any time, it is recommended that a DO TMDL be developed for the segment.

**WALNUT POINT LAKE WATERSHED**

- Segment RBK: It is recommended that Walnut Point Lake be delisted for low DO impairment because no violation of applicable water quality standard was recorded during the sampling period; however, a TP TMDL should be developed for the segment. The Walnut Point Lake is not designated for the use of public and food processing water supply. The nitrate standard is not applicable to the segment.

Table 2 summarizes the number of water quality violations for each segment based on Stage 2 results compared to Stage 1 findings. The final decision on Stage 3 will be made through consultation with IEPA.

**TABLE 2**
**SUMMARY OF IMPAIRED SEGMENTS, PARAMETERS, AND NUMBER OF VIOLATIONS**

| Segment ID | Segment Name | Station ID | Parameters | No. of Violations/No. of Data Points Based on Stage 1 Report | Date of Last Violation | No. of Violations/No. of Data Points Based on Stage 2 Data Collection | Recommendation |
|---|---|---|---|---|---|---|---|
| BPGD | Hoopeston Branch | BPGD-H-A1 | DO[a] | 1/1 (FRSS data) | 9/23/2002 | 0/13 | Delisting |
| | | BPGD-H-C1 | | 1/3 (FRSS data) | No Violation | 0/13 | |
| BPJ10 | Salt Fork Vermilion River | BPJ-10 | pH | 0/16 | 10/12/2006 | 1/11 | TMDL development |
| | | | $NO_2$[b] | 0/4 | 6/19/2006 | 4/11 | TMDL development |
| | | BPJ-16 | pH | No Data | 6/21/2006 | 1/10 | TMDL development |
| | | | $NO_2$[b] | | 6/21/2006 | 4/13 | TMDL development |
| BPJ08 | Salt Fork Vermilion River | BPJ-08 | pH | 2/7 | 10/12/2006 | 1/14 | TMDL development |
| | | | $NO_2$[b] | 0/6 | 6/21/2006 | 3/15 | TMDL development |
| BPJ03 | Jordan Creek | BPJA-03 | Fecal Coliform | No Data | 10/12/2006 | 6/11 | TMDL development |
| | Salt Fork Vermilion River | BPJ-03 | | | 9/14/2006 | 7/13 | |
| BPJC08 | Saline Branch | BPJC-08 | DO[a] | 3/23 (including FRSS data) | 8/13/2001 | 0/12 | Delisting |
| | | BPJC-UC-A2 | | | | 0/11 | |
| BPJD02 | Spoon Branch | BPJD-01 | DO[a] | 1/6 | 8/30/2006 | 1/11 | TMDL development |
| | | BPJD-02 | | | No Violation | 0/11 | |

**TABLE 2 (Continued)**
**SUMMARY OF IMPAIRED SEGMENTS, PARAMETERS, NUMBER OF VIOLATIONS**

| Segment ID | Segment Name | Station ID | Parameters | No. of Violations/No. of Data Points Based on Stage 1 Report | Date of Last Violation | No. of Violations/No. of Data Points Based on Stage 2 Data Collection | Recommendation |
|---|---|---|---|---|---|---|---|
| BMC2 | Sugar Creek | BMC-2 | DO[a] | 1/224 (including FRSS data) | 9/14/2006 | 53/687[c] | TMDL development |
| RBK | Walnut Point Lake | BEX-1 | TP[d] | No data | 9/12/2006 | 4/11 | TMDL development |
| | | | DO[a] | | No Violation | 0/11 | Delisting |
| | | RBK-1 | TP[d] | 19/25 | 9/26/2006 | 7/14 | TMDL development |
| | | | $NO_2$[b, d] | 0/20 | No Violation | 0/14 | Delisting |
| | | | DO[a] | 59/107 | 10/13/1987 | 0/14 | Delisting |
| | | RBK-2 | TP[d] | 11/15 | 9/26/2006 | 9/14 | TMDL development |
| | | | $NO_2$[b, d] | 0/15 | No Violation | 0/14 | Delisting |
| | | | DO[a] | 49/101 | 10/4/1995 | 0/14 | Delisting |
| | | RBK-3 | TP[d] | 11/15 | 9/26/2006 | 10/14 | TMDL development |
| | | | $NO_2$[b, d] | 0/15 | No Violation | 0/14 | Delisting |
| | | | DO[a] | 30/80 | No Violation | 0/14 | Delisting |

Notes:
DO Dissolved oxygen
FRSS 2002 Facility-related stream survey
ID Identification
$NO_2$ Nitrate
$NO_3$ Nitrite
TMDL Total maximum daily load
TP Total phosphorus

a Based on DO standard of not-less-than 5 mg/L at any time; only data points within 1-foot of water surface considered
b $NO_2 + NO_3$ data used as surrogate
c Continuous samples collected taken at 30-minute intervals
d Data points within 1 foot of water surface

STAGE 2 APPENDICES AVAILABLE UPON REQUEST
CONTACT Illinois EPA at 217-782-3362

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# Attachment 3
# Stage Three Report
# CDM, 2008

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CDM

Illinois Environmental Protection Agency

**Sugar Creek Watershed**
**Total Maximum Daily Load**
**Stage 3 Report**

May 2008

*Final Report*

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# Contents

## Section 3 Implementation Plan for the Sugar Creek Watershed



## Section 4 References

## Appendices

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# Section 1
# Model Development

## 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 lists water bodies not meeting water quality standards every two years. This list is called the 303(d) list and water bodies on the list are then targeted for TMDL development.

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

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

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

Water quality standards consist of three elements:

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

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

## 1.2 TMDL Goals and Objectives for 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 Stage 3 TMDL development for impairments caused by dissolved oxygen (DO) and fecal coliform in the Sugar Creek watershed (Figure 1-1). Stage 1 of the TMDL (Attachment 1, Tetra Tech 2005) was completed in 2005 and included the Paris Twin Lakes. At the time of Stage 1 report preparation, adequate data did not exist to properly analyze conditions on Sugar Creek. Tetra Tech and Illinois EPA collected additional data during 2005 and 2006 to further characterize Sugar Creek (Attachment 2, Tetra Tech 2007). Table 1-1 contains information on the impaired segments, associated uses and parameters of concern for which TMDLs were developed under this Stage 3 report.

**Table 1-1: Impaired Segments and Uses Addressed by Stage 3 TMDLs**

| Segment Name | Segment ID | Impaired Use | Cause of Impairment |
|---|---|---|---|
| Sugar Creek | BMC2 | Aquatic Life | Low Dissolved Oxygen |
| | BM02 | Primary Contact Recreation | Fecal Coliform |

Sugar Creek segment BM02 was listed as impaired for primary contact, based on fecal coliform, in the 1992 cycle report. However, in the 1994 and 1996 cycle reports, primary contact was removed as a use for that segment based on the disinfection exemption. The primary contact use was then added back in the 2000 cycle report and was listed as an impaired use on Sugar Creek for the 2000, -02 and -04 cycle 305(b) reports. Segment BM02 was not included in the 2006 integrated report, however, data collected in 2005 and 2006 show impairment where primary contact use may occur and therefore, a TMDL has been developed.

## 1.3 Historic Data

Historic data were reviewed during Stage 1 of TMDL development. Water quality data collected in Sugar Creek at Illinois EPA monitoring stations BM-1 and BM-2 are available from 1972 to 2002. Illinois EPA has historically monitored ambient stations every six weeks. Additionally, a Facility-Related Stream Survey (FRSS) was conducted in 1994 on Sugar Creek both upstream and downstream of the Paris-South sewage treatment plant (STP). The FRSS was a longitudinal survey comprised of six sampling locations, where each location was a specified distance from the Paris-South STP. Water quality constituents included sediment, nutrients, DO, and metals. A summary of the historic DO and fecal coliform water quality data is presented below.

### 1.3.1 Dissolved Oxygen

Dissolved oxygen shall not be less than 6.0 mg/l during at least 16 hours of any 24 hour period, nor less than 5.0 mg/l at any time (Title 35, Environmental Protection; Subtitle C, Water Pollution; Chapter I, Pollution Control Board; Part 302.206). Table 1-2 and 1-3 present the period of record, a statistical summary, and summary of violations (samples less than 5.0 mg/L) for all available DO data in Sugar Creek. It should be noted that data from downstream of the listed segment are included in these tables and figures for reference purposes because so few data are available for the impaired segment.

A review of the data revealed that only one violation of the DO standard occurred in Sugar Creek over the period of record. This single sample occurred during the FRSS sampling in 1994 at a location approximately 75 yards upstream of the Paris-South STP. Biological monitoring also indicated degraded aquatic communities. Low flows might have contributed to the low DO concentration. The monitoring report states that "Negligible flow was observed upstream of the Paris-South facility…" and "…flow over the Paris Twin Lakes spillway was negligible and the Paris-North facility was not discharging during the survey." Modeling (further discussed in Section 2) determined that low flows are causing DO issues in the impaired segment. Because a pollutant was not found to be the cause of low DO, no TMDL was developed.

**Table 1-2 Historic Dissolved Oxygen Data for Sugar Creek**

| Parameter | Samples (Count) | Start | End | Minimum (mg/L) | Average (mg/L) | Maximum (mg/L) | CV* |
|---|---|---|---|---|---|---|---|
| Dissolved Oxygen | 218 | 3/9/1972 | 11/18/2002 | 5.23 | 10.85 | 17.20 | 0.23 |
| Dissolved Oxygen (FRSS Data) | 6 | 8/31/1994 | 8/31/1994 | 3.00 | 6.35 | 8.90 | 0.31 |

*CV = standard deviation/average

**Table 1-3 Historic Dissolved Oxygen Violations**

| Parameter | Samples (Count) | Violations (Count) | Percent Violating | Total Count 1998 to Present | Violations 1998 to present | Percent Violating, 1998 to Present |
|---|---|---|---|---|---|---|
| Dissolved Oxygen | 218 | 0 | 0% | 25 | 0 | 0% |
| Dissolved Oxygen (FRSS Data) | 6 | 1 | 17% | 0 | 0 | 0% |

### 1.3.2 Fecal Coliform

Table 1-4 presents a data summary of fecal coliform data collected in Sugar Creek. During the months May through October, based on a minimum of five samples taken over not more than a 30 day period, fecal coliform shall not exceed a geometric mean of 200 per 100 ml, nor shall more than 10% of the samples during any 30 day period exceed 400 per 100 ml in protected waters. (Title 35, Environmental Protection; Subtitle C, Water Pollution; Chapter I, Pollution Control Board; Part 302.209). For purposes of TMDL development, the general use standard of 200 cfu/100mL will be used, however, no more than two samples in any month have been collected historically by Illinois EPA, and most months have only one sample. A significant number of the individual fecal coliform samples exceed 200 colonies/100 mL. In addition, the geometric mean for all samples in most months exceeds the standard (Table 1-4).

**Table 1-4 Historic Fecal Coliform Data for Sugar Creek**

| Fecal Coliform | Samples (Count) | Start | End | Minimum (count/ 100mL) | Geometric Mean (count/ 100mL)[1] | Maximum (count/ 100mL) |
|---|---|---|---|---|---|---|
| All Data | 253 | 3/9/1972 | 6/21/04 | 0 | 325 | 180,000 |
| May | 27 | 5/3/1972 | 5/26/04 | 10 | 526 | 34,100 |
| June | 22 | 6/20/1972 | 6/20/04 | 10 | 528 | 6,600 |
| July | 20 | 7/13/1972 | 7/21/04 | 30 | 591 | 6,900 |
| August | 20 | 8/23/1973 | 8/26/02 | 0 | 306 | 7,000 |
| September | 25 | 9/20/1972 | 9/10/04 | 40 | 409 | 52,000 |
| October | 19 | 10/31/1972 | 10/15/03 | 10 | 228 | 11,600 |

1 The reported value reflects the geometric mean calculated from all fecal coliform samples collected within a given month.

## 1.4 Stage 2 Data

In order to support development of models for this Stage 3 TMDL analysis, Tetra Tech and Illinois EPA collected additional data during the summers of 2005 and 2006. Data from this effort are summarized in the following sections. Stage 2 data, coupled with available historic data were used for Stage 3 TMDL development.

### 1.4.1 Dissolved Oxygen Data

Tetra Tech collected bi-weekly DO data from Sugar Creek during the summer of 2006. These data never violated the Illinois EPA DO standard of not less than 5.0 mg/L at any time. A total of 15 measurements were taken that ranged from 7.48 to 12.92 mg/L. DO concentrations were highest in May and gradually decreased with time after May.

The Illinois EPA surface water section independently conducted continuous DO sampling every 30 minutes in July and September 2006, and data indicate that DO concentrations did violate the 5.0 mg/L DO standard (see Figures 1-2 and 1-3). However, it should be noted that violations were not regularly seen (i.e., during each diurnal cycle) and associated flow data are not available for possible correlation. In addition, daily precipitation records are unavailable for the weather station at Edgar County Airport in Paris, Illinois through the National Climatic Data Center from July 20, 2006 through October.

### 1.4.2 Fecal Coliform Data

The Illinois EPA collected fecal coliform data multiple times from May to August of 2005. Data were collected so that they could be assessed against the geometric mean standard, which requires at least five samples during a 30-day period. Data were collected at sites BM02 and BM03. Table 1-5 contains the results of this sampling effort.

**Table 1-5 Geometric mean of fecal coliform samples taken during Summer 2005**

| Station | 1st round sampling: May-June 2005 | 2nd round sampling: July-August 2005 |
|---|---|---|
| BM 02 | 305.29 | 255.57 |
| BM 03 | 699.96 | 828.94 |

# 1.5 Methodology Development

The following sections further discuss and describe the methodologies utilized to examine DO and fecal coliform levels in the impaired segments of Sugar Creek.

## 1.5.1 TMDL Endpoints

The TMDL endpoints for DO and fecal coliform for the impaired segments in the Sugar Creek watershed are summarized in Table 1-6. Fecal coliform concentrations must be below the TMDL endpoint in the portion of the segment where the primary contact recreation use is applicable. A portion of this segment is exempt from the use and the associated standard and is discussed in further detail in Section 2.2.4. DO concentrations must be above 6.0 mg/L during 16 hours of any 24-hour period and must never go below 5.0 mg/L. The endpoints are based on the protection of aquatic life and recreational uses of Sugar Creek. Further monitoring, as outlined in the monitoring plan presented in Section 3 of this report, will help further define when impairments are occurring in the watershed and support the TMDL allocations outlined in section 2 of this report.

**Table 1-6 TMDL Endpoints and Average Observed Concentrations for Impaired Constituents in the Sugar Creek Watershed**

| Impaired Segment | Constituent | TMDL Endpoint | Average Observed Value on Impaired Segment | Maximum Observed Value on Impaired Segment | Minimum Observed Value on Impaired Segment |
|---|---|---|---|---|---|
| Sugar Creek BM02 | Fecal Coliform | 200 cfu/100 mL during October – May | 532 cfu/mL (geometric mean) | 11,600 cfu/mL | 0 cfu/mL |
| Sugar Creek BMC02 | DO | 6.0 mg/L (16 hours of any 24-hour period), 5.0 mg/L instantaneous minimum | 6.7 mg/L | 17.2 mg/L | 3.0 mg/L |

## 1.5.2 Pollutant Source and Linkage

Potential pollutant sources for the impaired waterbodies in the Sugar Creek watershed were identified through the existing data review described in the Stage One report. DO impairments in Sugar Creek segment BMC2 are mostly attributed to low flow or stagnant conditions within the stream. The Paris Twin Lakes dam regulates flows into Sugar Creek from the Paris Twin East Lake and discharges no water to the creek during portions of the year. Problems are potentially caused by slow-moving waters, low reaeration, and increased water temperatures during summer months that promote algal growth. In addition, runoff from nonpoint sources may also contribute loading of oxygen-demanding materials in the segment.

The TMDL analysis performed for fecal coliform in Sugar Creek segment BM02 showed that the majority of the samples collected have exceeded the standard and that all samples collected during higher flow conditions have exceeded the standard. This indicates that potential sources are likely stormwater runoff and resuspension of instream fecal material. In addition, violations of the standard have also been recorded during lower flow scenarios. Sources of fecal coliform during low flows can potentially be attributed to point source flows, failing septic systems in unsewered communities and livestock with access to streams. The unsewered communities of Vermillion and Elbridge are located within the BM02 watershed and livestock have been observed in the stream. The riparian corridor of segment BM02 is also heavily forested which suggests wildlife presence and contribution. All potential sources are discussed at length in Section 3 with additional information regarding implementation and mitigation suggestions.

### 1.5.3 Allocation

The TMDLs for the impaired segments in the Sugar Creek watershed will address the following equation:

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

where:

| | | | |
|---|---|---|---|
| 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 |

Methodologies to determine each of these elements are discussed below while Section 2 provides modeling results for each element along with a discussion of seasonal variation in the TMDL calculations.

## 1.6 Methodology Overview

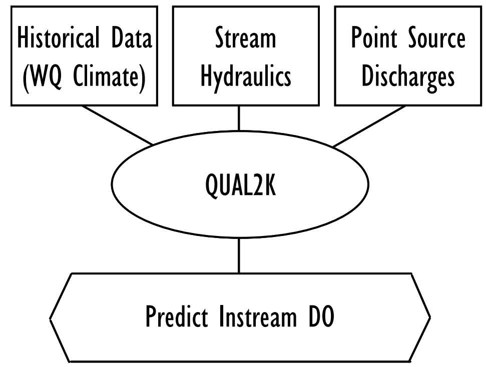
Table 1-7 contains information on the methodologies selected and used to develop TMDLs for impaired segments within the Sugar Creek watershed.

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

| Segment Name/ID | Cause of Impairment | Methodology |
|---|---|---|
| Sugar Creek/BMC2 | Dissolved Oxygen | QUAL2K |
| Sugar Creek/BM02 | Fecal Coliform | Load-Duration Curve |

### 1.6.1 QUAL2K Overview

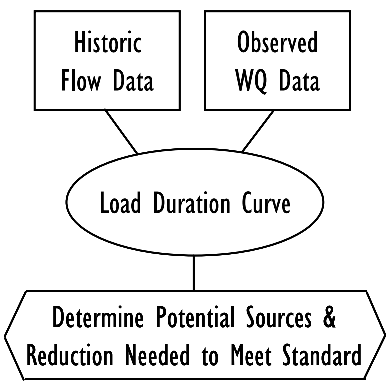
The QUAL2K model was used to develop the DO TMDL for segment BMC2 of Sugar Creek. QUAL2K is a stream water quality model that is one-dimensional and applicable to well-mixed streams. The model assumes steady-state hydraulics and allows for point source inputs, diffuse loading, and tributary flows. Historic water quality data, observed and estimated hydraulic information, and point source discharge data were coupled with model defaults to predict the external oxygen-demanding load to the system and the resulting instream DO concentrations.




*Schematic 1*

### 1.6.2 Load-Duration Curve Overview

A loading capacity analysis was performed for Sugar Creek segment BM02. A load-duration curve is a graphical representation of the maximum load of a pollutant, in this case fecal coliform, which a segment can assimilate over a range of flow scenarios while still meeting the instream water quality standard. The load-duration curve approach was chosen for this watershed due to the amount of water quality and associated flow data.  A detailed approach would have included the development of a watershed model which may or may not be able to further identify sources and which would have required much more extensive data collection throughout the watershed.  The load-duration curve approach provides useful information using the available data regarding the magnitude and frequency of exceedences as well as the flow scenarios when exceedences occur most often (Schematic 2).




*Schematic 2*

## 1.7 QUAL2K Model

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 U.S. Environmental Protection Agency (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 (COD), 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, 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.

## 1.7.1 QUAL2K Inputs

Table 1-8 contains the categories of data required for the Q2K model along with the sources of data used to analyze segment BMC2 of Sugar Creek.

**Table 1-8 Q2K Data Inputs**

| Input Category | Data Source |
|---|---|
| Stream Segmentation | GIS data |
| Hydraulic characteristics | Tetra Tech field surveys and GIS analysis |
| Headwater conditions | DMR records from Paris STP and historic data from a Facility Related Stream Survey (FRSS) |
| Meteorologic conditions | National Climatic Data Center |

Empirical data collected during Stage 2 of TMDL development (Attachment 2) were used to truth-check the Q2K model for Sugar Creek.

### 1.7.1.1 Stream Segmentation

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. Figure 1-4 shows the stream segmentation used for the Q2K model.

For this model, Sugar Creek was broken into two reaches. The headwaters reach is represented by data from the Paris STP. The Paris STP effluent data was chosen to represent headwater conditions because the low-flow 7Q10 value for Sugar Creek upstream of the discharge point is zero cubic feet per second (cfs) (Permit No. IL0021377). It is assumed that during low flows, when DO problems are most likely to occur, the stream is fed entirely by the treatment plant effluent. The second reach extends from the end of the headwaters reach and is represented by Stage 2 data collected at site BMC2.

### 1.7.1.2 Hydraulic Characteristics

Stream hydraulics were specified in the model based on Discharge Monitoring Reports (DMR) discharge values for the Paris STP during the summer of 2005 and 2006, aerial photographs of the segment and site observations noted during Stage 2 data collection at site BMC2.

### 1.7.1 3 Headwater Conditions

The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary condition. Again, Paris STP effluent data were used to represent headwater conditions. Measured data were available for discharge rate (flow), ammonia and $BOD_5$. Additional model parameters were pulled from various sources. DO concentrations were entered as 6.0 mg/L as that is the effluent limit for the plant. Nutrient values (other than ammonia) were entered using historic effluent data from the FRSS performed in 1994 and, in the absence of other options, downstream data collected during Stage 2. It is thought that this data is adequate since there are no other significant flow or potential pollutant sources introduced to the stream between the STP and the Stage 2 sampling location. Data used for the model are from summer months assuming that critical conditions for DO on the stream occur during low flow periods when there is little stream reaeration and high temperatures. More historic information on this point source is provided below in Section 1.6.1.5.

It should be noted that historically, only one sample violated the DO standard (5.0 mg/L minimum concentration) on this segment. A single sample collected just upstream of the Paris STP facility on August 31, 1994 violated the DO standard with a concentration of 3.0 mg/L. Field notes indicate that flow at this time was negligible and that no water was entering the system from the Paris spillway upstream.

Flows for the headwater condition were determined using 2005 and 2006 summer discharge rates from the Paris facility based on DMR records provided by Illinois EPA.

### 1.7.1.4 Climate

Q2K requires inputs for climate. Hourly temperature and wind speed data from the Edgar County Airport in Paris, Illinois were used for the model.

### 1.7.1.5 Point Sources

No other point sources contribute significantly to the impaired segment of Sugar Creek under low-flow conditions. The main point source, the Paris STP is incorporated into the model as the headwater conditions.

Historic DMR records were reviewed as part of Stage 1 TMDL development. The Paris STP discharges under permit IL0021377. The facility has been operating under this permit since 1974 and the permit was recently reissued in June of 2007 and expires in 2012. The permit covers discharges from the facility's main STP outfall as well as discharges from the facility's treated combined sewage outfalls. Table 1-9 contains a summary of historic DMR records relevant to DO modeling on Sugar Creek. The facility was not required to monitor DO concentrations in the past but has been required to monitor $BOD_5$ and ammonia concentrations. The QUAL2K model simulates DO dynamics as a function of many things including nitrogenous and carbonaceous oxygen demand. $BOD_5$ and ammonia contribute to this oxygen demand occurring in the stream. A copy of the current permit is available in Appendix B.

**Table 1-9 Historic DMR data from Paris South STP (Illinois EPA 1997-2007)**

| Parameter | Period of Record | Sample Count | Average Result (mg/L) | Number of Permit Limit Violations |
|---|---|---|---|---|
| $CBOD_5$ | 12/97-2/07 | 110 | 2.81 | 4 |
| Ammonia as N | 12/97-2/07 | 110 | 0.06 | 0 |

### 1.7.1.6 QUAL2K Verification

The QUAL2K model for Sugar Creek was set up and run as discussed in the preceding sections. Data collected during Stage 2 at sample location BMC2 were used for model verification. Because only one data point was available downstream, a true calibration was not performed. However, "truth checking" was performed on key model calculated parameters, such as reaeration rates, SOD fluxes, temperature, and phytoplankton concentrations using literature values and best professional judgment. The model adequately predicts the observed downstream data for key parameters. Appendix A contains the model input/output worksheets.

## 1.8 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 in segment BM02 of Sugar Creek.

### 1.8.1 Flow Data

In order to create a load duration curve, it is necessary to obtain flow data corresponding to each water quality sample. As discussed in the Stage 1 report (Tetra Tech 2005), there are no U.S. Geological Survey (USGS) stream gages within the watersheds 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 03346000 (North Fork Embarras River near Oblong, Illinois) was chosen as an appropriate gage from which to estimate flows in Sugar Creek. The Embarras River watershed is approximately 40 miles southwest of sampling sites BM02 and BM03 on Sugar Creek. The gage drains an area that is approximately one order of magnitude greater and receives comparable precipitation over similar landuse throughout the year. Gage 03346000 captures flow from a drainage area of 320 square miles of which approximately 99% of the land cover is either agricultural or categorized as grassland/forest. The Sugar Creek watershed drains 13 square miles at sampling site BM03 and 32 square miles at sampling site BM02 below the reservoir. Land cover in the Sugar Creek watershed is 94% agricultural or grassland/forest.

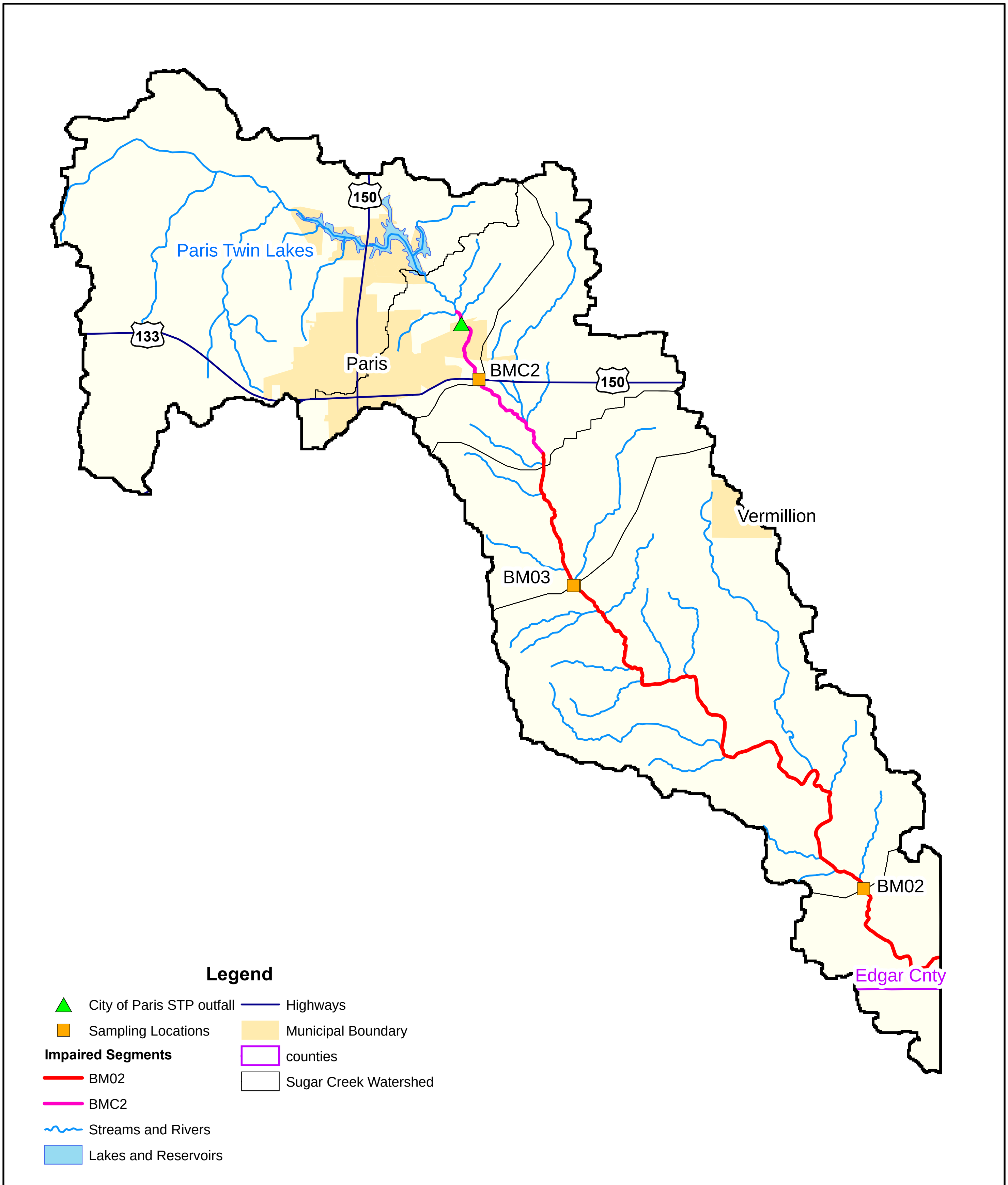
Data were downloaded through the USGS for the Embarras River gage from 1940 through 2007 and adjusted to account for point sources in both watersheds. There are three regularly discharging facilities upstream of the USGS gage on the North Fork Embarras River. The combined flow rate from the facilities is 0.56 million gallons per day (mgd). These flows were subtracted from the USGS gage flows to account for flows associated with precipitation and overland runoff only. Once these flows were determined, they were multiplied by the area ratio to determine flows within the Sugar Creek watershed. Finally, flows from the Paris STP and Water Treatment Plant (WTP) were added back in to provide the best estimate for the Sugar Creek watershed.

### 1.8.2 Fecal Coliform Analysis for Sugar Creek Segment BM02

A flow duration curve was developed by determining the percent of days each 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 Stages 1 and 2 of TMDL development. These data were then paired with the corresponding flows for the sampling dates and plotted against the load duration curve. Figure 1-5 show the load duration curve for the segment as a solid line and the observed pollutant loads as points on the graphs. Appendix C contains the spreadsheet used for this analysis. Table 1-10 contains a breakdown of samples collected under varying flow scenarios. This information is the basis for TMDL development discussed in Section 2.

**Table 1-10 Fecal Coliform Load Duration Analysis for Sugar Creek Segment BM02**

| Zone | Flow Exceedance Range (%) | Sample Count | Number of Exceedances | Median Flow (cfs) | Allowable Load (mil col/day) | Geometric Mean of Actual Load (mil col/day) |
|---|---|---|---|---|---|---|
| High | 0-10 | 20 | 19 | 74.39 | 364,055 | 4,420,724 |
| Moist | 10-20 | 8 | 8 | 18.26 | 89,346 | 455,353 |
| | 20-30 | 16 | 12 | 10.09 | 49,398 | 97,971 |
| | 30-40 | 11 | 8 | 6.77 | 33,122 | 51,020 |
| Mid-Range | 40-50 | 12 | 8 | 5.06 | 24,738 | 46,322 |
| Dry | 50-60 | 14 | 8 | 4.05 | 19,806 | 28,150 |
| | 60-70 | 10 | 6 | 3.34 | 16,354 | 21,217 |
| | 70-80 | 11 | 7 | 2.88 | 14,085 | 15,198 |
| | 80-90 | 12 | 7 | 2.55 | 12,457 | 14,386 |
| Low Flow | 90-100 | 10 | 6 | 2.30 | 11,279 | 17,184 |



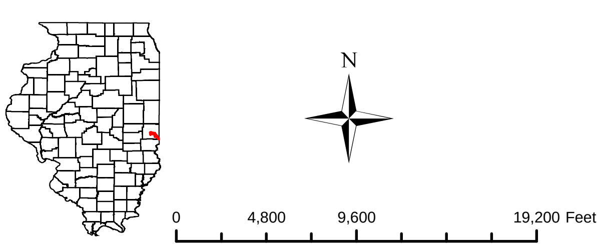




Figure 1-1: Sugar Creek Watershed

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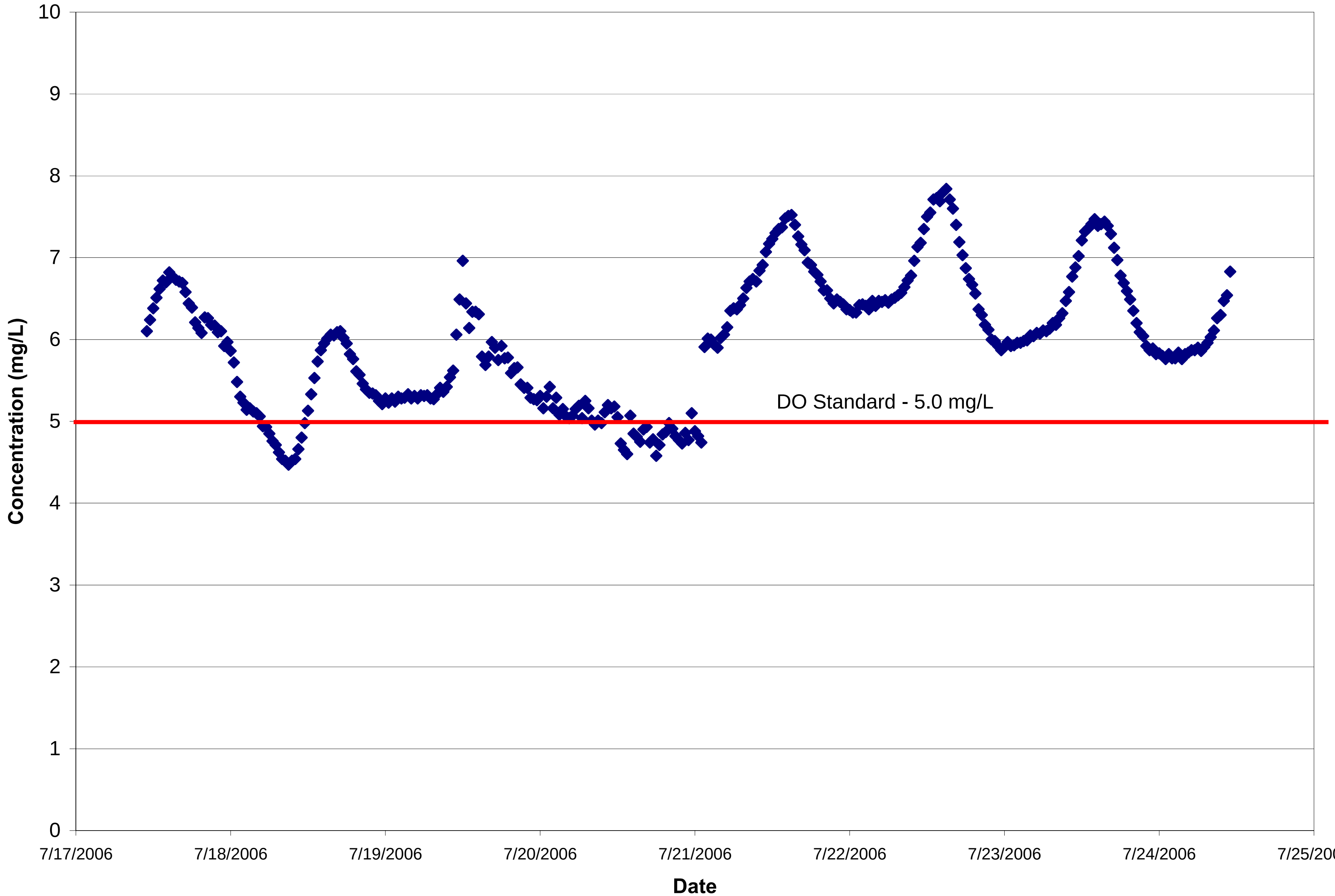


CDM

**Figure 1-2:**
**Continuous DO Monitoring**
**Sugar Creek Segment BMC2**

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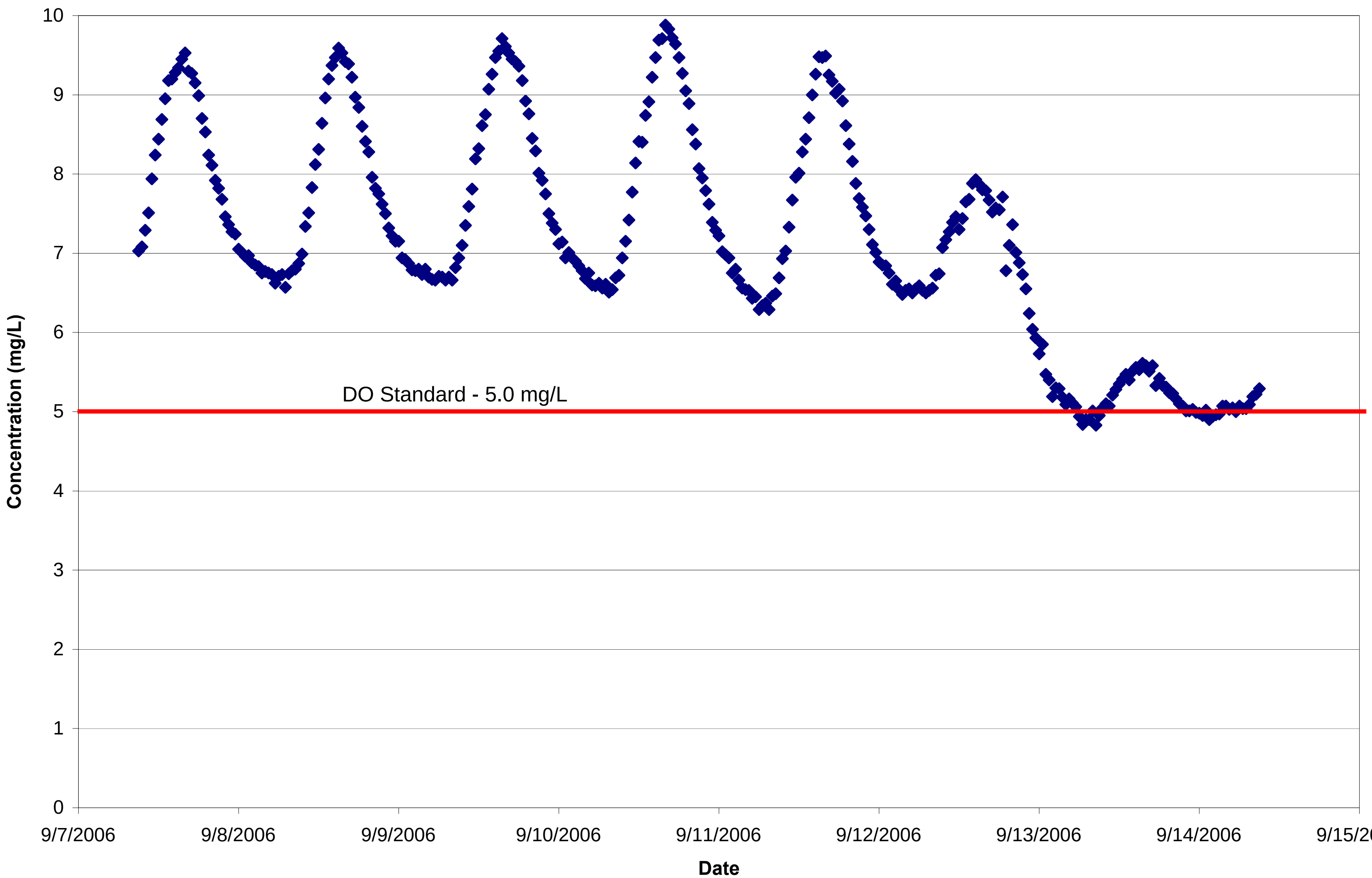


CDM

**Figure 1-3:**
**Continuous DO Monitoring**
**Sugar Creek Segment BMC2**

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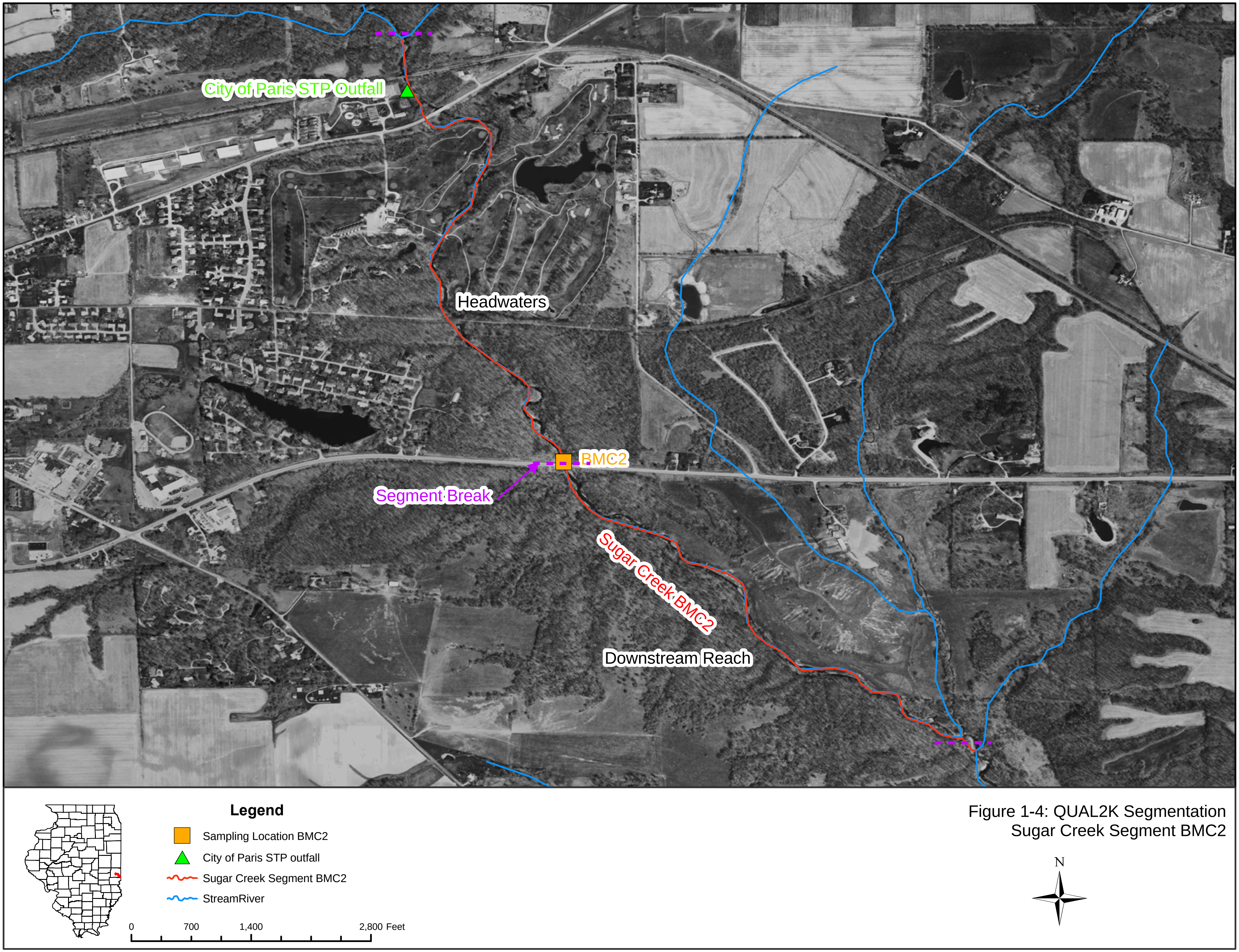


Figure 1-4: QUAL2K Segmentation
Sugar Creek Segment BMC2

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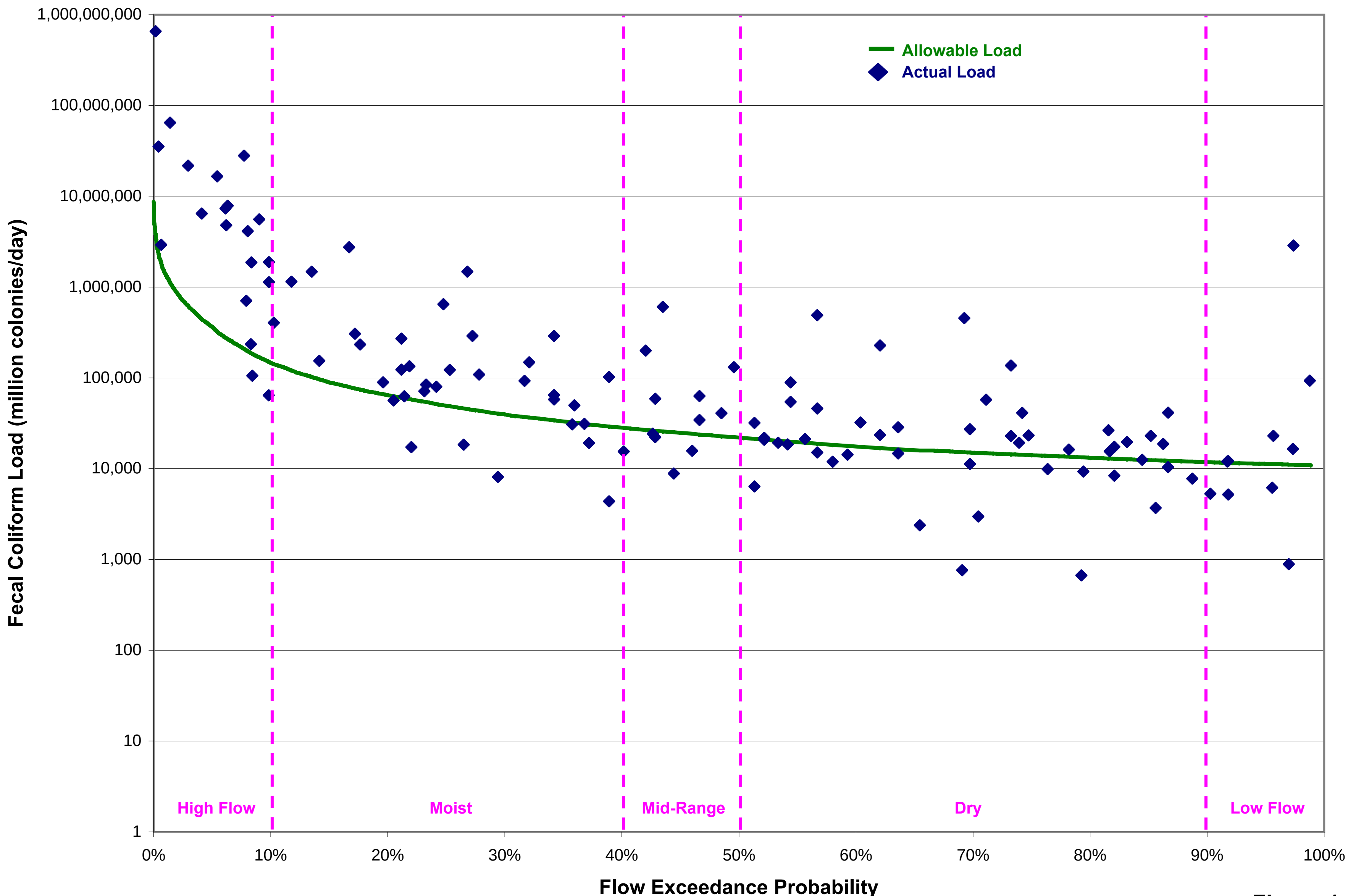


CDM

**Figure 1-5:**
**Fecal Coliform**
**Load Duration Curve**
**Sugar Creek Segment BM02**

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# Section 2
# Total Maximum Daily Loads for the Sugar Creek Watershed

## 2.1 Sugar Creek DO TMDL

### 2.1.1 Loading Capacity

The loading capacity (LC) is the maximum amount of oxygen-demanding material that Sugar Creek can receive and still maintain compliance with the water quality standards. The allowable loads of oxygen-demanding material that can be generated in the watershed and still maintain water quality standards were determined with the methodology discussed in Section 1.7.

In the absence of a reasonable measured calibration data set, model DO, forcing variables were adjusted to achieve reasonable values based on limited site-specific data (e.g., hydraulics, water temperature) and literature/experience (e.g., SOD, benthic algae, phytoplankton). Model internal rates were maintained at default (recommended) values. Results show that re-aeration dominates over oxidation in the shallow target reach for the assumed loading conditions and kinetic rates

Based on model analysis, flow and reaeration would need to be increased during summer months. The Paris STP recently completed a permit renewal that increased the discharge from the facility to 1.4 mgd. The model was also run with this discharge rate and permit limits for ammonia and $BOD_5$. The model showed no violations of the standard under the new permit conditions. Because a TMDL can not be developed for reaeration, no TMDL will be developed at this time.

Further monitoring and implementation measures to increase aeration in the system are discussed in Section 3.

## 2.2 Sugar Creek Fecal Coliform TMDL

### 2.2.1 Loading Capacity

The LC is the maximum amount of fecal coliform that Sugar Creek can receive and still maintain compliance with the water quality standard. The allowable fecal coliform loads that can be generated in the watershed and still maintain the water quality standard of 200 cfu/100mL were determined with the methodology discussed in Section 1.8. The fecal coliform loading capacity according to flow is presented in Table 2-1.

**Table 2-1 Fecal Coliform LC for Sugar Creek Segment BM02**

| Zone | Flow Exceedance Range (%) | Median Flow (cfs) | LC (mil col/day) |
|---|---|---|---|
| High | 0-10 | 74.39 | 364,055 |
| Moist | 10-20 | 18.26 | 89,346 |
| | 20-30 | 10.09 | 49,398 |
| | 30-40 | 6.77 | 33,122 |
| Mid-Range | 40-50 | 5.06 | 24,738 |
| Dry | 50-60 | 4.05 | 19,806 |
| | 60-70 | 3.34 | 16,354 |
| | 70-80 | 2.88 | 14,085 |
| | 80-90 | 2.55 | 12,457 |
| Low Flow | 90-100 | 2.30 | 11,279 |

### 2.2.2 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 condition during the recreation season. The fecal coliform standard must be met under all flow scenarios and standard exceedances have occurred during all flow scenarios. By using the load duration curve method, all of these “critical conditions” are accounted for in the loading allocations.

### 2.2.3 Margin of Safety

The margin of safety (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 Sugar Creek TMDL includes an implicit MOS because the more stringent standard of 200 cfu/100mL was used in the analysis. In addition, the analysis did not consider the die-off of bacteria, which is likely occurring within the stream system.

### 2.2.4 Waste Load Allocation

There is one point source that has the potential to contribute fecal coliform to the impaired segment of Sugar Creek. The Paris STP (NPDES ID IL0021377) discharges to Sugar Creek through Outfall 001, which is located upstream of segment BM02. The facility is permitted to discharge a daily average flow of 1.4 mgd.

Sewage from treatment plants treating domestic and/or municipal waste contains fecal coliform as it is indigenous to sanitary sewage. In Illinois, a number of these treatment plants have applied for and received a disinfection exemption, which allows a facility to discharge waste water without disinfection. All of these treatment facilities are required to comply with the geometric mean fecal coliform water quality standard of 200 cfu/100 mL at the closest point downstream where recreational use could occur in the receiving water or where the water flows into a fecal-impaired segment. The Paris STP has a disinfection exemption and the extent of the exemption is shown on Figure 2-1. As shown in the figure, the exemption extends into segment BM02 of Sugar Creek, which is impaired for fecal coliform. The sampling location BM03 is within the disinfection exemption; however, the exemption ends prior to sampling location BM02.

Facilities with year-round disinfection exemptions may be required to provide the Agency with updated information to demonstrate compliance with these requirements. The newly reissued Paris South STP NPDES permit now requires monthly monitoring of fecal coliform. In addition, facilities directly discharging into a segment whose recreational use is impaired by fecal coliform may have their year-round disinfection exemption revoked through future National Pollutant Discharge Elimination System (NPDES) permitting actions.

Additionally, the Paris STP has two permitted treated combined sewage outfalls; outfall 003 to the north and outfall A01 to the south. WLAs were determined by multiplying the fecal coliform standard of 200 cfu/100mL by the design average flow for the STP (1.4 mgd) and the design maximum flow for the STP (4.0 mgd) and additionally by the combined flow from the two treated combined sewage outfalls during high flow scenarios. The mean flow observed from the Paris treated combined sewage outfalls during high flow events between May 1998 and October 2006 was 1.79 mgd. WLAs for the STP outfall were determined to be 10,766 million colonies per day under average discharge rates and 30,287 million colonies per day under maximum discharge rates. The additional high flow WLA for the treated combined sewage outfalls during high flow conditions was determined to be 13,551 million colonies per day. Table 2-2 shows a summary of the WLA calculations for the Paris STP and treated combined sewage outfalls.

**Table 2-2 Summary of the Paris STP WLA**

| Permit IL0021377 Outfalls | Flow (mgd) | Fecal Coliform Standard (cfu/100mL) | WLA[1] (mil col/d) |
|---|---|---|---|
| STP (Outfall 001 under DAF) | 1.4 | 200 | 10,766 |
| STP (Outfall 001 under DMF) | 4.0 | 200 | 30,287 |
| *North treated combined sewage outfall (Outfall 003)* | *0.47* | *200* | *3,588* |
| *South treated combined sewage outfall (Outfall A01)* | *1.32* | *200* | *9,963* |
| Combined treated combined sewage outfall Total | 1.79 | 200 | 13,551 |

(1) WLA given are not end of pipe, but rather are applied to the point in the stream where primary contact use applies.

## 2.2.5 Load Allocation and TMDL Summary

The load duration analysis described in Section 1.7 determined that load reductions need to occur under all flow conditions in order to meet the TMDL endpoint of an instream concentration of 200 cfu/100mL. The LA was determined by subtracting the

WLA from the determined LC. Table 2-3 shows a summary of the fecal coliform TMDL for Sugar Creek segment BM02.

**Table 2-3 Fecal Coliform TMDL for Sugar Creek Segment BM02**

| Zone | Flow Exceedance Range (%) | LC (mil col/day) | WLA | | LA (mil col/day) | MOS | Geometric Mean of Actual Load (mil col/day) | Percent Reduction Needed (%) |
|---|---|---|---|---|---|---|---|---|
| | | | Paris STP Outfall 001 (mil col/day) | Paris Treated Combined Sewage Outfalls (mil col/day) | | | | |
| High | 0-10 | 364,055 | 30,287 | 13,551 | 320,217 | implicit | 4,420,724 | 92% |
| Moist | 10-20 | 89,346 | 30,287 | | 59,059 | implicit | 455,353 | 80% |
| | 20-30 | 49,398 | 30,287 | | 19,111 | implicit | 97,971 | 50% |
| | 30-40 | 33,122 | 30,287 | | 2,835 | implicit | 51,020 | 35% |
| Mid-Range | 40-50 | 24,738 | 10,766 | | 13,972 | implicit | 46,322 | 47% |
| Dry | 50-60 | 19,806 | 10,766 | | 9,040 | implicit | 28,150 | 30% |
| | 60-70 | 16,354 | 10,766 | | 5,588 | implicit | 21,217 | 23% |
| | 70-80 | 14,085 | 10,766 | | 3,319 | implicit | 15,198 | 7% |
| | 80-90 | 12,457 | 10,766 | | 1,691 | implicit | 14,386 | 13% |
| Low Flow | 90-100 | 11,279 | 10,766 | | 513 | implicit | 17,184 | 34% |

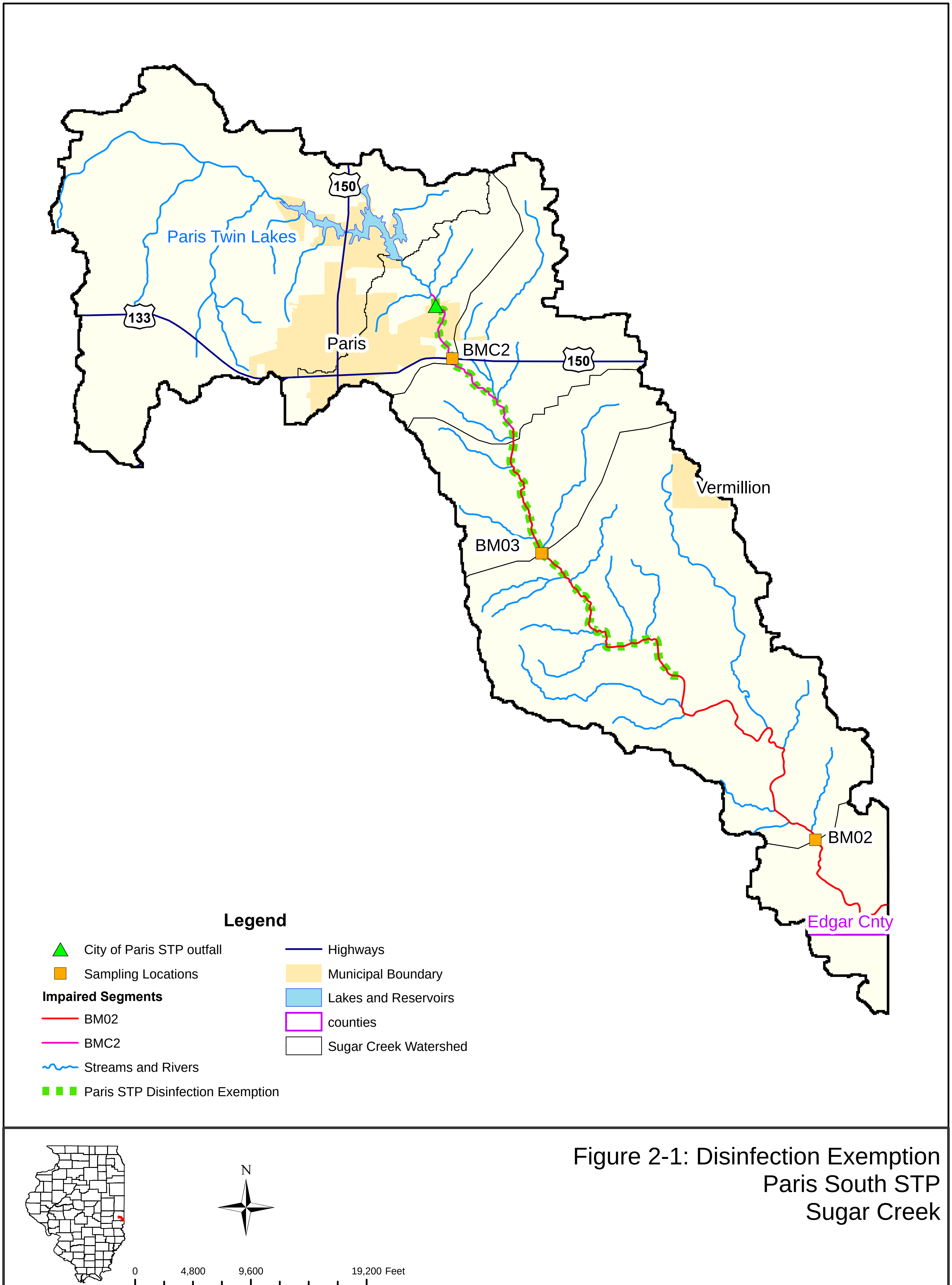


Figure 2-1: Disinfection Exemption
Paris South STP
Sugar Creek

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# Section 3
# Implementation Plan for the Sugar Creek Watershed

## 3.1 Adaptive Management

An adaptive management or phased approach is recommended for the TMDLs developed for the Sugar Creek watershed. 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.

# 3.2 Implementation Actions and Management Measures for DO in Sugar Creek

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 2 established a relationship between low flows, oxygen-demanding materials (BOD5, ammonia-nitrogen and organic nitrogen), and DO concentrations in Sugar Creek segment BMC2. Management measures for segment BMC2 will focus on increasing reaeration and decreasing loads of oxygen-demanding materials to increase DO concentrations.

DO impairments in Sugar Creek segment BMC2 are mostly attributed to low flow or stagnant conditions within the stream. The Paris Twin Lakes dam regulates flows into Sugar Creek from the Paris Twin East Lake and discharges no water to the creek during portions of the year. The FRSS performed in 1994 noted that little to no flow was observed upstream of the Paris South STP discharge and that no water was observed over the Paris Twin East Lake spillway. It should be noted that the City of Paris has looked into purchasing water from Indiana with the intention of no longer using the Paris Twin Lakes as public drinking water sources for the community. This may result in more days when the dam would discharge, potentially increasing flows in segment BMC2 in the future.

Runoff from nonpoint sources may also contribute loading of oxygen-demanding materials in the segment. An additional contributor to low DO may also be increased water temperatures. Therefore, management measures for the segment BMC2 watershed will focus on reducing nonpoint source loading through sediment and surface runoff controls, reducing stream temperatures, and reducing stagnant conditions through reaeration.

## 3.2.1 Point Sources of Oxygen-Demanding Materials

### 3.2.1.1 Municipal Sources

The City of Paris STP discharges to Sugar Creek segment BMC2 (see Figures 1-1 and 1-4). Table 3-1 contains permit information for this facility. The permit was recently renewed in June 2007 and is available in Appendix B for review.

**Table 3-1 Point Source Discharges to Sugar Creek Segment BMC2**

| Facility Name | Permit Number | Daily Average Flow (mgd) | Daily Max Flow (mgd) | Permit Expiration |
|---|---|---|---|---|
| Paris South STP | IL0021377 | 1.4 | 4.0 | 07/31/2012 |

Illinois EPA will evaluate the need for point source controls through the NPDES permitting program as the permit is due for renewal in 2012. The City of Paris STP permit has limits for $BOD_5$ and ammonia-nitrogen. The facility is required to discharge effluent with ammonia concentrations less than 4.1 mg/L (during low flow months), and $BOD_5$ concentrations less than 10 mg/L. Past DMR data shows very few violations of the $BOD_5$ limits (4 violations in 110 samples over ten years) and no violations of the ammonia limits. These permit limits are thought to be adequately protective of aquatic life uses within the creek.

## 3.2.2 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 nonpoint sources of pollutants to Sugar Creek segment BMC2 include streambank erosion, low flows, and high temperatures. BMPs evaluated for treatment of these nonpoint sources are:

- Filter strips
- Grassed waterways
- Riparian buffers
- Reaeration/Erosion Control/Streambank Stabilization

### 3.2.2.1 Filter Strips

Filter strips can be used as a control to reduce pollutant loads, including nutrients and sediment, to Sugar Creek. 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 in the Sugar Creek watershed. Finally, design criteria and size selection of filter strips are detailed.

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 Sugar Creek. 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 Sugar Creek.

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 BOD5 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.

Filter strip widths for the Sugar Creek TMDL 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 3-2 outlines the guidance for filter strip flow length by slope (NRCS 1999).

**Table 3-2 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 of the Stage 1 report (Attachment 1) 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, the most predominant soil type in the watershed is Drummer Silty Clay Loam ranging from silts to clays on 0 to 2 percent slopes. Based on these slope values, filter strip widths of 72 to 144 feet could be incorporated into agricultural lands adjacent to the creek and its tributaries. Mapping software was then used to buffer stream segments to determine the total area found within 144 feet of tributaries in the Sugar Creek segment BMC2 watershed. There are approximately 1,812 total acres within this buffer distance throughout the entire watershed (figure 3-1). 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 398 total acres within this buffer distance in the BMC2 watershed, of which 59 acres are agricultural land where filter strips could potentially be installed to help reduce the loading of oxygen-demanding materials. Landowners should evaluate their land near Sugar Creek and its tributaries and install or extend filter strips according to the NRCS guidance provided in Table 3-2. Programs available to fund the construction of these buffer strips are discussed in Section 3.4.

### 3.2.2.2 Grassed Waterways

Grassed waterways are stormwater conveyances lined with grass that prevent erosion of the transport channel. In addition, the grassed channel reduces runoff velocities, allows for some infiltration, and filters out some particulate pollutants. Phosphorus reductions for grassed waterways are reported at 30 percent (Winer, 2000).

### 3.2.2.3 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 ft wide buffers and 70 to 80 percent for 60 to 90 ft wide buffers. Again, landuse data were clipped to 25 feet buffer zones created around Sugar Creek. There are 97 acres within 25 feet of the creek. 69 of these acres are existing grassland or forest while 23 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 ft 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).

### 3.2.2.4 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.

#### 3.2.2.5 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 (STP)
- Rock Riffle Grade Control (RR)

Stone Toe Protection uses nonerodible 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. STP 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).

Channel hydraulics were studied in the “Aerial Assessment Report of Sugar Creek” (Kinney, 2005). A copy of the report is available in Appendix D. Low level geo-referenced video was taken of Sugar Creek in March 2004 to produce a DVD showing flight data and location. The USGS used this DVD to identify ground locations that warranted further investigation. Eight cross-sections were selected along Sugar Creek and the report suggested that limited amounts of STP could be implemented in segment BM02 and that RR structures may be used in segment BMC2 as reaeration structures to improve DO levels.

The report estimates bank stabilization at $25 per foot and RR at $7,500 per riffle.

## 3.3 Implementation Actions and Management Measures for Fecal Coliform in Sugar Creek

The TMDL analysis performed for fecal coliform in Sugar Creek segment BM02 showed that the majority of the samples collected have exceeded the standard and that all samples collected during higher flow conditions have exceeded the standard. This indicates that potential sources are likely stormwater runoff and resuspension of instream fecal material. In addition, violations of the standard have also been recorded during lower flow scenarios. Sources of fecal coliform during low flows can potentially be attributed to point source flow and livestock with access to streams.

## 3.3.1 Point Sources of Fecal Coliform

### 3.3.1.1 Municipal Wastewater Sources

The permitted City of Paris STP is a source of fecal coliform to Sugar Creek. Sewage from treatment plants treating domestic and/or municipal waste contains fecal coliform as it is indigenous to sanitary sewage. As discussed in Section 2.2.4, this facility has a disinfection exemption meaning that it does not have to disinfect as long as the instream fecal coliform standard is being met at the downstream point where primary contact recreation could occur. It is expected that with die-off, the fecal concentration will be met at the end of the exempted stream reach.

Sugar Creek segment BM02 was listed as impaired for primary contact, based on fecal coliform, in the 1992 cycle report. However, in the 1994 and 1996 cycle reports, primary contact was removed as a use for that segment based on the disinfection exemption. The primary contact use was then added back in the 2000 cycle report and was listed as an impaired use on Sugar Creek for the 2000, -02 and -04 cycle 305(b) reports.

The exemption for the Paris STP applies to approximately 9 miles downstream of the discharge location (see Figure 2-1). The first 2.22 miles are in segment BMC2. The remaining 6.8 miles of the exemption comprise half of segment BM02 (13.58 miles). The primary contact use is applicable to the remaining portion of segment BM02 that is not covered by the disinfection exemption.

Facilities with year-round disinfection exemptions may be required to provide the Agency with updated information to demonstrate compliance with these requirements. It should be noted that the city engineer has communicated that the city hopes to install UV disinfection to treat outfall 001 sometime within the next 5 years. A condition of Paris South STP's new permit requires monthly fecal coliform sampling.

**Table 3-3 Fecal Coliform Data from the Paris STP Outfall (Illinois EPA 2006)**

| Sample Date | Result (#/100mL) |
|---|---|
| 8/10/06 | 3,200 |
| 8/16/06 | 4,600 |
| 8/24/06 | 5,700 |
| 8/30/06 | 5,600 |

Because the facility has a disinfection exemption and has not previously been required to monitor fecal coliform, the actual historic load of fecal coliform originating at each facility is unknown. Table 3-3 contains fecal coliform data collected from the STP outfall by Illinois EPA staff during August 2006. The average fecal coliform discharge would need to experience a 95% die-off by the end of the disinfection exemption to meet the instream water quality standard of 200 cfu/100mL.

**Table 3-4 Fecal Coliform Data from Treated Combined Sewage Outfalls (Illinois EPA 1999-2006)**

| Outfall | Average Result (#/100mL) |
|---|---|
| 003 | 47 |
| A01 | 45 |

In addition, the City of Paris has two treated combined sewage outfalls for emergency high flow situations. Monitoring is required from outfalls 003 and A01. Historic DMR records from both outfalls were reviewed and data collected during events in the recreation seasons of 1999 through 2006 are summarized in Table 3-4. It is unlikely that the treated combined sewage outfall discharge is contributing significantly to the fecal coliform issues seen on segment BM02.

### 3.3.2 Nonpoint Sources of Fecal Coliform

Several management options have been identified to help reduce fecal coliform counts in Sugar Creek. These management options focus on potential 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 Sugar Creek and Tributaries

Each alternative is discussed briefly in this section.

#### 3.3.2.1 Filter Strips

Filter strips were discussed in Section 3.2.2.1. Filter strips implemented along stream segments slow and filter sediment and attached pollutants (including fecal coliform) out of runoff, and provide bank stabilization decreasing erosion and deposition. Increasing the length of stream bordered by grass and riparian buffer strips will decrease the amount of fecal coliform load associated with sediment loads to Sugar Creek. Reductions in fecal coliform loading of 55 to 87 percent have been reported (USEPA, 2003; Kalita, 2000; Woerner et al., 2006).

The same technique as discussed in Section 3.2.2.1 for evaluating available land was applied to the entire Sugar Creek watershed draining to the fecal coliform impaired segment. There are 1,812 acres of land within 144 feet of Sugar Creek and its tributaries (Figure 3-1), of this area, 424 acres are categorized as agricultural and could potentially be converted into filter strips.

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

According to the Edgar County Public Health Department, the number of septic systems in the watershed is limited to rural areas not serviced by the City of Paris STP. This previously included the subdivision of Eads and currently includes the towns of Vermillion and Elbridge. Although no recent survey of septics in the area has been conducted, the health department has records of permits issued throughout the watershed and keeps a log of complaints received regarding septic systems. No complaints have been logged since 2000 (as far as the nuisance log goes back), however, if a complaint were received, the health department would investigate the claim and provide information on corrective action to remediate the problem. According to the city engineer, the home septic systems associated with the Eads subdivision used to be connected to field tiles that regularly discharged raw sewage directly to the streams for decades. The city of Paris has spent significant funds to lay sewer lines and remove these homes from septic systems. There are 79 homes located in the subdivision. At this time, 50 homes have been tied into the city sewer system and the remaining homes are slated to be connected by June 30, 2008.

Illinois EPA has proposed a permitting program for individual private sewage disposal systems. The draft general permit is intended to minimize discharges to the ground surface and receiving waters, and includes requirements designed to protect surface waters. Illinois EPA held three public hearings throughout the state to solicit questions and comments about the proposed permit.

In addition, 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 grinds, 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)

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

Livestock are present in Edgar County, which encompasses the Sugar Creek watershed. It is unknown to what extent these animals have access to Sugar Creek or its tributaries as there are no permitted facilities currently operating in the watershed; however livestock have been observed near the stream at sample location BM03. The Edgar County Soil and Water Conservation District indicated that a few small calf/cow operations likely exist throughout the watershed but there are no concentrated facilities and overall numbers are likely relatively low.

Reduction of livestock access to streams is recommended to reduce bacteria loads. Cattle manure is a substantial source of nutrient and fecal coliform loading to streams, particularly where direct access is not restricted and/or where cattle feeding structures are located adjacent to riparian areas. Direct deposition of feces into streams may be a primary mechanism of fecal coliform loading during baseflow periods. During storm events, overbank and overland flow may entrain manure accumulated in riparian areas resulting in pulsed loads of nutrients, total organic carbon (TOC), biological oxygen demand (BOD), and fecal coliform bacteria into streams. In addition, cattle with unrestrained stream access typically cause severe streambank erosion. Fencing cattle from streams and riparian areas using vegetative or fencing materials will reduce streambank trampling and direct deposition of fecal material in the streams. A reduction of 29 to 46 percent of fecal coliform concentrations is reported (USEPA, 2003). Allowing limited or no animal access to streams will provide the greatest water quality protection. On properties where cattle need to cross streams to have access to pasture, stream crossings should be built so that cattle can travel across streams without degrading streambanks and contaminating streams with manure.

An additional management tool for pasture-based systems is supplying cattle with watering systems away from streams and riparian areas. Livestock producers who currently rely on streams to provide water for their animals must develop alternative watering systems, or controlled access systems, before they can exclude cattle from streams and riparian areas. One method of providing an alternative water source is the development of off-stream watering using wells with tank or trough systems. These systems are often highly successful, as cattle often prefer spring or well water to surface water sources. Landowners should work with an agricultural extension agent to properly design and locate watering facilities. Whether or not animals are allowed access to streams, the landowner should provide an alternative shady location and water source so that animals are encouraged to stay away from riparian areas.
Some researchers have studied the impacts of providing alternative watering sites without structural exclusions and found that cattle spend 90 percent less time in the stream when alternative drinking water is furnished (USEPA, 2003).

It should also be noted that the Louis A. Mattingly feedlot operation used to hold an NPDES permit (IL0061123) but ceased operations at least 10 years ago. This feedlot caused a large fish kill in November 1980 during which an estimated 400,000 gallons of cattle manure were spilled and an estimated 62,108 fish were killed. It is possible that historic high fecal coliform loads were associated with this facility.

## 3.4 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 be in practice to some degree within the watershed. The discussion in the preceding sections provided information on available BMPs for loads from nonpoint sources. The remainder of this section discusses an estimate of costs to the watershed for implementing these practices and programs available to assist with funding.

### 3.4.1 Available Cost-Share Programs

Approximately 60 percent of the Sugar Creek watershed is classified as agricultural row crop, and small grains land. There are several voluntary conservation programs established through the 2002 U.S. Farm Bill (the 2007 Farm Bill is currently being developed), 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.

#### 3.4.1.1 Conservation Reserve Program (CRP)

This voluntary program encourages landowners to plant long-term resource-conserving cover to improve soils, water, and wildlife resources. 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 two of the five 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.

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)

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

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

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

### 3.4.1.3 Environmental Quality Incentive Program (EQIP)

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. It provides technical, financial, and educational assistance primarily in designated "priority areas." National priorities include the reduction of non-point source pollution, such as nutrients, sediment, pesticides, or excess salinity in impaired watersheds, consistent with TMDLs where available, and the reduction in soil erosion and sedimentation from unacceptable levels on agricultural land. The program goal is to maximize environmental benefits per dollar expended and provides "(1) flexible technical and financial assistance to farmers and ranchers that face the most serious natural resource problems, (2) assistance to farmers and ranchers in complying with Federal, State, and tribal environmental laws, and encourage environmental enhancement, (3) assistance to farmers and ranchers in making beneficial, cost-effective changes to measures needed to conserve and improve natural resources, and (4) for the consolidation and simplification of the conservation planning process (NRCS 2002)."  Of particular interest in this watershed, EQIP is available to assist landowners with fencing along streams to reduce livestock access to these areas.

Landowners, with the assistance of a local NRCS or other service provider, are responsible for the development of an EQIP plan which includes a specific conservation and environmental objective, one or more conservation practices in the conservation management system to be implemented to achieve the conservation and environmental objectives, and the schedule for implementing the conservation practices. This plan becomes the basis of the cost-share agreement between NRCS and the participant. NRCS provides cost-share payments to landowners under these agreements that can be up to 10 years in duration.

Cost-share assistance may pay landowners up to 75 percent of the costs of conservation practices, such as grassed waterways, filter strips, manure management, capping abandoned wells, and other practices important to improving and maintaining the health of natural resources in the area. EQIP cost-share rates for limited resource producers and beginning farmers may be up to 90 percent. Total incentive and cost-share payments are limited to an aggregate of $450,000 (NRCS 2006).

### 3.4.1.4 Wildlife Habitat Incentives Program (WHIP)

The Wildlife Habitat Incentives Program (WHIP) is voluntary program that encourages the creation of high quality wildlife habitat of national, state, tribal, or local significance. WHIP is administered through NRCS, which provides technical and financial assistance to landowners for development of upland, riparian, and aquatic habitat areas on their property. NRCS works with the participant to develop a wildlife habitat development plan which becomes the basis of the cost-share agreement between NRCS and the participant. Most contracts are 5 to 10 years in duration, depending upon the practices to be installed. However, longer term contracts of 15 years or greater may also funded. 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.

### 3.4.1.5 Streambank Stabilization and Restoration Practice

The Streambank Stabilization and Restoration Practice (SSRP) was established by the Illinois Department of Agriculture to address problems associated with streambank erosion, such as loss or damage to valuable farmland, wildlife habitat, roads; stream capacity reduction through sediment deposition; and degraded water quality, fish, and wildlife habitat. The primary goals of the SSRP are to develop and demonstrate vegetative, stone structure and other low cost bio-engineering techniques for stabilizing streambanks and to encourage the adoption of low-cost streambank stabilization practices by making available financial incentives, technical assistance, and educational information to landowners with critically eroding streambanks. A cost share of 75 percent is available for approved project components; such as willow post installation, bendway weirs, rock riffles, stream barbs/rock, vanes, lunker structures, gabion baskets, and stone toe protection techniques. There is no limit on the total program payment for cost-share projects that a landowner can receive in a fiscal year. However, maximum cost per foot of bank treated is used to cap the payment assistance on a per foot basis and maintain the program's objectives of funding low-cost techniques (IDA 2000).

### 3.4.1.6 Conservation Practices Cost-Share Program

The Conservation Practices Program (CPP) is a 10-year program. The practices consist of waterways, water and sediment control basins (WASCOBs), pasture/hayland establishment, critical area, terrace system, no-till system, diversions, well decommissioning, nutrient management planning, and grade stabilization structures. The CPP is funded by the Illinois Department of Agriculture and is administered locally by the Edgar County Soil and Water Conservation District. The Edgar County SWCD does not have a set limit per landowner. CPP is a 60% cost share program for the majority of practices mentioned above.

### 3.4.1.7 Illinois Conservation and Climate Initiative (ICCI)

The 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).

#### 3.4.1.8 Local Program Information

The Farm Service Agency (FSA) administers the CRP. NRCS administers the EQIP, WRP, and WHIP. SWCD administers the CPP. Local contact information in Edgar County is listed in Table 3-5 below.

**Table 3-5 Edgar County USDA Service Center Contact Information**

| Contact | Address | Phone |
|---|---|---|
| Ray Coombes<br>Edgar County<br>District Conservationist | USDA-Natural Resources Conservation Service<br>11757 IL Hwy 1<br>Paris, IL 61944-2212 | 217-465-5325 |
| Charla Coombe<br>Edgar County<br>Resource Conservationist | Soil and Water Conservation District<br>11757 IL Hwy 1<br>Paris, IL 61944-2212 | 217-465-5325 |

### 3.4.2 Cost Estimates of BMPs

Cost estimates for different best management practices and individual practice prices such as filter strip installation are detailed in the following sections. Table 3-6 outlines the estimated cost of implementation measures in the Sugar Creek watershed.

#### 3.4.2.1 Filter Strips and Riparian Buffers

Filter strips can be seeded with grass for immediate function. The seeded filter strips cost approximately $0.30 per sq ft to construct. Generally, it is assumed that the required filter strip area is 2 percent of the area drained. This means that 870 square feet of filter strip are required for each acre of agricultural land treated. The construction cost to treat one acre of land is therefore $261/ac for a seeded filter strip. At an assumed system life of 20 years (Weiss et al., 2007), the annualized construction costs are $13/ac/yr. Annual maintenance of filter strips is estimated at $0.01 per sq ft (USEPA, 2002b) for an additional cost of $8.70/ac/yr of agricultural land treated. In addition, the area converted from agricultural production to filter strip will result in a net annual income loss of $3.50.

Restoration of riparian areas costs approximately $100/ac to construct and $475/ac to maintain over the life of the buffer (Wossink and Osmond, 2001; NCEEP, 2004). Maintenance of a riparian buffer should be minimal, but may include items such as period inspection of the buffer, minor grading to prevent short circuiting, and replanting/reseeding dead vegetation following premature death or heavy storms.

Assuming a buffer width of 144 ft on either side of the stream channel and an adjacent treated width of 300 ft of agricultural land, one acre of buffer will treat approximately 3.3 acres of adjacent agricultural land. The cost per treated area is thus $30/ac to construct and $142.50/ac to maintain over the life of the buffer. Assuming a system life of 30 years results in an annualized cost of $59.25/yr for each acre of agricultural land treated.

### 3.4.2.2 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.

### 3.4.2.3 Planning Level Cost Estimates for Implementation Measures

Cost estimates for different implementation measures are presented in Table 3-6. Cost estimates shown in Table 3-6 are the total estimated cost per acre and many costs could be reduced through cost share opportunities discussed in Section 3.4.1. 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 Soil Stabilization and Restoration Practice (SSRP), the Conservation Reserve Program (CRP), National Resource Conservation Service (NRCS), Conservation Cost-Share Program (CPP), Illinois EPA, and Illinois Department of Agriculture (IDA). It should be noted that Illinois EPA 319 Grants are applicable to all of these practices.

**Table 3-6 Cost Estimate of Various BMP Measures**

| Source | Program | Sponsor | BMP | Installation Mean Cost |
|---|---|---|---|---|
| Nonpoint | CRP/CPP | NRCS and IDA | Seeded filter strip | $25/acre |
| | CRP/CPP | NRCS and IDA | Riparian Buffer | $60/acre |
| | EQIP | NRCS | Livestock Fencing – Woven Wire | $1.55/ft |
| | | | Livestock Fencing – Barbed Wire | $1.22/ft |
| | | | Livestock Fencing – Electrified | $0.70/ft |
| | SSRP | IDA | Bank Stabilization | $25/ft |
| | | | Rock Riffle Grade Control | $7,500/riffle |
| | ICCI | CCX | Tree and Grass Planting | 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.

## 3.5 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
- Monitor quantity and quality of discharges from Paris Lake East spillway
- Continued ambient monitoring of all TMDL segments
- Further information gathering on area septic systems including locations and failure rates
- Perform a livestock survey within the watershed to assess access to Sugar Creek and tributaries
- Storm-based monitoring of high flow events
- Low flow monitoring of dissolved oxygen
- 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
- Further clarify the contributions from point sources
- Support work-load and costing analysis for assistance or regulatory programs
- Determine the extent to which management measures are properly maintained and operated

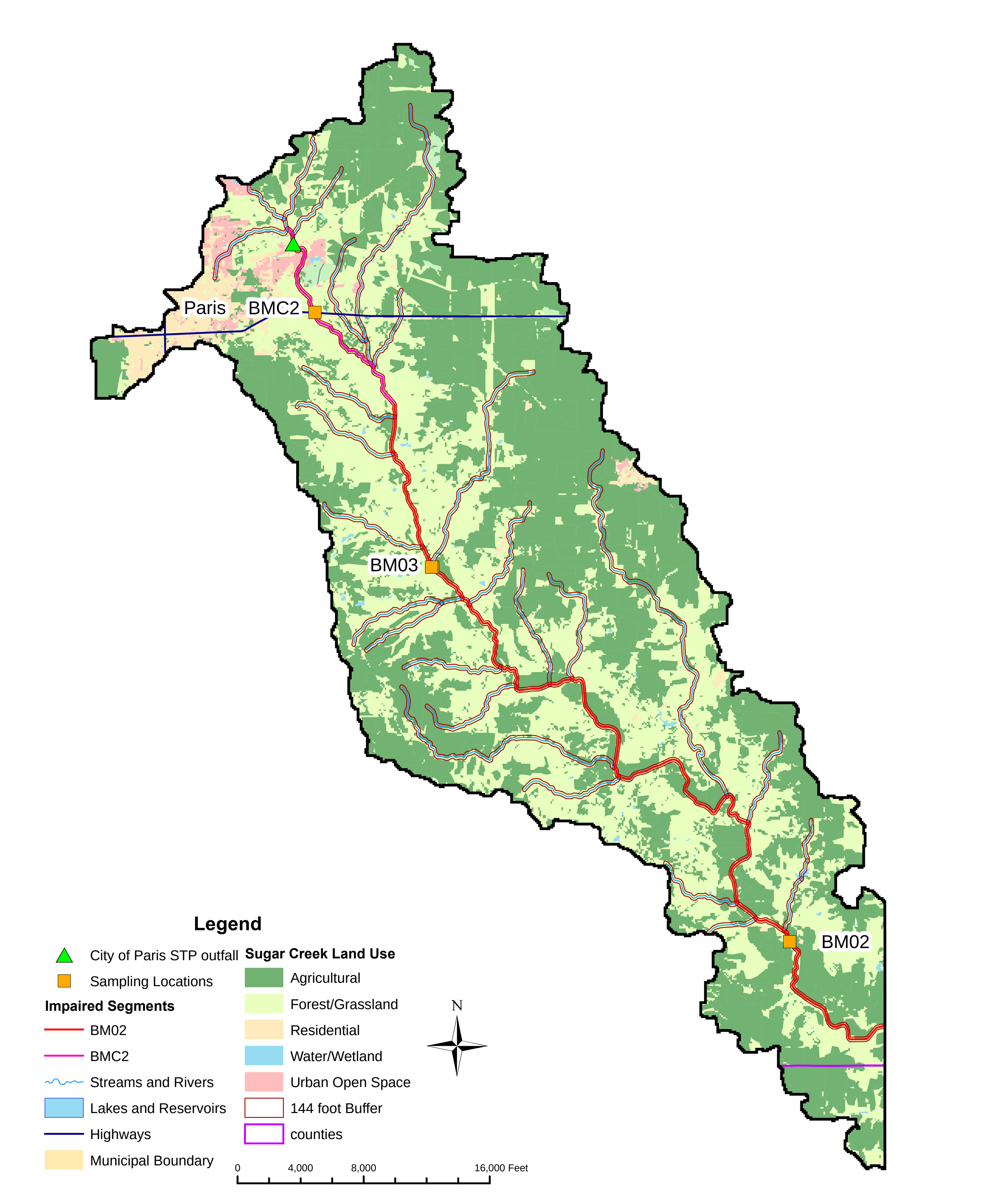
Estimating the effectiveness of the BMPs implemented in the watershed could be completed by monitoring before and after the BMP is incorporated into the watershed.

Illinois EPA's ambient monitoring program is currently in the process of being reestablished. In addition to Illinois EPA sampling, local volunteer monitoring efforts could be conducted along both impaired segments and main tributaries to further assess water quality issues as well as assess progress from implementation activities.

Regular and more extensive monitoring of point sources in the watershed would confirm their collective contributions and provide additional information regarding oxygen-demanding materials and fecal coliform to the Sugar Creek. As permits come up for renewal, Illinois EPA NPDES program should review the permits and decide if further management measures are required.

## 3.6 Implementation Time Line

Implementing the actions outlined in this section for the Sugar Creek watershed should occur in phases and assessing effectiveness of the management actions as improvements are made. It is assumed that it may take up to five 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 impaired segments 10 years or more to reach their water quality standard targets. In summary, it may take up to 20 years for impaired segments to meet the applicable water quality standards.



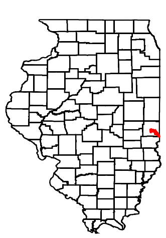



Figure 3-1: Buffer Zone for Potential Filter Strips
Sugar Creek Watershed

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# Section 4
# References

Al-Kaisi, M., M. Hanna, and M. Tidman. 2000. Survey: Iowa No-till Holds Steady. Integrated Crop Management, IC-484(23), October 23, 2000.

Al-Kaisi, M. 2002. *Can Residue be Managed Successfully with No-Till?* Integrated Crop Management. IC-496(11). May.

Buman, R.A., B.A. Alesii, J.L. Hatfield, and D.L. Karlen. 2004. Profit, yield, and soil quality effects of tillage systems in corn - soybean rotations, *Journal of Soil and Water Conservation,* Vol.59, No. 6.

Chapra, S. C., 1997. Surface Water Quality Modeling. McGraw Hill. Boston, Massachusetts.

Cooke, G.D., E.B. Welch, S.A. Peterson, and P.R. Newroth. 1993. Restoration and management of lakes and reservoirs. Lewis Publishers, Boca Raton, FL. 548 pp.

Cooke, Richard. 2005. Economic Aspects of Drainage and Water Management, University of Illinois, 2005 Corn & Soybean Classic.

Czapar, G.F., J.M. Laflen, G.F. McIsaac, D.P. McKenna. 2006. Effects of Erosion Control Practices on Nutrient Loss, University of Illinois.

Denison, D. and D. Tilton. 1993. Rouge River National Wet Weather Demonstration Program: Technical Memorandum. Rouge River Project: RPO-NPS-TM-12.01. August.

FSA (Farm Service Agency). 1997. *Conservation Reserve Program: Continuous Sign-Up for High Priority Conservation Practices*. USDA. February.

Gentry, L.E., M.B. David, T.V. Royer, C.A. Mitchell, and K.M. Starks. 2007. Phosphorus Transport Pathways to Streams in Tile-Drained Agricultural Watersheds. *Journal of Environmental Quality* Volume 36: 408:415, American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America.

Gilliam, J.W., D.L. Osmond, and R.O. Evans. 1997. Selected Agricultural Best Management Practices to Control Nitrogen in the Neuse River Basin. North Carolina Agricultural Research Service Technical Bulletin 311, North Carolina State University, Raleigh, NC.

Hajjar, L.M. 2000. Final Report for Section 309 – Cumulative and Secondary Impacts Task 2 – Model Septic System Maintenance Program. Office of Ocean and Coastal

Resource Management South Carolina Department of Health and Environmental Control.

Harman, W.L., T. Gerik, H.A. Torbert III, K.N. Potter. 2003. Agronomic and economic implications of conservation tillage and ultra-narrow row cropping systems. National Conservation Tillage Cotton and Rice Conference Proceedings. Jan. 23-24, Houston, TX. p. 11-13.

HRWCI. 2005. Agricultural Phosphorus Management and Water Quality in the Midwest. Heartland Regional Water Coordination Initiative. Iowa State University, Kansas State University, the University of Missouri, the University of Nebraska–Lincoln and the USDA Cooperative State Research, Education and Extension Service.

IAH. 2002. Illinois Agronomy Handbook, 23rd Edition. University of Illinois Extension, College of Agricultural, Consumer, and Environmental Sciences.

IILCP (Illinois Interagency Landscape Classification Project). 1999-2000: Land Cover of Illinois. http://www.agr.state.il.us/gis/landcover99-00.html
IDA (Illinois Department of Agriculture). 2006.http://www.agr.state.il.us/ Environment /conserv/ index.html

Illinois Department of Agriculture (IDA). 2004. 2004 Illinois Soil Conservation Transect Survey Summary.

Illinois Department of Natural Resources (IDNR), Illinois Natural History Survey (INHS), Illinois Department of Agriculture (IDA), United States Department of Agriculture (USDA) National Agricultural Statistics Survey (NASS)'s 1:1000,000 Scale Land Cover of Illinois 1999-2000. Raster Digital Data. Version 2.0, Sept 2003. *http://www.inhs.uiuc.edu/cwe/gap/landcover.htm*

Illinois EPA (Illinois Environmental Protection Agency). 2005. Water Quality Data.

________.2004a. Illinois Water Quality Report, 2004. IEPA/BOW/04-006.

________. 2004b. Clean Water Act Section 303(d) List -Illinois' Submittal for 2004.

Illinois Natural Resources Geospatial Data Clearinghouse. 2005 Illinois Digital Orthophoto Quarter Quadrangle Data.
http://www.isgs.uiuc.edu/nsdihome/webdocs/doq05/

Kalita, Prasanta. 2000. Vegetative Filter Strips to Reduce Pathogens and Nutrients in Runoff from Livestock Feedlots. Department of Crop Sciences College of Agriculture, Consumer and Environmental Sciences, University of Illinois Extension.

Kinney, Wayne. *Aerial Assessment Report for Sugar Creek.* Edgar County. September 2005. IL Department of Agriculture

Kovacic, D.A., M.B. David, L.E. Gentry, K.M. Starks and R.A. Cooke. 2000 *Effectiveness of constructed wetlands in reducing nitrogen and phosphorus export from agricultural tile drainage*. J. Environ. Qual. 29:1262-1274.

Ledwith, Tyler. 1996. Effects of Buffer Strip Width on Air Temperature and Relative Humidity in a Stream Riparian Zone. Watershed Management Council Networker; 6(4):6-7. http://www.watershed.org/news/sum_96/buffer.html

NCDC (National Climatic Data Center). 2007. Weather stations.

NCDENR. 2005. Updated Draft Manual of Stormwater Best Management Practices. North Carolina Department of Environment and Natural Resources, Division of Water Quality.

NCEEP. 2004. North Carolina Ecosystem Enhancement Program Annual Report 2003-2004. North Carolina Department of Environment and Natural Resources.

NCSU. 2002. Riparian Buffers and Controlled Drainage to Reduce Agricultural Nonpoint Source Pollution. Departments of Soil Science and Biological and Agricultural Engineering, North Carolina Agricultural Research Service, North Carolina State University, Raleigh, North Carolina. Technical Bulletin 318, September 2002.

NCSU (North Carolina State University) Water Quality Group. 2000. National Management Measures to Control Nonpoint Source Pollution from Agriculture. United States Environmental Protection Agency: Contract # 68-C99-249.

NRCS (Natural Resources Conservation Service). 2006. EQIP Fact Sheet. http://www.nrcs.usda.gov/PROGRAMS/EQIP/

________. 2004. Wetland Reserves Program. http://www.nrcs.usda.gov/programs/WRP/

________. 2002. Natural Resources Conservation Service Conservation Practice Standard Field Border (Feet) Code 386.

________. 1999. Illinois Urban Manual: PRACTICE STANDARD -FILTER STRIP (acre) CODE 835. http://www.il.nrcs.usda.gov/technical/engineer/urban/standards/urbst835.html

Olson, K.D. and N.B. Senjem. 2002. Economic Comparison of Incremental Changes in Till Systems in the Minnesota River Basin, University of Minnesota, 2002.

Osmond, D.L., J. Spooner, and D.E. Line. 1995. Systems of Best Management Practices for Controlling Agricultural Nonpoint Source Pollution: The Rural Clean

Water Program Experience. North Carolina State University Water Quality Control Group: brochure 6. March.

OSUE. 1994. Vegetative Filter Strips: Application, Installation and Maintenance. Ohio State University Extension Food, Agricultural and Biological Engineering. Fact Sheet AEX-467-94.
Personal Communications with Ray Coombes. Edgar County NRCS. 2007.

Personal Communications with Robbie Barker. Edgar County Department of Environmental Health. 2007.

Sharpley, A.N., T. Daniel, T. Sims, J. Lemunyon, R. Stevens, and R. Parry. 1999. Agricultural Phosphorus and Eutrophication. United States Department of Agriculture: ARS-149. July. http://www.ars.usda.gov/is/np/Phos&Eutro/phos%26eutro.pdf

Stauffer, R.E. 1981. Sampling strategies for estimating the magnitude and importance of internal phosphorus supplies in lakes. U.S. EPA 600/3-81-015. Washington, D.C.

Tan, C.S., C.F. Drury, T.Q. Zhang, W.D. Reynolds, J.D. Gaynor. 2003. Wetland-Reservoir System Improves Water Quality and Crop Production, Paper number 032327, 2003 ASAE Annual Meeting.

Tetra Tech. 2005. TMDL Development for the Paris Twin Lakes/Sugar Creek Watershed. Stage One Report: Watershed Characterization and Water Quality Analysis.

_______. 2007. Stage Two Water Quality Sampling Report. For TMDLs in North Fork Vermilion River, Salt Fork Vermilion River, Sugar Creek, and Walnut Point Lake.

USACE (United States Army Corps of Engineers) in cooperation with FEMA's National Dam Safety Program. 2005. National Inventory of Dams. http://www.tec.army.mil/nid

_______. 1999. *Simplified Procedures for Eutrophication and Assessment and Prediction: User Manual.* William Walker. Instruction Report W-96-2. Waterways Experiment Station. USACE Headquarters.

USDA (United States Department of Agriculture). 2006a. Farm Service Agency Online: Conservation Reserve Program Fact Sheet. http:/www.fsa.usda.gov/pas/publications/ facts/html/crp06.htm.October

________. 2006b. National Agricultural Statistics Survey (NASS) 2002 Census of Agriculture. *http://www.nass.usda.gov/census/census02/volume1/index2.htm*

________. 1994. Natural Resource Conservation Service Online: Planning and Design Manual for the Control of Erosion, Sediment, and Stormwater. http://www.abe. msstate.edu/ Tools/csd/p-dm/index.html

USEPA (U.S. Environmental Protection Agency). 2004a. *BASINS - Better Assessment Science Integrating Point and Nonpoint Sources*. Download: BASINS Data. http://www.epa.gov/OST/BASINS/

________. 2004b. *STORET – Storage and Retrieval*. Download: Water Quality Data. http://www.epa.gov/storet/

________. 1999. Draft Guidance for Water Quality-based Decisions: The TMDL Process (Second Edition). Office of Water. EPA 841/D/99/001.

________. 1997. Compendium of Tools for Watershed Assessment and TMDL Development. Office of Water. EPA/841/B/97/006.

US Fish and Wildlife Service. 2006. National Wetlands Inventory. http://www.fws.gov /nwi/

USGS (U.S. Geological Survey). 2007. Daily Streamflow. Download: Daily Flows for Stream Gage 03336900 (Salt Fork near St. Josepth, Illinois). http://waterdata.usgs.gov/nwis.

Welch, E.B. 1992. Ecological effects of wastewater. 2nd Edition. Chapman and Hall, New York, NY.

Wetzel, R. G. 1983. *Limnology*. Saunders College Publishing. Orlando, Florida. pp. 289–297.

WIDNR. 2003. Alum Treatments to Control Phosphorus in Lakes. Wisconsin Department of Natural Resources, March 2003.

Woerner, B. and J. Lorimer. 2006. Alternative Treatments to Minimize Water Pollution from Open Animal Feedlots. Department of Ag and Bio Systems Engineering, Iowa State University.

Wossink, A., and D. Osmond. 2001. Cost and Benefits of Best Management Practices to Control Nitrogen in the Piedmont. North Carolina Cooperative Extension Service.

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# Appendix A
# QUAL2K Model Files

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*QUAL2K FORTRAN*

*Stream Water Quality Model*

*Steve Chapra, Hua Tao and Greg Pelletier*

*Version 2.07*

| | | |
|---|---|---|
| ***System ID:*** | | |
| **River name** | **Sugar Creek** | |
| **Saved file name** | **SugarCreek_Baseline** | |
| **Directory where file saved** | **C:\qual2k** | |
| **Month** | **7** | |
| **Day** | **19** | |
| **Year** | **2006** | |
| **Time zone** | **Central** | |
| **Daylight savings time** | **Yes** | |
| ***Calculation:*** | | |
| **Calculation step** | **0.0625** | **hours** |
| **Final time** | **20** | **day** |
| **Solution method (integration)** | **Euler** | |
| **Solution method (pH)** | **Bisection** | |
| **Program determined calc step** | **0.046875** | **hours** |
| **Time of last calculation** | **0.04** | **minutes** |
| **Time of sunrise** | **5:38 AM** | |
| **Time of solar noon** | **12:56 PM** | |
| **Time of sunset** | **8:14 PM** | |
| **Photoperiod** | **14.60** | **hours** |

*QUAL2K*

*Stream Water Quality Model*

*Sugar Creek (7/19/2006)*

*Headwater Data:*

SEE DODATA_SUGAR.XLS for Data Sources

Values entered were Average July-August Values

***Note:*** **** required field***

| ID | Number of Headwaters* | 1 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. 1 | Reach No.* | Headwater Name | Flow* | Elevation | Weir | | | | Rating Curves | | | | |
| | | | Rate | | Height | Width | adam | bdam | Velocity | | Depth | | Channel |
| | | | ($m^3/s$) | (m) | (m) | (m) | | | Coefficient | Exponent | Coefficient | Exponent | Slope |
| | 1 | Mainstem headwate | 0.061 | 195.5 | | | 1.2500 | 0.9000 | 0.0250 | 0.000 | 0.1900 | 0.000 | |
| | Headwater Water Quality | Units | 12:00 AM | 1:00 AM | 2:00 AM | 3:00 AM | 4:00 AM | 5:00 AM | 6:00 AM | 7:00 AM | 8:00 AM | 9:00 AM | 10:00 AM |
| | Temperature | C | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 |
| | Conductivity | umhos | | | | | | | | | | | |
| | Inorganic Solids | mgD/L | | | | | | | | | | | |
| | Dissolved Oxygen | mg/L | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 |
| | CBODslow | mgO2/L | | | | | | | | | | | |
| | CBODfast | mgO2/L | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 |
| | Organic Nitrogen | ugN/L | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 |
| | NH4-Nitrogen | ugN/L | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 |
| | NO3-Nitrogen | ugN/L | 6500 | 6500 | 6500 | 6500 | 6500 | 6500 | 6500 | 6500 | 6500 | 6500 | 6500 |
| | Organic Phosphorus | ugP/L | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 |
| | Inorganic Phosphorus (SRP) | ugP/L | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 |
| | Phytoplankton | ugA/L | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 |
| | Detritus (POM) | mgD/L | | | | | | | | | | | |
| | Pathogen | cfu/100 mL | | | | | | | | | | | |
| | Alkalinity | mgCaCO3/L | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| | pH | s.u. | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| **Manning Formula** | | | | ***Prescribed*** | | | | | | | | |
| ***Manning*** | ***Bot Width*** | ***Side*** | ***Side*** | ***Dispersion*** | | | | | | | | |
| ***n*** | ***m*** | ***Slope*** | ***Slope*** | ***m2/s*** | | | | | | | | |
| | | | | | | | | | | | | |
| ***11:00 AM*** | ***12:00 PM*** | ***1:00 PM*** | ***2:00 PM*** | ***3:00 PM*** | ***4:00 PM*** | ***5:00 PM*** | ***6:00 PM*** | ***7:00 PM*** | ***8:00 PM*** | ***9:00 PM*** | ***10:00 PM*** | ***11:00 PM*** |
| 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 |
| | | | | | | | | | | | | |
| 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 |
| 879.487 | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 | 879.487 |
| 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 | 4100.000 |
| 6500 | 6500 | 6500 | 6500 | 6500 | 6500 | 6500 | 6500 | 6500 | 6500 | 6500 | 6500 | 6500 |
| 83.333 | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 | 83.333 |
| 941.111 | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 | 941.111 |
| 15.000 | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 | 15.000 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** |
| **7.00** | **7.00** | **7.00** | **7.00** | **7.00** | **7.00** | **7.00** | **7.00** | **7.00** | **7.00** | **7.00** | **7.00** | **7.00** |

*QUAL2K*

*Stream Water Quality Model*

*Sugar Creek (7/19/2006)*

*Reach Data:*

| Reach for diel plot | 2 | | | | | | | | | | | | | | | | Hydra |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Element for diel plot | 2 | Reach | Headwater | Reach | Downstream | | Location | | Element | Elevation | | Downstream | | | | | |
| Reach | Downstream | Number | Reach | length | Downstream | | Upstream | Downstream | Number | Upstream | Downstream | Latitude | | | Longitude | | |
| Label | end of reach label | | | (km) | Latitude | Longitude | (km) | (km) | >=1 | (m) | (m) | Degrees | Minutes | Seconds | Degrees | Minutes | Seconds |
| Headwaters | | 1 | Yes | 2.21 | 39.61 | 87.66 | 4.99 | 2.79 | 2 | 195.5 | 188 | 39 | 36 | 27.014 | 87.00 | 39 | 40.014 |
| BMC2 | | 2 | | 2.79 | 39.59 | 87.64 | 2.79 | 0.00 | 2 | 188 | 185.5 | 39 | 35 | 19.738 | 87.00 | 38 | 34.721 |

aulic Model (Weir Overrides Manning Formula; Manning Formula Override Rating Curves)

| Weir | | | | Rating Curves | | | | Manning Formula | | | | | Prescribed | Bottom | Bottom | Prescribed | Prescribed | Prescribed | Prescribed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height | Width | adam | bdam | Velocity | | Depth | | Channel | Manning | Bot Width | Side | Side | Dispersion | Algae | SOD | SOD | CH4 flux | NH4 flux | Inorg P flux |
| (m) | (m) | | | Coefficient | Exponent | Coefficient | Exponent | Slope | n | m | Slope | Slope | m2/s | Coverage | Coverage | gO2/m2/d | gO2/m2/d | mgN/m2/d | mgP/m2/d |
| 0.0000 | 0.0000 | 1.2500 | 0.9000 | 0.0250 | 0.000 | 0.1900 | 0.000 | | | | | | 0.00 | 50.00% | 50.00% | 5.00 | 0.0000 | 0.0000 | 0.0000 |
| 0.0000 | 0.0000 | 1.2500 | 0.9000 | 0.0250 | 0.000 | 0.1900 | 0.000 | | | | | | 0.00 | 50.00% | 50.00% | 5.00 | 0.0000 | 0.0000 | 0.0000 |

*QUAL2K*

*Stream Water Quality Model*

*Sugar Creek (7/19/2006)*

*Air Temperature Data:*

| | | | | Upstream | Downstream | 12:00 AM | 1:00 AM | 2:00 AM | 3:00 AM | 4:00 AM | 5:00 AM | 6:00 AM | 7:00 AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Upstream | Reach | Downstream | Reach | Distance | Distance | Hourly air temperature for each reach (degrees C) | | | | | | | |
| Label | Label | Label | Number | km | km | (The input values are applied as point estimates at each time. Linear interpolation is used to estima | | | | | | | |
| Mainstem headwater | Headwaters | | 1 | 4.99 | 2.79 | 20.00 | 20.00 | 20.00 | 18.00 | 18.00 | 20.00 | 21.00 | 24.00 |
| | BMC2 | | 2 | 2.79 | 0.00 | 20.00 | 20.00 | 20.00 | 18.00 | 18.00 | 20.00 | 21.00 | 24.00 |

| 8:00 AM | 9:00 AM | 10:00 AM | 11:00 AM | 12:00 PM | 1:00 PM | 2:00 PM | 3:00 PM | 4:00 PM | 5:00 PM | 6:00 PM | 7:00 PM | 8:00 PM | 9:00 PM | 10:00 PM | 11:00 PM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| *te values between the hourly inputs.* | | | | | | | | | | | | | | | |
| 25.00 | 27.00 | 28.00 | 30.00 | 31.00 | 31.00 | 31.00 | 31.00 | 29.00 | 27.00 | 26.00 | 25.00 | 25.00 | 25.00 | 23.00 | 22.00 |
| 25.00 | 27.00 | 28.00 | 30.00 | 31.00 | 31.00 | 31.00 | 31.00 | 29.00 | 27.00 | 26.00 | 25.00 | 25.00 | 25.00 | 23.00 | 22.00 |

*QUAL2K*
*Stream Water Quality Model*
*Sugar Creek (7/19/2006)*
*Dew Point Temperature Data:*

| | | | | Upstream | Downstream | 12:00 AM | 1:00 AM | 2:00 AM | 3:00 AM | 4:00 AM | 5:00 AM | 6:00 AM | 7:00 AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Upstream | Reach | Downstream | Reach | Distance | Distance | Hourly dewpoint temperature for each reach (degrees C) | | | | | | | |
| Label | Label | Label | Number | km | km | (The input values are applied as point estimates at each time. Linear interpolation is used to estima | | | | | | | |
| Mainstem headwater | Headwaters | | 1 | 4.99 | 2.79 | 18.00 | 19.00 | 19.00 | 18.00 | 18.00 | 19.00 | 20.00 | 21.00 |
| | BMC2 | | 2 | 2.79 | 0.00 | 18.00 | 19.00 | 19.00 | 18.00 | 18.00 | 19.00 | 20.00 | 21.00 |

| 8:00 AM | 9:00 AM | 10:00 AM | 11:00 AM | 12:00 PM | 1:00 PM | 2:00 PM | 3:00 PM | 4:00 PM | 5:00 PM | 6:00 PM | 7:00 PM | 8:00 PM | 9:00 PM | 10:00 PM | 11:00 PM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| te values between the hourly inputs. | | | | | | | | | | | | | | | |
| 22.00 | 22.00 | 23.00 | 23.00 | 24.00 | 24.00 | 23.00 | 23.00 | 25.00 | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 |
| 22.00 | 22.00 | 23.00 | 23.00 | 24.00 | 24.00 | 23.00 | 23.00 | 25.00 | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 |

*QUAL2K*
*Stream Water Quality Model*
*Sugar Creek (7/19/2006)*
*Wind Speed Data:*

| | | | | Upstream | Downstream | 12:00 AM | 1:00 AM | 2:00 AM | 3:00 AM | 4:00 AM | 5:00 AM | 6:00 AM | 7:00 AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Upstream | Reach | Downstream | Reach | Distance | Distance | Wind speed for each reach 7m above water surface (m/s) | | | | | | | |
| Label | Label | Label | Number | km | km | (The input values are applied as point estimates at each time. Linear interpolation is used to estima | | | | | | | |
| Mainstem headwater | Headwaters | | 1 | 4.99 | 2.79 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.68 |
| | BMC2 | | 2 | 2.79 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.68 |

| 8:00 AM | 9:00 AM | 10:00 AM | 11:00 AM | 12:00 PM | 1:00 PM | 2:00 PM | 3:00 PM | 4:00 PM | 5:00 PM | 6:00 PM | 7:00 PM | 8:00 PM | 9:00 PM | 10:00 PM | 11:00 PM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| *te values between the hourly inputs.* | | | | | | | | | | | | | | | |
| 0.00 | 0.00 | 1.34 | 3.13 | 1.34 | 1.34 | 1.34 | 0.00 | 0.00 | 1.79 | 0.00 | 4.92 | 1.79 | 4.02 | 0.00 | 2.68 |
| 0.00 | 0.00 | 1.34 | 3.13 | 1.34 | 1.34 | 1.34 | 0.00 | 0.00 | 1.79 | 0.00 | 4.92 | 1.79 | 4.02 | 0.00 | 2.68 |

*QUAL2K*
*Stream Water Quality Model*
*Sugar Creek (7/19/2006)*
*Cloud Cover Data:*

| | | | | Upstream | Downstream | 12:00 AM | 1:00 AM | 2:00 AM | 3:00 AM | 4:00 AM | 5:00 AM | 6:00 AM | 7:00 AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Upstream | Reach | Downstream | Reach | Distance | Distance | Hourly cloud cover shade for each reach (Percent) | | | | | | | |
| Label | Label | Label | Number | km | km | (Percent of sky that is covered by clouds. The input values are applied as point estimates at each ti | | | | | | | |
| Mainstem headwater | Headwaters | | 1 | 4.99 | 2.79 | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% |

| 8:00 AM | 9:00 AM | 10:00 AM | 11:00 AM | 12:00 PM | 1:00 PM | 2:00 PM | 3:00 PM | 4:00 PM | 5:00 PM | 6:00 PM | 7:00 PM | 8:00 PM | 9:00 PM | 10:00 PM | 11:00 PM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| ime. Linear interpolation is used to estimate values between the hourly inputs | | | | | | | | | | | | | | | |
| 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% |

*QUAL2K*

*Stream Water Quality Model*

*Sugar Creek (7/19/2006)*

*Water Column Rates*

| Parameter | Value | Units | Symbol |
|---|---|---|---|
| *Stoichiometry:* | | | |
| Carbon | 40 | gC | gC |
| Nitrogen | 7.2 | gN | gN |
| Phosphorus | 1 | gP | gP |
| Dry weight | 100 | gD | gD |
| Chlorophyll | 1 | gA | gA |
| *Inorganic suspended solids:* | | | |
| Settling velocity | 0.3 | m/d | $v_i$ |
| *Oxygen:* | | | |
| Reaeration model | Internal | | |
| User reaeration coefficient α | 3.93 | | $\alpha$ |
| User reaeration coefficient β | 0.5 | | $\beta$ |
| User reaeration coefficient γ | 1.5 | | $\gamma$ |
| Temp correction | 1.024 | | $\theta_a$ |
| Reaeration wind effect | Banks-Herrera | | |
| O2 for carbon oxidation | 2.69 | $gO_2/gC$ | $r_{oc}$ |
| O2 for NH4 nitrification | 4.57 | $gO_2/gN$ | $r_{on}$ |
| Oxygen inhib model CBOD oxidation | Exponential | | |
| Oxygen inhib parameter CBOD oxidation | 0.60 | L/mgO2 | $K_{socf}$ |
| Oxygen inhib model nitrification | Exponential | | |
| Oxygen inhib parameter nitrification | 0.60 | L/mgO2 | $K_{sona}$ |
| Oxygen enhance model denitrification | Exponential | | |
| Oxygen enhance parameter denitrification | 0.60 | L/mgO2 | $K_{sodn}$ |
| Oxygen inhib model phyto resp | Exponential | | |
| Oxygen inhib parameter phyto resp | 0.60 | L/mgO2 | $K_{sop}$ |
| Oxygen enhance model bot alg resp | Exponential | | |
| Oxygen enhance parameter bot alg resp | 0.60 | L/mgO2 | $K_{sob}$ |
| *Slow CBOD:* | | | |
| Hydrolysis rate | 0.1 | /d | $k_{hc}$ |
| Temp correction | 1.07 | | $\theta_{hc}$ |
| Oxidation rate | 0 | /d | $k_{dcs}$ |
| Temp correction | 1.047 | | $\theta_{dcs}$ |
| *Fast CBOD:* | | | |
| Oxidation rate | 0.23 | /d | $k_{dc}$ |
| Temp correction | 1.047 | | $\theta_{dc}$ |

| | | | |
|---|---|---|---|
| ***Organic N:*** | | | |
| **Hydrolysis** | **0.2** | **/d** | $k_{hn}$ |
| **Temp correction** | **1.07** | | $\theta_{hn}$ |
| **Settling velocity** | **0.1** | **m/d** | $v_{on}$ |
| ***Ammonium:*** | | | |
| **Nitrification** | **1** | **/d** | $k_{na}$ |
| **Temp correction** | **1.07** | | $\theta_{na}$ |
| ***Nitrate:*** | | | |
| **Denitrification** | **0** | **/d** | $k_{dn}$ |
| **Temp correction** | **1.07** | | $\theta_{dn}$ |
| **Sed denitrification transfer coeff** | **0** | **m/d** | $v_{di}$ |
| **Temp correction** | **1.07** | | $\theta_{di}$ |
| ***Organic P:*** | | | |
| **Hydrolysis** | **0.2** | **/d** | $k_{hp}$ |
| **Temp correction** | **1.07** | | $\theta_{hp}$ |
| **Settling velocity** | **0.1** | **m/d** | $v_{op}$ |
| ***Inorganic P:*** | | | |
| **Settling velocity** | **2** | **m/d** | $v_{ip}$ |
| **Inorganic P sorption coefficient** | **0** | **L/mgD** | $K_{dpi}$ |
| **Sed P oxygen attenuation half sat constant** | **0.05** | **$mgO_2/L$** | $k_{spi}$ |
| ***Phytoplankton:*** | | | |
| **Max Growth rate** | **4** | **/d** | $k_{gp}$ |
| **Temp correction** | **1.07** | | $\theta_{gp}$ |
| **Respiration rate** | **0.2** | **/d** | $k_{rp}$ |
| **Temp correction** | **1.07** | | $\theta_{rp}$ |
| **Death rate** | **0.2** | **/d** | $k_{dp}$ |
| **Temp correction** | **1.07** | | $\theta_{dp}$ |
| **Nitrogen half sat constant** | **25** | **ugN/L** | $k_{sPp}$ |
| **Phosphorus half sat constant** | **5** | **ugP/L** | $k_{sNp}$ |
| **Inorganic carbon half sat constant** | **1.30E-05** | **moles/L** | $k_{sCp}$ |
| **Light model** | **Half saturation** | | |
| **Light constant** | **100** | **langleys/d** | $K_{Lp}$ |
| **Ammonia preference** | **25** | **ugN/L** | $k_{hnxp}$ |
| **Settling velocity** | **0.5** | **m/d** | $v_a$ |

| | | | |
|---|---|---|---|
| ***Bottom Algae:*** | | | |
| **Growth model** | **Zero-order** | | |
| **Max Growth rate** | **25** | **mgA/m$^2$/d or /d** | $C_{gb}$ |
| **Temp correction** | **1.07** | | $\theta_{gb}$ |
| **First-order model carrying capacity** | **1000** | **mgA/m$^2$** | $a_{b,max}$ |
| **Respiration rate** | **0.1** | **/d** | $k_{rb}$ |
| **Temp correction** | **1.07** | | $\theta_{rb}$ |
| **Excretion rate** | **0.05** | **/d** | $k_{eb}$ |
| **Temp correction** | **1.07** | | $\theta_{db}$ |
| **Death rate** | **0.1** | **/d** | $k_{db}$ |
| **Temp correction** | **1.07** | | $\theta_{db}$ |
| **External nitrogen half sat constant** | **300** | **ugN/L** | $k_{sPb}$ |
| **External phosphorus half sat constant** | **100** | **ugP/L** | $k_{sNb}$ |
| **Inorganic carbon half sat constant** | **1.30E-05** | **moles/L** | $k_{sCb}$ |
| **Light model** | **Half saturation** | | |
| **Light constant** | **100** | **langleys/d** | $K_{Lb}$ |
| **Ammonia preference** | **25** | **ugN/L** | $k_{hnxb}$ |
| **Subsistence quota for nitrogen** | **0.72** | **mgN/mgA** | $q_{0N}$ |
| **Subsistence quota for phosphorus** | **0.1** | **mgP/mgA** | $q_{0P}$ |
| **Maximum uptake rate for nitrogen** | **72** | **mgN/mgA/d** | $\rho_{mN}$ |
| **Maximum uptake rate for phosphorus** | **5** | **mgP/mgA/d** | $\rho_{mP}$ |
| **Internal nitrogen half sat constant** | **0.9** | **mgN/mgA** | $K_{qN}$ |
| **Internal phosphorus half sat constant** | **0.13** | **mgP/mgA** | $K_{qP}$ |
| ***Detritus (POM):*** | | | |
| **Dissolution rate** | **0.5** | **/d** | $k_{dt}$ |
| **Temp correction** | **1.07** | | $\theta_{dt}$ |
| **Fraction of dissolution to fast CBOD** | **1.00** | | $F_f$ |
| **Settling velocity** | **0.1** | **m/d** | $v_{dt}$ |
| ***Pathogens:*** | | | |
| **Decay rate** | **0.8** | **/d** | $k_{dx}$ |
| **Temp correction** | **1.07** | | $\theta_{dx}$ |
| **Settling velocity** | **1** | **m/d** | $v_x$ |
| **Light efficiency factor** | **1.00** | | $\alpha_{path}$ |
| ***pH:*** | | | |
| **Partial pressure of carbon dioxide** | **347** | **ppm** | $p_{CO2}$ |

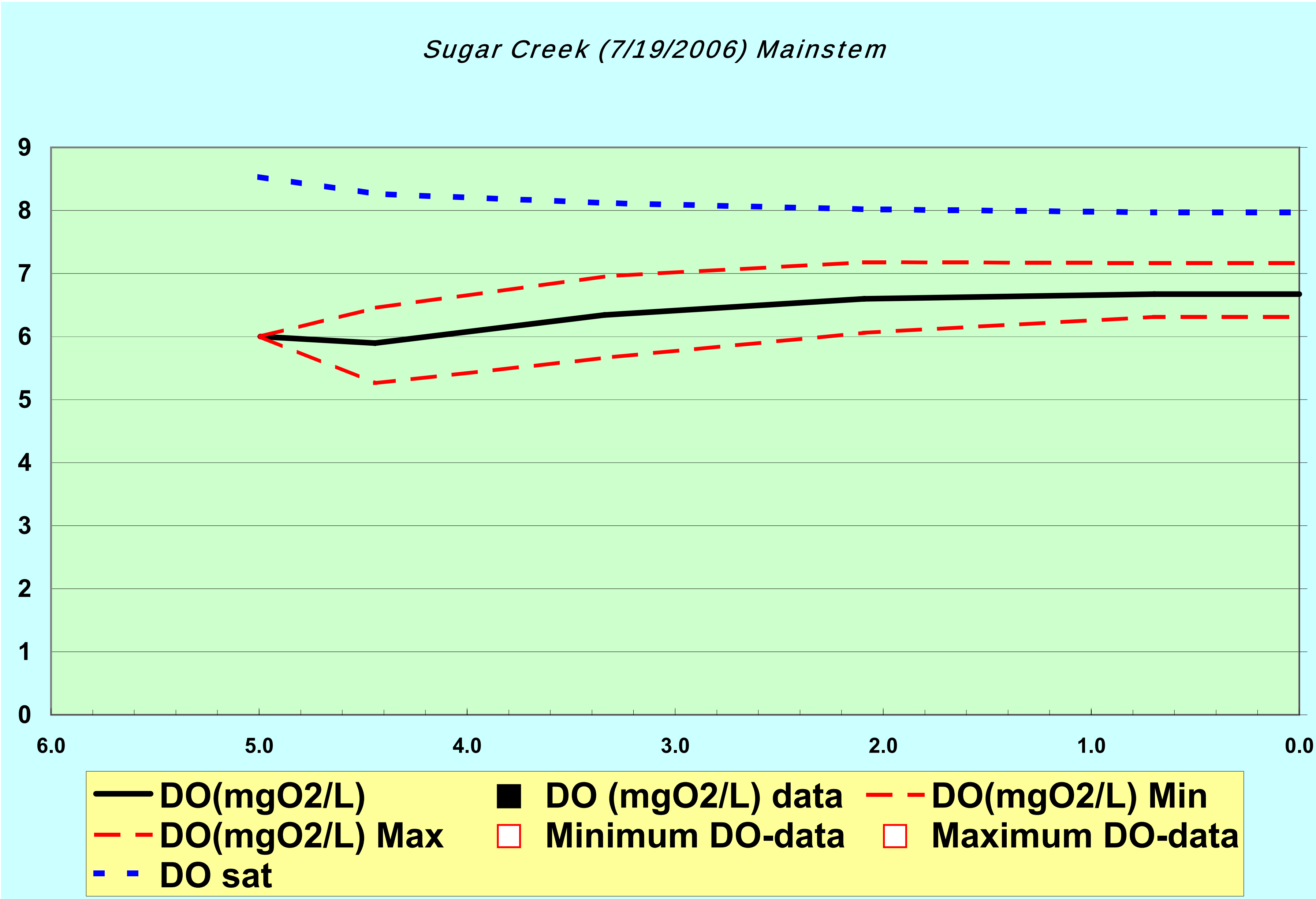
*QUAL2K*

*Stream Water Quality Model*

*Sugar Creek (7/19/2006)*

*Light Parameters and Surface Heat Transfer Models:*

| *Parameter* | *Value* | *Unit* | |
|---|---|---|---|
| **Photosynthetically Available Radiation** | **0.47** | | |
| **Background light extinction** | **0.2** | */m* | $k_{eb}$ |
| **Linear chlorophyll light extinction** | **0.0088** | *1/m-(ugA/L)* | $\alpha_p$ |
| **Nonlinear chlorophyll light extinction** | **0.054** | *1/m-(ugA/L)2/3* | $\alpha_{pn}$ |
| **ISS light extinction** | **0.052** | *1/m-(mgD/L)* | $\alpha_\iota$ |
| **Detritus light extinction** | **0.174** | *1/m-(mgD/L)* | $\alpha_o$ |
| ***Solar shortwave radiation model*** | | | |
| **Atmospheric attenuation model for solar** | **Bras** | | |
| ***Bras solar parameter (used if Bras solar model is selected)*** | | | |
| **atmospheric turbidity coefficient (2=clear, 5=smoggy, default=2)** | **2** | | $n_{fac}$ |
| ***Ryan-Stolzenbach solar parameter (used if Ryan-Stolzenbach solar model is selected)*** | | | |
| **atmospheric transmission coefficient (0.70-0.91, default 0.8)** | **0.8** | | $a_{tc}$ |
| ***Downwelling atmospheric longwave IR radiation*** | | | |
| **atmospheric longwave emissivity model** | **Brunt** | | |
| ***Evaporation and air convection/conduction*** | | | |
| **wind speed function for evaporation and air convection/conduction** | **Brady-Graves-Geyer** | | |
| ***Sediment heat parameters*** | | | |
| **Sediment thermal thickness** | **15** | *cm* | $H_s$ |
| **Sediment thermal diffusivity** | **0.0064** | *$cm^2/s$* | $\alpha_s$ |
| **Sediment density** | **1.6** | *$g/cm^3$* | $\rho_s$ |
| **Water density** | **1** | *$g/cm^3$* | $\rho_w$ |
| **Sediment heat capacity** | **0.4** | *$cal/(g\ ^oC)$* | $C_{ps}$ |
| **Water heat capacity** | **2** | *$cal/(g\ ^oC)$* | $C_{pw}$ |
| ***Sediment diagenesis model*** | | | |
| **Compute SOD and nutrient fluxes** | **Yes** | | |


Sugar Creek (7/19/2006) Mainstem
9
8
7
6
5
4
3
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1
0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
DO(mgO2/L)
DO (mgO2/L) data
DO(mgO2/L) Min
DO(mgO2/L) Max
Minimum DO-data
Maximum DO-data
DO sat

# Appendix B
# Paris South STP
# NPDES Permit

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NPDES Permit No. IL0021377
Notice No. RJH:07032101.bah

Public Notice Beginning Date: **April 23, 2007**

Public Notice Ending Date: **May 23, 2007**

National Pollutant Discharge Elimination System (NPDES)
Permit Program

PUBLIC NOTICE/FACT SHEET
of
Draft Reissued NPDES Permit to Discharge into Waters of the State

Public Notice/Fact Sheet Issued By:

Illinois EPA
Division of Water Pollution Control
Permit Section
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276
217/782-0610

Name and Address of Discharger:

City of Paris
206 South Central
Paris, Illinois 61944

Name and Address of Facility:

Paris Sewage Treatment Plant
929 Clinton Road
Paris, Illinois
(Edgar County)

The Illinois Environmental Protection Agency (IEPA) has made a tentative determination to issue a NPDES Permit to discharge into the waters of the state and has prepared a draft Permit and associated fact sheet for the above named discharger. The Public Notice period will begin and end on the dates indicated in the heading of this Public Notice/Fact Sheet. All comments on the draft Permit and requests for hearing must be received by the IEPA by U.S. Mail, carrier mail or hand delivered by the Public Notice Ending Date. Interested persons are invited to submit written comments on the draft Permit to the IEPA at the above address. Commentors shall provide his or her name and address and the nature of the issues proposed to be raised and the evidence proposed to be presented with regards to those issues. Commentors may include a request for public hearing. Persons submitting comments and/or requests for public hearing shall also send a copy of such comments or requests to the Permit applicant. The NPDES Permit and notice numbers must appear on each comment page.

The application, engineer's review notes including load limit calculations, Public Notice/Fact Sheet, draft Permit, comments received, and other documents are available for inspection and may be copied at the IEPA between 9:30 a.m. and 3:30 p.m. Monday through Friday when scheduled by the interested person.

If written comments or requests indicates a significant degree of public interest in the draft Permit, the permitting authority may, at its discretion, hold a public hearing. Public notice will be given 45 days before any public hearing. Response to comments will be provided when the final Permit is issued. For further information, please call Ralph Hahn at 217/782-0610.

The following water quality and effluent standards and limitations were applied to the discharge:

Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter I: Pollution Control Board and the Clean Water Act were applied in determining the applicable standards, limitations and conditions contained in the draft Permit.

The applicant is engaged in treating domestic wastewater for the City of Paris.

The length of the Permit is approximately 5 years.

The main discharge number is 001. The seven day once in ten year low flow (7Q10) of the receiving stream, Sugar Creek, is 0 cfs.

The design average flow (DAF) for the facility is 1.4 million gallons per day (MGD) and the design maximum flow (DMF) for the facility is 4.0 MGD. Treatment consists of screening, grit removal, excess flow treatment, sedimentation (settling), activated sludge, rapid sand filtration, discharge to surface water, aerobic digestion, belt filtration, drying beds, sludge lagoons and land application of sludge.

This reissued NPDES Permit does not increase the facility's DAF, DMF, concentration limits, and/or load limits.

This Permit recognizes and continues the year-round disinfection exemption approved by the IEPA on March 30, 1989 and included in past NPDES permit actions since that date. It is the IEPA's tentative decision that under Illinois Pollution Control Board regulations, the following reach of waterbody is not classified for primary contact use activities and is not subject to the fecal coliform water quality standard of 35 Ill. Adm. Code 302.209.

This draft permit does not contain requirements for disinfection of the discharge from discharge number(s) 001. From the point of discharge to the bridge in Section 35, T13N-R11W of the 2nd P.M. has been determined to be unsuited to support primary contact activities (swimming) due to physical, hydrologic or geographic configuration. Anyone knowing of primary contact activities occurring within this water segment is invited to submit comments to the IEPA. Comments should give the nature of the activities (i.e swimming, fishing, canoeing, etc.), the location and months of the year when these activities have been observed. The IEPA is also interested in obtaining information on the proximity of residential dwellings and the accessibility of the public to this water segment. Anyone with such information is asked to submit comments to the IEPA on this draft permit action. Instructions for submitting comments are contained earlier in this document.

Application is made for the existing discharge(s) which is (are) located in Edgar County, Illinois. The following information identifies the discharge point, receiving stream and stream classifications:

| Outfall | Receiving Stream | Latitude | Longitude | Stream Classification | Biological Stream Characterization |
|---|---|---|---|---|---|
| 001 | Sugar Creek | 39E 37' 07" North | 87E 39' 55" West | General Use | Not Rated |
| A01 | Sugar Creek | 39E 37' 09" North | 87E 39' 56" West | General Use | Not Rated |
| 003 | Unnamed Tributary of Sugar Creek | 39E 37' 44" North | 87E 40' 40" West | General Use | Not Rated |

To assist you further in identifying the location of the discharge(s) please see the attached map.

The stream segment(s), BM-C2, receiving the discharge from outfall(s) 001 and A01 is (are) on the 303 (d) list of impaired waters.

The following parameters have been identified as the pollutants causing impairment:

| Potential Causes | Potential Sources |
|---|---|
| Dissolved oxygen, sedimentation/siltation and other flow regime alterations | Municipal point source discharges and hydrostructure flow regulation/modification |

The stream segment(s) receiving the discharge from outfall(s) 003 is (are) not on the 303 (d) list of impaired waters.

The discharge(s) from the facility is (are) proposed to be monitored and limited at all times as follows:

Discharge Number(s) and Name(s): 001 STP Outfall

Load limits computed based on a design average flow (DAF) of 1.4 MGD (design maximum flow (DMF) of 4.0 MGD).

The effluent of the above discharge(s) shall be monitored and limited at all times as follows:

| | LOAD LIMITS lbs/day* DAF (DMF) | | | CONCENTRATION LIMITS mg/L | | | |
|---|---|---|---|---|---|---|---|
| Parameter | Monthly Average | Weekly Average | Daily Maximum | Monthly Average | Weekly Average | Daily Maximum | Regulation |
| $CBOD_5$ | 117 (334) | | 234 (667) | 10 | | 20 | 35 IAC 304.120<br>40 CFR 133.102 |
| Suspended Solids | 140 (400) | | 280 (801) | 12 | | 24 | 35 IAC 304.120<br>40 CFR 133.102 |
| Dissolved Oxygen | Shall not be less than 6 mg/L | | | | | | 35 IAC 302.206 |
| pH | Shall be in the range of 6 to 9 Standard Units | | | | | | 35 IAC 304.125 |
| Fecal Coliform | May through October | | | | | Report | 35 IAC 309.146 |
| Ammonia Nitrogen:<br>April, May, Sept., Oct.<br>June-August<br>November-February<br>March | <br>18 (50)<br>15 (43)<br>25 (70)<br>19 (53) | <br>48 (137)<br>39 (110)<br>----<br>48 (137) | <br>76 (217)<br>74 (210)<br>83 (237)<br>81 (230) | <br>1.5<br>1.3<br>2.1<br>1.6 | <br>4.1<br>3.3<br>----<br>4.1 | <br>6.5<br>6.3<br>7.1<br>6.9 | 35 IAC 355 and<br>35 IAC 302 |

*Load Limits are calculated by using the formula: 8.34 x (Design Average and/or Maximum Flow in MGD) x (Applicable Concentration in mg/L).

This Permit contains an authorization to treat and discharge excess flow as follows:

Discharge Number(s) and Name(s): A01 South Facility Treated Combined Sewage Outfall

| | | | CONCENTRATION LIMITS mg/L | |
|---|---|---|---|---|
| Parameter | | | Monthly Average | Regulation |
| $BOD_5$ | | | | 40 CFR 133.102 |
| Suspended Solids | | | | 40 CFR 133.102 |
| Fecal Coliform | Daily Maximum Shall Not Exceed 400 per 100 mL | | | 35 IAC 304.121 |
| pH | Shall be in the range of 6 to 9 Standard Units | | | 35 IAC 304.125 |
| Chlorine Residual | | | 0.75 | 35 IAC 302.208 |

This Permit contains an authorization to treat and discharge excess flow as follows:

Discharge Number(s) and Name(s): 003 North Facility Treated Combined Sewage Outfall

| | | | CONCENTRATION LIMITS mg/L | |
|---|---|---|---|---|
| Parameter | | | Monthly Average | Regulation |
| $BOD_5$ | | | | 40 CFR 133.102 |
| Suspended Solids | | | | 40 CFR 133.102 |
| Fecal Coliform | Daily Maximum Shall Not Exceed 400 per 100 mL | | | 35 IAC 304.121 |
| pH | Shall be in the range of 6 to 9 Standard Units | | | 35 IAC 304.125 |
| Chlorine Residual | | | 0.75 | 35 IAC 302.208 |

This draft Permit also contains the following requirements as special conditions:

1. Reopening of this Permit to include different final effluent limitations.

2. Operation of the facility by or under the supervision of a certified operator.

3. Submission of the operational data in a specified form and at a required frequency at any time during the effective term of this Permit.

4. More frequent monitoring requirement without Public Notice in the event of operational, maintenance or other problems resulting in possible effluent deterioration.

5. Prohibition against causing or contributing to violations of water quality standards.

6. Effluent sampling point location.

7. Controlling the sources of infiltration and inflow into the sewer system.

8. A requirement to monitor and a limit of 0.05 mg/L for residual chlorine when it is used.

9. Monitoring for arsenic, barium, cadmium, hexavalent chromium, total chromium, copper, weak acid dissociable cyanide, total cyanide, fluoride, dissolved iron, total iron, lead, manganese, mercury, nickel, oil, phenols, selenium, silver and zinc is required eighteen (18) months prior to the expiration date and again at twelve (12) months prior to the expiration date and to submit the results of such tests with the NPDES renewal application prior to filing of the NPDES renewal application.

10. The Permittee is required to monitor for zinc monthly for the six months beginning three months after the effective date of this Permit.

11. Burden reduction.

12. Submission of annual fiscal data.

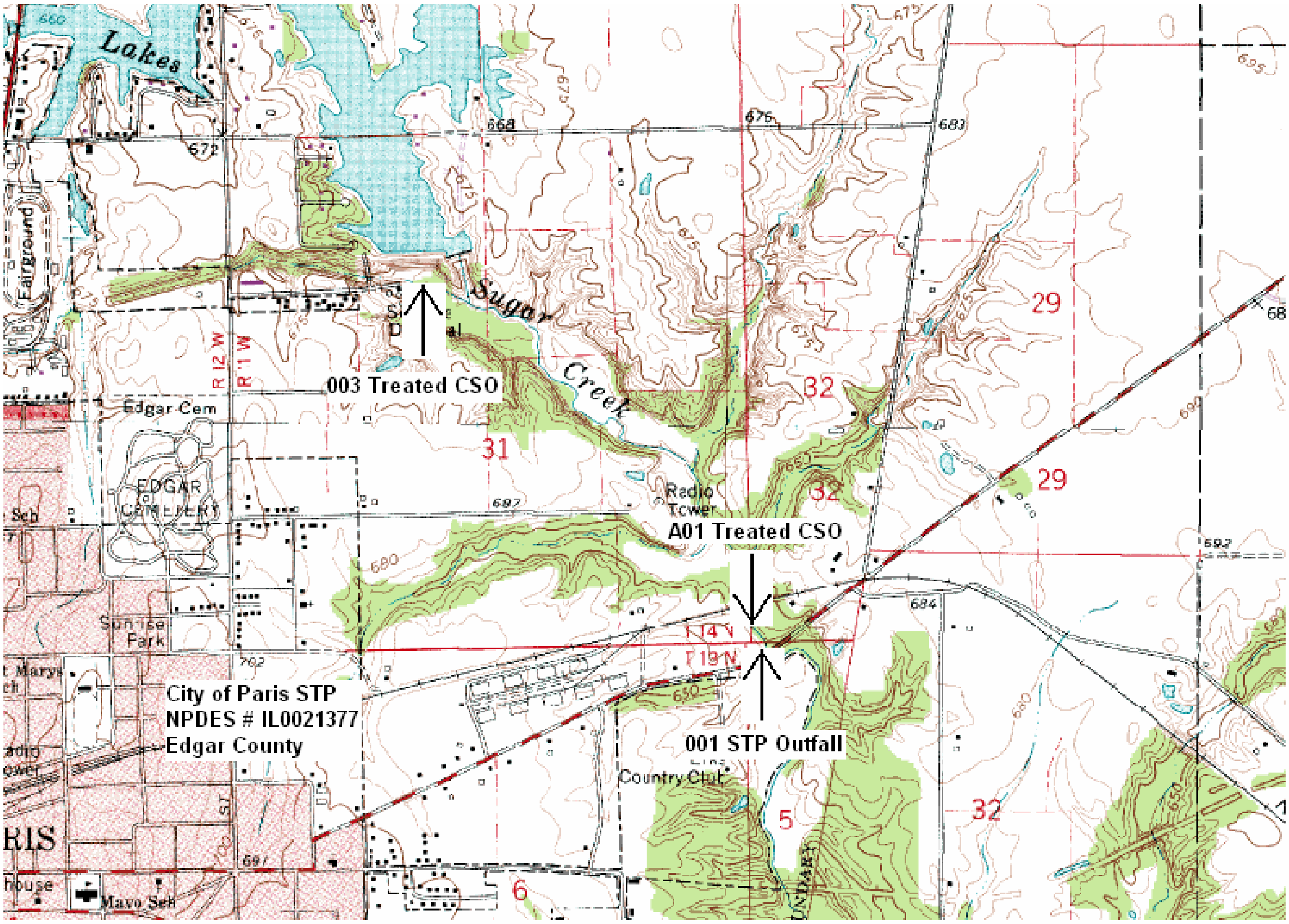
13. A requirement for biomonitoring of the effluent.

14. Submission of semi annual reports indicating the quantities of sludge generated and disposed.

15. Reopening of this Permit to include revised effluent limitations based on a Total Maximum Daily Load (TMDL) or other water quality study.

16. Recording the monitoring results on Discharge Monitoring Report Forms using one such form for each outfall each month and submitting the forms to IEPA each month.

17. Metal translator for zinc.


003 Treated CSO
A01 Treated CSO
001 STP Outfall
City of Paris STP
NPDES # IL0021377
Edgar County
Sugar Creek
Lakes
Edgar Cem
EDGAR CEMETERY
Sunrise Park
Radio Tower
Country Club
Fairground
T 14 N
T 13 N
R 12 W
R 11 W
29
32
31
5
6

NPDES Permit No. IL0021377

Illinois Environmental Protection Agency

Division of Water Pollution Control

1021 North Grand Avenue East

Post Office Box 19276

Springfield, Illinois 62794-9276

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Reissued (NPDES) Permit

Expiration Date:

Issue Date:
Effective Date:

Name and Address of Permittee:

City of Paris
206 South Central
Paris, Illinois 61944

Facility Name and Address:

Paris Sewage Treatment Plant
929 Clinton Road
Paris, Illinois
(Edgar County)

Receiving Waters: Sugar Creek

In compliance with the provisions of the Illinois Environmental Protection Act, Title 35 of the Ill. Adm. Code, Subtitle C, Chapter I, and the Clean Water Act (CWA), the above-named Permittee is hereby authorized to discharge at the above location to the above-named receiving stream in accordance with the standard conditions and attachments herein.

Permittee is not authorized to discharge after the above expiration date. In order to receive authorization to discharge beyond the expiration date, the Permittee shall submit the proper application as required by the Illinois Environmental Protection Agency (IEPA) not later than 180 days prior to the expiration date.

Alan Keller, P.E.
Manager, Permit Section
Division of Water Pollution Control

SAK:RJH:07032101.bah

NPDES Permit No. IL0021377

Effluent Limitations, Monitoring, and Reporting

FINAL

Discharge Number(s) and Name(s): 001 STP Outfall

Load limits computed based on a design average flow (DAF) of 1.4 MGD (design maximum flow (DMF) of 4.0 MGD).

Excess flow facilities (if applicable) shall not be utilized until the main treatment facility is receiving its maximum practical flow.

From the effective date of this Permit until the expiration date, the effluent of the above discharge(s) shall be monitored and limited at all times as follows:

| | LOAD LIMITS lbs/day DAF (DMF)* | | | CONCENTRATION LIMITS MG/L | | | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | Monthly Average | Weekly Average | Daily Maximum | Monthly Average | Weekly Average | Daily Maximum | Sample Frequency | Sample Type |
| Flow (MGD) | | | | | | | Continuous | |
| $CBOD_5$** | 117 (334) | | 234 (667) | 10 | | 20 | 1 Day/Week | Composite |
| Suspended Solids | 140 (400) | | 280 (801) | 12 | | 24 | 1 Day/Week | Composite |
| Dissolved Oxygen | Shall not be less than 6 mg/L | | | | | | 1 Day/Week | Grab |
| pH | Shall be in the range of 6 to 9 Standard Units | | | | | | 1 Day/Week | Grab |
| Fecal Coliform | May through October | | | | | Report | 1 Day/Week | Grab |
| Chlorine Residual*** | | | | | | 0.05 | | Grab |
| Ammonia Nitrogen as (N) | | | | | | | | |
| April, May, Sept., Oct. | 18 (50) | 48 (137) | 76 (217) | 1.5 | 4.1 | 6.5 | 1 Day/Week | Composite |
| June-August | 15 (43) | 39 (110) | 74 (210) | 1.3 | 3.3 | 6.3 | 1 Day/Week | Composite |
| November-February | 25 (70) | ---- | 83 (237) | 2.1 | ---- | 7.1 | 1 Day/Week | Composite |
| March | 19 (53) | 48 (137) | 81 (230) | 1.6 | 4.1 | 6.9 | 1 Day/Week | Composite |

*Load limits based on design maximum flow shall apply only when flow exceeds design average flow.
**Carbonaceous $BOD_5$ ($CBOD_5$) testing shall be in accordance with 40 CFR 136.
***See Special Condition 8.

Flow shall be reported on the Discharge Monitoring Report (DMR) as monthly average and daily maximum.

Fecal Coliform shall be reported on the DMR as daily maximum.

pH shall be reported on the DMR as a minimum and a maximum.

Chlorine Residual shall be reported on DMR as daily maximum.

Dissolved oxygen shall be reported on DMR as minimum.

NPDES Permit No. IL0021377

Effluent Limitations, Monitoring, and Reporting

FINAL

Discharge Number(s) and Name(s): A01 South Facility Treated Combined Sewage Outfall

These flow facilities shall not be utilized until the main treatment facility is receiving its maximum practical flow.

Flows in excess of 4.0 MGD and up to 15.6 MGD.

From the effective date of this Permit until the expiration date, the effluent of the above discharge(s) shall be monitored and limited at all times as follows:

| | | | CONCENTRATION LIMITS mg/L | | |
|---|---|---|---|---|---|
| Parameter | | | Monthly Average | Sample Frequency | Sample Type |
| Total Flow (MG) | See Below | | | Daily When Discharging | Continuous |
| $BOD_5$ | | | | Daily When Discharging | Grab |
| Suspended Solids | | | | Daily When Discharging | Grab |
| Fecal Coliform | Daily Maximum Shall Not Exceed 400 per 100 mL | | | Daily When Discharging | Grab |
| pH | Shall be in the range of 6 to 9 Standard Units | | | Daily When Discharging | Grab |
| Chlorine Residual | | | 0.75 | Daily When Discharging | Grab |

Total flow in million gallons shall be reported on the Discharge Monitoring Report (DMR) in the quantity maximum column.

Report the number of days of discharge in the comments section of the DMR.

Fecal Coliform shall be reported on the DMR as daily maximum.

Chlorine Residual shall be reported on the DMR as a monthly average concentration.

pH shall be reported on the DMR as a minimum and a maximum.

$BOD_5$ and Suspended Solids shall be reported on the DMR as a monthly average concentration.

NPDES Permit No. IL0021377

Effluent Limitations, Monitoring, and Reporting

FINAL

Discharge Number(s) and Name(s): 003 North Facility Treated Combined Sewage Outfall

These flow facilities shall not be utilized until the main treatment facility is receiving its maximum practical flow.

Flows in excess of first flush storage and lift station capacity.

From the effective date of this Permit until the expiration date, the effluent of the above discharge(s) shall be monitored and limited at all times as follows:

| | | | CONCENTRATION LIMITS mg/L | | |
|---|---|---|---|---|---|
| Parameter | | | Monthly Average | Sample Frequency | Sample Type |
| Total Flow (MG) | See Below | | | Daily When Discharging | Continuous |
| $BOD_5$ | | | | Daily When Discharging | Grab |
| Suspended Solids | | | | Daily When Discharging | Grab |
| Fecal Coliform | Daily Maximum Shall Not Exceed 400 per 100 mL | | | Daily When Discharging | Grab |
| pH | Shall be in the range of 6 to 9 Standard Units | | | Daily When Discharging | Grab |
| Chlorine Residual | | | 0.75 | Daily When Discharging | Grab |

Total flow in million gallons shall be reported on the Discharge Monitoring Report (DMR) in the quantity maximum column.

Report the number of days of discharge in the comments section of the DMR.

Fecal Coliform shall be reported on the DMR as daily maximum.

Chlorine Residual shall be reported on the DMR as a monthly average concentration.

pH shall be reported on the DMR as a minimum and a maximum.

$BOD_5$ and Suspended Solids shall be reported on the DMR as a monthly average concentration.

NPDES Permit No. IL0021377

Influent Monitoring, and Reporting

The influent to the plant shall be monitored as follows:

| Parameter | Sample Frequency | Sample Type |
|---|---|---|
| Flow (MGD) | Continuous | |
| $BOD_5$ | 1 Day/Week | Composite |
| Suspended Solids | 1 Day/Week | Composite |

Influent samples shall be taken at a point representative of the influent.

Flow (MGD) shall be reported on the Discharge Monitoring Report (DMR) as monthly average and daily maximum.

$BOD_5$ and Suspended Solids shall be reported on the DMR as a monthly average concentration.

NPDES Permit No. IL0021377

Special Conditions

SPECIAL CONDITION 1. This Permit may be modified to include different final effluent limitations or requirements which are consistent with applicable laws, regulations, or judicial orders. The IEPA will public notice the permit modification.

SPECIAL CONDITION 2. The use or operation of this facility shall be by or under the supervision of a Certified Class 1 operator.

SPECIAL CONDITION 3. The IEPA may request in writing submittal of operational information in a specified form and at a required frequency at any time during the effective period of this Permit.

SPECIAL CONDITION 4. The IEPA may request more frequent monitoring by permit modification pursuant to 40 CFR э 122.63 and Without Public Notice in the event of operational, maintenance or other problems resulting in possible effluent deterioration.

SPECIAL CONDITION 5. The effluent, alone or in combination with other sources, shall not cause a violation of any applicable water quality standard outlined in 35 Ill. Adm. Code 302.

SPECIAL CONDITION 6. Samples taken in compliance with the effluent monitoring requirements shall be taken at a point representative of the discharge, but prior to entry into the receiving stream.

SPECIAL CONDITION 7. This Permit may be modified to include requirements for the Permittee on a continuing basis to evaluate and detail its efforts to effectively control sources of infiltration and inflow into the sewer system and to submit reports to the IEPA if necessary.

SPECIAL CONDITION 8. For Discharge No. 001, any use of chlorine to control slime growths, odors or as an operational control, etc. shall not exceed the limit of 0.05 mg/L (daily maximum) total residual chlorine in the effluent. Sampling is required on a daily grab basis during the chlorination process. Reporting shall be submitted on the DMR's on a monthly basis.

SPECIAL CONDITION 9. The Permittee shall monitor the effluent and report concentrations (in mg/L) of the following listed parameters eighteen (18) months prior to the expiration date and again at twelve (12) months prior to the expiration date. The sample shall be a 24-hour effluent composite except as otherwise specifically provided below and the results shall be submitted on Discharge Monitoring Report Forms to IEPA unless otherwise specified by the IEPA. The parameters to be sampled and the minimum reporting limits to be attained are as follows:

| STORET CODE | PARAMETER | Minimum reporting limit |
|---|---|---|
| 01002 | Arsenic | 0.05 mg/L |
| 01007 | Barium | 0.5 mg/L |
| 01027 | Cadmium | 0.001 mg/L |
| 01032 | Chromium (hexavalent) (grab) | 0.01 mg/L |
| 01034 | Chromium (total) | 0.05 mg/L |
| 01042 | Copper | 0.005 mg/L |
| 00718 | Cyanide (grab) (weak acid dissociable) | 5.0 ug/L |
| 00720 | Cyanide (grab not to exceed 24 hours) (total) | 5.0 ug/L |
| 00951 | Fluoride | 0.1 mg/L |
| 01045 | Iron (total) | 0.5 mg/L |
| 01046 | Iron (Dissolved) | 0.5 mg/L |
| 01051 | Lead | 0.05 mg/L |
| 01055 | Manganese | 0.5 mg/L |
| 71900 | Mercury (grab) (using USEPA Method 1631 or equivalent) | 1.0 ng/L* |
| 01067 | Nickel | 0.005 mg/L |
| 00556 | Oil (hexane soluble or equivalent) (Grab Sample only) | 5.0 mg/L |
| 32730 | Phenols (grab) | 0.005 mg/L |
| 01147 | Selenium | 0.005 mg/L |
| 01077 | Silver (total) | 0.003 mg/L |
| 01092 | Zinc | 0.025 mg/L |

Unless otherwise indicated, concentrations refer to the total amount of the constituent present in all phases, whether solid, suspended or dissolved, elemental or combined, including all oxidation states.

*1.0 ng/L = 1 part per trillion.

NPDES Permit No. IL0021377

Special Conditions

SPECIAL CONDITION 10. The Permittee shall monitor the effluent for the following parameters monthly for a period of six (6) consecutive months, beginning three (3) months from the effective date of this Permit. This Permit may be modified with public notice to establish effluent limitations if appropriate, based on information obtained through sampling. The sample shall be a 24-hour effluent composite except as otherwise specifically provided below and the results shall be submitted on the DMR's to IEPA. The parameters to be sampled and the minimum reporting limits to be attained are as follows:

| STORET CODE | PARAMETER | Minimum reporting limit |
|---|---|---|
| 01092 | Zinc | 0.025 mg/L |

Unless otherwise indicated, concentrations refer to the total amount of the constituent present in all phases, whether solid, suspended or dissolved, elemental or combined, including all oxidation states.

SPECIAL CONDITION 11. The Permittee has undergone a Monitoring Reduction review and the influent and effluent sample frequency has been reduced for $BOD_5$, $CBOD_5$, suspended solids, pH, dissolved oxygen and ammonia nitrogen due to sustained compliance. The IEPA will require that the influent and effluent sampling frequency for these parameters be increased to 3 days/week if effluent deterioration occurs due to increased wasteload, operational, maintenance or other problems. The increased monitoring will be required Without Public Notice when a permit modification is received by the Permittee from the IEPA.

SPECIAL CONDITION 12. During January of each year the Permittee shall submit annual fiscal data regarding sewerage system operations to the Illinois Environmental Protection Agency/Division of Water Pollution Control/Compliance Assurance Section. The Permittee may use any fiscal year period provided the period ends within twelve (12) months of the submission date.

Submission shall be on forms provided by IEPA titled "Fiscal Report Form For NPDES Permittees".

SPECIAL CONDITION 13. The Permittee shall conduct biomonitoring of the effluent from Discharge Number(s) 001.

Biomonitoring

1. Acute Toxicity - Standard definitive acute toxicity tests shall be run on at least two trophic levels of aquatic species (fish, invertebrate) representative of the aquatic community of the receiving stream. Testing must be consistent with Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms (Fifth Ed.) EPA/821-R-02-012. Unless substitute tests are pre-approved; the following tests are required:

    a. Fish - 96 hour static $LC_{50}$ Bioassay using fathead minnows (Pimephales promelas).

    b. Invertebrate 48-hour static $LC_{50}$ Bioassay using Ceriodaphnia.

2. Testing Frequency - The above tests shall be conducted using 24-hour composite samples unless otherwise authorized by the IEPA. Samples must be collected in the 18th, 15th, 12th, and 9th month prior to the expiration date of this Permit.

3. Reporting - Results shall be reported according to EPA/821-R-02-012, Section 12, Report Preparation, and shall be submitted to IEPA, Bureau of Water, Compliance Assurance Section within one week of receipt from the laboratory. Reports are due to the IEPA no later than the 16th, 13th, 10th, and 7th month prior to the expiration date of this Permit.

4. Toxicity Reduction Evaluation - Should the results of the biomonitoring program identify toxicity, the IEPA may require that the Permittee prepare a plan for toxicity reduction evaluation and identification. This plan shall be developed in accordance with Toxicity Reduction Evaluation Guidance for Municipal Wastewater Treatment Plants, EPA/833B-99/002, and shall include an evaluation to determine which chemicals have a potential for being discharged in the plant wastewater, a monitoring program to determine their presence or absence and to identify other compounds which are not being removed by treatment, and other measures as appropriate. The Permittee shall submit to the IEPA its plan for toxicity reduction evaluation within ninety (90) days following notification by the IEPA. The Permittee shall implement the plan within ninety (90) days or other such date as contained in a notification letter received from the IEPA.

    The IEPA may modify this Permit during its term to incorporate additional requirements or limitations based on the results of the biomonitoring. In addition, after review of the monitoring results, the IEPA may modify this Permit to include numerical limitations for specific toxic pollutants. Modifications under this condition shall follow public notice and opportunity for hearing.

Special Conditions

SPECIAL CONDITION 14. For the duration of this Permit, the Permittee shall determine the quantity of sludge produced by the treatment facility in dry tons or gallons with average percent total solids analysis. The Permittee shall maintain adequate records of the quantities of sludge produced and have said records available for IEPA inspection. The Permittee shall submit to the IEPA, at a minimum, a semi-annual summary report of the quantities of sludge generated and disposed of, in units of dry tons or gallons (average total percent solids) by different disposal methods including but not limited to application on farmland, application on reclamation land, landfilling, public distribution, dedicated land disposal, sod farms, storage lagoons or any other specified disposal method. Said reports shall be submitted to the IEPA by January 31 and July 31 of each year reporting the preceding January thru June and July thru December interval of sludge disposal operations.

Duty to Mitigate. The Permittee shall take all reasonable steps to minimize any sludge use or disposal in violation of this Permit.

Sludge monitoring must be conducted according to test procedures approved under 40 CFR 136 unless otherwise specified in 40 CFR 503, unless other test procedures have been specified in this Permit.

Planned Changes. The Permittee shall give notice to the IEPA on the semi-annual report of any changes in sludge use and disposal.

The Permittee shall retain records of all sludge monitoring, and reports required by the Sludge Permit as referenced in Standard Condition 23 for a period of at least five (5) years from the date of this Permit.

If the Permittee monitors any pollutant more frequently than required by the Sludge Permit, the results of this monitoring shall be included in the reporting of data submitted to the IEPA.

Monitoring reports for sludge shall be reported on the form titled "Sludge Management Reports" to the following address:

Illinois Environmental Protection Agency
Bureau of Water
Compliance Assurance Section
Mail Code #19
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

SPECIAL CONDITION 15. This Permit may be modified to include alternative or additional final effluent limitations pursuant to an approved Total Maximum Daily Load (TMDL) Study or upon completion of an alternate Water Quality Study.

SPECIAL CONDITION 16. The Permittee shall record monitoring results on Discharge Monitoring Report (DMR) Forms using one such form for each outfall each month.

In the event that an outfall does not discharge during a monthly reporting period, the DMR Form shall be submitted with no discharge indicated.

The Permittee may choose to submit electronic DMRs (eDMRs) instead of mailing paper DMRs to the IEPA. More information, including registration information for the eDMR program, can be obtained on the IEPA website, http://www.epa.state.il.us/water/edmr/index.html.

The completed Discharge Monitoring Report forms shall be submitted to IEPA no later than the 15th day of the following month, unless otherwise specified by the permitting authority.

Permittees not using eDMRs shall mail Discharge Monitoring Reports with an original signature to the IEPA at the following address:

Illinois Environmental Protection Agency
Division of Water Pollution Control
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

Attention: Compliance Assurance Section, Mail Code # 19

Special Conditions

SPECIAL CONDITION 17. The Permittee may collect data in support of developing a site-specific metals translator for zinc. Total and dissolved metals for a minimum of twelve weekly samples need to be collected from the effluent and at a downstream location indicative of complete mixing between the effluent and the receiving water to determine a metal translator for these parameters. The IEPA will review submitted sample data and may reopen and modify this Permit to eliminate or include revised effluent limitations for these parameters based on the metal translator determined from the collected data.

# Appendix C
# Load Duration Analysis
# Fecal Coliform

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| DATE | EMBARRAS Q (cfs) | EMBARRAS minus NPDES | $A_u/A_g$ | $Q_{est}$ | $Q_{est + NPDES}$ | Rank | Flow Exceedance % | | 100mL/ft$^3$ | s/d | Actual Load (Mil Col/day) | Allowable Load | Exceedence |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5/8/1996 | 7790 | 7789.13368 | 0.10 | 785.0 | 787.3 | 20 | 0.1634% | 34100 | 283.2 | 86400 | 656846386 | 3852471 | Yes |
| 6/6/2001 | 4750 | 4749.13368 | 0.10 | 478.6 | 480.9 | 50 | 0.4085% | 3000 | 283.2 | 86400 | 35299984 | 2353332 | Yes |
| 8/8/2000 | 3690 | 3689.13368 | 0.10 | 371.8 | 374.1 | 80 | 0.6536% | 320 | 283.2 | 86400 | 2928970 | 1830606 | Yes |
| 10/16/2001 | 2240 | 2239.13368 | 0.10 | 225.7 | 228.0 | 170 | 1.3890% | 11600 | 283.2 | 86400 | 64702260 | 1115556 | Yes |
| 8/30/1989 | 1240 | 1239.13368 | 0.10 | 124.9 | 127.2 | 359 | 2.9332% | 7000 | 283.2 | 86400 | 21784641 | 622418 | Yes |
| 5/25/1978 | 878 | 877.13368 | 0.10 | 88.4 | 90.7 | 502 | 4.1016% | 2899.99 | 283.2 | 86400 | 6436563 | 443902 | Yes |
| 10/17/2006 | 635 | 634.13368 | 0.10 | 63.9 | 66.2 | 663 | 5.4171% | 10200 | 283.2 | 86400 | 16527565 | 324070 | Yes |
| 6/19/1990 | 540 | 539.13368 | 0.10 | 54.3 | 56.7 | 750 | 6.1280% | 5300 | 283.2 | 86400 | 7346378 | 277222 | Yes |
| 9/23/1992 | 534 | 533.13368 | 0.10 | 53.7 | 56.1 | 759 | 6.2015% | 3500 | 283.2 | 86400 | 4799602 | 274263 | Yes |
| 10/15/2003 | 519 | 518.13368 | 0.10 | 52.2 | 54.5 | 775 | 6.3322% | 5900 | 283.2 | 86400 | 7872544 | 266866 | Yes |
| 5/6/1991 | 400 | 399.13368 | 0.10 | 40.2 | 42.5 | 944 | 7.7130% | 27000 | 283.2 | 86400 | 28104637 | 208182 | Yes |
| 5/5/1999 | 388 | 387.13368 | 0.10 | 39.0 | 41.3 | 968 | 7.9091% | 700 | 283.2 | 86400 | 707927 | 202265 | Yes |
| 5/7/2003 | 376 | 375.13368 | 0.10 | 37.8 | 40.1 | 983 | 8.0317% | 4200 | 283.2 | 86400 | 4123291 | 196347 | Yes |
| 6/10/1999 | 359 | 358.13368 | 0.10 | 36.1 | 38.4 | 1017 | 8.3095% | 250 | 283.2 | 86400 | 234955 | 187964 | Yes |
| 10/23/1984 | 356 | 355.13368 | 0.10 | 35.8 | 38.1 | 1021 | 8.3422% | 2000 | 283.2 | 86400 | 1864844 | 186484 | Yes |
| 6/9/1993 | 320 | 319.13368 | 0.10 | 32.2 | 34.5 | 1103 | 9.0122% | 6600 | 283.2 | 86400 | 5568138 | 168731 | Yes |
| 5/9/1984 | 284 | 283.13368 | 0.10 | 28.5 | 30.9 | 1203 | 9.8292% | 85 | 283.2 | 86400 | 64166 | 150979 | No |
| 10/27/1986 | 283 | 282.13368 | 0.10 | 28.4 | 30.8 | 1207 | 9.8619% | 1500 | 283.2 | 86400 | 1128640 | 150485 | Yes |
| 7/21/1992 | 283 | 282.13368 | 0.10 | 28.4 | 30.8 | 1207 | 9.8619% | 2500 | 283.2 | 86400 | 1881067 | 150485 | Yes |
| 5/17/1983 | 265 | 264.13368 | 0.10 | 26.6 | 28.9 | 1256 | 10.2623% | 570 | 283.2 | 86400 | 403585 | 141609 | Yes |
| 8/15/1990 | 223 | 222.13368 | 0.10 | 22.4 | 24.7 | 1441 | 11.7738% | 1900 | 283.2 | 86400 | 1148522 | 120897 | Yes |
| 5/3/1989 | 185 | 184.13368 | 0.10 | 18.6 | 20.9 | 1654 | 13.5142% | 2900 | 283.2 | 86400 | 1481289 | 102158 | Yes |
| 5/30/2002 | 173 | 172.13368 | 0.10 | 17.3 | 19.7 | 1733 | 14.1597% | 320 | 283.2 | 86400 | 153984 | 96240 | Yes |
| 7/30/1996 | 139 | 138.13368 | 0.10 | 13.9 | 16.2 | 2043 | 16.6925% | 6900 | 283.2 | 86400 | 2741836 | 79474 | Yes |
| 5/26/2004 | 133 | 132.13368 | 0.10 | 13.3 | 15.6 | 2106 | 17.2073% | 800 | 283.2 | 86400 | 306059 | 76515 | Yes |
| 5/30/1989 | 128 | 127.13368 | 0.10 | 12.8 | 15.1 | 2159 | 17.6403% | 630 | 283.2 | 86400 | 233254 | 74049 | Yes |
| 5/23/2006 | 112 | 111.13368 | 0.10 | 11.2 | 13.5 | 2400 | 19.6094% | 270 | 283.2 | 86400 | 89314 | 66159 | Yes |
| 10/19/2000 | 105 | 104.13368 | 0.10 | 10.5 | 12.8 | 2508 | 20.4919% | 180 | 283.2 | 86400 | 56436 | 62707 | No |
| 7/6/1983 | 100 | 99.13368 | 0.10 | 10.0 | 12.3 | 2591 | 21.1700% | 410 | 283.2 | 86400 | 123494 | 60241 | Yes |
| 7/1/1985 | 100 | 99.13368 | 0.10 | 10.0 | 12.3 | 2591 | 21.1700% | 900 | 283.2 | 86400 | 271085 | 60241 | Yes |
| 5/23/1994 | 99 | 98.13368 | 0.10 | 9.9 | 12.2 | 2622 | 21.4233% | 210 | 283.2 | 86400 | 62735 | 59748 | Yes |
| 5/20/1985 | 96 | 95.13368 | 0.10 | 9.6 | 11.9 | 2674 | 21.8482% | 460 | 283.2 | 86400 | 134018 | 58269 | Yes |
| 5/2/1990 | 95 | 94.13368 | 0.10 | 9.5 | 11.8 | 2694 | 22.0116% | 60 | 283.2 | 86400 | 17333 | 57775 | No |
| 6/12/1997 | 89 | 88.13368 | 0.10 | 8.9 | 11.2 | 2831 | 23.1310% | 260 | 283.2 | 86400 | 71262 | 54817 | Yes |
| 9/9/1981 | 88 | 87.13368 | 0.10 | 8.8 | 11.1 | 2848 | 23.2699% | 310 | 283.2 | 86400 | 84201 | 54323 | Yes |
| 6/16/2003 | 82 | 81.13368 | 0.10 | 8.2 | 10.5 | 2955 | 24.1441% | 310 | 283.2 | 86400 | 79615 | 51365 | Yes |
| 6/25/1996 | 79 | 78.13368 | 0.10 | 7.9 | 10.2 | 3031 | 24.7651% | 2600 | 283.2 | 86400 | 648508 | 49885 | Yes |
| 8/20/1985 | 77 | 76.13368 | 0.10 | 7.7 | 10.0 | 3095 | 25.2880% | 500 | 283.2 | 86400 | 122247 | 48899 | Yes |
| 5/17/1993 | 71 | 70.13368 | 0.10 | 7.1 | 9.4 | 3242 | 26.4891% | 80 | 283.2 | 86400 | 18376 | 45940 | No |
| 5/9/1995 | 70 | 69.13368 | 0.10 | 7.0 | 9.3 | 3279 | 26.7914% | 6500 | 283.2 | 86400 | 1477027 | 45447 | Yes |
| 6/23/1982 | 68 | 67.13368 | 0.10 | 6.8 | 9.1 | 3335 | 27.2490% | 1300 | 283.2 | 86400 | 288995 | 44461 | Yes |
| 6/21/2004 | 66 | 65.13368 | 0.10 | 6.6 | 8.9 | 3403 | 27.8046% | 500 | 283.2 | 86400 | 108686 | 43474 | Yes |
| 5/3/1978 | 60 | 59.13368 | 0.10 | 6.0 | 8.3 | 3599 | 29.4060% | 40 | 283.2 | 86400 | 8103 | 40516 | No |
| 6/5/1998 | 53 | 52.13368 | 0.10 | 5.3 | 7.6 | 3877 | 31.6774% | 500 | 283.2 | 86400 | 92659 | 37064 | Yes |
| 6/4/1991 | 52 | 51.13368 | 0.10 | 5.2 | 7.5 | 3926 | 32.0778% | 810 | 283.2 | 86400 | 148111 | 36571 | Yes |
| 5/5/1981 | 47 | 46.13368 | 0.10 | 4.6 | 7.0 | 4187 | 34.2103% | 340 | 283.2 | 86400 | 57978 | 34105 | Yes |
| 5/19/1982 | 47 | 46.13368 | 0.10 | 4.6 | 7.0 | 4187 | 34.2103% | 1700 | 283.2 | 86400 | 289891 | 34105 | Yes |
| 9/21/1993 | 47 | 46.13368 | 0.10 | 4.6 | 7.0 | 4187 | 34.2103% | 380 | 283.2 | 86400 | 64799 | 34105 | Yes |
| 7/17/1990 | 43 | 42.13368 | 0.10 | 4.2 | 6.6 | 4398 | 35.9343% | 310 | 283.2 | 86400 | 49805 | 32132 | Yes |
| 8/4/1998 | 41 | 40.13368 | 0.10 | 4.0 | 6.4 | 4505 | 36.8086% | 200 | 283.2 | 86400 | 31146 | 31146 | No |
| 9/10/2003 | 40 | 39.13368 | 0.10 | 3.9 | 6.3 | 4553 | 37.2008% | 125 | 283.2 | 86400 | 19158 | 30653 | No |
| 7/25/1979 | 37 | 36.13368 | 0.10 | 3.6 | 6.0 | 4761 | 38.9002% | 700 | 283.2 | 86400 | 102107 | 29173 | Yes |
| 5/6/1987 | 37 | 36.13368 | 0.10 | 3.6 | 6.0 | 4761 | 38.9002% | 30 | 283.2 | 86400 | 4376 | 29173 | No |
| 7/25/2006 | 35 | 34.13368 | 0.10 | 3.4 | 5.8 | 4916 | 40.1667% | 110 | 283.2 | 86400 | 15503 | 28187 | No |
| 7/16/1991 | 32 | 31.13368 | 0.10 | 3.1 | 5.5 | 5146 | 42.0459% | 1500 | 283.2 | 86400 | 200308 | 26708 | Yes |
| 6/7/1979 | 31 | 30.13368 | 0.10 | 3.0 | 5.4 | 5245 | 42.8548% | 450 | 283.2 | 86400 | 58983 | 26215 | Yes |
| 7/22/1987 | 31 | 30.13368 | 0.10 | 3.0 | 5.4 | 5245 | 42.8548% | 170 | 283.2 | 86400 | 22282 | 26215 | No |
| 6/25/1981 | 30 | 29.13368 | 0.10 | 2.9 | 5.3 | 5325 | 43.5085% | 4700 | 283.2 | 86400 | 604455 | 25721 | Yes |
| 5/11/1988 | 29 | 28.13368 | 0.10 | 2.8 | 5.2 | 5438 | 44.4317% | 70 | 283.2 | 86400 | 8830 | 25228 | No |

| DATE | EMBARRAS Q (cfs) | EMBARRAS minus NPDES | $A_u/A_g$ | $Q_{est}$ | $Q_{est + NPDES}$ | Rank | Flow Exceedance % | | $100mL/ft^3$ | s/d | Actual Load (Mil Col/day) | Allowable Load | Exceedence |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/10/1980 | 27 | 26.13368 | 0.10 | 2.6 | 5.0 | 5630 | 46.0005% | 130 | 283.2 | 86400 | 15757 | 24242 | No |
| 6/24/1987 | 26 | 25.13368 | 0.10 | 2.5 | 4.9 | 5707 | 46.6296% | 530 | 283.2 | 86400 | 62935 | 23749 | Yes |
| 10/24/1990 | 26 | 25.13368 | 0.10 | 2.5 | 4.9 | 5707 | 46.6296% | 290 | 283.2 | 86400 | 34436 | 23749 | Yes |
| 9/29/1981 | 24 | 23.13368 | 0.10 | 2.3 | 4.7 | 5938 | 48.5170% | 360 | 283.2 | 86400 | 40973 | 22763 | Yes |
| 8/9/2001 | 23 | 22.13368 | 0.10 | 2.2 | 4.6 | 6066 | 49.5629% | 1180 | 283.2 | 86400 | 131390 | 22270 | Yes |
| 8/24/1998 | 21 | 20.13368 | 0.10 | 2.0 | 4.3 | 6281 | 51.3196% | 300 | 283.2 | 86400 | 31925 | 21283 | Yes |
| 5/15/2001 | 21 | 20.13368 | 0.10 | 2.0 | 4.3 | 6281 | 51.3196% | 60 | 283.2 | 86400 | 6385 | 21283 | No |
| 6/12/1984 | 20 | 19.13368 | 0.10 | 1.9 | 4.2 | 6384 | 52.1611% | 200 | 283.2 | 86400 | 20790 | 20790 | No |
| 7/31/1989 | 20 | 19.13368 | 0.10 | 1.9 | 4.2 | 6384 | 52.1611% | 210 | 283.2 | 86400 | 21830 | 20790 | Yes |
| 8/11/1993 | 19 | 18.13368 | 0.10 | 1.8 | 4.1 | 6529 | 53.3459% | 190 | 283.2 | 86400 | 19282 | 20297 | No |
| 8/10/1982 | 18 | 17.13368 | 0.10 | 1.7 | 4.0 | 6661 | 54.4244% | 550 | 283.2 | 86400 | 54461 | 19804 | Yes |
| 7/5/1994 | 18 | 17.13368 | 0.10 | 1.7 | 4.0 | 6661 | 54.4244% | 900 | 283.2 | 86400 | 89117 | 19804 | Yes |
| 10/30/1989 | 17 | 16.13368 | 0.10 | 1.6 | 3.9 | 6811 | 55.6500% | 220 | 283.2 | 86400 | 21242 | 19311 | Yes |
| 9/11/1979 | 16 | 15.13368 | 0.10 | 1.5 | 3.8 | 6939 | 56.6958% | 160 | 283.2 | 86400 | 15054 | 18818 | No |
| 7/21/1986 | 16 | 15.13368 | 0.10 | 1.5 | 3.8 | 6939 | 56.6958% | 490 | 283.2 | 86400 | 46103 | 18818 | Yes |
| 7/21/2003 | 16 | 15.13368 | 0.10 | 1.5 | 3.8 | 6939 | 56.6958% | 5200 | 283.2 | 86400 | 489256 | 18818 | Yes |
| 8/5/1981 | 15 | 14.13368 | 0.10 | 1.4 | 3.7 | 7099 | 58.0031% | 130 | 283.2 | 86400 | 11911 | 18324 | No |
| 9/22/1982 | 14 | 13.13368 | 0.10 | 1.3 | 3.6 | 7255 | 59.2777% | 160 | 283.2 | 86400 | 14265 | 17831 | No |
| 9/15/1995 | 12 | 11.13368 | 0.10 | 1.1 | 3.4 | 7595 | 62.0557% | 280 | 283.2 | 86400 | 23583 | 16845 | Yes |
| 9/10/1997 | 12 | 11.13368 | 0.10 | 1.1 | 3.4 | 7595 | 62.0557% | 2700 | 283.2 | 86400 | 227407 | 16845 | Yes |
| 8/15/1984 | 11 | 10.13368 | 0.10 | 1.0 | 3.3 | 7783 | 63.5918% | 350 | 283.2 | 86400 | 28616 | 16352 | Yes |
| 6/25/1986 | 11 | 10.13368 | 0.10 | 1.0 | 3.3 | 7783 | 63.5918% | 180 | 283.2 | 86400 | 14717 | 16352 | No |
| 7/31/1997 | 10 | 9.13368 | 0.10 | 0.9 | 3.2 | 8011 | 65.4547% | 30 | 283.2 | 86400 | 2379 | 15859 | No |
| 10/26/1998 | 8.7 | 7.83368 | 0.10 | 0.8 | 3.1 | 8453 | 69.0661% | 10 | 283.2 | 86400 | 761 | 15218 | No |
| 7/18/2002 | 8.6 | 7.73368 | 0.10 | 0.8 | 3.1 | 8476 | 69.2540% | 6000 | 283.2 | 86400 | 455050 | 15168 | Yes |
| 7/18/1995 | 8.4 | 7.53368 | 0.10 | 0.8 | 3.1 | 8534 | 69.7279% | 150 | 283.2 | 86400 | 11302 | 15070 | No |
| 9/11/2006 | 8.4 | 7.53368 | 0.10 | 0.8 | 3.1 | 8534 | 69.7279% | 360 | 283.2 | 86400 | 27125 | 15070 | Yes |
| 9/21/1998 | 8.1 | 7.23368 | 0.10 | 0.7 | 3.0 | 8621 | 70.4388% | 40 | 283.2 | 86400 | 2984 | 14922 | No |
| 8/27/1996 | 7.8 | 6.93368 | 0.10 | 0.7 | 3.0 | 8704 | 71.1169% | 780 | 283.2 | 86400 | 57618 | 14774 | Yes |
| 9/10/1991 | 7 | 6.13368 | 0.10 | 0.6 | 2.9 | 8963 | 73.2331% | 1900 | 283.2 | 86400 | 136603 | 14379 | Yes |
| 9/29/1995 | 7 | 6.13368 | 0.10 | 0.6 | 2.9 | 8963 | 73.2331% | 320 | 283.2 | 86400 | 23007 | 14379 | Yes |
| 9/16/1985 | 6.8 | 5.93368 | 0.10 | 0.6 | 2.9 | 9049 | 73.9358% | 270 | 283.2 | 86400 | 19279 | 14281 | Yes |
| 7/12/1984 | 6.7 | 5.83368 | 0.10 | 0.6 | 2.9 | 9081 | 74.1972% | 580 | 283.2 | 86400 | 41271 | 14231 | Yes |
| 8/26/1992 | 6.5 | 5.63368 | 0.10 | 0.6 | 2.9 | 9149 | 74.7528% | 330 | 283.2 | 86400 | 23319 | 14133 | Yes |
| 8/10/1988 | 5.3 | 4.43368 | 0.10 | 0.4 | 2.8 | 9570 | 78.1927% | 240 | 283.2 | 86400 | 16249 | 13541 | Yes |
| 10/26/1987 | 4.9 | 4.03368 | 0.10 | 0.4 | 2.7 | 9700 | 79.2548% | 10 | 283.2 | 86400 | 667 | 13344 | No |
| 10/23/1996 | 4.8 | 3.93368 | 0.10 | 0.4 | 2.7 | 9719 | 79.4101% | 140 | 283.2 | 86400 | 9306 | 13294 | No |
| 6/20/1988 | 4.1 | 3.23368 | 0.10 | 0.3 | 2.6 | 9983 | 81.5671% | 410 | 283.2 | 86400 | 26546 | 12949 | Yes |
| 8/24/1987 | 3.9 | 3.03368 | 0.10 | 0.3 | 2.6 | 10044 | 82.0655% | 130 | 283.2 | 86400 | 8353 | 12851 | No |
| 7/20/2005 | 3.9 | 3.03368 | 0.10 | 0.3 | 2.6 | 10044 | 82.0655% | 270 | 283.2 | 86400 | 17348 | 12851 | Yes |
| 10/21/1991 | 3.6 | 2.73368 | 0.10 | 0.3 | 2.6 | 10177 | 83.1522% | 310 | 283.2 | 86400 | 19689 | 12703 | Yes |
| 6/17/1992 | 3.2 | 2.33368 | 0.10 | 0.2 | 2.6 | 10335 | 84.4432% | 200 | 283.2 | 86400 | 12505 | 12505 | No |
| 9/6/1984 | 2.9 | 2.03368 | 0.10 | 0.2 | 2.5 | 10476 | 85.5952% | 60 | 283.2 | 86400 | 3707 | 12357 | No |
| 8/23/1994 | 2.6 | 1.73368 | 0.10 | 0.2 | 2.5 | 10607 | 86.6656% | 170 | 283.2 | 86400 | 10378 | 12210 | No |
| 8/26/2002 | 2.6 | 1.73368 | 0.10 | 0.2 | 2.5 | 10607 | 86.6656% | 680 | 283.2 | 86400 | 41512 | 12210 | Yes |
| 9/10/1986 | 2.1 | 1.23368 | 0.10 | 0.1 | 2.4 | 10860 | 88.7327% | 130 | 283.2 | 86400 | 7776 | 11963 | No |
| 9/9/1999 | 1.7 | 0.83368 | 0.10 | 0.1 | 2.4 | 11048 | 90.2688% | 90 | 283.2 | 86400 | 5295 | 11766 | No |
| 9/15/1994 | 1.3 | 0.43368 | 0.10 | 0.0 | 2.4 | 11235 | 91.7967% | 210 | 283.2 | 86400 | 12147 | 11568 | Yes |
| 10/18/1999 | 1.3 | 0.43368 | 0.10 | 0.0 | 2.4 | 11235 | 91.7967% | 90 | 283.2 | 86400 | 5206 | 11568 | No |
| 10/7/2002 | 0.63 | -0.23632 | 0.10 | 0.0 | 2.3 | 11696 | 95.5634% | 110 | 283.2 | 86400 | 6181 | 11238 | No |
| 8/31/2005 | 0.6 | -0.26632 | 0.10 | 0.0 | 2.3 | 11707 | 95.6532% | 410 | 283.2 | 86400 | 23008 | 11223 | Yes |
| 10/23/1997 | 0.32 | -0.54632 | 0.10 | -0.1 | 2.3 | 11869 | 96.9769% | 16 | 283.2 | 86400 | 887 | 11085 | No |
| 9/28/1983 | 0.25 | -0.61632 | 0.10 | -0.1 | 2.3 | 11911 | 97.3200% | 300 | 283.2 | 86400 | 16576 | 11051 | Yes |
| 9/20/1988 | 0.23 | -0.63632 | 0.10 | -0.1 | 2.3 | 11918 | 97.3772% | 52000 | 283.2 | 86400 | 2870599 | 11041 | Yes |
| 10/25/1988 | 0.07 | -0.79632 | 0.10 | -0.1 | 2.2 | 12089 | 98.7744% | 1700 | 283.2 | 86400 | 93176 | 10962 | Yes |

# Appendix D
# Aerial Assessment Report
# For Sugar Creek

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# AERIAL ASSESSMENT REPORT FOR SUGAR CREEK

## EDGAR COUNTY

**SEPTEMBER 2005**

**Prepared by Wayne Kinney for IL. Dept. of Agriculture**

TetraTech, Inc. reported the status of TMDL development for Sugar Creek in a stage one report dated April, 2005. Both Paris Twin West Lake and Paris Twin East Lake are impaired by Total Phosphorus, Excessive Algal Growth and Total Suspended Solids (TSS). Segment BMC2 of 2.9 miles immediately below Paris Twin Lakes is impaired by Dissolved Oxygen, Sedimentation/Siltation and other unspecified nutrients. Segment BM02, which is the lower 12.9 miles to the Illinois-Indiana line, is impaired by Pathogens.

**Assessment Procedure**

Low level geo-referenced video was taken of Sugar Creek in March, 2004. Video taping was completed by Fostaire Helicopters, Sauget, IL, using a camera mounted beneath a helicopter to record data from just above tree top level in DVD format for further evaluation and assessment. Video mapping began at the Illinois-Indiana State Line. The mapping progressed upstream to Paris Twin Lakes continued for approximately 1 mile above the lakes. Aerial video of tributaries was not part of the project, regardless of the stream size or vegetation.

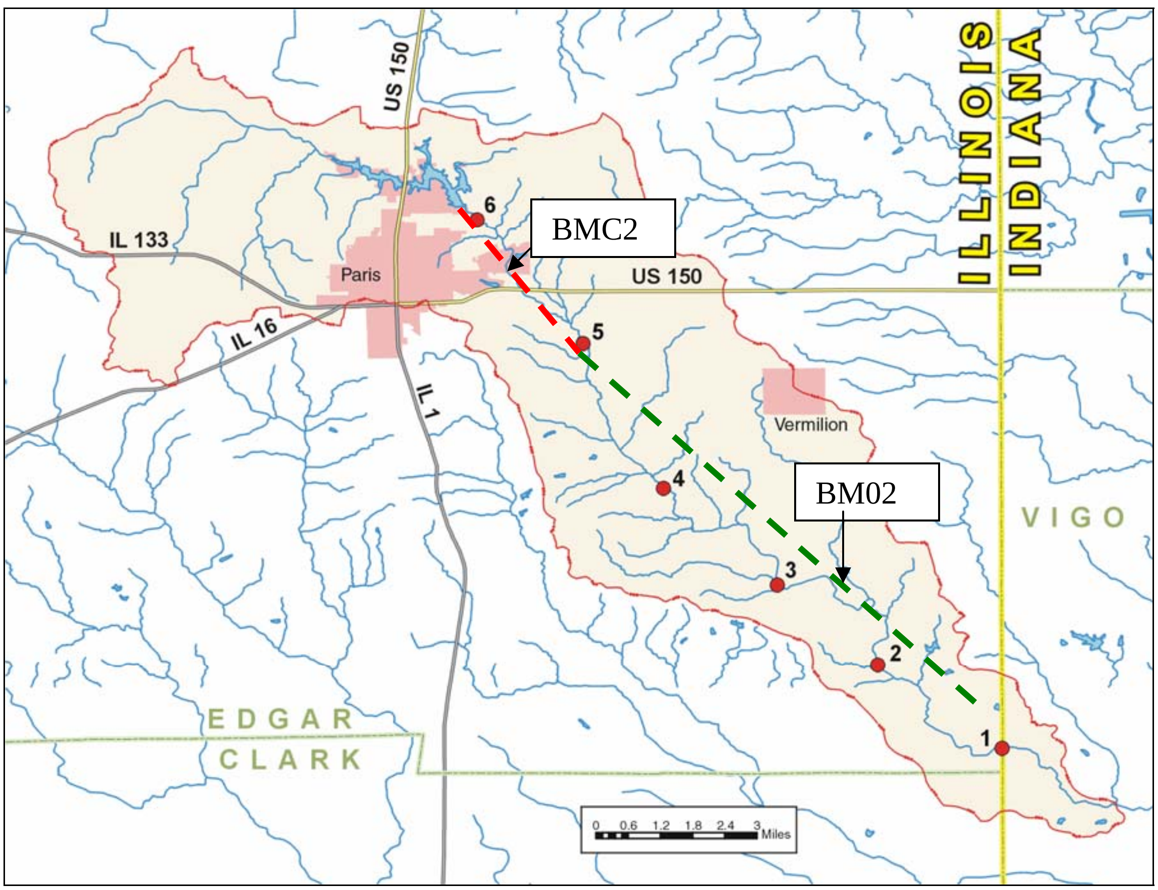



**Fig. 1** Aerial Assessment Map of Sugar Creek

After videotaping the stream, the DVD tapes were processed by USGS to produce a geo-referenced DVD showing flight data and location. Next, USGS identified features from the video and created shapefiles containing the GPS location, type of feature identified, and the time on the DVD to allow cross referencing. The shape-files along with the DVD were then used to identify and locate the points where ground investigations were needed to verify aerial assessment assumptions and gather additional data.

The ground investigations or “ground truthing” is intended to accomplish two primary functions. First, it provides those viewing videos the opportunity to verify the correct interpretation of the video. Second, the video allows the user to identify and gather field data at the most appropriate locations to more closely represent the entire study portion of the stream.

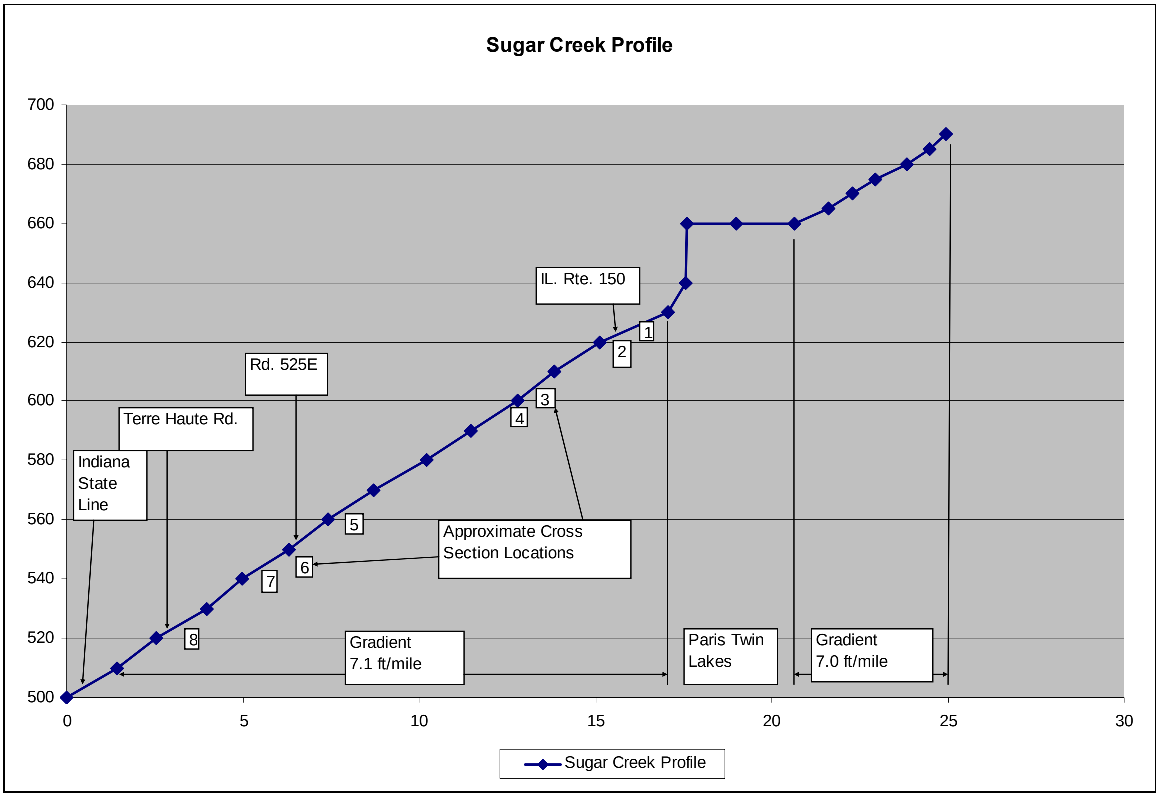



Figure 2 Channel Profile of Sugar Creek

Detailed elevation data is not available; therefore the channel slope is calculated from USGS topo maps by measuring the channel length between contour lines. The report refers to this as “valley profile” although a true valley profile would use a straight line distance down the floodplain rather than channel length. However, this method is used because it incorporates sinuosity into the calculation and allows the channel slope to be assume equal to “valley slope” in order to estimate channel capacity, velocity, etc., although there are short segments where the channel slope may differ significantly near roads, logjams, knickpoints, etc.

| CHAPTERS ON DVD AND ASSESSMENT REPORT<br>Sugar Creek--Edgar County | | | | |
|---|---|---|---|---|
| DVD Disc | DVD chapter | Beginning Time | Report Chapter | Cross Sections |
| 1 | 2 | 5:00 | 1 | 8 |
| 1 | 3 | 10:00 | 2 | 6,7 |
| 1 | 4 | 15:00 | 3 | 5 |
| 1 | 5 | 20:00 | 4 | 3,4 |
| 1 | 6 | 25:00 | 5 | 1,2 |
| 1 | 7 | 30:00 | 6 | |

Note: Flight path is from downstream to upstream

Fig. 3 DVD Chapters and Report Guide

The DVD has been divided into “chapters” of approximately five minutes of video (Fig. 3) to enhance the ability to navigate within the flight video and provide a simple way to identify and discuss different stream segments. Although the report will begin with a broader more general assessment of the entire study reach, it will also provide an assessment and treatment recommendations by chapter or group of chapters. The chapter divisions are clearly arbitrary and do not reflect “change points” in the stream characteristics or treatment recommendations. For clarity the conclusions and recommendations are presented for each stream “chapter”.

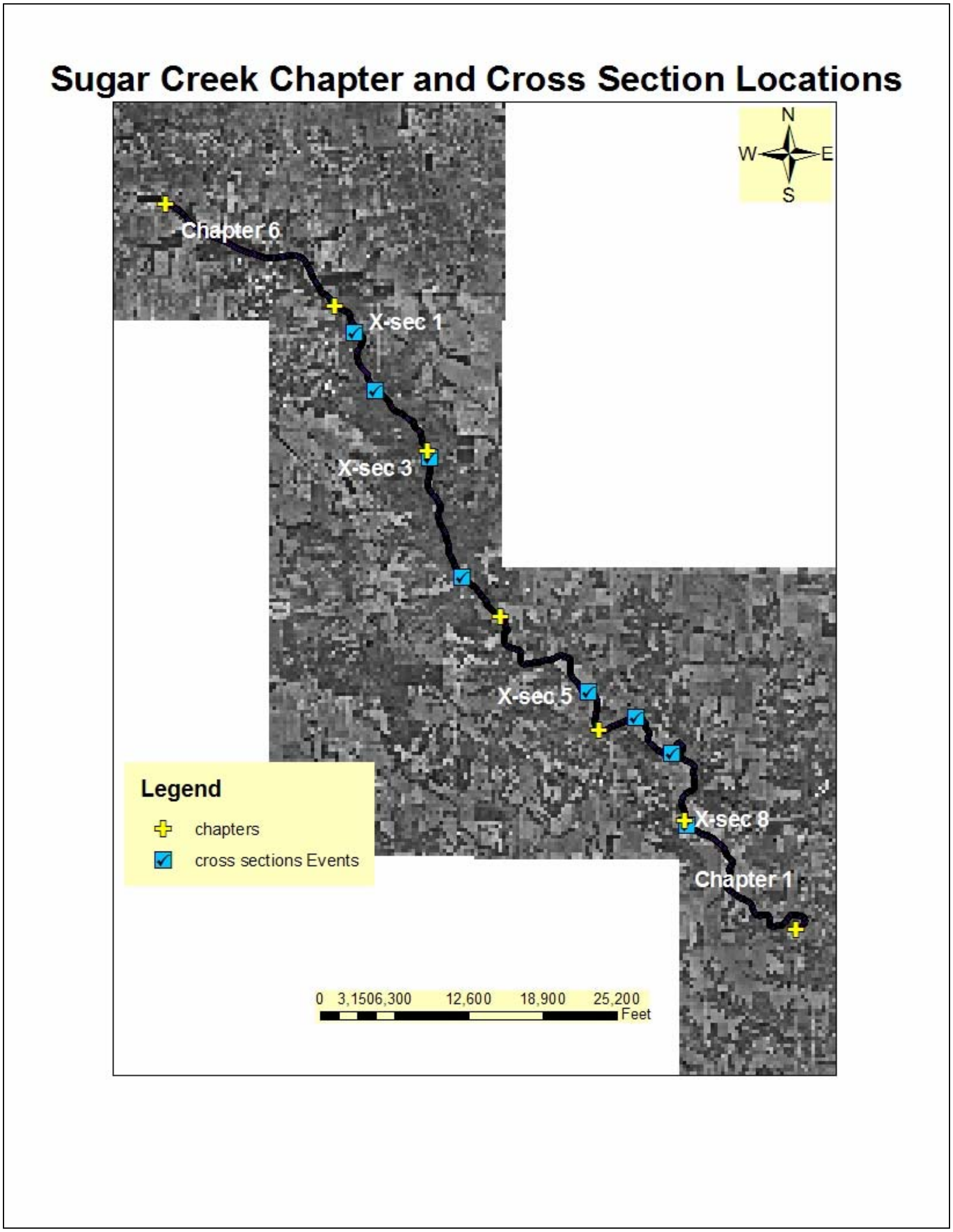



Fig. 4 Chapter Division and Cross Section locations

The major factors indicating channel conditions identified from the aerial assessment have been totaled by DVD chapter in Table 1 below. This tabulation allows a general comparison of the relative dominance of features found in each chapter and provides a means of comparing stream characteristic between chapters. A discussion of the major differences will follow later in this report.

| FEATURES IDENTIFIED BY CHAPTER | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SUGAR CREEK | | | | | | | | |
| CHAPTER | ROCK OUTCROP | LOGJAM | GEOTECH FAILURE | DEPOSITION | BED CONTROL | BREAK POINT | EROSION | SEVERE EROSION |
| 1 | 1 | 4 | 4 | 5 | 0 | 6 | 24 | 0 |
| 2 | 1 | 0 | 7 | 10 | 2 | 17 | 11 | 0 |
| 3 | 2 | 1 | 6 | 9 | 0 | 15 | 27 | 3 |
| 4 | 2 | 7 | 2 | 1 | 0 | 2 | 40 | 5 |
| 5 | 2 | 4 | 2 | 5 | 0 | 5 | 25 | 3 |
| 6 | 0 | 1 | 1 | 0 | 0 | 0 | 10 | 0 |
| TOTALS | 8 | 17 | 22 | 30 | 2 | 45 | 137 | 11 |

Table 1 Features by Chapter Identified with Aerial Assessment

Eight cross sections were taken at selected locations on Sugar Creek after viewing the DVD's. The cross sections are located at "riffle" locations to best represent the channel characteristics and to allow for comparison of width, depth, x-sec. area, etc. along the channel at similar geometric locations. The result of the hydraulic analysis at each site is presented in summary form in Table 2 and the approximate location of each cross section along the channel profile is found in Fig. 2. Aerial views of cross sections locations are shown in Figs. 11 thru 17. Exact locations as Eastings and Northings and more detail can be found in Appendix A.

| Cross Section Data --Sugar Creek, Edgar County, IL | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X-sec | Easting | Northing | ADA Sq. Mi. | Valley Slope ft/mi. | Q2 cfs | Bank Full Q cfs | Width Ft. | Mean Depth Ft. | W/D Ratio | Vel. fps | Bedload Dia. Inches | CEM Simon | CFS/ sq. mi. | BKF Q/ Q2 |
| 1 | 442861 | 4385712 | 23 | 7.7 | 1311 | 985 | 55 | 4.76 | 11.6 | 3.8 | 2 | 4 | 42.83 | 0.75 |
| 2 | 443381 | 4384205 | 25.5 | 7.7 | 1423 | 1097 | 67 | 4.53 | 14.8 | 3.6 | 2 | 5 | 43.02 | 0.77 |
| 3 | 444806 | 4382467 | 31.5 | 6.9 | 1595 | 1050 | 50 | 5.28 | 9.47 | 4 | 3 | 5 | 33.33 | 0.66 |
| 4 | 445630 | 4379397 | 39.4 | 7.3 | 1956 | 1301 | 60 | 5.36 | 11.2 | 4 | 2 | 4 | 33.02 | 0.67 |
| 5 | 448902 | 4376418 | 46.2 | 7.2 | 2299 | 1341 | 62 | 5.33 | 11.6 | 4.1 | 4 | 4 | 29.03 | 0.58 |
| 6 | 450135 | 4375769 | 49.8 | 7.4 | 2368 | 1412 | 59 | 5.71 | 10.3 | 4.2 | 6 | 5 | 28.35 | 0.60 |
| 7 | 451081 | 4374826 | 50.6 | 7.6 | 2429 | 1510 | 64 | 5.58 | 11.5 | 4 | 1 | 5 | 29.84 | 0.62 |
| 8 | 451472 | 4372978 | 58.9 | 7.6 | 2739 | 1663 | 88 | 4.91 | 17.9 | 3.8 | 4 | 4 | 28.23 | 0.61 |

Table 2 Cross Section Summary

Fig. 5 Channel changes due to large sand deposits and lateral erosion (Chapter 1)

Fig. 6  Large point bar developing as lateral migration destroys riparian zone and encroaches on cropland


Fig. 7  Large cobble for stable riffles in Chapter 1 and 2


Fig. 8  Concrete ford with 3-4 ft. overfall on Road S625

**General Observations**

1. Flow data is not available for any streams in Edgar or Clark counties; therefore the 2 yr. discharge from Bluegrass Creek in Vermillion Co. at Potomic has been used as a guide. This stream has a similar valley slope and slightly smaller drainage area but is located approximately 50 miles away in a different hydrologic group and should not be relied on for flow determinations.
2. Sugar Creek appears to be a stream driven predominantly by bedload rather than by flow.
3. Large sandy unvegetated point bars are found on almost every bend in segment BM02 (chapters 1 thru 4) indicating severe lateral erosion. The streambank erosion is therefore suspected to be a major contributor of the sand bedload and wash load found in this segment.
4. Several large escarpments 40 to 50 ft. high may be contributing a disproportional amount of material to the stream.
5. Sugar creek has large sections of very wide shallow flow with an absence of deeper pools.
6. Large cobble bedload has formed stable riffles in many locations, they are most often found on the aerial assessment feature list as “breakpoints”. Therefore downcutting is not believed to be a significant problem. However, two concrete fords on public roads are maintained with 3 to 4 ft. overfalls downstream. It is uncertain if the overfalls are a result of downcutting below the fords, or if the fords have been elevated to create the overfalls.
7. Stream Barbs are recommended as the primary lateral bank treatment for erosion control in combination with limited amounts of Stone Toe Protection. No grade control is recommended for BM02.
8. Rock Riffle Grade Control structures may be used in BMC2 (chapter 5 and 6) as re-aeration structures to improve DO levels. Riffles will be limited in height to approximately 1.5 ft. to prevent increased flooding or backwater.
9. The aerial assessment extends only a short distance above Paris Twin Lake West, therefore this report does not adequately address the streambank contributions of Sugar Creek above the Paris Twin Lakes.

Fig. 9  Large escarpment in Chapter 3

Fig. 10  Downstream lateral migration resulting in unstable planform and eminent cutoffs

**Recommendations—Chapter 1-4**

This segment has very heavy bedload with large point bars, mid channel bars and some tortuous channel meanders as a result of downstream migration the meanders. Lateral migration and failing banks are contributing large sediment loads and mature trees are undermined and falling into channel resulting in formation of numerous logjams.

While this segment is impaired only by pathogens, it is a very unstable channel with long shallow sediment/sand waves that tend to drive flow into the eroding banks accelerating the lateral bank movement even more. The recommended treatment for these chapters is to address the lateral migration with a combination of Stream Barbs and Stone Toe Protection to reduce sediment entering the channel from streambank erosion and encourage redevelopment of natural riffles and pools as sediment loads come into balance with flow. The estimated quantities and cost are provided in Table 3.

| ` | TREATMENT --CHAPTERS 1 THRU 4 | | | | |
|---|---|---|---|---|---|
| | Lateral Bank Protection | | | | |
| Chapter | Erosion Sites | Average Length(ft) | Total Length | Average Cost/foot | Total Cost |
| 1 | 24 | 500 | 12000 | $25.00 | $300,000.00 |
| 2 | 11 | 400 | 4400 | $25.00 | $110,000.00 |
| 3 | 27 | 300 | 8100 | $25.00 | $202,500.00 |
| 4 | 40 | 300 | 12000 | $25.00 | $300,000.00 |
| Total | 102 | | 36500 | | $912,500.00 |

Table 3 Treatment recommendations for Chapters 1 through 4

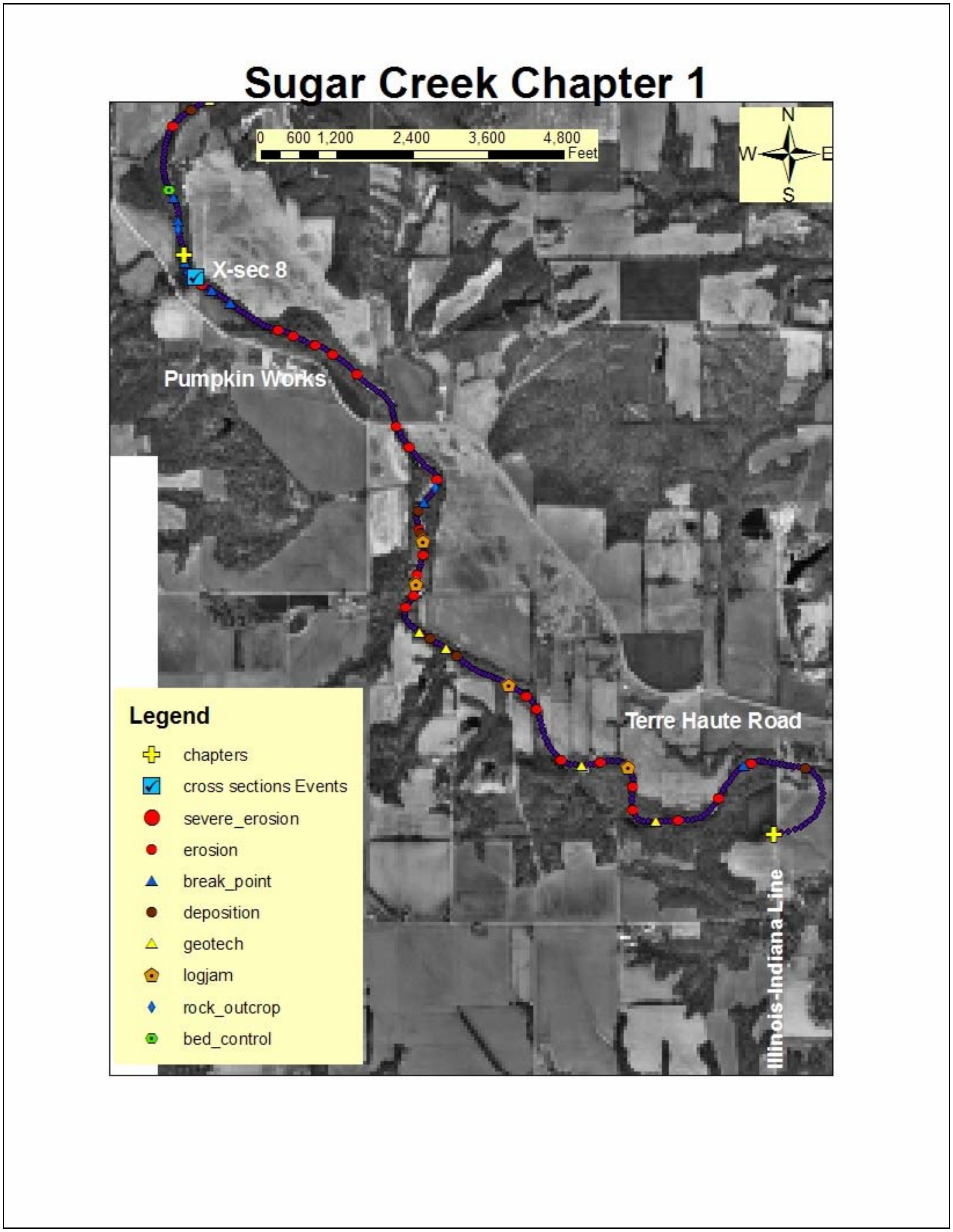



Fig. 11 Chapter 1

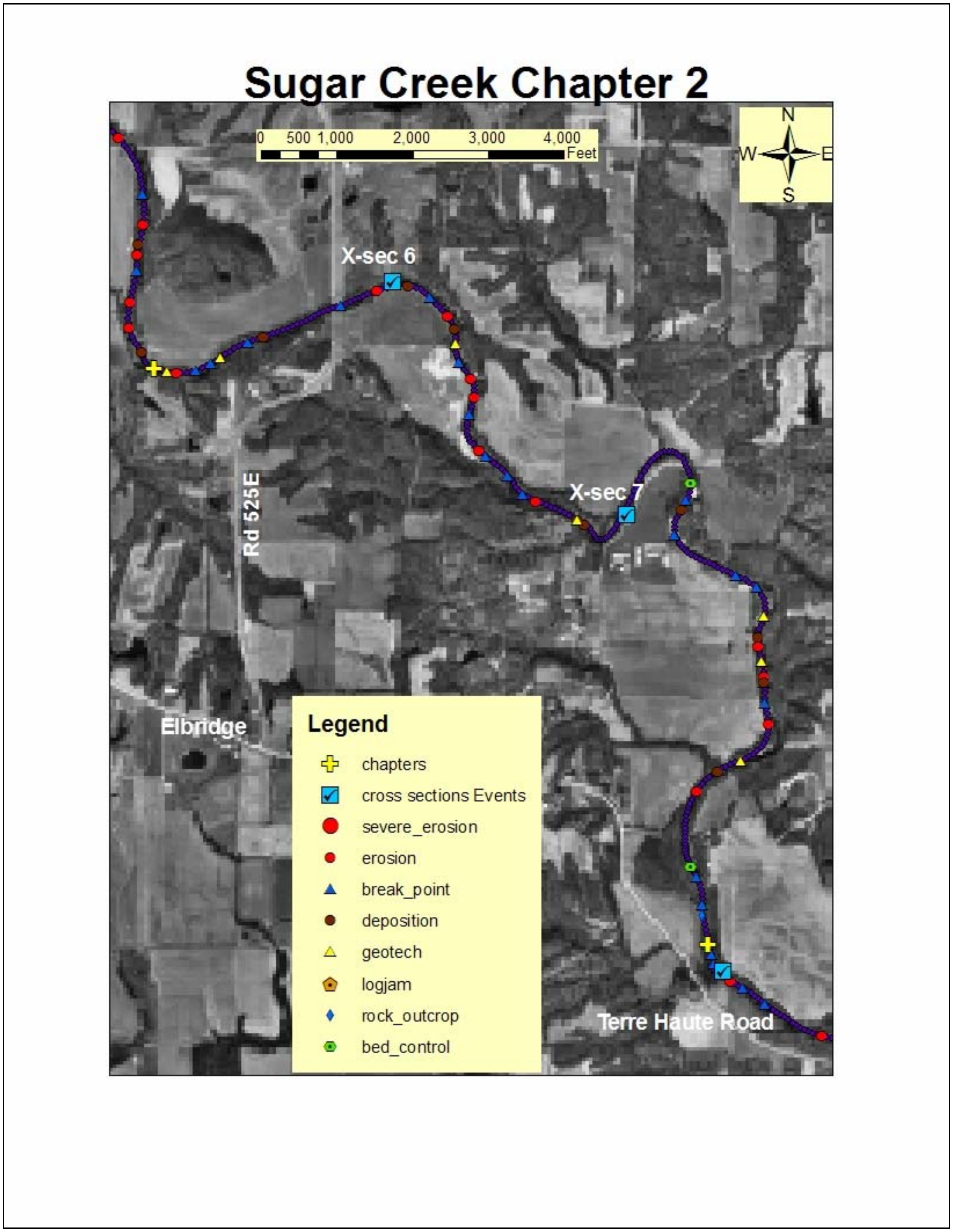



Fig. 12 Chapter 2

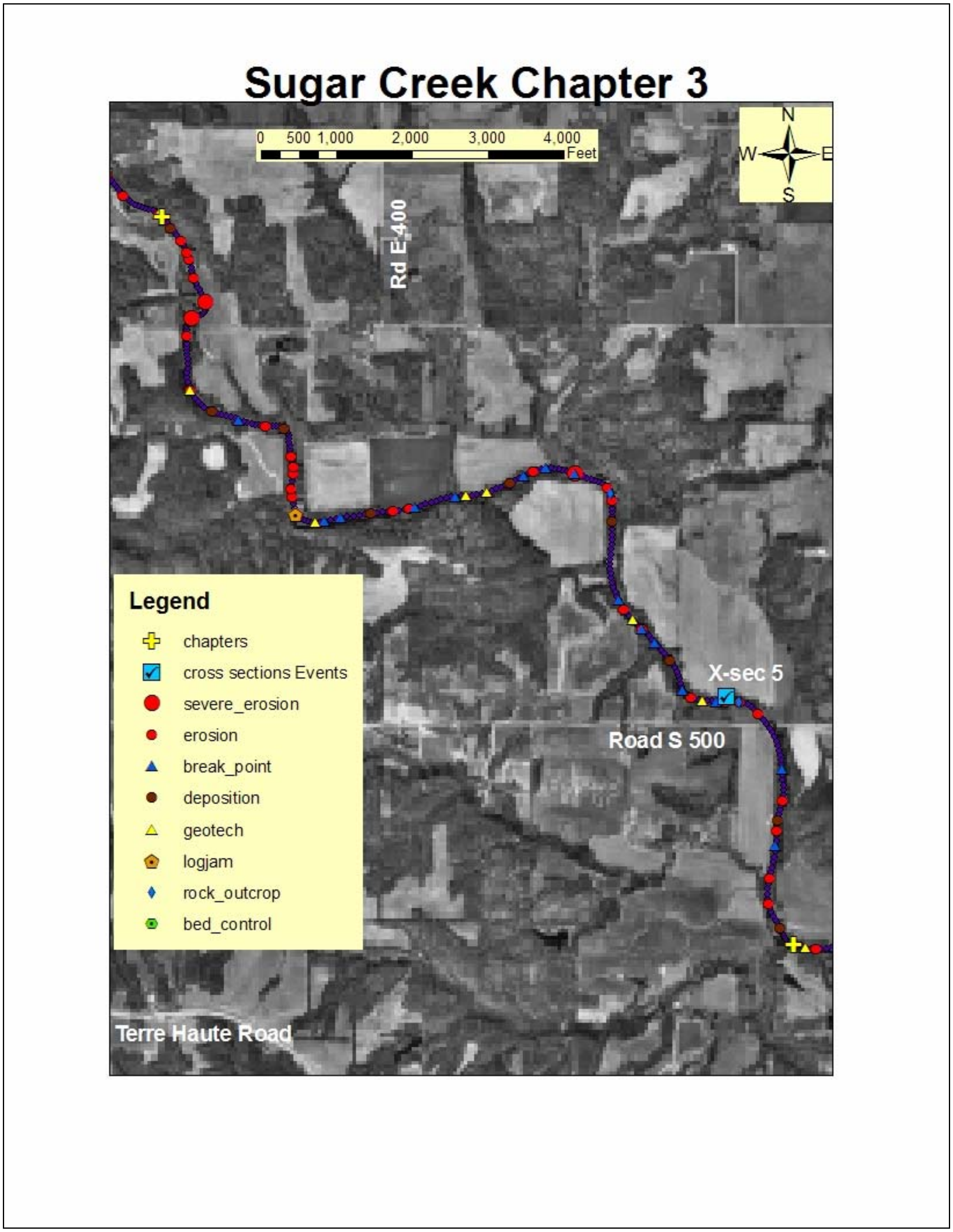



Fig. 13 Chapter 3

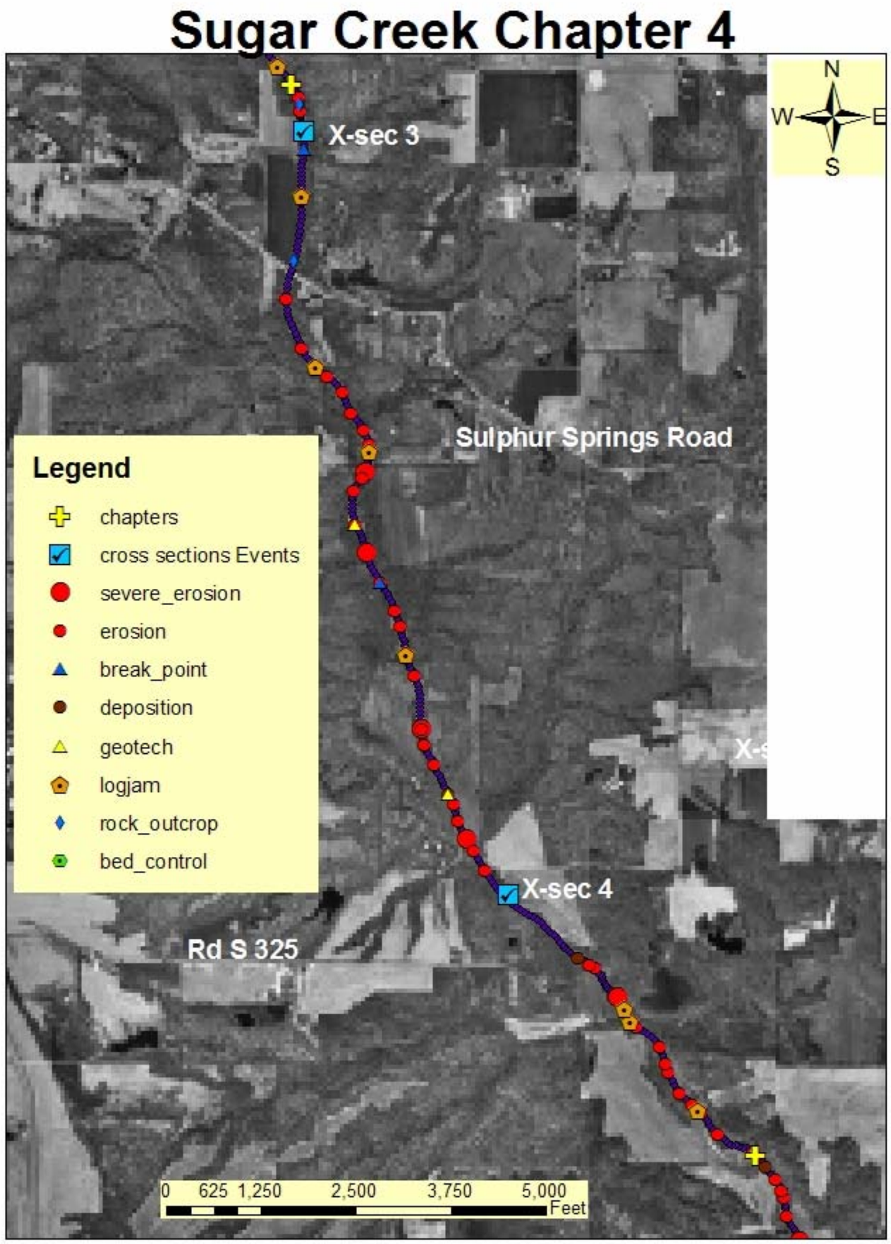



Fig. 14 Chapter 4


Fig. 15  Low water crossing on Rd. S625 with 3-4 ft. overfall (Chapter 2)

**Recommendation—Chapter 5 and 6**

This segment has significantly less erosion with less rapid lateral migration. Chapters 5 and 6 correspond to segment BMC2 which is impaired by low DO and sedimentation/siltation. Chapter 6 also includes the short section above Paris Twin West Lake to the point where Sugar Creek becomes a man-made drainage ditch. The recommended treatment for this segment is to install Rock Riffle Grade Control Structures to increase turbulence and re-aeration to assist with the DO impairment. Additionally there will be a need for streambank stabilization treatment between riffles, although the recommendation is to begin installation with the Rock Riffles and monitor results before determining the need for bank stabilization. Table 4 includes all streambank treatment identified in the aerial assessment; however Rock Riffle can be expected to reduce this need significantly by creating a riffle-pool sequence to dissipate energy that now attacks the eroding banks. Table 4 presents the estimated quantities and cost of treatment for this segment.

| | TREATMENT --CHAPTERS 5 through 6 | | | | |
|---|---|---|---|---|---|
| | **Lateral Bank Treatment** | | | | |
| **Chapter** | **Erosion Sites** | **Average Length(ft)** | **Total Length** | **Average Cost/foot** | **Total Cost** |
| 5 | 25 | 250 | 6250 | $25.00 | $156,250.00 |
| 6 | 10 | 250 | 2500 | $25.00 | $62,500.00 |
| **Total** | **35** | | **8750** | | **$218,750.00** |
| | | | | | |
| **Rock Riffle Grade Control** | | | | | |
| | **Rock Riffles** | **Average Tonnage** | **Ave. Cost Ton** | **Average Cost/Riffle** | |
| 5 | 46 | 250 | $30.00 | $7,500.00 | $345,000.00 |
| 6 | 5 | 250 | $30.00 | $7,500.00 | $37,500.00 |
| **Total** | **51** | | | | $382,500.00 |

Table 4  Treatment recommendations Chapters 5 and 6

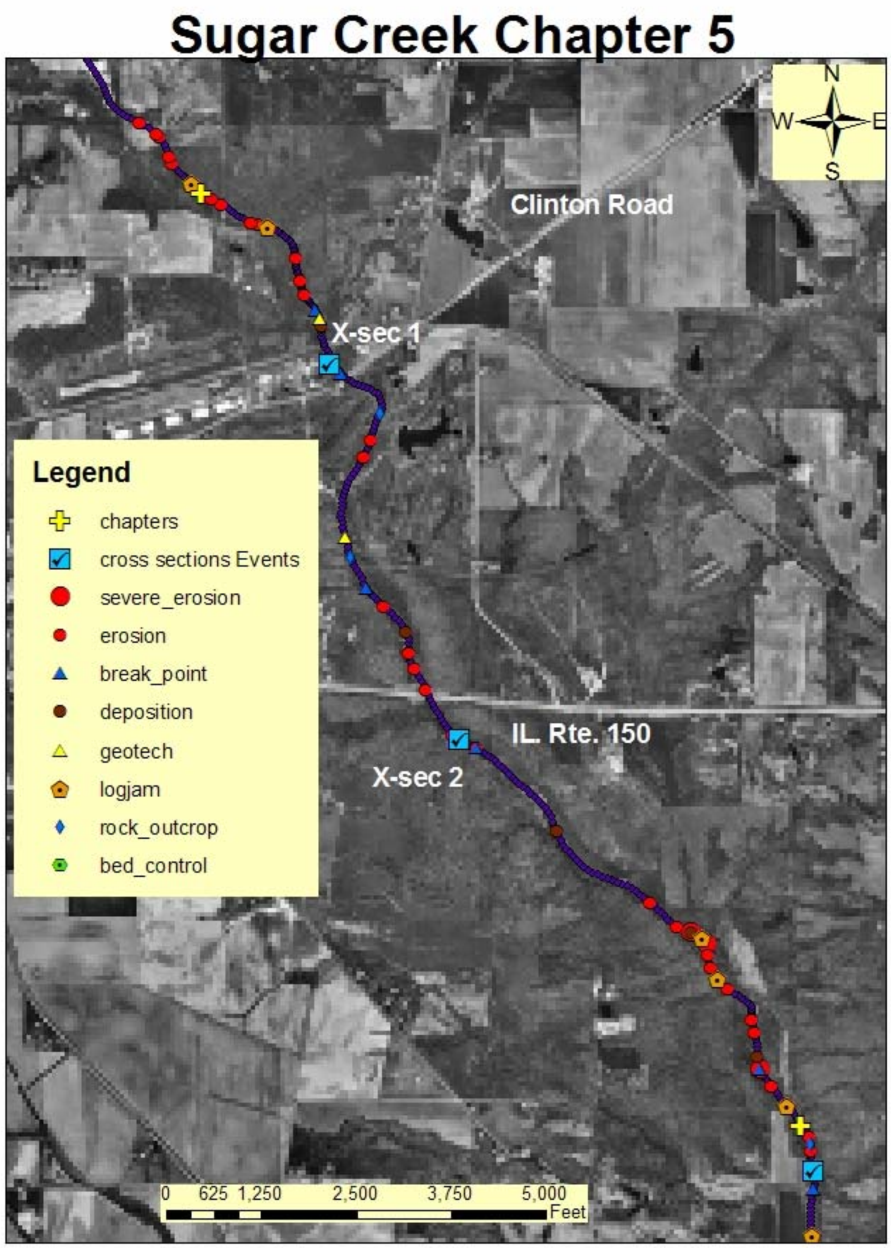



Fig. 16 Chapter 5

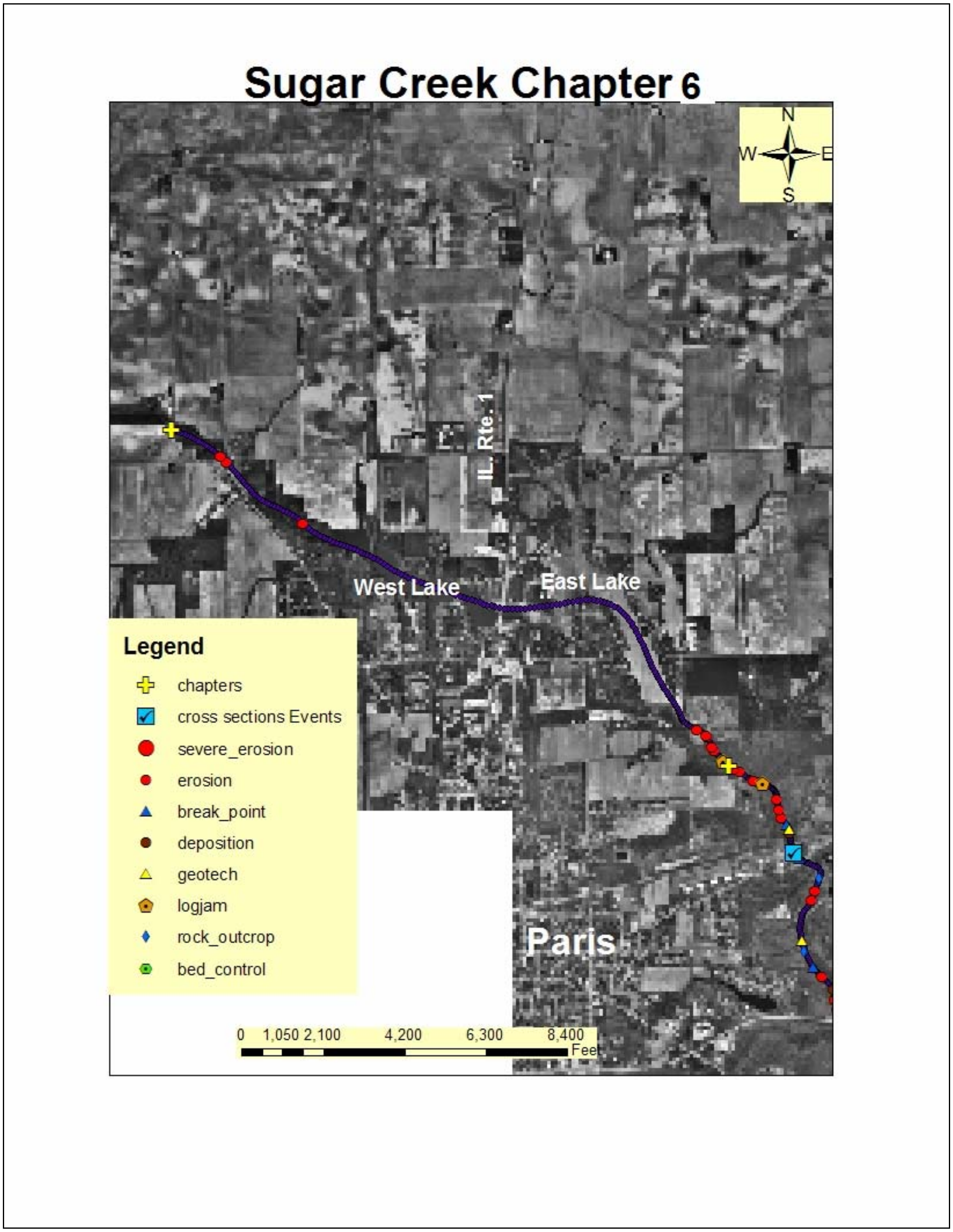



Fig. 17 Chapter 6

# APPENDIX A

# CROSS SECTION DATA

## Stream Stabilization I & E Form

*ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book*

**County** Vermilion T. R. Sec.

Date 9/16/2005 By Wayne Kinney

Stream Name Sugar Creek UTM Coord. E442861 N4385712

Landowner Name X-sec 1

Drainage Area 23 sq. mi. Clear Cells

*Regional Curve Predictions:*

| | | | | |
|---|---|---|---|---|
| Bankfull dimensions | Width | 51 ft. | Cross Sectional Area | 189 sq. ft. |
| | Depth | 3.7 ft. | | |

*Reference Stream Gage:*

Bluegrass Creek at Potomac

Station No. 03336500 Gage $Q_2$ 1850 cfs

Drainage Area 35 sq.mi Regression ( 1060 cfs

Vermilion County, IL **REFERENCE STREAM DATA ONLY**

*USGS Flood-Peak Discharge Predictions:*

Valley Slope: 7.7 *ft./mi. (user-entered)* Regression $Q_2$ 751 cfs

*ft/mi (from worksheet)* Rainfall 2.95 in *(2 yr, 24 hr)* Adjusted $Q_2$ 1311 cfs

0.0015 *ft./ft.* Regional Factor 1.057 Typical Range for Bankfull Discharge: 520 to 1050 cfs

*Local Stream Morphology:*

Channel Description: (c) Clean, winding, some pools and shoals

Manning's "n" 0.04

Stream Length *ft.*

Valley Length *ft.*

Contour Interval feet

Estimated Sinuosity

*Basic Field Data:*

| | | |
|---|---|---|
| Bankfull Width | 55 | *ft.* |
| Mean Bankfull Depth | 4.76 | *ft.* |
| Width/Depth Ratio | 11.55 | |
| Max. Bankfull Depth | 6.4 | *ft.* |
| Width at twice max. depth | 250 | *ft.* |
| ( 12.8 ft.) | | |
| Entrenchment Ratio | 4.55 | |

*Channel Slope:*

Surveyed: 0.00132 *ft./ft.*

Estimated: *ft./ft.*

Bankfull Q from:

| | | |
|---|---|---|
| Cross-Section | 966 | *cfs* |
| Basic field data | 1003 | *cfs* |
| Selected Q | 985 | *cfs* |

Radius of Curvature (Rc) ft.

Rc/Bankfull width: 0.00

*Bankfull Velocity Check:* *(typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)*

Bedload: $D_{90}$ 2 *in.*

$D_{50}$ *in.*

*GOAL: Develop confidence by matching velocities from different sources.*

| | | |
|---|---|---|
| Velocity required to move $D_{90}$: | 2.9 | *ft./sec.* |
| Velocity from Cross-Section data: | 3.69 | *ft./sec.* |
| Velocity from basic field data: | 3.83 | *ft./sec.* |
| Velocity from selected Q: | 3.8 | *ft./sec.* |

Channel Evolution Stage IV Stream Type (Rosgen)

**Notes**

42.8 cfs/sq. mi.

# Natural Open Channel Flow

back to I&E form

Clear Cells

| | |
|---|---|
| Project: | X-sec 1 |
| Assisted by: | Wayne Kinney |
| Date: | 9/16/2005 |
| Channel Slope (*S*): | 0.001320 *ft/ft* |
| Manning's *n*: | 0.040 |
| Flow Depth: | 6.9 *ft* |

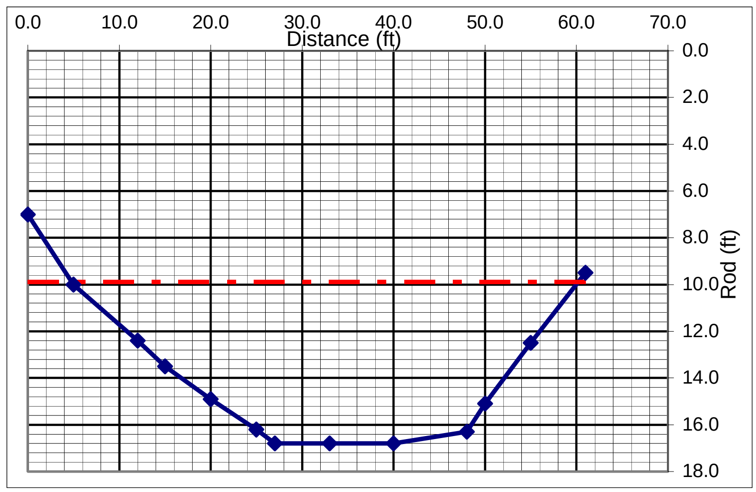
$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

*assuming uniform, steady flow*

| | | *Trial Depth 2* | *Trial Depth 3* |
|---|---|---|---|
| Selected Flow Depth: | 6.9 *ft* | 7.3 | |
| Channel Flow (*Q*): | 965.8 *cfs* | 1,086.8 | |
| Channel Velocity: | 3.7 *ft/sec* | 3.8 | |
| Cross-Sectional Area (*A*): | 262.0 *sq.ft.* | 284.4 | |
| Hydraulic Radius (*R*): | 4.5 *ft* | 4.8 | |

**Survey Data:**

| Rod *(ft)* | Distance *(ft)* |
|---|---|
| 7.0 | 0.0 |
| 10.0 | 5.0 |
| 12.4 | 12.0 |
| 13.5 | 15.0 |
| 14.9 | 20.0 |
| 16.2 | 25.0 |
| 16.8 | 27.0 |
| 16.8 | 33.0 |
| 16.8 | 40.0 |
| 16.30 | 48 |
| 15.10 | 50 |
| 12.50 | 55 |
| 9.50 | 61 |




COMMENTS:

## Stream Stabilization I & E Form

*ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book*

**County** Vermilion T. R. Sec.

Date 9/16/2005 By Wayne Kinney

Stream Name Sugar Creek UTM Coord. E443381 N4384205

Landowner Name X-sec 2

Drainage Area 25.5 sq. mi.

Clear Cells

*Regional Curve Predictions:*

Bankfull dimensions Width 53 ft. Cross Sectional Area 202 sq. ft.

Depth 3.8 ft.

*Reference Stream Gage:*

Bluegrass Creek at Potomac

Station No. 03336500 Gage $Q_2$ 1850 cfs

Drainage Area 35 sq.mi Regression ( 1060 cfs

Vermilion County, IL **REFERENCE STREAM DATA ONLY**

*USGS Flood-Peak Discharge Predictions:*

Valley Slope: 7.7 *ft./mi. (user-entered)* Regression $Q_2$ 815 cfs

*ft/mi (from worksheet)* Rainfall 2.95 in *(2 yr, 24 hr)* Adjusted $Q_2$ 1423 cfs

0.0015 *ft./ft.* Regional Factor 1.057 Typical Range for Bankfull Discharge:

560 to 1140 cfs

*Local Stream Morphology:*

Channel Description: (c) Clean, winding, some pools and shoals

Manning's "n" 0.04

*Basic Field Data:*

| | | | | | |
|---|---|---|---|---|---|
| Bankfull Width | 67 | *ft.* | Stream Length | | *ft.* |
| Mean Bankfull Depth | 4.53 | *ft.* | Valley Length | | *ft.* |
| Width/Depth Ratio | 14.79 | | Contour Interval | | feet |
| | | | Estimated Sinuosity | | |

*Channel Slope:*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Max. Bankfull Depth | 6.8 | *ft.* | Surveyed: | 0.00132 *ft./ft.* | Bankfull Q from: Cross-Section | 1069 | *cfs* |
| Width at twice max. depth | 300 | *ft.* | Estimated: | *ft./ft.* | Basic field data | 1125 | *cfs* |
| ( 13.6 ft.) | | | | | Selected Q | 1097 | *cfs* |
| Entrenchment Ratio | 4.48 | | Radius of Curvature (Rc) | ft. | | | |
| | | | Rc/Bankfull width: | 0.00 | | | |

*Bankfull Velocity Check:* *(typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)*

| | | | | | |
|---|---|---|---|---|---|
| Bedload: $D_{90}$ | 2 | *in.* | Velocity required to move $D_{90}$: | 2.9 | *ft./sec.* |
| $D_{50}$ | | *in.* | Velocity from Cross-Section data: | 3.51 | *ft./sec.* |
| *GOAL: Develop confidence by matching* | | | Velocity from basic field data: | 3.71 | *ft./sec.* |
| *velocities from different sources.* | | | Velocity from selected Q: | 3.6 | *ft./sec.* |

Channel Evolution Stage V Stream Type (Rosgen)

**Notes**

43.0 cfs/sq.mi.

# Natural Open Channel Flow

back to I&E form

Clear Cells

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

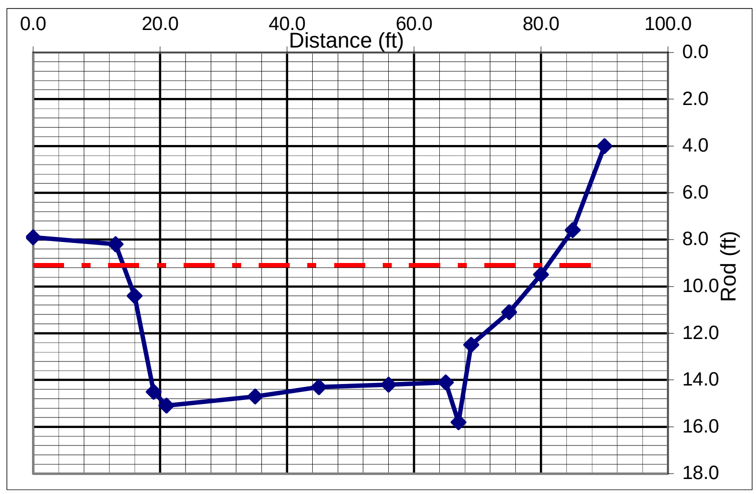
*assuming uniform, steady flow*

| | | |
|---|---|---|
| Project: | X-sec 2 | |
| Assisted by: | Wayne Kinney | |
| Date: | 9/16/2005 | |
| Channel Slope (***S***): | 0.001320 | *ft/ft* |
| Manning's ***n***: | 0.040 | |
| Flow Depth: | 6.7 | *ft* |

| | | *Trial Depth 2* | *Trial Depth 3* |
|---|---|---|---|
| Selected Flow Depth: | 6.7 *ft* | 7.9 | 7.6 |
| Channel Flow (***Q***): | 1,068.6 *cfs* | 1,390.4 | 1,402.3 |
| Channel Velocity: | 3.5 *ft/sec* | 3.6 | 3.8 |
| Cross-Sectional Area (***A***): | 304.1 *sq.ft.* | 389.1 | 365.9 |
| Hydraulic Radius (***R***): | 4.2 *ft* | 4.3 | 4.8 |

**Survey Data:**

| Rod *(ft)* | Distance *(ft)* |
|---|---|
| 7.9 | 0.0 |
| 8.2 | 13.0 |
| 10.4 | 16.0 |
| 14.5 | 19.0 |
| 15.1 | 21.0 |
| 14.7 | 35.0 |
| 14.3 | 45.0 |
| 14.2 | 56.0 |
| 14.1 | 65.0 |
| 15.80 | 67 |
| 12.50 | 69 |
| 11.10 | 75 |
| 9.50 | 80 |
| 7.60 | 85 |
| 4.00 | 90 |




COMMENTS:

## Stream Stabilization I & E Form

*ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book*

**County** Vermilion   T.   R.   Sec.

Date 9/16/2005   By Wayne Kinney

Stream Name Sugar Creek   UTM Coord. E 444806 N4382467

Landowner Name Xsec 3

Drainage Area 31.5 sq. mi.   Clear Cells

*Regional Curve Predictions:*

| | | | | |
|---|---|---|---|---|
| Bankfull dimensions | Width | 57 ft. | Cross Sectional Area | 233 sq. ft. |
| | Depth | 4.1 ft. | | |

*Reference Stream Gage:*

Bluegrass Creek at Potomac   Station No. 03336500   Gage $Q_2$ 1850 cfs

Drainage Area 35 sq.mi   Regression ( 1060 cfs

Vermilion County, IL   **REFERENCE STREAM DATA ONLY**

*USGS Flood-Peak Discharge Predictions:*

Valley Slope: 6.9 *ft./mi. (user-entered)*   Regression $Q_2$ 914 cfs

*ft/mi (from worksheet)*   Rainfall 2.95 in *(2 yr, 24 hr)*   Adjusted $Q_2$ 1595 cfs

0.0013 *ft./ft.*   Regional Factor 1.057   Typical Range for Bankfull Discharge: 630 to 1280 cfs

*Local Stream Morphology:*

Channel Description: (c) Clean, winding, some pools and shoals

Manning's "n" 0.04

Stream Length *ft.*

Valley Length *ft.*

Contour Interval feet

Estimated Sinuosity

*Basic Field Data:*

Bankfull Width 50 *ft.*

Mean Bankfull Depth 5.28 *ft.*

Width/Depth Ratio 9.47

*Channel Slope:*

Surveyed: 0.00132 *ft./ft.*

Estimated: *ft./ft.*

Bankfull Q from:

Cross-Section 1015 *cfs*

Basic field data 1084 *cfs*

Selected Q 1050 *cfs*

Max. Bankfull Depth 6.5 *ft.*

Width at twice max. depth 1000 *ft.* ( 13.0 ft.)

Entrenchment Ratio 20.00

Radius of Curvature (Rc) ft.

Rc/Bankfull width: 0.00

*Bankfull Velocity Check:* *(typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)*

Bedload: $D_{90}$ 3 *in.*   Velocity required to move $D_{90}$: 3.6 *ft./sec.*

$D_{50}$ *in.*   Velocity from Cross-Section data: 3.84 *ft./sec.*

*GOAL: Develop confidence by matching velocities from different sources.*

Velocity from basic field data: 4.11 *ft./sec.*

Velocity from selected Q: 4.0 *ft./sec.*

Channel Evolution Stage V   Stream Type (Rosgen)

**Notes**

33.3 cfs/mi

# Natural Open Channel Flow

back to I&E form

Clear Cells

| | | |
|---|---|---|
| Project: | Xsec 3 | |
| Assisted by: | Wayne Kinney | |
| Date: | 9/16/2005 | |
| Channel Slope (***S***): | 0.001320 | *ft/ft* |
| Manning's ***n***: | 0.040 | |
| Flow Depth: | 6.4 | *ft* |

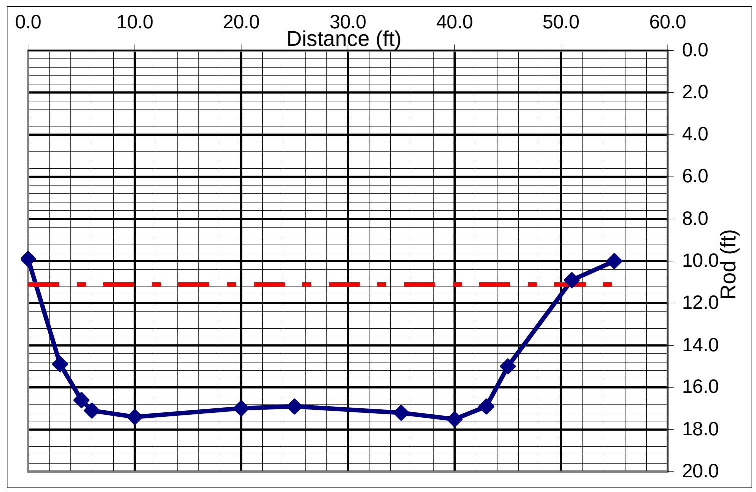
$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

*assuming uniform, steady flow*

| | | *Trial Depth 2* | *Trial Depth 3* |
|---|---|---|---|
| Selected Flow Depth: | 6.4 *ft* | 7.5 | |
| Channel Flow (***Q***): | 1,015.4 *cfs* | 1,319.2 | |
| Channel Velocity: | 3.8 *ft/sec* | 4.1 | |
| Cross-Sectional Area (***A***): | 264.1 *sq.ft.* | 321.6 | |
| Hydraulic Radius (***R***): | 4.8 *ft* | 5.3 | |

**Survey Data:**

| Rod *(ft)* | Distance *(ft)* |
|---|---|
| 9.9 | 0.0 |
| 14.9 | 3.0 |
| 16.6 | 5.0 |
| 17.1 | 6.0 |
| 17.4 | 10.0 |
| 17.0 | 20.0 |
| 16.9 | 25.0 |
| 17.2 | 35.0 |
| 17.5 | 40.0 |
| 16.90 | 43 |
| 15.00 | 45 |
| 10.90 | 51 |
| 10.00 | 55 |




COMMENTS:

## Stream Stabilization I & E Form

ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book

**County** Vermilion T. R. Sec.

Date 9/16/2005 By Wayne Kinney

Stream Name Sugar Creek UTM Coord. E445630 N4379397

Landowner Name Xsec 4

Drainage Area 39.4 sq. mi.

Clear Cells

*Regional Curve Predictions:*

| | | | | |
|---|---|---|---|---|
| Bankfull dimensions | Width | 63 ft. | Cross Sectional Area | 272 sq. ft. |
| | Depth | 4.3 ft. | | |

*Reference Stream Gage:*

Bluegrass Creek at Potomac — Station No. 03336500 — Gage $Q_2$ 1850 cfs

Drainage Area 35 sq.mi — Regression Q 1060 cfs

Vermilion County, IL — **REFERENCE STREAM DATA ONLY**

*USGS Flood-Peak Discharge Predictions:*

Valley Slope: 7.3 *ft./mi. (user-entered)* — Regression $Q_2$ 1120 cfs

*ft/mi (from worksheet)* — Rainfall 2.95 in *(2 yr, 24 hr)* — Adjusted $Q_2$ 1956 cfs

0.0014 *ft./ft.* — Regional Factor 1.057 — Typical Range for Bankfull Discharge: 780 to 1570 cfs

*Local Stream Morphology:*

Channel Description: (c) Clean, winding, some pools and shoals

Manning's "n" 0.04

*Basic Field Data:*

| | | | | |
|---|---|---|---|---|
| Bankfull Width | 60 ft. | Stream Length | ft. | |
| Mean Bankfull Depth | 5.36 ft. | Valley Length | ft. | |
| Width/Depth Ratio | 11.19 | Contour Interval | feet | |
| | | Estimated Sinuosity | | |

*Channel Slope:*

| | | | | | |
|---|---|---|---|---|---|
| Max. Bankfull Depth | 7.1 ft. | Surveyed: | 0.00132 ft./ft. | Cross-Section | 1268 cfs |
| Width at twice max. depth | 1000 ft. | Estimated: | ft./ft. | Basic field data | 1334 cfs |
| ( 14.2 ft.) | | | | Selected Q | 1301 cfs |
| Entrenchment Ratio | 16.67 | Radius of Curvature (Rc) | ft. | | |
| | | Rc/Bankfull width: | 0.00 | | |

Bankfull Q from: (Cross-Section / Basic field data / Selected Q)

*Bankfull Velocity Check:* *(typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)*

| | | | |
|---|---|---|---|
| Bedload: $D_{90}$ | 2 *in.* | Velocity required to move $D_{90}$: | 2.9 *ft./sec.* |
| $D_{50}$ | *in.* | Velocity from Cross-Section data: | 3.94 *ft./sec.* |
| *GOAL: Develop confidence by matching* | | Velocity from basic field data: | 4.15 *ft./sec.* |
| *velocities from different sources.* | | Velocity from selected Q: | 4.0 *ft./sec.* |

Channel Evolution Stage IV — Stream Type (Rosgen)

**Notes**

33.0 cfs/ sq. mi.

# Natural Open Channel Flow

back to I&E form

Clear Cells

| | |
|---|---|
| Project: | Xsec 4 |
| Assisted by: | Wayne Kinney |
| Date: | 9/16/2005 |
| Channel Slope (***S***): | 0.001320 ft/ft |
| Manning's ***n***: | 0.040 |
| Flow Depth: | 7.2 ft |

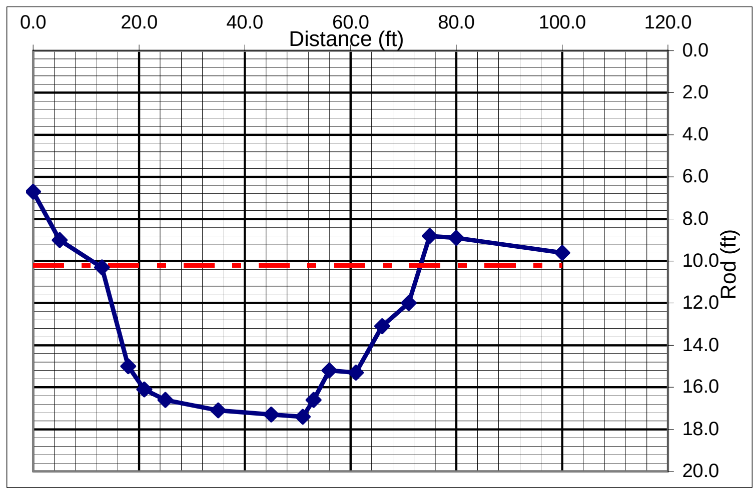
$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

*assuming uniform, steady flow*

| | | *Trial Depth 2* | *Trial Depth 3* |
|---|---|---|---|
| Selected Flow Depth: | 7.2 *ft* | 8.6 | |
| Channel Flow (***Q***): | 1,267.8 *cfs* | 1,439.0 | |
| Channel Velocity: | 3.9 *ft/sec* | 3.4 | |
| Cross-Sectional Area (***A***): | 322.1 *sq.ft.* | 427.0 | |
| Hydraulic Radius (***R***): | 5.0 *ft* | 3.9 | |

**Survey Data:**

| Rod *(ft)* | Distance *(ft)* |
|---|---|
| 6.7 | 0.0 |
| 9.0 | 5.0 |
| 10.3 | 13.0 |
| 15.0 | 18.0 |
| 16.1 | 21.0 |
| 16.6 | 25.0 |
| 17.1 | 35.0 |
| 17.3 | 45.0 |
| 17.4 | 51.0 |
| 16.60 | 53 |
| 15.20 | 56 |
| 15.30 | 61 |
| 13.10 | 66 |
| 12.00 | 71 |
| 8.80 | 75 |
| 8.9 | 80 |
| 9.6 | 100 |




COMMENTS:

## Stream Stabilization I & E Form

ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book

| | | | | | |
|---|---|---|---|---|---|
| **County** | Vermilion | T. | | R. | | Sec. | |
| Date | 9/16/2005 | By | Wayne Kinney | | |
| Stream Name | Sugar Creek | UTM Coord. | E448902 N4376418 | | |
| Landowner Name | xsec 5 | | | | |
| Drainage Area | 46.2 sq. mi. | Clear Cells | | | |

*Regional Curve Predictions:*

| | | | | |
|---|---|---|---|---|
| Bankfull dimensions | Width | 66 ft. | Cross Sectional Area | 303 sq. ft. |
| | Depth | 4.5 ft. | | |

*Reference Stream Gage:*

| | | | |
|---|---|---|---|
| Bluegrass Creek at Potomac | Station No. 03336500 | Gage $Q_2$ | 1850 cfs |
| | Drainage Area 35 sq.mi | Regression ( | 1060 cfs |
| Vermilion County, IL | **REFERENCE STREAM DATA ONLY** | | |

*USGS Flood-Peak Discharge Predictions:*

| | | | | | | |
|---|---|---|---|---|---|---|
| Valley Slope: | 7.9 | ft./mi. (user-entered) | | | Regression $Q_2$ | 1317 cfs |
| | | ft/mi (from worksheet) | Rainfall | 2.95 in (2 yr, 24 hr) | Adjusted $Q_2$ | 2299 cfs |
| | 0.0015 | ft./ft. | Regional Factor | 1.057 | Typical Range for Bankfull Discharge: | 910 to 1840 cfs |

*Local Stream Morphology:*

Channel Description: (c) Clean, winding, some pools and shoals

Manning's "n" 0.04

| | | | | | |
|---|---|---|---|---|---|
| | | | Stream Length | | ft. |
| *Basic Field Data:* | | | Valley Length | | ft. |
| Bankfull Width | 62 | ft. | Contour Interval | | feet |
| Mean Bankfull Depth | 5.34 | ft. | Estimated Sinuosity | | |
| Width/Depth Ratio | 11.61 | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | *Channel Slope:* | | Bankfull Q from: | | |
| Max. Bankfull Depth | 7 | ft. | Surveyed: | 0.00132 ft./ft. | Cross-Section | 1312 | cfs |
| Width at twice max. depth | 1000 | ft. | Estimated: | ft./ft. | Basic field data | 1370 | cfs |
| ( 14.0 ft.) | | | | | Selected Q | 1341 | cfs |
| Entrenchment Ratio | 16.13 | | Radius of Curvature (Rc) | ft. | | | |
| | | | Rc/Bankfull width: | 0.00 | | | |

*Bankfull Velocity Check:* *(typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)*

| | | | | | |
|---|---|---|---|---|---|
| Bedload: | $D_{90}$ | 4 *in.* | Velocity required to move $D_{90}$: | 4.2 | *ft./sec.* |
| | $D_{50}$ | *in.* | Velocity from Cross-Section data: | 3.96 | *ft./sec.* |
| *GOAL: Develop confidence by matching* | | | Velocity from basic field data: | 4.14 | *ft./sec.* |
| *velocities from different sources.* | | | Velocity from selected Q: | 4.1 | *ft./sec.* |

Channel Evolution Stage IV     Stream Type (Rosgen)

**Notes**

29.0 cfs/sq. mi.

# Natural Open Channel Flow

[back to I&E form]

Clear Cells

| | | |
|---|---|---|
| Project: | xsec 5 | |
| Assisted by: | Wayne Kinney | |
| Date: | 9/16/2005 | |
| Channel Slope (***S***): | 0.001320 | *ft/ft* |
| Manning's ***n*** : | 0.040 | |
| Flow Depth: | 6.8 | *ft* |

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

*assuming uniform, steady flow*

| | | *Trial Depth 2* | *Trial Depth 3* |
|---|---|---|---|
| Selected Flow Depth: | 6.8 *ft* | 8.7 | |
| Channel Flow (***Q***): | 1,311.6 *cfs* | 1,870.5 | |
| Channel Velocity: | 4.0 *ft/sec* | 4.1 | |
| Cross-Sectional Area (***A***): | 330.9 *sq.ft.* | 455.8 | |
| Hydraulic Radius (***R***): | 5.0 *ft* | 5.3 | |

**Survey Data:**

| Rod *(ft)* | Distance *(ft)* |
|---|---|
| 8.0 | 0.0 |
| 7.9 | 10.0 |
| 10.2 | 14.0 |
| 11.9 | 18.0 |
| 15.8 | 24.0 |
| 16.6 | 27.0 |
| 16.3 | 40.0 |
| 16.5 | 50.0 |
| 15.9 | 60.0 |
| 15.40 | 64 |
| 15.80 | 68 |
| 11.00 | 73 |
| 8.60 | 77 |
| 7.90 | 81 |
| 5.50 | 88 |
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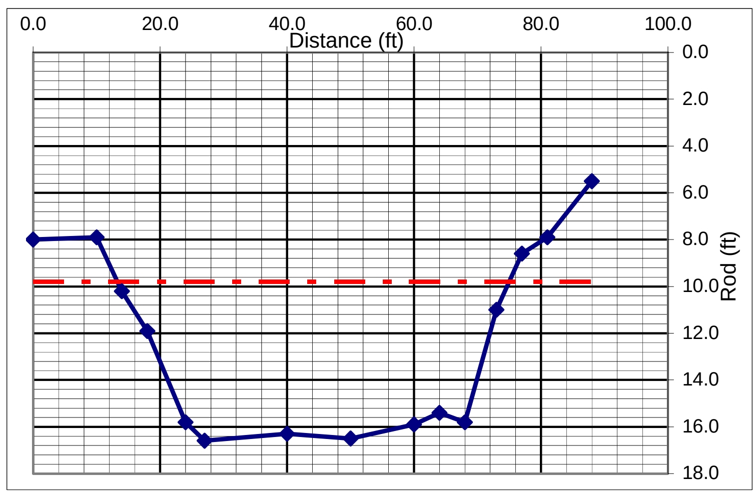


COMMENTS:

# Stream Stabilization I & E Form

ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book

**County** Vermilion T. R. Sec.

Date 9/16/2005 By Wayne Kinney

Stream Name Sugar Creek UTM Coord. E450135 N4375769

Landowner Name xsec 6

Drainage Area 49.8 sq. mi. Clear Cells

*Regional Curve Predictions:*

| | | | | |
|---|---|---|---|---|
| Bankfull dimensions | Width | 68 ft. | Cross Sectional Area | 318 sq. ft. |
| | Depth | 4.6 ft. | | |

*Reference Stream Gage:*

Bluegrass Creek at Potomac — Station No. 03336500 — Gage $Q_2$ 1850 cfs

Drainage Area 35 sq.mi — Regression Q 1060 cfs

Vermilion County, IL — **REFERENCE STREAM DATA ONLY**

*USGS Flood-Peak Discharge Predictions:*

| | | | | | |
|---|---|---|---|---|---|
| Valley Slope: | 7.4 | *ft./mi. (user-entered)* | | Regression $Q_2$ | 1357 cfs |
| | | *ft/mi (from worksheet)* | Rainfall 2.95 in *(2 yr, 24 hr)* | Adjusted $Q_2$ | 2368 cfs |
| | 0.0014 | *ft./ft.* | Regional Factor 1.057 | Typical Range for Bankfull Discharge: | 940 to 1900 cfs |

*Local Stream Morphology:*

Channel Description: (c) Clean, winding, some pools and shoals

Manning's "n" 0.04

*Basic Field Data:*

| | | | | | |
|---|---|---|---|---|---|
| | | | Stream Length | | *ft.* |
| | | | Valley Length | | *ft.* |
| Bankfull Width | 59 | *ft.* | Contour Interval | | feet |
| Mean Bankfull Depth | 5.71 | *ft.* | Estimated Sinuosity | | |
| Width/Depth Ratio | 10.33 | | | | |

*Channel Slope:*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Max. Bankfull Depth | 7 | *ft.* | Surveyed: | 0.00132 | *ft./ft.* | Cross-Section | 1366 *cfs* |
| Width at twice max. depth | 800 | *ft.* | Estimated: | | *ft./ft.* | Basic field data | 1457 *cfs* |
| ( 14.0 ft.) | | | | | | Selected Q | 1412 *cfs* |
| Entrenchment Ratio | 13.56 | | Radius of Curvature (Rc) | | ft. | | |
| | | | Rc/Bankfull width: | 0.00 | | | |

Bankfull Q from: (see above)

*Bankfull Velocity Check:* *(typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)*

| | | | | |
|---|---|---|---|---|
| Bedload: $D_{90}$ | 6 | *in.* | Velocity required to move $D_{90}$: | 5.1 *ft./sec.* |
| $D_{50}$ | | *in.* | Velocity from Cross-Section data: | 4.05 *ft./sec.* |
| *GOAL: Develop confidence by matching* | | | Velocity from basic field data: | 4.33 *ft./sec.* |
| *velocities from different sources.* | | | Velocity from selected Q: | 4.2 *ft./sec.* |

Channel Evolution Stage V — Stream Type (Rosgen)

**Notes**

28.3 cfs/ sq. mi.

# Natural Open Channel Flow

back to I&E form

Clear Cells

| | | |
|---|---|---|
| Project: | xsec 6 | |
| Assisted by: | Wayne Kinney | |
| Date: | 9/16/2005 | |
| Channel Slope (***S***): | 0.001320 | *ft/ft* |
| Manning's ***n***: | 0.040 | |
| Flow Depth: | 7.1 | *ft* |

$$Q \; 8 \; \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

*assuming uniform, steady flow*

| | | *Trial Depth 2* | *Trial Depth 3* |
|---|---|---|---|
| Selected Flow Depth: | 7.1 *ft* | 8.3 | |
| Channel Flow (***Q***): | 1,365.6 *cfs* | 1,604.2 | |
| Channel Velocity: | 4.1 *ft/sec* | 3.9 | |
| Cross-Sectional Area (***A***): | 337.0 *sq.ft.* | 410.9 | |
| Hydraulic Radius (***R***): | 5.2 *ft* | 4.9 | |

**Survey Data:**

| Rod *(ft)* | Distance *(ft)* |
|---|---|
| 9.2 | 0.0 |
| 10.6 | 6.0 |
| 11.8 | 9.0 |
| 15.8 | 13.0 |
| 16.4 | 14.0 |
| 17.7 | 15.0 |
| 17.8 | 25.0 |
| 18.0 | 35.0 |
| 18.7 | 45.0 |
| 18.30 | 55 |
| 18.40 | 62 |
| 14.40 | 63 |
| 10.60 | 68 |
| 10.40 | 72 |
| 10.60 | 80 |
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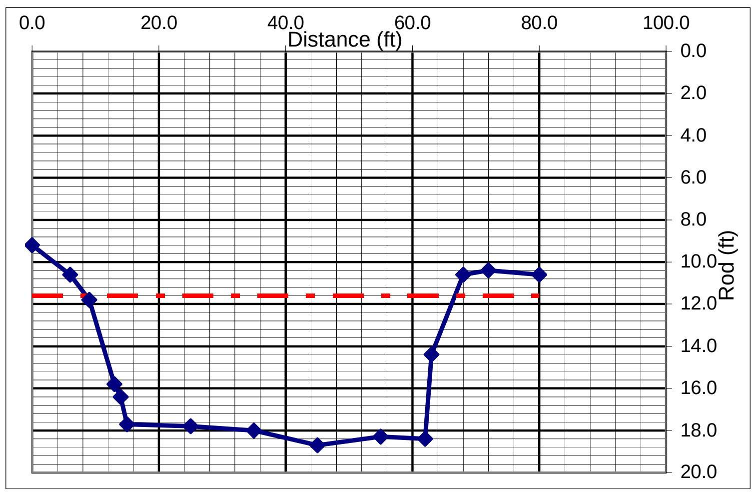



COMMENTS:

## Stream Stabilization I & E Form

*ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book*

**County** Vermilion | T. | R. | Sec.

Date 9/16/2005 | By Wayne Kinney

Stream Name Sugar Creek | UTM Coord. E451081 N4374826

Landowner Name xsec 7

Drainage Area 50.6 sq. mi. | Clear Cells

*Regional Curve Predictions:*

| | | | | |
|---|---|---|---|---|
| Bankfull dimensions | Width | 69 ft. | Cross Sectional Area | 322 sq. ft. |
| | Depth | 4.7 ft. | | |

*Reference Stream Gage:*

| | | | | |
|---|---|---|---|---|
| Bluegrass Creek at Potomac | Station No. | 03336500 | Gage $Q_2$ | 1850 cfs |
| | Drainage Area | 35 sq.mi | Regression ( | 1060 cfs |
| Vermilion County, IL | REFERENCE STREAM DATA ONLY | | | |

*USGS Flood-Peak Discharge Predictions:*

| | | | | | | |
|---|---|---|---|---|---|---|
| Valley Slope: | 7.6 | ft./mi. (user-entered) | | | Regression $Q_2$ | 1392 cfs |
| | | ft/mi (from worksheet) | Rainfall | 2.95 in (2 yr, 24 hr) | Adjusted $Q_2$ | 2429 cfs |
| | 0.0014 | ft./ft. | Regional Factor | 1.057 | Typical Range for Bankfull Discharge: | 970 to 1950 cfs |

*Local Stream Morphology:*

Channel Description: (c) Clean, winding, some pools and shoals

Manning's "n" 0.04

| | | | | | |
|---|---|---|---|---|---|
| | | Stream Length | ft. | | |
| *Basic Field Data:* | | Valley Length | ft. | | |
| Bankfull Width | 68 ft. | Contour Interval | feet | | |
| Mean Bankfull Depth | 5.58 ft. | Estimated Sinuosity | | | |
| Width/Depth Ratio | 12.19 | | | | |
| | | *Channel Slope:* | | Bankfull Q from: | |
| Max. Bankfull Depth | 6.7 ft. | Surveyed: | 0.00132 ft./ft. | Cross-Section | 1403 cfs |
| Width at twice max. depth | 1200 ft. | Estimated: | ft./ft. | Basic field data | 1616 cfs |
| ( 13.4 ft.) | | | | Selected Q | 1510 cfs |
| Entrenchment Ratio | 17.65 | Radius of Curvature (Rc) | ft. | | |
| | | Rc/Bankfull width: | 0.00 | | |

*Bankfull Velocity Check:* *(typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)*

| | | | | |
|---|---|---|---|---|
| Bedload: $D_{90}$ | 1 *in.* | Velocity required to move $D_{90}$: | 2.1 | *ft./sec.* |
| $D_{50}$ | *in.* | Velocity from Cross-Section data: | 3.93 | *ft./sec.* |
| *GOAL: Develop confidence by matching* | | Velocity from basic field data: | 4.26 | *ft./sec.* |
| *velocities from different sources.* | | Velocity from selected Q: | 4.0 | *ft./sec.* |

Channel Evolution Stage V | Stream Type (Rosgen)

**Notes**

29.8 cfs/ sq. mi.

# Natural Open Channel Flow

back to I&E form

Clear Cells

| | |
|---|---|
| Project: | xsec 7 |
| Assisted by: | Wayne Kinney |
| Date: | 9/16/2005 |
| Channel Slope (***S***): | 0.001320 *ft/ft* |
| Manning's ***n***: | 0.040 |
| Flow Depth: | 6.2 *ft* |

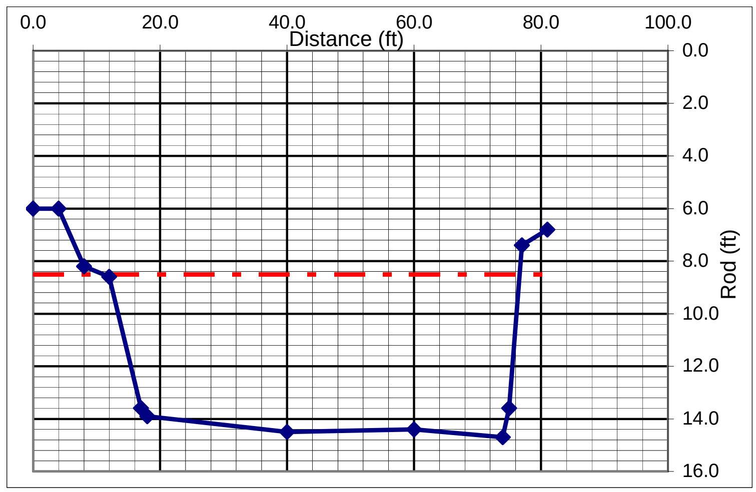
$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

*assuming uniform, steady flow*

| | | *Trial Depth 2* | *Trial Depth 3* |
|---|---|---|---|
| Selected Flow Depth: | 6.2 *ft* | 7.9 | |
| Channel Flow (***Q***): | 1,403.0 *cfs* | 2,063.2 | |
| Channel Velocity: | 3.9 *ft/sec* | 4.3 | |
| Cross-Sectional Area (***A***): | 357.2 *sq.ft.* | 476.9 | |
| Hydraulic Radius (***R***): | 5.0 *ft* | 5.7 | |

**Survey Data:**

| Rod *(ft)* | Distance *(ft)* |
|---|---|
| 6.0 | 0.0 |
| 6.0 | 4.0 |
| 8.2 | 8.0 |
| 8.6 | 12.0 |
| 13.6 | 17.0 |
| 13.9 | 18.0 |
| 14.5 | 40.0 |
| 14.4 | 60.0 |
| 14.7 | 74.0 |
| 13.60 | 75 |
| 7.40 | 77 |
| 6.80 | 81 |




COMMENTS:

## Stream Stabilization I & E Form

*ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book*

**County** Vermilion    T.    R.    Sec.

Date 9/16/2005    By Wayne Kinney

Stream Name Sugar Creek    UTM Coord. E451472 N4372978

Landowner Name xsec 8

Drainage Area 58.9 sq. mi.    Clear Cells

*Regional Curve Predictions:*

| | | | | |
|---|---|---|---|---|
| Bankfull dimensions | Width | 73 ft. | Cross Sectional Area | 357 sq. ft. |
| | Depth | 4.9 ft. | | |

*Reference Stream Gage:*

| | | | | |
|---|---|---|---|---|
| Bluegrass Creek at Potomac | Station No. | 03336500 | Gage $Q_2$ | 1850 cfs |
| | Drainage Area | 35 sq.mi | Regression ( | 1060 cfs |
| Vermilion County, IL | REFERENCE STREAM DATA ONLY | | | |

*USGS Flood-Peak Discharge Predictions:*

| | | | | | |
|---|---|---|---|---|---|
| Valley Slope: | 7.6 | *ft./mi. (user-entered)* | | Regression $Q_2$ | 1569 cfs |
| | | *ft/mi (from worksheet)* | Rainfall 2.95 in *(2 yr, 24 hr)* | Adjusted $Q_2$ | 2739 cfs |
| | 0.0014 | *ft./ft.* | Regional Factor 1.057 | Typical Range for Bankfull Discharge: | 1090 to 2200 cfs |

*Local Stream Morphology:*

Channel Description: (c) Clean, winding, some pools and shoals

Manning's "n" 0.04

| | | | | | |
|---|---|---|---|---|---|
| *Basic Field Data:* | | Stream Length | *ft.* | | |
| | | Valley Length | *ft.* | | |
| Bankfull Width | 88 *ft.* | Contour Interval | feet | | |
| Mean Bankfull Depth | 4.91 *ft.* | Estimated Sinuosity | | | |
| Width/Depth Ratio | 17.92 | | | | |
| | | *Channel Slope:* | | Bankfull Q from: | |
| Max. Bankfull Depth | 5.7 *ft.* | Surveyed: | 0.00132 *ft./ft.* | Cross-Section | 1637 *cfs* |
| Width at twice max. depth | 1200 *ft.* | Estimated: | *ft./ft.* | Basic field data | 1690 *cfs* |
| ( 11.4 ft.) | | | | Selected Q | 1663 *cfs* |
| Entrenchment Ratio | 13.64 | Radius of Curvature (Rc) | ft. | | |
| | | Rc/Bankfull width: | 0.00 | | |

*Bankfull Velocity Check:* *(typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)*

| | | | | |
|---|---|---|---|---|
| Bedload: | $D_{90}$ 4 *in.* | Velocity required to move $D_{90}$: | 4.2 | *ft./sec.* |
| | $D_{50}$ *in.* | Velocity from Cross-Section data: | 3.79 | *ft./sec.* |
| *GOAL: Develop confidence by matching* | | Velocity from basic field data: | 3.91 | *ft./sec.* |
| *velocities from different sources.* | | Velocity from selected Q: | 3.8 | *ft./sec.* |

Channel Evolution Stage IV    Stream Type (Rosgen)

**Notes**

28.2 cfs/sq. mi.

# Natural Open Channel Flow

back to I&E form

Clear Cells

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

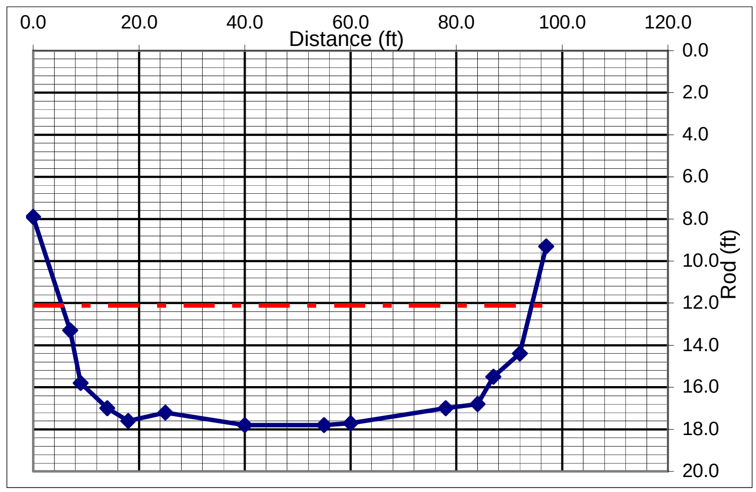
*assuming uniform, steady flow*

| | | |
|---|---|---|
| Project: | xsec 8 | |
| Assisted by: | Wayne Kinney | |
| Date: | 9/16/2005 | |
| Channel Slope (***S***): | 0.001320 | *ft/ft* |
| Manning's ***n***: | 0.040 | |
| Flow Depth: | 5.7 | *ft* |

| | | *Trial Depth 2* | *Trial Depth 3* |
|---|---|---|---|
| Selected Flow Depth: | 5.7 *ft* | 8.5 | |
| Channel Flow (***Q***): | 1,636.7 *cfs* | 3,362.9 | |
| Channel Velocity: | 3.8 *ft/sec* | 4.9 | |
| Cross-Sectional Area (***A***): | 432.3 *sq.ft.* | 689.9 | |
| Hydraulic Radius (***R***): | 4.7 *ft* | 6.9 | |

**Survey Data:**

| Rod *(ft)* | Distance *(ft)* |
|---|---|
| 7.9 | 0.0 |
| 13.3 | 7.0 |
| 15.8 | 9.0 |
| 17.0 | 14.0 |
| 17.6 | 18.0 |
| 17.2 | 25.0 |
| 17.8 | 40.0 |
| 17.8 | 55.0 |
| 17.7 | 60.0 |
| 17.00 | 78 |
| 16.80 | 84 |
| 15.50 | 87 |
| 14.40 | 92 |
| 9.30 | 97 |




COMMENTS:

# Appendix E
# Responsiveness Summary

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## Responsiveness Summary

This responsiveness summary responds to substantive questions and comments received during the public comment period from November 27, 2007 through January 31, 2008 postmarked, including those from the December 12, 2007 public meeting discussed below.

## What is a TMDL?

A Total Maximum Daily Load (TMDL) is the sum of the allowable amount of a pollutant that a water body can receive from all contributing sources and still meet water quality standards or designated uses. The Sugar Creek watershed TMDL report contains a plan detailing the actions necessary to reduce pollutant loads to the impaired water bodies and ensure compliance with applicable water quality standards. The Illinois EPA implements the TMDL program in accordance with Section 303(d) of the federal Clean Water Act and regulations thereunder.

## Background

The watershed targeted for TMDL development is Sugar Creek, located in Edgar County. The watershed encompasses an area of approximately 41,500 acres (65 square miles). Land use in the watershed is predominately agriculture. Sugar Creek segment BMC2 is approximately 2.9 miles in length, and Sugar Creek segment BM-02 is approximately 12.9 miles in length. Sugar Creek segment BMC2 is listed on the Illinois EPA 2006 Section 303(d) List as being impaired for dissolved oxygen and siltation/sedimentation. Illinois EPA is currently developing TMDLs for pollutants that have numeric water quality standards. Since Illinois does not have numeric water quality standards for siltation/sedimentation, the report only addressed DO. The 2004 Section 303(d) List included Sugar Creek segment BM-02 as impaired for total fecal coliform, but was not included in the 2006 Integrated Report. However, newer data showed violations of the total fecal coliform water quality standard, therefore a total fecal coliform TMDL was developed. The Clean Water Act and USEPA regulations require that states develop TMDLs for waters on the Section 303(d) List. Illinois EPA contracted with Tetra Tech, Inc. to conduct Stages 1 and 2, and CDM to prepare the Stage 3 TMDL report for the Sugar Creek watershed.

## Public Meetings

Public meetings were held at the Edgar County 4-H building on March 8, 2005 and at Paris City Hall on December 12, 2007. The Illinois EPA provided public notice for both meetings by placing display ads in the Paris Beacon News. This notice gave the date, time, location, and purpose of the meeting. The notice also provided references to obtain additional information about this specific site, the TMDL Program and other related issues. Approximately 60 individuals and organizations were also sent the public notice by first class mail. The draft TMDL Report was available for review at the Edgar County

Soil and Water Conservation District, Paris City Hall, and also on the Agency's web page at http://www.epa.state.il.us/public-notices/.

A public meeting started at 6:00 p.m. on Wednesday December 12, 2007. It was attended by approximately 10 people and concluded at 7:30 p.m. with the meeting record remaining open until midnight, January 31, 2008.

## Questions and Comments

1. A potential source for fecal coliform loads observed in the stream could be attributed to the Eads Subdivision near Sugar Creek. All of the septic systems were tied directly to tile lines which discharged directly to a tributary to Sugar Creek, just downstream from the treatment plant discharge. Raw sewage has been observed discharging from these tile lines. The City is in the process of hooking these houses up to the city's sewer system, and should be completed soon.

   **Response: Thank you for your comment. This will be noted in the final report.**

2. In regards to the Paris sewage treatment plant's disinfection exemption, the City is planning to add UV disinfection during their next plant upgrade if it is financially feasible.

   **Response: Thank you for your comment. This will be noted in the final report.**

3. The City of Paris is currently investigating alternative drinking water sources. If the lakes cease to be a public water supply, the dam may discharge more often, resulting in more flow and increasing dissolved oxygen to Sugar Creek.

   **Response: Thank you for your comment. This will be noted in the final report.**

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