



## Illinois Environmental Protection Agency

### **Cahokia Canal/Horseshoe Lake Watershed Total Maximum Daily Load Stage Three Report**

January 2008



*Draft Report*

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# Acronyms

°F	degrees Fahrenheit
ALMP	Ambient Lake Monitoring Program
BMP	best management practice
BOD	biochemical oxygen demand
CBOD <sub>5</sub>	5-day carbonaceous biochemical oxygen demand
cfs	cubic feet per second
CRP	Conservation Reserve Program
CWA	Clean Water Act
DEM	Digital Elevation Model
DMR	Discharge Monitoring Reports
DO	dissolved oxygen
DP	dissolved phosphorus
ft	foot
GIS	geographic information system
GWLF	generalized watershed loading function
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
ICLP	Illinois Clean Lakes Program
IDA	Illinois Department of Agriculture
IDNR	Illinois Department of Natural Resources
ILLCP	Illinois Interagency Landscape Classification Project
Illinois EPA	Illinois Environmental Protection Agency
IPCB	Illinois Pollution Control Board
ISWS	Illinois State Water Survey
LA	load allocation
LC	loading capacity
MBI	Macroinvertebrate Biotic Index
mg/L	milligrams per liter
MOS	margin of safety
NASS	National Agricultural Statistics Service
NCDC	National Climatic Data Center
NRCS	National Resource Conservation Service
PO <sub>4</sub>	phosphate
SSURGO	Soil Survey Geographic Database

*List of Acronyms*  
*Development of Total Maximum Daily Loads*  
*Cahokia Canal/Horseshoe Lake Watershed*

STATSGO	State Soil Geographic
STORET	Storage and Retrieval
TMDL	total maximum daily load
TP	total phosphorus
TSS	total suspended solids
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WLA	waste load allocation

# Section 7

## Methodology Development for the Cahokia Canal/Horseshoe Lake Watershed

### 7.1 Methodology Overview

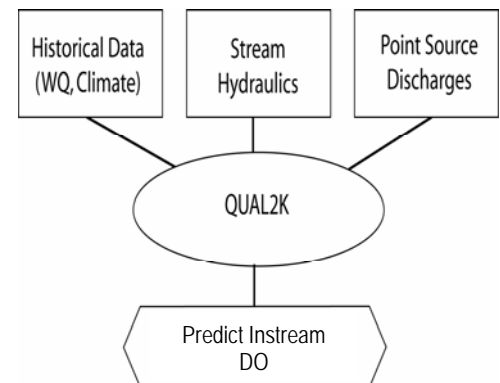
Table 7-1 contains information on the methodologies selected and used to develop TMDLs for impaired segments within the Cahokia Canal/Horseshoe Lake watershed.

**Table 7-1 Methodologies Used to Develop TMDLs in the Cahokia Canal/Horseshoe Lake Watershed**

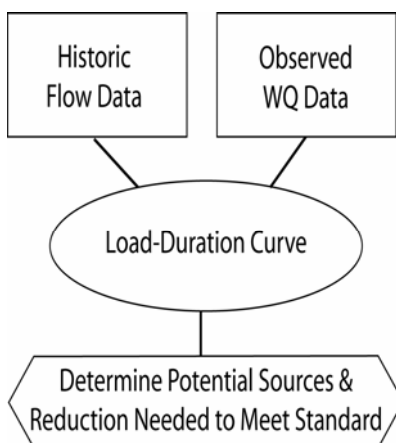
Segment Name/ID	Cause of Impairment	Methodology
Cahokia Canal/JN02	Dissolved Oxygen	QUAL2K
Canteen Creek/JNA01	Manganese	Load-Duration Curve
Harding Ditch/JMAC02	Fecal Coliform	Load-Duration Curve
Horseshoe Lake/RJC	Total Phosphorus/pH	BATHTUB
Frank Holten Lake #1/RJK	Total Phosphorus	BATHTUB
Frank Holten Lake #2/RJL	Total Phosphorus	BATHTUB
Frank Holten Lake #3/RJM	Total Phosphorus/Dissolved Oxygen	BATHTUB

#### 7.1.1 QUAL2K Overview

The QUAL2K model was used to develop the dissolved oxygen TMDL for segment JN02 of the Cahokia Canal. QUAL2K is a stream water quality model that is one-dimensional and applicable to well-mixed streams. The model assumes steady state hydraulics and allows for point source inputs, diffuse loading and tributary flows. Historic water quality data, observed hydraulic information, and point source discharge data were coupled with model defaults to predict the resulting instream DO concentrations.



Schematic 1



Schematic 2

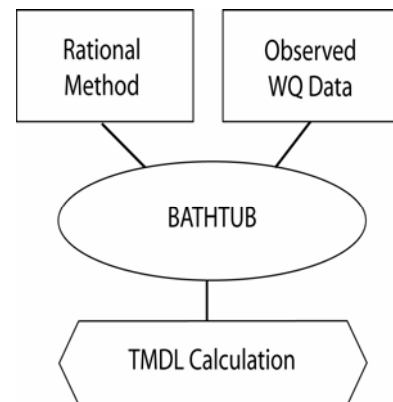
#### 7.1.2 Load-Duration Curve Overview

A loading capacity analysis was performed for Canteen Creek (segment JNA01) and Harding Ditch (segment JMAC02). A load-duration curve is a graphical representation of the maximum load of a pollutant, in this case total manganese for Canteen Creek and fecal coliform for Harding Ditch, that a segment can assimilate over a range of flow scenarios while still meeting the instream water quality standard. The load-duration curve approach provides useful information regarding the magnitude and frequency of exceedences as well as the flow scenarios when exceedences occur most often.

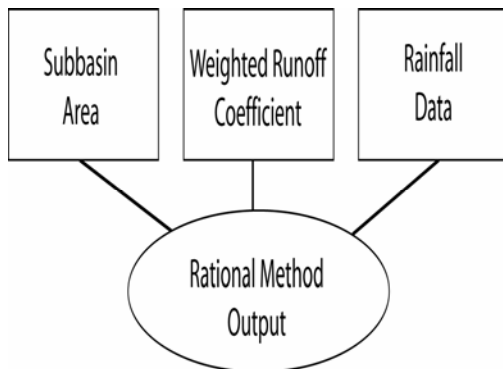
### 7.1.3 BATHTUB Overview

The approach taken for TMDL analysis for Horseshoe Lake and the Frank Holten Lakes included using observed data coupled with the rational method as inputs to the BATHTUB model. This method required inputs from several sources including online databases and GIS-compatible data.

Schematic 3 shows the data inputs for the BATHTUB model that were used to calculate the TMDLs. Flow and concentration data were limited to a single subbasin for both lakes' watersheds. Historic data were used when available and the rational method was used to estimate runoff and concentrations from small subbasins adjacent to the impaired lakes when no data were available. The rational method (see Schematic 4) calculates a subbasin discharge based on the subbasin area, precipitation data, and a weighted runoff coefficient derived from the imperviousness of the subbasin land uses. In addition, event mean



Schematic 3

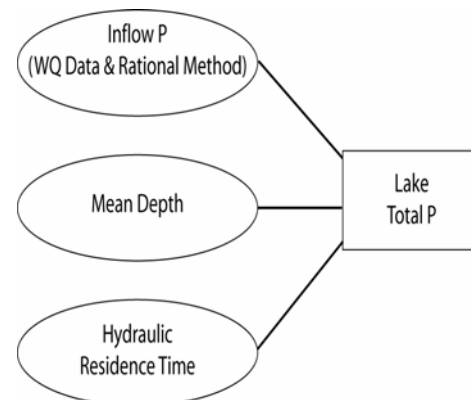


Schematic 4

concentration (EMC) data were used in conjunction with land use data to estimate total phosphorus concentrations from the subbasin areas with no historic data.

Once the subbasin flows and concentrations were estimated, they were used as input for the BATHTUB model. The BATHTUB

model uses empirical relationships between mean reservoir depth, total phosphorus inputted to the lake, and the hydraulic residence time to determine in-reservoir concentrations (see Schematic 5).



Schematic 5

## 7.2 Methodology Development

The following sections further discuss and describe the methodologies utilized to examine DO, manganese, fecal coliform and total phosphorus levels in the impaired waterbodies in the Cahokia Canal/Horseshoe Lake watershed.

## 7.2.1 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 USEPA-supported. The modernized version has been updated to use Microsoft Excel as the user interface and has expanded the options for stream segmentation as well as a number of other model inputs. Q2K simulates DO dynamics as a function of nitrogenous and carbonaceous oxygen demand, atmospheric reaeration, SOD, and plant photosynthesis and respiration. The model also simulates the fate and transport of nutrients and BOD and the growth and abundance of floating (phytoplankton) and attached (periphyton) algae (as chlorophyll-a). Stream hydrodynamics and temperature are important controlling parameters in the model. Headwater, point source, and non-point source loadings and flows are explicitly input by the user. The model simulates steady-state diurnal cycles. Model parameter default values are provided in the model based on past studies and are recommended in the absence of site-specific information.

### 7.2.1.1 QUAL2K Inputs

Table 7-2 contains the categories of data required for the Q2K model along with the sources of data used to analyze segment JN02 of the Cahokia Canal.

**Table 7-2 Q2K Data Inputs**

Input Category	Data Source
Stream Segmentation	GIS data
Hydraulic characteristics	CDM field survey; aerial photographs; GIS
Headwater conditions	CDM field survey; Historic water quality data collected at JN02
Meteorologic conditions	National Climatic Data Center
Point Source contributions	Illinois EPA

Empirical data amassed during Stage 1 of TMDL development were used to build the Q2K model for the Cahokia Canal. In addition to the Stage 1 data, aerial photographs, GIS data and stream cross-section and flow measurements from a CDM field survey were used for the Q2K model.

#### 7.2.1.1.1 Stream Segmentation

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. Cahokia Canal was divided into 5 reaches and Canteen Creek was added as a tributary. The modeled Canteen Creek segment extended from the Collinsville Sanitary Treatment Plant (STP) to the confluence with the canal. Figure 7-1 shows the stream segmentation used for the Q2K model.

#### 7.2.1.1.2 Hydraulic Characteristics

The majority of stream hydraulics were specified in the model based on a CDM field survey conducted in May 2007 under low-flow conditions. Four wetted cross-sections were surveyed by measuring depths, velocities, and widths at multiple points across a transect. The four cross-section locations, shown in Figure 7-1, were chosen to achieve an adequate spatial representation of the modeled reach. A fifth target location (near

the Route 203 crossing) was not wadeable and therefore was not gaged. Visual and photograph characterization, however, were used to guide model hydraulic inputs for this downstream area. Appendix E contains field sheets and photographs from this survey. In addition, no hydraulic data were available for the modeled portion of Canteen Creek. The Manning's Equation was used to drive hydraulics for this segment based on estimated channel width from aerial photographs, channel slope from the National Elevation Dataset, and an estimated Manning's roughness coefficient.

#### **7.2.1.1.3 Headwater Conditions**

The model was set up with two headwaters; Cahokia Canal and Canteen Creek. The following describes conditions for each segment.

##### **7.2.1.1.3.1 Cahokia Canal**

A review of historic water quality data for the modeled reach of Cahokia Canal showed that there have been 16 violations of the dissolved oxygen standard recorded since 1990 (out of 126 total samples). Of the 16 violating samples, 15 were collected between July and October, which are also the months that experience the lowest flows in the area. This indicated that dissolved oxygen problems are associated with low-flow periods. Therefore, low-flow, summer conditions were used for model development.

The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary condition. Measured concentration data were not specifically available for the modeled headwater segment. However, historic water quality data collected at sampling site JN02 (Cahokia Canal at Sand Prairie Rd, approximately 4.5 miles downstream) were available and were used as a surrogate headwater concentration data set. Only water quality data collected in the months of July, August, September, and October were used for this model. Because there are no major inputs to the system between the headwaters and the sampling location JN02, it was assumed that data collected at the sampling location were representative of conditions at the headwaters.

The upstream flows measured during the CDM field survey (May, 2007) were in the range of 4.2 – 4.9 cfs. Due to the fact that the modeled hydraulics (based on the only available data) are associated with this measured flow range, a headwater flow rate of 4.2 cfs is assumed in the model. This value is considered adequately representative of low-flow, critical conditions. For reference, the 7Q10 low flow for Cahokia Canal upstream of the confluence with Canteen Creek is 2.4 cfs.

##### **7.2.1.1.3.2 Canteen Creek**

Data for Canteen Creek are limited. The modeled segment extended from the Collinsville STP discharge point to the confluence with Cahokia Canal. According to the Collinsville STP permit, 7Q10 low flows on this segment are 0 cfs. Therefore, water quality conditions and flow for this segment were inputted using historic DMR



records from the STP assuming that the facility’s effluent discharge rate and quality are representative of instream flows and water quality during critical low flow times.

Where historic DMR data were missing, concentration data were estimated using mean summer values from Canteen Creek water quality monitoring station JNA01.

**7.2.1.1.4 Climate**

Q2K requires inputs for climate. Temperature and wind speed data from Lambert International Airport in St. Louis, Missouri were used for the model.

**7.2.1.1.5 Point Sources**

A number of point sources discharge within the Cahokia Canal watershed. Q2K allows user input of point source locations, flow and water quality data. Permit records were reviewed and permitted discharge data were used for model input. Table 7-3 contains information for each facility while Figure 7-1 shows the locations of each facility. Flow information was available for each discharger; however, permit limit concentration data are available only for parameters that are sampled per permit requirements.

**Table 7-3 Point Source Discharges within the Cahokia Canal Watershed**

Facility Name	Permit Number	Permitted Facility Flows	Segment Number
Stone Meadows MHP	IL0046914	0.07	1
Wheel Ranch MHP	IL0044598	0.02	1
Maryville WTP	ILG640139	0.01	1
Holiday MHP	IL0038288	0.05	2
Collinsville STP <sup>(1)</sup>	IL0028215	5.85	4
General Chemical	IL0000647	No Discharge	-
Elementis Pigments	IL0038709	2.0	6
Bowman Avenue Pump Station	IL0070955	No Discharge during low flow periods	-

(1) Collinsville STP is not explicitly modeled as a point source in the Cahokia Canal QUAL2K because it accounted for in the headwater conditions for Canteen Creek (see discussion in 7.1.1.3.2)

**7.2.1.2 QUAL2K Calibration**

Sufficient water quality data were not available to perform a calibration of model kinetic and transport rates. Specifically, a spatial distribution of measured data is lacking to guide parameterization of this steady-state model. All available data are from a single location on Cahokia Canal (JN02) and a single location on Canteen Creek (JNA01). Therefore, all model rates, including key rates of BOD decay, nitrification, and algae growth, were maintained at default values. Model hydrodynamic dispersion, reaeration, and sediment oxygen demand (SOD) are calculated internally in the model based on physical, chemical, and biological conditions. "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.

Appendix F contains the model input/output worksheets.

## 7.2.2 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 JMAC02 of Harding Ditch and total manganese in segment JNA01 of Canteen Creek.

### 7.2.2.1 Watershed Delineation and Flow Estimation

Watersheds for the areas contributing directly to Canteen Creek segment JNA01 and Harding Ditch segment JMAC02 were delineated with GIS analyses through use of the NED as discussed in Section 2.2. The delineation suggests that Canteen Creek segment JNA01 captures flows from a directly contributing watershed of approximately 27.2 square miles and Harding Ditch segment JMAC02 captures flows from a directly contributing watershed of approximately 56 square miles. Figures 7-2 and 7-3 at the end of this section show the location of the water quality stations on each segment as well as the boundary of the GIS-delineated watershed.

In order to create a load duration curve, it is necessary to obtain flow data corresponding to each water quality sample. As discussed in Section 2.6.2, there are no 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.

$$Q_{\text{gaged}} \left( \frac{\text{Area}_{\text{ungaged}}}{\text{Area}_{\text{gaged}}} \right) = Q_{\text{ungaged}}$$

where  $Q_{\text{gaged}}$  = Streamflow of the gaged basin  
 $Q_{\text{ungaged}}$  = Streamflow of the ungaged basin  
 $\text{Area}_{\text{gaged}}$  = Area of the gaged basin  
 $\text{Area}_{\text{ungaged}}$  = 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 05588000 (Indian Creek near Wanda, Illinois) was chosen as an appropriate gage from which to estimate flows in both Harding Ditch and Canteen Creek. The Indian Creek watershed is approximately 17 miles west northwest of Harding Ditch sampling site JMAC02 and 12 miles north of sampling site JNA01 on Canteen Creek. The gage drains an area that is a similar order of magnitude and receives comparable precipitation throughout the year. Gage 05588000 captures flow

from a drainage area of 37 square miles. The Harding Ditch watershed encompasses 33 square miles up to sampling site JMAC02 and the Canteen Creek watershed drains 27 square miles at sampling site JNA01.

Data were downloaded through the USGS for the Indian Creek gage and multiplied by the area ratio discussed above to estimate flows for each watershed. The Canteen Creek flows were further adjusted to account for the Collinsville STP which contributes 4.4 mgd to Canteen Creek upstream of the sampling location.

#### **7.2.2.2 Total Manganese Analysis for Canteen Creek Segment JNA01**

A flow duration curve for segment JNA01 of Canteen Creek was generated by ranking the estimated daily flow data generated through the area ratio method discussed above, determining the percent of days these flows were exceeded, and then graphically plotting the results. The flows in the duration curve were then multiplied by the water quality standard of 1,000 µg/L for total manganese to generate a load duration curve. Total manganese data collected from USEPA STORET and Illinois EPA databases during Stage 1 of TMDL development were paired with the corresponding flow for the sampling date and plotted against the load duration curve. Figure 7-4 shows the load duration curve as a solid line and the observed pollutant load as points on the graph. Appendix G contains the spreadsheet used for this analysis.

The load duration curve shows that only two exceedences of the standard have occurred since 1990. One occurred under high-flow conditions and one occurred during low-flow conditions. Under average conditions, the standard is not being exceeded.

#### **7.2.2.3 Fecal Coliform Analysis for Harding Ditch Segment JMAC02**

A flow duration curve for segment JMAC02 of Harding Ditch was also generated by ranking the estimated daily flow data generated through the area ratio method discussed above, determining the percent of days these flows were exceeded, and then graphically plotting the results. 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 geometric mean water quality standard of 200 cfu/100mL to generate a load duration curve. Fecal coliform data collected between May and October were compiled from USEPA STORET and Illinois EPA databases during Stage 1 of TMDL development and were paired with the corresponding flow for the sampling date and plotted against the load duration curve. Figure 7-5 shows the load duration curve as a solid line and the observed pollutant load as points on the graph. Appendix H contains the spreadsheet used for this analysis.

The load duration curve shows that only 1 of the 38 samples collected between May and October have been below the allowable load curve since 1990. The Illinois EPA 2004 303(d) list does not identify any potential sources of fecal coliform to Harding Ditch. The load duration analysis shows that the geometric mean standard of 200 cfu/100 mL is regularly exceeded during all flow scenarios and all samples collected

during higher flow scenarios have exceeded the allowable levels. Exceedences during high flows are likely attributable to the fecal matter introduced to the stream via overland runoff and the resuspension of fecal material in the ditch sediment. Dry weather sources of fecal coliform likely include failing septic systems in the watershed and livestock with direct access to the ditch or its tributaries.

### **7.2.3 BATHTUB Development for Horseshoe Lake**

The BATHTUB model was used to develop the total phosphorus TMDL for Horseshoe Lake. The aquatic life use of the lake is impaired by high phosphorus levels as well as high pH. Fluctuations in pH can be correlated to photosynthesis from algae. Plants and algae use carbon dioxide (CO<sub>2</sub>) during photosynthesis, which causes pH levels to rise. The photosynthetic rate progressively decreases as the residual CO<sub>2</sub> concentration declines and ceases completely with the extinction of light. During the night, reaeration and respiration replenish CO<sub>2</sub> causing the pH levels to decrease overnight (Welch 1980). Chlorophyll "a" indicates presence of excessive algal or aquatic plant growth. Reducing total phosphorus is likely to reduce algal growth thus resulting in attainment of the pH standard. Therefore, the BATHTUB model was used to investigate total phosphorus levels in Horseshoe Lake.

BATHTUB has three primary input interfaces: global, reservoir segment(s), and watershed inputs. The individual inputs for each of these interfaces are described in the following sections along with watershed and operational information for the lake.

#### **7.2.3.1 Horseshoe Lake Operations and Watershed Delineation**

Horseshoe Lake is an old oxbow lake of the Mississippi River located within Horseshoe Lake State Park, which is managed by the Illinois Department of Natural Resources (IDNR). Horseshoe Lake, as shown on Figure 7-6, has three "legs," the first leg to the west and the second and third to the east, respectively, which are separated by the land mass that is known as Walker's Island. At the southernmost tip of the east side of Horseshoe Lake, just south of the railroad, is Canteen Lake, which is privately owned. Siltation has occurred due to the diversion canal, which connects Canteen Lake (and effectively Horseshoe Lake) to the Cahokia Canal, and Walker's Island currently exists as a peninsula. There is a 180-acre portion of the lake (sub-impoundment) that is formed by this siltation and the causeway, the road that runs over the third, easternmost leg of the lake and connects to "Walker's Island." There is a valve located under the causeway that is closed under normal conditions and can be used to drain the sub-impoundment in the late summer.

Under normal conditions, Horseshoe Lake flows into Canteen Lake and then to the Cahokia Canal and ultimately to the Mississippi River by gravity. The outlet is located at the southern end of Canteen Lake, which consists of a 150-foot spillway at 437 feet of elevation, two 36-inch pipes at elevation 400.6 feet, and then the control structure, two 6-foot by 6-foot box culverts with sluice gates at elevation 399.0 feet. The lake pool elevation is maintained at an elevation of 403.8 feet. The gate is used to divert Cahokia Canal into Horseshoe Lake during wet weather. It is controlled by Metro East

Sanitary District (MESD), and is left open under normal conditions. There is a gate at the MESD-owned North Pump Station that is located where the Cahokia Canal meets the Mississippi River levee, and it is also left open under normal conditions.

During wet weather, when the Mississippi River elevation reaches 399.44 feet, the gate at the North Pump Station is closed. When the Cahokia Canal elevation reaches 403.7 feet, flow goes over the spillway and into the diversion canal, which is located just east of Highway 111 and Interstate 55. Cahokia Canal thereby backflows into Canteen Lake and Horseshoe Lake. The largest flows that enter the lake during a storm event are from Cahokia Canal. The area drained by Cahokia Canal is approximately 48,540 acres.

In early July, the 180-acre sub-impoundment is drained to stimulate growth of natural vegetation to attract water fowl. Water is pumped out of the sub-impoundment north of the causeway. It takes approximately a week of 24 hour per day pumping to drain the lake. During this time, depending on the water elevations in the sub-impoundment and the remaining portions of the lake, pumping costs can be reduced by draining the sub-impoundment to the north. When the water level at the northern end of the sub-impoundment is higher than the second leg of Horseshoe Lake, the causeway valve is opened. During this time about six plant species grow up to three feet high. Water is pumped out of the sub-impoundment after rain events (when the Cahokia Canal is diverted into Horseshoe Lake). By late August, pumping is stopped and rain water gradually contributes to the lake. Around September the causeway valve is opened to let lake water gravity flow from the north into the sub-impoundment. These pumps are also used for maintenance throughout the year. The outlet gate at the southern end of Canteen Lake can also be closed to bring up lake levels when necessary.

The area drained by Horseshoe Lake (not including Cahokia Canal drainage) is 17,118 acres. There are three sources of inflows into Horseshoe Lake:

- Stormwater runoff from surrounding residential and agricultural areas
- Granite City Steel treated point source discharge
- Wet weather diversion from Cahokia Canal

Stormwater runoff from Granite City discharges into Horseshoe Lake via three culverts. There is one culvert located at the north end of the lake, which discharges flow from Nameokie Ditch. There are two culverts at the northeast end of the lake, which flow from Elm Slough and Long Lake. There are nine culverts at the east end of the lake that discharge agricultural runoff into the lake. Granite City Steel uses intake water from the Mississippi River and is permitted to discharge 25mgd of treated water to Horseshoe Lake. This discharge is located on the west side of the lake. Runoff from the other areas adjacent to the lake also contributes to the lake.

### **7.2.3.2 Global Inputs**

The modeling approach for Horseshoe Lake is based on two distinct conditions; the portion of the year when flows from the Cahokia Canal are likely being diverted into the lake (March – May), and the remaining portion of the year which is dominated by

“normal” operations. Two separate models have been developed, one for each condition. Normal operation is defined as June through February, during which contributions to the lake originate from direct runoff from the surrounding watershed following precipitation, internal loading and the point source discharge from Granite City Steel. The wet season includes March through May, the high flow portion of the year, when Cahokia Canal can backflow and be diverted into Horseshoe Lake.

Global inputs represent the averaging period, precipitation, evaporation, and atmospheric contribution of phosphorus. The averaging period for the Horseshoe Lake “normal” scenario is 9 months and the wet scenario is 3 months. Based on precipitation and evaporation rates discussed in the previous sections, the average annual precipitation received at Horseshoe Lake is approximately 39.2 inches. Through the ISWS website, pan evaporation data are available from nine locations across Illinois (ISWS 2000). The Belleville station was chosen to be representative of pan evaporation conditions for Horseshoe Lake. The average monthly pan evaporation at the Belleville station for the years 1980 to 2002 (data was available for May-September) yields an average annual pan evaporation of 27 inches. Actual evaporation is typically less than pan evaporation, so the average annual pan evaporation was multiplied by 0.75 to calculate an average annual evaporation of 18 inches (ISWS 2007).

Precipitation and evaporation data from the corresponding wet (March through May) and normal (June through February) time periods were used for model inputs. The default atmospheric phosphorus deposition rate suggested in the BATHTUB model was used in absence of site-specific data, which is a value of 30 kg/km<sup>2</sup>-yr (USACE 1999).

### **7.2.3.3 Reservoir Segment Inputs**

Reservoir segment inputs in BATHTUB are used for physical characterization of the reservoir. Horseshoe Lake was modeled with six segments. The segment boundaries are shown on Figure 7-6. Segmentation was established based on available water quality and lake morphologic data.

Segment inputs to the model include average depth, segment length, and depth to the metalimnion. The lake's depths were represented by the averaged data from the water quality stations. Depth data were presented in Section 5.2.1. Segment lengths were determined using GIS.

### **7.2.3.4 Tributary Inputs**

Tributary inputs to BATHTUB include drainage area, flow, and total phosphorus (dissolved and solid-phase) loading. The drainage area of each tributary is equivalent to the basin or subbasin it represents, which was determined by reviewing the operations of the lake (see Section 7.2.3.1), land use data, aerial photography and GIS analyses. Table 7-4 is a summary of the subbasin characteristics.

**Table 7-4 Horseshoe Lake Subbasin Characteristics**

Subbasin/ Point Source ID	Lake Segment Receiving Drainage	Subbasin Area (mi <sup>2</sup> )	Estimated Flow (cfs)		Total Phosphorus (mg/L)	
			March – May	June - Feb	March – May	June - Feb
1	1	1.2	1.6	1.3	0.184	0.184
2	2	4.7	6.0	4.8	0.184	0.184
Granite City Steel <sup>(2)</sup>	1	N/A	12.2	11.4	0.237	0.237
3	4	13.7	17.4	13.8	0.184	0.184
4	5	1.4	1.8	1.4	0.184	0.184
5	6	2.5	3.1	2.5	0.184	0.184
Cahokia Canal Drainage Area <sup>(1)</sup>	6	74.4	84	N/A	0.224	N/A
<b>Total</b>		<b>84.3</b>	<b>43.6</b>		<b>0.78</b>	

<sup>1</sup> Cahokia Canal is diverted to Horseshoe Lake during high flow events. Flows and Total Phosphorus data available through monitoring stations on Cahokia Canal

<sup>2</sup> Granite City Steel flows are from historic discharge monitoring reports while total phosphorus data are from the most recent permit application

The model subbasins range in size from 1 to 74 square miles in area. Subbasin 1 includes the Granite City Steel facility. The majority of Subbasin 2 is residential area that drains into Nameoki Ditch, which discharges to the lake. Subbasin 3 consists of residential and agricultural lands that drain into Long Lake and Mitchell Ditch, which drain to Elm Slough and then to the lake. Subbasins 4 and 5 consist of wetlands and agricultural land that drain directly to the lake.

For the normal operations scenario, Subbasins 1 through 5 are included in the model. For the wet season scenario, the Cahokia Canal drainage area is also included in the model to represent the canal diversion into Horseshoe Lake during heavy rain events.

The Rational Method was used to estimate the runoff from each subbasin. The runoff coefficient and rainfall intensity used for the calculations were based on land use and the average monthly precipitation for the corresponding months for each scenario. The average flows for Cahokia Canal were estimated using data from a surrogate gage located on Indian Creek in Wanda, Illinois (USGS 05588000).

For both model scenarios, the Granite City Steel discharge is represented as a point source. The point source flow into Horseshoe Lake was determined by converting the historic average discharge flows from mgd to cfs. Granite City Steel is permitted to discharge 25mgd which is approximately 39 cfs, however, the facility discharges less than its permitted value. Average discharge rates between March and May were determined to be 10.9mgd while average discharge rates during the remainder of the year were determined to be 10.2mgd.

Based on depth and segment length information, the storage volume for Horseshoe Lake was determined to be 12,642 acre-feet (ac-ft). Using inflow data and storage volume, the lake residence time was estimated for both scenarios.

Because there was no available historic concentration data, phosphorus loads from the contributing watershed were estimated based on land use data and the median event mean concentrations (EMCs) for each land use. EMC data were based on values presented in the *Results of the Nationwide Urban Runoff Program (NURP), 1983*. The average wet season total phosphorus concentrations for Cahokia Canal, available from water quality station JN02, were also used in the model. Phosphorus sampling is not required by the Granite City Steel permit, however, effluent phosphorus concentration was reported in the most recent permit application for the facility at 0.237 mg/L. This value was used in the model to represent the point source contribution.

### 7.2.3.5 Horseshoe Lake BATHTUB Confirmatory Analysis

Available historical lake water quality data are summarized in Section 5. These data were used to help confirm model calculations. The following setup was used in the BATHTUB Model:

- Conservative Substance Balance: Not computed
- Phosphorus Balance: 2nd Order, Available Phosphorus
- Nitrogen Balance: Not computed
- Chlorophyll-*a*: Not computed
- Longitudinal Dispersion: Fischer-Numeric
- Error Analysis: Model and data
- Phosphorus Calibration: Decay rates
- Nitrogen Calibration: None
- Application of Nutrient Availability Factors: Ignore
- Calculation of Mass Balances: Use estimated concentration

The loadings described above were entered into the BATHTUB model and compared with available water quality data for the lake. When using these loadings, the BATHTUB model under-predicted the concentrations when compared to actual water quality data. To achieve a better match with actual water quality data, internal loading rates were adjusted. Internal loading rates reflect nutrient recycling from bottom sediments. Based on the confirmatory analysis internal cycling is occurring in all segments of Horseshoe Lake, but at a higher rate during the wet season. Table 7-5 shows the results of this analysis.

**Table 7-5 Summary of Horseshoe Lake Model Confirmatory Analyses**

Scenario	Predicted TP Concentration (mg/L)	Observed TP Concentration (mg/L)	Internal Loading Rate (mg/m <sup>2</sup> -day)
June-Feb	0.22	0.21	10
March-May	0.22	0.22	25



## 7.2.4 BATHTUB Development for Frank Holten Lakes

The BATHTUB model was used to develop the total phosphorus TMDL for the Frank Holten Lakes. Frank Holten Lakes 1, 2, and 3 are connected and were modeled as three segments of a contiguous waterbody. All of the Frank Holten Lakes are listed on the 2004 303(d) list for impairments caused by total phosphorus. In addition, Frank Holten Lake 3 has had two dissolved oxygen samples collected that were below the 5.0 mg/L instantaneous minimum standard. There are no known sources of oxygen demanding materials to the lakes and it is therefore assumed that reducing total phosphorus will likely result in improved dissolved oxygen levels.

### 7.2.4.1 Operation of Frank Holten Lakes and Watershed Delineation

Frank Holten State Park contains three small lakes, Frank Holten Lake 1, 2, and 3. These lakes are the remains of an old oxbow lake of the Mississippi River. Lakes 1 and 2 together are commonly known as Whispering Willow Lake and Lake 3 is known as Grand Marais Lake. The lakes and the park are managed by the Illinois Department of Conservation (IDOC).

The Frank Holten Lakes consists of three distinct lakes as shown on Figure 7-7. Under normal conditions, Lake 1 flows into Lake 2, Lake 2 flows into Lake 3 via a connection channel, and then Lake 3 drains to Harding Ditch. The only connection between the lakes and Harding Ditch is at the outlet at the southern end of Lake 3. The connection channel and Harding Ditch are directed through culverts beneath I-255. There is no water level control at the outlet, and therefore during wet weather, when the water level in Harding Ditch is rising, it flows freely into Lake 3. When the water level in Harding Ditch is falling, Lake 3 flows freely into Harding Ditch. The area drained by Harding Ditch is 23,755 acres.

The area drained directly by the Frank Holten Lakes is approximately 3,300 acres. There are two sources of inflows into the Frank Holten Lakes:

- Stormwater runoff from surrounding residential sites
- Wet weather flows from Harding Ditch

Stormwater runoff from low-density residential areas and a high school discharges into Lake 1 via three drainage district culverts. Also, direct overland runoff from the other areas surrounding the lakes contributes flows to the lakes.

The modeling approach for the Frank Holten Lakes is based on two distinct "seasons"; a dry and a wet season. Two separate models have been developed, one for each season. The wet season includes March through May, the high flow portion of the year, when Harding Ditch can backflow into Lake 3. The dry season is defined as the other 9 months of the year, during which flows are lower.

### 7.2.4.2 Global Inputs

Global inputs represent the averaging period, precipitation, evaporation, and atmospheric contribution of phosphorus. The averaging period for the Frank Holten

Lakes dry scenario is 9 months and the wet scenario is 3 months. Based on precipitation and evaporation rates discussed in the previous sections, the average annual precipitation received at Frank Holten Lakes is approximately 39.2 inches. Through the ISWS website, pan evaporation data are available from nine locations across Illinois (ISWS 2000). The Belleville station was chosen to be representative of pan evaporation conditions for Horseshoe Lake. The average monthly pan evaporation at the Belleville station for the years 1980 to 2002 (data was available for May-September) yields an average annual pan evaporation of 27 inches. Actual evaporation is typically less than pan evaporation, so the average annual pan evaporation was multiplied by 0.75 to calculate an average annual evaporation of 18 inches (ISWS 2007).

Precipitation and evaporation data from the corresponding wet (March through May) and dry (June through February) time periods were used for model inputs. The default atmospheric phosphorus deposition rate suggested in the BATHTUB model was used in absence of site-specific data, which is a value of 30 kg/km<sup>2</sup>-yr (USACE 1999).

#### 7.2.4.3 Reservoir Segment Inputs

Reservoir segment inputs in BATHTUB are used for physical characterization of the reservoir. The Frank Holten Lakes were modeled in 4 segments. The segment boundaries are shown on Figure 7-7. Segmentation was established based on available water quality and lake morphologic data.

Segment inputs to the model include average depth, segment length, and depth to the metalimnion. The lakes' depths were represented by the averaged data from the water quality stations. Depth data were presented in Section 5.2.2. Segment lengths were determined using GIS.

#### 7.2.4.4 Tributary Inputs

Tributary inputs to BATHTUB include drainage area, flow, and total phosphorus (dissolved and solid-phase) loading. The drainage area of each tributary is equivalent to the basin or subbasin it represents, which was determined by reviewing the operations of the lake (see Section 7.2.4.1), land use data, aerial photography and GIS analyses. Table 7-6 is a summary of the subbasin characteristics.

**Table 7-6 Frank Holten Lakes Subbasin Characteristics**

Subbasin ID	Lake Segment Receiving Drainage	Subbasin Area (mi <sup>2</sup> )	Estimated Flow (cfs)		Total Phosphorus (mg/L)	
			Dry Season	Wet Season	Dry Season	Wet Season
1	1	2.8	2.9	3.7	0.29	0.29
2	2	0.5	0.6	0.7	0.17	0.17
3	3	1.1	1.5	1.8	0.21	0.21
4	4	0.5	1.0	1.3	0.06	0.06
Harding Ditch Drainage Area <sup>1</sup>	4	41.0	N/A	46.6	N/A	0.44
<b>Total</b>		<b>46.0</b>	<b>6.0</b>	<b>54.1</b>	<b>0.73</b>	<b>1.17</b>

<sup>1</sup> Harding Ditch is diverted to Lake 3 during heavy rain events.

The model subbasins range in size from 0.5 to 41 square miles in area. The majority of Subbasin 1 is residential area, but it also includes a golf course adjacent to the Lake 1 and a high school to the north. Subbasin 2 is a mix of residential area, open space, and wetlands. The majority of Subbasin 3 is residential area. Subbasin 4 is mostly wetlands.

For the dry season scenario, Subbasins 1 through 4 are included in the model. For the wet season scenario, the Harding Ditch drainage area is also included in the model to represent the ditch backflow into Lake 3 during wet weather.

The Rational Method was used to estimate the runoff from each subbasin. The runoff coefficient and rainfall intensity used for the calculations were based on land use and the average monthly precipitation for the corresponding months for each season. The average wet and dry season flows for Harding Ditch were estimated using data from a surrogate gage located on Indian Creek in Wanda, Illinois (USGS 05588000). Based on depth and segment length information, the storage volume for Frank Holten Lakes was determined to be 1,783 ac-ft. Using inflow data and storage volume, the residence time was estimated for both scenarios.

Because no historic concentration data exist for Frank Holten Lakes' contributing subbasins, phosphorus loads from each subbasin in the lake were estimated based on land use data and the median event mean concentrations (EMCs) for each land use found in the *Results of the Nationwide Urban Runoff Program (NURP), 1983* report. The average wet season total phosphorus concentrations for Harding Ditch, available from water quality station JMAC02, were used in the model.

#### **7.2.4.5 Frank Holten Lakes BATHTUB Confirmatory Analysis**

Available historical lake water quality data are summarized in Section 5. These data were used to help confirm model calculations. The following setup was used in the BATHTUB Model:

- Conservative Substance Balance: Not computed
- Phosphorus Balance: 2nd Order, Available Phosphorus
- Nitrogen Balance: Not computed
- Chlorophyll-*a*: Not computed
- Longitudinal Dispersion: Fischer-Numeric
- Error Analysis: Model and data
- Phosphorus Calibration: Decay rates
- Nitrogen Calibration: None
- Application of Nutrient Availability Factors: Ignore
- Calculation of Mass Balances: Use estimated concentration

The loadings described above were entered into the BATHTUB model and compared with available water quality data for the lake. When using these loadings, the BATHTUB model under-predicted the concentrations when compared to actual water quality data. To achieve a better match with actual water quality data, internal loading

rates were adjusted. Internal loading rates reflect nutrient recycling from bottom sediments. Based on the confirmatory analysis internal cycling is occurring in all segments of Frank Holten Lakes, but at a higher rate during the wet season. Table 7-7 shows the results of this analysis.

**Table 7-7 Summary of Frank Holten Lakes Model Confirmatory Analyses**

<b>Scenario</b>	<b>Predicted TP Concentration (mg/L)</b>	<b>Observed TP Concentration (mg/L)</b>	<b>Internal Loading Rate (mg/m<sup>2</sup>-day)</b>
Dry Season	0.18	0.19	6.5
Wet Season	0.18	0.14	12

During the wet season, the predicted and observed concentration in the lake differs by approximately 28 percent. However, in Segments 1, 2 and 3, the percent difference is 3 percent or less. In Segment 4, where the Harding Ditch diversion occurs, the observed concentration is nearly 90 percent lower than the predicted concentration. As shown on Figure 7-7, the water quality station used for comparison is located at the very north end of Segment 4, very close to Segment 3. It is likely that this station does not monitor the impacts of the Harding Ditch diversion, which originates at the southern end of Segment 4.

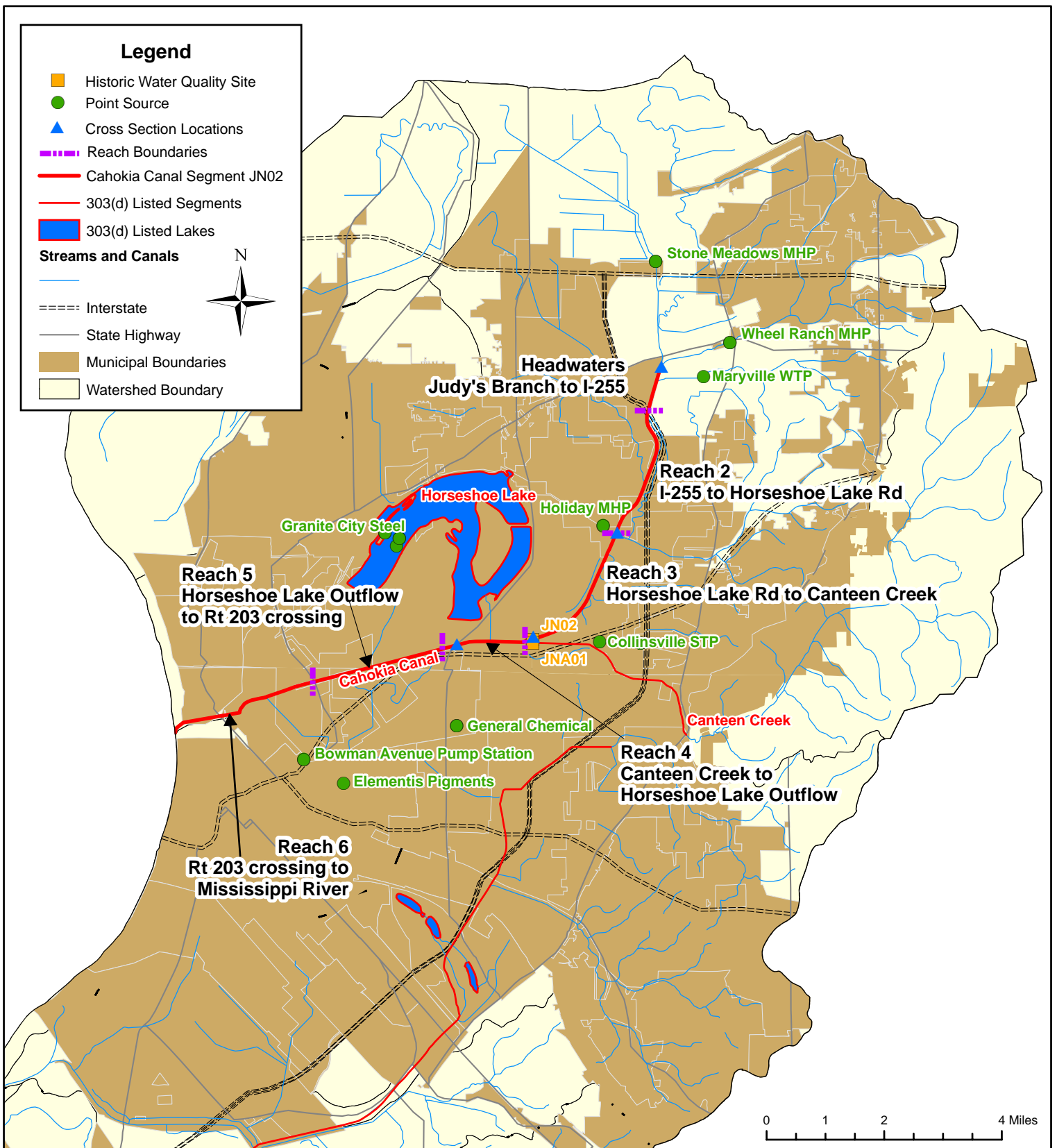


Figure 7-1  
 QUAL2K Segmentation  
 Cahokia Canal

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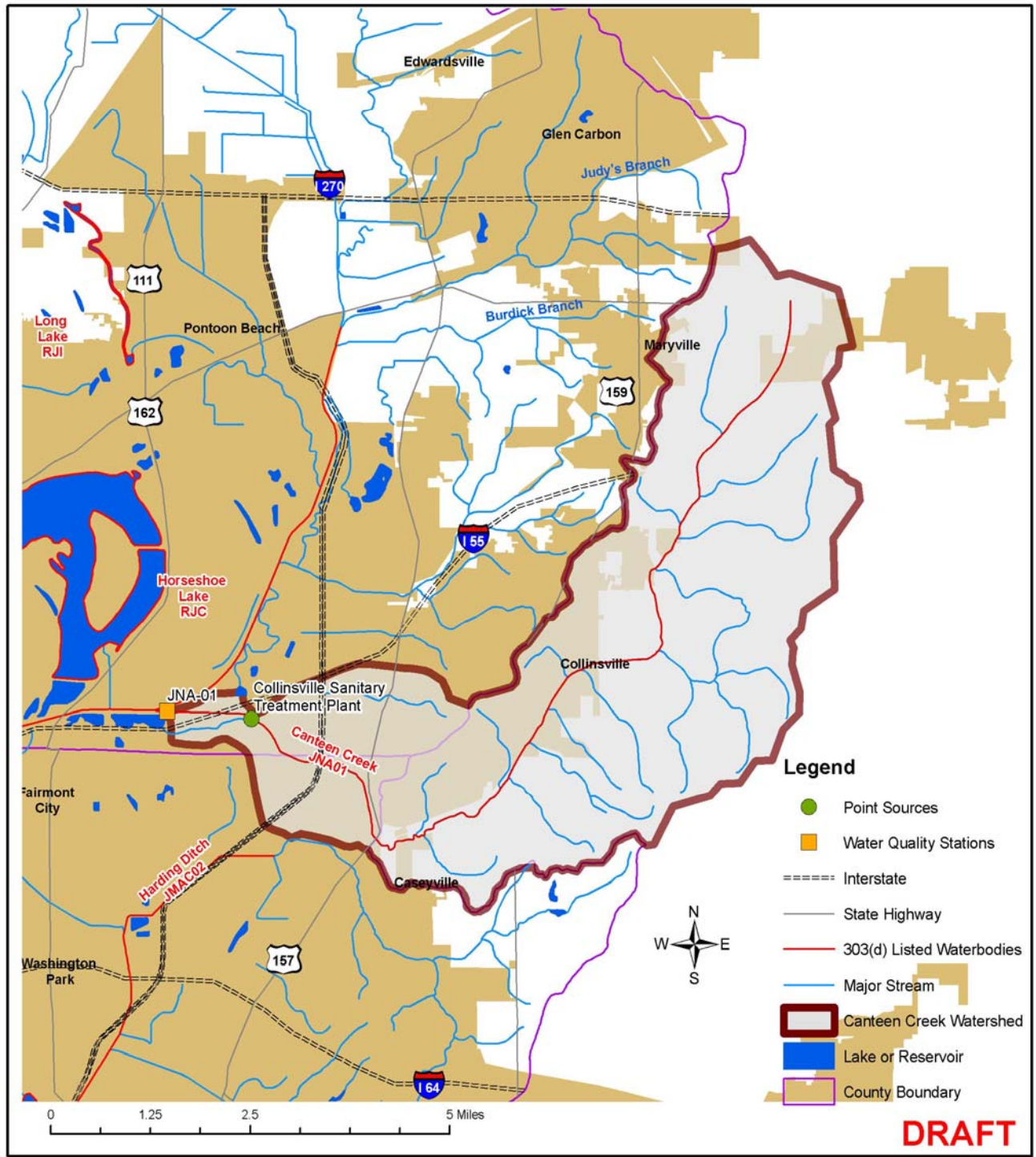


Figure 7-2  
Canteen Creek Watershed Delineation

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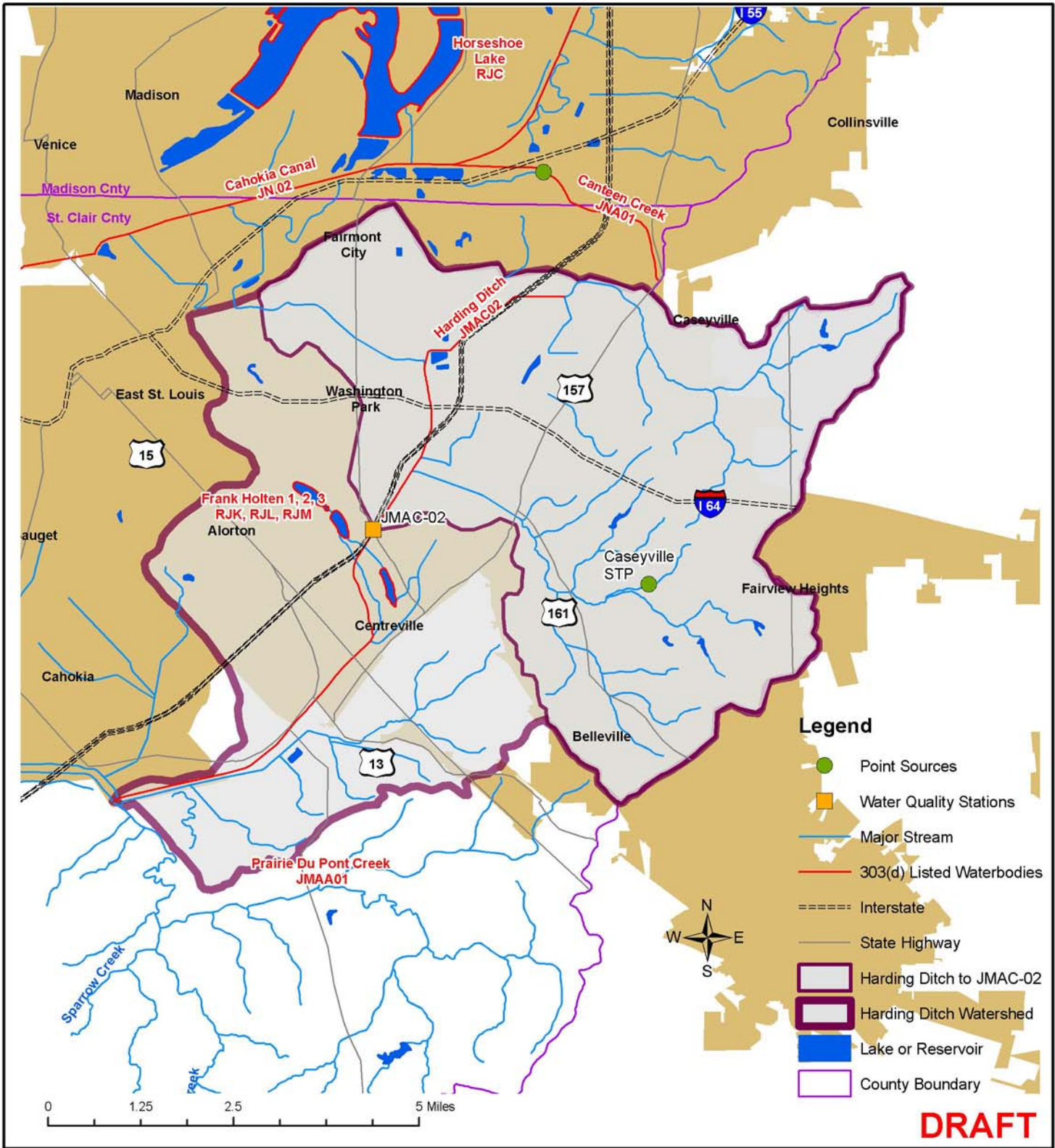
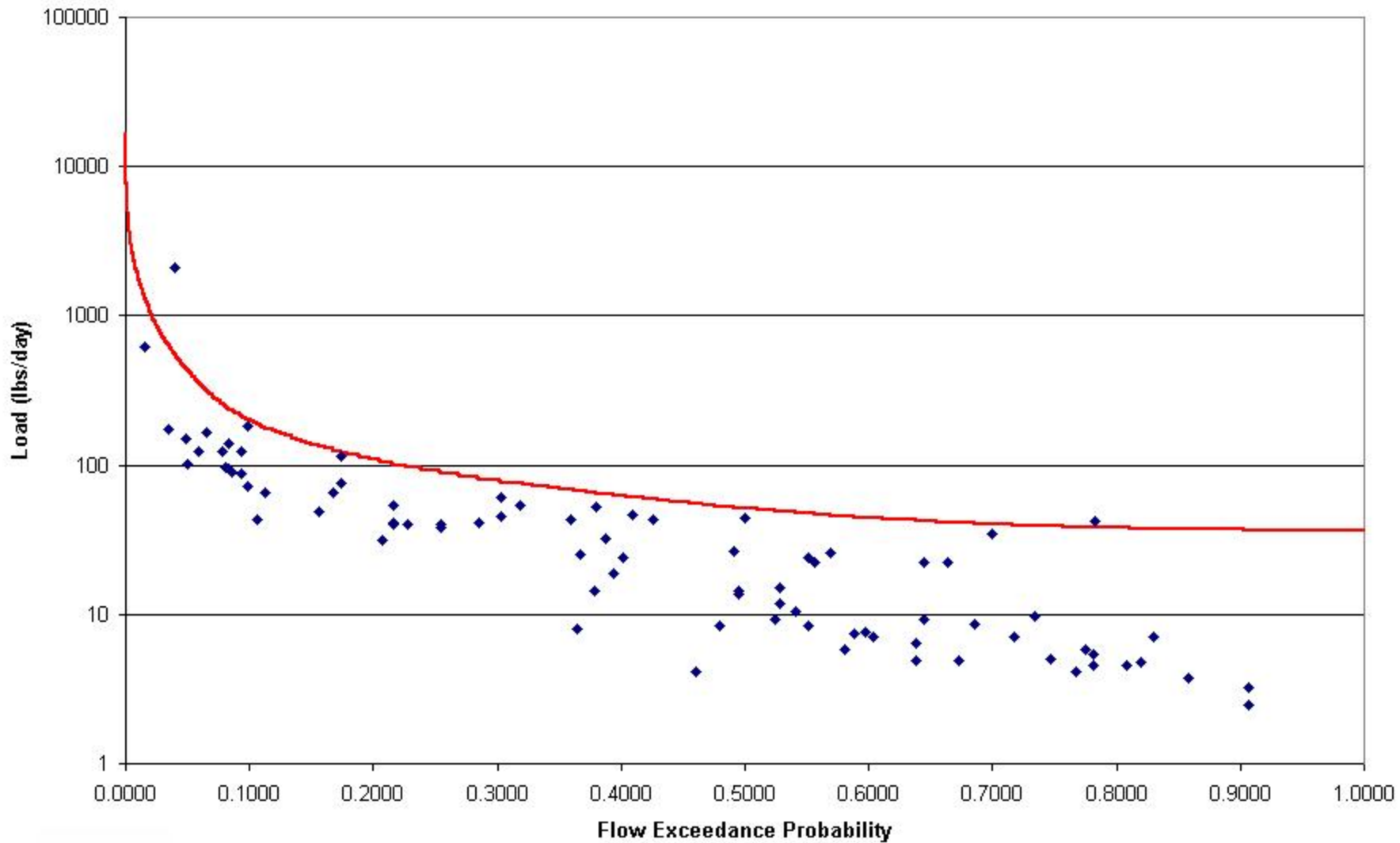


Figure 7-3  
Harding Ditch Watershed Delineation

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**Figure 7-4: Manganese  
Load Duration Series for  
Canteen Creek**

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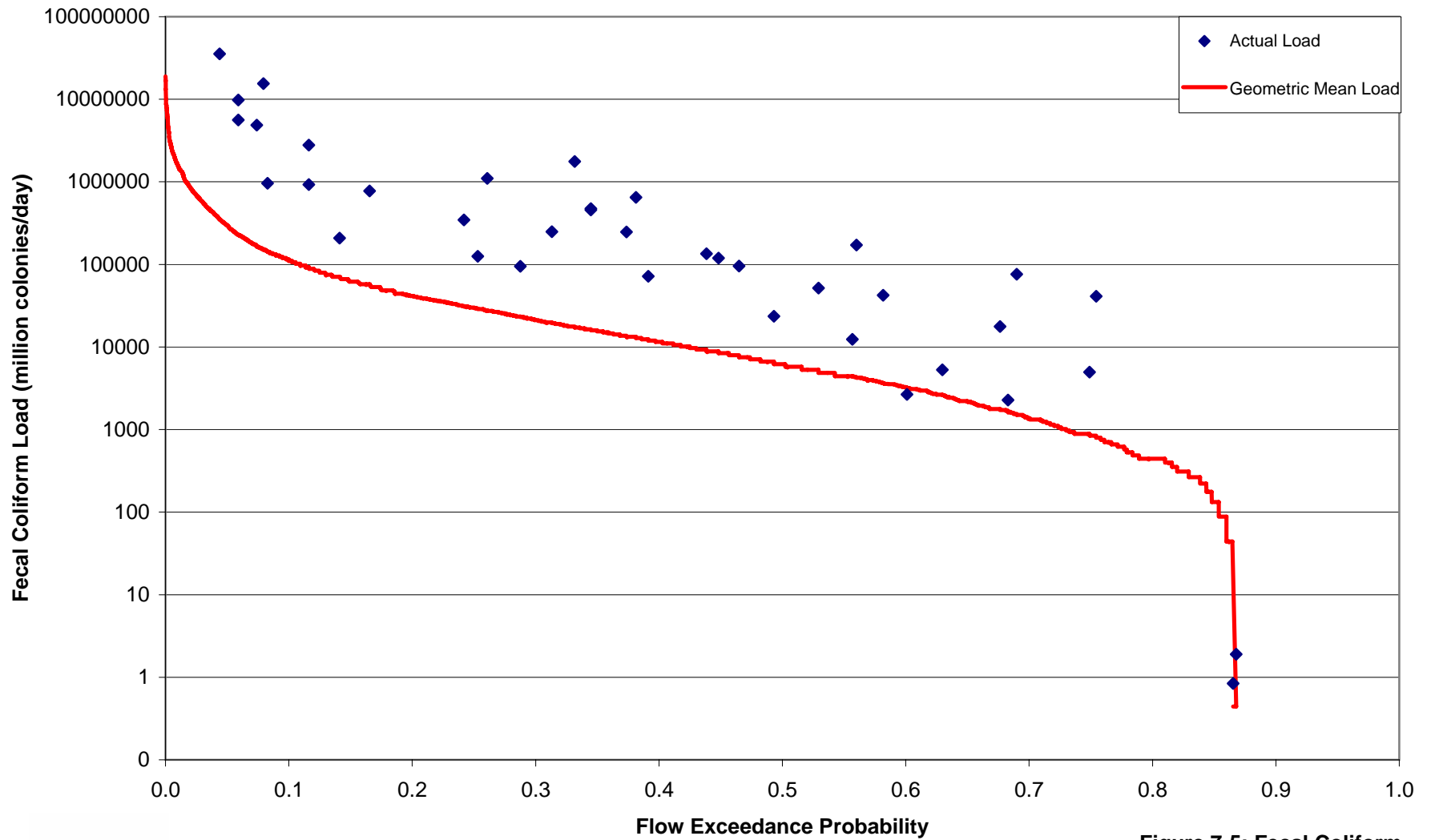
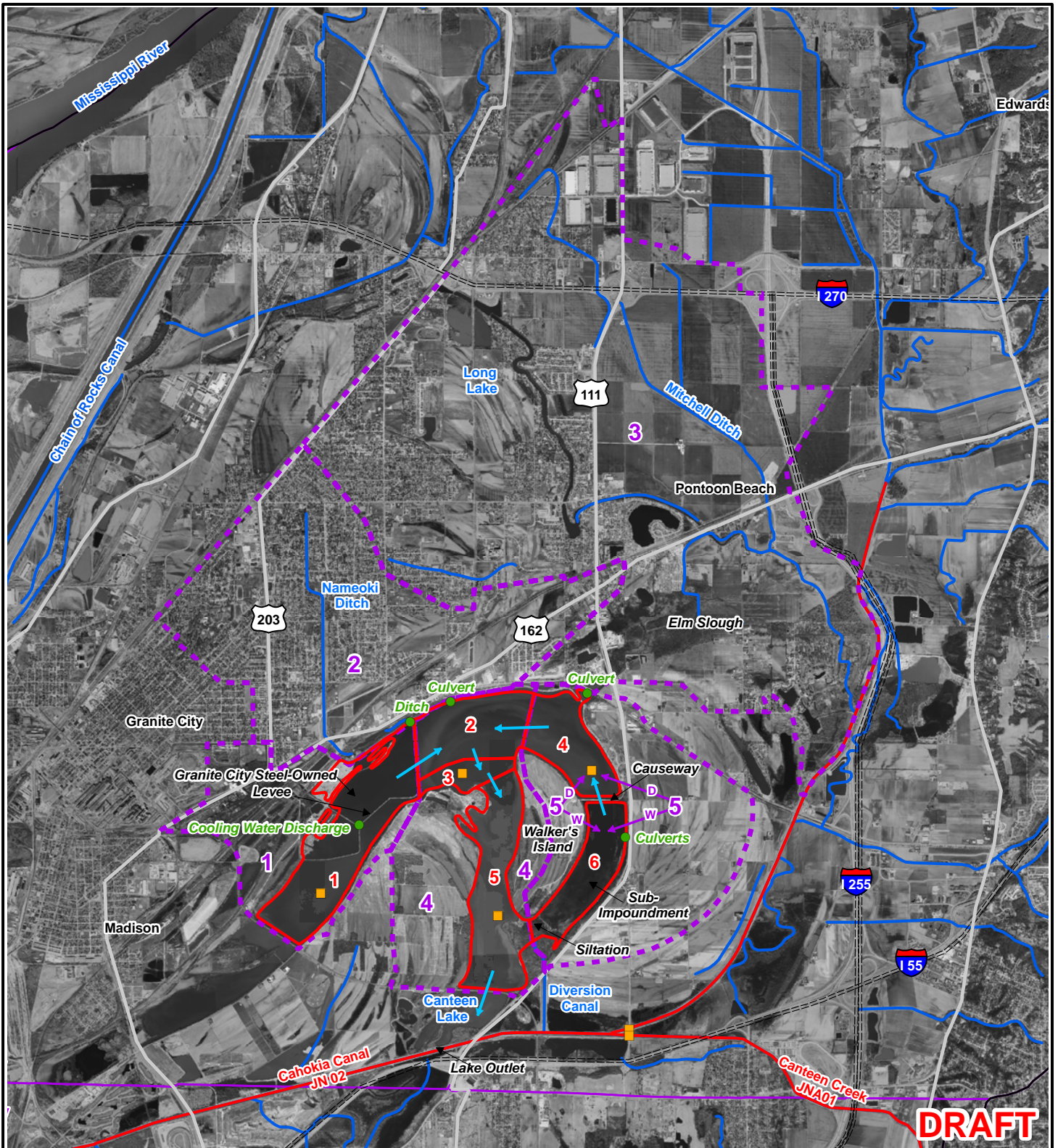


Figure 7-5: Fecal Coliform Load Duration Curve for Harding Ditch

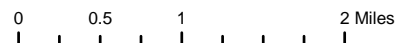


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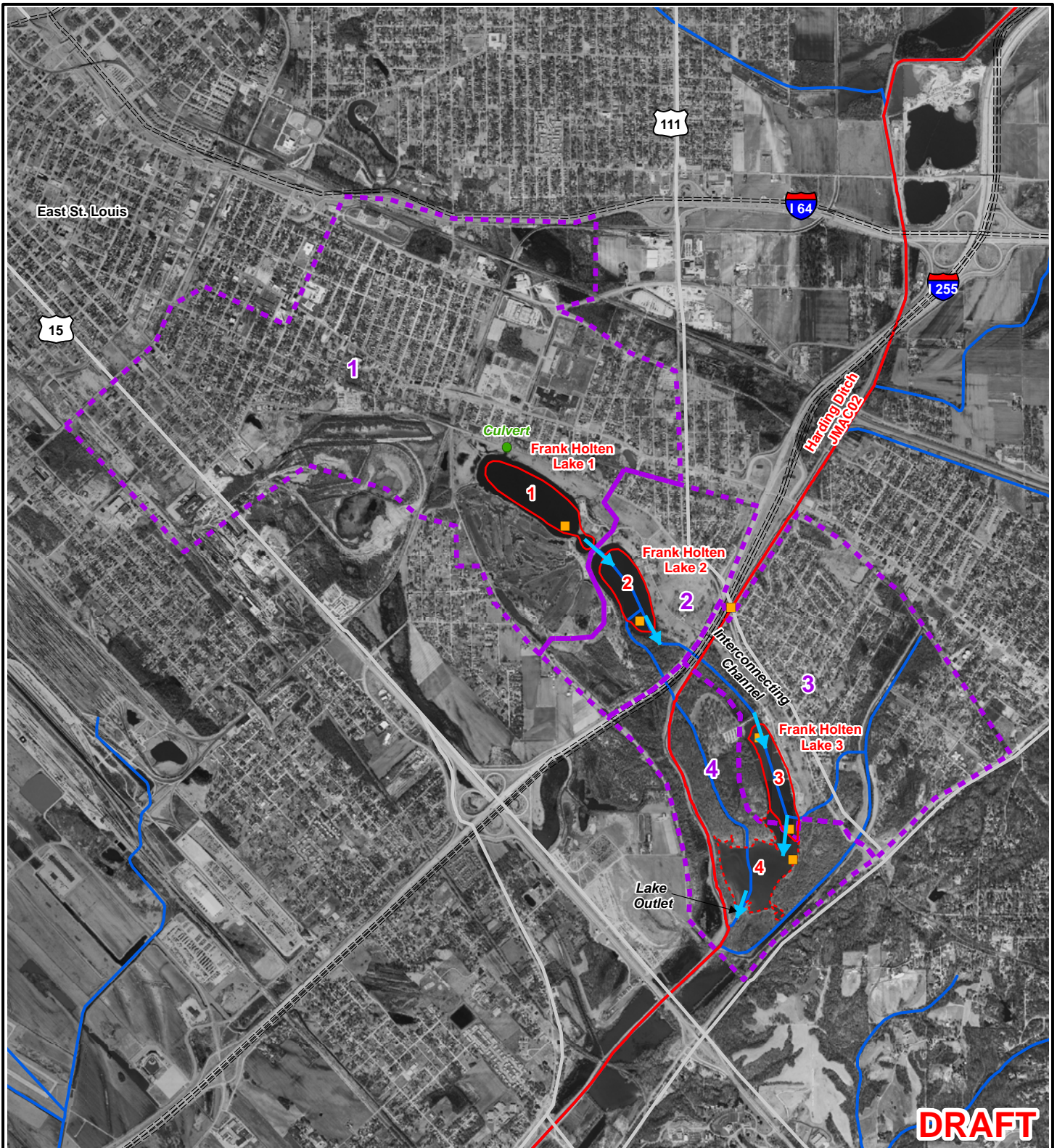
- |  |                         |  |                         |
|--|-------------------------|--|-------------------------|
|  | Interstate              |  | Water Quality Station   |
|  | US and State Highway    |  | Horseshoe Lake Segments |
|  | County Boundary         |  | Subwatershed            |
|  | 303(d) Listed Waterbody |  | Subwatershed 6 Flow     |
|  | Major Stream            |  | Lake Flow               |
|  | Watershed               |  | Inflow                  |
|  | Lake or Reservoir       |  |                         |














**Figure 7-6. Horseshoe Lake  
BATHTUB Schematic**



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- |   |  |
|---|--|
|  Interstate              |  Water Quality Station        |
|  US and State Highway    |  Part of Lake 3               |
|  County Boundary         |  FrankHoltenLk_subws          |
|  303(d) Listed Waterbody |  Lake Flow                    |
|  Major Stream            |  Inflow                       |
|  Watershed               |  Segmented_FrankHoltenLks_Prj |
|  Lake or Reservoir       |  |

**Figure 7-7. Frank Holten Lakes  
BATHTUB Schematic**



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# Section 8

## Total Maximum Daily Loads for the Cahokia Canal/Horseshoe Lake Watershed

### 8.1 TMDL Endpoints

The TMDL endpoints for DO, manganese, fecal coliform and total phosphorus for the impaired segments in the Cahokia Canal/Horseshoe Lake watershed are summarized in Table 8-1. All concentrations must be below the TMDL endpoints except for DO concentrations which need to 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 in Canteen Creek, Horseshoe Lake and the Frank Holten Lakes and the protection of the recreational uses of Harding Ditch. Some of the average concentrations, which are based on data sets discussed in Section 5, meet the desired endpoints. However, each data set has maximum or minimum values, again, presented in Section 5, that do not meet the desired endpoints and this was the basis for TMDL analysis. Further monitoring as outlined in the monitoring plan presented in Section 9, will help further define when impairments are occurring in the watershed and support the TMDL allocations outlined in the remainder of this section.

<b>Impaired Segment</b>	<b>Constituent</b>	<b>TMDL Endpoint</b>	<b>Average Observed Value on Impaired Segment</b>
Canteen Creek JNA01	Manganese	1,000 ug/L	423 ug/L
Harding Ditch JMAC02	Fecal Coliform	400 cfu/100 mL during October - May	2,454 cfu/mL (geometric mean)
Cahokia Canal JN02	DO	6.0 mg/L (16 hours of any 24-hour period), 5.0 mg/L instantaneous minimum	8.2 mg/L
Horseshoe Lake RJC	Total Phosphorus	0.05 mg/L	0.18 mg/L
Frank Holten Lakes RJK, RJL, and RJM	Total Phosphorus	0.05 mg/L	0.17 mg/L

### 8.2 Pollutant Source and Linkage

Potential pollutant sources for the impaired waterbodies in the Cahokia Canal/Horseshoe Lake watershed were identified through the existing data review described in sections 1 through 5 and the TMDL methodologies discussed and presented in sections 6 and 7. The source of manganese in Canteen Creek is most likely natural sources. The likely cause of low dissolved oxygen concentrations seen in Cahokia Canal are slow-moving waters and increased water temperatures that promote algal growth. Sources of fecal coliform to Harding Ditch during high flows are likely attributable to the fecal matter introduced to the stream via overland runoff and the resuspension of fecal material in the ditch sediment. Dry weather sources of fecal

coliform likely include failing septic systems in the watershed and livestock with direct access to the ditch or its tributaries. Nutrient sources to Horseshoe Lake and the Frank Holten Lakes are dominated by wet weather nonpoint sources.

### 8.3 Allocation

As explained in Section 1, the TMDLs for the impaired segments in the Cahokia Canal/Horseshoe Lake watershed will address the following equation:

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

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

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

#### 8.3.1 Cahokia Canal DO TMDL

##### 8.3.1.1 Loading Capacity

The LC is the maximum amount of oxygen-demanding material that Cahokia Canal 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 7.2.1.

In the absence of a reasonable measured calibration data set, model dissolved oxygen 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 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. 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 9.

### 8.3.2 Canteen Creek Manganese TMDL

#### 8.3.2.1 Loading Capacity

The LC is the maximum amount of manganese that Canteen Creek can receive and still maintain compliance with the water quality standards. The allowable manganese loads that can be generated in the watershed and still maintain water quality standards were determined with the methodology discussed in Section 7.2.2. The manganese loading capacity according to flow is presented in Table 8-2.

**Table 8-2: Manganese Loading Capacity for Canteen Creek Segment JNA01**

Estimated Mean Daily Flow (cfs)	Load Capacity (lbs/day)
7	38
15	81
30	160
50	267
100	541
200	1081
400	2152
1000	5394

The mean of the two exceedences on Canteen Creek was calculated and compared to the manganese standard of 1,000 µg/L. The mean of the exceedences was 2,450 µg/L. By comparing this value to the water quality standard, it was determined that a 59 percent reduction is needed to meet the standard.

#### 8.3.2.2 Seasonal Variation

Consideration to seasonality is inherent in the load duration. The standard is not seasonal and the full range of expected flows is represented. Therefore, the loading capacity represents conditions throughout the year. Similarly, by considering and addressing all flow scenarios, the critical conditions when the stream segment is most vulnerable to water quality exceedences were addressed.

#### 8.3.2.3 Margin of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The TMDL developed for Canteen Creek contains an explicit MOS of 10 percent. Ten percent is considered adequate to compensate for any uncertainty in the TMDL.

#### 8.3.2.4 Waste Load Allocation

There is one point source which discharges to Canteen Creek. The average discharge from the Collinsville STP is 4.41 mgd, or an average of 6.8 cfs. The facility is not believed to contribute significantly to manganese concentrations in Canteen Creek. Manganese loading to the creek most likely originates from natural sources such as groundwater and soils. Because of this, the WLA was set to zero.

#### 8.3.2.5 Load Allocation and TMDL Summary

Because there is no WLA in this TMDL, the manganese load has been allocated between the LA (nonpoint sources) and the MOS. As discussed in Section 8.3.2.1, the load duration analysis determined that a 59% reduction in manganese loading is needed to meet the water quality standard of 1,000 µg/L. Table 8-3 shows a summary of the TMDL for Canteen Creek.

**Table 8-3: TMDL Summary for Manganese in Canteen Creek**

Estimated Mean Daily Flow (cfs)	LC (lb/d)	WLA (lb/d)	LA (lb/d)	MOS (lb/d)
7	38	0	34.2	3.8
15	81	0	72.9	8.1
30	160	0	144	16
50	267	0	240.3	26.7
100	541	0	486.9	54.1
200	1081	0	972.9	108.1
400	2152	0	1936.8	215.2
1000	5394	0	4854.6	539.4

### 8.3.3 Harding Ditch Fecal Coliform TMDL

#### 8.3.3.1 Loading Capacity

The LC is the maximum amount of fecal coliform that Harding Ditch can receive and still maintain compliance with the water quality standards. The allowable fecal coliform loads that can be generated in the watershed and still maintain the geometric mean standard of 200 cfu/100mL were determined with the methodology discussed in Section 7.2.2. The fecal coliform loading capacity according to flow is presented in Table 8-4.

**Table 8-4: Fecal Coliform Loading Capacity**

Mean Daily Flow (cfs)	Geometric Mean Load Capacity (mil col/day)
5	24,300
10	44,200
20	88,400
50	221,000
100	442,000
200	884,000
500	2,200,000
1000	4,420,000

The mean of all the exceedences recorded on Harding Ditch was calculated and compared to the geometric mean fecal coliform standard of 200 cfu/100 mL. The mean of the exceedences was 5,210 cfu/100mL. By comparing this value to the water quality standard, it was determined that a 96 percent reduction is needed to meet the standard.

#### 8.3.3.2 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. Similarly, critical conditions have been addressed by considering all flow scenarios.

#### 8.3.3.3 Margin of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The MOS for the Harding Ditch TMDL is implicit as the analysis used the more conservative 200 cfu/100mL standard and did not consider die-off of bacteria which is likely occurring in the system but unquantified.

### 8.3.3.4 Waste Load Allocation

There is one point source which discharges within the Harding Ditch watershed. The Caseyville Township West STP discharges to Clare Creek which is a tributary of Harding Ditch. The permitted discharge from the facility is 0.786 mgd, or 1.2 cfs. The discharge has a fecal coliform limit of 400 cfu/100 mL and DMR records show that the actual average fecal coliform in the facility’s effluent is approximately 138 cfu/100 mL or a load of 3,660 million col/day. The Caseyville Township West STP is not considered to be a significant contributor of fecal coliform load to Harding Ditch. The WLA for Caseyville Township is based on the facility’s design average flow of 0.786 mgd multiplied by the fecal coliform limit of 400 cfu/100mL. The WLA was determined to be 11,744 million colonies per day and is applicable during each day of the recreation season.

### 8.3.3.5 Load Allocation and TMDL Summary

The load duration analysis described in Section 8.3.3.1 determined that a 96 percent reduction in fecal coliform loading needs to occur in order to meet the geometric mean instream water quality standard of 200 cfu/100 mL. The LA was determined by subtracting the WLA from the LC. Table 8-5 shows a summary of the TMDL for Harding Ditch.

**Table 8-5 TMDL Summary for Fecal Coliform in Harding Ditch**

Estimated Mean Daily Flow (cfs)	LC (mil col/d)	WLA (mil col/d)	LA (mil col/d)	MOS (mil col/d)
5	24,300	11,744	12,556	implicit
10	44,200	11,744	32,456	implicit
20	88,400	11,744	76,656	implicit
50	221,000	11,744	209,256	implicit
100	442,000	11,744	430,256	implicit
200	884,000	11,744	872,256	implicit
500	2,200,000	11,744	2,188,256	implicit
1000	4,420,000	11,744	4,408,256	implicit

## 8.3.4 Horseshoe Lake Total Phosphorus TMDL

### 8.3.4.1 Loading Capacity

The loading capacity of Horseshoe Lake is the total mass of phosphorus that can be assimilated by the lake and still meet the water quality standard of 0.05 mg/L total phosphorus. The allowable phosphorus loads that can be generated in the watershed and still maintain water quality standards were determined with the models that were set up and calibrated as discussed in section 7.2.3. To accomplish this, modeled phosphorus loads were reduced by a percentage and entered into the BATHTUB model until the water quality standard of 0.05-mg/L total phosphorus was met in Horseshoe Lake. The allowable phosphorus load was determined to be **19.7 lbs/day** from June to February and **55.9 lbs/day** when the Cahokia Canal is likely diverted to the lake (March – May). A spreadsheet summary of this analysis is included as Appendix I.

### 8.3.4.2 Seasonal Variation

Seasonal variation in lake water quality is captured in the Horseshoe Lake TMDL by simulating two different seasons: wet (March-May) and normal (remainder of the year). The wet scenario is characterized by higher loadings, higher dilution, and lower water temperatures. Loadings are higher in this wet season scenario due to increased runoff and an operational practice that diverts the Cahokia Canal to the lake during heavy rain events. The remainder of the year is characterized by normal operations where the lake is filled by rain and runoff from the surrounding watershed. The loadings for this TMDL are presented as daily amounts allowable during both operations. Because the TMDL includes loading during both scenarios, it is assumed that the critical condition is accounted for within the analysis.

### 8.3.4.3 Margin of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The MOS for the Horseshoe Lake TMDL includes both. The analysis completed for Horseshoe Lake is implicitly conservative because of the following:

- Default values were used in the BATHTUB model, which in absence of site-specific information are assumed conservative. Default model values, such as the phosphorus assimilation rate, are based on scientific data accumulated from a large survey of lakes. Because no site-specific data are available, default model rates are used which are based on error analysis calculations. The model used for this analysis uses estimates of second-order sedimentation coefficients which are generally accurate to within a factor of 2 for phosphorus. This provides a conservation range of where the predictions could fall and provides confidence in the predicted values.
- Because site-specific data were not available on internal cycling rates, conservative estimates were used based on available in-lake concentration data and predicted concentrations in the absence of internal loading. The model is set up to allow conservative estimates of internal loading which result in the model achieving a close estimate of in-lake concentration data for the average-loading conditions modeled in this scenario.
- In the absence of site-specific data, an atmospheric loading rate of 30 mg/m<sup>2</sup>-yr total phosphorus (USACE 1999) was taken from literature values and assumed in the BATHTUB model. This is a conservative value because atmospheric loadings of phosphorus are attributed to erosion that becomes wind borne and because of the low agricultural activity in the watershed the atmospheric loading is most likely negligible.



In addition, a 10% MOS was added to the TMDL to account for any uncertainty in the analysis. 10% is assumed to adequately account for any variability in loading due to the complex nature of the Horseshoe Lake operations.

### 8.3.4.4 Waste Load Allocation

There is one point source located within the Horseshoe Lake watershed. The US Steel Corporation Granite City Works is not required to collect phosphorus data; however, effluent concentration data for total phosphorus was available through a recent permit application. The WLA was determined by multiplying the historic average flows from DMRs during each scenario by the a slightly reduced effluent concentration of 0.185mg/L. The resulting phosphorus load generated by the US Steel Granite City Works is 15.8 lbs/day for the months of June through November and 16.8 lbs/day for the months of March, April and May.

### 8.3.4.5 Load Allocation and TMDL Summary

Table 8-6 contains a breakdown of the current estimated percent contribution of total phosphorus load from each source modeled for this analysis. A 91 percent reduction in total loading throughout the year would result in compliance with the water quality standard of 0.05 mg/L total phosphorus. Table 8-7 summarizes the dry and wet season TMDLs for Horseshoe Lake.

**Table 8-6 Current Estimated Percent Load Contribution by Source**

Scenario	Estimated Current Load (lb/day)	Point Source	Internal Loading	Direct Drainage from Subbasins	Cahokia Canal Diversion	Precipitation/ Atmospheric Deposition
June through Feb	223	9%	80%	10%	0	1%
March through May	601	3%	74%	5%	17%	1%

**Table 8-7 TMDL Summary for Total Phosphorus in Horseshoe Lake**

Load Source	Estimated Current Load (lb/day)	LC (lb/day)	WLA (lb/day)	LA (lb/day)	MOS (lb/day)	Reduction Needed (lb/day)	Reduction Needed (percent)
Total – June through Feb	223	19.7	15.8	1.94	1.97	203.3	91
Total – March through May	601	55.9	16.8	33.5	5.6	545.12	91

### 8.3.5 Frank Holten Lakes Total Phosphorus TMDL

#### 8.3.5.1 Loading Capacity

The loading capacity of the Frank Holten Lakes is the total mass of phosphorus that can be assimilated by the lake and still meet the water quality standard of 0.05 mg/L total phosphorus. The allowable phosphorus loads that can be generated in the watershed and still maintain water quality standards were determined with the models that were set up and calibrated as discussed in section 7.2.3. To accomplish this, modeled phosphorus loads were reduced by a percentage and entered into the BATHTUB model until the water quality standard of 0.05-mg/L total phosphorus was met in Horseshoe Lake. The allowable phosphorus load was determined to be **0.2 lbs/day** during the dry season and **11.5 lbs/day** during the wet season. A spreadsheet of this analysis is included as Appendix J.

#### 8.3.5.2 Seasonal Variation

Seasonal variation in lake water quality is captured in the Frank Holten Lakes TMDL by both wet and dry seasons. The wet scenario is characterized by higher loadings, higher dilution, and lower water temperatures. Loadings are higher in this wet season scenario due to increased runoff and the back flow of Harding Ditch into Frank Holten Lake #3. The summer scenario is characterized by higher water temperatures and lower dilution. The loadings for this TMDL are presented as daily amounts allowable during dry and wet seasons. Because the TMDL includes loading during both scenarios, it is assumed that the critical condition is accounted for within the analysis.

#### 8.3.5.3 Margin of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The MOS for the Frank Holten Lakes TMDL is implicit. The analysis completed for the lakes is conservative because of the following:

- Default values were used in the BATHTUB model, which in absence of site-specific information are assumed conservative. Default model values, such as the phosphorus assimilation rate, are based on scientific data accumulated from a large survey of lakes. Because no site-specific data are available, default model rates are used which are based on error analysis calculations. The model used for this analysis uses estimates of second-order sedimentation coefficients which are generally accurate to within a factor of 2 for phosphorus. This provides a conservation range of where the predictions could fall and provides confidence in the predicted values.
- Because site-specific data were not available on internal cycling rates, conservative estimates were used based on available in-lake concentration data and predicted concentrations in the absence of internal loading. The model is set up to allow conservative estimates of internal loading which result in the model achieving a

close estimate of in-lake concentration data for the average-loading conditions modeled in this scenario.

- In the absence of site-specific data, an atmospheric loading rate of 30 mg/m<sup>2</sup>-yr total phosphorus (USACE 1999) was taken from literature values and assumed in the BATHTUB model. This is a conservative value because atmospheric loadings of phosphorus are attributed to erosion that becomes wind borne and because of the low agricultural activity in the watershed the atmospheric loading is most likely negligible.

### 8.3.5.4 Waste Load Allocation

There are no point sources located within the Frank Holten Lakes watershed. There is one point source located in the Harding Ditch subbasin, however, it is located on a tributary to Harding Ditch and is significantly upstream of the lakes. Because point sources are not influencing nutrient levels in the lakes, the WLA is set to zero.

### 8.3.5.5 Load Allocation and TMDL Summary

Tables 8-8 and 8-9 show a summary of the TMDLs for the Frank Holten Lakes. On average, a total reduction of total phosphorus loads to the lake of 92 percent during the dry season and 88 percent during the wet season would result in compliance with the water quality standard of 0.05 mg/L total phosphorus.

**Table 8-8 TMDL Summary for Total Phosphorus in Frank Holten Lakes- Dry Season**

Load Source	Estimated Current Load (lb/day)	LC (lb/day)	WLA (lb/day)	LA (lb/day)	MOS (lb/day)	Reduction Needed (lb/day)	Reduction Needed (percent)
Total	2.4	0.2	0	0.2	0	2.2	92
Internal	2.3	0.1	0	0.1	0	2.2	96
External	0.1	0.1	0	0.1	0	0	0

**Table 8-9 TMDL Summary for Total Phosphorus in Frank Holten Lakes- Wet Season**

Load Source	Estimated Current Load (lb/day)	LC (lb/day)	WLA (lb/day)	LA (lb/day)	MOS (lb/day)	Reduction Needed (lb/day)	Reduction Needed (percent)
Total	95.9	11.5	0	11.5	0	84.3	88
Internal	4.2	0.4	0	0.4	0	3.8	90
External	91.7	11.1	0	11.1	0	80.5	88

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# Section 9

## Implementation Plan for the Cahokia Canal/Horseshoe Lake Watershed

### 9.1 Adaptive Management

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

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

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

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

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

## **9.2 Implementation Actions and Management Measures for DO in the Cahokia Canal**

A number of potential sources of oxygen-demanding material were identified through Stages 1 and 3 of TMDL development. Modeling determined that low flows and high temperatures are driving the low levels of DO recorded on the segment. Oxygen-demanding materials in the canal sediments consume oxygen during these low flow times. Potential contributors to oxygen-demanding materials in the impaired segment include include nonpoint sources (crop fertilization, lawn fertilization, and streambank erosion) as well as point sources contributions in the watershed.

### **9.2.1 Point Sources of Oxygen-Demanding Materials**

A DO TMDL for Cahokia Canal was not developed, however, a review of potential contributors of oxygen-demanding materials was performed for this implementation plan so that information on all potential sources are available to the community for any future monitoring or remediation work performed within the watershed.

#### **9.2.1.1 Stormwater Sources**

Portions of the Cahokia Canal watershed are dominated by urban land uses. Within the canal's watershed, the following municipalities have stormwater permits:

- Edwardsville
- Glen Carbon
- Pontoon Beach
- Maryville
- Granite City
- Collinsville
- Madison
- Venice
- East St. Louis
- Caseyville

Illinois MS4 permits require that six minimum controls be implemented to reduce pollutants discharged. The minimum controls are:

- Public Education/Outreach
- Public Participation/Involvement
- Illicit Discharge Detection/Elimination
- Construction Site Runoff Control
- Post Construction Runoff Control
- Pollution Prevention/Good Housekeeping

These six controls should result in stormwater quality that does not affect the loads of oxygen-demanding material to the canal. Future monitoring of stormwater outfalls will help determine the efficiency of the six minimum stormwater controls and will help to

gauge the contributions of oxygen-demanding materials from urban storm sewers. The permitting section of Illinois EPA has the authority to review stormwater permits.

### 9.2.1.2 Municipal/Industrial Sources

There are a number of point sources within the Cahokia Canal watershed that contribute oxygen-demanding materials to the canal (see Figure 7-1).

WLAs were not developed because the modeling determined that low flows, rather than point source contributions, were impairing the segment. Tables 9-1 and 9-2 estimate the actual loads of CBOD<sub>5</sub> and ammonia being discharged based on average values from recent DMR records available through USEPA's PCS. This analysis was not performed for organic nitrogen because there are no permit limits for the parameter and as a result, there are no DMR data available to use for an estimated load. It is recommended that monitoring be continued for DO, CBOD<sub>5</sub> and ammonia and that future monitoring be performed for organic nitrogen in effluent discharged within this watershed. Should new information and/or more data become available, the QUAL2K model for this segment could be updated.

**Table 9-1 Current Estimated CBOD<sub>5</sub> Load**

Facility Name	Average Flow (mgd)	Average CBOD <sub>5</sub> (mg/L)	Current Load (lbs/day)	Maximum Permitted Load (lbs/day)
Stone Meadows MHP	0.03	4.0	1.2	29
Holiday MHP	0.03	7.56	2.05	21
Collinsville STP	3.35	1.8	54	1251

**Table 9-2 Current Estimated Ammonia Load**

Facility Name	Average Flow (mgd)	Average ammonia (mg/L)	Current Load (lbs/day)	Maximum Permitted Load <sup>(1)</sup> (lbs/day)
Stone Meadows MHP	0.03	0.93	0.23	4.4-12
Holiday MHP	0.03	1.43	0.31	3.1-8.3
Collinsville STP	3.35	0.22	6.6	188-475
Elementis Pigments	0.7	1.02	6	NA

(1) Ammonia Permit Limits are seasonal

Illinois EPA will evaluate the need for point source controls through the NPDES permitting program as each permit is due for renewal. Table 9-3 contains permit expiration dates for the facilities discharging within the Cahokia Canal watershed.

**Table 9-3 Permit Expiration Dates for Point Source Discharges within the Cahokia Canal Watershed**

Facility Name	Permit Number	Permit Issued	Permit Expires
Stone Meadows MHP	IL0046914	Jan. 20, 2005	Feb. 28, 2010
Holiday MHP	IL0038288	Oct. 28, 2005	Nov. 30, 2010
Collinsville STP	IL0028215	Oct. 6, 2005	Nov. 30, 2010
General Chemical	IL0000647	Apr. 23, 2008	Mar. 31, 2008
Elementis Pigments	IL0038709	Jan. 24, 2006	Feb. 28, 2011
Bowman Avenue Pump Station	IL0070955	Dec. 18, 2002	Dec. 31, 2007

## 9.2.2 Nonpoint Sources of Oxygen-Demanding Materials

In addition to point sources of oxygen-demanding materials within the watershed, there are a number of potential nonpoint sources. The potential sources of nonpoint pollution to the Cahokia Canal include overfertilization, streambank erosion, low flows, and high temperatures. BMPs evaluated for treatment of these nonpoint sources are:

- Filter strips
- Reaeration/Erosion Control/Streambank Stabilization

Organic and nutrient loads originating from cropland are most efficiently treated with a combination of riparian buffer or grass filter strips. Streambank stabilization and erosion control can limit the oxygen-demanding material entering the stream. Instream management measures for DO focus on reaeration techniques. The Q2K model used to develop the TMDL utilizes reaeration coefficients. Increasing the reaeration coefficient by physical means will increase DO in the Cahokia Canal.

### 9.2.2.1 Filter Strips

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

Organic debris in topsoil contributes to the CBOD<sub>5</sub> load to water bodies (USEPA 1997). Increasing the length of stream bordered by grass and riparian buffer strips will decrease the amount of CBOD<sub>5</sub> and nutrient load associated with sediment loads to the Cahokia Canal. Nutrient criteria, currently being developed and expected to be adopted in the near future by the Illinois EPA, will assess the instream nutrient concentrations required for the watershed. Excess nutrients in streams can cause excessive algal growth, which can deplete DO in streams. Adoption of nutrient criteria will potentially affect this DO TMDL and help control exceedences of DO water quality criteria in the Cahokia Canal.

Filter strips will help control CBOD<sub>5</sub> 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 CBOD<sub>5</sub> 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 Cahokia Canal 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 9-4 outlines the guidance for filter strip flow length by slope (NRCS 1999).

**Table 9-4 Filter Strip Flow Lengths Based on Land Slope**

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

GIS land use data described in Section 5 were used in conjunction with soil slope data to provide an estimate of acreage where filter strips could be installed. As discussed in Section 2.4.1, the most predominant soil type in the watershed is Darwin Silty Clay on 0 to 2 percent slopes. Based on these slope values, filter strip widths of 36 to 144 feet could be incorporated into agricultural lands adjacent to canal 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 watershed. There are approximately 1,730 total acres within this buffer distance. 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 360 acres of agricultural land in the upper reaches of the Cahokia Canal watershed that could potentially be converted to filter strips (see Figure 9-1). Landowners should evaluate their land near the Cahokia Canal and its tributaries and create or extend filter strips according to the NRCS guidance provided in Table 9-4. Programs available to fund the construction of these buffer strips are discussed in Section 9.6.

### 9.2.2.2 Reaeration/Streambank Stabilization

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

## **9.3 Implementation Actions and Management Measures for Manganese in Canteen Creek**

Only two violations of the manganese standard have been recorded on Canteen Creek in the last 10 years. The only known sources of manganese to the creek are natural sources including overland runoff, soil erosion, and groundwater.

### **9.3.1 Nonpoint Sources of Manganese**

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

Following are examples of potentially applicable erosion control measures:

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

The remainder of this section discusses these management options.

#### **9.3.1.1 Filter Strips**

Filter strips were discussed in Section 9.2.2.1. The same technique for evaluating available land was applied to Canteen Creek. There are 500 acres of land within 144 feet of Canteen Creek; of this area, 79 acres are categorized as agricultural and could potentially be converted into filter strips (see Figure 9-1).

#### **9.3.1.2 Sediment Control Basins**

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

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

### **9.3.1.3 Streambank Stabilization/Erosion Control**

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

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

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

Stone Toe Protection uses nonerodible materials to protect the eroding banks. Meandering bends found in the Canteen 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).

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

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

## **9.4 Implementation Actions and Management Measures for Fecal Coliform in Harding Ditch**

The TMDL analysis performed for fecal coliform in Harding Ditch 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.

## **9.4.1 Point Sources of Fecal Coliform**

### **9.4.1.1 Stormwater Sources**

A large portion of the Harding Ditch watershed is urban in nature. Within the ditch's watershed, the following municipalities have stormwater permits:

- East St. Louis
- Fairview Heights
- Caseyville
- Centreville
- Alorton
- Cahokia
- Belleville

Illinois MS4 permits require that six minimum controls be implemented to reduce pollutants discharged. The minimum controls are:

- Public Education/Outreach
- Public Participation/Involvement
- Illicit Discharge Detection/Elimination
- Construction Site Runoff Control
- Post Construction Runoff Control
- Pollution Prevention/Good Housekeeping

These six controls should result in stormwater quality that does not affect the loads of fecal coliform to the canal. Again, it is recommended that a storm sewer survey be performed to determine the amount of fecal coliform being contributed to the ditch via urban stormwater sources. The permitting section of Illinois EPA has the ability to review stormwater permits.

### **9.4.1.2 Municipal Wastewater Sources**

There is one municipal treatment plant point source of fecal coliform to Harding Ditch. According to DMR records, the Caseyville Township West STP discharges 0.786 mgd with an average fecal coliform concentration of 138.0 cfu/100mL. The facility is located on Clare Creek and is significantly upstream of Harding Ditch. The treatment plant is assumed to have an insignificant impact to Harding Ditch due to the facility's location and low concentration discharge. Illinois EPA will examine this permit and will require the Caseyville Township West STP to demonstrate that their effluent will not impair water quality. The current Caseyville STP permit expires January 31, 2012.

## **9.4.2 Nonpoint Sources of Fecal Coliform**

Several management options have been identified to help reduce fecal coliform counts in Harding Ditch. 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 Harding Ditch and Tributaries

Each alternative is discussed briefly in this section.

#### **9.4.2.1 Filter Strips**

Filter strips were discussed in Section 9.2.2.1. The same technique for evaluating available land was applied to the Harding Ditch watershed. There are 775 acres of land within 144 feet of Harding Ditch, of this area, 146 acres are categorized as agricultural and could potentially be converted into filter strips (see Figure 9-1).

#### **9.4.2.2 Private Septic System Inspection and Maintenance Program**

The Stage 1 report identified 4,000 septic systems in Fairview Heights, which is located within Harding Ditch's contributing area and 700 septic systems within St. Clair County, in which Harding Ditch is situated. A program that actively manages functioning systems and addresses non-functioning systems could be put in place. The USEPA has developed guidance for managing septic systems, which includes assessing the functionality of systems, public health, and environmental risks (EPA 2005). It also introduces procedures for selecting and implementing a management plan.

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

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

The cost of each management measure is site specific and there is not specific data on septic systems and management practices for the watershed; therefore, costs for these practices were not outlined in Section 9.6.

Alternatively, a long-range solution to failing septic systems is a connection to a municipal sanitary sewer system. Installation of a sanitary sewer will reduce existing fecal coliform sources by replacing failing septic systems and will allow communities

to develop without further contribution of fecal material to Harding Ditch. Costs for the installation are generally paid over a period of several years (average of 20 years) instead of forcing homeowners to shoulder the entire cost of installing a new septic system. In addition, costs are sometimes shared between the community and the utility responsible for treating the wastewater generated from replacing the septic tanks. The planning process is involved and requires participation from townships, cities, counties, and citizens.

#### **9.4.2.3 Restrict Livestock Access to Harding Ditch and Tributaries**

Livestock are present in St. Clair County, which encompasses the Harding Ditch subwatershed, including nearly 7,000 head of cattle and over 30,000 hogs and pigs (NASS 2004). It is unknown to what extent these animals have access to Harding Ditch or its tributaries. Reduction of livestock access to streams, however, is recommended to reduce bacteria loads. The USEPA found that livestock exclusion from waterways and other grazing management measures were successful in reducing fecal coliform counts by 29 to 46 percent (2003). Fencing and alternate watering systems are effective ways to restrict livestock from streams.

### **9.5 Implementation Actions and Management Measures for Phosphorus in Horseshoe Lake and the Frank Holten Lakes**

Phosphorus loads in the Horseshoe Lake and Frank Holten Lakes watersheds originate from both external and internal sources. As discussed in previous sections, possible sources of total phosphorus in the Horseshoe Lake watershed include runoff from urban and agricultural areas coupled with point source contributions and internal loading while sources of total phosphorus to the Frank Holten Lakes include urban and parkland runoff and septic systems. To achieve a reduction of total phosphorus for these lakes, management measures must address loading through sediment and surface runoff controls and internal nutrient cycling through in-lake management.

#### **9.5.1 Point Sources of Phosphorus**

The phosphorus TMDLs for Horseshoe Lake and the Frank Holten Lakes describe waste load allocations for point source dischargers in the watershed. The Frank Holten Lakes do not have any point source contributions and the associated WLA was therefore set to zero.

##### **9.5.1.1 Stormwater Sources**

The 303(d) list identified urban runoff and storm sewers as potential pollutant sources of total phosphorus for both Horseshoe Lake and the Frank Holten Lakes. Figure 7-6 shows that the areas to the north and west of Horseshoe Lake are urbanized while the areas to the east and northeast are agricultural. Stormwater from Granite City and Pontoon Beach contribute flows to Horseshoe Lake. In addition, flows from Cahokia Canal are diverted into the lake during high runoff events. The urban stormwater sources contributing to the Cahokia Canal were discussed in Section 9.2.1.1.

Figure 7-7 shows that the majority of the land within the Frank Holten Lakes watershed is developed. Stormwater runoff from low-density residential areas and a high school discharges into Lake 1 via three drainage district culverts. In addition to these stormwater flows, Harding Ditch contributes flows to Lake 3 during wet weather events. Stormwater sources within the Harding Ditch watershed were discussed in Section 9.4.1.1.

Illinois MS4 permits require that six minimum controls be implemented to reduce pollutants discharged. The minimum controls are:

- Public Education/Outreach
- Public Participation/Involvement
- Illicit Discharge Detection/Elimination
- Construction Site Runoff Control
- Post Construction Runoff Control
- Pollution Prevention/Good Housekeeping

These six controls should result in stormwater quality that does not affect the loads of total phosphorus to the lakes. The permitting section of Illinois EPA has the ability to review stormwater permits.

#### **9.5.1.2 Industrial Sources**

The Granite City Steel facility (Permit #IL0000329) is permitted to discharge 26 mgd of treated water to Horseshoe Lake. The facility does not currently have phosphorus permit limits and therefore does not sample for phosphorus in the facility's effluent. The Granite City Steel facility discharges to Horseshoe Lake and was allocated loads associated with the facility's historic average discharge and a total phosphorus concentration of 0.185 mg/L. The facility is estimated to currently discharge concentrations of 0.237 mg/L total phosphorus. Illinois EPA may implement this discharge limit during the next permit renewal for the facility in March 2011 or at any permit modification date.

#### **9.5.2 Nonpoint Sources of Phosphorus**

Potential sources of nonpoint source phosphorus pollution to Horseshoe Lake identified by the 303(d) list include agricultural and urban runoff. Potential sources of nonpoint source phosphorus pollution to the Frank Holten Lakes include septic systems, urban runoff, and other recreational pollution sources. Other recreational pollution sources in the Frank Holten Lakes watershed include managed parkland and a golf course adjacent to Lakes 1 and 2.

BMPs available that could be utilized to treat these nonpoint sources in one or both watersheds are:

- Conservation tillage practices
- Filter strips
- Wetlands

- Nutrient management
- Septic system maintenance or sanitary system

Total phosphorus originating from cropland is most efficiently treated with a combination of no-till or conservation tillage practices and grass filter strips. Wetlands located upstream of the reservoir could provide further reductions in total and dissolved phosphorus in runoff from croplands in the Horseshoe Lake watershed. A combination of filter strips and possibly wetlands could reduce phosphorus loads from the golf course at Frank Holten State Park. Nutrient management focuses on source control of nonpoint source contributions to both lakes.

### **9.5.2.1 Conservation Tillage Practices**

For the Cahokia Canal/Horseshoe Lake watershed, conservation tillage practices could help reduce nutrient loads in the lakes. The lakes potentially receive nonpoint source runoff from the approximately 28 percent of the watershed, which is under cultivation. Total phosphorus loading from cropland is controlled through management BMPs, such as conservation tillage. Conservation tillage maintains at least 30 percent of the soil surface covered by residue after planting. Crop residuals or living vegetation cover on the soil surface protect against soil detachment from water and wind erosion. Conservation tillage practices can remove up to 45 percent of the dissolved and total phosphorus from runoff and approximately 75 percent of the sediment. Additionally, studies have found around 93 percent less erosion occurred from no-till acreage compared to acreage subject to moldboard plowing (USEPA 2003). The 2004 Illinois Department of Agriculture's Soil Transect Survey estimated that conventional till currently accounts for 68 percent of corn, 8 percent of soybean, and 6 percent of small grain tillage practices in Madison County; 96 percent of corn and 27 percent of soybeans in St. Clair County; and 60 percent of corn, 10 percent of soybeans, and 6 percent of small grains in Monroe County. To achieve TMDL load allocations, tillage practices already in place should be continued, and practices should be assessed and improved upon for all 73,373 agricultural acres in the Cahokia Canal/Horseshoe Lake watershed.

### **9.5.2.2 Filter Strips**

Filter strips were discussed in Section 9.2.2.1. The same technique for evaluating available land was applied to the both lake watersheds. In the Horseshoe Lake watershed there are 182 acres of land within 144 feet of the lake and its tributaries; of this area, 35 acres are categorized as agricultural and could potentially be converted into filter strips. In the Frank Holten Lakes watershed, there are seven-and-one-half acres of land between the golf course and Lakes 1 and 2 that could potentially be converted to filter strips. In addition, the filter strips suggested for implementation within the Canteen Creek, Cahokia Canal and Harding Ditch watersheds would provide additional benefits in potentially reducing lake nutrient levels because stream flows from these larger watersheds reach the lakes during wet weather (see Figure 9-1).



### 9.5.2.3 Wetlands

The use of wetlands as a structural control is applicable to nutrient reduction from agricultural lands in the Horseshoe Lake watershed and possibly from recreational land in the Frank Holten Lakes watershed. To treat loads from agricultural runoff, a wetland could be constructed on the upstream end of the reservoir. To treat loads generated at the Frank Holten State Park, a wetland could be constructed between the golf course and the lakes. Wetlands are an effective BMP for sediment and phosphorus control because they:

- Prevent floods by temporarily storing water, allowing the water to evaporate or percolate into the ground
- Improve water quality through natural pollution control such as plant nutrient uptake
- Filter sediment
- Slow overland flow of water thereby reducing soil erosion (USDA 1996)

A properly designed and functioning wetland can provide very efficient treatment of pollutants, such as phosphorus. Design of wetland systems is very important and should consider soils in the proposed location, hydraulic retention time, and space requirements. Constructed wetlands, which comprise the second or third stage of nonpoint source treatment, can be effective at improving water quality. Studies have shown that artificial wetlands designed and constructed specifically to remove pollutants from surface water runoff have removal rates for suspended solids of greater than 90 percent, 0 to 90 percent for total phosphorus, 20 to 80 percent of orthophosphate, and 10 to 75 percent for nitrogen species (Johnson, Evans, and Bass 1996; Moore 1993; USEPA 1993; Kovosic et al. 2000). Although the removal rate for phosphorus is low in long-term studies, the rate can be improved if sheet flow is maintained to the wetland and vegetation and substrate are monitored to ensure the wetland is operation optimally. Sediment or vegetation removal may be necessary if the wetland removal efficiency is lessened over time (USEPA 1993; NCSU 2000).

**Table 9-5 Acres of Wetland for Horseshoe Lake Watershed**

Subbasin	Area (acres)	Recommended Wetlands (acre)
3	8800	52.8
4	900	5.4
5	1600	9.6
Total	11300	68

Guidelines for wetland design suggest a wetland to watershed ratio of 0.6 percent for nutrient and sediment removal from agricultural runoff. Table 9-5 outlines estimated wetland areas for each agricultural subbasin in the Horseshoe Lake watershed based on these recommendations. A wetland system to treat agricultural runoff from the three subbasins could be approximately 68 acres (Denison and Tilton 1993).

### 9.5.2.4 Nutrient Management

Nutrient management could result in reduced nutrient loads to Horseshoe Lake and the Frank Holten Lakes. Crop management of nitrogen and phosphorus originating in the agricultural portions of the Horseshoe Lake watershed can be accomplished through

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

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

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

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

Additionally, nutrient management techniques could be applied to management practice currently employed at the Frank Holten State Park. Over-application of fertilizer to park lands and the golf course may be contributing to the nutrient problem and should be reviewed by park management.

#### **9.5.2.5 Septic System Maintenance and Sanitary System**

Septic systems are not considered an issue within the Horseshoe Lake watershed. However, septic systems in the Harding Ditch watershed are a potential source of nutrients to the Frank Holten Lakes. Septic system maintenance in the Harding Ditch watershed was discussed in Section 9.4.1.2.

#### **9.5.3 In-Lake Phosphorus**

Reduction of phosphorus from in-lake cycling through management strategies is also suggested for attainment of the TMDL allocation. Internal phosphorus loading occurs when the water above the sediments become anoxic causing the release of phosphorus from the sediment in a form that is available for plant uptake. The addition of

bioavailable phosphorus in the water column stimulates more plant growth and die-off, which perpetuates the anoxic conditions and enhances the subsequent release of phosphorus into the water.

Control of internal phosphorus cycling must limit the release of phosphorus from the sediments either through lake oxygen concentration or sediment management. Aeration, which simulates lake mixing and keeps oxygen conditions from being depleted in the epilimnion, can be very effective at preventing re-release of bound phosphorus. Reduction of internal phosphorus cycling from this measure is typically determined based on site-specific studies. Because the Horseshoe Lake system is heavily managed, it is possible that the practice of pumping out a section of the lake each year to allow vegetative growth to attract birds and then letting the lake refill over this section may be contributing to elevated nutrients by introducing significant plant materials each year. Very little is known regarding the effect of this practice on lake water quality. It is recommended that sampling be performed before and after and scenario changes to determine the effect of these management practices (i.e. canal diversion, impoundment pump-out, etc...).

Phosphorus release from the sediment is greatest from recently deposited layers. Dredging about one meter of recently deposited phosphorus-rich sediment can remove approximately 80 to 90 percent of the internally loaded phosphorus without the addition of potentially toxic compounds to the reservoir. Dredging is more costly than other management options (NRCS 1992), however, this may be an option for Horseshoe Lake where a portion of the lake is pumped out annually making the practice slightly more feasible. It should be noted that the Frank Holten Lakes were dredged in the early 1980s.

## **9.6 Reasonable Assurance**

Reasonable assurance means that a demonstration is given that nonpoint source reductions in this watershed will be implemented. It should be noted that all programs discussed in this section are voluntary and some may currently be in practice in the watershed. The discussion in Sections 9.2 through 9.5 provided information on available BMPs for reducing phosphorus loads from point and nonpoint sources. The remainder of this section discusses an estimate of costs to the watershed for implementing nonpoint source management practices and programs available to assist with funding.

### **9.6.1 Available Programs for Nonpoint Source Management**

There are several voluntary conservation programs established through the 2002 U.S. Farm Bill, which encourage landowners to implement resource-conserving practices for water quality and erosion control purposes. These programs would apply to crop fields and rural grasslands that are presently used as pasture land. Each program is discussed separately in the following paragraphs. It should be noted that the USDA has recently released proposals for the upcoming 2007 Farm Bill.

### **9.6.1.1 Illinois Department of Agriculture and Illinois EPA Nutrient Management Plan Project**

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

### **9.6.1.2 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)

The current extent of land enrolled in CRP within the Cahokia Canal/Horseshoe Lake watershed is unknown.

### **9.6.1.3 Clean Water Act Section 319 Grants**

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

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

### **9.6.1.4 Wetlands Reserve Program (WRP)**

The Wetlands Reserve Program (WRP) is a voluntary program that provides technical and financial assistance to eligible landowners to restore, enhance, and protect wetlands. The goal of WRP is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. At least 70 percent of each project area will be restored to the original natural condition, to the extent practicable. The remaining 30 percent of each area may be restored to other than natural conditions. Landowners have the option of enrolling eligible lands through permanent easements, 30-year easements, or 10-year restoration cost-share agreements. The program is offered on a continuous sign-up basis and is available nationwide. WRP offers landowners an opportunity to establish, at minimal cost, long-term conservation and wildlife habitat enhancement practices and protection. It is administered through the NRCS (2002b).

Eligible participants must have owned the land for at least one year and be able to provide clear title. Restoration agreement participants must show evidence of ownership. Owners may be an individual, partnership, association, corporation, estate, trust, business, or other legal entity; a state (when applicable); a political subdivision of a state; or any agency thereof owning private land. Land eligibility is dependent on length of ownership, whether the site has been degraded as a result of agriculture, and the land's ability to be restored.

The 2002 Farm Bill reauthorized the program through 2007. The reauthorization increased the acreage enrollment cap to 2,275,000 acres with an annual enrollment of 250,000 acres per calendar year. The program is limited by the acreage cap and not by program funding. Since the program began in 1985, the average cost per acre is \$1,400 in restorative costs and the average project size is 177 acres. The costs for each enrollment options follow in Table 9-6 (USDA 2006).

**Table 9-6 Costs for Enrollment Options of WRP Program**

<b>Option</b>	<b>Permanent Easement</b>	<b>30-year Easement</b>	<b>Restoration Agreement</b>
Payment for Easement	100% Agricultural Value	75% Agricultural Value	NA
Payment Options	Lump Sum	Lump Sum	NA
Restoration Payments	100% Restoration Cost Reimbursements	75% Restoration Cost Reimbursements	75% Restoration Cost Reimbursements

### **9.6.1.5 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)."

Landowners, with the assistance of a local NRCS or other service provider, are responsible for the development of an EQIP plan that 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).

#### **9.6.1.6 Wildlife Habitat Incentives Program (WHIP)**

The Wildlife Habitat Incentives Program (WHIP) is a 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 five to 10 years in duration, depending upon the practices to be installed. However, longer term contracts of 15 years or greater may also be 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.

#### **9.6.1.7 Streambank Stabilization and Restoration Practice**

The Streambank Stabilization and Restoration Practice (SSRP) was established to address problems associated with streambank erosion, such as loss or damage to valuable farmland, wildlife habitat, and 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, lunger 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).

#### **9.6.1.8 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, and grade

stabilization structures. The CPP is state-funded through the Department of Agriculture. There is a project cap of \$5,000 per landowner and costs per acre vary significantly from project to project.

### 9.6.1.9 Local Program Information

The Farm Service Agency (FSA) administers the CRP. NRCS administers the EQIP, WRP, and WHIP. Local NRCS contact information in St. Clair and Madison County are listed in the Table 9-7 below.

**Table 9-7 Local NRCS and FSA Contact Information**

Contact	Address	Phone
<b>Local NRCS Office</b>		
Madison County	7205 Marine Road Edwardsville, IL 62025	618.656.4710 ext. 3
St. Clair County	2031 Mascoutah Avenue Belleville, IL 62220	618.235.2500 ext. 3

### 9.6.2 Cost Estimates of BMPs

Cost estimates for different BMPs and individual practice prices such as filter strip installation are detailed in the following sections. Finally, an estimate of the total order of magnitude costs for implementation measures in the Cahokia Canal/Horseshoe Lake watershed are presented in Section 9.6.2.8 and Table 9-8.

#### 9.6.2.1 Wetlands

The price to establish a wetland is very site specific. There are many different costs that could be incurred depending on wetland construction. Examples of costs associated with constructed wetlands include excavation costs. NRCS estimates excavation cost at \$2/cubic foot. Establishment of vegetation in critical areas including seeding and fertilizing is estimated at \$230/acre. It should be noted that the larger the wetland acreage to be established, the more cost-effective the project.

#### 9.6.2.2 Filter Strips and Riparian Buffers

In previous studies, the NRCS has estimated an average cost per acre to install and maintain a grass filter strip with a five-year life span at \$54/acre for nonnative species and \$188/acre for native species. This price quote accounts for seeding and mowing every other year to remove woody sprouts. A riparian buffer strip established with bare root stock has a life span of 10-years and an installation cost of \$350/acre.

#### 9.6.2.3 Nutrient Management Plan – NRCS

A portion of the rural land in the Cahokia Canal/Horseshoe Lake watershed is comprised of cropland. The service for developing a nutrient management plan averages \$5 to \$15/acre.

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

The costs associated with development of Nutrient Management Plans co-sponsored by the IDA and the Illinois EPA is estimated as \$10/acre paid to the producer and



\$3/acre for a third party vendor who develops the plans. There is a 200 acre cap per producer. The total plan development cost is estimated at \$13/acre.

### 9.6.2.5 Conservation Tillage

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

### 9.6.2.6 Internal Cycling

Controls of internal phosphorus cycling in lakes are costly. As discussed above, an aeration system is very site-specific; therefore, cost is not discussed here. However, dredging is typically the most expensive management practice averaging \$8,000/acre. Although cost is high, the practice is 80 to 90 percent effective at nutrient removal and will last for at least 50 years (Cortell 2002; Geney 2002). The Frank Holten Lakes were dredged in the early 1980s.

### 9.6.2.7 Planning Level Cost Estimates for Implementation Measures

Cost estimates for different implementation measures are presented in Table 9-8. 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 Wetlands Reserve Program (WRP), 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 IEPA 319 Grants are applicable to all of these practices.

**Table 9-8 Cost Estimate of Various BMP Measures in McLean County**

Source	Program	Sponsor	BMP	Installation Mean \$/acre
Nonpoint	CRP/CPP	NRCS and IDA	Grass filter strip -native	\$188
	CRP/CPP	NRCS and IDA	Grass filter strip -nonnative	\$54
	WRP	NRCS	Wetland	varies
		NRCS	Nutrient Management Plan	\$10
		IDA and Illinois EPA	Nutrient Management Plan	\$13
	CRP/CPP	NRCS and IDA	Conservation Tillage	varies
Internal Cycling			Dredging	\$8,000

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

## 9.7 Monitoring Plan

The purpose of the monitoring plan for the Cahokia Canal/Horseshoe Lake 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
- Monitoring of point source discharges in the watershed
- Continued ambient monitoring of all TMDL segments
- Investigation of tile line flow and associated water quality from agricultural land
- Further information gathering on area septic systems including locations and failure rates
- Storm-based monitoring of high flow events
- Tributary monitoring
- Monitoring of pump out rates and diversion flows for Horseshoe Lake and Cahokia Canal
- Storm Sewer surveys to monitor outfall concentration of parameters of concern

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. Additional monitoring could be conducted on specific structural systems such as a constructed wetland. Inflow and outflow measurements could be conducted to determine site-specific removal efficiency. If aeration is used to control internal loading, site-specific data could be collected to assess the effectiveness of this management measure. In addition, sampling should be performed before and after

management operations employed within Horseshoe Lake to determine their effects on lake nutrient levels.

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

Regular and more extensive monitoring of point sources in the watershed would confirm their collective contributions and add confidence to the modeled conclusion that low flows and not point sources are the driving factor behind low DO levels in the canal. As permits come up for renewal, Illinois EPA NPDES program should review the permits and decide if further management measures are required.

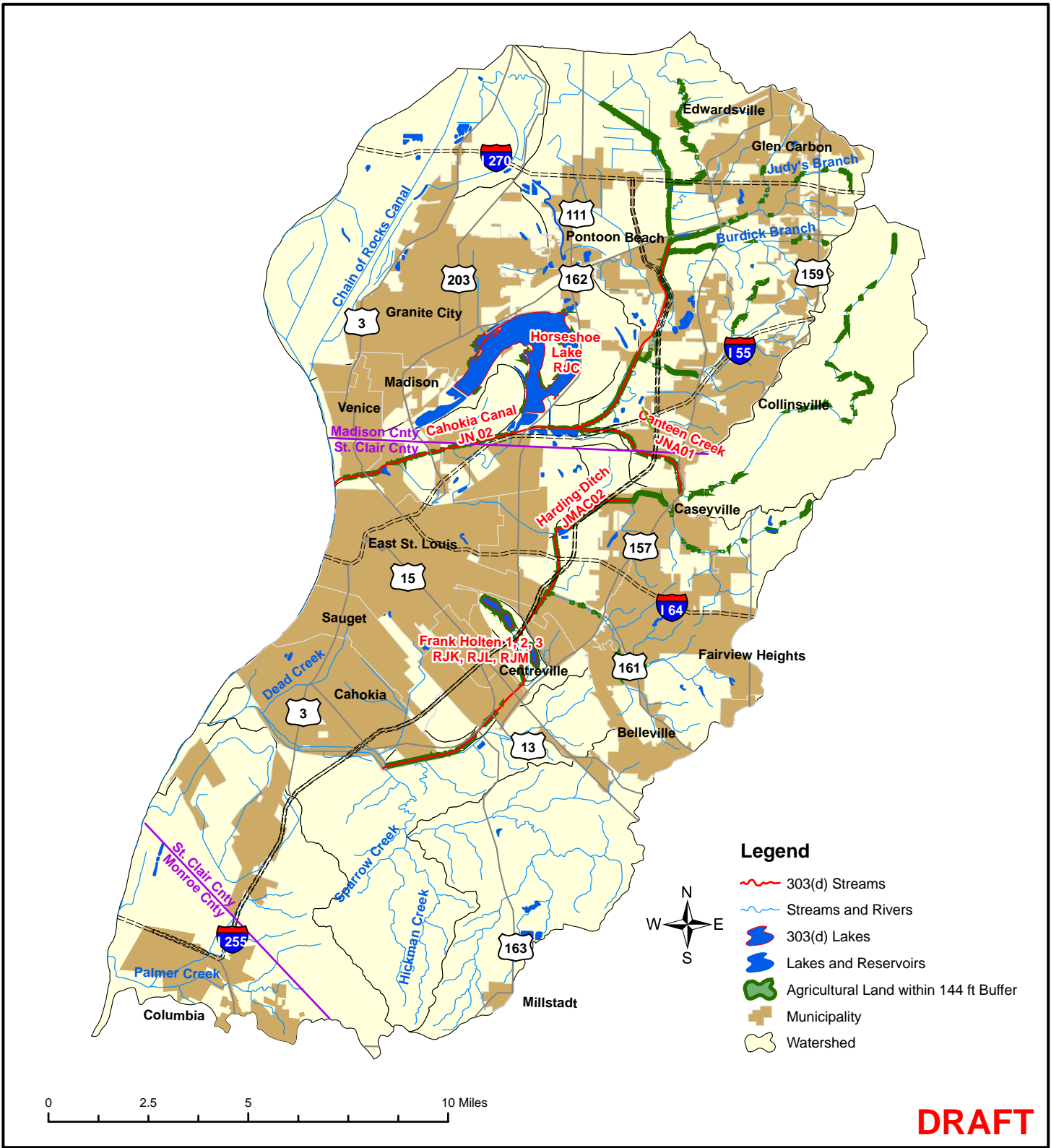
Stormwater outfall monitoring will also confirm stormwater contributions throughout the watershed. Urban stormwater is a potential pollutant source for each impaired waterbody segment in the watershed. Outfall monitoring for parameters of concern is suggested.

Continued tributary monitoring is needed to further assess the contribution of internal loading to the impaired watershed lakes. By having more knowledge on actual contributions from external loads a more precise estimate of internal loads could occur. Data on the different forms of phosphorus (dissolved, total, or orthophosphate) would also be beneficial to better assess reservoir responses to phosphorus loading.

## **9.8 Implementation Time Line**

Implementing the actions outlined in this section for the Cahokia Canal/Horseshoe Lake 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.

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Figure 9-1  
 Cahokia Canal/Horseshoe Lake Watershed  
 Potential Areas for Filter Strips



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# Section 10

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# **Attachment 1: Stage 1 Report**

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## Illinois Environmental Protection Agency

### **Cahokia Canal/Horseshoe Lake Watershed Total Maximum Daily Load Stage One Report**

October 2006



# *Final Report*

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# Acronyms

°F	degrees Fahrenheit
ALMP	Ambient Lake Monitoring Program
BMP	best management practice
BOD	biochemical oxygen demand
CBOD <sub>5</sub>	5-day carbonaceous biochemical oxygen demand
cfs	cubic feet per second
CRP	Conservation Reserve Program
CWA	Clean Water Act
DEM	Digital Elevation Model
DMR	Discharge Monitoring Reports
DO	dissolved oxygen
DP	dissolved phosphorus
ft	foot
GIS	geographic information system
GWLF	generalized watershed loading function
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
ICLP	Illinois Clean Lakes Program
IDA	Illinois Department of Agriculture
IDNR	Illinois Department of Natural Resources
ILLCP	Illinois Interagency Landscape Classification Project
Illinois EPA	Illinois Environmental Protection Agency
IPCB	Illinois Pollution Control Board
ISWS	Illinois State Water Survey
LA	load allocation
LC	loading capacity
MBI	Macroinvertebrate Biotic Index
mg/L	milligrams per liter
MOS	margin of safety
NASS	National Agricultural Statistics Service
NCDC	National Climatic Data Center
NRCS	National Resource Conservation Service
PO <sub>4</sub>	phosphate
SSURGO	Soil Survey Geographic Database

*List of Acronyms*  
*Development of Total Maximum Daily Loads*  
*Cahokia Canal/Horseshoe Lake Watershed*

STATSGO	State Soil Geographic
STORET	Storage and Retrieval
TMDL	total maximum daily load
TP	total phosphorus
TSS	total suspended solids
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WLA	waste load allocation

# Section 1

## Goals and Objectives for Cahokia Canal/ Horseshoe Lake Watershed (0714010105, 0714010106, 0714010104)

### 1.1 Total Maximum Daily Load (TMDL) Overview

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

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

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

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

Water quality standards consist of three elements:

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

Examples of designated uses are recreation and protection of aquatic life. Water quality criteria describe the quality of water that will support a designated use. Water quality criteria can be expressed as numeric limits or as a narrative statement.

Antidegradation policies are adopted so that water quality improvements are conserved, maintained, and protected.

## **1.2 TMDL Goals and Objectives for Cahokia Canal/ Horseshoe Lake Watershed**

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

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

This report addresses Stage 1 TMDL development for the Cahokia Canal/Horseshoe Lake watershed. Stage 2 and 3 will be conducted upon completion of Stage 1. Stage 2 is optional as data collection may not be necessary if additional data is not required to establish the TMDL.

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

- Cahokia Canal (JN 02)
- Horseshoe Lake (Madison) (RJC)
- Prairie Du Pont Creek (JMAA01)
- Harding Ditch (JMCA02)
- Frank Holten Main Lake (RJK)
- Frank Holten Lake #2 (RJL)
- Frank Holten Lake #3 (RJM)
- Canteen Creek (JNA 01)

These impaired water body segments are shown on Figure 1-1. There are eight impaired segments within the Cahokia Canal/Horseshoe Lake watershed. Table 1-1 lists the water body segment, water body size, and potential causes of impairment for the water body.



**Table 1-1 Impaired Water Bodies in Cahokia Canal/Horseshoe Lake Watershed**

<b>Water Body Segment ID</b>	<b>Water Body Name</b>	<b>Size</b>	<b>Causes of Impairment with Numeric Water Quality Standards</b>	<b>Causes of Impairment with Assessment Guidelines</b>
JN 02	Cahokia Canal	11.87 miles	Dissolved oxygen	Total nitrogen, sedimentation/siltation, habitat alterations (streams), total phosphorus
RJC	Horseshoe Lake	2,107 acres	Total phosphorus, pH	Excess algal growth, non-native fish/animals, heptachlor, PCBs, zinc, total phosphorus, total suspended solids (TSS)
JMAA01	Prairie Du Pont Creek	14.34 miles	Dissolved oxygen <sup>(1)</sup>	Total phosphorus
JMAC02	Harding Ditch	10.48 miles	Total fecal coliform	
RJK	Frank Holten Main Lake	97 acres	Total phosphorus	TSS, excess algal growth, PCBs, total phosphorus
RJL	Frank Holten Lake #2	40 acres	Total phosphorus	TSS, excess algal growth, PCBs, total phosphorus
RJM	Frank Holten Lake #3	80 acres	Total phosphorus, dissolved oxygen	TSS, excess algal growth, non-native fish/animals, PCBs, total phosphorus
JNA 01	Canteen Creek	4.31 miles	Manganese	Total nitrogen, sedimentation/siltation, habitat alterations (streams), TSS, total phosphorus

<sup>(1)</sup> Data collected in 2003 indicates that Prairie Du Pont Creek is no longer impaired for dissolved oxygen and the segment will no longer be on the State's 303(d) list. Therefore, a TMDL for dissolved oxygen is not being developed.

Illinois EPA is currently only developing TMDLs for parameters that have numeric water quality standards, and therefore the remaining sections of this report will focus on the manganese, dissolved oxygen, total phosphorus (numeric standard), pH, and total fecal coliform impairments in the Cahokia Canal/Horseshoe Lake watershed. For potential causes that do not have numeric water quality standards as noted in Table 1-1, TMDLs will not be developed at this time. However, in the implementation plans completed during Stage 3 of the TMDL, many of these potential causes may be addressed by implementation of controls for the pollutants with water quality standards.

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

- Loading Capacity (LC) or the maximum amount of pollutant loading a water body can receive without violating water quality standards
- Waste Load Allocation (WLA) or the portion of the TMDL allocated to existing or future point sources
- Load Allocation (LA) or the portion of the TMDL allocated to existing or future nonpoint sources and natural background

- Margin of Safety (MOS) or an accounting of uncertainty about the relationship between pollutant loads and receiving water quality

These elements are combined into the following equation:

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

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

### 1.3 Report Overview

The remaining sections of this report contain:

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

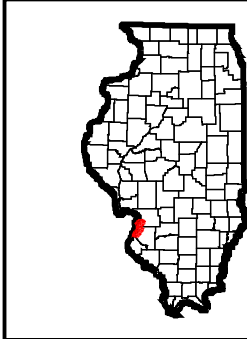
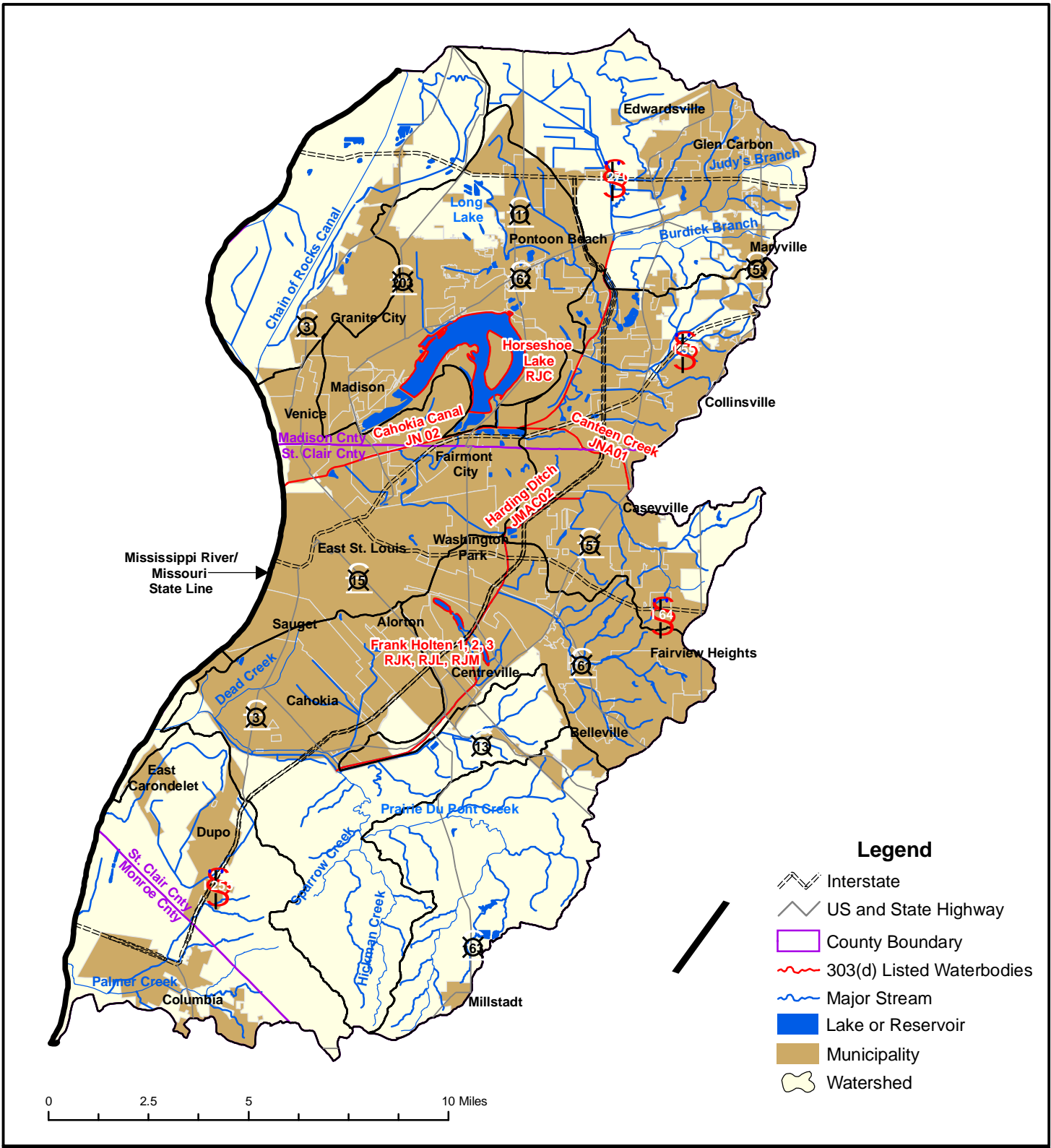


Figure 1-1  
Cahokia Canal/Horseshoe Lake Watershed

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# **Section 2**

## **Cahokia Canal/Horseshoe Lake Watershed Description**

### **2.1 Cahokia Canal/Horseshoe Lake Watershed Location**

The Cahokia Canal/Horseshoe Lake watershed (Figure 1-1) is located in southern Illinois, flows in a southwesterly direction, and drains approximately 181,673 acres within the state of Illinois. Approximately 75,472 acres lie in southwestern Madison County, 97,427 acres lie in western St. Clair County, and 8,775 acres lie in northern Monroe County.

### **2.2 Topography**

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

Elevation in the Cahokia Canal/Horseshoe Lake watershed ranges from 702 feet above sea level in the headwaters of Cahokia Canal to 374 feet at its most downstream point at the Mississippi River. The absolute elevation change is 26 feet over the approximately 12-mile stream length of Cahokia Canal, which yields a stream gradient of approximately 2.2 feet per mile. Prairie DuPont Creek, located in the southern half of the watershed, yields an absolute elevation change of 262 feet over the approximately 20-mile stream length and a stream gradient of approximately 13.3 feet per mile.

### **2.3 Land Use**

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

categories. (Source: IDNR, INHS, IDA, USDA NASS's 1:100,000 Scale Land Cover of Illinois 1999-2000, Raster Digital Data, Version 2.0, September 2003.)

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

The land cover data reveal that approximately 73,373 acres, representing nearly 40 percent of the total watershed area, are devoted to agricultural activities. Corn and soybean farming account for nearly 13 percent and 15 percent of the watershed area, respectively. Urban areas occupy approximately 33 percent of the watershed (about nine percent high density, 17 percent low/medium density, and eight percent urban open space). Upland forests occupy approximately 11 percent of the watershed, and urban open space and wetlands each occupy approximately eight percent. Other land cover categories represent five percent or less of the watershed area.

**Table 2-1 Land Use in Cahokia Canal/Horseshoe Lake Watershed**

Land Cover Category	Area (Acres)	Percentage
Corn	22,892	12.6%
Soybeans	27,284	15.0%
Winter Wheat	3,554	2.0%
Other Small Grains & Hay	552	0.3%
Winter Wheat/Soybeans	7,651	4.2%
Other Agriculture	2,440	1.3%
Rural Grassland	9,000	5.0%
Upland	19,385	10.7%
Forested Areas	5,283	2.9%
High Density	15,606	8.6%
Low/Medium Density	30,259	16.7%
Urban Open Space	14,126	7.8%
Wetlands	14,213	7.8%
Surface Water	8,591	4.7%
Barren & Exposed Land	837	0.4%
<b>Total</b>	<b>181,673</b>	<b>100%</b>

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

## 2.4 Soils

Detailed soils data and spatial coverages are available through the Soil Survey Geographic (SSURGO) database for a limited number of counties in Illinois. For SSURGO data, field mapping methods using national standards are used to construct the soil maps. Mapping scales generally range from 1:12,000 to 1:63,360 making SSURGO the most detailed level of NRCS soil mapping.

The Cahokia Canal/Horseshoe Lake watershed falls within Madison, Monroe, and St. Clare Counties. Figure 2-3 displays the SSURGO soil series in the Cahokia Canal/Horseshoe Lake watershed. Attributes of the spatial coverage can be linked to the SSURGO database, which provides information on various chemical and physical soil characteristics for each map unit and soil series. Of particular interest for TMDL development are the hydrologic soil groups as well as the K-factor of the Universal Soil Loss Equation. The following sections describe and summarize the specified soil characteristics for the Cahokia Canal/Horseshoe Lake watershed.

### **2.4.1 Cahokia Canal/Horseshoe Lake Watershed Soil Characteristics**

Appendix B contains the SSURGO soil series for the Cahokia Canal/Horseshoe Lake watershed. The table also contains the area, dominant hydrologic soil group, and k-factor range. Each of these characterizations is described in more detail in the following paragraphs. The predominant soil type in the watershed is Darwin Silty Clay on zero to 2 percent slopes followed by Marine Silt Loam on 0 to 5 percent slopes.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils are assigned to one of four groups. They are grouped according to their infiltration rates under saturated conditions during long duration storm events. All four hydrologic soil groups (A, B, C, and D) are found within the Cahokia Canal/Horseshoe Lake watershed with the majority of the watershed falling into category B. Category B soils are defined as "soils having a moderate infiltration rate when thoroughly wet." Category B soils "consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture." These soils have a moderate rate of water transmission. (NRCS, 2005)

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

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

The distribution of K-factor values in the Cahokia Canal/Horseshoe Lake watershed range from 0.02 to 0.55.

## 2.5 Population

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

Approximately 226,747 people reside in the watershed. The major municipalities in the Cahokia Canal/Horseshoe Lake watershed are shown in Figure 1-1. The cities of Granite City, East St. Louis, Collinsville, and Cahokia are the largest population centers in the watershed and contribute an estimated 31,301, 22,638, 16,455, and 16,391 people, respectively, to total watershed population.

## 2.6 Climate and Streamflow

### 2.6.1 Climate

Southern Illinois has a temperate climate with hot summers and cold, snowy winters. Monthly precipitation and temperature data were available for the Cahokia station (id. 1160) in St. Clair County and were extracted from the NCDC database. Data were available from 1969-2002. Cahokia, Illinois is located within the basin and was chosen to be representative of meteorological conditions throughout the Cahokia Canal/Horseshoe Lake watershed.

Table 2-2 contains the average monthly precipitation along with average high and low temperatures for the period of record. The average annual precipitation is approximately 39 inches.

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

Month	Total Precipitation (inches)	Maximum Temperature (degrees F)	Minimum Temperature (degrees F)
January	2.1	39	20
February	2.3	45	25
March	3.6	56	34
April	4.0	68	45
May	4.0	76	54
June	3.8	85	63
July	3.8	89	67
August	3.6	87	65
September	3.1	80	57
October	2.7	70	45
November	3.5	56	35
December	2.7	44	26
<b>Total</b>	<b>39.2</b>		



## 2.6.2 Streamflow

Analysis of the Cahokia Canal/Horseshoe Lake watershed requires an understanding of flow throughout the drainage area. Unfortunately, there are no USGS gages within the watershed that have current, or even recent, streamflow data. Streamflow values can possibly be collected in the watershed if any Stage 2 data collection occurs or values can be estimated through the drainage area ratio method which assumes that the flow per unit area is equivalent in watersheds with similar characteristics. If new data becomes available, it will be incorporated into Stage 3 TMDL development. In the absence of new data, flows will be estimated from a gage in a neighboring watershed.

## 2.7 Watershed Photographs

The photographs shown here are of the Cahokia Canal/Horseshoe Lake watershed that were taken in the fall of 2006. Appendix D contains additional photographs of the watershed.



*Horseshoe Lake Looking West Toward Saint Louis*



*Blue Heron in Horseshoe Lake*



*Cahokia Canal at Route 162 Looking South*



*Cahokia Canal at Route 162 Looking North*

Section 2  
Cahokia Canal/Horseshoe Lake Watershed Description



*Harding Ditch at Bunkham Road Looking North*



*Canteen Creek at Sand Prairie Road Looking West*



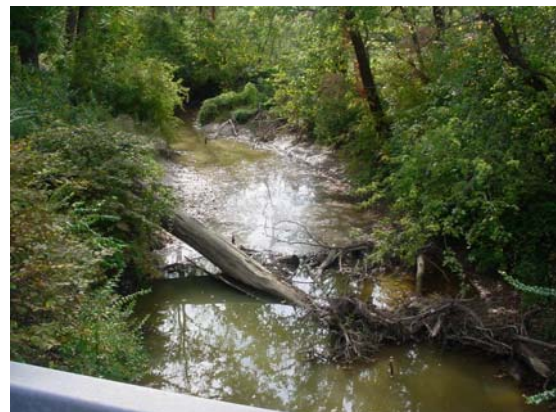
*Frank Holten Lake #1 Looking Northwest Toward Saint Louis*



*Frank Holten Lake #2 Looking Northwest*



*Frank Holten Lake #3*



*Canteen Creek Southeast of Bluff Road Looking West*

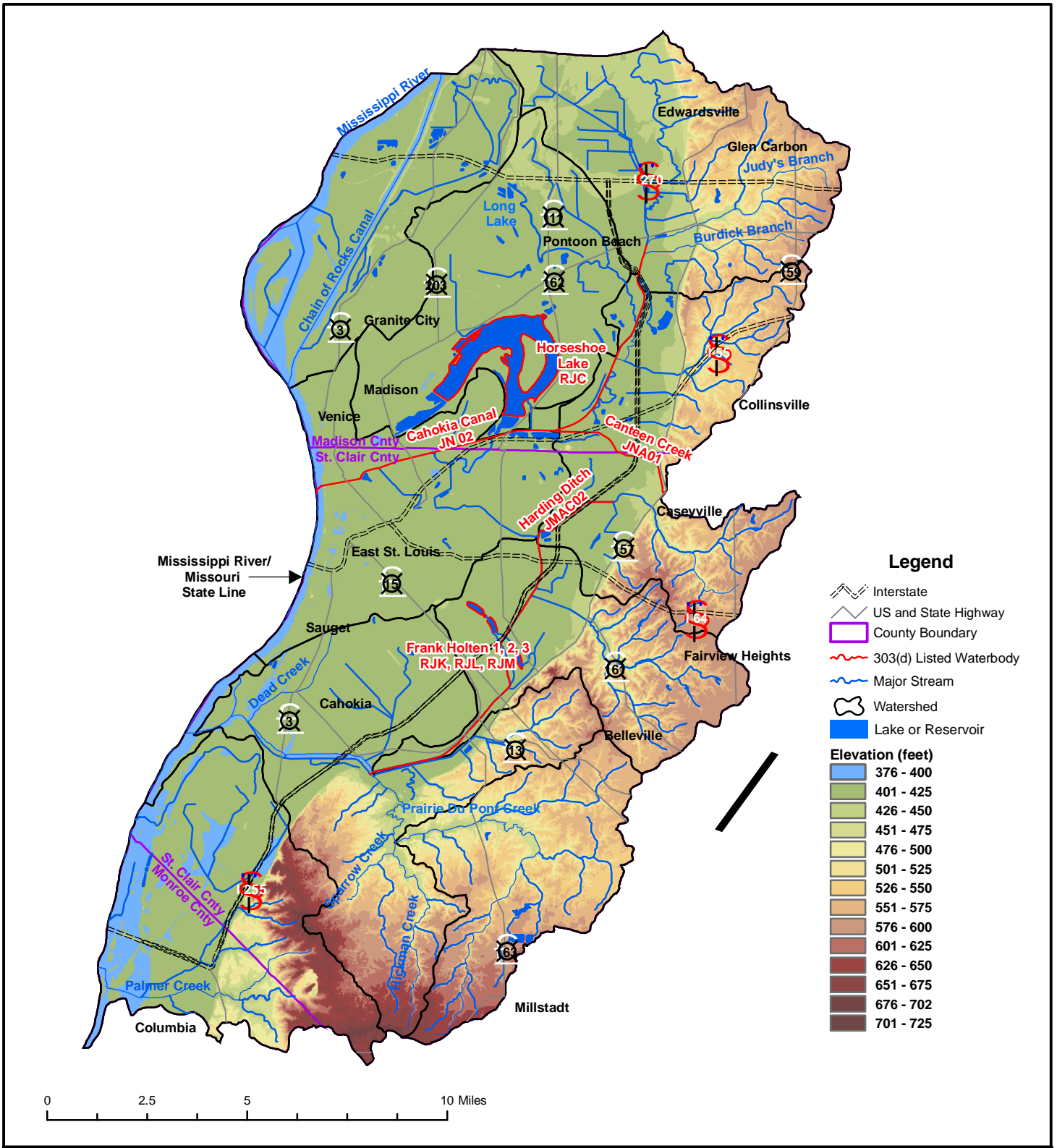


Figure 2-1  
Cahokia Canal/Horseshoe Lake Watershed  
Elevation

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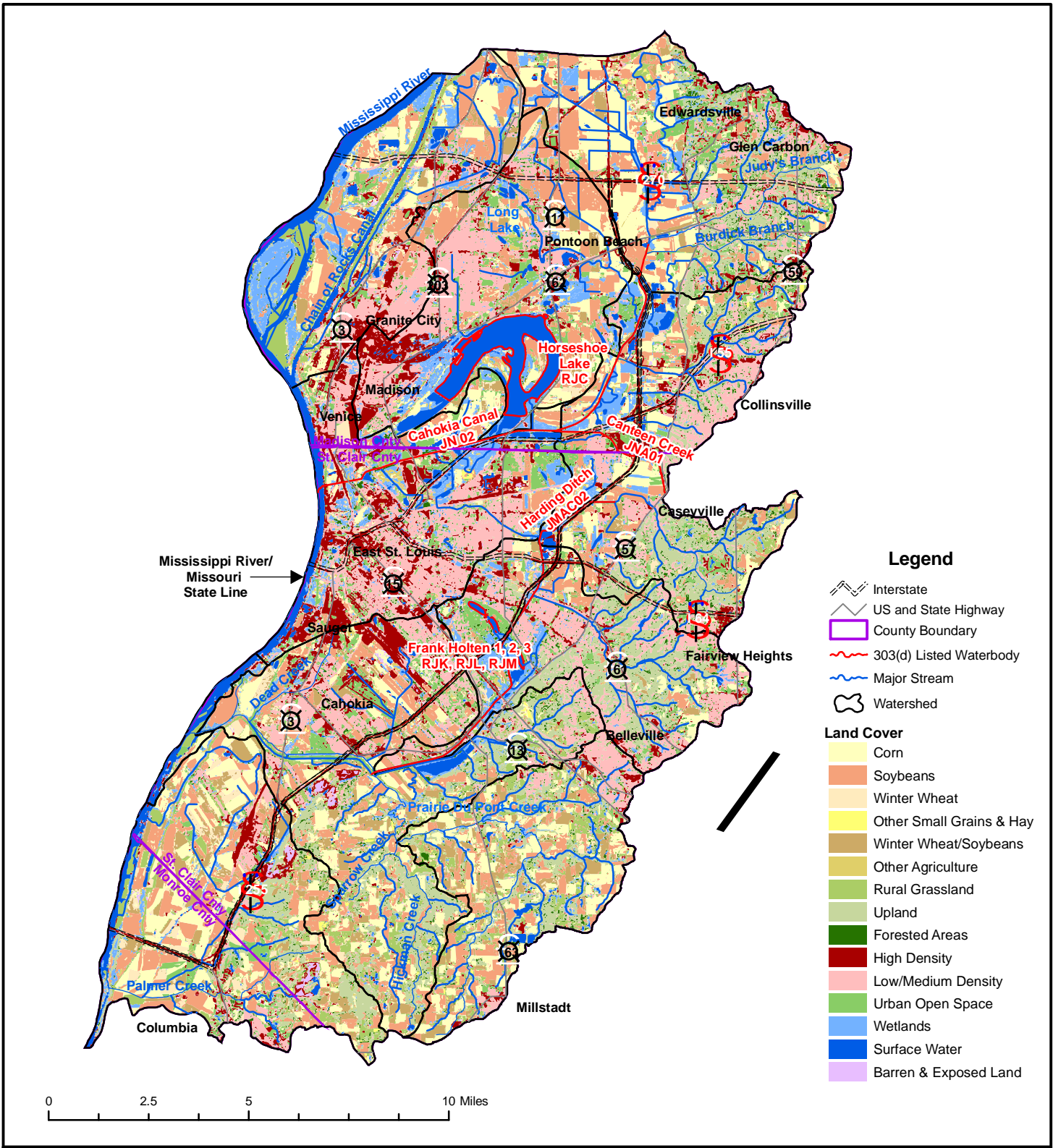


Figure 2-2  
Cahokia Canal/Horseshoe Lake Watershed  
Land Use



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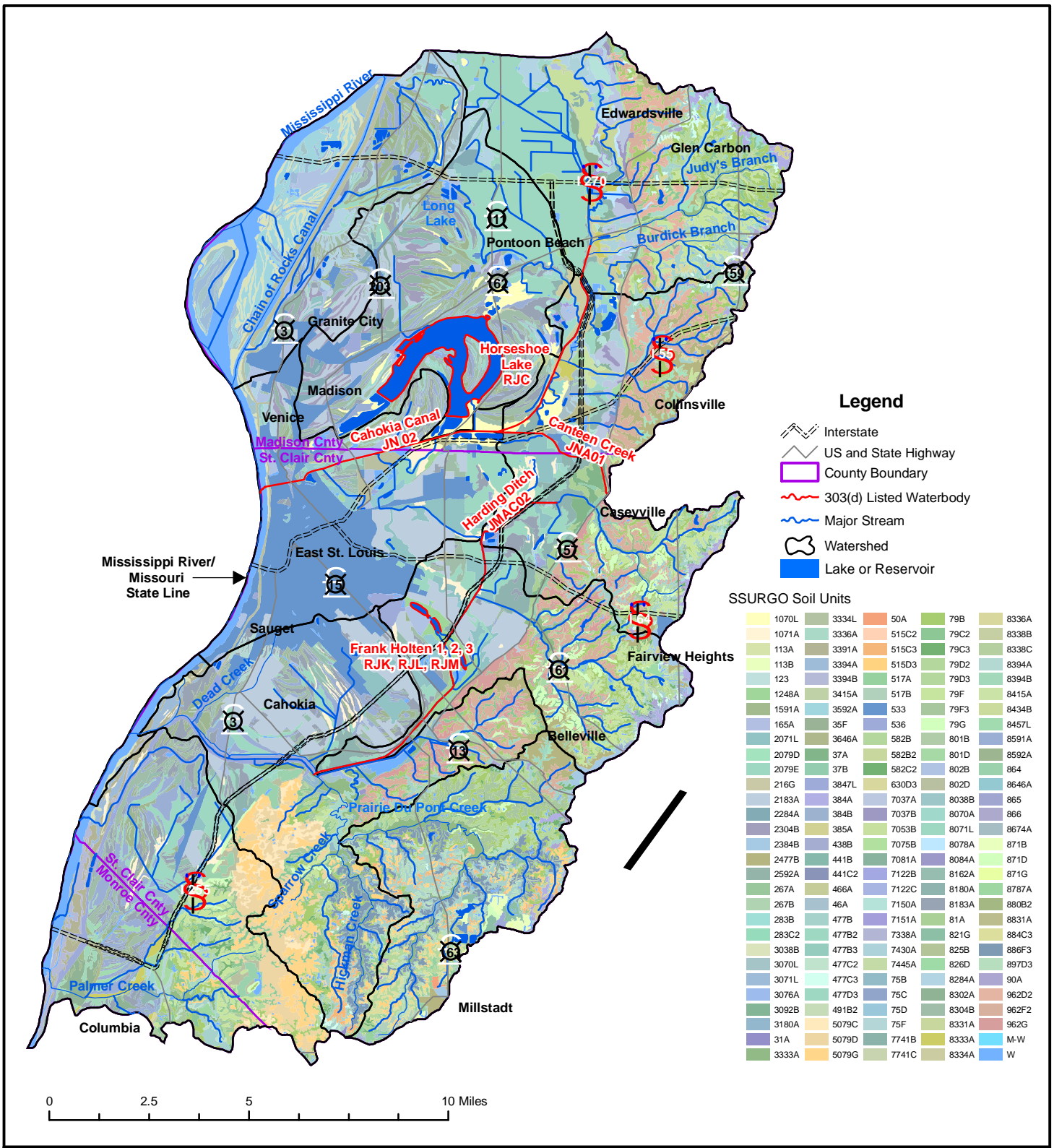


Figure 2-3  
Cahokia Canal/Horseshoe Lake Watershed  
Soils



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## **Section 3**

# **Public Participation and Involvement**

### **3.1 Cahokia Canal/Horseshoe Lake Watershed Public Participation and Involvement**

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

Illinois EPA, along with CDM, will hold up to four public meetings within the watershed throughout the course of the TMDL development. A public meeting was held on June 29, 2006 at IDOT District 8 Headquarters in Collinsville, Illinois to present Stage 1 of TMDL development for the Cahokia Canal/Horseshoe Lake watershed.

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# **Section 4**

## **Cahokia Canal/Horseshoe Lake Watershed Water Quality Standards**

### **4.1 Illinois Water Quality Standards**

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

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

### **4.2 Designated Uses**

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

#### **4.2.1 General Use**

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

#### **4.2.2 Public and Food Processing Water Supplies**

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

### **4.3 Illinois Water Quality Standards**

To make 303(d) listing determinations for aquatic life uses, Illinois EPA first collects biological data and if this data suggests that impairment to aquatic life is occurring, then a comparison of available water quality data with water quality standards occurs.

For public and food processing water supply waters, Illinois EPA compares available data with water quality standards to make impairment determinations. Tables 4-1 and 4-2 present the water quality standards of the potential causes of impairment for both lakes and streams within the Cahokia Canal/Horseshoe Lake watershed. Only constituents with numeric water quality standards will have TMDLs developed at this time.

**Table 4-1 Summary of Water Quality Standards for Potential Cahokia Canal/Horseshoe Lake Watershed Lake Impairments**

Parameter	Units	General Use Water Quality Standard	Public and Food Processing Water Supplies
Excess Algal Growth	NA	No numeric standard	No numeric standard
Heptachlor	mg/L	No numeric standard	0.1
Non-Native Fish/animals	NA	No numeric standard	No numeric standard
PCBs - Statistical Guideline	NA	No numeric standard	No numeric standard
pH		6.5 minimum 9.0 maximum	No numeric standard
Total Phosphorus	mg/L	0.05 <sup>(1)</sup>	No numeric standard
Total Phosphorus - Statistical Guideline	NA	No numeric standard	No numeric standard
Total Suspended Solids	NA	No numeric standard	No numeric standard
Zinc 9000	NA	No numeric standard	No numeric standard

µg/L = micrograms per liter mg/L = milligrams per liter NA = Not Applicable

- Standard applies in particular inland lakes and reservoirs (greater than 20 acres) and in any stream at the point where it enters any such lake or reservoir.

**Table 4-2 Summary of Water Quality Standards for Potential Cahokia Canal/Horseshoe Lake Watershed Stream Impairments**

Parameter	Units	General Use Water Quality Standard	Public and Food Processing Water Supplies
Habitat Alterations (Streams)	NA	No numeric standard	No numeric standard
Manganese	µg/L	1000	150
Oxygen, Dissolved	mg/L	5.0 instantaneous minimum; 6.0 minimum during at least 16 hours of any 24 hour period	No numeric standard
Sedimentation/ Siltation	NA	No numeric standard	No numeric standard
Total Fecal Coliform	Count/ 100 mL	May through Oct – 200 <sup>(1)</sup> , 400 <sup>(2)</sup> Nov through Apr – no numeric standard	2000 <sup>(1)</sup>
Total Nitrogen as N	NA	No numeric standard	No numeric standard
Total Phosphorus - Statistical Guideline	NA	No numeric standard	No numeric standard
Total Suspended Solids	NA	No numeric standard	No numeric standard

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

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

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

- Geometric mean based on a minimum of 5 samples taken over not more than a 30 day period.
- Standard shall not be exceeded by more than 10% of the samples collected during any 30 day period

## 4.4 Potential Pollutant Sources

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

**Table 4-3 Summary of Potential Sources for Cahokia Canal/Horseshoe Lake Watershed**

Segment ID	Segment Name	Potential Causes	Potential Sources
JN 02	Cahokia Canal	Total nitrogen as N, sedimentation/siltation, dissolved oxygen, habitat alterations (streams), total phosphorus	Agriculture, crop-related sources, nonirrigated crop production, construction, land development, urban runoff/storm sewers, hydromodification, channelization, source unknown
RJC	Horseshoe Lake	Total phosphorus, pH, total suspended solids, excess algal growth, non-native fish/animals, heptachlor, PCBs, zinc, total phosphorus	Industrial point sources, agriculture, crop-related sources, nonirrigated crop production, urban runoff/storm sewers, contaminated sediments, other, source unknown
JMAA01	Prairie Du Pont Creek	Dissolved oxygen, total phosphorus	Municipal point sources, agriculture, crop-related sources, nonirrigated crop production, intensive animal feeding operations, urban runoff/storm sewers
JMAC02	Harding Ditch	Total fecal coliform	Source unknown
RJK	Frank Holten Main Lake	Total phosphorus, total suspended solids, excess algal growth, PCBs, total phosphorus	Urban runoff/storm sewers, land disposal, onsite wastewater systems (septic tanks), recreation and tourism activities (other than boating), source unknown
RJL	Frank Holten Lake #2	Total phosphorus, total suspended solids, excess algal growth, PCBs, total phosphorus	Urban runoff/storm sewers, land disposal, onsite wastewater systems (septic tanks), recreation and tourism activities (other than boating), source unknown
RJM	Frank Holten Lake #3	Total phosphorus, dissolved oxygen, total suspended solids, excess algal growth, non-native fish/animals, PCBs, total phosphorus	Urban runoff/storm sewers, land disposal, onsite wastewater systems (septic tanks), other, source unknown
JNA 01	Canteen Creek	Manganese, total nitrogen as N, sedimentation/siltation, habitat alterations (streams), total suspended solids, total phosphorus	Municipal point sources, agriculture, crop-related sources, nonirrigated crop production, construction, land development, urban runoff/storm sewers, hydromodification, channelization, source unknown

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# Section 5

## Cahokia Canal/Horseshoe Lake Watershed Characterization

Data was collected and reviewed from many sources in order to further characterize the Cahokia Canal/Horseshoe Lake Watershed. Data has been collected for water quality, reservoirs, and both point and nonpoint sources. This information is presented and discussed in further detail in the remainder of this section.

### 5.1 Water Quality Data

There are 14 historic water quality stations within the Cahokia Canal/Horseshoe Lake watershed that were used for this report. Figure 5-1 shows the water quality data stations within the watershed that contain data relevant to the impaired segments.

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

#### 5.1.1 Stream Water Quality Data

The Cahokia Canal/Horseshoe Lake watershed has four impaired streams within its drainage area that are addressed in this report. There are five active water quality stations on impaired segments (see Figure 5-1). The data summarized in this section include water quality data for impaired constituents as well as parameters that could be useful in future modeling and analysis efforts. All historic data is available in Appendix C.

##### 5.1.1.1 Fecal Coliform

Segment JMAC02 of Harding Ditch is listed as impaired for total fecal coliform. Table 5-1 summarizes available historic fecal coliform data on the segment. The general use water quality standard for fecal coliform states that the standard of 200 per 100 mL not be exceeded by the geometric mean of at least five samples, nor can 10 percent of the samples collected exceed 400 per 100 mL in protected waters, except as provided in 35 Ill. Adm. Code 302.209(b). Samples must be collected over a 30 day period or less during peak fecal coliform application periods (May through October).

There are no instances since 1990 where at least five samples have been collected during a 30-day period. The summary of data presented in Table 5-1 reflects single samples compared to the standards during the appropriate months. Figure 5-2 shows the total fecal coliform samples collected over time on the impaired segment. Data is limited on the segment because samples collected between 1997 and 2003 were omitted due to exceeding the holding time.

**Table 5-1 Existing Fecal Coliform Data for Harding Ditch JMAC02**

Sample Location and Parameter	Period of Record and Number of Data Points	Geometric mean of all samples	Maximum	Minimum	Number of samples > 200 <sup>(1)</sup>	Number of samples > 400 <sup>(1)</sup>
<b>Harding Ditch Segment JMAC02; Sample Location JMAC02</b>						
Total Fecal Coliform (cfu/100 mL)	1990-2004; 73	2,028	20,000	165	37	34

- (1) Samples collected during the months of May through October
- (2) Only two samples were available during the months of May through October

### 5.1.1.2 Dissolved Oxygen

Segment JN02 of Cahokia Canal and JMAA01 of Prairie Du Pont Creek are currently listed as impaired for dissolved oxygen (DO). Recent data collected on segment JMAA01 show that a DO impairment no longer exists. In the summer of 2005 three-day continuous DO monitoring data was taken at half-hour intervals on three different locations on the stream segment. There were no violations in this data, and therefore, this segment will be delisted for DO in the future when new assessments are made. Table 5-2 summarizes the available historic DO data since 1990 for Segment JN02 of Cahokia Canal (raw data contained in Appendix C). The table also shows the number of violations recorded on the segment. A sample was considered a violation if it was below 5.0 mg/L. Figure 5-3 shows the instantaneous DO concentrations over time on the Cahokia Canal.

**Table 5-2 Existing Dissolved Oxygen Data for Cahokia Canal JN02**

Sample Location and Parameter	Illinois WQ Standard (mg/L)	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Violations
<b>Cahokia Canal Segment JN02; Sample Location JN02</b>						
DO	5.0 <sup>(1)</sup>	1990-2003; 126	8.2	13.9	2.3	16

- (1) Instantaneous Minimum

Table 5-3 contains information on data availability for other parameters that may be useful in data needs analysis and future modeling efforts for DO. Where available, all nutrient, biological oxygen demand (BOD), and total organic carbon data has been collected for possible use in future analysis.



**Table 5-3 Data Availability for DO Data Needs Analysis and Future Modeling Efforts**

Sample Location and Parameter	Available Period of Record Post 1990	Number of Samples
<b>Cahokia Canal Segment JN02; Sample Location JN02</b>		
Ammonia, Unionized (Calc Fr Temp-pH-NH4) (mg/L)	1990-1998	82
Ammonia, Unionized (mg/L as N)	1990-1998	82
BOD, 5-Day, 20 Deg C (mg/L)	1990	1
Carbon, Total Organic (mg/L as C)	1998	2
COD, .025N K2CR2O7 (mg/L)	1990-1993	36
Nitrite plus Nitrate, Total 1 Det. (mg/L as N)	1990-2002	115
Nitrogen, Ammonia, Total (mg/L as N)	1990-2002	115
Nitrogen, Kjeldahl, Total (mg/L as N)	1998-2002	26
Phosphorus, Dissolved (mg/L as P)	1990-2002	115
Phosphorus, Total (mg/L as P)	1990-2002	115

### 5.1.1.3 Manganese

Segment JNA01 of Canteen Creek is impaired for manganese. The applicable water quality standard is a maximum total manganese concentration of 1,000 µg/L. Table 5-4 summarizes the available historic manganese data since 1990 for the impaired stream. The table also shows the number of violations recorded on the segment. Figure 5-4 shows total manganese values recorded over time for Canteen Creek.

**Table 5-4 Existing Manganese Data for Canteen Creek JNA01**

Sample Location and Parameter	Illinois WQ Standard (µg/L)	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Violations
<b>Canteen Creek Segment JNA01; Sample Locations JNA01 and JNA02</b>						
Total Manganese (µg/L)	General Use: 1000	1990-1998; 83	423	3,800	68	2

## 5.1.2 Lake and Reservoir Water Quality Data

The Cahokia Canal/Horseshoe Lake watershed has four impaired lakes within its drainage area that are addressed in this report. There are nine active water quality stations on or tributary to the impaired water bodies (see Figure 5-1). The data summarized in this section include water quality data for impaired constituents as well as parameters that could be useful in future modeling and analysis efforts. All historic data is available in Appendix C.

### 5.1.2.1 Horseshoe Lake

There are four active stations on Horseshoe Lake. The reservoir is impaired for total phosphorus and pH. An inventory of all available phosphorus and pH data at all depths is presented in Table 5-5.

**Table 5-5 Horseshoe Lake Data Inventory for Impairments**

<b>Horseshoe Lake Segment RJC; Sample Locations RJC-1, RJC-2, RJC-3 and RJC-4</b>		
<b>RJC-1</b>	<b>Period of Record</b>	<b>Number of Samples</b>
Total Phosphorus	1993-2002	48
Dissolved Phosphorus	1993-1996	19
Total Phosphorus in Bottom Deposits	1993-1996	3
pH	1993-2002	37
<b>RJC-2</b>		
Total Phosphorus	1993-2002	20
Dissolved Phosphorus	1993-1996	10
pH	1993-2002	19
<b>RJC-3</b>		
Total Phosphorus	1993-2002	21
Dissolved Phosphorus	1993-1996	11
Total Phosphorus in Bottom Deposits	1993-1996	3
pH	1993-2002	20
<b>RJC-4</b>		
Total Phosphorus	1993-2002	19
Dissolved Phosphorus	1993-1996	10
pH	1993-2002	19

Table 5-6 contains information on data availability for other parameters that may be useful in data needs analysis and future modeling efforts for total phosphorus. DO at varying depths as well as chlorophyll-a data has been collected where available.

**Table 5-6 Horseshoe Lake Data Availability for Data Needs Analysis and Future Modeling Efforts**

<b>Horseshoe Lake Segment RJC; Sample Locations RJC-1, RJC-2, RJC-3 and RJC-4</b>		
<b>RJC-1</b>	<b>Period of Record</b>	<b>Number of Samples</b>
Chlorophyll-a Corrected	1993-2002	28
Chlorophyll-a Uncorrected	1993-2002	28
Total Depth	1993-2002	679
Dissolved Oxygen	1993-2002	598
Temperature	1993-2002	598
<b>RJC-2</b>		
Chlorophyll-a Corrected	1993-2002	18
Chlorophyll-a Uncorrected	1993-2002	18
Total Depth	1993-2002	120
Dissolved Oxygen	1993-2002	48
Temperature	1993-2002	19
<b>RJC-3</b>		
Chlorophyll-a Corrected	1993-2002	18
Chlorophyll-a Uncorrected	1993-2002	18
Total Depth	1993-2002	135
Dissolved Oxygen	1993-2002	60
Temperature	1993-2002	20
<b>RJC-4</b>		
Chlorophyll-a Corrected	1993-2002	18
Chlorophyll-a Uncorrected	1993-2002	18
Total Depth	1993-2005	114
Dissolved Oxygen	1993-2005	41
Temperature	1993-2002	19

### 5.1.2.1.1 Total Phosphorus

Compliance with the total phosphorus standard is based on samples collected at a one-foot depth from the lake surface. The average total phosphorus concentrations at a one-foot depth for each year of available data at each monitoring site in Horseshoe Lake are presented in Table 5-7. The water quality standard for total phosphorus is a concentration less than or equal to 0.05 mg/L.

**Table 5-7 Average Total Phosphorus Concentrations (mg/L) in Horseshoe Lake at One-Foot Depth**

Year	RJC-1		RJC-2		RJC-3		RJC-4		Lake Average	
	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average
1993	5;4	0.11	5;4	0.14	5;4	0.09	5;4	0.16	20;16	0.13
1996	5;5	0.15	5;5	0.22	5;5	0.14	5;5	0.22	20;20	0.18
1997	5;5	0.18	NA	NA	NA	NA	NA	NA	5;5	0.18
1998	5;5	0.14	NA	NA	NA	NA	NA	NA	5;5	0.14
1999	5;5	0.25	5;5	0.10	5;4	0.25	5;5	0.29	20;19	0.22
2002	4;4	0.15	4;4	0.40	4;4	0.17	4;4	0.26	16;16	0.25

The annual averages for total phosphorus at all four sites where data was available as well as the lake average have been greater than the 0.05 mg/L standard. The majority of the samples taken at all sites have been above the standard. Figure 5-5 shows the average values by year.

### 5.1.2.1.2 pH

Table 5-8 summarizes the available historic pH data since 1990 for the lake. The table also shows the number of violations for each segment. A sample was considered a violation if the value was not within the 6.5-9.0 pH range.

**Table 5-8 Average pH in Horseshoe Lake**

Year	RJC-1		RJC-2		RJC-3		RJC-4		Lake Average	
	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average
1993	9;0	7.87	5;0	8.18	6;0	8.25	5;1	8.36	25;1	8.16
1996	10;0	7.90	5;0	8.82	5;1	8.90	5;0	8.82	20;1	8.61
1999	10;0	7.75	5;0	8.62	5;1	8.84	5;0	8.72	20;1	8.48
2002	8;1	7.43	4;0	8.70	4;1	8.78	4;0	8.85	20;2	8.44

The average pH concentration was within the standard range at all locations. One violation occurred when pH values were sampled below 6.5. That sample was collected in 2002 at RJC-1. The remaining violations occurred when samples were above 9.0. Figure 5-6 shows the average annual pH values.

### 5.1.2.2 Frank Holten Lakes 1, 2, and 3

There are five active stations on the Frank Holten Lakes. The lakes are impaired for total phosphorus and Lake 3 is also impaired for DO. An inventory of all available phosphorus data for each lake as well as DO data for Lake 3 at all depths is presented in Table 5-9.

**Table 5-9 Frank Holten Lakes - Data Inventory for Impairments**  
**Frank Holten Lakes 1, 2, and 3 – Segments RJK, RJK, and RJK**

<b>RJK-1</b>	<b>Period of Record</b>	<b>Number of Samples</b>
Total Phosphorus	1990-2002	89
Dissolved Phosphorus	1990-2002	88
<b>RJK-1</b>		
Total Phosphorus	1990-2002	104
Dissolved Phosphorus	1990-2002	88
Total Phosphorus in Bottom Deposits	1992-1996	3
<b>RJK-1</b>		
Total Phosphorus	1990-2002	110
Dissolved Phosphorus	1990-2002	66
Total Phosphorus in Bottom Deposits	1992-1996	3
Dissolved Oxygen	1990-2002	216
<b>RJK-2</b>		
Total Phosphorus	1990-2002	47
Dissolved Phosphorus	1990-2002	43
Dissolved Oxygen	1990-2002	209
<b>RJK-3</b>		
Total Phosphorus	1990-2002	55
Dissolved Phosphorus	1990-2002	43
Total Phosphorus in Bottom Deposits	1992-1996	2
Dissolved Oxygen	1990-2002	179

Table 5-10 contains information on data availability for other parameters that may be useful in data needs analysis and future modeling efforts for total phosphorus and DO. DO and chlorophyll-a data has been collected where available for phosphorus impairments while nutrient data has been collected for the DO impairment.

**Table 5-10 Frank Holten Lakes -Data Availability for Data Needs Analysis and Future Modeling Efforts**

<b>Frank Holten Lakes 1, 2, and 3 – Segments RJK, RJK, and RJK</b>		
<b>RJK-1</b>	<b>Period of Record</b>	<b>Number of Samples</b>
Chlorophyll-a Corrected	1996-2002	29
Chlorophyll-a Uncorrected	1996-2002	29
Total Depth	1990-1998	51
Dissolved Oxygen	1999-2002	80
Temperature	1992-2002	81
<b>RJK-1</b>		
Chlorophyll-a Corrected	1990-2002	42
Chlorophyll-a Uncorrected	1990-2002	42
Depth of Pond or Reservoir in Feet	1990-1996	99
Oxygen, Dissolved, Analysis by Probe (mg/L)	1999-2002	115
Temperature	1990-2002	527
<b>RJK-1</b>		
Ammonia, Unionized (Calc Fr Temp-pH-NH4) (mg/L)	1990-1996	40
Ammonia, Unionized (mg/L as N)	1990-1996	40
Chlorophyll-a Corrected	1990-2002	42
Chlorophyll-a Uncorrected	1990-2002	42
COD, .025N K2CR2O7 (mg/L)	1990-1992	50
Depth of Pond or Reservoir in Feet	1990-1998	92
Nitrite plus Nitrate, Total 1 Det. (mg/L as N)	1990-1996	92
Nitrogen, Ammonia, Total (mg/L as N)	1990-1996	91
Nitrogen, Kjeldahl, Total (mg/L as N)	1990-1996	73

**Table 5-10 Frank Holten Lakes -Data Availability for Data Needs Analysis and Future Modeling Efforts (continued)**

<b>Frank Holten Lakes 1, 2, and 3 – Segments RJK, RJK, and RJK</b>		
<b>RJK-1 (continued)</b>	<b>Period of Record</b>	<b>Number of Samples</b>
Dissolved Oxygen, % of Saturation	1990-1996	172
Temperature	1990-2002	216
<b>RJK-2</b>		
Ammonia, Unionized (Calc Fr Temp-pH-NH4) (mg/L)	1990-1996	33
Ammonia, Unionized (mg/L as N)	1990-1996	33
Chlorophyll-a Corrected	1990-2002	44
Chlorophyll-a Uncorrected	1990-2002	44
COD, .025N K2CR2O7 (mg/L)	1990-1992	28
Depth of Pond or Reservoir in Feet	1990-1998	81
Nitrite plus Nitrate, Total 1 Det. (mg/L as N)	1990-1996	37
Nitrogen, Ammonia, Total (mg/L as N)	1990-1996	37
Nitrogen, Kjeldahl, Total (mg/L as N)	1990-1996	33
Dissolved Oxygen, % of Saturation	1990-1996	169
Temperature	1990-2002	209
<b>RJK-3</b>		
Ammonia, Unionized (Calc Fr Temp-pH-NH4) (mg/L)	1990-1996	33
Ammonia, Unionized (mg/L as N)	1990-1996	33
Chlorophyll-a Corrected	1990-2002	42
Chlorophyll-a Uncorrected	1990-2002	42
COD, .025N K2CR2O7 (mg/L)	1990-1992	28
Depth of Pond or Reservoir in Feet	1990-2002	81
Nitrite plus Nitrate, Total 1 Det. (mg/L as N)	1990-1996	45
TKN Bottom Deposits	1992-1996	2
Nitrogen, Ammonia, Total (mg/L as N)	1990-1996	45
Nitrogen, Kjeldahl, Total (mg/L as N)	1990-1996	33
Dissolved Oxygen, % of Saturation	1990-1996	153
Temperature	1990-2002	179

**5.1.2.2.1 Total Phosphorus**

The average total phosphorus concentrations at a one-foot depth for each year of available data at each monitoring site in the Frank Holten Lakes are presented in Table 5-11. The water quality standard for total phosphorus is a concentration less than or equal to 0.05 mg/L and compliance is assessed at a one-foot depth from the lake surface.

**Table 5-11 Average Total Phosphorus Concentrations (mg/L) in the Frank Holten Lakes at One-Foot Depth**

Year	RJK-1		RJK-1		RJK-1		RJK-2		RJK-3	
	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average
1990	21; 21	0.44	16; 15	0.14	32; 32	0.15	12; 12	0.15	12; 12	0.17
1991	7; 7	0.20	23; 23	0.16	25; 25	0.17	11; 11	0.15	23; 23	0.19
1992	24; 24	0.37	8; 8	0.15	19; 19	0.16	8; 8	0.11	5; 5	0.16
1996	6; 5	0.11	5; 5	0.15	5; 5	0.16	6; 6	0.17	5; 5	0.22
1997	6; 6	0.16	NA	NA	NA	NA	NA	NA	NA	NA
1998	5; 5	0.15	NA	NA	NA	NA	NA	NA	NA	NA
1999	5; 5	0.06	5; 5	0.06	5; 5	0.10	5; 5	0.11	5; 5	0.12
2002	5; 5	0.14	5; 5	0.15	5; 5	0.21	5; 5	0.23	5; 5	0.26

Only one sample collected was below the phosphorus standard on both Frank Holten Lake 1 (RJK) and 2 (RJL). No samples have been below the 0.05 mg/L total phosphorus standard on Frank Holten Lake 3 (RJM). Figure 5-7 shows the annual average total phosphorus concentrations for each sampling location on each lake. Average concentrations were highest in Frank Holten Lake 1 in 1990, in Frank Holten Lake 2 in 1991, and in Frank Holten Lake 3 in 2002.

#### 5.1.2.2.2 DO

The average DO concentrations at a one-foot depth for each year of available data at each monitoring site on Frank Holten Lake #3 are presented in Table 5-12. The water quality standard for DO is an instantaneous minimum concentration of 5.0 mg/L. Compliance is determined at a one-foot depth from the lake surface.

**Table 5-12 Average Dissolved Oxygen Concentrations (mg/L) in Frank Holten Lake #3 at One-Foot Depth**

Year	RJM-1		RJM-2		RJM-3		Lake Average	
	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average
1990	12; 0	9.9	12; 0	10.0	12; 0	9.9	36; 0	9.9
1991	11; 0	11.2	11; 0	11.0	11; 0	11.3	33; 0	11.2
1992	5; 0	10.8	5; 0	10.8	50; 0	11.3	15; 0	11.0
1996	5; 0	7.5	5; 0	8.3	5; 0	9.1	15; 0	8.3
1999	6; 1	9.0	5; 0	8.7	4; 0	10.0	14; 1	9.2
2002	5; 1	8.0	5; 0	8.5	5; 0	9.7	15; 1	8.7

The annual averages for DO at all three sites as well as the lake average are not in violation of the DO standard at one foot depth during any sampling year. Figure 5-8 shows DO sampling results at one-foot depth over time. Only two violations have occurred on the lake. Both violations were sampled at RJM-1; one in 1999, and one in 2002. Lake averages were calculated using data from each sampling location.

## 5.2 Reservoir Characteristic

There are four impaired reservoirs in the Cahokia Canal/Horseshoe Lake watershed. Reservoir information that can be used for future modeling efforts was collected from GIS analysis, the U.S. Army Corps of Engineers, the Illinois EPA, and USEPA water quality data. The following sections will discuss the available data for each reservoir.

### 5.2.1 Horseshoe Lake

Horseshoe Lake is located near East St. Louis in Madison County east of the Mississippi River and has a surface area of approximately 2,430 acres. The lake is part of Horseshoe Lake State Park, which is maintained by the Illinois Department of Natural Resources. During heavy spring floods, the Mississippi River would overflow its banks and flood into the low floodplain to the east of the river. A system of levies was constructed on the Mississippi to prevent the overflow, therefore creating Horseshoe Lake. Table 5-13 contains depth information for each sampling location on the lake. The average maximum depth in Horseshoe Lake is 54.5 feet.

**Table 5-13 Average Depths (ft) for Horseshoe Lake Segment RJC (Illinois EPA 2002 and USEPA 2002a)**

Year	RJC-1	RJC-2	RJC-3	RJC-4
1993	54.5	3.8	9.4	2.1
1996	53.0	3.4	4.5	2.9
1997	10.9	3.5	3.6	8.1
1998	14.5	4.2	4.8	4.0
1999	60.0	3.5	4.0	2.5
2002	59.1	3.7	4.8	2.9
2005	–	–	–	2.0
<b>Average</b>	<b>54.5</b>	<b>3.8</b>	<b>9.4</b>	<b>2.1</b>

### 5.2.2 Frank Holten Lakes 1, 2, and 3

The Frank Holten Lakes are located in East St. Louis in St. Clair County. All three lakes are located within the Frank Holten State Park, which is maintained by the Illinois Department of Natural Resources. Table 5-14 contains lake information for each lake.

**Table 5-14 Frank Holten Lakes**

	Lake No. 1	Lake No. 2	Lake No. 3
Surface Area (acres)	97	40	80
Capacity (acre-feet)	500	NA	92.4
Shoreline (miles)	2.5	NA	2

Tables 5-15, -16, and -17 contain depth information for each sampling location on the lakes. The maximum water depths for Frank Holten Lakes No. 1, No. 2, and No. 3 are 13.0 feet, 21.1 feet, and 7.8 feet respectively.

**Table 5-15 Average Depths (ft) for Frank Holten Lake No. 1 (Illinois EPA 2002 and USEPA 2002a)**

Year	RJK-1
1990	13.7
1991	15.5
1992	13.2
1996	11.3
1997	6.7
1998	8.6
1999	17.1
2002	17.5
<b>Average</b>	<b>13.0</b>

**Table 5-16 Average Depths (ft) for Frank Holten Lake No. 2 (Illinois EPA 2002 and USEPA 2002a)**

Year	RJL-1
1990	23.5
1991	23.6
1992	23.1
1996	15.8
1999	19.7
2002	21.4
<b>Average</b>	<b>21.2</b>

**Table 5-17 Average Depths (ft) for Frank Holten Lake No. 3 (Illinois EPA 2002 and USEPA 2002a)**

Year	RJM-1	RJM-2	RJM-3
1990	9.3	9.3	8.0
1991	8.9	8.9	7.4
1992	9.0	8.9	8.0
1996	7.9	7.8	5.9
1997	5.9	7.0	5.7
1998	8.5	7.9	5.4
1999	6.6	6.3	4.1
2002	6.6	6.5	4.4
<b>Average</b>	<b>7.8</b>	<b>7.8</b>	<b>6.1</b>

## 5.3 Point Sources

Point sources for the Cahokia Canal/Horseshoe Lake watershed have been separated into municipal/industrial sources and mining discharges. Available data has been summarized and presented in the following sections.

### 5.3.1 Municipal and Industrial Point Sources

Permitted facilities must provide Discharge Monitoring Reports (DMRs) to Illinois EPA as part of their NPDES permit compliance. DMRs contain effluent discharge sampling results, which are then maintained in a database by the state. Figure 5-9 shows all permitted facilities whose discharge potentially reaches impaired segments. In order to assess point source contributions to the watershed, the data has been examined by receiving water and then by the downstream impaired segment that has the potential to receive the discharge. Receiving waters were determined through information contained in the USEPA Permit Compliance System (PCS) database. Maps were used to determine downstream impaired receiving water information when PCS data was not available. Many of the point sources in this watershed discharge directly to the Mississippi River. These point sources have not been used for watershed assessment. The impairments for each segment or downstream segment were considered when reviewing DMR data. Data has been summarized for any sampled parameter that is associated with a downstream impairment (i.e., all available nutrient and biological oxygen demand data was reviewed for segments that are impaired for dissolved oxygen). This will help in future model selection as well as source assessment and load allocation.

#### 5.3.1.1 Cahokia Canal Segment JN 02

There are seven point sources with the potential to contribute discharge to Cahokia Canal Segment JN 02. Segment JN 02 is listed as impaired for dissolved oxygen. Table 5-18 contains a summary of available and pertinent DMR data for these point sources. Dissolved oxygen data is not required by all permits and was available for only three point sources.



**Table 5-18 Effluent Data from Point Sources Discharging Upstream of or Directly to Cahokia Canal Segment JN 02 (Illinois EPA 2005)**

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
Elementis Pigments, Inc. 1995-2005 IL0038709	Schoenberger Creek/Cahokia Canal Segment JN 02	Average Daily Flow	0.655 mgd	NA
		Nitrogen, Ammonia	1.12 mg/L	5.64
General Chemical LLC 2003-2004 IL0000647	Rose Creek/Cahokia Canal Segment JN 02	Average Daily Flow	0.0037 mgd	NA
Dot-Dist 8 Bowman Ave Pump Station 1997-2005 IL0070955	Cahokia Canal/Cahokia Canal Segment JN 02	Average Daily Flow	19 mgd	NA
		Nitrogen, Ammonia	0.722 mg/L	83.1
Maryville WTP 1996-2003 ILG640139	NA/Cahokia Canal Segment JN 02	Average Daily Flow	0.01 mgd	NA
Stone Meadows MHP 1994-2004 IL0046914	Cahokia Canal/Cahokia Canal Segment JN 02	Average Daily Flow	0.07 mgd	NA
		BOD, 5-Day	157.9 mg/L	
		CBOD, 5-Day	5.58 mg/L	2.05
		Oxygen, Dissolved	7.2 mg/L	
		Nitrogen, Ammonia	1.23 mg/L	0.36
Wheel Ranch MHP-Collinsville 1996-2003 IL0044598	NA/Cahokia Canal Segment JN 02	Average Daily Flow	0.015 mgd	NA
		BOD, 5-Day	431.8 mg/L	-
		CBOD, 5-Day	6.22 mg/L	0.258
		Nitrogen, Ammonia	2.94 mg/L	0.122
Holiday MHP 1995-2004 IL0038288	Unnamed Tributary to Cahokia Canal/Cahokia Canal Segment JN 02	Average Daily Flow	0.05 mgd	NA
		BOD, 5-Day	181.4 mg/L	71.9
		CBOD, 5-Day	7.01 mg/L	1.99
		Nitrogen, Ammonia	2.69 mg/L	0.39

### 5.3.1.2 Horseshoe Lake Segment RJC

There is one permitted facility that discharges to Horseshoe Lake Segment RJC. Horseshoe Lake is listed for total phosphorus and pH impairments. Table 5-19 contains a summary of available DMR data for this point source. DMR data reflects actual sampled values rather than permit maximums. As reported in the latest permit, the facility's maximum daily flow is 25 mgd, the three-day maximum flow is 21 mgd, and the long-term average flow is 16 mgd. Phosphorus sampling is not required by the US Steel-Granite City permit. However, it should be noted that in the facility's 2006 permit renewal application, a total phosphorous effluent concentration of 0.24 mg/L is recorded.

**Table 5-19 Effluent Data from Point Sources Discharging to Horseshoe Lake Segment RJC (Illinois EPA 2005)**

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
United States Steel-Granite City 1989-2005 IL0000329	Horseshoe Lake/ Horseshoe Lake Segment RJC	Average Daily Flow	26.3 mgd	NA
		pH	7.80 su	-

### 5.3.1.3 Harding Ditch Segment JMAC02

There is one point source with the potential to contribute discharge to Harding Ditch Segment JMAC02. Segment JMAC02 is impaired for total fecal coliform. Table 5-20 contains a summary of available DMR data.

**Table 5-20 Effluent Data from Point Sources Discharging to Harding Ditch Segment JMAC02 (Illinois EPA 2005)**

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
Caseyville Township West STP 1993-2004 IL0023043	Clare Creek/Harding Ditch Segment JMAC02	Average Daily Flow	0.786 mgd	NA
		Total fecal coliform	138.0 mg/L	–

### 5.3.1.4 Canteen Creek Segment JNA 01

There is one point source with the potential to contribute discharge to Canteen Creek Segment JNA 01. Segment JNA 01 is impaired for manganese. Table 5-21 contains a summary of available DMR data.

**Table 5-21 Effluent Data from Point Sources Discharging to Canteen Creek Segment JNA 01 (Illinois EPA 2005)**

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
Collinsville STP 1989-2005 IL0028215	Canteen Creek/Canteen Creek Segment JNA01	Average Daily Flow	4.41 mgd	NA
		Manganese	0.017 mg/L	–

### 5.3.1.5 Other

There are no permitted facilities that discharge directly to any of the Frank Holten Lakes.

## 5.3.2 Mining Discharges

There are no permitted mine sites or recently abandoned mines within the Cahokia Canal/Horseshoe Lake watershed. If additional information becomes available, it will be reviewed and considered during Stage 3 of TMDL development.

## 5.4 Nonpoint Sources

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

### 5.4.1 Crop Information

A portion of the land found within the Cahokia Canal/Horseshoe Lake watershed is devoted to crops. Corn and soybean farming account for approximately 13 percent and 15 percent of the watershed respectively. Tillage practices can be categorized as

conventional till, reduced till, mulch-till, and no-till. The percentage of each tillage practice for corn, soybeans, and small grains by county are generated by the Illinois Department of Agriculture from County Transect Surveys. The most recent survey was conducted in 2004. Data specific to the Cahokia Canal/Horseshoe Lake watershed were not available; however, the Madison, St. Clair, and Monroe County practices were available and are shown in the following tables.

**Table 5-22 Tillage Practices in Madison County**

Tillage System	Corn	Soybean	Small Grain
Conventional	68%	8%	6%
Reduced - Till	21%	35%	21%
Mulch - Till	7%	22%	23%
No - Till	4%	35%	49%

**Table 5-23 Tillage Practices in St. Clair County**

Tillage System	Corn	Soybean	Small Grain
Conventional	96%	27%	0%
Reduced - Till	1%	22%	0%
Mulch - Till	1%	10%	0%
No - Till	1%	41%	0%

**Table 5-24 Tillage Practices in Monroe County**

Tillage System	Corn	Soybean	Small Grain
Conventional	60%	10%	6%
Reduced - Till	32%	37%	21%
Mulch - Till	2%	19%	23%
No - Till	6%	33%	49%

The Cahokia Canal/Horseshoe Lake watershed is situated in a predominately urban area. Much of the watershed in Madison County is situated in the Mississippi River flood plain and is protected by a U.S. Army Corps of Engineers levee system. Communications with local NRCS offices indicate that soils are favorable for subsurface tile drainage systems although no specific watershed data is available. It is estimated that approximately 5,000 acres are tiled in the Madison County portion of this watershed. Tile drainage estimates from other watershed counties were not available. Site-specific data will be incorporated if it becomes available. Without local information, soils data will be reviewed for information on hydrologic soil group in order to provide a basis for tile drain estimates.

## 5.4.2 Animal Operations

Watershed specific animal numbers were not available for the Cahokia Canal/Horseshoe Lake watershed. Data from the National Agricultural Statistics Service was reviewed and is presented below to show countywide livestock numbers.

**Table 5-25 Madison County Animal Population (2002 Census of Agriculture)**

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

**Table 5-26 St. Clair County Animal Population (2002 Census of Agriculture)**

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

**Table 5-27 Monroe County Animal Population (2002 Census of Agriculture)**

	1997	2002	Percent Change
Cattle and Calves	10,200	9,846	-3%
Beef	3,525	3,451	-2%
Dairy	950	1,351	42%
Hogs and Pigs	52,235	42,551	-19%
Poultry	444	560	26%
Sheep and Lambs	973	667	-31%
Horses and Ponies	NA	446	NA

Again, the Cahokia Canal/Horseshoe Lake watershed is situated in a predominately urban area. It is estimated that there are very few livestock operations, although it is thought that there are a small number of horse stables located in the watershed. Any additional site-specific information that becomes available will be incorporated.

### 5.4.3 Septic Systems

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

Information on septic systems has been obtained for St. Clair and Monroe Counties. Septic system information for Madison County is not available.

Table 5-28 is a summary of the available septic system data in the Cahokia Canal/Horseshoe Lake watershed.

**Table 5-28 Estimated Septic Systems in the Cahokia Canal/Horseshoe Lake Watershed**

<b>County</b>	<b>Estimated No. of Septic Systems</b>	<b>Source of Septic Areas/ No. of Septic Systems</b>
Madison	N/A	
St. Clair	5,000	County Health Department, East Side Health District, City of Fairview Heights
Monroe	45	Health Department
<b>Total</b>	<b>5,045</b>	

There are approximately 5,000 septic systems in the Cahokia Canal/Horseshoe Lake watershed. The area within St. Clair County falls under three separate jurisdictions: St. Clair County, Fairview Heights, and East Side Health District. Estimates of the number of septic systems in the watersheds were obtained for each of the three entities and summed for the county total. There are 700 septic systems within St. Clair County's jurisdiction, 4,000 in Fairview Heights, and 300 within the East Side Health District's jurisdiction. All of the area in Monroe County within the watershed is served by septic systems. Most of the municipalities surrounding Long Lake, Horseshoe Lake, and Frank Holten 1, 2, and 3 are sewer.

## **5.5 Watershed Studies and Other Watershed Information**

Previous planning efforts have been conducted in the Cahokia Canal/Horseshoe Lake watershed. In the summer of 1998, an intensive survey of the Mississippi South Central Basin was conducted. A Phase III, Post-Restoration Monitoring Report was also completed for the Frank Holten Lakes in 1994. Data from these studies will be used as a reference during Stage 3 of TMDL development. Further investigation will be conducted on other watershed planning efforts and local watershed groups. Any available and relevant information will be collected and incorporated during Stage 3 of TMDL development.

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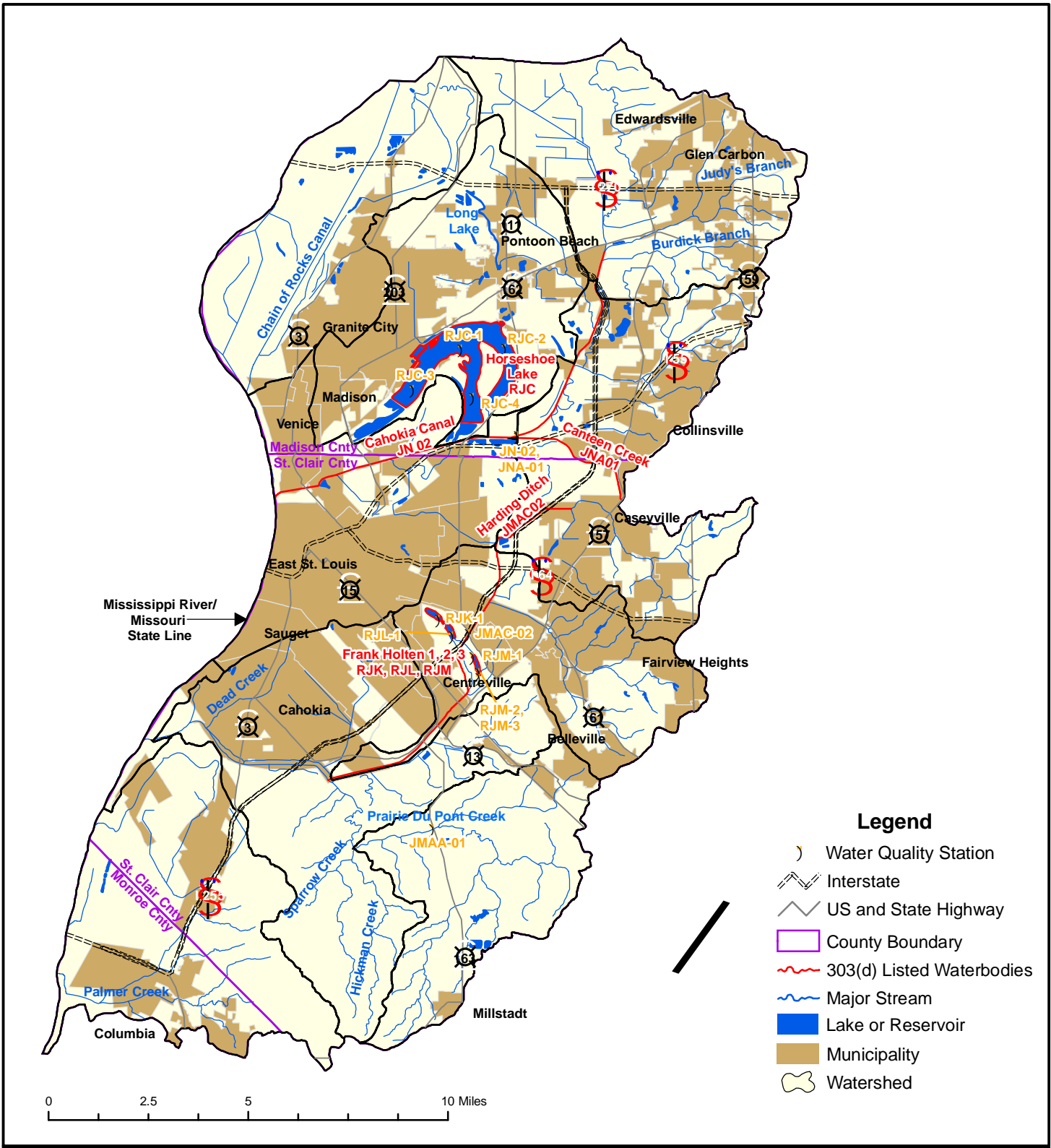
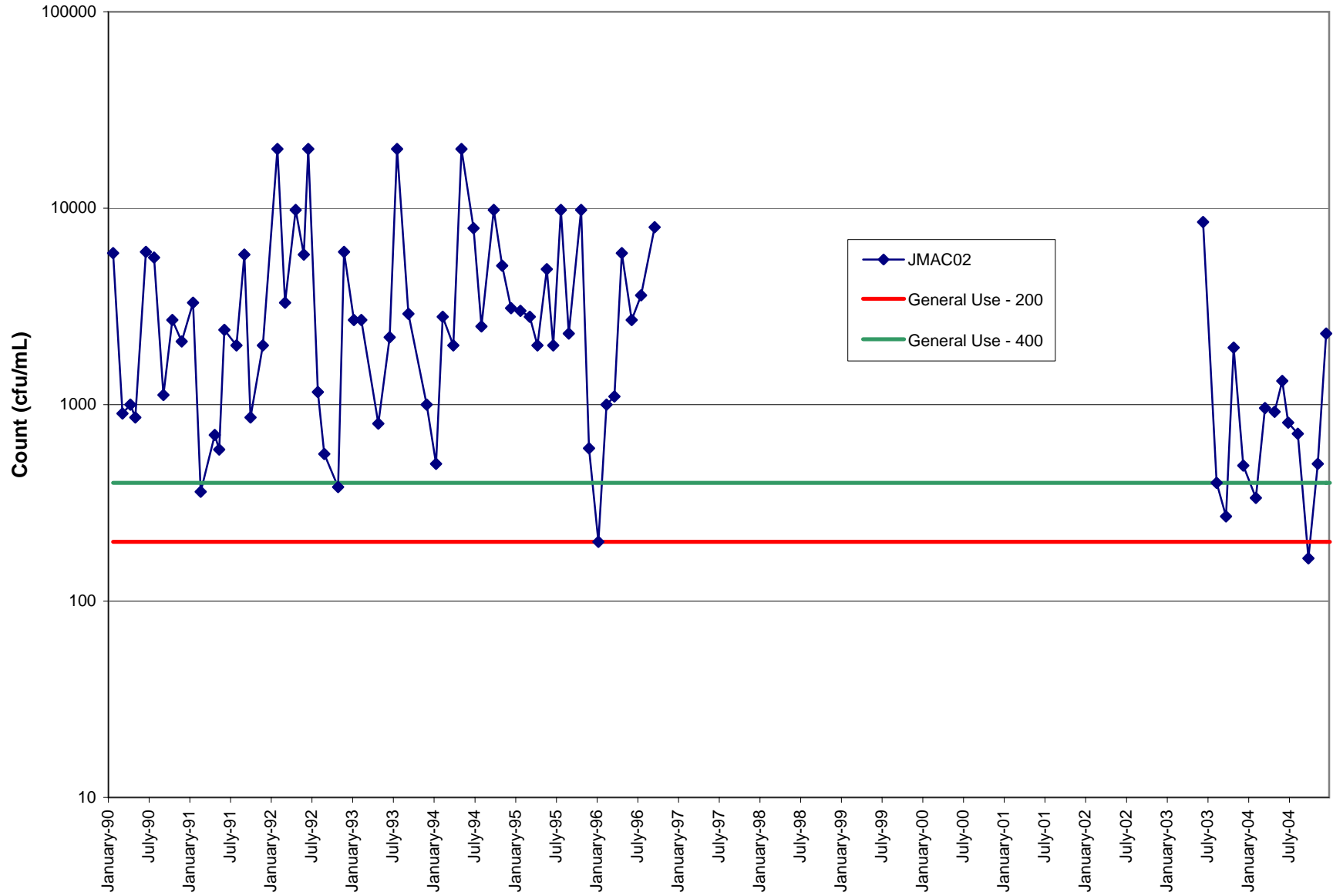


Figure 5-1  
 Cahokia Canal/Horseshoe Lake Watershed  
 Water Quality Stations

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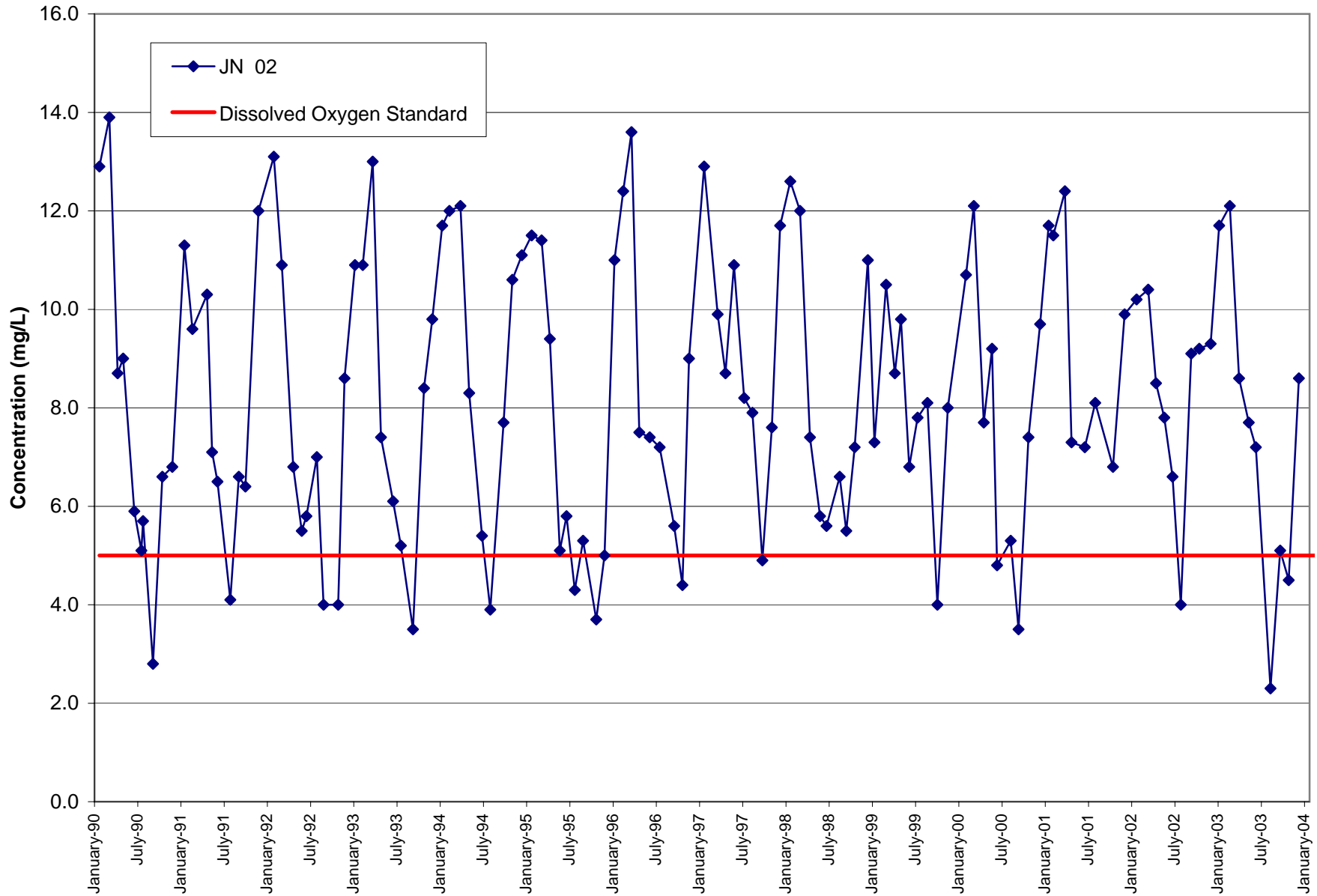


CDM

V:\6 Cahokia Canal\_Horseshoe Lake\Data\Stream-Fecal.xlsCahokia Canal Fecal

Figure 5-2:  
Harding Ditch JMAC02  
Total Fecal Coliform

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**Figure 5-3:**  
**Cahokia Canal Segment JN02**  
**Dissolved Oxygen Concentrations**

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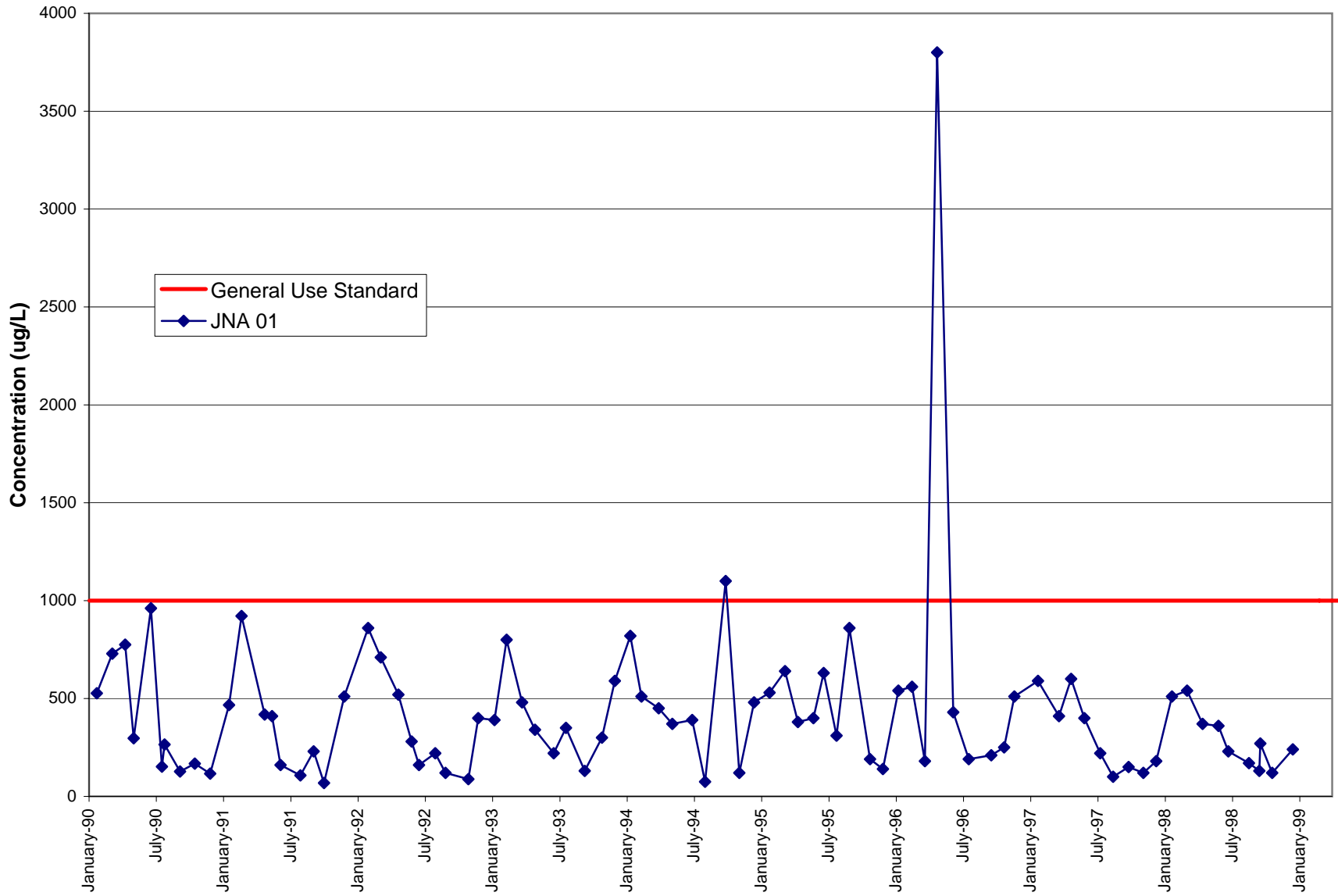
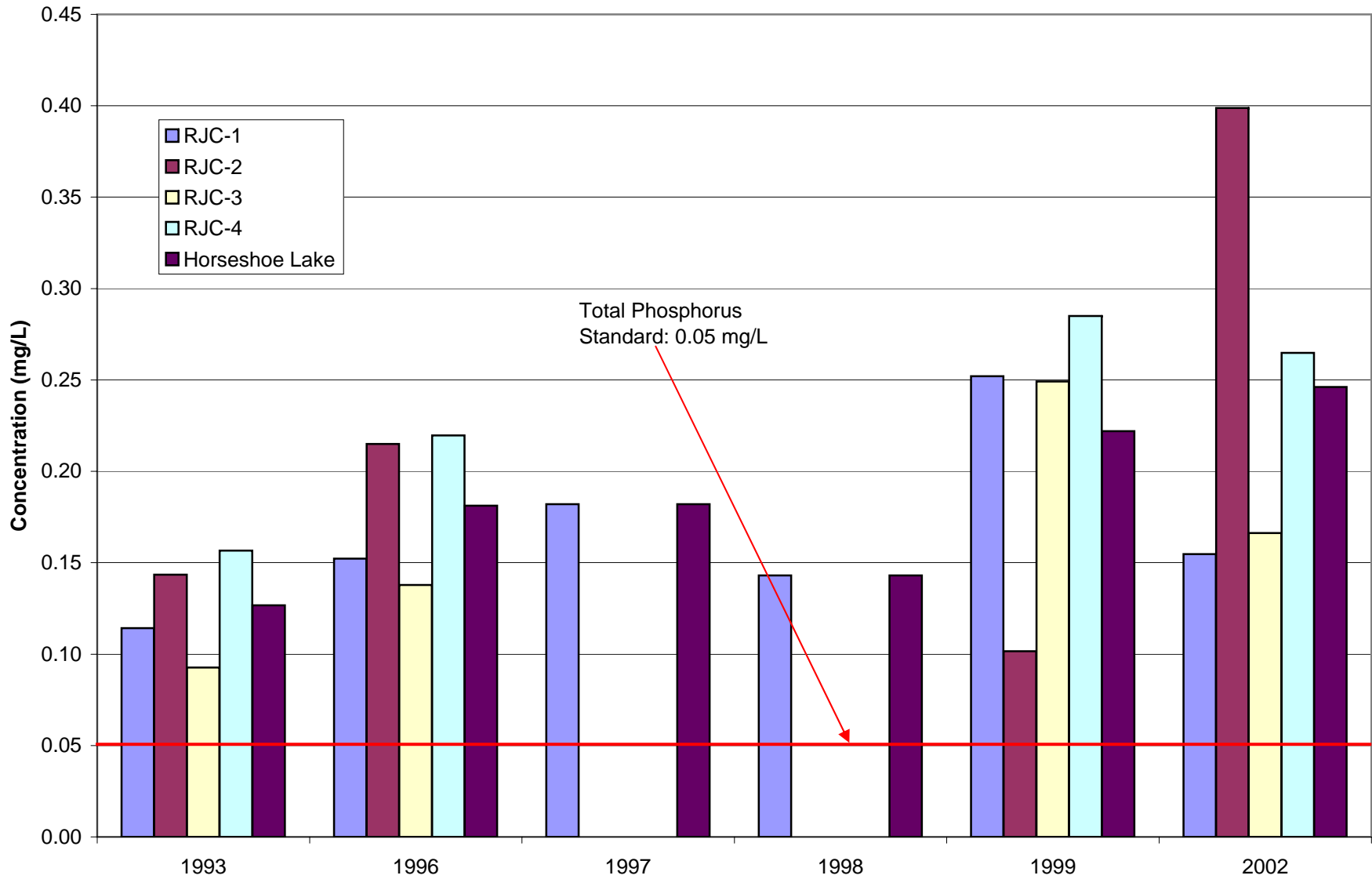


Figure 5-4:  
Canteen Creek JNA01  
Total Manganese Concentrations

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**Figure 5-5:**  
**Horseshoe Lake**  
**Average Annual Phosphorus Concentrations**  
**at One-Foot Depth**

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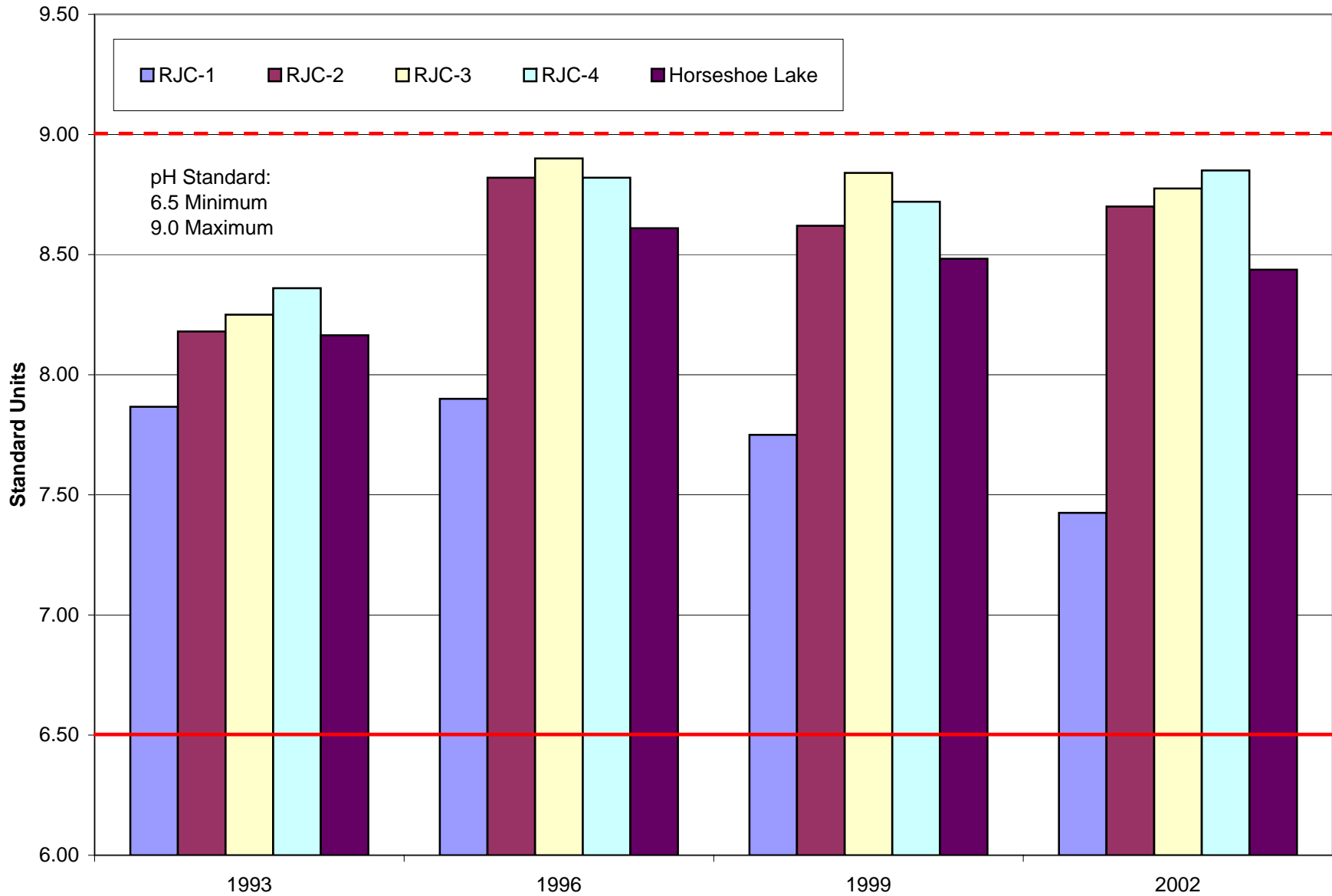


Figure 5-6:  
Horseshoe Lake  
Average Annual pH Values

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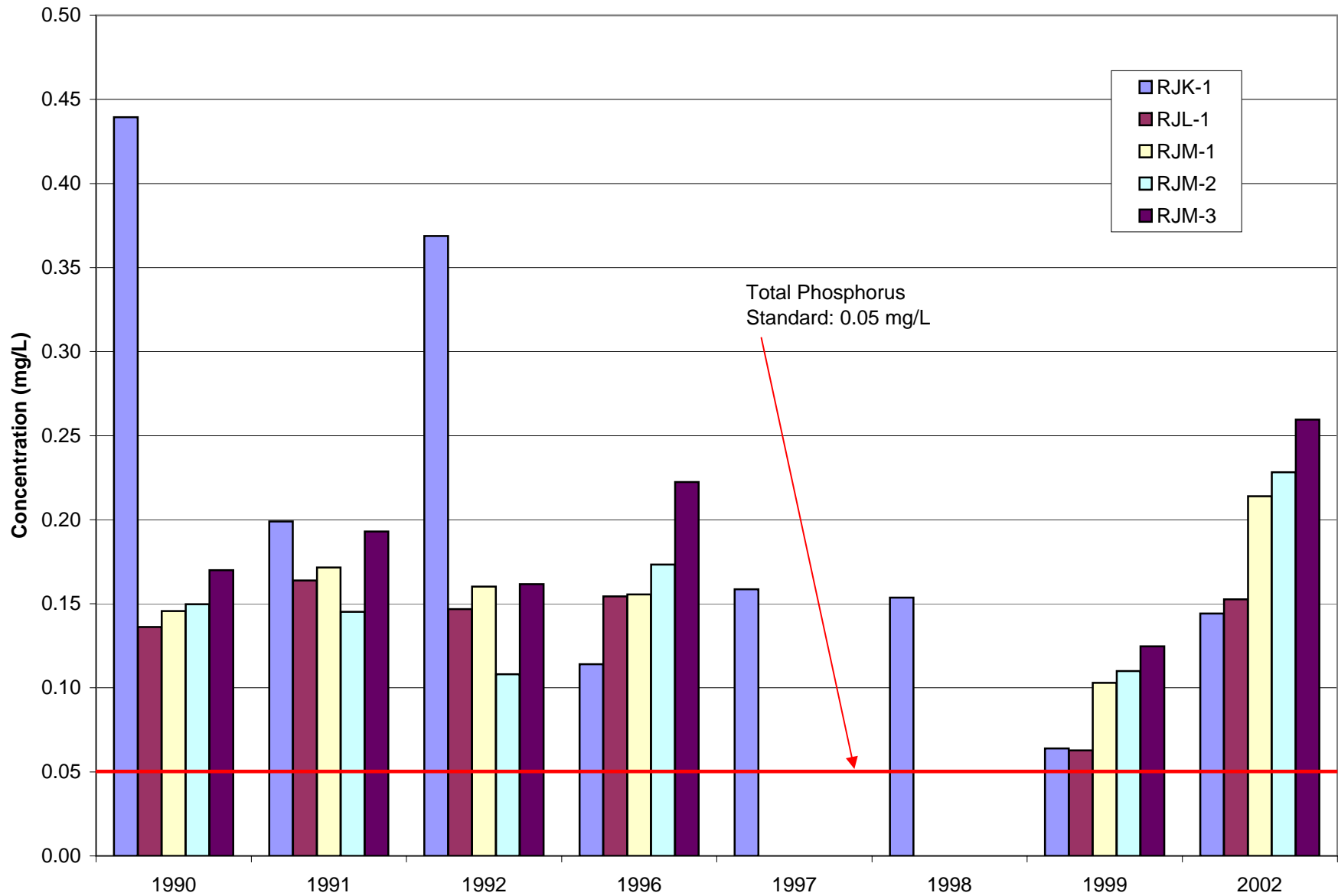


Figure 5-7:  
Frank Holten Lakes  
Annual Average Total Phosphorus Concentrations

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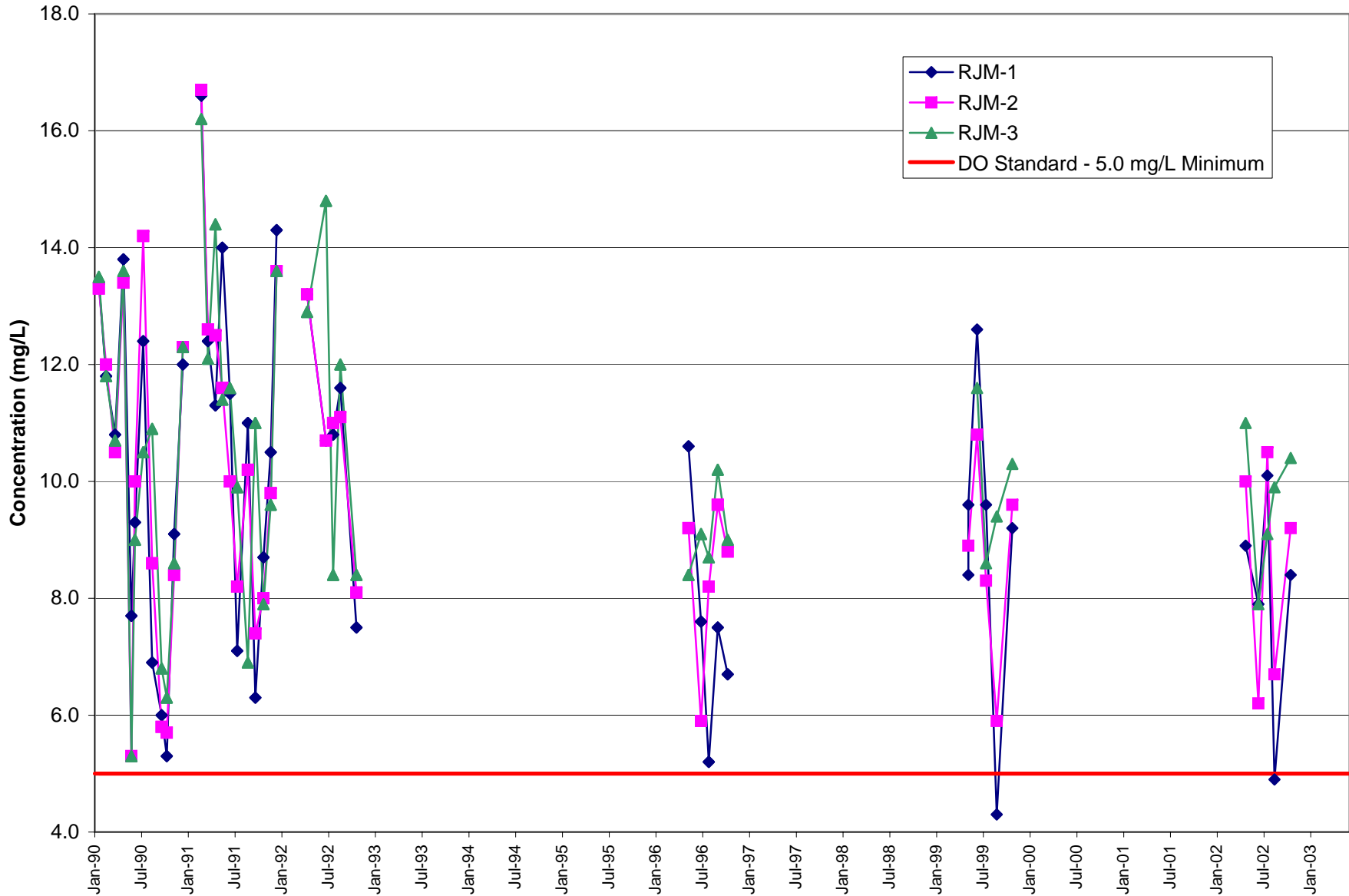


Figure 5-8:  
Frank Holten Lake #3  
Dissolved Oxygen Concentrations

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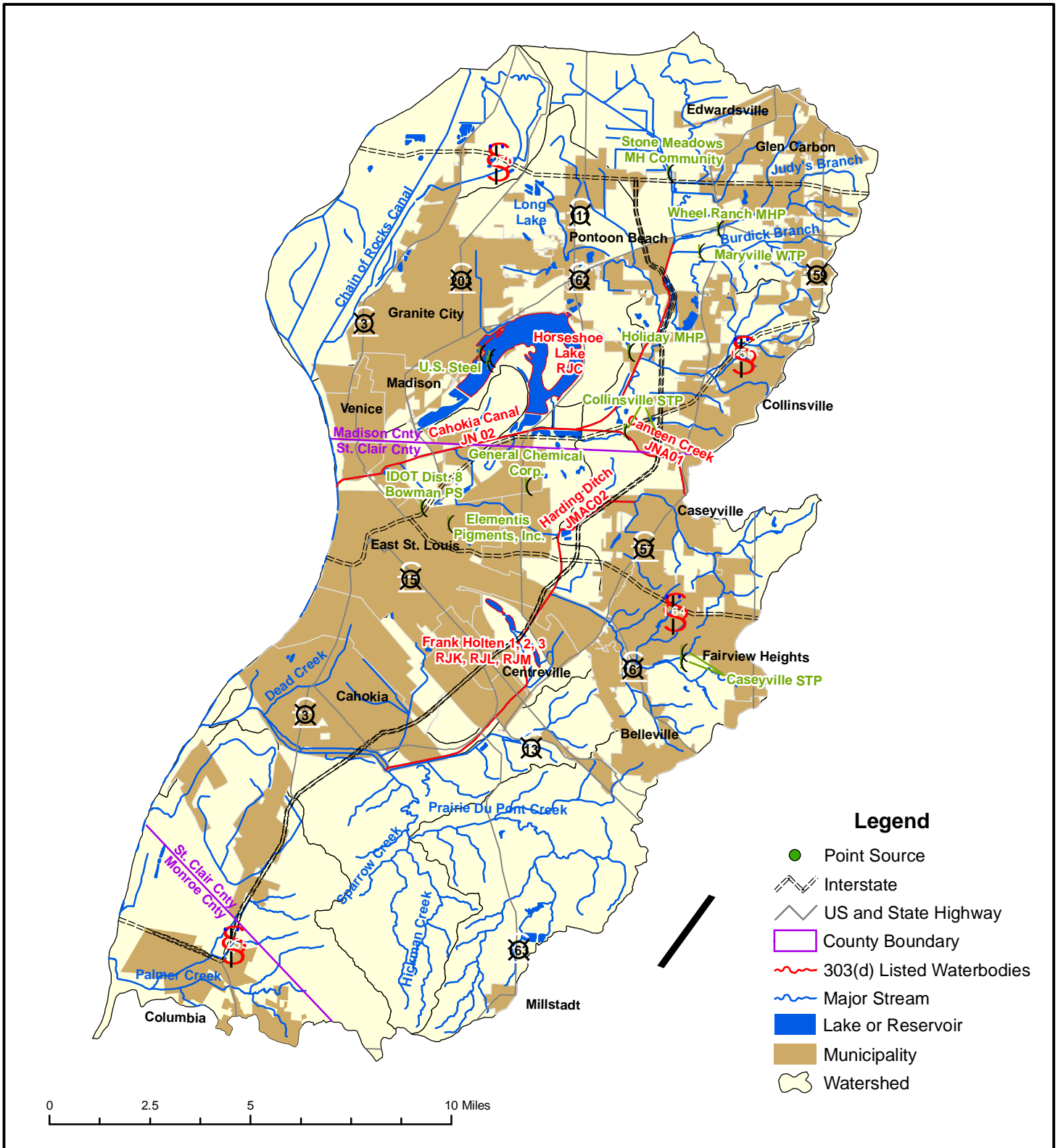


Figure 5-9  
Cahokia Canal/Horseshoe Lake Watershed  
NPDES Permits

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## **Section 6**

# **Approach to Developing TMDL and Identification of Data Needs**

Illinois EPA is currently developing TMDLs for pollutants that have numeric water quality standards. Of the pollutants impairing stream segments in the Cahokia Canal/Horseshoe Lake watershed, manganese, DO, and fecal coliform are the parameters with numeric water quality standards. For the impaired lakes in the watershed, phosphorus, DO, and pH are the parameters with numeric water quality standards. Illinois EPA believes that addressing these impairments should lead to an overall improvement in water quality due to the interrelated nature of the other listed pollutants. Recommended technical approaches for developing TMDLs for streams and lakes are presented in this section. Additional data needs are also discussed.

### **6.1 Simple and Detailed Approaches for Developing TMDLs**

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

### **6.2 Approaches for Developing TMDLs for Stream Segments in the Cahokia Canal/Horseshoe Lake Watershed**

All of the impaired stream segments with the watershed have major point sources discharging to them. Approaches for developing TMDLs for parameters that are possibly affected by point sources as well as TMDLs for parameters not likely influenced by point sources are described below.

#### **6.2.1 Recommended Approach for DO TMDLs for Segments with Major Point Sources**

Cahokia Canal Segment JN02 has point sources discharging directly to or upstream of it. For this segment a more complicated approach that would also incorporate the impacts of stream plant activity, and possibly sediment oxygen demand (SOD), and would require a more sophisticated numerical model and an adequate level of measured data to aide in model parameterization is recommended.

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

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

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

### **6.2.2 Recommended Approach for Fecal Coliform TMDLs**

Segment JMAC02 of Harding Ditch is impaired for fecal coliform. The general use water quality standard for total fecal coliform is:

- 200 cfu/100 mL geometric mean based on a minimum of five samples taken over not more than a 30 day period during the months of May through October
- 400 cfu/100 mL shall not be exceeded by more than 10 percent of the samples collected during any 30 day period during the months of May through October

As discussed in Section 5.1.1.1, there have been no instances when five or more samples have been taken within a 30 day period. More data is required in order to properly assess compliance with the standard.

If it is confirmed that the segment is impaired for total fecal coliform, the recommended approach for developing a TMDL for the segment would be to use the load-duration curve method. The load-duration methodology uses the cumulative frequency distribution of streamflow and pollutant concentration data to estimate the allowable loads for a waterbody.

### **6.2.3 Recommended Approach for Manganese TMDL**

Segment JNA01 of Canteen Creek is impaired for manganese. No apparent source of manganese has been identified to date and therefore, an empirical loading and spreadsheet analysis will be utilized to calculate this TMDL.

## **6.3 Approaches for Developing TMDLs for Lakes and Reservoirs in the Cahokia Canal/Horseshoe Lake Watershed**

Recommended TMDL approaches for Horseshoe Lake and the Frank Holten Lakes will be discussed in this section. It is assumed that enough data exists to develop a simple model for use in TMDL development.

### **6.3.1 Recommended Approach for Total Phosphorus, DO, and pH TMDLs**

Horseshoe Lake and each of the Frank Holten Lakes are impaired for total phosphorus. Horseshoe Lake is also impaired for pH, while Frank Holten Lake #3 is additionally impaired for DO. The BATHTUB model is recommended for all lake phosphorus and DO assessments in this watershed. The BATHTUB model performs steady-state water and nutrient balance calculations in a spatially segmented hydraulic network that accounts for advective and diffusive transport, and nutrient sedimentation. The model relies on empirical relationships to predict lake trophic conditions and subsequent DO conditions as functions of total phosphorus and nitrogen loads, residence time, and mean depth (USEPA 1997). Oxygen conditions in the model are simulated as meta and hypolimnetic depletion rates, rather than explicit concentrations.

Watershed loadings to the lakes will be based on empirical data or tributary data available in the lake watersheds. In addition, pH will be addressed empirically. Most likely, control of phosphorus concentrations will address pH impairments within Horseshoe Lake.

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# **Appendix A**

## **Land Use Categories**

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File names and descriptions:

Values and class names found in the Land Cover of Illinois 1999-2000 Arc/Info GRID coverage.

<u>Value</u>	<u>Class Names</u>
0	Background
	<b>AGRICULTURAL LAND</b>
11	Corn
12	Soybeans
13	Winter Wheat
14	Other Small Grains & Hay
15	Winter Wheat/Soybeans
16	Other Agriculture
17	Rural Grassland
	<b>FORESTED LAND</b>
21	Upland
25	Partial Canopy/Savannah Upland
26	Coniferous
	<b>URBAN &amp; BUILT-UP LAND</b>
31	High Density
32	Low/Medium Density
35	Urban Open Space
	<b>WETLAND</b>
41	Shallow Marsh/Wet Meadow
42	Deep Marsh
43	Seasonally/Temporally Flooded
44	Floodplain Forest
48	Swamp
49	Shallow Water
	<b>OTHER</b>
51	Surface Water
52	Barren & Exposed Land
53	Clouds
54	Cloud Shadows

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# **Appendix B**

## **Soil Characteristics**

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**Appendix B Cahokia Canal/Horseshoe Lake Watershed Soil Series Characteristics**

<b>SSURGO Soil Series Code</b>	<b>SSURGO Soil Series Code Definition</b>	<b>Acres</b>	<b>Percent of Watershed</b>	<b>Dominant Hydrologic Soil Group</b>	<b>Minimum K-factor</b>	<b>Maximum K-factor</b>
123	Riverwash	21.05	0.01%	NA	NA	NA
533	URBAN LAND	12564.23	6.92%	NA	0.24	0.43
536	DUMPS	646.34	0.36%	NA	0.32	0.32
864	PITS, QUARRIES	582.13	0.32%	NA	0.15	0.43
865	Pits, gravel	83.61	0.05%	NA	NA	NA
866	DUMPS, SLURRY	13.18	0.01%	NA	NA	NA
1070L	Oil waste land	1924.84	1.06%	D	0.28	0.32
1071A	DARWIN SILTY CLAY LOAM, UNDRAINED, 0 TO 2 PERCENT SLOPES, FREQUENTLY FLOODED	1650.68	0.91%	D	0.24	0.28
113A	Oconee silt loam, 0 to 2 percent slopes	2.81	0.00%	C	0.32	0.49
113B	Oconee silt loam, 2 to 5 percent slopes	18.54	0.01%	C	0.32	0.49
1248A	MCFAIN SILTY CLAY LOAM, UNDRAINED, 0 TO 2 PERCENT SLOPES, FREQUENTLY FLOODED	823.56	0.45%	C	0.24	0.32
1591A	Fults silty clay, undrained, 0 to 2 percent slopes, occasionally flooded	94.66	0.05%	D	0.24	0.32
165A	Weir silt loam, 0 to 2 percent slopes	2.89	0.00%	D	0.37	0.55
2071L	DARWIN-URBAN LAND COMPLEX, 0 TO 2 PERCENT SLOPES, OCCASIONALLY FLOODED, LONG DURATION	2992.84	1.65%	NA	0.24	0.28
2079D	MENFRO-URBAN LAND COMPLEX, 8 TO 15 PERCENT SLOPES	327.68	0.18%	NA	0.37	0.49
2079E	MENFRO-URBAN LAND COMPLEX, 15 TO 25 PERCENT SLOPES	99.99	0.06%	NA	0.37	0.49
216G	Stookey silt loam, 35 to 70 percent slopes	9.03	0.00%	B	0.43	0.55
2183A	SHAFFTON-URBAN LAND COMPLEX, 0 TO 2 PERCENT SLOPES, OCCASIONALLY FLOODED	8005.31	4.41%	NA	0.24	0.32
2284A	Tice-Fluents-Urban land complex, 0 to 2 percent slopes, occasionally flooded	565.73	0.31%	NA	0.24	0.32
2304B	Landes-Fluents-Urban land complex, 2 to 5 percent slopes, occasionally flooded	1332.74	0.73%	NA	0.2	0.32
2384B	EDWARDSVILLE-URBAN LAND COMPLEX, 1 TO 4 PERCENT SLOPES	447.86	0.25%	NA	0.28	0.49
2477B	WINFIELD-URBAN LAND COMPLEX, 2 TO 8 PERCENT SLOPES	2716.38	1.50%	NA	0.37	0.49

**Appendix B Cahokia Canal/Horseshoe Lake Watershed Soil Series Characteristics (continued)**

<b>SSURGO Soil Series Code</b>	<b>SSURGO Soil Series Code Definition</b>	<b>Acres</b>	<b>Percent of Watershed</b>	<b>Dominant Hydrologic Soil Group</b>	<b>Minimum K-factor</b>	<b>Maximum K-factor</b>
2592A	Nameoki-Fluvents-Urban land complex, 0 to 2 percent slopes, occasionally flooded	1279.51	0.70%	D	0.24	0.32
267A	Caseyville silt loam, 0 to 2 percent slopes	466.41	0.26%	B	0.37	0.55
267B	Caseyville silt loam, 2 to 5 percent slopes	154.98	0.09%	B	0.37	0.49
283B	Downsouth silt loam, 2 to 5 percent slopes	277.99	0.15%	B	0.24	0.49
283C2	Downsouth silt loam, 5 to 10 percent slopes, eroded	28.23	0.02%	B	0.24	0.49
3038B	Rocher loam, 2 to 5 percent slopes, frequently flooded	1558.97	0.86%	B	0.24	0.32
3070L	Beaucoup silty clay loam, 0 to 2 percent slopes, frequently flooded, long duration	895.76	0.49%	B/D	0.28	0.32
3071L	Darwin silty clay, 0 to 2 percent slopes, frequently flooded, long duration	750.80	0.41%	D	0.24	0.28
3076A	OTTER SILT LOAM, 0 TO 2 PERCENT SLOPES, FREQUENTLY FLOODED	68.56	0.04%	B/D	0.32	0.49
3092B	Sarpy fine sand, 2 to 5 percent slopes, frequently flooded	21.81	0.01%	A	0.15	0.15
3180A	DUPO SILT LOAM, 0 TO 2 PERCENT SLOPES, FREQUENTLY FLOODED	51.96	0.03%	C	0.24	0.55
31A	Pierron silt loam, 0 to 2 percent slopes	38.45	0.02%	D	0.37	0.55
3333A	Wakeland silt loam, 0 to 2 percent slopes, frequently flooded	4021.27	2.21%	C	0.28	0.55
3334L	Birds silt loam, 0 to 2 percent slopes, frequently flooded, long duration	266.90	0.15%	C/D	0.28	0.55
3336A	Wilbur silt loam, 0 to 2 percent slopes, frequently flooded	1177.73	0.65%	B	0.43	0.49
3391A	Blake silty clay loam, 0 to 2 percent slopes, frequently flooded	908.54	0.50%	B	0.24	0.55
3394A	HAYNIE SILT LOAM, 0 TO 2 PERCENT SLOPES, FREQUENTLY FLOODED	491.83	0.27%	B	0.24	0.37
3394B	Haynie silt loam, 2 to 5 percent slopes, frequently flooded	651.20	0.36%	B	0.24	0.37
3415A	Orion silt loam, 0 to 2 percent slopes, frequently flooded	385.25	0.21%	C	0.28	0.55
3592A	Nameoki silty clay loam, 0 to 2 percent slopes, frequently flooded	1836.45	1.01%	D	0.24	0.32
35F	Bold silt loam, 18 to 35 percent slopes	33.46	0.02%	B	0.43	0.55
3646A	Fluvaquents, loamy, 0 to 2 percent slopes, frequently flooded	171.21	0.09%	C	0.24	0.32

**Appendix B Cahokia Canal/Horseshoe Lake Watershed Soil Series Characteristics (continued)**

<b>SSURGO Soil Series Code</b>	<b>SSURGO Soil Series Code Definition</b>	<b>Acres</b>	<b>Percent of Watershed</b>	<b>Dominant Hydrologic Soil Group</b>	<b>Minimum K-factor</b>	<b>Maximum K-factor</b>
37A	WORTHEN SILT LOAM, 0 TO 2 PERCENT SLOPES	455.11	0.25%	B	0.32	0.49
37B	WORTHEN SILT LOAM, 2 TO 5 PERCENT SLOPES	318.00	0.18%	B	0.32	0.49
3847L	Fluvaquents-Orthents complex, frequently flooded, long duration	1339.60	0.74%	C	0.24	0.32
384A	Edwardsville silt loam, 0 to 2 percent slopes	796.01	0.44%	B	0.24	0.49
384B	EDWARDSVILLE SILT LOAM, 2 TO 5 PERCENT SLOPES	169.36	0.09%	B	0.28	0.49
385A	Mascoutah silty clay loam, 0 to 2 percent slopes	287.89	0.16%	B	0.24	0.49
438B	Aviston silt loam, 2 to 5 percent slopes	8.75	0.00%	B	0.24	0.49
441B	Wakenda silt loam, 2 to 5 percent slopes	85.07	0.05%	B	0.28	0.49
441C2	Wakenda silt loam, 5 to 10 percent slopes, eroded	15.07	0.01%	B	0.28	0.49
466A	BARTELSON SILT LOAM, 0 TO 2 PERCENT SLOPES	46.70	0.03%	D	0.28	0.43
46A	Herrick silt loam, 0 to 2 percent slopes	52.83	0.03%	B	0.24	0.49
477B	Winfield silt loam, 2 to 5 percent slopes	4853.69	2.67%	B	0.37	0.49
477B2	WINFIELD SILT LOAM, 2 TO 5 PERCENT SLOPES, ERODED	4.54	0.00%	B	0.37	0.49
477B3	Winfield silty clay loam, 2 to 5 percent slopes, severely eroded	27.77	0.02%	B	0.37	0.49
477C2	Winfield silt loam, 5 to 10 percent slopes, eroded	383.32	0.21%	B	0.37	0.49
477C3	Winfield silty clay loam, 5 to 10 percent slopes, severely eroded	439.81	0.24%	B	0.37	0.49
477D3	Winfield silty clay loam, 10 to 18 percent slopes, severely eroded	482.65	0.27%	B	0.37	0.49
491B2	RUMA SILTY CLAY LOAM, 2 TO 5 PERCENT SLOPES, ERODED	36.69	0.02%	B	0.37	0.43
5079C	Menfro silt loam, karst, 5 to 12 percent slopes, severely eroded	768.06	0.42%	B	0.37	0.49
5079D	Menfro silt loam, karst, 12 to 25 percent slopes, severely eroded	2676.77	1.47%	B	0.37	0.49
5079G	Menfro silt loam, karst, 25 to 60 percent slopes	2465.32	1.36%	B	0.37	0.49
50A	Virden silt loam, 0 to 2 percent slopes	55.93	0.03%	B/D	0.24	0.49
515C2	BUNKUM SILT LOAM, 5 TO 10 PERCENT SLOPES, ERODED	29.27	0.02%	C	0.37	0.49
515C3	Bunkum silty clay loam, 5 to 10 percent slopes, severely eroded	683.39	0.38%	C	0.37	0.49
515D3	Bunkum silty clay loam, 10 to 18 percent slopes, severely eroded	1262.21	0.69%	C	0.37	0.49
517A	Marine silt loam, 0 to 2 percent slopes	445.92	0.25%	C	0.32	0.55
517B	Marine silt loam, 2 to 5 percent slopes	152.51	0.08%	C	0.32	0.55
582B	Homen silt loam, 2 to 5 percent slopes	811.00	0.45%	B	0.37	0.49

**Appendix B Cahokia Canal/Horseshoe Lake Watershed Soil Series Characteristics (continued)**

<b>SSURGO Soil Series Code</b>	<b>SSURGO Soil Series Code Definition</b>	<b>Acres</b>	<b>Percent of Watershed</b>	<b>Dominant Hydrologic Soil Group</b>	<b>Minimum K-factor</b>	<b>Maximum K-factor</b>
582B2	Homen silt loam, 2 to 5 percent slopes, eroded	7.82	0.00%	B	0.37	0.43
582C2	Homen silt loam, 5 to 10 percent slopes, eroded	32.77	0.02%	B	0.37	0.43
630D3	Navlys silty clay loam, 10 to 18 percent slopes, severely eroded	388.26	0.21%	B	0.37	0.49
7037A	Worthen silt loam, 0 to 2 percent slopes, rarely flooded	1097.79	0.60%	B	0.28	0.49
7037B	Worthen silt loam, 2 to 5 percent slopes, rarely flooded	330.10	0.18%	B	0.32	0.49
7053B	Bloomfield loamy fine sand, 2 to 5 percent slopes, rarely flooded	549.50	0.30%	A	0.02	0.15
7075B	Drury silt loam, 2 to 5 percent slopes, rarely flooded	233.77	0.13%	B	0.32	0.49
7081A	Littleton silt loam, 0 to 2 percent slopes, rarely flooded	301.68	0.17%	B	0.28	0.49
7122B	Colp silt loam, 2 to 5 percent slopes, rarely flooded	20.37	0.01%	C	0.32	0.49
7122C	Colp silty clay loam, 5 to 10 percent slopes, severely eroded, rarely flooded	4.52	0.00%	C	0.32	0.37
7150A	Onarga sandy loam, 0 to 2 percent slopes, rarely flooded	336.57	0.19%	B	0.02	0.32
7151A	Ridgeville fine sandy loam, 0 to 2 percent slopes, rarely flooded	159.01	0.09%	B	0.02	0.28
7338A	Hurst silty clay loam, 0 to 2 percent slopes, rarely flooded	22.87	0.01%	D	0.28	0.49
7430A	Raddle silt loam, 0 to 2 percent slopes, rarely flooded	506.88	0.28%	B	0.32	0.49
7445A	Newhaven loam, 0 to 2 percent slopes, rarely flooded	59.16	0.03%	B	0.24	0.32
75B	Drury silt loam, 2 to 5 percent slopes	439.40	0.24%	B	0.43	0.49
75C	Drury silt loam, 5 to 10 percent slopes	17.76	0.01%	B	0.43	0.49
75D	Drury silt loam, 10 to 18 percent slopes	10.92	0.01%	B	0.43	0.49
75F	Drury silt loam, 18 to 35 percent slopes	69.98	0.04%	B	0.49	0.49
7741B	Oakville fine sand, 2 to 5 percent slopes, rarely flooded	188.92	0.10%	A	0.02	0.28
7741C	Oakville fine sand, 5 to 10 percent slopes, rarely flooded	64.93	0.04%	A	0.02	0.28
79B	Menfro silt loam, 2 to 5 percent slopes	7381.60	4.06%	B	0.37	0.55
79C2	Menfro silt loam, 5 to 10 percent slopes, eroded	2867.98	1.58%	B	0.37	0.49
79C3	Menfro silty clay loam, 5 to 10 percent slopes, severely eroded	598.51	0.33%	B	0.37	0.49
79D2	Menfro silt loam, 10 to 18 percent slopes, eroded	894.81	0.49%	B	0.37	0.49
79D3	Menfro silty clay loam, 10 to 18 percent slopes, severely eroded	2840.82	1.56%	B	0.37	0.49
79F	Menfro silt loam, 18 to 35 percent slopes	4212.20	2.32%	B	0.37	0.55

**Appendix B Cahokia Canal/Horseshoe Lake Watershed Soil Series Characteristics (continued)**

<b>SSURGO Soil Series Code</b>	<b>SSURGO Soil Series Code Definition</b>	<b>Acres</b>	<b>Percent of Watershed</b>	<b>Dominant Hydrologic Soil Group</b>	<b>Minimum K-factor</b>	<b>Maximum K-factor</b>
79F3	Menfro silty clay loam, 18 to 35 percent slopes, severely eroded	2000.89	1.10%	B	0.37	0.49
79G	Menfro silt loam, 35 to 60 percent slopes	1630.02	0.90%	B	0.37	0.49
801B	Orthents, silty, undulating	239.48	0.13%	C	0.24	0.43
801D	Orthents, silty, steep	1442.80	0.79%	C	0.43	0.43
802B	Orthents, loamy, undulating	2042.12	1.12%	C	0.24	0.49
802D	Orthents, loamy, steep	2193.69	1.21%	B	0.32	0.43
8038B	Rocher loam, 2 to 5 percent slopes, occasionally flooded	494.56	0.27%	B	0.24	0.32
8070A	Beaucoup silty clay loam, 0 to 2 percent slopes, occasionally flooded	1575.10	0.87%	B	0.28	0.32
8071L	Darwin silty clay, 0 to 2 percent slopes, occasionally flooded, long duration	15611.95	8.60%	D	0.24	0.28
8078A	Arenzville silt loam, 0 to 2 percent slopes, occasionally flooded	224.00	0.12%	B	0.43	0.49
8084A	Okaw silt loam, 0 to 2 percent slopes, occasionally flooded	13.87	0.01%	D	0.32	0.49
8162A	GORHAM SILTY CLAY LOAM, 0 TO 2 PERCENT SLOPES, OCCASIONALLY FLOODED	709.85	0.39%	B	0.24	0.32
8180A	Dupo silt loam, 0 to 2 percent slopes, occasionally flooded	2901.12	1.60%	C	0.24	0.55
8183A	Shaffton clay loam, 0 to 2 percent slopes, occasionally flooded	6009.83	3.31%	B	0.24	0.32
81A	LITTLETON SILT LOAM, 0 TO 2 PERCENT SLOPES	352.81	0.19%	B	0.32	0.49
821G	MORRISTOWN VERY STONY SILTY CLAY LOAM, 35 TO 70 PERCENT SLOPES	273.74	0.15%	C	0.28	0.37
825B	LENZBURG SILTY CLAY LOAM, ACID SUBSTRATUM, 1 TO 7 PERCENT SLOPES	114.04	0.06%	B	0.32	0.37
826D	ORTHENTS, SILTY, ACID SUBSTRATUM, ROLLING	65.32	0.04%	C	0.43	0.43
8284A	Tice silty clay loam, 0 to 2 percent slopes, occasionally flooded	2730.42	1.50%	B	0.24	0.32
8302A	Ambraw silty clay loam, 0 to 2 percent slopes, occasionally flooded	836.87	0.46%	B/D	0.24	0.28
8304B	Landes very fine sandy loam, 2 to 5 percent slopes, occasionally flooded	6430.52	3.54%	B	0.2	0.32
8331A	Haymond silt loam, 0 to 2 percent slopes, occasionally flooded	648.53	0.36%	B	0.28	0.55
8333A	Wakeland silt loam, 0 to 2 percent slopes, occasionally flooded	600.61	0.33%	C	0.43	0.55

**Appendix B Cahokia Canal/Horseshoe Lake Watershed Soil Series Characteristics (continued)**

<b>SSURGO Soil Series Code</b>	<b>SSURGO Soil Series Code Definition</b>	<b>Acres</b>	<b>Percent of Watershed</b>	<b>Dominant Hydrologic Soil Group</b>	<b>Minimum K-factor</b>	<b>Maximum K-factor</b>
8334A	Birds silt loam, 0 to 2 percent slopes, occasionally flooded	878.75	0.48%	C/D	0.43	0.49
8336A	Wilbur silt loam, 0 to 2 percent slopes, occasionally flooded	11.96	0.01%	B	0.37	0.55
8338B	Hurst silt loam, 2 to 5 percent slopes, occasionally flooded	25.43	0.01%	D	0.32	0.49
8338C	HURST SILTY CLAY LOAM, 5 TO 10 PERCENT SLOPES, ERODED, OCCASIONALLY FLOODED	8.81	0.00%	D	0.32	0.43
8394A	HAYNIE SILT LOAM, 0 TO 2 PERCENT SLOPES, OCCASIONALLY FLOODED	217.47	0.12%	B	0.24	0.37
8394B	Haynie silt loam, 2 to 5 percent slopes, occasionally flooded	255.05	0.14%	B	0.24	0.37
8415A	Orion silt loam, 0 to 2 percent slopes, occasionally flooded	168.34	0.09%	C	0.43	0.55
8434B	RIDGWAY SILT LOAM, 2 TO 5 PERCENT SLOPES, OCCASIONALLY FLOODED	7.93	0.00%	B	0.15	0.43
8457L	Booker clay, 0 to 2 percent slopes, occasionally flooded, long duration	230.37	0.13%	D	0.24	0.28
8591A	Fults silty clay, 0 to 2 percent slopes, occasionally flooded	5038.86	2.77%	D	0.24	0.32
8592A	Nameoki silty clay, 0 to 2 percent slopes, occasionally flooded	3772.00	2.08%	D	0.24	0.32
8646A	FLUVAQUENTS, LOAMY, 0 TO 2 PERCENT SLOPES, OCCASIONALLY FLOODED	1366.90	0.75%	C	0.24	0.32
8674A	Dozaville silt loam, 0 to 2 percent slopes, occasionally flooded	1104.48	0.61%	B	0.24	0.49
871B	LENZBURG GRAVELLY SILTY CLAY LOAM, 1 TO 7 PERCENT SLOPES, STONY	245.45	0.14%	B	0.24	0.37
871D	LENZBURG GRAVELLY SILTY CLAY LOAM, 7 TO 18 PERCENT SLOPES, STONY	81.24	0.04%	B	0.24	0.37
871G	LENZBURG GRAVELLY SILTY CLAY LOAM, 18 TO 70 PERCENT SLOPES, STONY	4.13	0.00%	B	0.24	0.37
8787A	Banlic silt loam, 0 to 2 percent slopes, occasionally flooded	67.08	0.04%	C	0.43	0.55
880B2	Coulterville-Darmstadt silt loams, 2 to 5 percent slopes, eroded	5.59	0.00%	D	0.37	0.49
8831A	Fluvaquents, clayey, 0 to 2 percent slopes, occasionally flooded	326.03	0.18%	0	0.37	0.55
884C3	Bunkum-Coulterville silty clay loams, 5 to 10 percent slopes, severely eroded	490.74	0.27%	C	0.37	0.49



**Appendix B Cahokia Canal/Horseshoe Lake Watershed Soil Series Characteristics (continued)**

<b>SSURGO Soil Series Code</b>	<b>SSURGO Soil Series Code Definition</b>	<b>Acres</b>	<b>Percent of Watershed</b>	<b>Dominant Hydrologic Soil Group</b>	<b>Minimum K-factor</b>	<b>Maximum K-factor</b>
886F3	Ruma-Ursa silty clay loams, 18 to 35 percent slopes, severely eroded	2763.49	1.52%	B	0.28	0.37
897D3	Bunkum-Atlas silty clay loams, 10 to 18 percent slopes, severely eroded	1034.60	0.57%	C	0.28	0.49
90A	Bethalto silt loam, 0 to 2 percent slopes	432.14	0.24%	B	0.24	0.49
962D2	Sylvan-Bold silt loams, 10 to 18 percent slopes, eroded	1571.50	0.87%	B	0.37	0.55
962F2	Sylvan-Bold silt loams, 18 to 35 percent slopes, eroded	6570.68	3.62%	B	0.37	0.55
962G	SYLVAN-BOLD SILT LOAMS, 35 TO 60 PERCENT SLOPES	1774.79	0.98%	B	0.37	0.55
M-W	Miscellaneous water	323.16	0.18%	NA	NA	NA
W	Water	10461.87	5.76%	NA	NA	NA
	TOTAL	181636.55	100.00%			

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# **Appendix C**

## **Water Quality Data**

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**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
JMAC02	1/22/1990	NA	Fecal Coliform cfu/100mL	5900
JMAC02	3/5/1990	NA	Fecal Coliform cfu/100mL	900
JMAC02	4/9/1990	NA	Fecal Coliform cfu/100mL	1000
JMAC02	5/2/1990	NA	Fecal Coliform cfu/100mL	860
JMAC02	6/18/1990	NA	Fecal Coliform cfu/100mL	6000
JMAC02	7/25/1990	NA	Fecal Coliform cfu/100mL	5600
JMAC02	9/5/1990	NA	Fecal Coliform cfu/100mL	1120
JMAC02	10/15/1990	NA	Fecal Coliform cfu/100mL	2700
JMAC02	11/26/1990	NA	Fecal Coliform cfu/100mL	2100
JMAC02	1/16/1991	NA	Fecal Coliform cfu/100mL	3300
JMAC02	2/19/1991	NA	Fecal Coliform cfu/100mL	360
JMAC02	4/23/1991	NA	Fecal Coliform cfu/100mL	700
JMAC02	5/13/1991	NA	Fecal Coliform cfu/100mL	590
JMAC02	6/5/1991	NA	Fecal Coliform cfu/100mL	2400
JMAC02	7/29/1991	NA	Fecal Coliform cfu/100mL	2000
JMAC02	9/3/1991	NA	Fecal Coliform cfu/100mL	5800
JMAC02	10/1/1991	NA	Fecal Coliform cfu/100mL	860
JMAC02	11/25/1991	NA	Fecal Coliform cfu/100mL	2000
JMAC02	1/29/1992	NA	Fecal Coliform cfu/100mL	20000
JMAC02	3/3/1992	NA	Fecal Coliform cfu/100mL	3300
JMAC02	4/20/1992	NA	Fecal Coliform cfu/100mL	9800
JMAC02	5/26/1992	NA	Fecal Coliform cfu/100mL	5800
JMAC02	6/15/1992	NA	Fecal Coliform cfu/100mL	20000
JMAC02	7/29/1992	NA	Fecal Coliform cfu/100mL	1160
JMAC02	8/26/1992	NA	Fecal Coliform cfu/100mL	560
JMAC02	10/27/1992	NA	Fecal Coliform cfu/100mL	380
JMAC02	11/23/1992	NA	Fecal Coliform cfu/100mL	6000
JMAC02	1/6/1993	NA	Fecal Coliform cfu/100mL	2700
JMAC02	2/8/1993	NA	Fecal Coliform cfu/100mL	2700
JMAC02	4/26/1993	NA	Fecal Coliform cfu/100mL	800
JMAC02	6/16/1993	NA	Fecal Coliform cfu/100mL	2200
JMAC02	7/19/1993	NA	Fecal Coliform cfu/100mL	20000
JMAC02	9/8/1993	NA	Fecal Coliform cfu/100mL	2900
JMAC02	11/29/1993	NA	Fecal Coliform cfu/100mL	1000
JMAC02	1/10/1994	NA	Fecal Coliform cfu/100mL	500
JMAC02	2/9/1994	NA	Fecal Coliform cfu/100mL	2800
JMAC02	3/28/1994	NA	Fecal Coliform cfu/100mL	2000
JMAC02	5/4/1994	NA	Fecal Coliform cfu/100mL	20000
JMAC02	6/27/1994	NA	Fecal Coliform cfu/100mL	7900
JMAC02	8/1/1994	NA	Fecal Coliform cfu/100mL	2500
JMAC02	9/26/1994	NA	Fecal Coliform cfu/100mL	9800
JMAC02	11/2/1994	NA	Fecal Coliform cfu/100mL	5100
JMAC02	12/12/1994	NA	Fecal Coliform cfu/100mL	3100
JMAC02	1/23/1995	NA	Fecal Coliform cfu/100mL	3000
JMAC02	3/6/1995	NA	Fecal Coliform cfu/100mL	2800
JMAC02	4/10/1995	NA	Fecal Coliform cfu/100mL	2000
JMAC02	5/22/1995	NA	Fecal Coliform cfu/100mL	4900
JMAC02	6/19/1995	NA	Fecal Coliform cfu/100mL	2000
JMAC02	7/24/1995	NA	Fecal Coliform cfu/100mL	9800
JMAC02	8/28/1995	NA	Fecal Coliform cfu/100mL	2300
JMAC02	10/23/1995	NA	Fecal Coliform cfu/100mL	9800

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
JMAC02	11/27/1995	NA	Fecal Coliform cfu/100mL	600
JMAC02	1/8/1996	NA	Fecal Coliform cfu/100mL	200
JMAC02	2/14/1996	NA	Fecal Coliform cfu/100mL	1000
JMAC02	3/20/1996	NA	Fecal Coliform cfu/100mL	1100
JMAC02	4/22/1996	NA	Fecal Coliform cfu/100mL	5900
JMAC02	6/5/1996	NA	Fecal Coliform cfu/100mL	2700
JMAC02	7/17/1996	NA	Fecal Coliform cfu/100mL	3600
JMAC02	9/16/1996	NA	Fecal Coliform cfu/100mL	8000
JMAC02	6/12/2003	NA	Fecal Coliform cfu/100mL	8500
JMAC02	8/12/2003	NA	Fecal Coliform cfu/100mL	400
JMAC02	9/23/2003	NA	Fecal Coliform cfu/100mL	270
JMAC02	10/28/2003	NA	Fecal Coliform cfu/100mL	1950
JMAC02	12/10/2003	NA	Fecal Coliform cfu/100mL	490
JMAC02	2/4/2004	NA	Fecal Coliform cfu/100mL	335
JMAC02	3/16/2004	NA	Fecal Coliform cfu/100mL	960
JMAC02	4/28/2004	NA	Fecal Coliform cfu/100mL	920
JMAC02	6/2/2004	NA	Fecal Coliform cfu/100mL	1320
JMAC02	6/28/2004	NA	Fecal Coliform cfu/100mL	810
JMAC02	8/10/2004	NA	Fecal Coliform cfu/100mL	710
JMAC02	9/27/2004	NA	Fecal Coliform cfu/100mL	165
JMAC02	11/8/2004	NA	Fecal Coliform cfu/100mL	500
JMAC02	12/16/2004	NA	Fecal Coliform cfu/100mL	2300
JN 02	1/11/1999	NA	DISSOLVED OXYGEN (DO) mg/l	7.3
JN 02	3/1/1999	NA	DISSOLVED OXYGEN (DO) mg/l	10.5
JN 02	4/7/1999	NA	DISSOLVED OXYGEN (DO) mg/l	8.7
JN 02	5/3/1999	NA	DISSOLVED OXYGEN (DO) mg/l	9.8
JN 02	6/7/1999	NA	DISSOLVED OXYGEN (DO) mg/l	6.8
JN 02	7/12/1999	NA	DISSOLVED OXYGEN (DO) mg/l	7.8
JN 02	8/23/1999	NA	DISSOLVED OXYGEN (DO) mg/l	8.1
JN 02	10/4/1999	NA	DISSOLVED OXYGEN (DO) mg/l	4
JN 02	11/17/1999	NA	DISSOLVED OXYGEN (DO) mg/l	8
JN 02	2/2/2000	NA	DISSOLVED OXYGEN (DO) mg/l	10.7
JN 02	3/6/2000	NA	DISSOLVED OXYGEN (DO) mg/l	12.1
JN 02	4/17/2000	NA	DISSOLVED OXYGEN (DO) mg/l	7.7
JN 02	5/22/2000	NA	DISSOLVED OXYGEN (DO) mg/l	9.2
JN 02	6/12/2000	NA	DISSOLVED OXYGEN (DO) mg/l	4.8
JN 02	8/9/2000	NA	DISSOLVED OXYGEN (DO) mg/l	5.3
JN 02	9/11/2000	NA	DISSOLVED OXYGEN (DO) mg/l	3.5
JN 02	10/23/2000	NA	DISSOLVED OXYGEN (DO) mg/l	7.4
JN 02	12/11/2000	NA	DISSOLVED OXYGEN (DO) mg/l	9.7
JN 02	1/16/2001	NA	DISSOLVED OXYGEN (DO) mg/l	11.7
JN 02	2/5/2001	NA	DISSOLVED OXYGEN (DO) mg/l	11.5
JN 02	3/26/2001	NA	DISSOLVED OXYGEN (DO) mg/l	12.4
JN 02	4/23/2001	NA	DISSOLVED OXYGEN (DO) mg/l	7.3
JN 02	6/18/2001	NA	DISSOLVED OXYGEN (DO) mg/l	7.2
JN 02	8/1/2001	NA	DISSOLVED OXYGEN (DO) mg/l	8.1
JN 02	10/15/2001	NA	DISSOLVED OXYGEN (DO) mg/l	6.8
JN 02	12/3/2001	NA	DISSOLVED OXYGEN (DO) mg/l	9.9
JN 02	1/23/2002	NA	DISSOLVED OXYGEN (DO) mg/l	10.2
JN 02	3/13/2002	NA	DISSOLVED OXYGEN (DO) mg/l	10.4
JN 02	4/15/2002	NA	DISSOLVED OXYGEN (DO) mg/l	8.5

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
JN 02	5/20/2002	NA	DISSOLVED OXYGEN (DO) mg/l	7.8
JN 02	6/24/2002	NA	DISSOLVED OXYGEN (DO) mg/l	6.6
JN 02	7/29/2002	NA	DISSOLVED OXYGEN (DO) mg/l	4
JN 02	9/11/2002	NA	DISSOLVED OXYGEN (DO) mg/l	9.1
JN 02	10/15/2002	NA	DISSOLVED OXYGEN (DO) mg/l	9.2
JN 02	12/2/2002	NA	DISSOLVED OXYGEN (DO) mg/l	9.3
JN 02	1/7/2003	NA	DISSOLVED OXYGEN (DO) mg/l	11.7
JN 02	2/21/2003	NA	DISSOLVED OXYGEN (DO) mg/l	12.1
JN 02	4/1/2003	NA	DISSOLVED OXYGEN (DO) mg/l	8.6
JN 02	5/12/2003	NA	DISSOLVED OXYGEN (DO) mg/l	7.7
JN 02	6/11/2003	NA	DISSOLVED OXYGEN (DO) mg/l	7.2
JN 02	8/12/2003	NA	DISSOLVED OXYGEN (DO) mg/l	2.3
JN 02	9/22/2003	NA	DISSOLVED OXYGEN (DO) mg/l	5.1
JN 02	10/28/2003	NA	DISSOLVED OXYGEN (DO) mg/l	4.5
JN 02	12/10/2003	NA	DISSOLVED OXYGEN (DO) mg/l	8.6
JN 02	1/22/1990	NA	DISSOLVED OXYGEN (DO) mg/l	12.90
JN 02	3/5/1990	NA	DISSOLVED OXYGEN (DO) mg/l	13.90
JN 02	4/9/1990	NA	DISSOLVED OXYGEN (DO) mg/l	8.70
JN 02	5/2/1990	NA	DISSOLVED OXYGEN (DO) mg/l	9.00
JN 02	6/18/1990	NA	DISSOLVED OXYGEN (DO) mg/l	5.90
JN 02	7/18/1990	NA	DISSOLVED OXYGEN (DO) mg/l	5.10
JN 02	7/25/1990	NA	DISSOLVED OXYGEN (DO) mg/l	5.70
JN 02	9/5/1990	NA	DISSOLVED OXYGEN (DO) mg/l	2.80
JN 02	10/15/1990	NA	DISSOLVED OXYGEN (DO) mg/l	6.60
JN 02	11/26/1990	NA	DISSOLVED OXYGEN (DO) mg/l	6.80
JN 02	1/16/1991	NA	DISSOLVED OXYGEN (DO) mg/l	11.30
JN 02	2/19/1991	NA	DISSOLVED OXYGEN (DO) mg/l	9.60
JN 02	4/22/1991	NA	DISSOLVED OXYGEN (DO) mg/l	10.30
JN 02	5/13/1991	NA	DISSOLVED OXYGEN (DO) mg/l	7.10
JN 02	6/5/1991	NA	DISSOLVED OXYGEN (DO) mg/l	6.50
JN 02	7/29/1991	NA	DISSOLVED OXYGEN (DO) mg/l	4.10
JN 02	9/3/1991	NA	DISSOLVED OXYGEN (DO) mg/l	6.60
JN 02	10/1/1991	NA	DISSOLVED OXYGEN (DO) mg/l	6.40
JN 02	11/25/1991	NA	DISSOLVED OXYGEN (DO) mg/l	12.00
JN 02	1/29/1992	NA	DISSOLVED OXYGEN (DO) mg/l	13.10
JN 02	3/3/1992	NA	DISSOLVED OXYGEN (DO) mg/l	10.90
JN 02	4/20/1992	NA	DISSOLVED OXYGEN (DO) mg/l	6.80
JN 02	5/26/1992	NA	DISSOLVED OXYGEN (DO) mg/l	5.50
JN 02	6/15/1992	NA	DISSOLVED OXYGEN (DO) mg/l	5.80
JN 02	7/29/1992	NA	DISSOLVED OXYGEN (DO) mg/l	7.00
JN 02	8/26/1992	NA	DISSOLVED OXYGEN (DO) mg/l	4.00
JN 02	10/27/1992	NA	DISSOLVED OXYGEN (DO) mg/l	4.00
JN 02	11/23/1992	NA	DISSOLVED OXYGEN (DO) mg/l	8.60
JN 02	1/6/1993	NA	DISSOLVED OXYGEN (DO) mg/l	10.90
JN 02	2/8/1993	NA	DISSOLVED OXYGEN (DO) mg/l	10.90
JN 02	3/22/1993	NA	DISSOLVED OXYGEN (DO) mg/l	13.00
JN 02	4/26/1993	NA	DISSOLVED OXYGEN (DO) mg/l	7.40
JN 02	6/16/1993	NA	DISSOLVED OXYGEN (DO) mg/l	6.10
JN 02	7/19/1993	NA	DISSOLVED OXYGEN (DO) mg/l	5.20
JN 02	9/8/1993	NA	DISSOLVED OXYGEN (DO) mg/l	3.50
JN 02	10/25/1993	NA	DISSOLVED OXYGEN (DO) mg/l	8.40

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
JN 02	11/29/1993	NA	DISSOLVED OXYGEN (DO) mg/l	9.80
JN 02	1/10/1994	NA	DISSOLVED OXYGEN (DO) mg/l	11.70
JN 02	2/9/1994	NA	DISSOLVED OXYGEN (DO) mg/l	12.00
JN 02	3/28/1994	NA	DISSOLVED OXYGEN (DO) mg/l	12.10
JN 02	5/4/1994	NA	DISSOLVED OXYGEN (DO) mg/l	8.30
JN 02	6/27/1994	NA	DISSOLVED OXYGEN (DO) mg/l	5.40
JN 02	8/1/1994	NA	DISSOLVED OXYGEN (DO) mg/l	3.90
JN 02	9/26/1994	NA	DISSOLVED OXYGEN (DO) mg/l	7.70
JN 02	11/2/1994	NA	DISSOLVED OXYGEN (DO) mg/l	10.60
JN 02	12/12/1994	NA	DISSOLVED OXYGEN (DO) mg/l	11.10
JN 02	1/23/1995	NA	DISSOLVED OXYGEN (DO) mg/l	11.50
JN 02	3/6/1995	NA	DISSOLVED OXYGEN (DO) mg/l	11.40
JN 02	4/10/1995	NA	DISSOLVED OXYGEN (DO) mg/l	9.40
JN 02	5/22/1995	NA	DISSOLVED OXYGEN (DO) mg/l	5.10
JN 02	6/19/1995	NA	DISSOLVED OXYGEN (DO) mg/l	5.80
JN 02	7/24/1995	NA	DISSOLVED OXYGEN (DO) mg/l	4.30
JN 02	8/28/1995	NA	DISSOLVED OXYGEN (DO) mg/l	5.30
JN 02	10/23/1995	NA	DISSOLVED OXYGEN (DO) mg/l	3.70
JN 02	11/27/1995	NA	DISSOLVED OXYGEN (DO) mg/l	5.00
JN 02	1/8/1996	NA	DISSOLVED OXYGEN (DO) mg/l	11.00
JN 02	2/14/1996	NA	DISSOLVED OXYGEN (DO) mg/l	12.40
JN 02	3/20/1996	NA	DISSOLVED OXYGEN (DO) mg/l	13.60
JN 02	4/22/1996	NA	DISSOLVED OXYGEN (DO) mg/l	7.50
JN 02	6/5/1996	NA	DISSOLVED OXYGEN (DO) mg/l	7.40
JN 02	7/17/1996	NA	DISSOLVED OXYGEN (DO) mg/l	7.20
JN 02	9/16/1996	NA	DISSOLVED OXYGEN (DO) mg/l	5.60
JN 02	10/21/1996	NA	DISSOLVED OXYGEN (DO) mg/l	4.40
JN 02	11/18/1996	NA	DISSOLVED OXYGEN (DO) mg/l	9.00
JN 02	1/21/1997	NA	DISSOLVED OXYGEN (DO) mg/l	12.90
JN 02	3/19/1997	NA	DISSOLVED OXYGEN (DO) mg/l	9.90
JN 02	4/21/1997	NA	DISSOLVED OXYGEN (DO) mg/l	8.70
JN 02	5/27/1997	NA	DISSOLVED OXYGEN (DO) mg/l	10.90
JN 02	7/9/1997	NA	DISSOLVED OXYGEN (DO) mg/l	8.20
JN 02	8/13/1997	NA	DISSOLVED OXYGEN (DO) mg/l	7.90
JN 02	9/24/1997	NA	DISSOLVED OXYGEN (DO) mg/l	4.90
JN 02	11/3/1997	NA	DISSOLVED OXYGEN (DO) mg/l	7.60
JN 02	12/8/1997	NA	DISSOLVED OXYGEN (DO) mg/l	11.70
JN 02	1/20/1998	NA	DISSOLVED OXYGEN (DO) mg/l	12.60
JN 02	3/2/1998	NA	DISSOLVED OXYGEN (DO) mg/l	12.00
JN 02	4/13/1998	NA	DISSOLVED OXYGEN (DO) mg/l	7.40
JN 02	5/26/1998	NA	DISSOLVED OXYGEN (DO) mg/l	5.80
JN 02	6/22/1998	NA	DISSOLVED OXYGEN (DO) mg/l	5.60
JN 02	8/17/1998	NA	DISSOLVED OXYGEN (DO) mg/l	6.60
JN 02	9/14/1998	NA	DISSOLVED OXYGEN (DO) mg/l	5.50
JN 02	10/19/1998	NA	DISSOLVED OXYGEN (DO) mg/l	7.20
JN 02	12/14/1998	NA	DISSOLVED OXYGEN (DO) mg/l	11.00
JNA 01	1/22/1990	NA	MANGANESE, TOTAL (UG/L AS MN)	527
JNA 01	3/5/1990	NA	MANGANESE, TOTAL (UG/L AS MN)	729
JNA 01	4/9/1990	NA	MANGANESE, TOTAL (UG/L AS MN)	775
JNA 01	5/2/1990	NA	MANGANESE, TOTAL (UG/L AS MN)	297
JNA 01	6/18/1990	NA	MANGANESE, TOTAL (UG/L AS MN)	961



**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
JNA 01	7/18/1990	NA	MANGANESE, TOTAL (UG/L AS MN)	152
JNA 01	7/25/1990	NA	MANGANESE, TOTAL (UG/L AS MN)	265
JNA 01	9/5/1990	NA	MANGANESE, TOTAL (UG/L AS MN)	127
JNA 01	10/15/1990	NA	MANGANESE, TOTAL (UG/L AS MN)	167
JNA 01	11/26/1990	NA	MANGANESE, TOTAL (UG/L AS MN)	116
JNA 01	1/16/1991	NA	MANGANESE, TOTAL (UG/L AS MN)	467
JNA 01	2/19/1991	NA	MANGANESE, TOTAL (UG/L AS MN)	921
JNA 01	4/23/1991	NA	MANGANESE, TOTAL (UG/L AS MN)	418
JNA 01	5/13/1991	NA	MANGANESE, TOTAL (UG/L AS MN)	410
JNA 01	6/5/1991	NA	MANGANESE, TOTAL (UG/L AS MN)	160
JNA 01	7/29/1991	NA	MANGANESE, TOTAL (UG/L AS MN)	107
JNA 01	9/3/1991	NA	MANGANESE, TOTAL (UG/L AS MN)	230
JNA 01	10/1/1991	NA	MANGANESE, TOTAL (UG/L AS MN)	68
JNA 01	11/25/1991	NA	MANGANESE, TOTAL (UG/L AS MN)	510
JNA 01	1/29/1992	NA	MANGANESE, TOTAL (UG/L AS MN)	860
JNA 01	3/3/1992	NA	MANGANESE, TOTAL (UG/L AS MN)	710
JNA 01	4/20/1992	NA	MANGANESE, TOTAL (UG/L AS MN)	520
JNA 01	5/26/1992	NA	MANGANESE, TOTAL (UG/L AS MN)	280
JNA 01	6/15/1992	NA	MANGANESE, TOTAL (UG/L AS MN)	160
JNA 01	7/29/1992	NA	MANGANESE, TOTAL (UG/L AS MN)	220
JNA 01	8/26/1992	NA	MANGANESE, TOTAL (UG/L AS MN)	120
JNA 01	10/27/1992	NA	MANGANESE, TOTAL (UG/L AS MN)	88
JNA 01	11/23/1992	NA	MANGANESE, TOTAL (UG/L AS MN)	400
JNA 01	1/6/1993	NA	MANGANESE, TOTAL (UG/L AS MN)	390
JNA 01	2/8/1993	NA	MANGANESE, TOTAL (UG/L AS MN)	800
JNA 01	3/22/1993	NA	MANGANESE, TOTAL (UG/L AS MN)	480
JNA 01	4/26/1993	NA	MANGANESE, TOTAL (UG/L AS MN)	340
JNA 01	6/16/1993	NA	MANGANESE, TOTAL (UG/L AS MN)	220
JNA 01	7/19/1993	NA	MANGANESE, TOTAL (UG/L AS MN)	350
JNA 01	9/8/1993	NA	MANGANESE, TOTAL (UG/L AS MN)	130
JNA 01	10/25/1993	NA	MANGANESE, TOTAL (UG/L AS MN)	300
JNA 01	11/29/1993	NA	MANGANESE, TOTAL (UG/L AS MN)	590
JNA 01	1/10/1994	NA	MANGANESE, TOTAL (UG/L AS MN)	820
JNA 01	2/9/1994	NA	MANGANESE, TOTAL (UG/L AS MN)	510
JNA 01	3/28/1994	NA	MANGANESE, TOTAL (UG/L AS MN)	450
JNA 01	5/4/1994	NA	MANGANESE, TOTAL (UG/L AS MN)	370
JNA 01	6/27/1994	NA	MANGANESE, TOTAL (UG/L AS MN)	390
JNA 01	8/1/1994	NA	MANGANESE, TOTAL (UG/L AS MN)	75
JNA 01	9/26/1994	NA	MANGANESE, TOTAL (UG/L AS MN)	1100
JNA 01	11/2/1994	NA	MANGANESE, TOTAL (UG/L AS MN)	120
JNA 01	12/12/1994	NA	MANGANESE, TOTAL (UG/L AS MN)	480
JNA 01	1/23/1995	NA	MANGANESE, TOTAL (UG/L AS MN)	530
JNA 01	3/6/1995	NA	MANGANESE, TOTAL (UG/L AS MN)	640
JNA 01	4/10/1995	NA	MANGANESE, TOTAL (UG/L AS MN)	380
JNA 01	5/22/1995	NA	MANGANESE, TOTAL (UG/L AS MN)	400
JNA 01	6/19/1995	NA	MANGANESE, TOTAL (UG/L AS MN)	630
JNA 01	7/24/1995	NA	MANGANESE, TOTAL (UG/L AS MN)	310
JNA 01	8/28/1995	NA	MANGANESE, TOTAL (UG/L AS MN)	860
JNA 01	10/23/1995	NA	MANGANESE, TOTAL (UG/L AS MN)	190
JNA 01	11/27/1995	NA	MANGANESE, TOTAL (UG/L AS MN)	140
JNA 01	1/8/1996	NA	MANGANESE, TOTAL (UG/L AS MN)	540

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
JNA 01	2/14/1996	NA	MANGANESE, TOTAL (UG/L AS MN)	560
JNA 01	3/20/1996	NA	MANGANESE, TOTAL (UG/L AS MN)	180
JNA 01	4/22/1996	NA	MANGANESE, TOTAL (UG/L AS MN)	3800
JNA 01	6/5/1996	NA	MANGANESE, TOTAL (UG/L AS MN)	430
JNA 01	7/17/1996	NA	MANGANESE, TOTAL (UG/L AS MN)	190
JNA 01	9/16/1996	NA	MANGANESE, TOTAL (UG/L AS MN)	210
JNA 01	10/21/1996	NA	MANGANESE, TOTAL (UG/L AS MN)	250
JNA 01	11/18/1996	NA	MANGANESE, TOTAL (UG/L AS MN)	510
JNA 01	1/21/1997	NA	MANGANESE, TOTAL (UG/L AS MN)	590
JNA 01	3/19/1997	NA	MANGANESE, TOTAL (UG/L AS MN)	410
JNA 01	4/21/1997	NA	MANGANESE, TOTAL (UG/L AS MN)	600
JNA 01	5/27/1997	NA	MANGANESE, TOTAL (UG/L AS MN)	400
JNA 01	7/9/1997	NA	MANGANESE, TOTAL (UG/L AS MN)	220
JNA 01	8/13/1997	NA	MANGANESE, TOTAL (UG/L AS MN)	100
JNA 01	9/24/1997	NA	MANGANESE, TOTAL (UG/L AS MN)	150
JNA 01	11/3/1997	NA	MANGANESE, TOTAL (UG/L AS MN)	120
JNA 01	12/8/1997	NA	MANGANESE, TOTAL (UG/L AS MN)	180
JNA 01	1/20/1998	NA	MANGANESE, TOTAL (UG/L AS MN)	510
JNA 01	3/2/1998	NA	MANGANESE, TOTAL (UG/L AS MN)	540
JNA 01	4/13/1998	NA	MANGANESE, TOTAL (UG/L AS MN)	370
JNA 01	5/26/1998	NA	MANGANESE, TOTAL (UG/L AS MN)	360
JNA 01	6/22/1998	NA	MANGANESE, TOTAL (UG/L AS MN)	230
JNA 01	8/17/1998	NA	MANGANESE, TOTAL (UG/L AS MN)	170
JNA 01	9/14/1998	NA	MANGANESE, TOTAL (UG/L AS MN)	130
JNA 01	10/19/1998	NA	MANGANESE, TOTAL (UG/L AS MN)	120
JNA 01	12/14/1998	NA	MANGANESE, TOTAL (UG/L AS MN)	240
JNA 02	9/17/1998	NA	MANGANESE, TOTAL (UG/L AS MN)	270
RJC-1	4/6/1993	1	PH (STANDARD UNITS)	8.20
RJC-1	6/24/1993	1	PH (STANDARD UNITS)	8.00
RJC-1	7/21/1993	1	PH (STANDARD UNITS)	8.20
RJC-1	8/23/1993	1	PH (STANDARD UNITS)	8.70
RJC-1	10/18/1993	1	PH (STANDARD UNITS)	8.10
RJC-1	5/8/1996	1	PH (STANDARD UNITS)	8.70
RJC-1	6/26/1996	1	PH (STANDARD UNITS)	8.80
RJC-1	7/25/1996	1	PH (STANDARD UNITS)	8.50
RJC-1	8/30/1996	1	PH (STANDARD UNITS)	8.40
RJC-1	10/8/1996	1	PH (STANDARD UNITS)	8.80
RJC-1	5/7/1999	1	PH (STANDARD UNITS)	7.60
RJC-1	6/9/1999	1	PH (STANDARD UNITS)	8.30
RJC-1	7/14/1999	1	PH (STANDARD UNITS)	8.40
RJC-1	8/25/1999	1	PH (STANDARD UNITS)	8.10
RJC-1	10/25/1999	1	PH (STANDARD UNITS)	8.40
RJC-1	4/23/2002	1	PH (STANDARD UNITS)	8.40
RJC-1	6/12/2002	1	PH (STANDARD UNITS)	8.50
RJC-1	8/14/2002	1	PH (STANDARD UNITS)	8.00
RJC-1	10/16/2002	1	PH (STANDARD UNITS)	8.00
RJC-1	4/6/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.04
RJC-1	4/6/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.04
RJC-1	6/24/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJC-1	6/24/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJC-1	7/21/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13

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**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJC-1	7/21/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJC-1	8/23/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.19
RJC-1	8/23/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.19
RJC-1	10/18/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJC-1	10/18/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJC-1	5/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
RJC-1	5/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
RJC-1	6/26/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJC-1	6/26/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJC-1	7/25/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJC-1	7/25/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJC-1	8/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
RJC-1	8/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
RJC-1	10/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJC-1	10/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJC-1	5/25/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJC-1	5/25/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJC-1	6/12/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJC-1	6/12/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJC-1	7/10/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.19
RJC-1	7/10/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.19
RJC-1	8/7/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.30
RJC-1	8/7/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.30
RJC-1	9/27/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJC-1	9/27/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJC-1	5/26/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJC-1	5/26/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJC-1	7/17/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJC-1	7/17/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJC-1	8/14/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJC-1	8/14/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJC-1	9/26/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
RJC-1	9/26/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
RJC-1	10/11/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
RJC-1	10/11/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
RJC-1	5/7/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.06
RJC-1	5/7/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.06
RJC-1	6/9/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.06
RJC-1	6/9/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.06
RJC-1	7/14/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.97
RJC-1	7/14/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.97
RJC-1	8/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.09
RJC-1	8/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.09
RJC-1	10/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-1	10/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-1	4/23/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-1	4/23/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-1	6/12/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJC-1	6/12/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJC-1	8/14/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJC-1	8/14/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22

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Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJC-1	10/16/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.19
RJC-1	10/16/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.19
RJC-2	4/6/1993	1	PH (STANDARD UNITS)	8.10
RJC-2	6/24/1993	1	PH (STANDARD UNITS)	8.00
RJC-2	7/21/1993	1	PH (STANDARD UNITS)	8.00
RJC-2	8/23/1993	1	PH (STANDARD UNITS)	8.70
RJC-2	10/18/1993	1	PH (STANDARD UNITS)	8.10
RJC-2	5/8/1996	1	PH (STANDARD UNITS)	8.60
RJC-2	6/26/1996	1	PH (STANDARD UNITS)	8.80
RJC-2	7/25/1996	1	PH (STANDARD UNITS)	8.90
RJC-2	8/30/1996	1	PH (STANDARD UNITS)	9.00
RJC-2	10/8/1996	1	PH (STANDARD UNITS)	8.80
RJC-2	5/7/1999	1	PH (STANDARD UNITS)	8.20
RJC-2	6/9/1999	1	PH (STANDARD UNITS)	8.50
RJC-2	7/14/1999	1	PH (STANDARD UNITS)	8.60
RJC-2	8/25/1999	1	PH (STANDARD UNITS)	8.90
RJC-2	10/25/1999	1	PH (STANDARD UNITS)	8.90
RJC-2	4/23/2002	1	PH (STANDARD UNITS)	8.70
RJC-2	6/12/2002	1	PH (STANDARD UNITS)	8.80
RJC-2	8/14/2002	1	PH (STANDARD UNITS)	8.50
RJC-2	10/16/2002	1	PH (STANDARD UNITS)	8.80
RJC-2	4/6/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.05
RJC-2	4/6/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.05
RJC-2	6/24/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJC-2	6/24/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJC-2	7/21/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
RJC-2	7/21/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
RJC-2	8/23/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.19
RJC-2	8/23/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.19
RJC-2	10/18/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJC-2	10/18/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJC-2	5/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJC-2	5/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJC-2	6/26/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJC-2	6/26/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJC-2	7/25/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.31
RJC-2	7/25/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.31
RJC-2	8/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.29
RJC-2	8/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.29
RJC-2	10/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJC-2	10/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJC-2	5/7/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-2	5/7/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-2	6/9/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-2	6/9/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-2	7/14/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJC-2	7/14/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJC-2	8/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJC-2	8/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJC-2	10/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.07
RJC-2	10/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.07

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Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJC-2	4/23/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.96
RJC-2	4/23/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.96
RJC-2	6/12/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJC-2	6/12/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJC-2	8/14/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.30
RJC-2	8/14/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.30
RJC-2	10/16/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJC-2	10/16/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJC-3	4/6/1993	1	PH (STANDARD UNITS)	8.30
RJC-3	6/24/1993	1	PH (STANDARD UNITS)	8.30
RJC-3	7/21/1993	1	PH (STANDARD UNITS)	8.10
RJC-3	8/23/1993	1	PH (STANDARD UNITS)	9.00
RJC-3	10/18/1993	1	PH (STANDARD UNITS)	8.60
RJC-3	5/8/1996	1	PH (STANDARD UNITS)	8.80
RJC-3	6/26/1996	1	PH (STANDARD UNITS)	9.30
RJC-3	7/25/1996	1	PH (STANDARD UNITS)	8.70
RJC-3	8/30/1996	1	PH (STANDARD UNITS)	8.70
RJC-3	10/8/1996	1	PH (STANDARD UNITS)	9.00
RJC-3	5/7/1999	1	PH (STANDARD UNITS)	8.50
RJC-3	6/9/1999	1	PH (STANDARD UNITS)	8.90
RJC-3	7/14/1999	1	PH (STANDARD UNITS)	9.20
RJC-3	8/25/1999	1	PH (STANDARD UNITS)	8.80
RJC-3	10/25/1999	1	PH (STANDARD UNITS)	8.80
RJC-3	4/23/2002	1	PH (STANDARD UNITS)	8.60
RJC-3	7/17/2002	1	PH (STANDARD UNITS)	9.10
RJC-3	8/14/2002	1	PH (STANDARD UNITS)	8.70
RJC-3	10/16/2002	1	PH (STANDARD UNITS)	8.70
RJC-3	4/6/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.03
RJC-3	4/6/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.03
RJC-3	6/24/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJC-3	6/24/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJC-3	7/21/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJC-3	7/21/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJC-3	8/23/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJC-3	8/23/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJC-3	10/18/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-3	10/18/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-3	5/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-3	5/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-3	6/26/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJC-3	6/26/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJC-3	7/25/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJC-3	7/25/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJC-3	8/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.21
RJC-3	8/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.21
RJC-3	10/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJC-3	10/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJC-3	5/7/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.50
RJC-3	5/7/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.50
RJC-3	6/9/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.50
RJC-3	6/9/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.50

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJC-3	7/14/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJC-3	7/14/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJC-3	8/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-3	8/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-3	10/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.04
RJC-3	10/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.04
RJC-3	4/23/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-3	4/23/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJC-3	7/17/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.21
RJC-3	7/17/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.21
RJC-3	8/14/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.21
RJC-3	8/14/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.21
RJC-3	10/16/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
RJC-3	10/16/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
RJC-4	4/6/1993	1	PH (STANDARD UNITS)	8.20
RJC-4	6/24/1993	1	PH (STANDARD UNITS)	8.20
RJC-4	7/21/1993	1	PH (STANDARD UNITS)	7.80
RJC-4	8/23/1993	1	PH (STANDARD UNITS)	9.10
RJC-4	10/18/1993	1	PH (STANDARD UNITS)	8.50
RJC-4	5/8/1996	1	PH (STANDARD UNITS)	8.70
RJC-4	6/26/1996	1	PH (STANDARD UNITS)	8.80
RJC-4	7/25/1996	1	PH (STANDARD UNITS)	8.90
RJC-4	8/30/1996	1	PH (STANDARD UNITS)	8.80
RJC-4	10/8/1996	1	PH (STANDARD UNITS)	8.90
RJC-4	5/7/1999	1	PH (STANDARD UNITS)	8.20
RJC-4	6/9/1999	1	PH (STANDARD UNITS)	8.80
RJC-4	7/14/1999	1	PH (STANDARD UNITS)	8.90
RJC-4	8/25/1999	1	PH (STANDARD UNITS)	8.80
RJC-4	10/25/1999	1	PH (STANDARD UNITS)	8.90
RJC-4	4/23/2002	1	PH (STANDARD UNITS)	8.80
RJC-4	7/17/2002	1	PH (STANDARD UNITS)	9.00
RJC-4	8/14/2002	1	PH (STANDARD UNITS)	8.80
RJC-4	10/16/2002	1	PH (STANDARD UNITS)	8.80
RJC-4	4/6/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.05
RJC-4	4/6/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.05
RJC-4	6/24/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJC-4	6/24/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJC-4	7/21/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
RJC-4	7/21/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
RJC-4	8/23/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
RJC-4	8/23/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
RJC-4	10/18/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJC-4	10/18/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJC-4	5/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJC-4	5/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJC-4	6/26/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJC-4	6/26/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJC-4	7/25/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJC-4	7/25/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJC-4	8/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.39
RJC-4	8/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.39

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJC-4	10/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJC-4	10/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJC-4	5/7/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.90
RJC-4	5/7/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.90
RJC-4	6/9/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
RJC-4	6/9/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
RJC-4	7/14/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJC-4	7/14/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJC-4	8/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJC-4	8/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJC-4	10/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.07
RJC-4	10/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.07
RJC-4	4/23/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJC-4	4/23/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJC-4	7/17/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.43
RJC-4	7/17/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.43
RJC-4	8/14/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.35
RJC-4	8/14/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.35
RJC-4	10/16/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
RJC-4	10/16/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
RJK-1	5/30/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJK-1	5/30/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJK-1	6/30/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJK-1	6/30/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJK-1	7/16/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJK-1	7/16/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJK-1	10/10/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.27
RJK-1	10/10/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJK-1	10/10/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.45
RJK-1	10/10/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJK-1	10/10/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.34
RJK-1	10/10/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
RJK-1	10/10/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.27
RJK-1	10/10/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJK-1	10/10/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.45
RJK-1	10/10/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJK-1	10/10/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.34
RJK-1	10/10/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
RJK-1	11/5/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJK-1	11/5/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJK-1	11/27/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.51
RJK-1	11/27/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.30
RJK-1	11/27/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.51
RJK-1	11/27/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.30
RJK-1	11/28/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.55
RJK-1	11/28/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.53
RJK-1	11/28/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.61
RJK-1	11/28/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.55
RJK-1	11/28/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.53
RJK-1	11/28/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.61
RJK-1	12/17/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.37

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJK-1	12/17/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	3.40
RJK-1	12/17/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.41
RJK-1	12/17/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.37
RJK-1	12/17/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	3.40
RJK-1	12/17/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.41
RJK-1	12/18/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	12/18/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJK-1	12/18/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJK-1	12/18/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	12/18/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJK-1	12/18/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJK-1	3/19/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
RJK-1	3/19/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	3/19/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.19
RJK-1	3/19/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
RJK-1	3/19/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	3/19/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.19
RJK-1	10/22/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.43
RJK-1	10/22/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.43
RJK-1	12/3/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.23
RJK-1	12/3/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.23
RJK-1	12/12/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJK-1	12/12/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJK-1	12/26/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJK-1	12/26/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJK-1	1/29/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
RJK-1	1/29/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
RJK-1	2/27/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	2/27/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	3/11/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	3/11/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	4/9/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJK-1	4/9/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJK-1	4/21/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.28
RJK-1	4/21/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.28
RJK-1	5/5/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.29
RJK-1	5/5/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.29
RJK-1	5/15/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJK-1	5/15/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJK-1	5/28/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	5/28/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	6/8/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
RJK-1	6/8/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
RJK-1	6/22/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	6/22/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	7/20/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.32
RJK-1	7/20/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.32
RJK-1	8/3/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.39
RJK-1	8/3/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.39
RJK-1	8/17/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.58
RJK-1	8/17/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.58



**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJK-1	8/28/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
RJK-1	8/28/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
RJK-1	9/10/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJK-1	9/10/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJK-1	9/23/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	1.64
RJK-1	9/23/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	1.64
RJK-1	10/8/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	1.85
RJK-1	10/8/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	1.85
RJK-1	11/2/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJK-1	11/2/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJK-1	11/16/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
RJK-1	11/16/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
RJK-1	11/30/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.30
RJK-1	11/30/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.30
RJK-1	12/15/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.26
RJK-1	12/15/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.31
RJK-1	12/15/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.26
RJK-1	12/15/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.31
RJK-1	12/16/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.46
RJK-1	12/16/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.40
RJK-1	12/16/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.46
RJK-1	12/16/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.40
RJK-1	6/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.09
RJK-1	6/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.09
RJK-1	7/20/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	7/20/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	8/31/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJK-1	8/31/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJK-1	9/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.01
RJK-1	9/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.01
RJK-1	10/21/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJK-1	10/21/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJK-1	10/31/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.06
RJK-1	10/31/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.06
RJK-1	5/25/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	5/25/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	6/12/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.09
RJK-1	6/12/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.09
RJK-1	7/10/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJK-1	7/10/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJK-1	8/9/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.21
RJK-1	8/9/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.21
RJK-1	9/27/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.21
RJK-1	9/27/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.21
RJK-1	10/31/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJK-1	10/31/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJK-1	5/26/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJK-1	5/26/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJK-1	7/25/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	7/25/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJK-1	8/22/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJK-1	8/22/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
RJK-1	9/21/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJK-1	9/21/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJK-1	10/11/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJK-1	10/11/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJK-1	5/6/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.057
RJK-1	5/6/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.057
RJK-1	6/9/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.051
RJK-1	6/9/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.051
RJK-1	7/14/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.073
RJK-1	7/14/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.073
RJK-1	8/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.078
RJK-1	8/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.078
RJK-1	10/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.061
RJK-1	10/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.061
RJK-1	4/23/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.112
RJK-1	4/23/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.112
RJK-1	6/12/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.126
RJK-1	6/12/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.126
RJK-1	7/17/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJK-1	7/17/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJK-1	8/14/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.184
RJK-1	8/14/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.184
RJK-1	10/16/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.169
RJK-1	10/16/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.169
RJK-1	5/30/1990	1	Total Phosphorus, mg/L	0.18
RJK-1	6/30/1990	1	Total Phosphorus, mg/L	0.22
RJK-1	7/16/1990	1	Total Phosphorus, mg/L	0.11
RJK-1	10/10/1990	1	Total Phosphorus, mg/L	0.27
RJK-1	10/10/1990	1	Total Phosphorus, mg/L	0.11
RJK-1	10/10/1990	1	Total Phosphorus, mg/L	0.45
RJK-1	10/10/1990	1	Total Phosphorus, mg/L	0.12
RJK-1	10/10/1990	1	Total Phosphorus, mg/L	0.34
RJK-1	10/10/1990	1	Total Phosphorus, mg/L	0.10
RJK-1	11/5/1990	1	Total Phosphorus, mg/L	0.22
RJK-1	11/27/1990	1	Total Phosphorus, mg/L	0.51
RJK-1	11/27/1990	1	Total Phosphorus, mg/L	0.30
RJK-1	11/28/1990	1	Total Phosphorus, mg/L	0.55
RJK-1	11/28/1990	1	Total Phosphorus, mg/L	0.53
RJK-1	11/28/1990	1	Total Phosphorus, mg/L	0.61
RJK-1	12/17/1990	1	Total Phosphorus, mg/L	0.37
RJK-1	12/17/1990	1	Total Phosphorus, mg/L	3.40
RJK-1	12/17/1990	1	Total Phosphorus, mg/L	0.41
RJK-1	12/18/1990	1	Total Phosphorus, mg/L	0.16
RJK-1	12/18/1990	1	Total Phosphorus, mg/L	0.13
RJK-1	12/18/1990	1	Total Phosphorus, mg/L	0.15
RJK-1	3/19/1991	1	Total Phosphorus, mg/L	0.20
RJK-1	3/19/1991	1	Total Phosphorus, mg/L	0.16
RJK-1	3/19/1991	1	Total Phosphorus, mg/L	0.19
RJK-1	10/22/1991	1	Total Phosphorus, mg/L	0.43
RJK-1	12/3/1991	1	Total Phosphorus, mg/L	0.23

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJK-1	12/12/1991	1	Total Phosphorus, mg/L	0.11
RJK-1	12/26/1991	1	Total Phosphorus, mg/L	0.08
RJK-1	1/29/1992	1	Total Phosphorus, mg/L	0.10
RJK-1	2/27/1992	1	Total Phosphorus, mg/L	0.16
RJK-1	3/11/1992	1	Total Phosphorus, mg/L	0.16
RJK-1	4/9/1992	1	Total Phosphorus, mg/L	0.12
RJK-1	4/21/1992	1	Total Phosphorus, mg/L	0.28
RJK-1	5/5/1992	1	Total Phosphorus, mg/L	0.29
RJK-1	5/15/1992	1	Total Phosphorus, mg/L	0.12
RJK-1	5/28/1992	1	Total Phosphorus, mg/L	0.16
RJK-1	6/8/1992	1	Total Phosphorus, mg/L	0.17
RJK-1	6/22/1992	1	Total Phosphorus, mg/L	0.16
RJK-1	7/20/1992	1	Total Phosphorus, mg/L	0.32
RJK-1	8/3/1992	1	Total Phosphorus, mg/L	0.39
RJK-1	8/17/1992	1	Total Phosphorus, mg/L	0.58
RJK-1	8/28/1992	1	Total Phosphorus, mg/L	0.20
RJK-1	9/10/1992	1	Total Phosphorus, mg/L	0.13
RJK-1	9/23/1992	1	Total Phosphorus, mg/L	1.64
RJK-1	10/8/1992	1	Total Phosphorus, mg/L	1.85
RJK-1	11/2/1992	1	Total Phosphorus, mg/L	0.13
RJK-1	11/16/1992	1	Total Phosphorus, mg/L	0.17
RJK-1	11/30/1992	1	Total Phosphorus, mg/L	0.30
RJK-1	12/15/1992	1	Total Phosphorus, mg/L	0.26
RJK-1	12/15/1992	1	Total Phosphorus, mg/L	0.31
RJK-1	12/16/1992	1	Total Phosphorus, mg/L	0.46
RJK-1	12/16/1992	1	Total Phosphorus, mg/L	0.40
RJK-1	6/30/1996	1	Total Phosphorus, mg/L	0.09
RJK-1	7/20/1996	1	Total Phosphorus, mg/L	0.16
RJK-1	8/31/1996	1	Total Phosphorus, mg/L	0.22
RJK-1	9/30/1996	1	Total Phosphorus, mg/L	0.01
RJK-1	10/21/1996	1	Total Phosphorus, mg/L	0.14
RJK-1	10/31/1996	1	Total Phosphorus, mg/L	0.06
RJK-1	5/25/1997	1	Total Phosphorus, mg/L	0.16
RJK-1	6/12/1997	1	Total Phosphorus, mg/L	0.09
RJK-1	7/10/1997	1	Total Phosphorus, mg/L	0.14
RJK-1	8/9/1997	1	Total Phosphorus, mg/L	0.21
RJK-1	9/27/1997	1	Total Phosphorus, mg/L	0.21
RJK-1	10/31/1997	1	Total Phosphorus, mg/L	0.14
RJK-1	5/26/1998	1	Total Phosphorus, mg/L	0.12
RJK-1	7/25/1998	1	Total Phosphorus, mg/L	0.16
RJK-1	8/22/1998	1	Total Phosphorus, mg/L	0.20
RJK-1	9/21/1998	1	Total Phosphorus, mg/L	0.15
RJK-1	10/11/1998	1	Total Phosphorus, mg/L	0.15
RJK-1	5/6/1999	1	Total Phosphorus, mg/L	0.06
RJK-1	6/9/1999	1	Total Phosphorus, mg/L	0.05
RJK-1	7/14/1999	1	Total Phosphorus, mg/L	0.07
RJK-1	8/25/1999	1	Total Phosphorus, mg/L	0.08
RJK-1	10/25/1999	1	Total Phosphorus, mg/L	0.06
RJK-1	4/23/2002	1	Total Phosphorus, mg/L	0.11
RJK-1	6/12/2002	1	Total Phosphorus, mg/L	0.13
RJK-1	7/17/2002	1	Total Phosphorus, mg/L	0.13

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJK-1	8/14/2002	1	Total Phosphorus, mg/L	0.18
RJK-1	10/16/2002	1	Total Phosphorus, mg/L	0.17
RJL-1	1/17/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJL-1	1/17/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJL-1	2/14/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJL-1	2/14/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJL-1	3/21/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	3/21/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	4/23/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJL-1	4/23/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJL-1	5/16/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJL-1	5/16/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
RJL-1	5/24/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	5/24/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	5/30/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJL-1	5/30/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJL-1	6/7/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJL-1	6/7/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJL-1	6/30/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJL-1	6/30/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJL-1	7/9/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	7/9/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	7/16/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.04
RJL-1	7/16/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.04
RJL-1	8/13/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJL-1	8/13/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJL-1	9/19/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJL-1	9/19/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJL-1	10/9/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	10/9/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	11/7/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJL-1	11/7/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJL-1	12/11/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJL-1	12/11/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJL-1	2/21/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
RJL-1	2/21/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
RJL-1	3/19/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.09
RJL-1	3/19/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.09
RJL-1	4/17/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJL-1	4/17/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJL-1	5/14/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
RJL-1	5/14/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
RJL-1	6/13/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJL-1	6/13/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJL-1	7/11/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	7/11/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	8/22/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
RJL-1	8/22/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
RJL-1	9/4/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.28
RJL-1	9/4/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	9/4/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.44

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJL-1	9/4/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	9/4/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	9/4/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJL-1	9/4/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.28
RJL-1	9/4/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	9/4/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.44
RJL-1	9/4/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	9/4/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	9/4/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
RJL-1	9/18/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.19
RJL-1	9/18/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	9/18/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	9/18/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	9/18/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJL-1	9/18/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	9/18/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.19
RJL-1	9/18/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	9/18/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	9/18/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	9/18/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	9/18/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJL-1	9/18/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	9/20/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.32
RJL-1	9/20/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.32
RJL-1	10/22/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	10/22/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	11/19/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJL-1	11/19/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJL-1	12/12/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJL-1	12/12/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
RJL-1	4/9/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJL-1	4/9/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJL-1	6/22/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	6/22/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	7/15/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	7/15/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJL-1	7/15/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJL-1	7/15/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
RJL-1	7/15/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJL-1	7/15/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
RJL-1	7/20/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	7/20/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	8/17/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
RJL-1	8/17/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
RJL-1	10/19/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	10/19/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	5/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJL-1	5/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
RJL-1	6/26/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJL-1	6/26/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
RJL-1	7/26/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJL-1	7/26/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJL-1	8/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJL-1	8/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.18
RJL-1	10/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	10/8/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
RJL-1	5/6/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.053
RJL-1	5/6/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.053
RJL-1	6/9/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.059
RJL-1	6/9/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.059
RJL-1	7/14/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.077
RJL-1	7/14/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.077
RJL-1	8/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.069
RJL-1	8/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.069
RJL-1	10/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.056
RJL-1	10/25/1999	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.056
RJL-1	4/23/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.112
RJL-1	4/23/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.112
RJL-1	6/12/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.145
RJL-1	6/12/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.145
RJL-1	7/17/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.147
RJL-1	7/17/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.147
RJL-1	8/14/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.192
RJL-1	8/14/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.192
RJL-1	10/16/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.167
RJL-1	10/16/2002	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.167
RJL-1	1/17/1990	1	Total Phosphorus, mg/L	0.15
RJL-1	2/14/1990	1	Total Phosphorus, mg/L	0.11
RJL-1	3/21/1990	1	Total Phosphorus, mg/L	0.14
RJL-1	4/23/1990	1	Total Phosphorus, mg/L	0.13
RJL-1	5/16/1990	1	Total Phosphorus, mg/L	0.12
RJL-1	5/24/1990	1	Total Phosphorus, mg/L	0.16
RJL-1	5/30/1990	1	Total Phosphorus, mg/L	0.18
RJL-1	6/7/1990	1	Total Phosphorus, mg/L	0.15
RJL-1	6/30/1990	1	Total Phosphorus, mg/L	0.18
RJL-1	7/9/1990	1	Total Phosphorus, mg/L	0.16
RJL-1	7/16/1990	1	Total Phosphorus, mg/L	0.04
RJL-1	8/13/1990	1	Total Phosphorus, mg/L	0.15
RJL-1	9/19/1990	1	Total Phosphorus, mg/L	0.22
RJL-1	10/9/1990	1	Total Phosphorus, mg/L	0.14
RJL-1	11/7/1990	1	Total Phosphorus, mg/L	0.08
RJL-1	12/11/1990	1	Total Phosphorus, mg/L	0.08
RJL-1	2/21/1991	1	Total Phosphorus, mg/L	0.10
RJL-1	3/19/1991	1	Total Phosphorus, mg/L	0.09
RJL-1	4/17/1991	1	Total Phosphorus, mg/L	0.08
RJL-1	5/14/1991	1	Total Phosphorus, mg/L	0.10
RJL-1	6/13/1991	1	Total Phosphorus, mg/L	0.13
RJL-1	7/11/1991	1	Total Phosphorus, mg/L	0.16
RJL-1	8/22/1991	1	Total Phosphorus, mg/L	0.17
RJL-1	9/4/1991	1	Total Phosphorus, mg/L	0.28
RJL-1	9/4/1991	1	Total Phosphorus, mg/L	0.16
RJL-1	9/4/1991	1	Total Phosphorus, mg/L	0.44
RJL-1	9/4/1991	1	Total Phosphorus, mg/L	0.16

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJL-1	9/4/1991	1	Total Phosphorus, mg/L	0.16
RJL-1	9/4/1991	1	Total Phosphorus, mg/L	0.22
RJL-1	9/18/1991	1	Total Phosphorus, mg/L	0.19
RJL-1	9/18/1991	1	Total Phosphorus, mg/L	0.14
RJL-1	9/18/1991	1	Total Phosphorus, mg/L	0.14
RJL-1	9/18/1991	1	Total Phosphorus, mg/L	0.14
RJL-1	9/18/1991	1	Total Phosphorus, mg/L	0.15
RJL-1	9/18/1991	1	Total Phosphorus, mg/L	0.14
RJL-1	9/20/1991	1	Total Phosphorus, mg/L	0.32
RJL-1	10/22/1991	1	Total Phosphorus, mg/L	0.16
RJL-1	11/19/1991	1	Total Phosphorus, mg/L	0.08
RJL-1	12/12/1991	1	Total Phosphorus, mg/L	0.08
RJL-1	4/9/1992	1	Total Phosphorus, mg/L	0.11
RJL-1	6/22/1992	1	Total Phosphorus, mg/L	0.14
RJL-1	7/15/1992	1	Total Phosphorus, mg/L	0.14
RJL-1	7/15/1992	1	Total Phosphorus, mg/L	0.15
RJL-1	7/15/1992	1	Total Phosphorus, mg/L	0.13
RJL-1	7/20/1992	1	Total Phosphorus, mg/L	0.16
RJL-1	8/17/1992	1	Total Phosphorus, mg/L	0.20
RJL-1	10/19/1992	1	Total Phosphorus, mg/L	0.16
RJL-1	5/8/1996	1	Total Phosphorus, mg/L	0.15
RJL-1	6/26/1996	1	Total Phosphorus, mg/L	0.11
RJL-1	7/26/1996	1	Total Phosphorus, mg/L	0.18
RJL-1	8/30/1996	1	Total Phosphorus, mg/L	0.18
RJL-1	10/8/1996	1	Total Phosphorus, mg/L	0.16
RJL-1	5/6/1999	1	Total Phosphorus, mg/L	0.05
RJL-1	6/9/1999	1	Total Phosphorus, mg/L	0.06
RJL-1	7/14/1999	1	Total Phosphorus, mg/L	0.08
RJL-1	8/25/1999	1	Total Phosphorus, mg/L	0.07
RJL-1	10/25/1999	1	Total Phosphorus, mg/L	0.06
RJL-1	4/23/2002	1	Total Phosphorus, mg/L	0.11
RJL-1	6/12/2002	1	Total Phosphorus, mg/L	0.15
RJL-1	7/17/2002	1	Total Phosphorus, mg/L	0.15
RJL-1	8/14/2002	1	Total Phosphorus, mg/L	0.19
RJL-1	10/16/2002	1	Total Phosphorus, mg/L	0.17
RJM-1	1/17/1990	1	Dissolved Oxygen, mg/L	13.4
RJM-1	2/14/1990	1	Dissolved Oxygen, mg/L	11.8
RJM-1	3/21/1990	1	Dissolved Oxygen, mg/L	10.8
RJM-1	4/23/1990	1	Dissolved Oxygen, mg/L	13.8
RJM-1	5/24/1990	1	Dissolved Oxygen, mg/L	7.7
RJM-1	6/7/1990	1	Dissolved Oxygen, mg/L	9.3
RJM-1	7/9/1990	1	Dissolved Oxygen, mg/L	12.4
RJM-1	8/13/1990	1	Dissolved Oxygen, mg/L	6.9
RJM-1	9/19/1990	1	Dissolved Oxygen, mg/L	6.0
RJM-1	10/9/1990	1	Dissolved Oxygen, mg/L	5.3
RJM-1	11/7/1990	1	Dissolved Oxygen, mg/L	9.1
RJM-1	12/11/1990	1	Dissolved Oxygen, mg/L	12.0
RJM-1	2/21/1991	1	Dissolved Oxygen, mg/L	16.6
RJM-1	3/19/1991	1	Dissolved Oxygen, mg/L	12.4
RJM-1	4/17/1991	1	Dissolved Oxygen, mg/L	11.3
RJM-1	5/14/1991	1	Dissolved Oxygen, mg/L	14.0

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJM-1	6/13/1991	1	Dissolved Oxygen, mg/L	11.5
RJM-1	7/11/1991	1	Dissolved Oxygen, mg/L	7.1
RJM-1	8/22/1991	1	Dissolved Oxygen, mg/L	11.0
RJM-1	9/20/1991	1	Dissolved Oxygen, mg/L	6.3
RJM-1	10/22/1991	1	Dissolved Oxygen, mg/L	8.7
RJM-1	11/19/1991	1	Dissolved Oxygen, mg/L	10.5
RJM-1	12/12/1991	1	Dissolved Oxygen, mg/L	14.3
RJM-1	4/9/1992	1	Dissolved Oxygen, mg/L	13.2
RJM-1	6/22/1992	1	Dissolved Oxygen, mg/L	10.7
RJM-1	7/20/1992	1	Dissolved Oxygen, mg/L	10.8
RJM-1	8/17/1992	1	Dissolved Oxygen, mg/L	11.6
RJM-1	10/19/1992	1	Dissolved Oxygen, mg/L	7.5
RJM-1	5/8/1996	1	Dissolved Oxygen, mg/L	10.6
RJM-1	6/26/1996	1	Dissolved Oxygen, mg/L	7.6
RJM-1	7/26/1996	1	Dissolved Oxygen, mg/L	5.2
RJM-1	8/30/1996	1	Dissolved Oxygen, mg/L	7.5
RJM-1	10/8/1996	1	Dissolved Oxygen, mg/L	6.7
RJM-1	5/6/1999	1	Dissolved Oxygen, mg/L	8.4
RJM-1	5/6/1999	1	Dissolved Oxygen, mg/L	9.6
RJM-1	6/9/1999	1	Dissolved Oxygen, mg/L	12.6
RJM-1	7/14/1999	1	Dissolved Oxygen, mg/L	9.6
RJM-1	8/25/1999	1	Dissolved Oxygen, mg/L	4.3
RJM-1	10/25/1999	1	Dissolved Oxygen, mg/L	9.2
RJM-1	4/23/2002	1	Dissolved Oxygen, mg/L	8.9
RJM-1	6/12/2002	1	Dissolved Oxygen, mg/L	7.9
RJM-1	7/17/2002	1	Dissolved Oxygen, mg/L	10.1
RJM-1	8/14/2002	1	Dissolved Oxygen, mg/L	4.9
RJM-1	10/16/2002	1	Dissolved Oxygen, mg/L	8.4
RJM-1	1/17/1990	1	Total Phosphorus, mg/L	0.16
RJM-1	2/14/1990	1	Total Phosphorus, mg/L	0.11
RJM-1	3/21/1990	1	Total Phosphorus, mg/L	0.08
RJM-1	4/23/1990	1	Total Phosphorus, mg/L	0.08
RJM-1	5/24/1990	1	Total Phosphorus, mg/L	0.24
RJM-1	5/30/1990	1	Total Phosphorus, mg/L	0.24
RJM-1	6/7/1990	1	Total Phosphorus, mg/L	0.21
RJM-1	6/30/1990	1	Total Phosphorus, mg/L	0.09
RJM-1	7/9/1990	1	Total Phosphorus, mg/L	0.15
RJM-1	7/16/1990	1	Total Phosphorus, mg/L	0.21
RJM-1	8/13/1990	1	Total Phosphorus, mg/L	0.09
RJM-1	9/19/1990	1	Total Phosphorus, mg/L	0.13
RJM-1	10/9/1990	1	Total Phosphorus, mg/L	0.10
RJM-1	11/5/1990	1	Total Phosphorus, mg/L	0.59
RJM-1	11/5/1990	1	Total Phosphorus, mg/L	0.06
RJM-1	11/5/1990	1	Total Phosphorus, mg/L	0.06
RJM-1	11/5/1990	1	Total Phosphorus, mg/L	0.11
RJM-1	11/7/1990	1	Total Phosphorus, mg/L	0.12
RJM-1	11/27/1990	1	Total Phosphorus, mg/L	0.10
RJM-1	11/27/1990	1	Total Phosphorus, mg/L	0.11
RJM-1	11/27/1990	1	Total Phosphorus, mg/L	0.23
RJM-1	11/27/1990	1	Total Phosphorus, mg/L	0.13
RJM-1	11/28/1990	1	Total Phosphorus, mg/L	0.12



**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJM-1	11/28/1990	1	Total Phosphorus, mg/L	0.12
RJM-1	11/28/1990	1	Total Phosphorus, mg/L	0.13
RJM-1	12/11/1990	1	Total Phosphorus, mg/L	0.14
RJM-1	12/17/1990	1	Total Phosphorus, mg/L	0.11
RJM-1	12/17/1990	1	Total Phosphorus, mg/L	0.10
RJM-1	12/17/1990	1	Total Phosphorus, mg/L	0.13
RJM-1	12/18/1990	1	Total Phosphorus, mg/L	0.15
RJM-1	12/18/1990	1	Total Phosphorus, mg/L	0.13
RJM-1	12/18/1990	1	Total Phosphorus, mg/L	0.13
RJM-1	2/21/1991	1	Total Phosphorus, mg/L	0.11
RJM-1	3/19/1991	1	Total Phosphorus, mg/L	0.14
RJM-1	3/19/1991	1	Total Phosphorus, mg/L	0.13
RJM-1	3/19/1991	1	Total Phosphorus, mg/L	0.11
RJM-1	3/19/1991	1	Total Phosphorus, mg/L	0.11
RJM-1	4/17/1991	1	Total Phosphorus, mg/L	0.20
RJM-1	5/14/1991	1	Total Phosphorus, mg/L	0.31
RJM-1	6/13/1991	1	Total Phosphorus, mg/L	0.19
RJM-1	7/10/1991	1	Total Phosphorus, mg/L	0.25
RJM-1	7/10/1991	1	Total Phosphorus, mg/L	0.16
RJM-1	7/11/1991	1	Total Phosphorus, mg/L	0.16
RJM-1	7/11/1991	1	Total Phosphorus, mg/L	0.21
RJM-1	7/11/1991	1	Total Phosphorus, mg/L	0.26
RJM-1	7/11/1991	1	Total Phosphorus, mg/L	0.28
RJM-1	8/22/1991	1	Total Phosphorus, mg/L	0.17
RJM-1	9/20/1991	1	Total Phosphorus, mg/L	0.13
RJM-1	10/22/1991	1	Total Phosphorus, mg/L	0.13
RJM-1	10/22/1991	1	Total Phosphorus, mg/L	0.12
RJM-1	11/3/1991	1	Total Phosphorus, mg/L	0.45
RJM-1	11/3/1991	1	Total Phosphorus, mg/L	0.13
RJM-1	11/3/1991	1	Total Phosphorus, mg/L	0.10
RJM-1	11/19/1991	1	Total Phosphorus, mg/L	0.16
RJM-1	12/12/1991	1	Total Phosphorus, mg/L	0.10
RJM-1	12/12/1991	1	Total Phosphorus, mg/L	0.11
RJM-1	12/26/1991	1	Total Phosphorus, mg/L	0.09
RJM-1	1/29/1992	1	Total Phosphorus, mg/L	0.06
RJM-1	2/27/1992	1	Total Phosphorus, mg/L	0.10
RJM-1	3/11/1992	1	Total Phosphorus, mg/L	0.13
RJM-1	3/30/1992	1	Total Phosphorus, mg/L	0.35
RJM-1	3/30/1992	1	Total Phosphorus, mg/L	0.25
RJM-1	3/30/1992	1	Total Phosphorus, mg/L	0.19
RJM-1	4/1/1992	1	Total Phosphorus, mg/L	0.09
RJM-1	4/9/1992	1	Total Phosphorus, mg/L	0.17
RJM-1	4/9/1992	1	Total Phosphorus, mg/L	0.09
RJM-1	4/21/1992	1	Total Phosphorus, mg/L	0.13
RJM-1	5/5/1992	1	Total Phosphorus, mg/L	0.14
RJM-1	5/15/1992	1	Total Phosphorus, mg/L	0.10
RJM-1	5/28/1992	1	Total Phosphorus, mg/L	0.13
RJM-1	6/8/1992	1	Total Phosphorus, mg/L	0.11
RJM-1	6/22/1992	1	Total Phosphorus, mg/L	0.12
RJM-1	7/20/1992	1	Total Phosphorus, mg/L	0.16
RJM-1	8/17/1992	1	Total Phosphorus, mg/L	0.11

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJM-1	8/28/1992	1	Total Phosphorus, mg/L	0.50
RJM-1	10/19/1992	1	Total Phosphorus, mg/L	0.10
RJM-1	5/8/1996	1	Total Phosphorus, mg/L	0.22
RJM-1	6/26/1996	1	Total Phosphorus, mg/L	0.15
RJM-1	7/26/1996	1	Total Phosphorus, mg/L	0.12
RJM-1	8/30/1996	1	Total Phosphorus, mg/L	0.13
RJM-1	10/8/1996	1	Total Phosphorus, mg/L	0.15
RJM-1	5/6/1999	1	Total Phosphorus, mg/L	0.08
RJM-1	6/9/1999	1	Total Phosphorus, mg/L	0.10
RJM-1	7/14/1999	1	Total Phosphorus, mg/L	0.10
RJM-1	8/25/1999	1	Total Phosphorus, mg/L	0.16
RJM-1	10/25/1999	1	Total Phosphorus, mg/L	0.09
RJM-1	4/23/2002	1	Total Phosphorus, mg/L	0.14
RJM-1	6/12/2002	1	Total Phosphorus, mg/L	0.16
RJM-1	7/17/2002	1	Total Phosphorus, mg/L	0.24
RJM-1	8/14/2002	1	Total Phosphorus, mg/L	0.32
RJM-1	10/16/2002	1	Total Phosphorus, mg/L	0.21
RJM-2	1/17/1990	1	Dissolved Oxygen, mg/L	13.3
RJM-2	2/14/1990	1	Dissolved Oxygen, mg/L	12.0
RJM-2	3/21/1990	1	Dissolved Oxygen, mg/L	10.5
RJM-2	4/23/1990	1	Dissolved Oxygen, mg/L	13.4
RJM-2	5/24/1990	1	Dissolved Oxygen, mg/L	5.3
RJM-2	6/7/1990	1	Dissolved Oxygen, mg/L	10.0
RJM-2	7/9/1990	1	Dissolved Oxygen, mg/L	14.2
RJM-2	8/13/1990	1	Dissolved Oxygen, mg/L	8.6
RJM-2	9/19/1990	1	Dissolved Oxygen, mg/L	5.8
RJM-2	10/9/1990	1	Dissolved Oxygen, mg/L	5.7
RJM-2	11/7/1990	1	Dissolved Oxygen, mg/L	8.4
RJM-2	12/11/1990	1	Dissolved Oxygen, mg/L	12.3
RJM-2	2/21/1991	1	Dissolved Oxygen, mg/L	16.7
RJM-2	3/19/1991	1	Dissolved Oxygen, mg/L	12.6
RJM-2	4/17/1991	1	Dissolved Oxygen, mg/L	12.5
RJM-2	5/14/1991	1	Dissolved Oxygen, mg/L	11.6
RJM-2	6/13/1991	1	Dissolved Oxygen, mg/L	10.0
RJM-2	7/11/1991	1	Dissolved Oxygen, mg/L	8.2
RJM-2	8/22/1991	1	Dissolved Oxygen, mg/L	10.2
RJM-2	9/20/1991	1	Dissolved Oxygen, mg/L	7.4
RJM-2	10/22/1991	1	Dissolved Oxygen, mg/L	8.0
RJM-2	11/19/1991	1	Dissolved Oxygen, mg/L	9.8
RJM-2	12/12/1991	1	Dissolved Oxygen, mg/L	13.6
RJM-2	4/9/1992	1	Dissolved Oxygen, mg/L	13.2
RJM-2	6/22/1992	1	Dissolved Oxygen, mg/L	10.7
RJM-2	7/20/1992	1	Dissolved Oxygen, mg/L	11.0
RJM-2	8/17/1992	1	Dissolved Oxygen, mg/L	11.1
RJM-2	10/19/1992	1	Dissolved Oxygen, mg/L	8.1
RJM-2	5/8/1996	1	Dissolved Oxygen, mg/L	9.2
RJM-2	6/26/1996	1	Dissolved Oxygen, mg/L	5.9
RJM-2	7/26/1996	1	Dissolved Oxygen, mg/L	8.2
RJM-2	8/30/1996	1	Dissolved Oxygen, mg/L	9.6
RJM-2	10/8/1996	1	Dissolved Oxygen, mg/L	8.8
RJM-2	5/6/1999	1	Dissolved Oxygen, mg/L	8.9

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJM-2	6/9/1999	1	Dissolved Oxygen, mg/L	10.8
RJM-2	7/14/1999	1	Dissolved Oxygen, mg/L	8.3
RJM-2	8/25/1999	1	Dissolved Oxygen, mg/L	5.9
RJM-2	10/25/1999	1	Dissolved Oxygen, mg/L	9.6
RJM-2	4/23/2002	1	Dissolved Oxygen, mg/L	10.0
RJM-2	6/12/2002	1	Dissolved Oxygen, mg/L	6.2
RJM-2	7/17/2002	1	Dissolved Oxygen, mg/L	10.5
RJM-2	8/14/2002	1	Dissolved Oxygen, mg/L	6.7
RJM-2	10/16/2002	1	Dissolved Oxygen, mg/L	9.2
RJM-2	1/17/1990	1	Total Phosphorus, mg/L	0.20
RJM-2	2/14/1990	1	Total Phosphorus, mg/L	0.11
RJM-2	3/21/1990	1	Total Phosphorus, mg/L	0.09
RJM-2	4/23/1990	1	Total Phosphorus, mg/L	0.10
RJM-2	5/24/1990	1	Total Phosphorus, mg/L	0.28
RJM-2	6/7/1990	1	Total Phosphorus, mg/L	0.22
RJM-2	7/9/1990	1	Total Phosphorus, mg/L	0.16
RJM-2	8/13/1990	1	Total Phosphorus, mg/L	0.09
RJM-2	9/19/1990	1	Total Phosphorus, mg/L	0.14
RJM-2	10/9/1990	1	Total Phosphorus, mg/L	0.15
RJM-2	11/7/1990	1	Total Phosphorus, mg/L	0.12
RJM-2	12/11/1990	1	Total Phosphorus, mg/L	0.15
RJM-2	2/21/1991	1	Total Phosphorus, mg/L	0.10
RJM-2	3/19/1991	1	Total Phosphorus, mg/L	0.09
RJM-2	4/17/1991	1	Total Phosphorus, mg/L	0.16
RJM-2	5/14/1991	1	Total Phosphorus, mg/L	0.13
RJM-2	6/13/1991	1	Total Phosphorus, mg/L	0.15
RJM-2	7/11/1991	1	Total Phosphorus, mg/L	0.26
RJM-2	8/22/1991	1	Total Phosphorus, mg/L	0.16
RJM-2	9/20/1991	1	Total Phosphorus, mg/L	0.15
RJM-2	10/22/1991	1	Total Phosphorus, mg/L	0.13
RJM-2	11/19/1991	1	Total Phosphorus, mg/L	0.17
RJM-2	12/12/1991	1	Total Phosphorus, mg/L	0.10
RJM-2	3/30/1992	1	Total Phosphorus, mg/L	0.10
RJM-2	3/30/1992	1	Total Phosphorus, mg/L	0.10
RJM-2	3/30/1992	1	Total Phosphorus, mg/L	0.10
RJM-2	4/9/1992	1	Total Phosphorus, mg/L	0.09
RJM-2	6/22/1992	1	Total Phosphorus, mg/L	0.11
RJM-2	7/20/1992	1	Total Phosphorus, mg/L	0.15
RJM-2	8/17/1992	1	Total Phosphorus, mg/L	0.13
RJM-2	10/19/1992	1	Total Phosphorus, mg/L	0.09
RJM-2	5/8/1996	1	Total Phosphorus, mg/L	0.21
RJM-2	6/3/1996	1	Total Phosphorus, mg/L	0.18
RJM-2	6/26/1996	1	Total Phosphorus, mg/L	0.18
RJM-2	7/26/1996	1	Total Phosphorus, mg/L	0.16
RJM-2	8/30/1996	1	Total Phosphorus, mg/L	0.14
RJM-2	10/8/1996	1	Total Phosphorus, mg/L	0.18
RJM-2	5/6/1999	1	Total Phosphorus, mg/L	0.07
RJM-2	6/9/1999	1	Total Phosphorus, mg/L	0.10
RJM-2	7/14/1999	1	Total Phosphorus, mg/L	0.12
RJM-2	8/25/1999	1	Total Phosphorus, mg/L	0.17
RJM-2	10/25/1999	1	Total Phosphorus, mg/L	0.09

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJM-2	4/23/2002	1	Total Phosphorus, mg/L	0.15
RJM-2	6/12/2002	1	Total Phosphorus, mg/L	0.14
RJM-2	7/17/2002	1	Total Phosphorus, mg/L	0.26
RJM-2	8/14/2002	1	Total Phosphorus, mg/L	0.39
RJM-2	10/16/2002	1	Total Phosphorus, mg/L	0.21
RJM-3	1/17/1990	1	Dissolved Oxygen, mg/L	13.5
RJM-3	2/14/1990	1	Dissolved Oxygen, mg/L	11.8
RJM-3	3/21/1990	1	Dissolved Oxygen, mg/L	10.7
RJM-3	4/23/1990	1	Dissolved Oxygen, mg/L	13.6
RJM-3	5/24/1990	1	Dissolved Oxygen, mg/L	5.3
RJM-3	6/7/1990	1	Dissolved Oxygen, mg/L	9.0
RJM-3	7/9/1990	1	Dissolved Oxygen, mg/L	10.5
RJM-3	8/13/1990	1	Dissolved Oxygen, mg/L	10.9
RJM-3	9/19/1990	1	Dissolved Oxygen, mg/L	6.8
RJM-3	10/9/1990	1	Dissolved Oxygen, mg/L	6.3
RJM-3	11/7/1990	1	Dissolved Oxygen, mg/L	8.6
RJM-3	12/11/1990	1	Dissolved Oxygen, mg/L	12.3
RJM-3	2/21/1991	1	Dissolved Oxygen, mg/L	16.2
RJM-3	3/19/1991	1	Dissolved Oxygen, mg/L	12.1
RJM-3	4/17/1991	1	Dissolved Oxygen, mg/L	14.4
RJM-3	5/14/1991	1	Dissolved Oxygen, mg/L	11.4
RJM-3	6/13/1991	1	Dissolved Oxygen, mg/L	11.6
RJM-3	7/11/1991	1	Dissolved Oxygen, mg/L	9.9
RJM-3	8/22/1991	1	Dissolved Oxygen, mg/L	6.9
RJM-3	9/20/1991	1	Dissolved Oxygen, mg/L	11.0
RJM-3	10/22/1991	1	Dissolved Oxygen, mg/L	7.9
RJM-3	11/19/1991	1	Dissolved Oxygen, mg/L	9.6
RJM-3	12/12/1991	1	Dissolved Oxygen, mg/L	13.6
RJM-3	4/9/1992	1	Dissolved Oxygen, mg/L	12.9
RJM-3	6/22/1992	1	Dissolved Oxygen, mg/L	14.8
RJM-3	7/20/1992	1	Dissolved Oxygen, mg/L	8.4
RJM-3	8/17/1992	1	Dissolved Oxygen, mg/L	12.0
RJM-3	10/19/1992	1	Dissolved Oxygen, mg/L	8.4
RJM-3	5/8/1996	1	Dissolved Oxygen, mg/L	8.4
RJM-3	6/26/1996	1	Dissolved Oxygen, mg/L	9.1
RJM-3	7/26/1996	1	Dissolved Oxygen, mg/L	8.7
RJM-3	8/30/1996	1	Dissolved Oxygen, mg/L	10.2
RJM-3	10/8/1996	1	Dissolved Oxygen, mg/L	9.0
RJM-3	6/9/1999	1	Dissolved Oxygen, mg/L	11.6
RJM-3	7/14/1999	1	Dissolved Oxygen, mg/L	8.6
RJM-3	8/25/1999	1	Dissolved Oxygen, mg/L	9.4
RJM-3	10/25/1999	1	Dissolved Oxygen, mg/L	10.3
RJM-3	4/23/2002	1	Dissolved Oxygen, mg/L	11.0
RJM-3	6/12/2002	1	Dissolved Oxygen, mg/L	7.9
RJM-3	7/17/2002	1	Dissolved Oxygen, mg/L	9.1
RJM-3	8/14/2002	1	Dissolved Oxygen, mg/L	9.9
RJM-3	10/16/2002	1	Dissolved Oxygen, mg/L	10.4
RJM-3	1/17/1990	1	Total Phosphorus, mg/L	0.20
RJM-3	2/14/1990	1	Total Phosphorus, mg/L	0.14
RJM-3	3/21/1990	1	Total Phosphorus, mg/L	0.11
RJM-3	4/23/1990	1	Total Phosphorus, mg/L	0.10

**Water Quality Data**  
**Cahokia Canal/Horseshoe Lake Watershed**

Station ID	Sampling Date	Sample Depth (ft)	Parameter	Result Value
RJM-3	5/24/1990	1	Total Phosphorus, mg/L	0.28
RJM-3	6/7/1990	1	Total Phosphorus, mg/L	0.19
RJM-3	7/9/1990	1	Total Phosphorus, mg/L	0.12
RJM-3	8/13/1990	1	Total Phosphorus, mg/L	0.15
RJM-3	9/19/1990	1	Total Phosphorus, mg/L	0.15
RJM-3	10/9/1990	1	Total Phosphorus, mg/L	0.27
RJM-3	11/7/1990	1	Total Phosphorus, mg/L	0.16
RJM-3	12/11/1990	1	Total Phosphorus, mg/L	0.18
RJM-3	2/21/1991	1	Total Phosphorus, mg/L	0.13
RJM-3	3/19/1991	1	Total Phosphorus, mg/L	0.13
RJM-3	4/17/1991	1	Total Phosphorus, mg/L	0.17
RJM-3	5/14/1991	1	Total Phosphorus, mg/L	0.14
RJM-3	6/13/1991	1	Total Phosphorus, mg/L	0.16
RJM-3	7/10/1991	1	Total Phosphorus, mg/L	0.28
RJM-3	7/10/1991	1	Total Phosphorus, mg/L	0.28
RJM-3	7/10/1991	1	Total Phosphorus, mg/L	0.27
RJM-3	7/11/1991	1	Total Phosphorus, mg/L	0.28
RJM-3	7/11/1991	1	Total Phosphorus, mg/L	0.28
RJM-3	7/11/1991	1	Total Phosphorus, mg/L	0.26
RJM-3	7/11/1991	1	Total Phosphorus, mg/L	0.28
RJM-3	8/22/1991	1	Total Phosphorus, mg/L	0.23
RJM-3	9/20/1991	1	Total Phosphorus, mg/L	0.22
RJM-3	10/22/1991	1	Total Phosphorus, mg/L	0.14
RJM-3	11/3/1991	1	Total Phosphorus, mg/L	0.13
RJM-3	11/19/1991	1	Total Phosphorus, mg/L	0.19
RJM-3	11/20/1991	1	Total Phosphorus, mg/L	0.17
RJM-3	11/20/1991	1	Total Phosphorus, mg/L	0.17
RJM-3	11/20/1991	1	Total Phosphorus, mg/L	0.16
RJM-3	12/3/1991	1	Total Phosphorus, mg/L	0.13
RJM-3	12/3/1991	1	Total Phosphorus, mg/L	0.12
RJM-3	12/12/1991	1	Total Phosphorus, mg/L	0.10
RJM-3	4/9/1992	1	Total Phosphorus, mg/L	0.10
RJM-3	6/22/1992	1	Total Phosphorus, mg/L	0.23
RJM-3	7/20/1992	1	Total Phosphorus, mg/L	0.19
RJM-3	8/17/1992	1	Total Phosphorus, mg/L	0.20
RJM-3	10/19/1992	1	Total Phosphorus, mg/L	0.10
RJM-3	5/8/1996	1	Total Phosphorus, mg/L	0.16
RJM-3	6/26/1996	1	Total Phosphorus, mg/L	0.36
RJM-3	7/26/1996	1	Total Phosphorus, mg/L	0.23
RJM-3	8/30/1996	1	Total Phosphorus, mg/L	0.19
RJM-3	10/8/1996	1	Total Phosphorus, mg/L	0.18
RJM-3	5/6/1999	1	Total Phosphorus, mg/L	0.10
RJM-3	6/9/1999	1	Total Phosphorus, mg/L	0.10
RJM-3	7/14/1999	1	Total Phosphorus, mg/L	0.16
RJM-3	8/25/1999	1	Total Phosphorus, mg/L	0.16
RJM-3	10/25/1999	1	Total Phosphorus, mg/L	0.11
RJM-3	4/23/2002	1	Total Phosphorus, mg/L	0.14
RJM-3	6/12/2002	1	Total Phosphorus, mg/L	0.27
RJM-3	7/17/2002	1	Total Phosphorus, mg/L	0.27
RJM-3	8/14/2002	1	Total Phosphorus, mg/L	0.36
RJM-3	10/16/2002	1	Total Phosphorus, mg/L	0.26

**Continuous Dissolved Oxygen Data  
Cahokia Canal/Horseshoe Lake Watershed**

Log File Name	Sampling Date	Sampling Time	Sample Depth (ft)	Parameter	Result Value
JMAA-02-PO	7/25/2005	12:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.38
JMAA-02-PO	7/25/2005	12:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.69
JMAA-02-PO	7/25/2005	13:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.98
JMAA-02-PO	7/25/2005	13:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.23
JMAA-02-PO	7/25/2005	14:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.44
JMAA-02-PO	7/25/2005	14:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.58
JMAA-02-PO	7/25/2005	15:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.62
JMAA-02-PO	7/25/2005	15:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.59
JMAA-02-PO	7/25/2005	16:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.59
JMAA-02-PO	7/25/2005	16:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.52
JMAA-02-PO	7/25/2005	17:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.49
JMAA-02-PO	7/25/2005	17:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.42
JMAA-02-PO	7/25/2005	18:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.38
JMAA-02-PO	7/25/2005	18:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.24
JMAA-02-PO	7/25/2005	19:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.09
JMAA-02-PO	7/25/2005	19:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.87
JMAA-02-PO	7/25/2005	20:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.64
JMAA-02-PO	7/25/2005	20:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.49
JMAA-02-PO	7/25/2005	21:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.34
JMAA-02-PO	7/25/2005	21:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.15
JMAA-02-PO	7/25/2005	22:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6
JMAA-02-PO	7/25/2005	22:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.82
JMAA-02-PO	7/25/2005	23:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.69
JMAA-02-PO	7/25/2005	23:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.62
JMAA-02-PO	7/26/2005	0:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.52
JMAA-02-PO	7/26/2005	0:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.51
JMAA-02-PO	7/26/2005	1:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.37
JMAA-02-PO	7/26/2005	1:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.32
JMAA-02-PO	7/26/2005	2:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.25
JMAA-02-PO	7/26/2005	2:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.23
JMAA-02-PO	7/26/2005	3:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.18
JMAA-02-PO	7/26/2005	3:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.24
JMAA-02-PO	7/26/2005	4:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.17
JMAA-02-PO	7/26/2005	4:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.16
JMAA-02-PO	7/26/2005	5:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.13
JMAA-02-PO	7/26/2005	5:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.14
JMAA-02-PO	7/26/2005	6:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.16
JMAA-02-PO	7/26/2005	6:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.2
JMAA-02-PO	7/26/2005	7:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.23
JMAA-02-PO	7/26/2005	7:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.3
JMAA-02-PO	7/26/2005	8:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.3
JMAA-02-PO	7/26/2005	8:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.36
JMAA-02-PO	7/26/2005	9:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.4
JMAA-02-PO	7/26/2005	9:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.47
JMAA-02-PO	7/26/2005	10:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.57
JMAA-02-PO	7/26/2005	10:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.73
JMAA-02-PO	7/26/2005	11:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.94
JMAA-02-PO	7/26/2005	11:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.23
JMAA-02-PO	7/26/2005	12:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.51
JMAA-02-PO	7/26/2005	12:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.78
JMAA-02-PO	7/26/2005	13:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.06
JMAA-02-PO	7/26/2005	13:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.4
JMAA-02-PO	7/26/2005	14:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.67
JMAA-02-PO	7/26/2005	14:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.77

**Continuous Dissolved Oxygen Data  
Cahokia Canal/Horseshoe Lake Watershed**

JMAA-02-PO	7/26/2005	15:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.87
JMAA-02-PO	7/26/2005	15:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.87
JMAA-02-PO	7/26/2005	16:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.81
JMAA-02-PO	7/26/2005	16:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.71
JMAA-02-PO	7/26/2005	17:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.65
JMAA-02-PO	7/26/2005	17:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.67
JMAA-02-PO	7/26/2005	18:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.47
JMAA-02-PO	7/26/2005	18:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.4
JMAA-02-PO	7/26/2005	19:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.23
JMAA-02-PO	7/26/2005	19:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.08
JMAA-02-PO	7/26/2005	20:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.88
JMAA-02-PO	7/26/2005	20:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.7
JMAA-02-PO	7/26/2005	21:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.47
JMAA-02-PO	7/26/2005	21:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.25
JMAA-02-PO	7/26/2005	22:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.14
JMAA-02-PO	7/26/2005	22:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.94
JMAA-02-PO	7/26/2005	23:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.9
JMAA-02-PO	7/26/2005	23:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.82
JMAA-02-PO	7/27/2005	0:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.78
JMAA-02-PO	7/27/2005	0:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.69
JMAA-02-PO	7/27/2005	1:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.68
JMAA-02-PO	7/27/2005	1:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.7
JMAA-02-PO	7/27/2005	2:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.71
JMAA-02-PO	7/27/2005	2:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.72
JMAA-02-PO	7/27/2005	3:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.73
JMAA-02-PO	7/27/2005	3:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.75
JMAA-02-PO	7/27/2005	4:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.77
JMAA-02-PO	7/27/2005	4:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.77
JMAA-02-PO	7/27/2005	5:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.75
JMAA-02-PO	7/27/2005	5:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.74
JMAA-02-PO	7/27/2005	6:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.79
JMAA-02-PO	7/27/2005	6:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.73
JMAA-02-PO	7/27/2005	7:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.78
JMAA-02-PO	7/27/2005	7:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.77
JMAA-02-PO	7/27/2005	8:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.71
JMAA-02-PO	7/27/2005	8:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.75
JMAA-02-PO	7/27/2005	9:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.78
JMAA-02-PO	7/27/2005	9:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.9
JMAA-02-PO	7/27/2005	10:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.96
JMAA-02-PO	7/27/2005	10:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.06
JMAA-02-PO	7/27/2005	11:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.27
JMAA-02-PO	7/27/2005	11:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.53
JMAA-02-PO	7/27/2005	12:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.72
JMAA-02-PO	7/27/2005	12:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.14
JMAA-02-PO	7/27/2005	13:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.35
JMAA-02-PO	7/27/2005	13:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.64
JMAA-02-PO	7/27/2005	14:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.76
JMAA-02-PO	7/27/2005	14:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.87
JMAA-02-PO	7/27/2005	15:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.04
JMAA-02-PO	7/27/2005	15:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.13
JMAA-02-PO	7/27/2005	16:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.2
JMAA-02-PO	7/27/2005	16:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.13
JMAA-02-PO	7/27/2005	17:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.11
JMAA-02-PO	7/27/2005	17:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.06
JMAA-02-PO	7/27/2005	18:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.86

**Continuous Dissolved Oxygen Data  
Cahokia Canal/Horseshoe Lake Watershed**

JMAA-02-PO	7/27/2005	18:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.7
JMAA-02-PO	7/27/2005	19:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.49
JMAA-02-PO	7/27/2005	19:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.23
JMAA-02-PO	7/27/2005	20:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.04
JMAA-02-PO	7/27/2005	20:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.89
JMAA-02-PO	7/27/2005	21:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.75
JMAA-02-PO	7/27/2005	21:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.59
JMAA-02-PO	7/27/2005	22:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.53
JMAA-02-PO	7/27/2005	22:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.41
JMAA-02-PO	7/27/2005	23:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.34
JMAA-02-PO	7/27/2005	23:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.26
JMAA-02-PO	7/28/2005	0:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.22
JMAA-02-PO	7/28/2005	0:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.19
JMAA-02-PO	7/28/2005	1:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.15
JMAA-02-PO	7/28/2005	1:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.12
JMAA-02-PO	7/28/2005	2:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.18
JMAA-02-PO	7/28/2005	2:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.17
JMAA-02-PO	7/28/2005	3:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.2
JMAA-02-PO	7/28/2005	3:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.2
JMAA-02-PO	7/28/2005	4:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.19
JMAA-02-PO	7/28/2005	4:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.19
JMAA-02-PO	7/28/2005	5:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.24
JMAA-02-PO	7/28/2005	5:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.29
JMAA-02-PO	7/28/2005	6:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.3
JMAA-02-PO	7/28/2005	6:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.31
JMAA-02-PO	7/28/2005	7:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.33
JMAA-02-PO	7/28/2005	7:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.37
JMAA-02-PO	7/28/2005	8:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.4
JMAA-02-PO	7/28/2005	8:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.37
JMAA-02-PO	7/28/2005	9:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.44
JMAA-02-PO	7/28/2005	9:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.47
JMAA-02-PO	7/28/2005	10:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.55
JMAA-02-PO	7/28/2005	10:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.78
JMAA-02-PO	7/28/2005	11:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.96
JMAA-02-PO	7/28/2005	11:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.23
JMAA-02-PO	7/28/2005	12:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.56
JMAA-02-RU	7/25/2005	12:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.51
JMAA-02-RU	7/25/2005	12:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.77
JMAA-02-RU	7/25/2005	13:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7
JMAA-02-RU	7/25/2005	13:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.21
JMAA-02-RU	7/25/2005	14:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.45
JMAA-02-RU	7/25/2005	14:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.53
JMAA-02-RU	7/25/2005	15:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.6
JMAA-02-RU	7/25/2005	15:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.58
JMAA-02-RU	7/25/2005	16:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.5
JMAA-02-RU	7/25/2005	16:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.46
JMAA-02-RU	7/25/2005	17:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.43
JMAA-02-RU	7/25/2005	17:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.35
JMAA-02-RU	7/25/2005	18:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.31
JMAA-02-RU	7/25/2005	18:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.2
JMAA-02-RU	7/25/2005	19:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.06
JMAA-02-RU	7/25/2005	19:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.9
JMAA-02-RU	7/25/2005	20:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.69
JMAA-02-RU	7/25/2005	20:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.45
JMAA-02-RU	7/25/2005	21:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.28



**Continuous Dissolved Oxygen Data  
Cahokia Canal/Horseshoe Lake Watershed**

JMAA-02-RU	7/25/2005	21:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.13
JMAA-02-RU	7/25/2005	22:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.01
JMAA-02-RU	7/25/2005	22:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.87
JMAA-02-RU	7/25/2005	23:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.72
JMAA-02-RU	7/25/2005	23:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.69
JMAA-02-RU	7/26/2005	0:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.57
JMAA-02-RU	7/26/2005	0:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.52
JMAA-02-RU	7/26/2005	1:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.46
JMAA-02-RU	7/26/2005	1:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.37
JMAA-02-RU	7/26/2005	2:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.36
JMAA-02-RU	7/26/2005	2:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.33
JMAA-02-RU	7/26/2005	3:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.27
JMAA-02-RU	7/26/2005	3:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.31
JMAA-02-RU	7/26/2005	4:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.23
JMAA-02-RU	7/26/2005	4:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.27
JMAA-02-RU	7/26/2005	5:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.22
JMAA-02-RU	7/26/2005	5:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.23
JMAA-02-RU	7/26/2005	6:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.29
JMAA-02-RU	7/26/2005	6:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.28
JMAA-02-RU	7/26/2005	7:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.29
JMAA-02-RU	7/26/2005	7:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.34
JMAA-02-RU	7/26/2005	8:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.38
JMAA-02-RU	7/26/2005	8:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.44
JMAA-02-RU	7/26/2005	9:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.5
JMAA-02-RU	7/26/2005	9:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.62
JMAA-02-RU	7/26/2005	10:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.69
JMAA-02-RU	7/26/2005	10:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.9
JMAA-02-RU	7/26/2005	11:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.09
JMAA-02-RU	7/26/2005	11:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.34
JMAA-02-RU	7/26/2005	12:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.66
JMAA-02-RU	7/26/2005	12:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.91
JMAA-02-RU	7/26/2005	13:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.23
JMAA-02-RU	7/26/2005	13:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.5
JMAA-02-RU	7/26/2005	14:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.77
JMAA-02-RU	7/26/2005	14:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.89
JMAA-02-RU	7/26/2005	15:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.93
JMAA-02-RU	7/26/2005	15:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.89
JMAA-02-RU	7/26/2005	16:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.8
JMAA-02-RU	7/26/2005	16:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.78
JMAA-02-RU	7/26/2005	17:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.71
JMAA-02-RU	7/26/2005	17:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.69
JMAA-02-RU	7/26/2005	18:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.54
JMAA-02-RU	7/26/2005	18:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.5
JMAA-02-RU	7/26/2005	19:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.33
JMAA-02-RU	7/26/2005	19:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.16
JMAA-02-RU	7/26/2005	20:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.94
JMAA-02-RU	7/26/2005	20:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.73
JMAA-02-RU	7/26/2005	21:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.55
JMAA-02-RU	7/26/2005	21:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.37
JMAA-02-RU	7/26/2005	22:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.21
JMAA-02-RU	7/26/2005	22:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.06
JMAA-02-RU	7/26/2005	23:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.95
JMAA-02-RU	7/26/2005	23:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.89
JMAA-02-RU	7/27/2005	0:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.85
JMAA-02-RU	7/27/2005	0:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.79

**Continuous Dissolved Oxygen Data  
Cahokia Canal/Horseshoe Lake Watershed**

JMAA-02-RU	7/27/2005	1:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.82
JMAA-02-RU	7/27/2005	1:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.78
JMAA-02-RU	7/27/2005	2:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.8
JMAA-02-RU	7/27/2005	2:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.82
JMAA-02-RU	7/27/2005	3:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.8
JMAA-02-RU	7/27/2005	3:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.89
JMAA-02-RU	7/27/2005	4:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.86
JMAA-02-RU	7/27/2005	4:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.9
JMAA-02-RU	7/27/2005	5:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.88
JMAA-02-RU	7/27/2005	5:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.86
JMAA-02-RU	7/27/2005	6:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.83
JMAA-02-RU	7/27/2005	6:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.87
JMAA-02-RU	7/27/2005	7:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.81
JMAA-02-RU	7/27/2005	7:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.83
JMAA-02-RU	7/27/2005	8:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.85
JMAA-02-RU	7/27/2005	8:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.85
JMAA-02-RU	7/27/2005	9:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.92
JMAA-02-RU	7/27/2005	9:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.98
JMAA-02-RU	7/27/2005	10:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.01
JMAA-02-RU	7/27/2005	10:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.2
JMAA-02-RU	7/27/2005	11:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.34
JMAA-02-RU	7/27/2005	11:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.65
JMAA-02-RU	7/27/2005	12:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.8
JMAA-02-RU	7/27/2005	12:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.24
JMAA-02-RU	7/27/2005	13:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.47
JMAA-02-RU	7/27/2005	13:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.77
JMAA-02-RU	7/27/2005	14:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.85
JMAA-02-RU	7/27/2005	14:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.01
JMAA-02-RU	7/27/2005	15:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.16
JMAA-02-RU	7/27/2005	15:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.24
JMAA-02-RU	7/27/2005	16:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.33
JMAA-02-RU	7/27/2005	16:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.29
JMAA-02-RU	7/27/2005	17:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.19
JMAA-02-RU	7/27/2005	17:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.11
JMAA-02-RU	7/27/2005	18:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.02
JMAA-02-RU	7/27/2005	18:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.82
JMAA-02-RU	7/27/2005	19:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.52
JMAA-02-RU	7/27/2005	19:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.31
JMAA-02-RU	7/27/2005	20:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.13
JMAA-02-RU	7/27/2005	20:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.92
JMAA-02-RU	7/27/2005	21:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.79
JMAA-02-RU	7/27/2005	21:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.68
JMAA-02-RU	7/27/2005	22:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.57
JMAA-02-RU	7/27/2005	22:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.5
JMAA-02-RU	7/27/2005	23:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.46
JMAA-02-RU	7/27/2005	23:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.41
JMAA-02-RU	7/28/2005	0:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.38
JMAA-02-RU	7/28/2005	0:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.32
JMAA-02-RU	7/28/2005	1:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.3
JMAA-02-RU	7/28/2005	1:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.21
JMAA-02-RU	7/28/2005	2:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.22
JMAA-02-RU	7/28/2005	2:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.25
JMAA-02-RU	7/28/2005	3:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.23
JMAA-02-RU	7/28/2005	3:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.34
JMAA-02-RU	7/28/2005	4:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.33

**Continuous Dissolved Oxygen Data  
Cahokia Canal/Horseshoe Lake Watershed**

JMAA-02-RU	7/28/2005	4:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.31
JMAA-02-RU	7/28/2005	5:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.38
JMAA-02-RU	7/28/2005	5:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.4
JMAA-02-RU	7/28/2005	6:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.44
JMAA-02-RU	7/28/2005	6:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.36
JMAA-02-RU	7/28/2005	7:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.41
JMAA-02-RU	7/28/2005	7:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.37
JMAA-02-RU	7/28/2005	8:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.45
JMAA-02-RU	7/28/2005	8:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.48
JMAA-02-RU	7/28/2005	9:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.52
JMAA-02-RU	7/28/2005	9:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.56
JMAA-02-RU	7/28/2005	10:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.63
JMAA-02-RU	7/28/2005	10:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.8
JMAA-02-RU	7/28/2005	11:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.09
JMAA-02-RU	7/28/2005	11:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.35
JMAA-02-RU	7/28/2005	12:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.66
JMAA-02-RI	7/25/2005	12:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.53
JMAA-02-RI	7/25/2005	12:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.78
JMAA-02-RI	7/25/2005	13:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7
JMAA-02-RI	7/25/2005	13:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.2
JMAA-02-RI	7/25/2005	14:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.43
JMAA-02-RI	7/25/2005	14:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.51
JMAA-02-RI	7/25/2005	15:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.55
JMAA-02-RI	7/25/2005	15:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.49
JMAA-02-RI	7/25/2005	16:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.45
JMAA-02-RI	7/25/2005	16:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.4
JMAA-02-RI	7/25/2005	17:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.37
JMAA-02-RI	7/25/2005	17:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.3
JMAA-02-RI	7/25/2005	18:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.24
JMAA-02-RI	7/25/2005	18:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.11
JMAA-02-RI	7/25/2005	19:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.04
JMAA-02-RI	7/25/2005	19:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.79
JMAA-02-RI	7/25/2005	20:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.64
JMAA-02-RI	7/25/2005	20:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.45
JMAA-02-RI	7/25/2005	21:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.3
JMAA-02-RI	7/25/2005	21:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.12
JMAA-02-RI	7/25/2005	22:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.09
JMAA-02-RI	7/25/2005	22:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.98
JMAA-02-RI	7/25/2005	23:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.8
JMAA-02-RI	7/25/2005	23:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.8
JMAA-02-RI	7/26/2005	0:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.68
JMAA-02-RI	7/26/2005	0:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.63
JMAA-02-RI	7/26/2005	1:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.54
JMAA-02-RI	7/26/2005	1:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.44
JMAA-02-RI	7/26/2005	2:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.43
JMAA-02-RI	7/26/2005	2:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.41
JMAA-02-RI	7/26/2005	3:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.38
JMAA-02-RI	7/26/2005	3:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.37
JMAA-02-RI	7/26/2005	4:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.36
JMAA-02-RI	7/26/2005	4:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.34
JMAA-02-RI	7/26/2005	5:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.32
JMAA-02-RI	7/26/2005	5:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.36
JMAA-02-RI	7/26/2005	6:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.35
JMAA-02-RI	7/26/2005	6:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.39
JMAA-02-RI	7/26/2005	7:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.38

**Continuous Dissolved Oxygen Data  
Cahokia Canal/Horseshoe Lake Watershed**

JMAA-02-RI	7/26/2005	7:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.43
JMAA-02-RI	7/26/2005	8:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.48
JMAA-02-RI	7/26/2005	8:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.54
JMAA-02-RI	7/26/2005	9:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.63
JMAA-02-RI	7/26/2005	9:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.72
JMAA-02-RI	7/26/2005	10:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.8
JMAA-02-RI	7/26/2005	10:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.99
JMAA-02-RI	7/26/2005	11:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.17
JMAA-02-RI	7/26/2005	11:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.41
JMAA-02-RI	7/26/2005	12:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.66
JMAA-02-RI	7/26/2005	12:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.95
JMAA-02-RI	7/26/2005	13:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.22
JMAA-02-RI	7/26/2005	13:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.45
JMAA-02-RI	7/26/2005	14:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.67
JMAA-02-RI	7/26/2005	14:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.8
JMAA-02-RI	7/26/2005	15:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.79
JMAA-02-RI	7/26/2005	15:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.78
JMAA-02-RI	7/26/2005	16:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.83
JMAA-02-RI	7/26/2005	16:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.72
JMAA-02-RI	7/26/2005	17:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.55
JMAA-02-RI	7/26/2005	17:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.55
JMAA-02-RI	7/26/2005	18:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.5
JMAA-02-RI	7/26/2005	18:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.45
JMAA-02-RI	7/26/2005	19:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.32
JMAA-02-RI	7/26/2005	19:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.13
JMAA-02-RI	7/26/2005	20:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.94
JMAA-02-RI	7/26/2005	20:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.79
JMAA-02-RI	7/26/2005	21:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.55
JMAA-02-RI	7/26/2005	21:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.38
JMAA-02-RI	7/26/2005	22:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.24
JMAA-02-RI	7/26/2005	22:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.1
JMAA-02-RI	7/26/2005	23:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.02
JMAA-02-RI	7/26/2005	23:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.97
JMAA-02-RI	7/27/2005	0:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.91
JMAA-02-RI	7/27/2005	0:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.86
JMAA-02-RI	7/27/2005	1:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.88
JMAA-02-RI	7/27/2005	1:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.88
JMAA-02-RI	7/27/2005	2:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.92
JMAA-02-RI	7/27/2005	2:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.9
JMAA-02-RI	7/27/2005	3:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.93
JMAA-02-RI	7/27/2005	3:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.97
JMAA-02-RI	7/27/2005	4:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.99
JMAA-02-RI	7/27/2005	4:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.99
JMAA-02-RI	7/27/2005	5:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.99
JMAA-02-RI	7/27/2005	5:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.97
JMAA-02-RI	7/27/2005	6:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.96
JMAA-02-RI	7/27/2005	6:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.94
JMAA-02-RI	7/27/2005	7:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.94
JMAA-02-RI	7/27/2005	7:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.95
JMAA-02-RI	7/27/2005	8:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	5.96
JMAA-02-RI	7/27/2005	8:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6
JMAA-02-RI	7/27/2005	9:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.03
JMAA-02-RI	7/27/2005	9:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.12
JMAA-02-RI	7/27/2005	10:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.18
JMAA-02-RI	7/27/2005	10:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.32

**Continuous Dissolved Oxygen Data  
Cahokia Canal/Horseshoe Lake Watershed**

JMAA-02-RI	7/27/2005	11:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.5
JMAA-02-RI	7/27/2005	11:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.72
JMAA-02-RI	7/27/2005	12:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.96
JMAA-02-RI	7/27/2005	12:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.28
JMAA-02-RI	7/27/2005	13:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.52
JMAA-02-RI	7/27/2005	13:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.8
JMAA-02-RI	7/27/2005	14:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.87
JMAA-02-RI	7/27/2005	14:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.96
JMAA-02-RI	7/27/2005	15:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.08
JMAA-02-RI	7/27/2005	15:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.19
JMAA-02-RI	7/27/2005	16:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.24
JMAA-02-RI	7/27/2005	16:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.22
JMAA-02-RI	7/27/2005	17:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.11
JMAA-02-RI	7/27/2005	17:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	8.05
JMAA-02-RI	7/27/2005	18:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.94
JMAA-02-RI	7/27/2005	18:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.75
JMAA-02-RI	7/27/2005	19:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.52
JMAA-02-RI	7/27/2005	19:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.3
JMAA-02-RI	7/27/2005	20:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.1
JMAA-02-RI	7/27/2005	20:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.99
JMAA-02-RI	7/27/2005	21:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.84
JMAA-02-RI	7/27/2005	21:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.71
JMAA-02-RI	7/27/2005	22:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.65
JMAA-02-RI	7/27/2005	22:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.6
JMAA-02-RI	7/27/2005	23:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.53
JMAA-02-RI	7/27/2005	23:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.49
JMAA-02-RI	7/28/2005	0:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.46
JMAA-02-RI	7/28/2005	0:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.44
JMAA-02-RI	7/28/2005	1:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.37
JMAA-02-RI	7/28/2005	1:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.37
JMAA-02-RI	7/28/2005	2:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.36
JMAA-02-RI	7/28/2005	2:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.41
JMAA-02-RI	7/28/2005	3:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.41
JMAA-02-RI	7/28/2005	3:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.43
JMAA-02-RI	7/28/2005	4:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.45
JMAA-02-RI	7/28/2005	4:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.43
JMAA-02-RI	7/28/2005	5:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.5
JMAA-02-RI	7/28/2005	5:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.49
JMAA-02-RI	7/28/2005	6:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.49
JMAA-02-RI	7/28/2005	6:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.54
JMAA-02-RI	7/28/2005	7:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.56
JMAA-02-RI	7/28/2005	7:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.57
JMAA-02-RI	7/28/2005	8:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.6
JMAA-02-RI	7/28/2005	8:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.65
JMAA-02-RI	7/28/2005	9:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.68
JMAA-02-RI	7/28/2005	9:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.74
JMAA-02-RI	7/28/2005	10:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	6.84
JMAA-02-RI	7/28/2005	10:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.04
JMAA-02-RI	7/28/2005	11:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.24
JMAA-02-RI	7/28/2005	11:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.47
JMAA-02-RI	7/28/2005	12:00:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.76
JMAA-02-RI	7/28/2005	12:30:00	NA	DISSOLVED OXYGEN (DO) mg/l	7.9

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# **Appendix D**

## **Watershed Photographs**

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**Canteen Creek Southeast of Bluff Road  
Looking West**



**Canteen Creek Southeast of Bluff Road  
Looking West**



**Harding Ditch at Bunkham Road Looking  
North**



**Harding Ditch at Bunkham Road Looking  
South**



**Harding Ditch Southwest of Lake Boulevard  
Looking North**



**Frank Holten Lake #1 Looking Northwest  
Toward Saint Louis**



**Frank Holten Lake #2 Looking Northwest**



**Frank Holten Lake #3**



**Frank Holten Lake #3 Shoreline**



**Frank Holten Golf Course**



**Frank Holten Lake #3 with Golf Course in Background**



**Canteen Creek at Sand Prairie Road Looking West**



**Canteen Creek at Sand Prairie Road Looking East**



**Canteen Creek at Sand Prairie Road Looking West**



**Blue Heron in Horseshoe Lake**



**Horseshoe Lake East of Lake Road**



**Fisherman at Horseshoe Lake**



**Horseshoe Lake with U.S. Steel Facility in Background**



**Horseshoe Lake Looking West Toward Saint Louis**



**Cahokia Canal at Route 162 Looking South**



**Cahokia Canal at Route 162 Looking North**



**Cahokia Canal at Route 162 Looking South (Construction Activity)**

**Appendix E:  
Cross Section Data and  
Stream Photographs**

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## APPENDIX E: CROSS-SECTION DATA FOR CAHOKIA CANAL

Judy's Branch						
Measurement #	Distance, y (ft)	width, w (ft)	Depth, z (ft)	Velocity at 0.6y (ft/s)	Area, $A = w \cdot z$ (ft <sup>2</sup> )	Discharge, $Q = V \cdot A$ (cfs)
1	0.0	0.0	0.0	0.00	0.00	0.00
2	1.0	1.0	0.3	0.75	0.30	0.23
3	2.0	1.0	0.4	0.51	0.40	0.20
4	3.0	1.0	0.4	0.95	0.40	0.38
5	4.0	1.0	0.4	1.10	0.40	0.44
6	5.0	1.0	0.4	1.03	0.40	0.41
7	6.0	1.0	0.4	1.32	0.40	0.53
8	7.0	1.0	0.5	0.87	0.50	0.44
9	8.0	1.0	0.6	1.30	0.60	0.78
10	9.0	1.0	0.7	1.10	0.70	0.77
11	10.0	1.0	0.7	0.75	0.70	0.53
12	10.3	0.3	0.0	0.00	0.00	0.00
Stream Conditions: No visible flow					<b>Total Q (cfs)</b>	4.7
					<b>Total Area (ft<sup>2</sup>)</b>	4.1
					<b>Average Velocity</b>	0.8
					<b>Stream Width (ft)</b>	10.3



Confluence with Judy's Branch

## APPENDIX E: CROSS-SECTION DATA FOR CAHOKIA CANAL

Horseshoe Lake Rd						
Measurement #	Distance, y (ft)	width, w (ft)	Depth, z (ft)	Velocity at 0.6y (ft/s)	Area, $A = w \cdot z$ (ft <sup>2</sup> )	Discharge, $Q = V \cdot A$ (cfs)
1	0.0	0	0	0	0.00	0.00
2	2.0	2	0.9	0.18	1.80	0.34
3	4.0	2	1.1	0.19	2.20	0.46
4	6.0	2	1.1	0.21	2.20	0.99
5	8.0	2	0.6	0.45	1.20	0.40
6	10.0	2	1.2	0.33	2.40	0.84
7	12.0	2	1	0.35	2.00	0.80
8	14.0	2	1	0.40	2.00	0.52
9	16.0	2	0.9	0.26	1.80	0.00
<b>Stream Conditions:</b>					<b>Total Q (cfs)</b>	4.35
					<b>Total Area (ft<sup>2</sup>)</b>	15.6
					<b>Average Velocity</b>	0.26
					<b>Stream Width (ft)</b>	16.0





## APPENDIX E: CROSS-SECTION DATA FOR CAHOKIA CANAL

Sand Prairie Road						
Measurement #	Distance, y (ft)	width, w (ft)	Depth, z (ft)	Velocity at 0.6y (ft/s)	Area, A = w*z (ft <sup>2</sup> )	Discharge, Q = V*A (cfs)
1	0	0	0.00	0	0.00	0.00
2	2	2	2.10	0.130	4.20	0.63
3	4	2	2.60	0.150	5.20	0.52
4	6	2	2.60	0.100	5.20	0.47
5	8	2	2.70	0.090	5.40	1.13
6	10	2	2.70	0.210	5.40	1.13
7	12	2	2.50	0.210	5.00	1.00
8	14	2	2.30	0.200	4.60	0.00
9	16	2	1.90	0.000	3.80	0.00
10	18	2	1.00	0.000	2.00	0.00
<b>Stream Conditions:</b>					<b>Total Q (cfs)</b>	4.89
					<b>Total Area (ft<sup>2</sup>)</b>	40.8
					<b>Average Velocity</b>	0.11
					<b>Stream Width (ft)</b>	18.0



## APPENDIX E: CROSS-SECTION DATA FOR CAHOKIA CANAL

Rt 111						
Measurement #	<i>Distance, y (ft)</i>	<i>width, w (ft)</i>	<i>Depth, z (ft)</i>	<i>Velocity at 0.6y (ft/s)</i>	<i>Area, A = w*z (ft<sup>2</sup>)</i>	<i>Discharge, Q = V*A (cfs)</i>
1	0.0	0.0	0	0.00	0.00	0.00
2	5.0	5.0	1.2	0.19	6.00	1.14
3	10.0	5.0	1.4	0.14	7.00	0.98
4	15.0	5.0	2.4	0.25	12.00	3.00
5	20.0	5.0	2.8	0.19	14.00	2.66
6	25.0	5.0	2.7	0.23	13.50	3.11
7	30.0	5.0	2.9	0.26	14.50	3.77
8	35.0	5.0	3.1	0.27	15.50	4.19
9	40.0	5.0	3.0	0.22	15.00	3.30
10	42.0	2.0	0.0	0.00	0.00	0.00
<b>Stream Conditions:</b>					<b>Total Q (cfs)</b>	22.1
					<b>Total Area (ft<sup>2</sup>)</b>	97.5
					<b>Average Velocity</b>	0.2
					<b>Stream Width (ft)</b>	42.0



**Appendix F:  
QUAL2K Model  
Cahokia Canal**

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**QUAL2K FORTRAN**

*Stream Water Quality Model*

*Steve Chapra, Hua Tao and Greg Pelletier*

*Version 2.07*



<b>System ID:</b>		
<b>River name</b>	Cahokia Canal	
<b>Saved file name</b>	Cahokia_FINAL	
<b>Directory where file saved</b>	C:\qual2k\	
<b>Month</b>	7	
<b>Day</b>	31	
<b>Year</b>	2006	
<b>Time zone</b>	Central	
<b>Daylight savings time</b>	Yes	
<b>Calculation:</b>		
<b>Calculation step</b>	0.0625	hours
<b>Final time</b>	25	day
<b>Solution method (integration)</b>	Euler	
<b>Solution method (pH)</b>	Bisection	
<b>Program determined calc step</b>	0.046875	hours
<b>Time of last calculation</b>	1.45	minutes
<b>Time of sunrise</b>	6:01 AM	
<b>Time of solar noon</b>	1:07 PM	
<b>Time of sunset</b>	8:12 PM	
<b>Photoperiod</b>	14.18	hours



**QUAL2K**  
 Stream Water Quality Model  
 Cahokia Canal (7/31/2006)  
 Reach Data:

Reach for diel plot											Hydra									
Element for diel plot	3		2		Reach		Headwater		Reach		Downstream		Location		Element	Elevation		Downstream		
Reach	Downstream	Number	Reach	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		
Cahokia Headwaters	I-255 bridge	1	Yes		4.19	38.72	90.03	19.230	15.041	2	125.100	123.500	38.00	43	20	90.00	1	44.26		
Reach 2	Horseshoe Lake Road	2			3.29	38.69	90.04	15.041	11.750	2	123.500	122.100	38.00	41	36	90.00	2	21.95		
JN02 WQ location	Canteen Creek	3			2.54	38.67	90.07	11.750	9.214	2	122.100	120.450	38.00	40	2	90.00	4	5.6		
Canteen Creek Trib	Cahokia	4	Yes		1.75	38.67	90.07	1.750	0.000	2	122.100	120.450	38.00	40	2	90.00	4	5.6		
Reach 4	Horseshoe Lake Outflow	5			4.22	38.66	90.10	9.214	4.995	2	120.450	120.240	38.00	39	51	90.00	5	48.93		
Reach 5	Rt 203 Crossing	6			3.73	38.64	90.14	4.995	1.270	2	120.240	118.500	38.00	38	23	90.00	8	6.37		
Reach 6	Mississippi River	7			1.27	38.64	90.18	1.270	0.000	2	118.500	115.000	38.00	38	41	90.00	10	42.66		

Mullic Model (Weir Overrides Manning Formula; Manning Formula Override Rating Curves)																			
Weir				Rating Curves				Manning Formula					Prescribed	Bottom	Bottom	Prescribed	Prescribed	Prescribed	Prescribed
Height (m)	Width (m)	adam	bdam	Velocity		Depth		Channel Slope	Manning n	Bot Width m	Side Slope	Side Slope	Dispersion m2/s	Algae Coverage	SOD Coverage	SOD gO2/m2/d	CH4 flux gO2/m2/d	NH4 flux mgN/m2/d	Inorg P flux mgP/m2/d
		1.2500	0.9000	0.2500	0.000	0.1500	0.000	0.0013			0.3000	0.3500		50.00%	50.00%		0.0000	0.0000	0.0000
		1.2500	0.9000	0.0800	0.000	0.3000	0.000	0.0004			0.4500	0.9000		50.00%	50.00%		0.0000	0.0000	0.0000
		1.2500	0.9000	0.0300	0.000	0.6900	0.000	0.0004			0.5750	0.6500		50.00%	50.00%		0.0000	0.0000	0.0000
		1.2500	0.9000					0.0020	0.0250	5.00	0.2500	0.2500							
		1.2500	0.9000	0.0500	0.000	0.7400	0.000	0.0001			0.2400	0.4400		50.00%	50.00%		0.0000	0.0000	0.0000
		1.2500	0.9000	0.0305	0.000	1.2200	0.000	0.0051			0.1398	0.1586		50.00%	50.00%		0.0000	0.0000	0.0000
		1.2500	0.9000	0.0305	0.000	1.2200	0.000	0.0008			0.2100	0.3340		50.00%	50.00%		0.0000	0.0000	0.0000





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
<i>(Interpolate values between the hourly inputs.)</i>															
32.80	33.90	35.00	36.70	37.20	37.80	37.80	37.20	37.20	36.10	34.40	33.30	32.80	31.10	30.60	29.40
32.80	33.90	35.00	36.70	37.20	37.80	37.80	37.20	37.20	36.10	34.40	33.30	32.80	31.10	30.60	29.40
32.80	33.90	35.00	36.70	37.20	37.80	37.80	37.20	37.20	36.10	34.40	33.30	32.80	31.10	30.60	29.40
32.80	33.90	35.00	36.70	37.20	37.80	37.80	37.20	37.20	36.10	34.40	33.30	32.80	31.10	30.60	29.40
32.80	33.90	35.00	36.70	37.20	37.80	37.80	37.20	37.20	36.10	34.40	33.30	32.80	31.10	30.60	29.40

**QUAL2K**  
 Stream Water Quality Model  
 Cahokia Canal (7/31/2006)  
 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	<i>(The input values are applied as point estimates at each time. Linear interpolation is used to estimate values between input points.)</i>							
Cahokia headwater	Cahokia Headwaters	I-255 bridge	1	19.230	15.041	22.80	22.80	22.80	22.80	22.20	22.20	22.20	21.70
I-255 bridge	Reach 2	Horseshoe Lake Road	2	15.041	11.750	22.80	22.80	22.80	22.80	22.20	22.20	22.20	21.70
Horseshoe Lake Road	JN02 WQ location	Canteen Creek	3	11.750	9.214	22.80	22.80	22.80	22.80	22.20	22.20	22.20	21.70
Canteen Creek Trib	Canteen Creek Trib	Cahokia	4	1.750	0.000	22.80	22.80	22.80	22.80	22.20	22.20	22.20	21.70
Cahokia	Reach 4	Horseshoe Lake Outfl	5	9.214	4.995	22.80	22.80	22.80	22.80	22.20	22.20	22.20	21.70
Horseshoe Lake Outfl	Reach 5	Rt 203 Crossing	6	4.995	1.270	22.80	22.80	22.80	22.80	22.20	22.20	22.20	21.70
Rt 203 Crossing	Reach 6	Mississippi River	7	1.270	0.000	22.80	22.80	22.80	22.80	22.20	22.20	22.20	21.70

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
<i>te values between the hourly inputs.</i>															
21.70	21.70	21.10	21.10	20.00	20.60	19.40	20.00	20.60	19.40	20.00	20.60	20.60	21.70	22.80	22.80
21.70	21.70	21.10	21.10	20.00	20.60	19.40	20.00	20.60	19.40	20.00	20.60	20.60	21.70	22.80	22.80
21.70	21.70	21.10	21.10	20.00	20.60	19.40	20.00	20.60	19.40	20.00	20.60	20.60	21.70	22.80	22.80
21.70	21.70	21.10	21.10	20.00	20.60	19.40	20.00	20.60	19.40	20.00	20.60	20.60	21.70	22.80	22.80
21.70	21.70	21.10	21.10	20.00	20.60	19.40	20.00	20.60	19.40	20.00	20.60	20.60	21.70	22.80	22.80
21.70	21.70	21.10	21.10	20.00	20.60	19.40	20.00	20.60	19.40	20.00	20.60	20.60	21.70	22.80	22.80

**QUAL2K**  
 Stream Water Quality Model  
 Cahokia Canal (7/31/2006)  
 Wind Speed Data:

Upstream	Reach	Downstream	Reach	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
Label	Label	Label	Number	Distance	Distance	Wind speed for each reach 7m above water surface (m/s)							
<i>(The input values are applied as point estimates at each time. Linear interpolation is used to estimate values between input times.)</i>													
Cahokia headwater	Cahokia Headwaters	I-255 bridge	1	19.230	15.041	4.02	3.13	4.47	3.58	3.58	2.68	2.68	3.58
I-255 bridge	Reach 2	Horseshoe Lake Road	2	15.041	11.750	4.02	3.13	4.47	3.58	3.58	2.68	2.68	3.58
Horseshoe Lake Road	JN02 WQ location	Canteen Creek	3	11.750	9.214	4.02	3.13	4.47	3.58	3.58	2.68	2.68	3.58
Canteen Creek Trib	Canteen Creek Trib	Cahokia	4	1.750	0.000	4.02	3.13	4.47	3.58	3.58	2.68	2.68	3.58
Cahokia	Reach 4	Horseshoe Lake Outfall	5	9.214	4.995	4.02	3.13	4.47	3.58	3.58	2.68	2.68	3.58
Horseshoe Lake Outfall	Reach 5	Rt 203 Crossing	6	4.995	1.270	4.02	3.13	4.47	3.58	3.58	2.68	2.68	3.58
Rt 203 Crossing	Reach 6	Mississippi River	7	1.270	0.000	4.02	3.13	4.47	3.58	3.58	2.68	2.68	3.58













**QUAL2K**

*Stream Water Quality Model*

*Cahokia Canal (7/31/2006)*

*Water Column Rates*

Parameter	Value	Units	Symbol
<b>Stoichiometry:</b>			
Carbon	40	gC	gC
Nitrogen	7.2	gN	gN
Phosphorus	1	gP	gP
Dry weight	100	gD	gD
Chlorophyll	1	gA	gA
<b>Inorganic suspended solids:</b>			
Settling velocity	0.3	m/d	$v_i$
<b>Oxygen:</b>			
Reaeration model	Internal		
User reaeration coefficient $\alpha$	3.93		$\alpha$
User reaeration coefficient $\beta$	0.5		$\beta$
User reaeration coefficient $\gamma$	1.5		$\gamma$
Temp correction	1.024		$\theta_a$
Reaeration wind effect	Banks-Herrera		
O2 for carbon oxidation	2.69	gO <sub>2</sub> /gC	$r_{oc}$
O2 for NH4 nitrification	4.57	gO <sub>2</sub> /gN	$r_{on}$
Oxygen inhib model CBOD oxidation	Exponential		
Oxygen inhib parameter CBOD oxidation	0.60	L/mgO <sub>2</sub>	$K_{socf}$
Oxygen inhib model nitrification	Exponential		
Oxygen inhib parameter nitrification	0.60	L/mgO <sub>2</sub>	$K_{sona}$
Oxygen enhance model denitrification	Exponential		
Oxygen enhance parameter denitrification	0.60	L/mgO <sub>2</sub>	$K_{sodn}$
Oxygen inhib model phyto resp	Exponential		
Oxygen inhib parameter phyto resp	0.60	L/mgO <sub>2</sub>	$K_{sop}$
Oxygen enhance model bot alg resp	Exponential		
Oxygen enhance parameter bot alg resp	0.60	L/mgO <sub>2</sub>	$K_{sob}$
<b>Slow CBOD:</b>			
Hydrolysis rate	0.1	/d	$k_{hc}$
Temp correction	1.07		$\theta_{hc}$
Oxidation rate	0	/d	$k_{des}$
Temp correction	1.047		$\theta_{des}$
<b>Fast CBOD:</b>			
Oxidation rate	0.23	/d	$k_{dc}$
Temp correction	1.047		$\theta_{dc}$

<b>Organic N:</b>			
Hydrolysis	0.2	/d	$k_{hn}$
Temp correction	1.07		$\theta_{hn}$
Settling velocity	0.1	m/d	$v_{on}$
<b>Ammonium:</b>			
Nitrification	1	/d	$k_{na}$
Temp correction	1.07		$\theta_{na}$
<b>Nitrate:</b>			
Denitrification	0	/d	$k_{dn}$
Temp correction	1.07		$\theta_{dn}$
Sed denitrification transfer coeff	0	m/d	$v_{di}$
Temp correction	1.07		$\theta_{di}$
<b>Organic P:</b>			
Hydrolysis	0.2	/d	$k_{hp}$
Temp correction	1.07		$\theta_{hp}$
Settling velocity	0.1	m/d	$v_{op}$
<b>Inorganic P:</b>			
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 <sub>2</sub> /L	$k_{spi}$
<b>Phytoplankton:</b>			
Max Growth rate	2.5	/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	$v_a$

<b>Bottom Algae:</b>			
Growth model	Zero-order		
Max Growth rate	50	mgA/m <sup>2</sup> /d or /d	$C_{gb}$
Temp correction	1.07		$\theta_{gb}$
First-order model carrying capacity	1000	mgA/m <sup>2</sup>	$a_{b,max}$
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	$K_{qP}$
<b>Detritus (POM):</b>			
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	$v_{dt}$
<b>Pathogens:</b>			
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		$\alpha_{path}$
<b>pH:</b>			
Partial pressure of carbon dioxide	347	ppm	$p_{CO2}$

QUAL2K

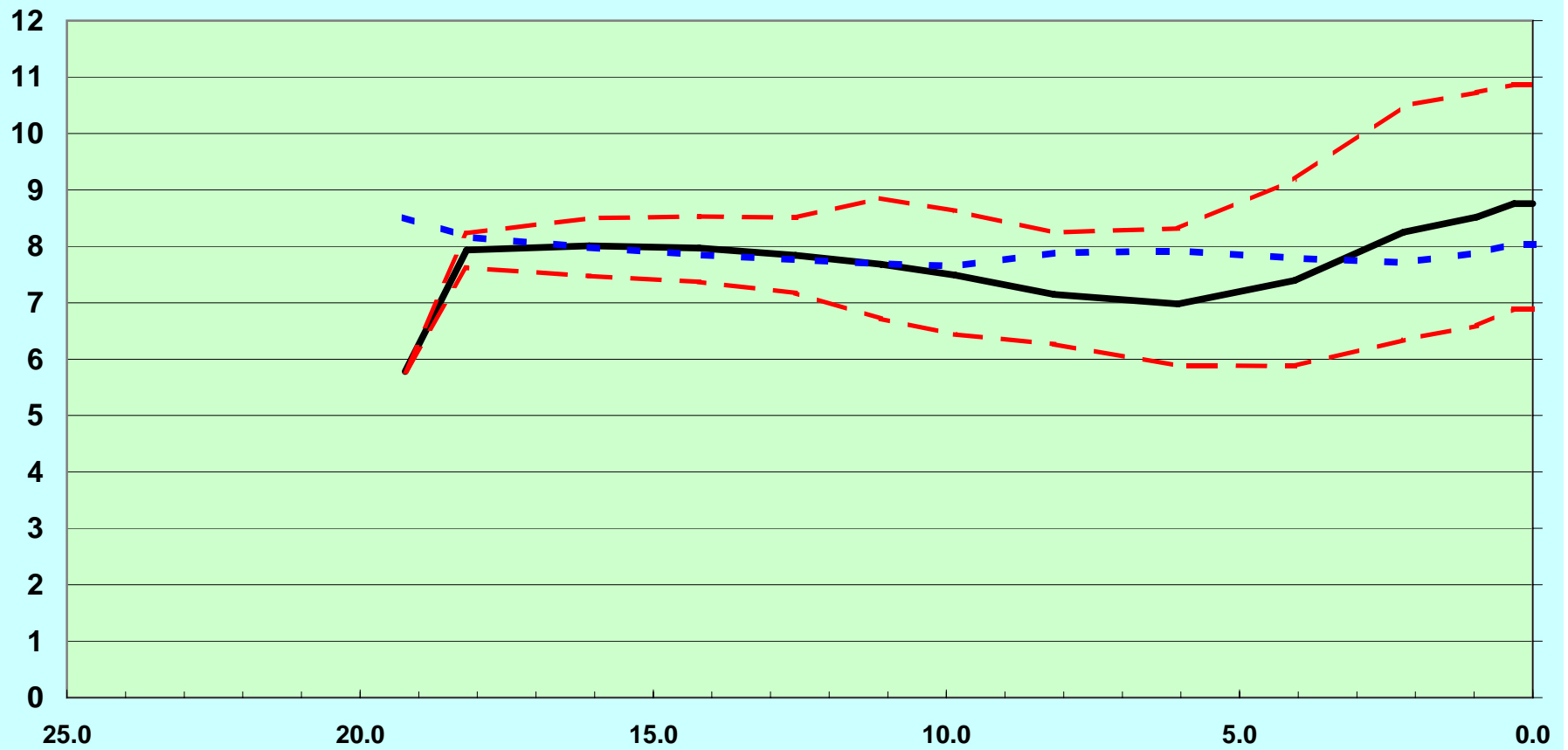
Stream Water Quality Model

Cahokia Canal (7/31/2006)

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) <sup>2/3</sup>	$\alpha_{pn}$
ISS light extinction	0.052	1/m-(mgD/L)	$\alpha_i$
Detritus light extinction	0.174	1/m-(mgD/L)	$\alpha_o$
<i>Solar shortwave radiation model</i>			
Atmospheric attenuation model for solar	Bras		
<i>Bras solar parameter (used if Bras solar model is selected)</i>			
atmospheric turbidity coefficient (2=clear, 5=smoggy, default=2)	2		$n_{fac}$
<i>Ryan-Stolzenbach solar parameter (used if Ryan-Stolzenbach solar model is selected)</i>			
atmospheric transmission coefficient (0.70-0.91, default 0.8)	0.8		$a_{tc}$
<i>Downwelling atmospheric longwave IR radiation</i>			
atmospheric longwave emissivity model	Brunt		
<i>Evaporation and air convection/conduction</i>			
wind speed function for evaporation and air convection/conduction	Brady-Graves-Geyer		
<i>Sediment heat parameters</i>			
Sediment thermal thickness	15	cm	$H_s$
Sediment thermal diffusivity	0.0064	cm <sup>2</sup> /s	$\alpha_s$
Sediment density	1.6	g/cm <sup>3</sup>	$\rho_s$
Water density	1	g/cm <sup>3</sup>	$\rho_w$
Sediment heat capacity	0.4	cal/(g °C)	$C_{ps}$
Water heat capacity	1	cal/(g °C)	$C_{pw}$
<i>Sediment diagenesis model</i>			
Compute SOD and nutrient fluxes	Yes		

*Cahokia Canal (7/31/2006) Mainstem*



— DO(mgO<sub>2</sub>/L)      ■ DO (mgO<sub>2</sub>/L) data      - - DO(mgO<sub>2</sub>/L) Min  
- - DO(mgO<sub>2</sub>/L) Max      □ Minimum DO-data      □ Maximum DO-data  
- - DO sat

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**Appendix G:  
Load Duration Analysis  
Canteen Creek**

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Date	Indian Creek Q	A <sub>u</sub> /A <sub>g</sub>	WW Plant Q	Q <sub>est</sub>	Rank	Exceedance Probability	Total Mn (ug/L)	sec/day	L/ft <sup>3</sup>	Lbs/ug	Product of conversions	Actual Load	Allowable Load	
1/16/1991	326	0.74	6.81		<b>246.7</b>	372.0	0.0153	467	86400	28.31685	2.20462E-09	0.005393776	621	1331
9/17/1998	152	0.74	6.81		<b>118.7</b>	830.0	0.0342	270	86400	28.31685	2.20462E-09	0.005393776	173	640
4/22/1996	130	0.74	6.81		<b>102.5</b>	967.0	0.0398	3800	86400	28.31685	2.20462E-09	0.005393776	2100	553
4/26/1993	103	0.74	6.81		<b>82.6</b>	1181.0	0.0487	340	86400	28.31685	2.20462E-09	0.005393776	151	446
6/22/1998	101	0.74	6.81		<b>81.1</b>	1204.0	0.0496	230	86400	28.31685	2.20462E-09	0.005393776	101	438
7/19/1993	80	0.74	6.81		<b>65.7</b>	1440.0	0.0593	350	86400	28.31685	2.20462E-09	0.005393776	124	354
4/20/1992	70	0.74	6.81		<b>58.3</b>	1574.0	0.0648	520	86400	28.31685	2.20462E-09	0.005393776	164	315
3/22/1993	55	0.74	6.81		<b>47.3</b>	1897.0	0.0782	480	86400	28.31685	2.20462E-09	0.005393776	122	255
5/22/1995	52	0.74	6.81		<b>45.1</b>	1966.0	0.0810	400	86400	28.31685	2.20462E-09	0.005393776	97	243
4/21/1997	50	0.74	6.81		<b>43.6</b>	2031.0	0.0837	600	86400	28.31685	2.20462E-09	0.005393776	141	235
11/23/1992	50	0.74	6.81		<b>43.6</b>	2030.0	0.0836	400	86400	28.31685	2.20462E-09	0.005393776	94	235
1/6/1993	49	0.74	6.81		<b>42.9</b>	2085.0	0.0859	390	86400	28.31685	2.20462E-09	0.005393776	90	231
11/29/1993	44	0.74	6.81		<b>39.2</b>	2272.0	0.0936	590	86400	28.31685	2.20462E-09	0.005393776	125	211
3/19/1997	44	0.74	6.81		<b>39.2</b>	2273.0	0.0936	410	86400	28.31685	2.20462E-09	0.005393776	87	211
2/19/1991	41	0.74	6.81		<b>37.0</b>	2403.0	0.0990	921	86400	28.31685	2.20462E-09	0.005393776	184	199
5/26/1998	41	0.74	6.81		<b>37.0</b>	2404.0	0.0990	360	86400	28.31685	2.20462E-09	0.005393776	72	199
9/3/1991	38	0.74	6.81		<b>34.8</b>	2585.0	0.1065	230	86400	28.31685	2.20462E-09	0.005393776	43	188
5/4/1994	35	0.74	6.81		<b>32.6</b>	2747.0	0.1132	370	86400	28.31685	2.20462E-09	0.005393776	65	176
4/13/1998	24	0.74	6.81		<b>24.5</b>	3778.0	0.1556	370	86400	28.31685	2.20462E-09	0.005393776	49	132
1/23/1995	22	0.74	6.81		<b>23.0</b>	4059.0	0.1672	530	86400	28.31685	2.20462E-09	0.005393776	66	124
6/18/1990	21	0.74	6.81		<b>22.3</b>	4232.0	0.1744	961	86400	28.31685	2.20462E-09	0.005393776	115	120
6/19/1995	21	0.74	6.81		<b>22.3</b>	4233.0	0.1744	630	86400	28.31685	2.20462E-09	0.005393776	76	120
10/25/1993	17	0.74	6.81		<b>19.3</b>	5018.0	0.2067	300	86400	28.31685	2.20462E-09	0.005393776	31	104
3/2/1998	16	0.74	6.81		<b>18.6</b>	5242.0	0.2160	540	86400	28.31685	2.20462E-09	0.005393776	54	100
5/13/1991	16	0.74	6.81		<b>18.6</b>	5240.0	0.2159	410	86400	28.31685	2.20462E-09	0.005393776	41	100
5/27/1997	16	0.74	6.81		<b>18.6</b>	5241.0	0.2159	400	86400	28.31685	2.20462E-09	0.005393776	40	100
4/23/1991	15	0.74	6.81		<b>17.8</b>	5516.0	0.2272	418	86400	28.31685	2.20462E-09	0.005393776	40	96
3/28/1994	13	0.74	6.81		<b>16.4</b>	6178.0	0.2545	450	86400	28.31685	2.20462E-09	0.005393776	40	88
6/5/1996	13	0.74	6.81		<b>16.4</b>	6179.0	0.2546	430	86400	28.31685	2.20462E-09	0.005393776	38	88
2/9/1994	11	0.74	6.81		<b>14.9</b>	6922.0	0.2852	510	86400	28.31685	2.20462E-09	0.005393776	41	80
2/8/1993	10	0.74	6.81		<b>14.2</b>	7347.0	0.3027	800	86400	28.31685	2.20462E-09	0.005393776	61	76
1/21/1997	10	0.74	6.81		<b>14.2</b>	7348.0	0.3027	590	86400	28.31685	2.20462E-09	0.005393776	45	76
3/3/1992	9.6	0.74	6.81		<b>13.9</b>	7742.0	0.3190	710	86400	28.31685	2.20462E-09	0.005393776	53	75
3/6/1995	7.9	0.74	6.81		<b>12.6</b>	8735.0	0.3599	640	86400	28.31685	2.20462E-09	0.005393776	44	68
10/19/1998	7.7	0.74	6.81		<b>12.5</b>	8835.0	0.3640	120	86400	28.31685	2.20462E-09	0.005393776	8	67
4/10/1995	7.5	0.74	6.81		<b>12.3</b>	8923.0	0.3676	380	86400	28.31685	2.20462E-09	0.005393776	25	66
6/16/1993	7.1	0.74	6.81		<b>12.0</b>	9188.0	0.3785	220	86400	28.31685	2.20462E-09	0.005393776	14	65
1/10/1994	7	0.74	6.81		<b>12.0</b>	9224.0	0.3800	820	86400	28.31685	2.20462E-09	0.005393776	53	65
1/20/1998	6.8	0.74	6.81		<b>11.8</b>	9397.0	0.3871	510	86400	28.31685	2.20462E-09	0.005393776	32	64
5/2/1990	6.6	0.74	6.81		<b>11.7</b>	9553.0	0.3936	297	86400	28.31685	2.20462E-09	0.005393776	19	63

Date	Indian Creek Q	$A_u/A_g$	WW Plant Q	$Q_{est}$	Rank	Exceedance Probability	Total Mn (ug/L)	sec/day	L/ft <sup>3</sup>	Lbs/ug	Product of conversions	Actual Load	Allowable Load	
6/27/1994	6.3	0.74	6.81		11.4	9760.0	0.4021	390	86400	28.31685	2.20462E-09	0.005393776	24	62
4/9/1990	6	0.74	6.81		11.2	9936.0	0.4093	775	86400	28.31685	2.20462E-09	0.005393776	47	61
3/5/1990	5.5	0.74	6.81		10.9	10336.0	0.4258	729	86400	28.31685	2.20462E-09	0.005393776	43	59
8/1/1994	4.5	0.74	6.81		10.1	11179.0	0.4606	75	86400	28.31685	2.20462E-09	0.005393776	4	55
6/15/1992	4	0.74	6.81		9.8	11642.0	0.4796	160	86400	28.31685	2.20462E-09	0.005393776	8	53
11/18/1996	3.8	0.74	6.81		9.6	11925.0	0.4913	510	86400	28.31685	2.20462E-09	0.005393776	26	52
5/26/1992	3.7	0.74	6.81		9.5	12020.0	0.4952	280	86400	28.31685	2.20462E-09	0.005393776	14	51
7/25/1990	3.7	0.74	6.81		9.5	12019.0	0.4952	265	86400	28.31685	2.20462E-09	0.005393776	14	51
1/29/1992	3.6	0.74	6.81		9.5	12135.0	0.4999	860	86400	28.31685	2.20462E-09	0.005393776	44	51
7/17/1996	3.1	0.74	6.81		9.1	12721.0	0.5241	190	86400	28.31685	2.20462E-09	0.005393776	9	49
7/24/1995	3	0.74	6.81		9.0	12829.0	0.5285	310	86400	28.31685	2.20462E-09	0.005393776	15	49
12/14/1998	3	0.74	6.81		9.0	12830.0	0.5286	240	86400	28.31685	2.20462E-09	0.005393776	12	49
7/29/1992	2.8	0.74	6.81		8.9	13138.0	0.5413	220	86400	28.31685	2.20462E-09	0.005393776	11	48
11/25/1991	2.6	0.74	6.81		8.7	13384.0	0.5514	510	86400	28.31685	2.20462E-09	0.005393776	24	47
3/20/1996	2.6	0.74	6.81		8.7	13385.0	0.5514	180	86400	28.31685	2.20462E-09	0.005393776	8	47
12/12/1994	2.5	0.74	6.81		8.6	13495.0	0.5560	480	86400	28.31685	2.20462E-09	0.005393776	22	47
2/14/1996	2.3	0.74	6.81		8.5	13828.0	0.5697	560	86400	28.31685	2.20462E-09	0.005393776	26	46
9/8/1993	2.1	0.74	6.81		8.4	14082.0	0.5802	130	86400	28.31685	2.20462E-09	0.005393776	6	45
10/15/1990	2	0.74	6.81		8.3	14267.0	0.5878	167	86400	28.31685	2.20462E-09	0.005393776	7	45
8/17/1998	1.9	0.74	6.81		8.2	14487.0	0.5968	170	86400	28.31685	2.20462E-09	0.005393776	8	44
6/5/1991	1.8	0.74	6.81		8.1	14651.0	0.6036	160	86400	28.31685	2.20462E-09	0.005393776	7	44
9/24/1997	1.4	0.74	6.81		7.8	15481.0	0.6378	150	86400	28.31685	2.20462E-09	0.005393776	6	42
11/26/1990	1.4	0.74	6.81		7.8	15480.0	0.6377	116	86400	28.31685	2.20462E-09	0.005393776	5	42
7/9/1997	1.3	0.74	6.81		7.8	15655.0	0.6450	220	86400	28.31685	2.20462E-09	0.005393776	9	42
1/22/1990	1.3	0.74	6.81		7.8	15656.0	0.6450	527	86400	28.31685	2.20462E-09	0.005393776	22	42
1/8/1996	1.1	0.74	6.81		7.6	16103.0	0.6634	540	86400	28.31685	2.20462E-09	0.005393776	22	41
8/26/1992	1	0.74	6.81		7.5	16318.0	0.6723	120	86400	28.31685	2.20462E-09	0.005393776	5	41
9/16/1996	0.97	0.74	6.81		7.5	16632.0	0.6852	210	86400	28.31685	2.20462E-09	0.005393776	9	41
8/28/1995	0.83	0.74	6.81		7.4	16988.0	0.6999	860	86400	28.31685	2.20462E-09	0.005393776	34	40
12/8/1997	0.7	0.74	6.81		7.3	17421.0	0.7177	180	86400	28.31685	2.20462E-09	0.005393776	7	39
10/21/1996	0.6	0.74	6.81		7.2	17804.0	0.7335	250	86400	28.31685	2.20462E-09	0.005393776	10	39
9/14/1998	0.51	0.74	6.81		7.2	18129.0	0.7469	130	86400	28.31685	2.20462E-09	0.005393776	5	39
7/29/1991	0.4	0.74	6.81		7.1	18628.0	0.7674	107	86400	28.31685	2.20462E-09	0.005393776	4	38
7/18/1990	0.39	0.74	6.81		7.1	18809.0	0.7749	152	86400	28.31685	2.20462E-09	0.005393776	6	38
11/27/1995	0.36	0.74	6.81		7.1	18960.0	0.7811	140	86400	28.31685	2.20462E-09	0.005393776	5	38
11/3/1997	0.36	0.74	6.81		7.1	18961.0	0.7812	120	86400	28.31685	2.20462E-09	0.005393776	5	38
9/26/1994	0.35	0.74	6.81		7.1	18997.0	0.7826	1100	86400	28.31685	2.20462E-09	0.005393776	42	38
11/2/1994	0.25	0.74	6.81		7.0	19621.0	0.8083	120	86400	28.31685	2.20462E-09	0.005393776	5	38
9/5/1990	0.2	0.74	6.81		7.0	19901.0	0.8199	127	86400	28.31685	2.20462E-09	0.005393776	5	38
10/23/1995	0.19	0.74	6.81		6.9	20134.0	0.8295	190	86400	28.31685	2.20462E-09	0.005393776	7	37

Date	Indian Creek Q	A <sub>u</sub> /A <sub>g</sub>	WW Plant Q	Q <sub>est</sub>	Rank	Exceedance Probability	Total Mn (ug/L)	sec/day	L/ft <sup>3</sup>	Lbs/ug	Product of conversions	Actual Load	Allowable Load	
8/13/1997	0.1	0.74	6.81		<b>6.9</b>	20813.0	0.8575	100	86400	28.31685	2.20462E-09	0.005393776	4	37
10/27/1992	0	0.74	6.81		<b>6.8</b>	21995.0	0.9062	88	86400	28.31685	2.20462E-09	0.005393776	3	37
10/1/1991	0	0.74	6.81		<b>6.8</b>	21994.0	0.9061	68	86400	28.31685	2.20462E-09	0.005393776	2	37

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**Appendix H:  
Load Duration Analysis  
Harding Ditch**

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Date	Indian Q	A <sub>u</sub> /A <sub>g</sub>	Q <sub>est</sub>	Rank	Flow Exceedance %	Fecal Coliform (col/100mL)	100mL/ft <sup>3</sup>	s/d	Actual Load (Mil Col/day)	Geometric mean load
7/19/1993	80	0.90	72.3	540	0.0439	20000.00	283.2	86400	35376689	353767
6/12/2003	52	0.90	47.0	726	0.0590	8500.00	283.2	86400	9772810	229948
5/22/1995	52	0.90	47.0	727	0.0591	4900.00	283.2	86400	5633738	229948
9/3/1991	38	0.90	34.3	911	0.0741	5800.00	283.2	86400	4873139	168039
5/4/1994	35	0.90	31.6	976	0.0794	20000.00	283.2	86400	15477301	154773
6/2/2004	33	0.90	29.8	1017	0.0827	1320.00	283.2	86400	963130	145929
6/18/1990	21	0.90	19.0	1429	0.1162	6000.00	283.2	86400	2785914	92864
6/19/1995	21	0.90	19.0	1428	0.1161	2000.00	283.2	86400	928638	92864
5/13/1991	16	0.90	14.5	1736	0.1412	590.00	283.2	86400	208722	70753
6/5/1996	13	0.90	11.7	2035	0.1655	2700.00	283.2	86400	776076	57487
6/16/1993	7.1	0.90	6.4	2975	0.2419	2200.00	283.2	86400	345365	31397
5/2/1990	6.6	0.90	6.0	3112	0.2530	860.00	283.2	86400	125499	29186
6/27/1994	6.3	0.90	5.7	3208	0.2609	7900.00	283.2	86400	1100436	27859
6/28/2004	5.3	0.90	4.8	3536	0.2875	810.00	283.2	86400	94920	23437
8/1/1994	4.5	0.90	4.1	3852	0.3132	2500.00	283.2	86400	248742	19899
6/15/1992	4	0.90	3.6	4079	0.3317	20000.00	283.2	86400	1768834	17688
5/26/1992	3.7	0.90	3.3	4240	0.3448	5800.00	283.2	86400	474490	16362
7/25/1990	3.7	0.90	3.3	4241	0.3449	5600.00	283.2	86400	458128	16362
7/17/1996	3.1	0.90	2.8	4595	0.3736	3600.00	283.2	86400	246752	13708
7/24/1995	3	0.90	2.7	4689	0.3813	9800.00	283.2	86400	650047	13266
7/29/1992	2.8	0.90	2.5	4812	0.3913	1160.00	283.2	86400	71815	12382
9/8/1993	2.1	0.90	1.9	5392	0.4384	2900.00	283.2	86400	134653	9286
10/15/1990	2	0.90	1.8	5512	0.4482	2700.00	283.2	86400	119396	8844
6/5/1991	1.8	0.90	1.6	5717	0.4649	2400.00	283.2	86400	95517	7960
8/10/2004	1.5	0.90	1.4	6064	0.4931	710.00	283.2	86400	23548	6633
10/28/2003	1.2	0.90	1.1	6509	0.5293	1950.00	283.2	86400	51738	5307
8/26/1992	1	0.90	0.9	6846	0.5567	560.00	283.2	86400	12382	4422
9/16/1996	0.97	0.90	0.9	6888	0.5601	8000.00	283.2	86400	171577	4289
8/28/1995	0.83	0.90	0.8	7154	0.5817	2300.00	283.2	86400	42209	3670
9/27/2004	0.73	0.90	0.7	7390	0.6009	165.00	283.2	86400	2663	3228
8/12/2003	0.6	0.90	0.5	7743	0.6296	400.00	283.2	86400	5307	2653
7/29/1991	0.4	0.90	0.4	8318	0.6764	2000.00	283.2	86400	17688	1769
9/23/2003	0.38	0.90	0.3	8399	0.6830	270.00	283.2	86400	2269	1680
9/26/1994	0.35	0.90	0.3	8485	0.6899	9800.00	283.2	86400	75839	1548
9/5/1990	0.2	0.90	0.2	9211	0.7490	1120.00	283.2	86400	4953	884
10/23/1995	0.19	0.90	0.2	9277	0.7544	9800.00	283.2	86400	41170	840
10/1/1991	0	0.90	0.0	10673	0.8679	860.00	283.2	86400	0	0
10/27/1992	0	0.90	0.0	10641	0.8653	380.00	283.2	86400	0	0
	1.2	0.90	1.1	12298	1.0000	138	283.2	86400	3661	5307

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**Appendix I:  
BATHTUB  
Horseshoe Lake**

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**HORSESHOE LAKE: JUNE THROUGH FEBRUARY "NORMAL" SCENARIO**

LANDUSE TYPE	TOTAL AREA	PERCENT OF TOTAL	Runoff C-Coefficient	Total P (ug/L)
Barren/Exposed Land	160730	0.263%	0.2	121
Farmland	24992437	40.840%	0.18	121
Forested	833964	1.363%	0.13	121
High Density Residential	4647474	7.594%	0.4	383
Low/Medium Density Residential	14185813	23.181%	0.4	383
Surface Water Adjusted	1783481	2.914%	1	0
Urban Open Space	7204984	11.774%	0.18	121
Wetlands_Adjusted	7387544	12.072%	1	0
Grand Total_Adjusted	61196427	100.000%		
Weighted C-Coeff			0.370	
Weighted P Conc (ug/L)				183.50

subbasin TP conc

Weighted C-Coeff	0.369963375
------------------	-------------

Annual Precip  
Source: Stage 1 Report

Month	Total Precipitation (inches)
January	2.1
February	2.3
March	3.6
April	4.0
May	4.0
June	3.8
July	3.8
August	3.6
September	3.1
October	2.7
November	3.5
December	2.7
Total	39.2

	inch	inch/yr	m/in	m/yr
WET	11.6	46.4	0.0254	1.17856
REST OF YEAR	27.6	36.8	0.0254	0.93472

Q = CiA

	Wet Calc C	i	A	
		0.369963375	0.93472	61196427
Q (million m3/yr) =	21.16246902			
Q (cfs) =	23.68080284			
Subwatershed	TOTAL AREA	PERCENT OF TOTAL	FLOW - BATHTUB	FLOW - cfs
1	3234404.495	0.052852832	1.118496425	1.2515975
2	12279496.32	0.200657079	4.246399222	4.75172073
3	35581609.46	0.581432792	12.30455345	13.76879531
4	3694676.627	0.060374058	1.277664128	1.429706159
5	6406240.205	0.104683239	2.215355803	2.478983143
	61196427.1			

Title: Horseshoe Lake - June - Feb  
Notes: Portion of Year when Cahokia Canal likely loads to Lake

**m/in 0.0254**

	Historic Data	Units	Model Input	Model units
Averaging Period:	NA			0.75 yr
Precipitation		36.8 inches		0.93472 meters
Evaporation		35.3 inches		0.89662 meters
Increase in Storage	NA	NA		meters
Atmospheric Loads	NA	NS		



Segment ID	Monitoring Station	Name	Outflow	Surface Area(sq km)	Mean Depth (m)	Length (km)
1	RJC-3	near Granite City	2	2.45	1.6	3.05
2	N/A	northern segment	3	1.30	2.1	1.16
3	RJC-1	Deep Segment	5	0.38	12.8	0.29
4	RJC-2	NE segment	2	1.06	1.1	1.49
5	RJC-4	out of res	out of reservoir	1.83	1.1	2.90
6	N/A	subimpoundment	4	1.06	0.9	2.14

Observed P
148.25
223.32
258.78
222.75
263.50
223.32

Tributary	To Segment	Trib Type	Area (km2)	Flow	Total P	SOURCE
1		Monitored Inflow	3.2	1.1185	<b>183.50</b>	Landuse Calc
2		Monitored Inflow	12.3	4.2464	<b>183.50</b>	Landuse Calc
3		Monitored Inflow	35.6	12.3046	<b>183.50</b>	Landuse Calc
4		Monitored Inflow	3.7	1.2777	<b>183.50</b>	Landuse Calc
5		Monitored Inflow	6	2.2154	<b>183.50</b>	Landuse Calc
Granite City		Point Source	NA	14.1200	<b>237.00</b>	Permit Application

Horseshoe Lake - Non-Wet Weather Loading Scenario

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Variable: TOTAL P MG/M3

Segment	Predicted		Observed	
	Mean	CV	Mean	CV
RJC-3	214.4	0.19	148.3	0.00
northern Segment	206.6	0.20	223.3	0.00
RJC-1	204.5	0.20	258.8	0.00
RJC-2	212.2	0.19	222.8	0.00
RJC-4	205.8	0.20	263.5	0.00
subimpoundment	253.7	0.19	223.3	0.00
Area-Wtd Mean	215.6	0.19	211.3	0.00

Horseshoe Lake - Non-Wet Weather Loading Scenario

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Overall Water & Nutrient Balances

Overall Water Balance

Trb	Type	Seg	Name	Averaging Period = 0.75 years			
				Area km <sup>2</sup>	Flow hm <sup>3</sup> /yr	Variance (hm <sup>3</sup> /yr) <sup>2</sup>	CV runoff - m/yr
1	1	1	Granite City - Trib 1	3.2	1.1	0.00E+00	0.00 0.35
2	1	2	Nameoki Ditch - Trib 2	12.3	4.2	0.00E+00	0.00 0.35
3	1	4	Long Lake - Trib 3	35.6	12.3	0.00E+00	0.00 0.35
4	1	5	Agricultural Area - Trib 4	3.7	1.3	0.00E+00	0.00 0.35
5	1	6	Trib 5	6.0	2.2	0.00E+00	0.00 0.37
6	3	1	US Steel - Granite City NPDES		14.1	0.00E+00	0.00
PRECIPITATION				8.1	10.1	0.00E+00	0.00 1.25
TRIBUTARY INFLOW				60.8	21.2	0.00E+00	0.00 0.35
POINT-SOURCE INFLOW					14.1	0.00E+00	0.00
***TOTAL INFLOW				68.9	45.4	0.00E+00	0.00 0.66
ADVECTIVE OUTFLOW				68.9	35.7	0.00E+00	0.00 0.52
***TOTAL OUTFLOW				68.9	35.7	0.00E+00	0.00 0.52
***EVAPORATION					9.7	0.00E+00	0.00

**Overall Mass Balance Based Upon Component:**

**Predicted TOTAL P**

**Outflow & Reservoir Concentrations**

Trb	Type	Seg	Name	Load		Load Variance		CV	Conc mg/m <sup>3</sup>	Export kg/km <sup>2</sup> /yr
				kg/yr	%Total	(kg/yr) <sup>2</sup>	%Total			
1	1	1	Granite City - Trib 1	205.2	0.6%	0.00E+00	0.00	0.00	183.5	64.1
2	1	2	Nameoki Ditch - Trib 2	779.2	2.1%	0.00E+00	0.00	0.00	183.5	63.4
3	1	4	Long Lake - Trib 3	2257.9	6.1%	0.00E+00	0.00	0.00	183.5	63.4
4	1	5	Agricultural Area - Trib 4	234.5	0.6%	0.00E+00	0.00	0.00	183.5	63.4
5	1	6	Trib 5	406.5	1.1%	0.00E+00	0.00	0.00	183.5	67.8
6	3	1	US Steel - Granite City I	3346.4	9.0%	0.00E+00	0.00	0.00	237.0	
PRECIPITATION				242.4	0.7%	1.47E+04	100.0%	0.50	24.1	30.0
INTERNAL LOAD				29512.2	79.8%	0.00E+00		0.00		
TRIBUTARY INFLOW				3883.3	10.5%	0.00E+00		0.00	183.5	63.9
POINT-SOURCE INFLOW				3346.4	9.0%	0.00E+00		0.00	237.0	
***TOTAL INFLOW				36984.4	100.0%	1.47E+04	100.0%	0.00	815.5	536.9 lbs/yr    81550.55 lbs/day    223.4262
ADVECTIVE OUTFLOW				7345.2	19.9%	2.20E+06		0.20	205.8	106.6
***TOTAL OUTFLOW				7345.2	19.9%	2.20E+06		0.20	205.8	106.6
***RETENTION				29639.1	80.1%	2.21E+06		0.05		
Overflow Rate (m/yr)				4.4		Nutrient Resid. Time (yrs)	0.0912			
Hydraulic Resid. Time (yrs)				0.4384		Turnover Ratio	8.2			
Reservoir Conc (mg/m3)				216		Retention Coef.	0.801			

Tributary	Total P	Reduction to	5										
1	183.50		97.3%										
2	183.50		97.3%										
3	183.50		97.3%										
4	183.50		97.3%										
5	183.50		97.3%										
Granite City	237.00	185.5		*0.185 mg/L would be new permit limit for Granite City (21.7% reduction)									
INTERNAL	Percent Reduction	99	99	98	97	96	95	94	93	92	91	90	
	10	0.1	0.15	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	

Horseshoe Lake - Non-Wet Weather Loading Scenario  
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Overall Water & Nutrient Balances

Overall Water Balance

Trb	Type	Seg	Name	Area km <sup>2</sup>	Flow hm <sup>3</sup> /yr	Averaging Period = 0.75 years		Runoff m/yr
						Variance (hm <sup>3</sup> /yr) <sup>2</sup>	CV	
1	1	1	Granite Ci	3.2	1.1	0.00E+00	0.00	0.35
2	1	2	Nameoki I	12.3	4.2	0.00E+00	0.00	0.35
3	1	4	Long Lake	35.6	12.3	0.00E+00	0.00	0.35
4	1	5	Agriculture	3.7	1.3	0.00E+00	0.00	0.35
5	1	6	Trib 5	6.0	2.2	0.00E+00	0.00	0.37
6	3	1	US Steel - Granite		14.1	0.00E+00	0.00	
PRECIPITATION				8.1	10.1	0.00E+00	0.00	1.25
TRIBUTARY INFLOW				60.8	21.2	0.00E+00	0.00	0.35
POINT-SOURCE INFLOW					14.1	0.00E+00	0.00	
***TOTAL INFLOW				68.9	45.4	0.00E+00	0.00	0.66
ADVECTIVE OUTFLOW				68.9	35.7	0.00E+00	0.00	0.52
***TOTAL OUTFLOW				68.9	35.7	0.00E+00	0.00	0.52
***EVAPORATION					9.7	0.00E+00	0.00	

**Overall Mass Balance Based Upon Component:**

**Predicted TOTAL P**      **Outflow & Reservoir Concentrations**

Trb	Type	Seq	Name	Load		Load Variance		CV	Conc Export			
				kg/yr	%Total	(kg/yr) <sup>2</sup>	%Total		mg/m <sup>3</sup>	µ/km <sup>2</sup> /yr	lbs/yr	lbs/day
1	1	1	Granite Ci	5.6	0.2%	0.00E+00		0.00	5.0	1.7	12.33146191	0.0338
2	1	2	Nameoki I	21.2	0.7%	0.00E+00		0.00	5.0	1.7	46.81655657	0.1283
3	1	4	Long Lake	61.5	1.9%	0.00E+00		0.00	5.0	1.7	135.6582124	0.3717
4	1	5	Agriculture	6.4	0.2%	0.00E+00		0.00	5.0	1.7	14.08664192	0.0386
5	1	6	Trib 5	11.1	0.3%	0.00E+00		0.00	5.0	1.8	24.42478426	0.0669
6	3	1	US Steel -	2619.3	80.3%	0.00E+00		0.00	185.5		5775.468322	15.823
PRECIPITATION				242.4	7.4%	1.47E+04	100.0%	0.50	24.1	30.0	534.4919865	1.4644
INTERNAL LOAD				295.1	9.0%	0.00E+00		0.00			650.7439632	1.7829
TRIBUTARY INFLOW				105.8	3.2%	0.00E+00		0.00	5.0	1.7	233.317656	0.6392
POINT-SOURCE INFLOW				2619.3	80.3%	0.00E+00		0.00	185.5		5775.468322	15.823
***TOTAL INFLOW				3262.6	100.0%	1.47E+04	100.0%	0.04	71.9	47.4	7194.02191	19.71
ADVECTIVE OUTFLOW				1682.7	51.6%	6.54E+04		0.15	47.1	24.4	3710.282064	10.165
***TOTAL OUTFLOW				1682.7	51.6%	6.54E+04		0.15	47.1	24.4	3710.282064	10.165
***RETENTION				1579.9	48.4%	6.97E+04		0.17				

Overflow Rate (m/yr)	4.4	Nutrient Resid. Time (yrs)	0.2335
Hydraulic Resid. Time (yrs)	0.4384	Turnover Ratio	3.2
Reservoir Conc (mg/m <sup>3</sup> )	49	Retention Coef.	0.484

Rest of Year TMDL (June-Feb)					
(lbs/day)					
LC	Current Estimated Load	Reduction Needed	WLA	LA	MOS
19.71	223	91%	15.8	1.939	1.971

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**HORSESHOE LAKE: MARCH-MAY "WET" SCENARIO**

LANDUSE TYPE	TOTAL AREA	PERCENT OF TOTAL	Runoff C-Coefficient	Total P (ug/L)
Barren/Exposed Land	160730	0.263%	0.2	121
Farmland	24992437	40.840%	0.18	121
Forested	833964	1.363%	0.13	121
High Density Residential	4647474	7.594%	0.4	383
Low/Medium Density Residential	14185813	23.181%	0.4	383
Surface Water Adjusted	1783481	2.914%	1	0
Urban Open Space	7204984	11.774%	0.18	121
Wetlands_Adjusted	7387544	12.072%	1	0
Grand Total_Adjusted	61196427	100.000%		
Weighted C-Coeff			0.370	
Weighted P Conc (ug/L)				183.50

Weighted C-Coeff 0.369963375

Annual Precip  
Source: Stage 1 Report

Month	Total Precipitation (inches)
January	2.1
February	2.3
March	3.6
April	4.0
May	4.0
June	3.8
July	3.8
August	3.6
September	3.1
October	2.7
November	3.5
December	2.7
Total	39.2

	inch	inch/yr	m/in	m/yr
WET	11.6	46.4	0.0254	1.17856
REST OF YEAR	27.6	36.8	0.0254	0.93472

Q = CiA

	Wet Calc C	i	A	
	0.369963375		1.17856	61196427
Q (million m3/yr) =	26.68311312			
Q (cfs) =	29.85840358			
Subwatershed	TOTAL AREA	PERCENT OF TOTAL	FLOW	
1	3234404.495	0.052852832	1.410278101	1.578101195
2	12279496.32	0.200657079	5.354155541	5.99130005
3	35581609.46	0.581432792	15.51443695	17.36065495
4	3694676.627	0.060374058	1.610967814	1.802672984
5	6406240.205	0.104683239	2.793274708	3.125674398
	61196427.1			

Title: Horseshoe Lake - Wet (March-May)  
Notes: Portion of Year when Cahokia Canal likely loads to Lake

**m/in 0.0254**

	Historic Data	Units	Model Input	Model units
Averaging Period:	NA			0.25 yr
Precipitation		46.4 inches		1.17856 meters
Evaporation		35.3 inches		0.89662 meters
Increase in Storage	NA	NA		meters
Atmospheric Loads	NA	NS		

Segment ID	Monitoring Station	Name	Outflow	Surface Area(sq km)	Mean Depth (m)	Length (km)	Observed P	NOTES
1	RJC-3	near Granite City	2	2.45	1.6	3.05	172.50	WQ
2	N/A	northern segment	3	1.30	2.1	1.16	213.09	no data - used average
3	RJC-1	Deep Segment	5	0.38	12.8	0.29	82.88	WQ
4	RJC-2	NE segment	2	1.06	1.1	1.49	303.50	WQ
5	RJC-4	out of res	out of reservoir	1.83	1.1	2.90	293.50	WQ
6	N/A	subimpoundment	4	1.06	0.9	2.14	213.09	no data - used average

<b>Tributary</b>	<b>To Segment</b>	<b>Trib Type</b>	<b>Area (km2)</b>	<b>Flow</b>	<b>Total P</b>	<b>SOURCE</b>
1	1	Monitored Inflow	3.2	1.4103	<b>183.50</b>	Landuse Calc
2	2	Monitored Inflow	12.3	5.3542	<b>183.50</b>	Landuse Calc
3	4	Monitored Inflow	35.6	15.5144	<b>183.50</b>	Landuse Calc
4	5	Monitored Inflow	3.7	1.6110	<b>183.50</b>	Landuse Calc
5	6	Monitored Inflow	6	2.7933	<b>183.50</b>	Landuse Calc
Cahokia Canal (6)	6	Monitored Inflow	192.8	75.4670	<b>224.47</b>	WQ Data
Granite City	1	Point Source	NA	15.0138	<b>237.00</b>	Permit Application

**Horseshoe Lake - Wet Weather Loading Scenario**

File: C:\BATHTUB\HORSESHOE-WET-BD-CAL.btb

Variable: TOTAL P MG/M3

<u>Segment</u>	<u>Predicted</u>		<u>Observed</u>	
	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>
RJC-3	230.6	0.19	172.5	0.00
northern Segment	220.5	0.19	213.1	0.00
RJC-1	219.0	0.19	82.9	0.00
RJC-2	223.3	0.18	303.5	0.00
RJC-4	219.9	0.19	293.5	0.00
subimpoundment	228.0	0.16	213.1	0.00
Area-Wtd Mean	224.7	0.18	224.7	0.00

**Horseshoe Lake - Wet Weather Loading Scenario**

File: C:\BATHTUB\HORSESHOE-WET-BD-CAL.btb

**Overall Water & Nutrient Balances**

**Overall Water Balance**

<u>Trb</u>	<u>Type</u>	<u>Seg</u>	<u>Name</u>	<u>Area</u> <u>km<sup>2</sup></u>	<u>Averaging Period = 0.25 years</u>		
					<u>Flow</u> <u>hm<sup>3</sup>/yr</u>	<u>Variance</u> <u>(hm3/yr)<sup>2</sup></u>	<u>CV</u> <u>Runoff</u> <u>- m/yr</u>
1	1	1	Granite City - Trib 1	3.2	1.4	0.00E+00	0.00 0.44
2	1	2	Nameoki Ditch - Trib 2	12.3	5.5	0.00E+00	0.00 0.45
3	1	4	Long Lake - Trib 3	35.6	15.5	0.00E+00	0.00 0.44
4	1	5	Agricultural Area - Trib 4	3.7	1.6	0.00E+00	0.00 0.44
5	1	6	Trib 5	6.0	2.8	0.00E+00	0.00 0.47
6	1	6	Cahokia Canal - Trib-6	192.8	75.5	0.00E+00	0.00 0.39
7	3	1	US Steel - Granite City NPDES		15.0	0.00E+00	0.00
PRECIPITATION				8.1	38.1	0.00E+00	0.00 4.71
TRIBUTARY INFLOW				253.6	102.3	0.00E+00	0.00 0.40
POINT-SOURCE INFLOW					15.0	0.00E+00	0.00
***TOTAL INFLOW				261.7	155.4	0.00E+00	0.00 0.59
ADVECTIVE OUTFLOW				261.7	126.5	0.00E+00	0.00 0.48
***TOTAL OUTFLOW				261.7	126.5	0.00E+00	0.00 0.48
***EVAPORATION					29.0	0.00E+00	0.00

**Overall Mass Balance Based Upon Component:**

**Predicted TOTAL P**

**Outflow & Reservoir Concentrations**

<u>Trb</u>	<u>Type</u>	<u>Seq</u>	<u>Name</u>	<u>Load</u>		<u>Load Variance</u>		<u>CV</u>	<u>Conc</u>		<u>Export</u>
				<u>kg/yr</u>	<u>%Total</u>	<u>(kg/yr)<sup>2</sup></u>	<u>%Total</u>		<u>mg/m<sup>3</sup></u>	<u>kg/km<sup>2</sup>/yr</u>	
1	1	1	Granite City - Trib 1	258.8	0.3%	0.00E+00		0.00	183.5	80.9	
2	1	2	Nameoki Ditch - Trib 2	1015.7	1.0%	0.00E+00		0.00	183.5	82.6	
3	1	4	Long Lake - Trib 3	2846.9	2.9%	0.00E+00		0.00	183.5	80.0	
4	1	5	Agricultural Area - Trib 4	295.6	0.3%	0.00E+00		0.00	183.5	79.9	
5	1	6	Trib 5	512.6	0.5%	0.00E+00		0.00	183.5	85.4	
6	1	6	Cahokia Canal - Trib-6	16940.1	17.0%	0.00E+00		0.00	224.5	87.9	
7	3	1	US Steel - Granite City I	3557.4	3.6%	0.00E+00		0.00	237.0		
PRECIPITATION				242.4	0.2%	1.47E+04	100.0%	0.50	6.4	30.0	
INTERNAL LOAD				73780.5	74.2%	0.00E+00		0.00			
TRIBUTARY INFLOW				21869.7	22.0%	0.00E+00		0.00	213.7	86.2	
POINT-SOURCE INFLOW				3557.4	3.6%	0.00E+00		0.00	237.0		lbs/year lbs/day
***TOTAL INFLOW				99450.0	100.0%	1.47E+04	100.0%	0.00	639.8	380.0	219287.2 600.7868
ADVECTIVE OUTFLOW				27801.3	28.0%	2.71E+07		0.19	219.9	106.2	
***TOTAL OUTFLOW				27801.3	28.0%	2.71E+07		0.19	219.9	106.2	
***RETENTION				71648.7	72.0%	2.71E+07		0.07			
Overflow Rate (m/yr)				15.7					Nutrient Resid. Time (yrs)	0.0354	
Hydraulic Resid. Time (yrs)				0.1237					Turnover Ratio	7.1	
Reservoir Conc (mg/m3)				225					Retention Coef.	0.720	

		Reduction to standard									
Tributary	Total P	50									
1	183.50	72.8%									
2	183.50	72.8%									
3	183.50	72.8%									
4	183.50	72.8%									
5	183.50	72.8%									
Cahokia Canal (6)	224.47	77.7%									
Granite City	237.00	185.5									
	Percent Reduction	99	99	98	97	96	95	94	93	92	91
INTERNAL	25	0.25	0.375	0.5	0.75	1	1.25	1.5	1.75	2	2.25

Horseshoe Lake - Wet Weather Loading Scenario  
 File: C:\BATHTUB\HORSESHOE-WET-BD-TMDL.btb

Overall Water & Nutrient Balances

Overall Water Balance

		Averaging Period = 0.25 years						
Trb	Type	Seg	Name	Area km <sup>2</sup>	Flow hm <sup>3</sup> /yr	Variance (hm <sup>3</sup> /yr) <sup>2</sup>	CV	Runoff m/yr
1	1	1	Granite Ci	3.2	1.4	0.00E+00	0.00	0.44
2	1	2	Nameoki I	12.3	5.5	0.00E+00	0.00	0.45
3	1	4	Long Lake	35.6	15.5	0.00E+00	0.00	0.44
4	1	5	Agriculture	3.7	1.6	0.00E+00	0.00	0.44
5	1	6	Trib 5	6.0	2.8	0.00E+00	0.00	0.47
6	1	6	Cahokia C	192.8	75.5	0.00E+00	0.00	0.39
7	3	1	US Steel - Granite		15.0	0.00E+00	0.00	
PRECIPITATION				8.1	38.1	0.00E+00	0.00	4.71
TRIBUTARY INFLOW				253.6	102.3	0.00E+00	0.00	0.40
POINT-SOURCE INFLOW					15.0	0.00E+00	0.00	
***TOTAL INFLOW				261.7	155.4	0.00E+00	0.00	0.59
ADVECTIVE OUTFLOW				261.7	126.5	0.00E+00	0.00	0.48
***TOTAL OUTFLOW				261.7	126.5	0.00E+00	0.00	0.48
***EVAPORATION					29.0	0.00E+00	0.00	



**Overall Mass Balance Based Upon Component:**

<u>Trb</u>	<u>Type</u>	<u>Seg</u>	<u>Name</u>	<u>Predicted TOTAL P Load</u>		<u>Load Variance</u>		<u>Outflow &amp; Reservoir Concentrations</u>		
				<u>kg/yr</u>	<u>%Total</u>	<u>(kg/yr)<sup>2</sup></u>	<u>%Total</u>	<u>CV</u>	<u>mg/m<sup>3</sup></u>	<u>g/km<sup>2</sup>/yr</u>
1	1	1	Granite Ci	70.5	0.8%	0.00E+00		0.00	50.0	22.0
2	1	2	Nameoki I	276.8	3.0%	0.00E+00		0.00	50.0	22.5
3	1	4	Long Lake	775.7	8.4%	0.00E+00		0.00	50.0	21.8
4	1	5	Agriculture	80.5	0.9%	0.00E+00		0.00	50.0	21.8
5	1	6	Trib 5	139.7	1.5%	0.00E+00		0.00	50.0	23.3
6	1	6	Cahokia C	3773.4	40.8%	0.00E+00		0.00	50.0	19.6
7	3	1	US Steel -	2784.4	30.1%	0.00E+00		0.00	185.5	
PRECIPITATION				242.4	2.6%	1.47E+04	100.0%	0.50	6.4	30.0
INTERNAL LOAD				1106.7	12.0%	0.00E+00		0.00		
TRIBUTARY INFLOW				5116.6	55.3%	0.00E+00		0.00	50.0	20.2 lbs/yr
POINT-SOURCE INFLOW				2784.4	30.1%	0.00E+00		0.00	185.5	6139.502732
***TOTAL INFLOW				9250.0	100.0%	1.47E+04	100.0%	0.01	59.5	35.3 20396.32537
ADVECTIVE OUTFLOW				5913.6	63.9%	5.04E+05		0.12	46.8	22.6
***TOTAL OUTFLOW				5913.6	63.9%	5.04E+05		0.12	46.8	22.6
***RETENTION				3336.4	36.1%	5.05E+05		0.21		
Overflow Rate (m/yr)				15.7		Nutrient Resid. Time (yrs)		0.0819		
Hydraulic Resid. Time (yrs)				0.1237		Turnover Ratio		3.1		
Reservoir Conc (mg/m3)				48		Retention Coef.		0.361		

<b>Wet Weather TMDL (March-May)</b>					
<b>(lbs/day)</b>					
<b>LC</b>	<b>Current Estimated Load</b>	<b>Reduction Needed</b>	<b>WLA</b>	<b>LA</b>	<b>MOS</b>
55.88	601	91%	16.821	33.471	5.588

545.12

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**Appendix J:**  
**BATHTUB**  
**Frank Holten Lakes**

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**Frank Holten Lakes**  
**BATHTUB Modeling Parameter Development**

Frank Holten Lakes

Segment ID	Monitoring Station	Wet Obs Total P (ppb)	Dry Obs Total P (ppb)	Surface Area (acres)	Mean Depth (ft)	Length (ft)	Tributary Area (acre)	Surface Area(sq km)	Mean Depth (m)	Length (km)	
1	RJK-1	166.54	267.27	42	13.0	3,160	1,806	0.17	4.0	0.96	
2	RJL-1	116.25	131.37	31	21.2	2,130	314	0.13	6.5	0.65	
3	RJM-1 & RJM-2	144.49	148.82	31	7.8	2,500	730	0.12	2.4	0.76	
4	RJM-3	138.75	184.72	55	6.1	2,140	342	0.22	1.9	0.65	
							3192.8				

Tributary ID	Tributary Area (sq km)	Weighted C-Coeff	Segment ID			Flow (hm <sup>3</sup> /yr), h-million			Total P Concentration (ppb)		
			Dry	Wet	Fall/Winter	Dry (July-August)	Wet (March-May)	Fall/Winter	Dry (July-August)	Wet (March-May)	Wet CV
1	7.3	0.38	1	1		2.59	3.27		290.77	290.77	0.90
2	1.3	0.43	2	2		0.51	0.64		170.32	170.32	1.00
3	3.0	0.47	3	3		1.30	1.64		207.80	207.80	0.83
4	1.4	0.72	4	4		0.93	1.18		59.08	59.08	0.52
Harding Ditch (5)				4			41.6			439.05	
							727.97		1167.02		

Tributary ID	Area_acres (GIS)
1	1848
2	346
3	760
4	397

Calculated in Horseshoe\_LU.xls

Report

Tributary ID	Area (sq mi)	Dry Flow (cfs)	Wet Flow (cfs)
1	2.8	2.9	3.7
2	0.5	0.6	0.7
3	1.1	1.5	1.8
4	0.5	1.0	1.3
Harding Ditch (5)	41.0	0.0	46.6
<i>total</i>	46.0	6.0	54.1

Rainfall

Source: Stage 1 Report

Month	Total Precipitation (inches)	Maximum Temperature (degrees F)	Minimum Temperature (degrees F)
January	2.1	39	20
February	2.3	45	25
March	3.6	56	34
April	4.0	68	45
May	4.0	76	54
June	3.8	85	63
July	3.8	89	67
August	3.6	87	65
September	3.1	80	57
October	2.7	70	45
November	3.5	56	35
December	2.7	44	26
Total	39.2		

	Average Precipitation (inches)	Total Precipitation (meters)	Total Precipitation (inches)
<i>Dry (Other Months)</i>	3.1	0.7010	27.60
<i>Wet (March-May)</i>	3.9	0.2946	11.60

Evaporation

[http://www.sws.uiuc.edu/atmos/statecli/pan\\_evap/panevap.htm](http://www.sws.uiuc.edu/atmos/statecli/pan_evap/panevap.htm)

Month	Evaporation (inches)
April	#VALUE!
May	5.1
June	5.9
July	6.1
August	5.3
September	4.1

	Average Evaporation (inches)	Total Evaporation (meters)	Total Evaporation (inches)
<i>Dry (Other Months)</i>	5.3	0.5429	21.4
<i>Wet (March-May)</i>	5.1	0.1307	5.1

Estimated Harding Ditch Monthly Flow

Month	Flow (cfs)
Jan	37
Feb	40
Mar	44
Apr	50
May	46
Jun	33
Jul	21
Aug	13
Sep	8
Oct	8
Nov	21
Dec	29

	Mean Flow (cfs)
<i>Wet (March-May)</i>	46.6

**Harding Ditch Total P Data (JMAC02)**

Calculated in HardingDitch-P.xls

Month	Total Phosphorous (mg/L)
January	0.41
February	0.37
March	0.32
April	0.53
May	0.47
June	0.43
July	0.46
August	0.51
September	1.14
October	0.74
November	0.70
December	0.44

**Total P (mg/L)**  
*Wet (March-May)* 0.439

**Model Averaging Periods**

Scenario	Months	Fraction of Year
Dry	All Other Months	0.75
Wet	March-May	0.25

**Observed Total Phosphorous Data (mg/L)**

Month	RJK-1	RJL-1	RJM-1	RJM-2	RJM-3
January	0.10	0.15	0.11	0.20	0.20
February	0.16	0.10	0.11	0.11	0.14
March	0.18	0.11	0.17	0.09	0.12
April	0.17	0.11	0.13	0.12	0.13
May	0.15	0.13	0.18	0.17	0.17
June	0.13	0.13	0.14	0.15	0.22
July	0.16	0.13	0.19	0.18	0.24
August	0.26	0.16	0.21	0.18	0.21
September	0.43	0.20	0.13	0.14	
October	0.31	0.14	0.13	0.14	0.17
November	0.37	0.08	0.17	0.15	0.16
December	0.50	0.08	0.12	0.13	0.13
<i>Wet (March-May)</i>	0.17	0.12	0.16	0.13	0.14
<i>Dry (Other Months)</i>	0.27	0.13	0.14	0.15	0.18

**Legend**

- Used to develop parameters for Wet model
- Used to develop parameters for Dry model
- Calculated from flow, WQ data
- Model Input
- Global Model Input

**Frank Holten Lakes  
Dry Weather Scenario- Existing Conditions  
BATHTUB Modeling Files**



**Frank Holten Lakes- Dry**

**File:** E:\IEPA-TMDL St 3 Cahokia Creek\Modeling\BATHTUB\FrankHoltenLks\FrankHolt

**Segment & Tributary Network**

-----Segment: 1 1- Frank Holten Lake 1  
Outflow Segment: 2 2- Frank Holten Lake 2  
Tributary: 1 1- Trib 1 Type: Non Point Inflow

-----Segment: 2 2- Frank Holten Lake 2  
Outflow Segment: 3 3- Frank Holten Lake 3- North  
Tributary: 2 2- Trib 2 Type: Non Point Inflow

-----Segment: 3 3- Frank Holten Lake 3- North  
Outflow Segment: 4 4- Frank Holten Lake 3- South  
Tributary: 3 3- Trib 3 Type: Non Point Inflow

-----Segment: 4 4- Frank Holten Lake 3- South  
Outflow Segment: 0 Out of Reservoir  
Tributary: 4 4- Trib 4 Type: Non Point Inflow

**Frank Holten Lakes- Dry**

File: E:\NEPA-TMDL St 3 Cahokia Creek\Modeling\BATHTUB\FrankHoltenLks\FrankHoltenLks\_DryCAL.btb

**Description:**

Frank Holten Lakes during all months except March-May

<u>Global Variables</u>	<u>Mean</u>	<u>CV</u>	<u>Model Options</u>	<u>Code</u>	<u>Description</u>
Averaging Period (yrs)	0.75	0.0	Conservative Substance	0	NOT COMPUTED
Precipitation (m)	0.701	0.0	Phosphorus Balance	1	2ND ORDER, AVAIL P
Evaporation (m)	0.5429	0.0	Nitrogen Balance	0	NOT COMPUTED
Storage Increase (m)	0	0.0	Chlorophyll-a	2	P, LIGHT, T
			Secchi Depth	1	VS. CHLA & TURBIDITY
			Dispersion	1	FISCHER-NUMERIC
			Phosphorus Calibration	1	DECAY RATES
			Nitrogen Calibration	1	DECAY RATES
			Error Analysis	1	MODEL & DATA
			Availability Factors	0	IGNORE
			Mass-Balance Tables	1	USE ESTIMATED CONCS
			Output Destination	2	EXCEL WORKSHEET

<u>Atmos. Loads (kg/km<sup>2</sup>-yr)</u>	<u>Mean</u>	<u>CV</u>
Conserv. Substance	0	0.00
Total P	30	0.50
Total N	1000	0.50
Ortho P	15	0.50
Inorganic N	500	0.50

**Segment Morphometry**

<u>Seg</u>	<u>Name</u>	<u>Outflow Segment</u>	<u>Group</u>	<u>Area km<sup>2</sup></u>	<u>Depth m</u>	<u>Length Mixed Depth (m)</u>			<u>Hypol Depth</u>		<u>Internal Loads ( mg/m2-day)</u>							
						<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Non-Algal Turb (m<sup>-1</sup>)</u>		<u>Conserv.</u>		<u>Total P</u>		<u>Total N</u>		
										<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>
1	1- Frank Holten Lake 1	2	1	0.17	4	0.96	4	0	0	0	0.08	0.2	0	0	2.75	0	0	0
2	2- Frank Holten Lake 2	3	2	0.13	6.5	0.65	6.5	0	0	0	0.08	0.2	0	0	1.25	0	0	0
3	3- Frank Holten Lake 3- North	4	3	0.12	2.4	0.76	2.4	0	0	0	0.08	0.2	0	0	1.25	0	0	0
4	4- Frank Holten Lake 3- South	0	3	0.22	1.9	0.65	1.9	0	0	0	0.08	0.2	0	0	1.25	0	0	0

**Segment Observed Water Quality**

<u>Seg</u>	<u>Conserv</u>		<u>Total P (ppb)</u>		<u>Total N (ppb)</u>		<u>Chl-a (ppb)</u>		<u>Secchi (m)</u>		<u>Organic N (ppb)</u>		<u>TP - Ortho P (ppb)</u>		<u>HOD (ppb/day)</u>		<u>MOD (ppb/day)</u>	
	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>
1	0	0	267.27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	131.37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	148.82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	184.72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

**Segment Calibration Factors**

<u>Seg</u>	<u>Dispersion Rate</u>		<u>Total P (ppb)</u>		<u>Total N (ppb)</u>		<u>Chl-a (ppb)</u>		<u>Secchi (m)</u>		<u>Organic N (ppb)</u>		<u>TP - Ortho P (ppb)</u>		<u>HOD (ppb/day)</u>		<u>MOD (ppb/day)</u>	
	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>
1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
2	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
3	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
4	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0

**Tributary Data**

<u>Trib</u>	<u>Trib Name</u>	<u>Segment</u>	<u>Type</u>	<u>Dr Area</u>		<u>Flow (hm<sup>3</sup>/yr)</u>		<u>Conserv.</u>		<u>Total P (ppb)</u>		<u>Total N (ppb)</u>		<u>Ortho P (ppb)</u>		<u>Inorganic N (ppb)</u>	
				<u>km<sup>2</sup></u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>	<u>Mean</u>
1	1- Trib 1	1	2	7.3	2.59	0.1	0	0	290.77	0.9	0	0	0	0	0	0	0
2	2- Trib 2	2	2	1.3	0.51	0.1	0	0	170.32	1	0	0	0	0	0	0	0
3	3- Trib 3	3	2	3	1.3	0.1	0	0	207.8	0.83	0	0	0	0	0	0	0
4	4- Trib 4	4	2	1.4	0.93	0.1	0	0	59.08	0.52	0	0	0	0	0	0	0

<b><u>Model Coefficients</u></b>	<b><u>Mean</u></b>	<b><u>CV</u></b>
Dispersion Rate	1.000	0.70
Total Phosphorus	1.000	0.45
Total Nitrogen	1.000	0.55
Chl-a Model	1.000	0.26
Secchi Model	1.000	0.10
Organic N Model	1.000	0.12
TP-OP Model	1.000	0.15
HODv Model	1.000	0.15
MODv Model	1.000	0.22
Secchi/Chla Slope (m <sup>2</sup> /mg)	0.025	0.00
Minimum Qs (m/yr)	0.100	0.00
Chl-a Flushing Term	1.000	0.00
Chl-a Temporal CV	0.620	0
Avail. Factor - Total P	0.330	0
Avail. Factor - Ortho P	1.930	0
Avail. Factor - Total N	0.590	0
Avail. Factor - Inorganic N	0.790	0

**Frank Holten Lakes- Dry**

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**Predicted & Observed Values Ranked Against CE Model Development Dataset**

<b>Segment:</b>	<b>5 Area-Wtd Mean</b>			<b>Observed Values---&gt;</b>		
<b>Variable</b>	<b>Predicted Values---&gt;</b>			<b>Mean</b>	<b>CV</b>	<b>Rank</b>
	<u>Mean</u>	<u>CV</u>	<u>Rank</u>			
TOTAL P MG/M3	201.8	0.21	94.5%	189.1		93.6%
CHL-A MG/M3	55.3	0.27	98.9%			
SECCHI M	0.8	0.26	34.1%			
ORGANIC N MG/M3	1423.7	0.27	98.4%			
TP-ORTHO-P MG/M3	96.2	0.31	89.0%			
ANTILOG PC-1	2109.2	0.51	95.0%			
ANTILOG PC-2	15.1	0.08	94.7%			
TURBIDITY 1/M	0.1	0.10	1.1%	0.1	0.10	1.1%
ZMIX * TURBIDITY	0.3	0.11	0.1%	0.3	0.11	0.1%
ZMIX / SECCHI	4.3	0.27	42.3%			
CHL-A * SECCHI	37.5	0.10	96.7%			
CHL-A / TOTAL P	0.3	0.30	70.7%			
FREQ(CHL-a>10) %	97.1	0.02	98.9%			
FREQ(CHL-a>20) %	83.9	0.10	98.9%			
FREQ(CHL-a>30) %	68.0	0.18	98.9%			
FREQ(CHL-a>40) %	53.7	0.25	98.9%			
FREQ(CHL-a>50) %	41.9	0.33	98.9%			
FREQ(CHL-a>60) %	32.7	0.40	98.9%			
CARLSON TSI-P	80.5	0.04	94.5%	79.2		93.6%
CARLSON TSI-CHLA	69.2	0.04	98.9%			
CARLSON TSI-SEC	64.5	0.06	65.9%			

<b>Segment:</b>	<b>1 1- Frank Holten Lake 1</b>			<b>Observed Values---&gt;</b>		
<b>Variable</b>	<b>Predicted Values---&gt;</b>			<b>Mean</b>	<b>CV</b>	<b>Rank</b>
	<u>Mean</u>	<u>CV</u>	<u>Rank</u>			
TOTAL P MG/M3	246.8	0.21	96.6%	267.3		97.2%
CHL-A MG/M3	43.6	0.26	97.7%			
SECCHI M	0.9	0.26	37.9%			
ORGANIC N MG/M3	1158.1	0.26	96.0%			
TP-ORTHO-P MG/M3	75.5	0.31	83.4%			
ANTILOG PC-1	1242.5	0.49	89.2%			
ANTILOG PC-2	15.3	0.08	95.0%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.3	0.20	0.2%	0.3	0.20	0.2%
ZMIX / SECCHI	4.7	0.26	48.8%			
CHL-A * SECCHI	37.3	0.10	96.6%			
CHL-A / TOTAL P	0.2	0.31	43.6%			
FREQ(CHL-a>10) %	98.1	0.02	97.7%			
FREQ(CHL-a>20) %	82.9	0.13	97.7%			
FREQ(CHL-a>30) %	61.6	0.26	97.7%			
FREQ(CHL-a>40) %	43.3	0.38	97.7%			
FREQ(CHL-a>50) %	29.8	0.49	97.7%			
FREQ(CHL-a>60) %	20.5	0.59	97.7%			

CARLSON TSI-P	83.6	0.04	96.6%	84.7	97.2%
CARLSON TSI-CHLA	67.6	0.04	97.7%		
CARLSON TSI-SEC	62.3	0.06	62.1%		

**Segment:**

**2 2- Frank Holten Lake 2**

<u>Variable</u>	<u>Predicted Values---&gt;</u>			<u>Observed Values---&gt;</u>		
	<u>Mean</u>	<u>CV</u>	<u>Rank</u>	<u>Mean</u>	<u>CV</u>	<u>Rank</u>
TOTAL P MG/M3	165.7	0.25	91.6%	131.4		86.9%
CHL-A MG/M3	25.7	0.26	90.5%			
SECCHI M	1.4	0.25	62.7%			
ORGANIC N MG/M3	749.6	0.24	81.6%			
TP-ORTHO-P MG/M3	43.6	0.32	65.3%			
ANTILOG PC-1	480.1	0.48	69.6%			
ANTILOG PC-2	15.6	0.08	95.4%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.5	0.20	1.0%	0.5	0.20	1.0%
ZMIX / SECCHI	4.7	0.25	49.0%			
CHL-A * SECCHI	35.6	0.11	96.1%			
CHL-A / TOTAL P	0.2	0.33	35.7%			
FREQ(CHL-a>10) %	88.8	0.09	90.5%			
FREQ(CHL-a>20) %	53.8	0.31	90.5%			
FREQ(CHL-a>30) %	28.8	0.50	90.5%			
FREQ(CHL-a>40) %	15.3	0.66	90.5%			
FREQ(CHL-a>50) %	8.3	0.80	90.5%			
FREQ(CHL-a>60) %	4.7	0.91	90.5%			
CARLSON TSI-P	77.8	0.05	91.6%	74.5		86.9%
CARLSON TSI-CHLA	62.5	0.04	90.5%			
CARLSON TSI-SEC	55.3	0.07	37.3%			

**Segment:**

**3 3- Frank Holten Lake 3- North**

<u>Variable</u>	<u>Predicted Values---&gt;</u>			<u>Observed Values---&gt;</u>		
	<u>Mean</u>	<u>CV</u>	<u>Rank</u>	<u>Mean</u>	<u>CV</u>	<u>Rank</u>
TOTAL P MG/M3	178.3	0.22	92.8%	148.8		89.6%
CHL-A MG/M3	62.4	0.27	99.3%			
SECCHI M	0.6	0.27	22.6%			
ORGANIC N MG/M3	1584.9	0.27	99.1%			
TP-ORTHO-P MG/M3	108.8	0.32	91.2%			
ANTILOG PC-1	2384.8	0.51	95.9%			
ANTILOG PC-2	14.9	0.08	94.6%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.2	0.20	0.0%	0.2	0.20	0.0%
ZMIX / SECCHI	3.9	0.28	37.0%			
CHL-A * SECCHI	38.0	0.10	96.9%			
CHL-A / TOTAL P	0.3	0.30	81.9%			
FREQ(CHL-a>10) %	99.6	0.01	99.3%			
FREQ(CHL-a>20) %	93.6	0.06	99.3%			
FREQ(CHL-a>30) %	80.8	0.14	99.3%			
FREQ(CHL-a>40) %	65.8	0.24	99.3%			
FREQ(CHL-a>50) %	51.9	0.33	99.3%			
FREQ(CHL-a>60) %	40.2	0.42	99.3%			
CARLSON TSI-P	78.9	0.04	92.8%	76.3		89.6%

CARLSON TSI-CHLA	71.1	0.04	99.3%
CARLSON TSI-SEC	67.1	0.06	77.4%

**Segment:**

**4 4- Frank Holten Lake 3- South**

<u>Variable</u>	<u>Predicted Values---&gt;</u>			<u>Observed Values---&gt;</u>		
	<u>Mean</u>	<u>CV</u>	<u>Rank</u>	<u>Mean</u>	<u>CV</u>	<u>Rank</u>
TOTAL P MG/M3	201.0	0.20	94.4%	184.7		93.3%
CHL-A MG/M3	77.9	0.27	99.7%			
SECCHI M	0.5	0.27	15.1%			
ORGANIC N MG/M3	1939.2	0.28	99.7%			
TP-ORTHO-P MG/M3	136.5	0.31	94.5%			
ANTILOG PC-1	3591.3	0.51	98.0%			
ANTILOG PC-2	14.7	0.08	94.2%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.2	0.20	0.0%	0.2	0.20	0.0%
ZMIX / SECCHI	3.9	0.28	35.7%			
CHL-A * SECCHI	38.4	0.10	96.9%			
CHL-A / TOTAL P	0.4	0.29	85.8%			
FREQ(CHL-a>10) %	99.9	0.00	99.7%			
FREQ(CHL-a>20) %	97.0	0.03	99.7%			
FREQ(CHL-a>30) %	89.1	0.09	99.7%			
FREQ(CHL-a>40) %	77.8	0.16	99.7%			
FREQ(CHL-a>50) %	65.7	0.24	99.7%			
FREQ(CHL-a>60) %	54.4	0.31	99.7%			
CARLSON TSI-P	80.6	0.04	94.4%	79.4		93.3%
CARLSON TSI-CHLA	73.3	0.04	99.7%			
CARLSON TSI-SEC	70.2	0.06	84.9%			

Frank Holten Lakes- Dry

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Overall Water & Nutrient Balances

Overall Water Balance

Averaging Period = 0.75 years

<u>Trb</u> <u>Type</u> <u>Seq</u> <u>Name</u>	<u>Area</u> <u>km<sup>2</sup></u>	<u>Flow</u> <u>hm<sup>3</sup>/yr</u>	<u>Variance</u> <u>(hm3/yr)<sup>2</sup></u>	<u>CV</u> <u>-</u>	<u>Runoff</u> <u>m/yr</u>
PRECIPITATION	0.6	0.6	0.00E+00	0.00	0.93
***TOTAL INFLOW	13.6	0.6	0.00E+00	0.00	0.04
ADVECTIVE OUTFLOW	13.6	0.1	0.00E+00	0.00	0.01
***TOTAL OUTFLOW	13.6	0.1	0.00E+00	0.00	0.01
***EVAPORATION		0.5	0.00E+00	0.00	

Overall Mass Balance Based Upon Component:

Predicted TOTAL P

Outflow & Reservoir Concentrations

<u>Trb</u> <u>Type</u> <u>Seq</u> <u>Name</u>	<u>Load</u> <u>kg/yr</u>	<u>%Total</u>	<u>Load Variance</u> <u>(kg/yr)<sup>2</sup></u>	<u>%Total</u>	<u>CV</u>	<u>Conc</u> <u>mg/m<sup>3</sup></u>	<u>Export</u> <u>kg/km<sup>2</sup>/yr</u>
PRECIPITATION	19.2	4.7%	9.22E+01	100.0%	0.50	32.1	30.0
INTERNAL LOAD	385.3	95.3%	0.00E+00		0.00		
***TOTAL INFLOW	404.5	100.0%	9.22E+01	100.0%	0.02	676.3	29.7
ADVECTIVE OUTFLOW	27.1	6.7%	3.07E+01		0.20	201.0	2.0
***TOTAL OUTFLOW	27.1	6.7%	3.07E+01		0.20	201.0	2.0
***RETENTION	377.4	93.3%	1.15E+02		0.03		
Overflow Rate (m/yr)	0.2		Nutrient Resid. Time (yrs)		1.1127		
Hydraulic Resid. Time (yrs)	16.5367		Turnover Ratio		0.7		
Reservoir Conc (mg/m3)	202		Retention Coef.		0.933		

**Frank Holten Lakes- Dry**

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**Hydraulic & Dispersion Parameters**

<u>Seg</u>	<u>Name</u>	<u>Outflow</u> <u>Seg</u>	<u>Net</u> <u>Inflow</u> <u>hm<sup>3</sup>/yr</u>	<u>Resid</u> <u>Time</u> <u>years</u>	<u>Overflow</u> <u>Rate</u> <u>m/yr</u>	<u>Dispersion-----&gt;</u>			<u>Exchange</u> <u>hm<sup>3</sup>/yr</u>
						<u>Velocity</u> <u>km/yr</u>	<u>Estimated</u> <u>km<sup>2</sup>/yr</u>	<u>Numeric</u> <u>km<sup>2</sup>/yr</u>	
1	1- Frank Holten Lake 1	2	0.0	18.9753	0.2	1.0	1.0	0.0	0.7
2	2- Frank Holten Lake 2	3	0.1	13.3618	0.5	1.0	0.8	0.0	1.6
3	3- Frank Holten Lake 3- No	4	0.1	3.2529	0.7	1.0	1.2	0.1	0.6
4	4- Frank Holten Lake 3- Sc	0	0.1	3.0983	0.6	1.0	6.7	0.1	0.0

**Morphometry**

<u>Seg</u>	<u>Name</u>	<u>Area</u> <u>km<sup>2</sup></u>	<u>Zmean</u> <u>m</u>	<u>Zmix</u> <u>m</u>	<u>Length</u> <u>km</u>	<u>Volume</u> <u>hm<sup>3</sup></u>	<u>Width</u> <u>km</u>	<u>L/W</u> <u>-</u>
1	1- Frank Holten Lake 1	0.2	4.0	4.0	1.0	0.7	0.2	5.4
2	2- Frank Holten Lake 2	0.1	6.5	6.5	0.6	0.8	0.2	3.2
3	3- Frank Holten Lake 3- No	0.1	2.4	2.4	0.8	0.3	0.2	4.8
4	4- Frank Holten Lake 3- Sc	0.2	1.9	1.9	0.6	0.4	0.3	1.9
Totals		0.6	3.5			2.2		



**Frank Holten Lakes- Dry**

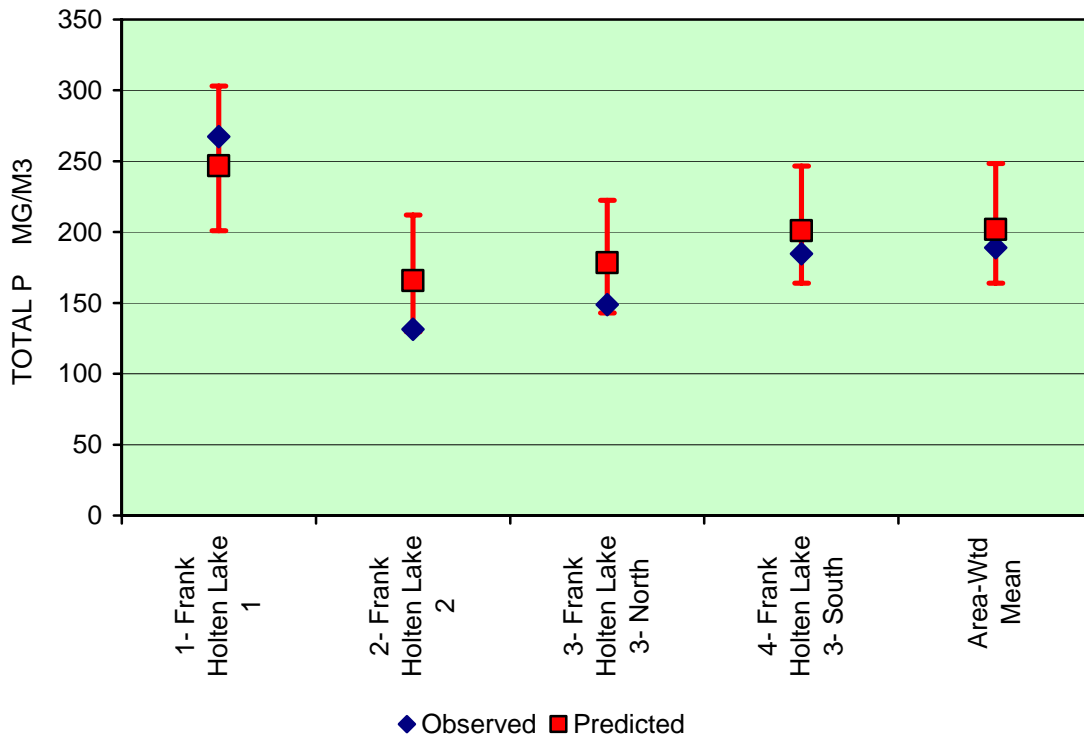
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**Variable:**

TOTAL P MG/M3

<u>Segment</u>	<u>Predicted</u>		<u>Observed</u>	
	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>
1- Frank Holten Lake 1	246.8	0.21	267.3	0.00
2- Frank Holten Lake 2	165.7	0.25	131.4	0.00
3- Frank Holten Lake 3- Nor	178.3	0.22	148.8	0.00
4- Frank Holten Lake 3- Sou	201.0	0.20	184.7	0.00
Area-Wtd Mean	201.8	0.21	189.1	0.00



**Frank Holten Lakes**  
**Dry Weather Scenario- Reduced Loading Conditions**  
**BATHTUB Modeling Files**

**Frank Holten Lakes- Dry**

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**Segment & Tributary Network**

-----Segment:	1	1- Frank Holten Lake 1	
Outflow Segment:	2	2- Frank Holten Lake 2	
Tributary:	1	1- Trib 1	Type: Non Point Inflow
-----Segment:	2	2- Frank Holten Lake 2	
Outflow Segment:	3	3- Frank Holten Lake 3- North	
Tributary:	2	2- Trib 2	Type: Non Point Inflow
-----Segment:	3	3- Frank Holten Lake 3- North	
Outflow Segment:	4	4- Frank Holten Lake 3- South	
Tributary:	3	3- Trib 3	Type: Non Point Inflow
-----Segment:	4	4- Frank Holten Lake 3- South	
Outflow Segment:	0	Out of Reservoir	
Tributary:	4	4- Trib 4	Type: Non Point Inflow



<b><u>Model Coefficients</u></b>	<b><u>Mean</u></b>	<b><u>CV</u></b>
Dispersion Rate	1.000	0.70
Total Phosphorus	1.000	0.45
Total Nitrogen	1.000	0.55
Chl-a Model	1.000	0.26
Secchi Model	1.000	0.10
Organic N Model	1.000	0.12
TP-OP Model	1.000	0.15
HODv Model	1.000	0.15
MODv Model	1.000	0.22
Secchi/Chla Slope (m <sup>2</sup> /mg)	0.025	0.00
Minimum Qs (m/yr)	0.100	0.00
Chl-a Flushing Term	1.000	0.00
Chl-a Temporal CV	0.620	0
Avail. Factor - Total P	0.330	0
Avail. Factor - Ortho P	1.930	0
Avail. Factor - Total N	0.590	0
Avail. Factor - Inorganic N	0.790	0

**Frank Holten Lakes- Dry**

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**Predicted & Observed Values Ranked Against CE Model Development Dataset**

Segment:	5 Area-Wtd Mean			Observed Values--->		
	Predicted Values--->			Mean	CV	Rank
Variable	Mean	CV	Rank	Mean	CV	Rank
TOTAL P MG/M3	46.9	0.25	49.1%	189.1		93.6%
CHL-A MG/M3	23.8	0.34	88.7%			
SECCHI M	1.5	0.30	67.9%			
ORGANIC N MG/M3	706.6	0.29	78.3%			
TP-ORTHO-P MG/M3	40.2	0.39	62.1%			
ANTILOG PC-1	433.0	0.62	66.8%			
ANTILOG PC-2	15.6	0.08	95.4%			
TURBIDITY 1/M	0.1	0.10	1.1%	0.1	0.10	1.1%
ZMIX * TURBIDITY	0.3	0.11	0.1%	0.3	0.11	0.1%
ZMIX / SECCHI	2.1	0.30	8.5%			
CHL-A * SECCHI	35.1	0.11	95.9%			
CHL-A / TOTAL P	0.5	0.26	93.2%			
FREQ(CHL-a>10) %	83.8	0.14	88.7%			
FREQ(CHL-a>20) %	47.7	0.42	88.7%			
FREQ(CHL-a>30) %	25.1	0.66	88.7%			
FREQ(CHL-a>40) %	13.3	0.86	88.7%			
FREQ(CHL-a>50) %	7.3	1.03	88.7%			
FREQ(CHL-a>60) %	4.1	1.17	88.7%			
CARLSON TSI-P	59.6	0.06	49.1%	79.2		93.6%
CARLSON TSI-CHLA	61.5	0.05	88.7%			
CARLSON TSI-SEC	54.1	0.08	32.1%			

Segment:	1 1- Frank Holten Lake 1			Observed Values--->		
	Predicted Values--->			Mean	CV	Rank
Variable	Mean	CV	Rank	Mean	CV	Rank
TOTAL P MG/M3	48.4	0.25	50.5%	267.3		97.2%
CHL-A MG/M3	21.9	0.32	86.4%			
SECCHI M	1.6	0.30	69.5%			
ORGANIC N MG/M3	662.6	0.27	74.4%			
TP-ORTHO-P MG/M3	36.8	0.37	58.5%			
ANTILOG PC-1	361.4	0.58	61.7%			
ANTILOG PC-2	15.6	0.08	95.4%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.3	0.20	0.2%	0.3	0.20	0.2%
ZMIX / SECCHI	2.5	0.30	13.5%			
CHL-A * SECCHI	34.9	0.11	95.9%			
CHL-A / TOTAL P	0.5	0.27	90.6%			
FREQ(CHL-a>10) %	83.0	0.16	86.4%			
FREQ(CHL-a>20) %	43.5	0.47	86.4%			
FREQ(CHL-a>30) %	20.7	0.72	86.4%			
FREQ(CHL-a>40) %	10.0	0.92	86.4%			
FREQ(CHL-a>50) %	5.0	1.09	86.4%			
FREQ(CHL-a>60) %	2.7	1.23	86.4%			

CARLSON TSI-P	60.1	0.06	50.5%	84.7	97.2%
CARLSON TSI-CHLA	60.9	0.05	86.4%		
CARLSON TSI-SEC	53.3	0.08	30.5%		

**Segment:**

**2 2- Frank Holten Lake 2**

<u>Variable</u>	<u>Predicted Values---&gt;</u>			<u>Observed Values---&gt;</u>		
	<u>Mean</u>	<u>CV</u>	<u>Rank</u>	<u>Mean</u>	<u>CV</u>	<u>Rank</u>
TOTAL P MG/M3	44.3	0.26	46.6%	131.4		86.9%
CHL-A MG/M3	15.7	0.31	74.8%			
SECCHI M	2.1	0.27	81.2%			
ORGANIC N MG/M3	520.8	0.24	57.3%			
TP-ORTHO-P MG/M3	25.7	0.37	43.6%			
ANTILOG PC-1	201.9	0.54	44.1%			
ANTILOG PC-2	15.6	0.08	95.4%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.5	0.20	1.0%	0.5	0.20	1.0%
ZMIX / SECCHI	3.1	0.27	22.4%			
CHL-A * SECCHI	33.2	0.12	95.2%			
CHL-A / TOTAL P	0.4	0.28	82.4%			
FREQ(CHL-a>10) %	66.2	0.27	74.8%			
FREQ(CHL-a>20) %	24.2	0.64	74.8%			
FREQ(CHL-a>30) %	8.8	0.91	74.8%			
FREQ(CHL-a>40) %	3.4	1.12	74.8%			
FREQ(CHL-a>50) %	1.5	1.29	74.8%			
FREQ(CHL-a>60) %	0.7	1.43	74.8%			
CARLSON TSI-P	58.8	0.06	46.6%	74.5		86.9%
CARLSON TSI-CHLA	57.6	0.05	74.8%			
CARLSON TSI-SEC	49.2	0.08	18.8%			

**Segment:**

**3 3- Frank Holten Lake 3- North**

<u>Variable</u>	<u>Predicted Values---&gt;</u>			<u>Observed Values---&gt;</u>		
	<u>Mean</u>	<u>CV</u>	<u>Rank</u>	<u>Mean</u>	<u>CV</u>	<u>Rank</u>
TOTAL P MG/M3	45.2	0.26	47.4%	148.8		89.6%
CHL-A MG/M3	25.5	0.36	90.3%			
SECCHI M	1.4	0.33	63.1%			
ORGANIC N MG/M3	744.4	0.30	81.2%			
TP-ORTHO-P MG/M3	43.2	0.40	64.9%			
ANTILOG PC-1	472.6	0.64	69.2%			
ANTILOG PC-2	15.6	0.08	95.4%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.2	0.20	0.0%	0.2	0.20	0.0%
ZMIX / SECCHI	1.7	0.33	4.0%			
CHL-A * SECCHI	35.5	0.11	96.1%			
CHL-A / TOTAL P	0.6	0.26	95.2%			
FREQ(CHL-a>10) %	88.5	0.12	90.3%			
FREQ(CHL-a>20) %	53.3	0.43	90.3%			
FREQ(CHL-a>30) %	28.4	0.69	90.3%			
FREQ(CHL-a>40) %	15.0	0.90	90.3%			
FREQ(CHL-a>50) %	8.1	1.07	90.3%			
FREQ(CHL-a>60) %	4.5	1.22	90.3%			
CARLSON TSI-P	59.1	0.06	47.4%	76.3		89.6%

CARLSON TSI-CHLA	62.4	0.06	90.3%
CARLSON TSI-SEC	55.2	0.09	36.9%

**Segment:**

**4 4- Frank Holten Lake 3- South**

<u>Variable</u>	<u>Predicted Values---&gt;</u>			<u>Observed Values---&gt;</u>		
	<u>Mean</u>	<u>CV</u>	<u>Rank</u>	<u>Mean</u>	<u>CV</u>	<u>Rank</u>
TOTAL P MG/M3	48.2	0.25	50.3%	184.7		93.3%
CHL-A MG/M3	29.2	0.36	93.0%			
SECCHI M	1.2	0.34	56.9%			
ORGANIC N MG/M3	829.8	0.31	86.4%			
TP-ORTHO-P MG/M3	49.9	0.41	70.4%			
ANTILOG PC-1	603.4	0.66	75.4%			
ANTILOG PC-2	15.5	0.08	95.3%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.2	0.20	0.0%	0.2	0.20	0.0%
ZMIX / SECCHI	1.5	0.34	2.6%			
CHL-A * SECCHI	36.1	0.11	96.3%			
CHL-A / TOTAL P	0.6	0.26	96.2%			
FREQ(CHL-a>10) %	92.2	0.09	93.0%			
FREQ(CHL-a>20) %	61.9	0.35	93.0%			
FREQ(CHL-a>30) %	36.3	0.60	93.0%			
FREQ(CHL-a>40) %	20.7	0.80	93.0%			
FREQ(CHL-a>50) %	12.0	0.98	93.0%			
FREQ(CHL-a>60) %	7.1	1.12	93.0%			
CARLSON TSI-P	60.0	0.06	50.3%	79.4		93.3%
CARLSON TSI-CHLA	63.7	0.06	93.0%			
CARLSON TSI-SEC	57.0	0.09	43.1%			



Frank Holten Lakes- Dry

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Overall Water & Nutrient Balances

Overall Water Balance

Averaging Period = 0.75 years

<u>Trb</u> <u>Type</u> <u>Seg</u> <u>Name</u>	<u>Area</u> <u>km<sup>2</sup></u>	<u>Flow</u> <u>hm<sup>3</sup>/yr</u>	<u>Variance</u> <u>(hm3/yr)<sup>2</sup></u>	<u>CV</u> <u>-</u>	<u>Runoff</u> <u>m/yr</u>
PRECIPITATION	0.6	0.6	0.00E+00	0.00	0.93
***TOTAL INFLOW	13.6	0.6	0.00E+00	0.00	0.04
ADVECTIVE OUTFLOW	13.6	0.1	0.00E+00	0.00	0.01
***TOTAL OUTFLOW	13.6	0.1	0.00E+00	0.00	0.01
***EVAPORATION		0.5	0.00E+00	0.00	

Overall Mass Balance Based Upon Component:

Predicted  
TOTAL P

Outflow & Reservoir Concentrations

<u>Trb</u> <u>Type</u> <u>Seg</u> <u>Name</u>	<u>Load</u> <u>kg/yr</u>	<u>%Total</u>	<u>Load Variance</u> <u>(kg/yr)<sup>2</sup></u>	<u>%Total</u>	<u>CV</u>	<u>Conc</u> <u>mg/m<sup>3</sup></u>	<u>Export</u> <u>kg/km<sup>2</sup>/yr</u>
PRECIPITATION	19.2	57.8%	9.22E+01	100.0%	0.50	32.1	30.0
INTERNAL LOAD	14.0	42.2%	0.00E+00		0.00		
***TOTAL INFLOW	33.2	100.0%	9.22E+01	100.0%	0.29	55.5	2.4
ADVECTIVE OUTFLOW	6.5	19.6%	2.67E+00		0.25	48.2	0.5
***TOTAL OUTFLOW	6.5	19.6%	2.67E+00		0.25	48.2	0.5
***RETENTION	26.7	80.4%	7.44E+01		0.32		

Overflow Rate (m/yr)	0.2	Nutrient Resid. Time (yrs)	3.1496
Hydraulic Resid. Time (yrs)	16.5367	Turnover Ratio	0.2
Reservoir Conc (mg/m3)	47	Retention Coef.	0.804

Frank Holten Lakes- Dry

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Hydraulic & Dispersion Parameters

<u>Seg</u>	<u>Name</u>	<u>Outflow</u> <u>Seg</u>	<u>Net</u> <u>Inflow</u> <u>hm<sup>3</sup>/yr</u>	<u>Resid</u> <u>Time</u> <u>years</u>	<u>Overflow</u> <u>Rate</u> <u>m/yr</u>	<u>Dispersion-----&gt;</u>			<u>Exchange</u> <u>hm<sup>3</sup>/yr</u>
						<u>Velocity</u> <u>km/yr</u>	<u>Estimated</u> <u>km<sup>2</sup>/yr</u>	<u>Numeric</u> <u>km<sup>2</sup>/yr</u>	
1	1- Frank Holten Lake 1	2	0.0	18.9753	0.2	1.0	1.0	0.0	0.7
2	2- Frank Holten Lake 2	3	0.1	13.3618	0.5	1.0	0.8	0.0	1.6
3	3- Frank Holten Lake 3- North	4	0.1	3.2529	0.7	1.0	1.2	0.1	0.6
4	4- Frank Holten Lake 3- South	0	0.1	3.0983	0.6	1.0	6.7	0.1	0.0

Morphometry

<u>Seg</u>	<u>Name</u>	<u>Area</u> <u>km<sup>2</sup></u>	<u>Zmean</u> <u>m</u>	<u>Zmix</u> <u>m</u>	<u>Length</u> <u>km</u>	<u>Volume</u> <u>hm<sup>3</sup></u>	<u>Width</u> <u>km</u>	<u>L/W</u> <u>-</u>
1	1- Frank Holten Lake 1	0.2	4.0	4.0	1.0	0.7	0.2	5.4
2	2- Frank Holten Lake 2	0.1	6.5	6.5	0.6	0.8	0.2	3.2
3	3- Frank Holten Lake 3- North	0.1	2.4	2.4	0.8	0.3	0.2	4.8
4	4- Frank Holten Lake 3- South	0.2	1.9	1.9	0.6	0.4	0.3	1.9
Totals		0.6	3.5			2.2		

**Frank Holten Lakes- Dry**

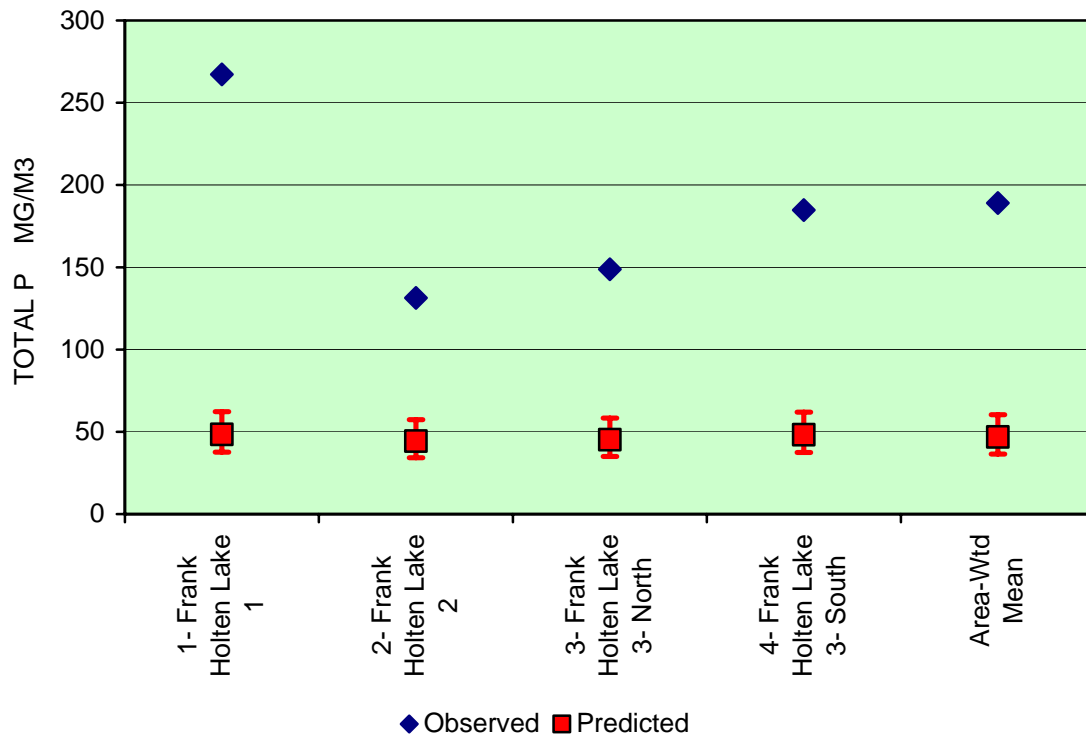
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**Variable:**

**TOTAL P MG/M3**

<u>Segment</u>	<u>Predicted</u>		<u>Observed</u>	
	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>
1- Frank Holten Lake 1	48.4	0.25	267.3	0.00
2- Frank Holten Lake 2	44.3	0.26	131.4	0.00
3- Frank Holten Lake 3- North	45.2	0.26	148.8	0.00
4- Frank Holten Lake 3- South	48.2	0.25	184.7	0.00
Area-Wtd Mean	46.9	0.25	189.1	0.00



**Frank Holten Lakes**  
**Wet Weather Scenario- Existing Conditions**  
**BATHTUB Modeling Files**

**Frank Holten Lakes- Wet**

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**Segment & Tributary Network**

-----Segment:	1	1- Frank Holten Lake 1	
Outflow Segment:	2	2- Frank Holten Lake 2	
Tributary:	1	1- Trib 1	Type: Non Point Inflow
-----Segment:	2	2- Frank Holten Lake 2	
Outflow Segment:	3	3- Frank Holten Lake 3- North	
Tributary:	2	2- Trib 2	Type: Non Point Inflow
-----Segment:	3	3- Frank Holten Lake 3- North	
Outflow Segment:	4	4- Frank Holten Lake 3- South	
Tributary:	3	3- Trib 3	Type: Non Point Inflow
-----Segment:	4	4- Frank Holten Lake 3- South	
Outflow Segment:	0	Out of Reservoir	
Tributary:	4	4- Trib 4	Type: Non Point Inflow
Tributary:	5	5- Harding Ditch	Type: Monitored Inflow



<b><u>Model Coefficients</u></b>	<b><u>Mean</u></b>	<b><u>CV</u></b>
Dispersion Rate	1.000	0.70
Total Phosphorus	1.000	0.45
Total Nitrogen	1.000	0.55
Chl-a Model	1.000	0.26
Secchi Model	1.000	0.10
Organic N Model	1.000	0.12
TP-OP Model	1.000	0.15
HODv Model	1.000	0.15
MODv Model	1.000	0.22
Secchi/Chla Slope (m <sup>2</sup> /mg)	0.025	0.00
Minimum Qs (m/yr)	0.100	0.00
Chl-a Flushing Term	1.000	0.00
Chl-a Temporal CV	0.620	0
Avail. Factor - Total P	0.330	0
Avail. Factor - Ortho P	1.930	0
Avail. Factor - Total N	0.590	0
Avail. Factor - Inorganic N	0.790	0

**Frank Holten Lakes- Wet**

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**Predicted & Observed Values Ranked Against CE Model Development Dataset**

Variable	5 Area-Wtd Mean			Observed Values--->		
	Mean	CV	Rank	Mean	CV	Rank
TOTAL P MG/M3	182.8	0.16	93.2%	142.6		88.7%
CHL-A MG/M3	35.9	0.27	95.9%			
SECCHI M	1.1	0.25	51.0%			
ORGANIC N MG/M3	981.9	0.25	92.3%			
TP-ORTHO-P MG/M3	61.7	0.31	77.6%			
ANTILOG PC-1	936.7	0.50	84.7%			
ANTILOG PC-2	15.4	0.08	95.2%			
TURBIDITY 1/M	0.1	0.10	1.1%	0.1	0.10	1.1%
ZMIX * TURBIDITY	0.3	0.11	0.1%	0.3	0.11	0.1%
ZMIX / SECCHI	3.2	0.26	25.1%			
CHL-A * SECCHI	36.5	0.10	96.4%			
CHL-A / TOTAL P	0.2	0.29	57.1%			
FREQ(CHL-a>10) %	93.6	0.05	95.9%			
FREQ(CHL-a>20) %	69.2	0.19	95.9%			
FREQ(CHL-a>30) %	46.4	0.32	95.9%			
FREQ(CHL-a>40) %	30.7	0.43	95.9%			
FREQ(CHL-a>50) %	20.4	0.53	95.9%			
FREQ(CHL-a>60) %	13.8	0.62	95.9%			
CARLSON TSI-P	78.6	0.03	93.2%	75.6		88.7%
CARLSON TSI-CHLA	65.3	0.04	95.9%			
CARLSON TSI-SEC	59.1	0.06	49.0%			

Variable	1 1- Frank Holten Lake 1			Observed Values--->		
	Mean	CV	Rank	Mean	CV	Rank
TOTAL P MG/M3	162.6	0.20	91.3%	166.5		91.7%
CHL-A MG/M3	39.9	0.27	97.0%			
SECCHI M	0.9	0.26	42.1%			
ORGANIC N MG/M3	1072.4	0.26	94.5%			
TP-ORTHO-P MG/M3	68.8	0.31	80.9%			
ANTILOG PC-1	1055.1	0.50	86.7%			
ANTILOG PC-2	15.3	0.08	95.1%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.3	0.20	0.2%	0.3	0.20	0.2%
ZMIX / SECCHI	4.3	0.26	43.1%			
CHL-A * SECCHI	37.0	0.10	96.6%			
CHL-A / TOTAL P	0.2	0.30	63.8%			
FREQ(CHL-a>10) %	97.3	0.03	97.0%			
FREQ(CHL-a>20) %	78.9	0.15	97.0%			
FREQ(CHL-a>30) %	55.9	0.30	97.0%			
FREQ(CHL-a>40) %	37.6	0.43	97.0%			
FREQ(CHL-a>50) %	25.0	0.55	97.0%			
FREQ(CHL-a>60) %	16.6	0.65	97.0%			
CARLSON TSI-P	77.6	0.04	91.3%	77.9		91.7%



CARLSON TSI-CHLA	66.8	0.04	97.0%
CARLSON TSI-SEC	61.1	0.06	57.9%

**Segment:**

**2 2- Frank Holten Lake 2**

<u>Variable</u>	<u>Predicted Values---&gt;</u>			<u>Observed Values---&gt;</u>		
	<u>Mean</u>	<u>CV</u>	<u>Rank</u>	<u>Mean</u>	<u>CV</u>	<u>Rank</u>
TOTAL P MG/M3	118.1	0.24	84.2%	116.3		83.8%
CHL-A MG/M3	23.9	0.27	88.7%			
SECCHI M	1.5	0.25	66.0%			
ORGANIC N MG/M3	707.4	0.24	78.4%			
TP-ORTHO-P MG/M3	40.3	0.32	62.2%			
ANTILOG PC-1	420.5	0.49	66.0%			
ANTILOG PC-2	15.6	0.08	95.4%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.5	0.20	1.0%	0.5	0.20	1.0%
ZMIX / SECCHI	4.4	0.26	44.5%			
CHL-A * SECCHI	35.3	0.11	96.0%			
CHL-A / TOTAL P	0.2	0.32	51.9%			
FREQ(CHL-a>10) %	86.3	0.11	88.7%			
FREQ(CHL-a>20) %	49.0	0.35	88.7%			
FREQ(CHL-a>30) %	24.9	0.55	88.7%			
FREQ(CHL-a>40) %	12.7	0.72	88.7%			
FREQ(CHL-a>50) %	6.7	0.86	88.7%			
FREQ(CHL-a>60) %	3.6	0.97	88.7%			
CARLSON TSI-P	73.0	0.05	84.2%	72.7		83.8%
CARLSON TSI-CHLA	61.7	0.04	88.7%			
CARLSON TSI-SEC	54.4	0.07	34.0%			

**Segment:**

**3 3- Frank Holten Lake 3- North**

<u>Variable</u>	<u>Predicted Values---&gt;</u>			<u>Observed Values---&gt;</u>		
	<u>Mean</u>	<u>CV</u>	<u>Rank</u>	<u>Mean</u>	<u>CV</u>	<u>Rank</u>
TOTAL P MG/M3	139.9	0.21	88.3%	144.5		89.0%
CHL-A MG/M3	55.9	0.28	99.0%			
SECCHI M	0.7	0.27	26.9%			
ORGANIC N MG/M3	1437.4	0.27	98.5%			
TP-ORTHO-P MG/M3	97.3	0.32	89.2%			
ANTILOG PC-1	1951.1	0.52	94.3%			
ANTILOG PC-2	15.0	0.08	94.7%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.2	0.20	0.0%	0.2	0.20	0.0%
ZMIX / SECCHI	3.5	0.28	30.5%			
CHL-A * SECCHI	37.8	0.10	96.8%			
CHL-A / TOTAL P	0.4	0.29	86.9%			
FREQ(CHL-a>10) %	99.3	0.01	99.0%			
FREQ(CHL-a>20) %	91.1	0.08	99.0%			
FREQ(CHL-a>30) %	75.6	0.18	99.0%			
FREQ(CHL-a>40) %	59.1	0.29	99.0%			
FREQ(CHL-a>50) %	44.8	0.39	99.0%			
FREQ(CHL-a>60) %	33.6	0.48	99.0%			
CARLSON TSI-P	75.4	0.04	88.3%	75.9		89.0%
CARLSON TSI-CHLA	70.1	0.04	99.0%			
CARLSON TSI-SEC	65.6	0.06	73.1%			

Segment:

4 4- Frank Holten Lake 3- South

Predicted Values--->

Observed Values--->

<u>Variable</u>	<u>Mean</u>	<u>CV</u>	<u>Rank</u>	<u>Mean</u>	<u>CV</u>	<u>Rank</u>
TOTAL P MG/M3	260.0	0.10	97.0%	138.8		88.1%
CHL-A MG/M3	29.1	0.26	92.9%			
SECCHI M	1.2	0.25	57.2%			
ORGANIC N MG/M3	825.7	0.24	86.2%			
TP-ORTHO-P MG/M3	49.5	0.31	70.1%			
ANTILOG PC-1	596.8	0.48	75.2%			
ANTILOG PC-2	15.5	0.08	95.3%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.2	0.20	0.0%	0.2	0.20	0.0%
ZMIX / SECCHI	1.5	0.25	2.6%			
CHL-A * SECCHI	36.0	0.11	96.3%			
CHL-A / TOTAL P	0.1	0.28	18.9%			
FREQ(CHL-a>10) %	92.1	0.06	92.9%			
FREQ(CHL-a>20) %	61.5	0.26	92.9%			
FREQ(CHL-a>30) %	35.9	0.43	92.9%			
FREQ(CHL-a>40) %	20.5	0.59	92.9%			
FREQ(CHL-a>50) %	11.8	0.71	92.9%			
FREQ(CHL-a>60) %	7.0	0.82	92.9%			
CARLSON TSI-P	84.3	0.02	97.0%	75.3		88.1%
CARLSON TSI-CHLA	63.7	0.04	92.9%			
CARLSON TSI-SEC	56.9	0.06	42.8%			

**Frank Holten Lakes- Wet**

File: E:\IEPA-TMDL St 3 Cahokia Creek\Modeling\BATHTUB\FrankHoltenLks\FrankHoltenLks\_WetCAL.btb

**Overall Water & Nutrient Balances**

**Overall Water Balance**

Averaging Period = 0.25 years

<u>Trb</u>	<u>Type</u>	<u>Seg</u>	<u>Name</u>	<u>Area</u> <u>km<sup>2</sup></u>	<u>Flow</u> <u>hm<sup>3</sup>/yr</u>	<u>Variance</u> <u>(hm3/yr)<sup>2</sup></u>	<u>CV</u> <u>-</u>	<u>Runoff</u> <u>m/yr</u>
5	1	4	5- Harding Ditch		41.6	0.00E+00	0.00	
			PRECIPITATION	0.6	0.8	0.00E+00	0.00	1.18
			TRIBUTARY INFLOW		41.6	0.00E+00	0.00	
			***TOTAL INFLOW	13.6	42.4	0.00E+00	0.00	3.11
			ADVECTIVE OUTFLOW	13.6	42.0	0.00E+00	0.00	3.08
			***TOTAL OUTFLOW	13.6	42.0	0.00E+00	0.00	3.08
			***EVAPORATION		0.3	0.00E+00	0.00	

**Overall Mass Balance Based Upon Component:**

**Predicted  
TOTAL P**

**Outflow & Reservoir Concentrations**

<u>Trb</u>	<u>Type</u>	<u>Seg</u>	<u>Name</u>	<u>Load</u> <u>kg/yr</u>	<u>%Total</u>	<u>Load Variance</u> <u>(kg/yr)<sup>2</sup></u>	<u>%Total</u>	<u>Conc</u> <u>mg/m<sup>3</sup></u>	<u>Export</u> <u>kg/km<sup>2</sup>/yr</u>
5	1	4	5- Harding Ditch	15188.2	95.5%	0.00E+00		365.1	
			PRECIPITATION	19.2	0.1%	9.22E+01	99.9%	25.5	30.0
			INTERNAL LOAD	701.3	4.4%	0.00E+00		0.00	
			TRIBUTARY INFLOW	15188.2	95.5%	0.00E+00		365.1	
			***TOTAL INFLOW	15908.6	100.0%	9.22E+01	100.0%	375.6	1166.3
			ADVECTIVE OUTFLOW	10926.9	68.7%	1.21E+06		260.0	801.1
			***TOTAL OUTFLOW	10926.9	68.7%	1.21E+06		260.0	801.1
			***RETENTION	4981.8	31.3%	1.21E+06		0.22	
			Overflow Rate (m/yr)	65.7				Nutrient Resid. Time (yrs)	0.0256
			Hydraulic Resid. Time (yrs)	0.0531				Turnover Ratio	9.8
			Reservoir Conc (mg/m3)	183				Retention Coef.	0.313

Frank Holten Lakes- Wet

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Hydraulic & Dispersion Parameters

<u>Seg</u>	<u>Name</u>	<u>Outflow</u> <u>Seg</u>	<u>Net</u> <u>Inflow</u> <u>hm<sup>3</sup>/yr</u>	<u>Resid</u> <u>Time</u> <u>years</u>	<u>Overflow</u> <u>Rate</u> <u>m/yr</u>	<u>Dispersion-----&gt;</u>			<u>Exchange</u> <u>hm<sup>3</sup>/yr</u>
						<u>Velocity</u> <u>km/yr</u>	<u>Estimated</u> <u>km<sup>2</sup>/yr</u>	<u>Numeric</u> <u>km<sup>2</sup>/yr</u>	
1	1- Frank Holten Lake 1	2	0.1	6.1013	0.7	1.0	1.0	0.1	0.7
2	2- Frank Holten Lake 2	3	0.2	4.2963	1.5	1.0	0.8	0.0	1.6
3	3- Frank Holten Lake 3- Nc	4	0.3	1.0459	2.3	1.0	1.2	0.3	0.5
4	4- Frank Holten Lake 3- Sc	0	42.0	0.0099	191.0	65.3	436.6	21.2	0.0

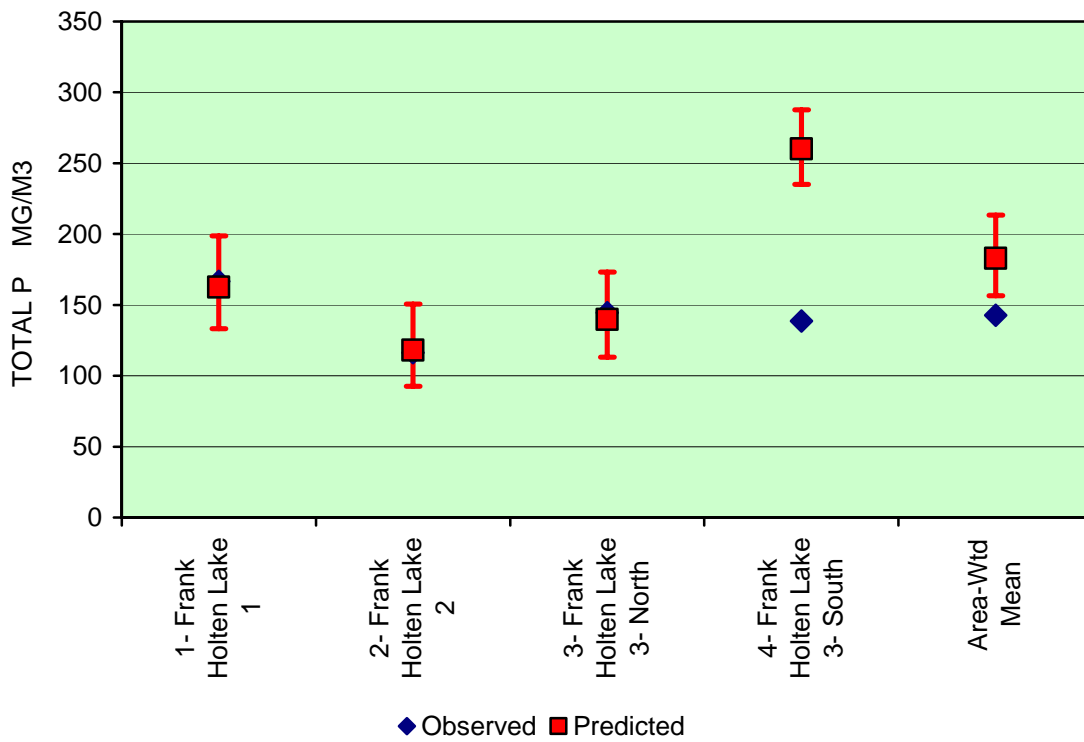
Morphometry

<u>Seg</u>	<u>Name</u>	<u>Area</u> <u>km<sup>2</sup></u>	<u>Zmean</u> <u>m</u>	<u>Zmix</u> <u>m</u>	<u>Length</u> <u>km</u>	<u>Volume</u> <u>hm<sup>3</sup></u>	<u>Width</u> <u>km</u>	<u>L/W</u> <u>-</u>
1	1- Frank Holten Lake 1	0.2	4.0	4.0	1.0	0.7	0.2	5.4
2	2- Frank Holten Lake 2	0.1	6.5	6.5	0.6	0.8	0.2	3.2
3	3- Frank Holten Lake 3- Nc	0.1	2.4	2.4	0.8	0.3	0.2	4.8
4	4- Frank Holten Lake 3- Sc	0.2	1.9	1.9	0.6	0.4	0.3	1.9
Totals		0.6	3.5			2.2		

**Frank Holten Lakes- Wet**

**File:** E:\IEPA-TMDL St 3 Cahokia Creek\Modeling\BATHTUB\FrankHoltenLks\Fra  
**Variable:** TOTAL P MG/M3

<u>Segment</u>	<u>Predicted</u>		<u>Observed</u>	
	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>
1- Frank Holten Lake 1	162.6	0.20	166.5	0.00
2- Frank Holten Lake 2	118.1	0.24	116.3	0.00
3- Frank Holten Lake 3- Nor	139.9	0.21	144.5	0.00
4- Frank Holten Lake 3- Sou	260.0	0.10	138.8	0.00
Area-Wtd Mean	182.8	0.16	142.6	0.00



**Frank Holten Lakes**  
**Wet Weather Scenario- Reduced Loading Conditions**  
**BATHTUB Modeling Files**

**Frank Holten Lakes- Wet**

**File:** E:\NEPA-TMDL St 3 Cahokia Creek\Modeling\BATHTUB\FrankHoltenLks\Frank

**Segment & Tributary Network**

-----Segment:	1	1- Frank Holten Lake 1	
Outflow Segment:	2	2- Frank Holten Lake 2	
Tributary:	1	1- Trib 1	Type: Non Point Inflow
-----Segment:	2	2- Frank Holten Lake 2	
Outflow Segment:	3	3- Frank Holten Lake 3- North	
Tributary:	2	2- Trib 2	Type: Non Point Inflow
-----Segment:	3	3- Frank Holten Lake 3- North	
Outflow Segment:	4	4- Frank Holten Lake 3- South	
Tributary:	3	3- Trib 3	Type: Non Point Inflow
-----Segment:	4	4- Frank Holten Lake 3- South	
Outflow Segment:	0	Out of Reservoir	
Tributary:	4	4- Trib 4	Type: Non Point Inflow
Tributary:	5	5- Harding Ditch	Type: Monitored Inflow





<b><u>Model Coefficients</u></b>	<b><u>Mean</u></b>	<b><u>CV</u></b>
Dispersion Rate	1.000	0.70
Total Phosphorus	1.000	0.45
Total Nitrogen	1.000	0.55
Chl-a Model	1.000	0.26
Secchi Model	1.000	0.10
Organic N Model	1.000	0.12
TP-OP Model	1.000	0.15
HODv Model	1.000	0.15
MODv Model	1.000	0.22
Secchi/Chla Slope (m <sup>2</sup> /mg)	0.025	0.00
Minimum Qs (m/yr)	0.100	0.00
Chl-a Flushing Term	1.000	0.00
Chl-a Temporal CV	0.620	0
Avail. Factor - Total P	0.330	0
Avail. Factor - Ortho P	1.930	0
Avail. Factor - Total N	0.590	0
Avail. Factor - Inorganic N	0.790	0

**Frank Holten Lakes- Wet**

**File:** E:\IEPA-TMDL St 3 Cahokia Creek\Modeling\BATHTUB\FrankHoltenLks\Fr

**Predicted & Observed Values Ranked Against CE Model Development Dataset**

Segment:	5 Area-Wtd Mean			Observed Values--->		
	Predicted Values--->			Mean	CV	Rank
Variable	Mean	CV	Rank	Mean	CV	Rank
TOTAL P MG/M3	42.9	0.13	45.1%	142.6		88.7%
CHL-A MG/M3	18.4	0.28	81.0%			
SECCHI M	1.9	0.25	77.1%			
ORGANIC N MG/M3	583.5	0.24	65.8%			
TP-ORTHO-P MG/M3	30.6	0.34	50.9%			
ANTILOG PC-1	274.1	0.51	53.4%			
ANTILOG PC-2	15.6	0.08	95.4%			
TURBIDITY 1/M	0.1	0.10	1.1%	0.1	0.10	1.1%
ZMIX * TURBIDITY	0.3	0.11	0.1%	0.3	0.11	0.1%
ZMIX / SECCHI	1.9	0.26	5.2%			
CHL-A * SECCHI	33.9	0.11	95.5%			
CHL-A / TOTAL P	0.4	0.26	89.1%			
FREQ(CHL-a>10) %	73.1	0.19	81.0%			
FREQ(CHL-a>20) %	32.7	0.48	81.0%			
FREQ(CHL-a>30) %	14.2	0.70	81.0%			
FREQ(CHL-a>40) %	6.5	0.88	81.0%			
FREQ(CHL-a>50) %	3.1	1.02	81.0%			
FREQ(CHL-a>60) %	1.6	1.15	81.0%			
CARLSON TSI-P	58.3	0.03	45.1%	75.6		88.7%
CARLSON TSI-CHLA	59.0	0.05	81.0%			
CARLSON TSI-SEC	51.0	0.07	22.9%			

Segment:	1 1- Frank Holten Lake 1			Observed Values--->		
	Predicted Values--->			Mean	CV	Rank
Variable	Mean	CV	Rank	Mean	CV	Rank
TOTAL P MG/M3	48.3	0.19	50.3%	166.5		91.7%
CHL-A MG/M3	21.8	0.30	86.3%			
SECCHI M	1.6	0.27	69.7%			
ORGANIC N MG/M3	660.9	0.25	74.3%			
TP-ORTHO-P MG/M3	36.7	0.35	58.4%			
ANTILOG PC-1	359.2	0.54	61.5%			
ANTILOG PC-2	15.6	0.08	95.4%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.3	0.20	0.2%	0.3	0.20	0.2%
ZMIX / SECCHI	2.5	0.28	13.4%			
CHL-A * SECCHI	34.9	0.11	95.9%			
CHL-A / TOTAL P	0.5	0.26	90.6%			
FREQ(CHL-a>10) %	82.9	0.14	86.3%			
FREQ(CHL-a>20) %	43.3	0.43	86.3%			
FREQ(CHL-a>30) %	20.5	0.67	86.3%			
FREQ(CHL-a>40) %	9.9	0.85	86.3%			
FREQ(CHL-a>50) %	5.0	1.01	86.3%			
FREQ(CHL-a>60) %	2.6	1.14	86.3%			

CARLSON TSI-P	60.1	0.05	50.3%	77.9	91.7%
CARLSON TSI-CHLA	60.9	0.05	86.3%		
CARLSON TSI-SEC	53.2	0.07	30.3%		

**Segment:**

**2 2- Frank Holten Lake 2**

<u>Variable</u>	<u>Predicted Values---&gt;</u>			<u>Observed Values---&gt;</u>		
	<u>Mean</u>	<u>CV</u>	<u>Rank</u>	<u>Mean</u>	<u>CV</u>	<u>Rank</u>
TOTAL P MG/M3	39.7	0.20	41.8%	116.3		83.8%
CHL-A MG/M3	14.6	0.29	71.5%			
SECCHI M	2.3	0.26	83.3%			
ORGANIC N MG/M3	494.9	0.23	53.4%			
TP-ORTHO-P MG/M3	23.7	0.35	40.2%			
ANTILOG PC-1	177.4	0.52	40.3%			
ANTILOG PC-2	15.5	0.08	95.3%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.5	0.20	1.0%	0.5	0.20	1.0%
ZMIX / SECCHI	2.9	0.26	19.4%			
CHL-A * SECCHI	32.8	0.12	95.0%			
CHL-A / TOTAL P	0.4	0.27	83.7%			
FREQ(CHL-a>10) %	61.6	0.29	71.5%			
FREQ(CHL-a>20) %	20.5	0.66	71.5%			
FREQ(CHL-a>30) %	7.0	0.92	71.5%			
FREQ(CHL-a>40) %	2.6	1.13	71.5%			
FREQ(CHL-a>50) %	1.1	1.29	71.5%			
FREQ(CHL-a>60) %	0.5	1.43	71.5%			
CARLSON TSI-P	57.2	0.05	41.8%	72.7		83.8%
CARLSON TSI-CHLA	56.9	0.05	71.5%			
CARLSON TSI-SEC	48.3	0.08	16.7%			

**Segment:**

**3 3- Frank Holten Lake 3- North**

<u>Variable</u>	<u>Predicted Values---&gt;</u>			<u>Observed Values---&gt;</u>		
	<u>Mean</u>	<u>CV</u>	<u>Rank</u>	<u>Mean</u>	<u>CV</u>	<u>Rank</u>
TOTAL P MG/M3	40.8	0.17	42.9%	144.5		89.0%
CHL-A MG/M3	23.0	0.31	87.7%			
SECCHI M	1.5	0.29	67.6%			
ORGANIC N MG/M3	687.0	0.26	76.7%			
TP-ORTHO-P MG/M3	38.7	0.36	60.6%			
ANTILOG PC-1	393.1	0.56	64.1%			
ANTILOG PC-2	15.6	0.08	95.4%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.2	0.20	0.0%	0.2	0.20	0.0%
ZMIX / SECCHI	1.6	0.29	2.8%			
CHL-A * SECCHI	35.1	0.11	96.0%			
CHL-A / TOTAL P	0.6	0.26	95.1%			
FREQ(CHL-a>10) %	84.9	0.13	87.7%			
FREQ(CHL-a>20) %	46.6	0.42	87.7%			
FREQ(CHL-a>30) %	23.0	0.66	87.7%			
FREQ(CHL-a>40) %	11.4	0.85	87.7%			
FREQ(CHL-a>50) %	5.9	1.01	87.7%			
FREQ(CHL-a>60) %	3.2	1.14	87.7%			
CARLSON TSI-P	57.6	0.04	42.9%	75.9		89.0%

CARLSON TSI-CHLA	61.4	0.05	87.7%
CARLSON TSI-SEC	53.9	0.08	32.4%

**Segment:**

**4 4- Frank Holten Lake 3- South**

<u>Variable</u>	<u>Predicted Values---&gt;</u>			<u>Observed Values---&gt;</u>		
	<u>Mean</u>	<u>CV</u>	<u>Rank</u>	<u>Mean</u>	<u>CV</u>	<u>Rank</u>
TOTAL P MG/M3	41.7	0.03	43.9%	138.8		88.1%
CHL-A MG/M3	15.6	0.26	74.6%			
SECCHI M	2.1	0.23	81.3%			
ORGANIC N MG/M3	519.6	0.22	57.1%			
TP-ORTHO-P MG/M3	25.6	0.32	43.4%			
ANTILOG PC-1	200.7	0.46	43.9%			
ANTILOG PC-2	15.6	0.08	95.4%			
TURBIDITY 1/M	0.1	0.20	1.1%	0.1	0.20	1.1%
ZMIX * TURBIDITY	0.2	0.20	0.0%	0.2	0.20	0.0%
ZMIX / SECCHI	0.9	0.24	0.2%			
CHL-A * SECCHI	33.2	0.11	95.2%			
CHL-A / TOTAL P	0.4	0.26	84.6%			
FREQ(CHL-a>10) %	66.0	0.23	74.6%			
FREQ(CHL-a>20) %	24.0	0.55	74.6%			
FREQ(CHL-a>30) %	8.7	0.78	74.6%			
FREQ(CHL-a>40) %	3.4	0.96	74.6%			
FREQ(CHL-a>50) %	1.4	1.11	74.6%			
FREQ(CHL-a>60) %	0.7	1.23	74.6%			
CARLSON TSI-P	57.9	0.01	43.9%	75.3		88.1%
CARLSON TSI-CHLA	57.6	0.04	74.6%			
CARLSON TSI-SEC	49.1	0.07	18.7%			

**Frank Holten Lakes- Wet**

File: E:\IEPA-TMDL St 3 Cahokia Creek\Modeling\BATHTUB\FrankHoltenLks\FrankHoltenLks\_WetRED.btb

**Overall Water & Nutrient Balances**

**Overall Water Balance**

Averaging Period = 0.25 years

<u>Trb</u>	<u>Type</u>	<u>Seg</u>	<u>Name</u>	<u>Area</u> <u>km<sup>2</sup></u>	<u>Flow</u> <u>hm<sup>3</sup>/yr</u>	<u>Variance</u> <u>(hm3/yr)<sup>2</sup></u>	<u>CV</u> <u>-</u>	<u>Runoff</u> <u>m/yr</u>
5	1	4	5- Harding Ditch		41.6	0.00E+00	0.00	
			PRECIPITATION	0.6	0.8	0.00E+00	0.00	1.18
			TRIBUTARY INFLOW		41.6	0.00E+00	0.00	
			***TOTAL INFLOW	13.6	42.4	0.00E+00	0.00	3.11
			ADVECTIVE OUTFLOW	13.6	42.0	0.00E+00	0.00	3.08
			***TOTAL OUTFLOW	13.6	42.0	0.00E+00	0.00	3.08
			***EVAPORATION		0.3	0.00E+00	0.00	

**Overall Mass Balance Based Upon Component:**

**Predicted  
TOTAL P**

**Outflow & Reservoir Concentrations**

<u>Trb</u>	<u>Type</u>	<u>Seg</u>	<u>Name</u>	<u>Load</u> <u>kg/yr</u>	<u>%Total</u>	<u>Load Variance</u> <u>(kg/yr)<sup>2</sup></u>	<u>%Total</u>	<u>Conc</u> <u>mg/m<sup>3</sup></u>	<u>Export</u> <u>kg/km<sup>2</sup>/yr</u>
5	1	4	5- Harding Ditch	1826.7	95.3%	0.00E+00		43.9	
			PRECIPITATION	19.2	1.0%	9.22E+01	100.0%	0.50	30.0
			INTERNAL LOAD	70.1	3.7%	0.00E+00		0.00	
			TRIBUTARY INFLOW	1826.7	95.3%	0.00E+00		0.00	
			***TOTAL INFLOW	1916.0	100.0%	9.22E+01	100.0%	0.01	140.5
			ADVECTIVE OUTFLOW	1752.6	91.5%	2.47E+03		0.03	128.5
			***TOTAL OUTFLOW	1752.6	91.5%	2.47E+03		0.03	128.5
			***RETENTION	163.4	8.5%	2.49E+03		0.31	
			Overflow Rate (m/yr)	65.7				Nutrient Resid. Time (yrs)	0.0499
			Hydraulic Resid. Time (yrs)	0.0531				Turnover Ratio	5.0
			Reservoir Conc (mg/m3)	43				Retention Coef.	0.085

**Frank Holten Lakes- Wet**

File: E:\NEPA-TMDL St 3 Cahokia Creek\Modeling\BATHTUB\FrankHoltenLks\FrankHoltenLks\_WetRED.btb

**Hydraulic & Dispersion Parameters**

<u>Seg</u>	<u>Name</u>	<u>Outflow</u> <u>Seg</u>	<u>Net</u> <u>Inflow</u> <u>hm<sup>3</sup>/yr</u>	<u>Resid</u> <u>Time</u> <u>years</u>	<u>Overflow</u> <u>Rate</u> <u>m/yr</u>	<u>Dispersion-----&gt;</u>			<u>Exchange</u> <u>hm<sup>3</sup>/yr</u>
						<u>Velocity</u> <u>km/yr</u>	<u>Estimated</u> <u>km<sup>2</sup>/yr</u>	<u>Numeric</u> <u>km<sup>2</sup>/yr</u>	
1	1- Frank Holten Lake 1	2	0.1	6.1013	0.7	1.0	1.0	0.1	0.7
2	2- Frank Holten Lake 2	3	0.2	4.2963	1.5	1.0	0.8	0.0	1.6
3	3- Frank Holten Lake 3- North	4	0.3	1.0459	2.3	1.0	1.2	0.3	0.5
4	4- Frank Holten Lake 3- South	0	42.0	0.0099	191.0	65.3	436.6	21.2	0.0

**Morphometry**

<u>Seg</u>	<u>Name</u>	<u>Area</u> <u>km<sup>2</sup></u>	<u>Zmean</u> <u>m</u>	<u>Zmix</u> <u>m</u>	<u>Length</u> <u>km</u>	<u>Volume</u> <u>hm<sup>3</sup></u>	<u>Width</u> <u>km</u>	<u>L/W</u> <u>-</u>
1	1- Frank Holten Lake 1	0.2	4.0	4.0	1.0	0.7	0.2	5.4
2	2- Frank Holten Lake 2	0.1	6.5	6.5	0.6	0.8	0.2	3.2
3	3- Frank Holten Lake 3- North	0.1	2.4	2.4	0.8	0.3	0.2	4.8
4	4- Frank Holten Lake 3- South	0.2	1.9	1.9	0.6	0.4	0.3	1.9
Totals		0.6	3.5			2.2		

**Frank Holten Lakes- Wet**

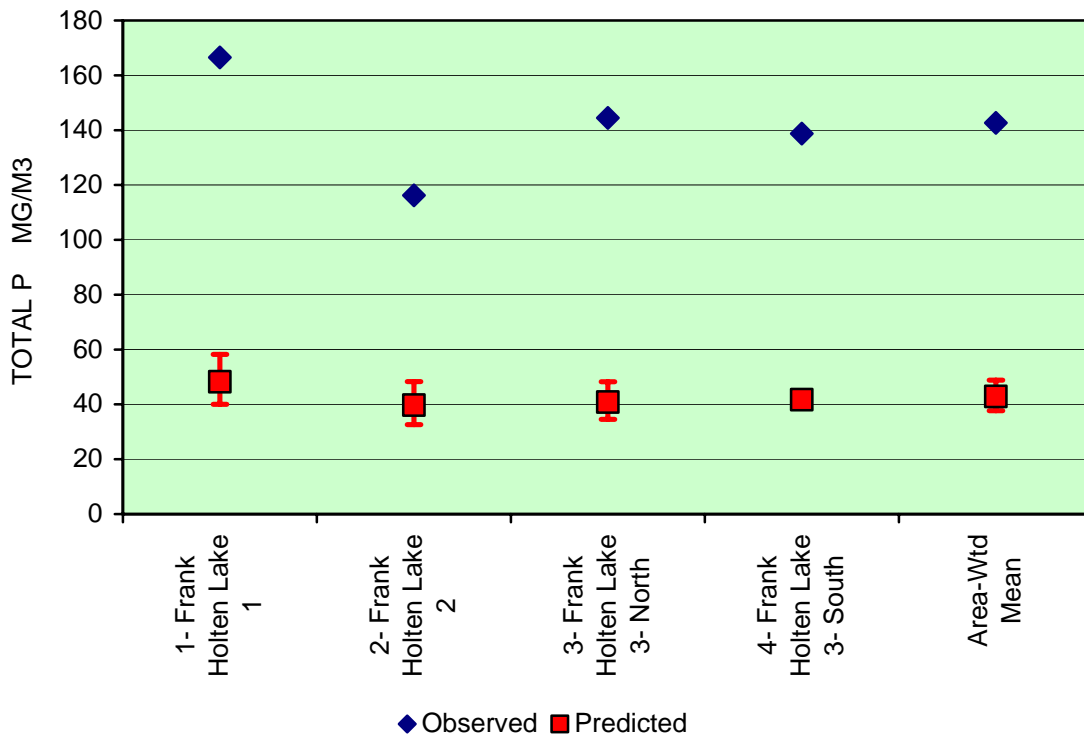
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**Variable:**

TOTAL P MG/M3

<u>Segment</u>	<u>Predicted</u>		<u>Observed</u>	
	<u>Mean</u>	<u>CV</u>	<u>Mean</u>	<u>CV</u>
1- Frank Holten Lake 1	48.3	0.19	166.5	0.00
2- Frank Holten Lake 2	39.7	0.20	116.3	0.00
3- Frank Holten Lake 3- Nor	40.8	0.17	144.5	0.00
4- Frank Holten Lake 3- Sou	41.7	0.03	138.8	0.00
Area-Wtd Mean	42.9	0.13	142.6	0.00



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