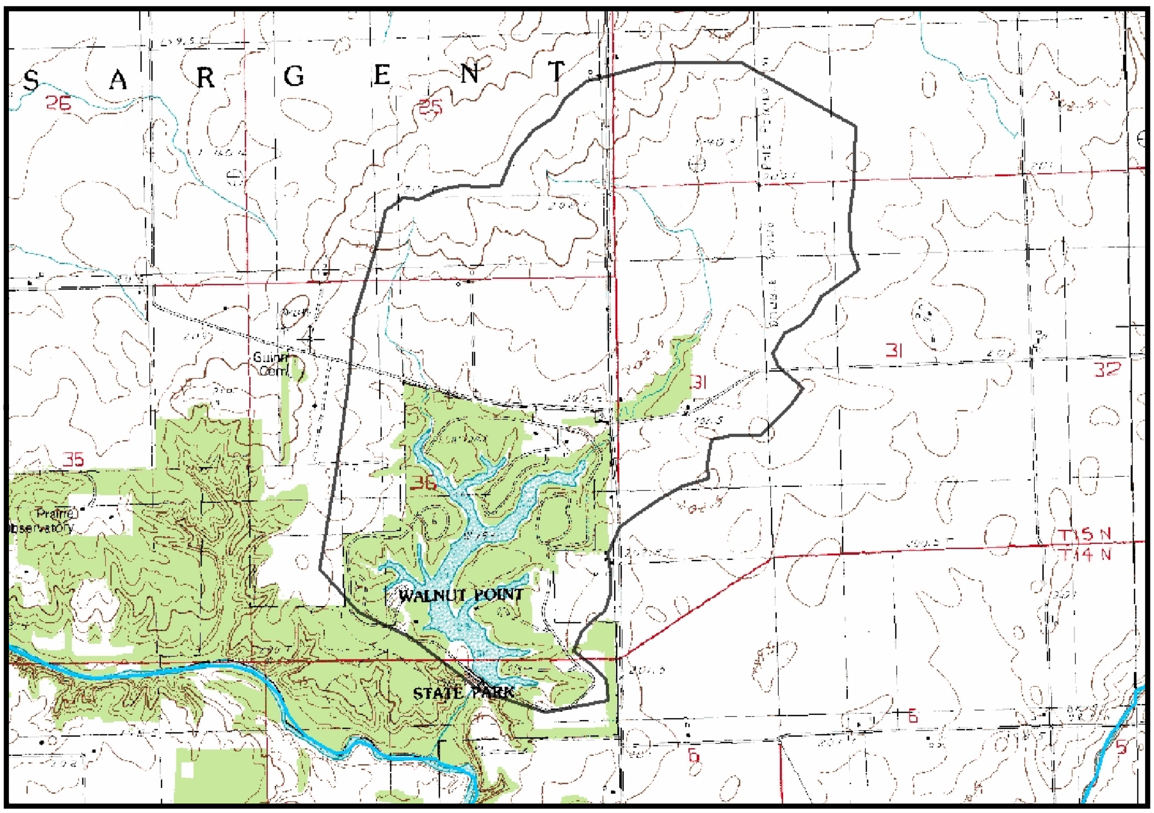
Illinois
Environmental
Protection Agency

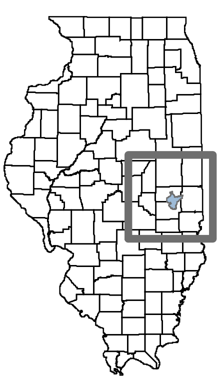
Bureau of Water
P.O. Box 19276
Springfield, IL 62794-9276

December 2007

IEPA/BOW/07-026

WALNUT POINT LAKE WATERSHED TMDL REPORT





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

REPLY TO THE ATTENTION OF:

SEP 28 2007

WW-16J

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

RECEIVED
OCT - 4 2007
BUREAU OF WATER
BUREAU CHIEF'S OFF

Dear Ms. Willhite:

The United States Environmental Protection Agency (U.S. EPA) has reviewed the final Total Maximum Daily Load (TMDL) from the Illinois Environmental Protection Agency (IEPA) for the Walnut Point Lake Watershed in Illinois. The TMDL is for phosphorus, addressing the Aesthetic Quality use impairment.

Based on this review, U.S. EPA has determined that Illinois' TMDL for phosphorus meets the requirements of Section 303(d) of the Clean Water Act and U.S. EPA's implementing regulations at 40 C.F.R. Part 130. Therefore, U.S. EPA hereby approves 1 TMDL for phosphorus (see Table 1 of the Enclosure). The statutory and regulatory requirements, and U.S. EPA's review of Illinois' compliance with each requirement, are described in the enclosed decision document.

We wish to acknowledge Illinois' effort in submitting this TMDL and look forward to future TMDL submissions by the State of Illinois. If you have any questions, please contact Dean Maraldo, TMDL Program Manager at 312-353-2098.

Sincerely yours,

Kevin M. Pierard
Acting Director, Water Division

Enclosure

cc: Dean Studer, IEPA

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Attachment 1
Stage One Report
Tetra Tech, 2005

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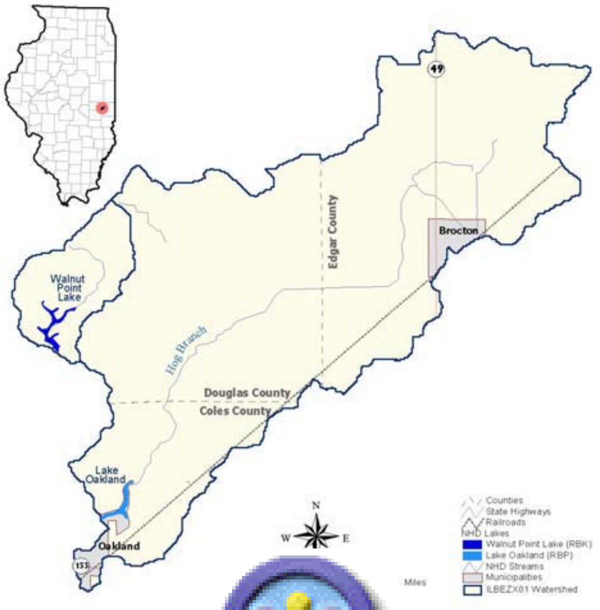
TMDL Development for the Lake Oakland and Walnut Point Lake Watersheds

April 8, 2005

Final Report

Stage One Report:
Watershed Characterization and Water Quality Analysis



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TMDL Development for the Lake Oakland and Walnut Point Lake Watersheds

Stage One Report: Watershed Characterization and Water Quality Analysis

FINAL REPORT

April 8, 2005

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

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

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Key Findings

As part of the Section 303(d) listing process, the Illinois Environmental Protection Agency has identified Lake Oakland and Walnut Point Lake as being impaired. The purpose of this report is to describe the watersheds in which these waters are located and review the available water quality data to confirm the impairments. This report also identifies several potential options for proceeding with developing total maximum daily loads (TMDLs) for these waters.

A review of the available water quality data confirms most of these impairments. However, insufficient recent data are available for Walnut Point Lake to characterize current conditions. Other key findings described in this report include:

- There does not appear to be any significant improving or degrading trend over time for the assessed water quality parameters. Nutrient levels in both lakes have remained relatively constant over the period of record, although total phosphorus may have increased in Walnut Point Lake.

- It is recommended that Walnut Point Lake be de-listed for nitrate nitrogen based on the fact it is not a public and food processing water supply and the available data do not indicate high nitrate concentrations.

- It is recommended that water quality sampling be performed on the tributaries of both lakes to better estimate loadings to the lakes. Total phosphorus, dissolved phosphorus, total Kjeldahl nitrogen, nitrate+nitrite, chlorophyll-a, total suspended solids, total volatile solids, dissolved oxygen, pH, temperature, and transparency should be sampled.

- It is recommended that water quality sampling be performed for Walnut Point Lake to gather information on current water quality conditions.

- Additional information on the potential for shoreline erosion of both lakes is needed.

1 Introduction

Lake Oakland and Walnut Point Lake are located within several miles of one another in east-central Illinois (Figure 2-1). The Lake Oakland watershed drains approximately 21 square miles and the Walnut Point Lake watershed drains less than 2 square miles. Together these two watersheds comprise Illinois Environmental Protection Agency (EPA) Watershed ID ILBEZX01.

As part of the Section 303(d) listing process, the Illinois EPA has identified both Lake Oakland (segment RBP) and Walnut Point Lake (segment RBK) as impaired waters (Table 1-1). Both Lake Oakland and Walnut Point Lake are listed for total phosphorus (TP), excessive algal growth, suspended solids, and sedimentation/siltation. Walnut Point Lake is also listed for nitrates, dissolved oxygen, and native aquatic plants (Illinois EPA, 2002). These impairments result in both non- and partial-support of the primary contact (swimming), secondary contact (recreation), and aquatic life designated uses.

Table 1-1. 2002 303(d) List Information for the Lake Oakland and Walnut Point Lake Watersheds.

Segment (size)	Name	Designated Uses and Support Status	Causes of Impairment	Potential Sources of Impairment
RBP (27.6 acres)	Lake Oakland[1]	Non supported–Primary Contact (swimming), Secondary Contact (recreation) Partially supported–Overall Use, Aquatic Life, Drinking Water Supply Fully–Fish Consumption	Total Phosphorus, Excessive Algal Growth, Suspended Solids, Sedimentation/Siltation	Agriculture– crop related sources, non–irrigated crop production, animal holding/management areas Habitat modification– streambank mod/destabilization Source unknown
RBK (41.6 acres)	Walnut Point Lake	Partially supported–Overall Use, Primary Contact (swimming), Secondary Contact (recreation) Fully–Aquatic Life Support Not Assessed– Fish Consumption, Drinking Water Supply	Total Phosphorus, Nitrogen Nitrate, Sedimentation/Siltation, Dissolved Oxygen, Suspended Solids, Aquatic Plants Native, Excess Algal Growth	Agriculture– crop related sources, non–irrigated crop production Contaminated sediments Forest/grassland/ parkland

Source: Illinois EPA, 2002.

[1] In February 2003, the City of Oakland began purchasing water from the Embarras Area Water District Public Water Supply. At that time the use of Lake Oakland as a water source was discontinued.

The Clean Water Act and USEPA regulations require that states develop total maximum daily loads (TMDLs) for waters on the Section 303(d) lists. Illinois EPA is currently developing TMDLs for pollutants that have water quality standards. Of the pollutants impairing Lake Oakland and Walnut Point Lake, phosphorus, nitrate, and dissolved oxygen are the only parameters with numeric water quality standards for lakes. 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. For example, reducing loads of phosphorus and nitrate should result in less algal growth and some of the management measures taken to reduce these loads (e.g., reducing shoreline erosion) should also reduce loads of suspended solids.

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

- Assess the water quality of the impaired waterbodies and identify key issues associated with the impairments and potential pollutant sources.
- Use the best available science and available data to determine the maximum load of pollutants that Lake Oakland and Walnut Point Lake can receive and fully support designated uses.
- Use the best available science and available data to determine current loads of pollutants to the impaired waterbodies.
- If current loads exceed the maximum allowable load, determine the load reduction that is needed.
- Identify feasible and cost-effective actions that can be taken to reduce loads.
- Inform and involve the public throughout the project to ensure that key concerns are addressed and the best available information is used.
- Submit a final TMDL report to USEPA for review and approval.

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

2 Watershed Characteristics

The physical characteristics of Lake Oakland and Walnut Point Lake and their watersheds are described in the following sections. For the purposes of this characterization, the Lake Oakland and Walnut Point Lake watersheds were delineated using the ArcView interface available with the Soil Water Assessment Tool (SWAT) model. The interface requires digital elevation data (DEM) covering the entire area of the watershed. Thirty-meter DEM data, representing 7.5 minute U.S. Geological Survey (USGS) quadrangle maps, were downloaded from the GEOCommunity <www.geocomm.com> web site. Subbasin delineation was based on the DEM data coupled with a "burn-in" of the National Hydrography Data set (NHD) spatial database of stream reaches. This approach ensures that the subbasin boundaries conform to topographic characteristics while ensuring that catalogued stream segments connect in the proper order and direction. The delineated subbasins, shown in Figure 2-1 and later watershed figures, conform very well to the drainage divides included within the Illinois 12-digit Hydrologic Unit Codes.

2.1 Location and Description of Waterbodies

The Lake Oakland and Walnut Point Lake watersheds (Figure 2-1) are located in east-central Illinois and drain approximately 21 square miles and 1.9 square miles, respectively. Approximately 45 percent of the Lake Oakland watershed lies in eastern Edgar County, 39 percent lies in Douglas County, and 16 percent lies in Coles County. The entire Walnut Point Lake watershed is in Douglas County.

Walnut Point Lake is stream fed and is formed by an earthen dam located on the south side of the lake. The dam was built in 1967 and water filled the basin to spillway level by the fall of 1968. The lake has a maximum depth of 31 feet, an average depth of 11.5 feet and a shoreline length of 6.3 miles (IDNR, 2004). No destratification devices are used in the lake (Rob Hackett, Walnut Point State Park, personal communications, October 13, 2004).

Lake Oakland is also stream fed and is formed by a dam located on the west side of the lake. The dam was originally constructed in 1937 with an original capacity of 94 acre feet. The lake has been periodically dredged over time due to sedimentation problems. The average depth of the lake is 3.9 feet with a maximum depth of 9 feet (during wet years) near the dam. The lake served as the sole source of drinking water to the City of Oakland until February 2003, when the city began purchasing water from the Embarras Area Water District Public Water Supply. At that time the use of Lake Oakland as a water source was discontinued.

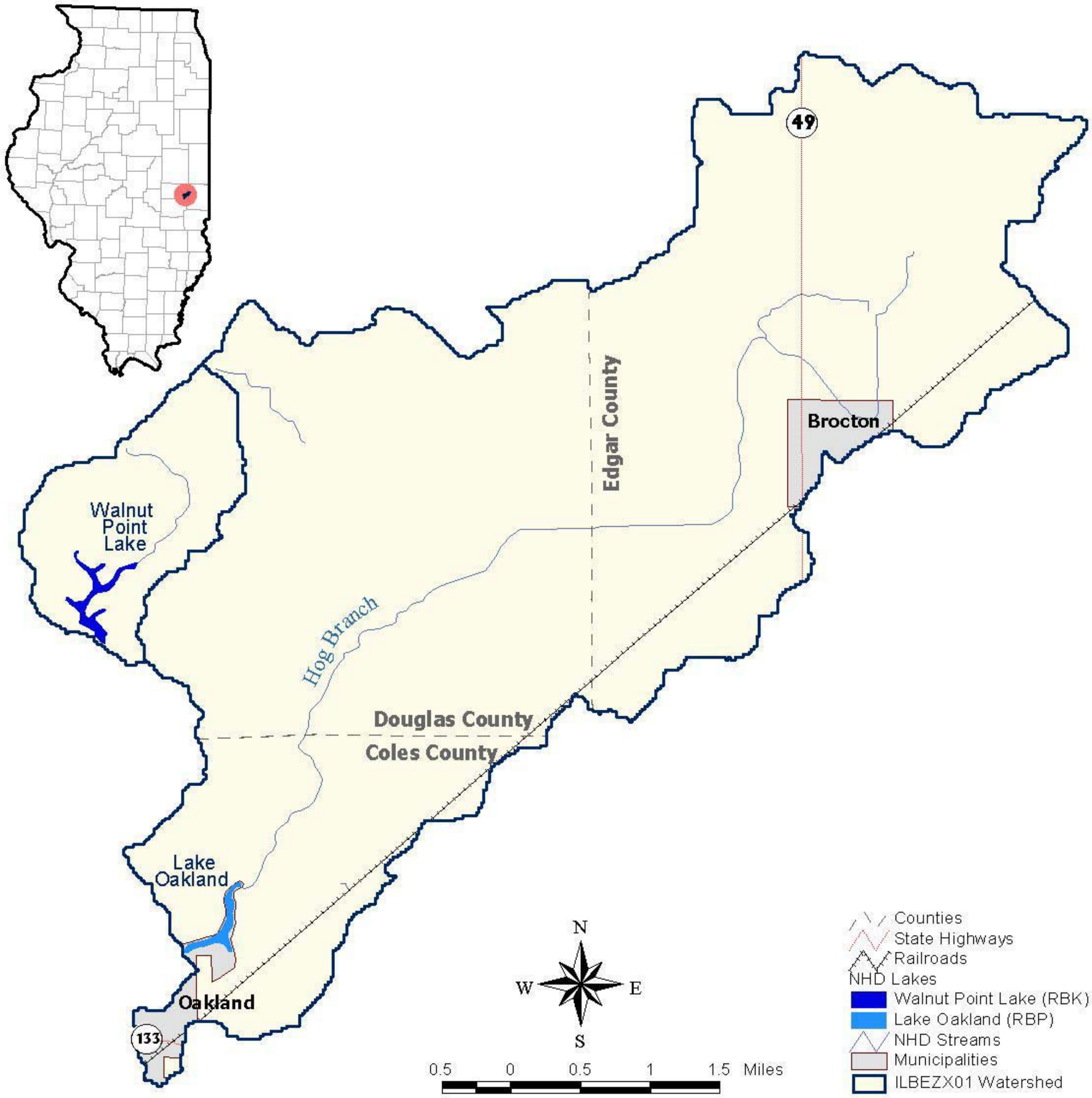

Figure 2-1. Location of the Lake Oakland and Walnut Point Lake watersheds.

2.2 Topography

Elevation in the two watersheds ranges from 730 feet above sea level in the Walnut Point Lake watershed headwaters to 633 feet at the outlet of Lake Oakland. The elevation at the outlet of Walnut Point Lake is 645 feet. The elevations of the two watersheds are shown in Figure 2-2.

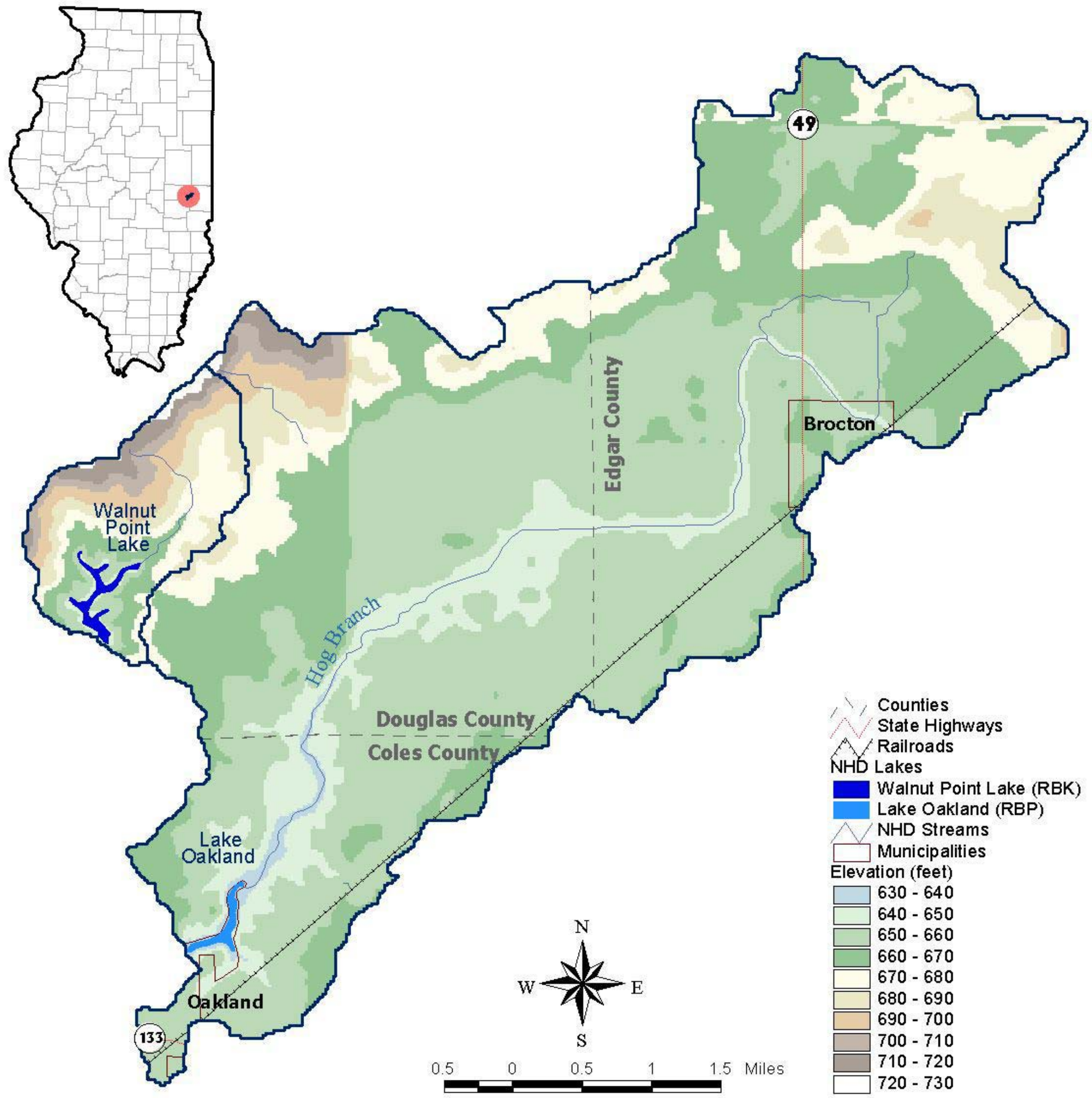

Figure 2-2. Elevation in the Lake Oakland and Walnut Point Lake watersheds.

2.3 Land Use and Land Cover

General land cover data for the Lake Oakland and Walnut Point Lake watersheds were extracted from the Illinois Natural History Survey's GAP Analysis Land cover database (INHS, 2003). This database was derived from satellite imagery taken during 1999 and 2000 and is the most current detailed land cover data known to be available for the two watersheds. Each 98-foot by 98-foot pixel contained within the satellite image is classified according to its reflective characteristics. A complete listing and definition of the Illinois GAP land cover categories is given in Appendix A. The following sections summarize land use and land cover for each of the two watersheds.

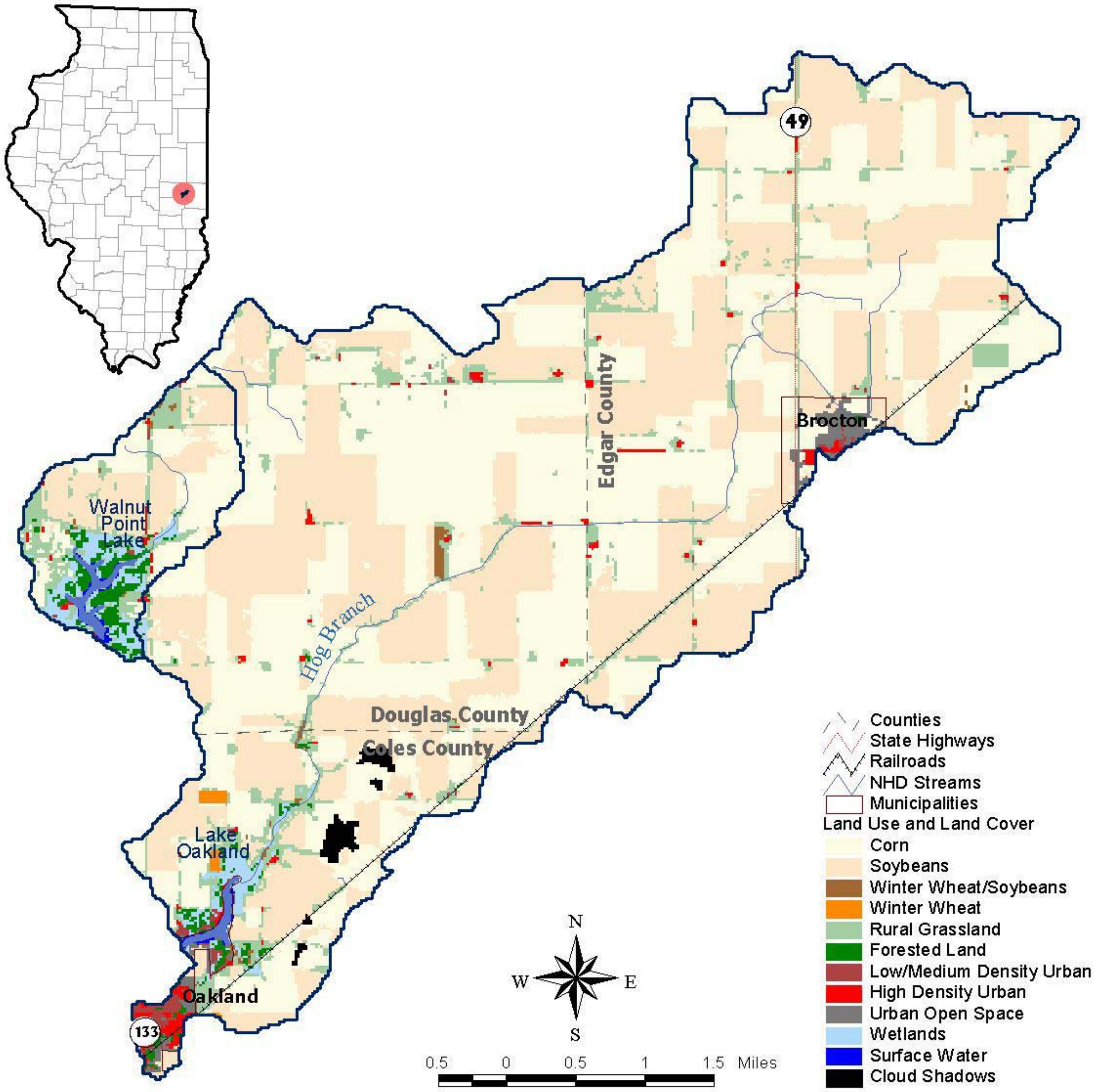

Figure 2-3. GAP land cover in the Lake Oakland and Walnut Point Lake watersheds.

Land use and land cover in the Lake Oakland watershed is summarized in Table 2-1. More than 95 percent of the watershed consists of agricultural land uses, with the primary crops being corn and soybeans. Urban land uses account for 2.1 percent of the land cover while wetlands and forest each represent less than one percent. All other cover types combined represent less that one percent of the watershed area.

Table 2-1. Land Use and Land Cover in the Lake Oakland Subwatershed.

Land Cover Description	Watershed Area		
	Acres	Square Miles	Percent
Agricultural Land: Corn	6,589.10	10.3	48.01
Agricultural Land: Soybeans	5,787.80	9.04	42.17
Agricultural Land: Rural Grassland	747	1.17	5.44
Urban And Built-Up Land: Urban Open Space	123.2	0.19	0.9
Urban And Built-Up Land: High Density	105	0.16	0.76
Other: Cloud Shadows	66.9	0.1	0.49
Urban And Built-Up Land: Low/Medium Density	64.5	0.1	0.47
Wetland: Floodplain Forest: Wet-Mesic	61.4	0.1	0.45
Forested Land: Partial Canopy/Savanna Upland	36	0.06	0.26
Agricultural Land: Winter Wheat/Soybeans	33.1	0.05	0.24
Wetland: Floodplain Forest: Wet	29.1	0.05	0.21
Other: Surface Water	28	0.04	0.2
Forested Land: Upland: Dry-Mesic	21.8	0.03	0.16
Agricultural Land: Winter Wheat	21.3	0.03	0.16
Wetland: Seasonally/Temporarily Flooded	3.6	0.01	0.03
Wetland: Shallow Water	2.9	<0.01	0.02
Wetland: Deep Marsh	2	<0.01	0.02
Forested Land: Upland: Mesic	0.9	<0.01	0.01
Total	13,723.60	21.44	100

Agricultural land uses are also dominant in the Walnut Point Lake watershed, accounting for 76 percent (918 acres) of the total area (Table 2-2). Approximately ten percent (123 acres) of the Walnut Point Lake watershed is classified as wetlands. Forest and surface water represent approximately 9 percent of the subwatershed area. Urban and other land use categories account for 3.4 percent and 1.5 percent of the remaining land uses, respectively.

Table 2-2. Land Use and Land Cover in the Walnut Point Lake Watershed.

Land Cover Description	Watershed Area		
	Acres	Square Miles	Percent
Agricultural Land: Corn	360.3	0.56	29.85
Agricultural Land: Soybeans	349.4	0.55	28.94
Agricultural Land: Rural Grassland	201.3	0.31	16.67
Forested Land: Upland: Dry-Mesic	87.6	0.14	7.26
Wetland: Floodplain Forest: Wet-Mesic	79.8	0.12	6.61
Other: Surface Water	41.1	0.06	3.41
Wetland: Floodplain Forest: Wet	26.9	0.04	2.23
Urban And Built-Up Land: High Density	14.2	0.02	1.18
Forested Land: Upland: Mesic	13.3	0.02	1.11
Wetland: Shallow Water	9.1	0.01	0.76
Agricultural Land: Winter Wheat/Soybeans	7.3	0.01	0.61
Wetland: Seasonally/Temporarily Flooded	6.2	0.01	0.52
Forested Land: Partial Canopy/Savanna Upland	5.3	0.01	0.44
Urban And Built-Up Land: Low/Medium Density	4.4	0.01	0.37
Wetland: Deep Marsh	0.7	<0.01	0.04
Total	1,206.90	1.87	100

2.3.1 Tillage Practices

Tillage system practices are not available specifically for either the Lake Oakland or Walnut Point Lake watersheds. However, countywide tillage system surveys have been undertaken by the Illinois Department of Agriculture (2000; 2002) and are available for Coles, Douglas, and Edgar Counties. It is assumed that the general tillage practice trends evidenced throughout these counties are applicable to the two watersheds. The results of these surveys are presented in Table 2-3. The table shows that the percentage of fields in conventional tillage, averaged across all counties and crop types, is approximately 40 percent for both surveys.

Table 2-3. Percentage of Agricultural Fields Surveyed with Indicated Tillage System in Edgar County, Illinois, in 2000 and 2002.

2000 Transect Survey					
County	Crop Field Type	Tillage Practice			
		Conventional	Reduced-till	Mulch-till	No-till
Edgar County	Corn	70	12	6	12
	Soybean	13	21	19	47
	Small Grain	0	0	0	0
Coles County	Corn	68	19	3	10
	Soybean	8	39	34	19
	Small Grain	43	14	0	43
Douglas County	Corn	94	3	1	3
	Soybean	23	27	2	48
	Small Grain	50	0	0	50
2002 Transect Survey					
County	Crop Field Type	Tillage Practice			
		Conventional	Reduced-till	Mulch-till	No-till
Edgar County	Corn	59	9	2	30
	Soybean	21	24	10	45
	Small Grain	0	100	0	0
Coles County	Corn	73	17	8	3
	Soybean	13	51	20	16
	Small Grain	29	43	14	14
Douglas County	Corn	87	9	1	3
	Soybean	18	37	7	38
	Small Grain	66	17	17	0

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

2.4 Soils

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

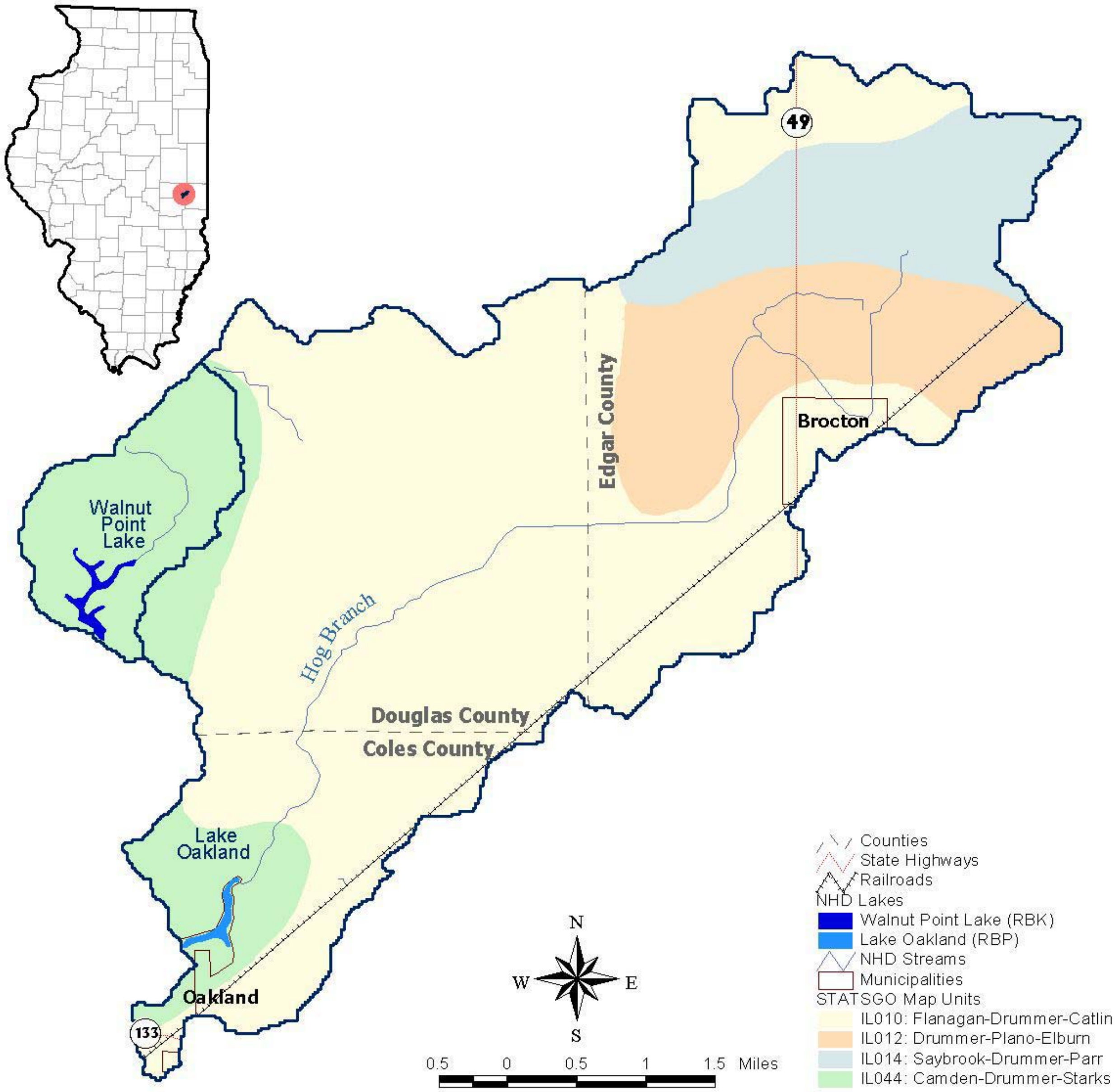

Figure 2-4. Location of STATSGO Map Units in the Lake Oakland and Walnut Point Lake watersheds.

2.4.1 Hydrologic Soil Group

The hydrologic soil group classification is a means for grouping soils by similar infiltration and runoff characteristics during periods of prolonged wetting. Typically, poorly drained clay soils have lower infiltration rates, while well-drained sandy soils have the greatest infiltration rates. NRCS (2001) has defined four hydrologic groups for soils as listed in Table 2-4. In addition, soils with tile drainage in Illinois should be designated as Class B soils (i.e., due to the presence of tile drainage the soil takes on the attribute of a Class B soil ((McKenna, personal communications, December 15, 2004)). Figure 2-5 presents the general distribution of hydrologic soil groups in the two watersheds. The figure shows that soils classified as hydrologic group B compose the entire watershed. This suggests that soils in each watershed are moderately deep, moderately well drained, and have moderate infiltration rates.

Table 2-4. NRCS Hydrologic Soil Groups

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

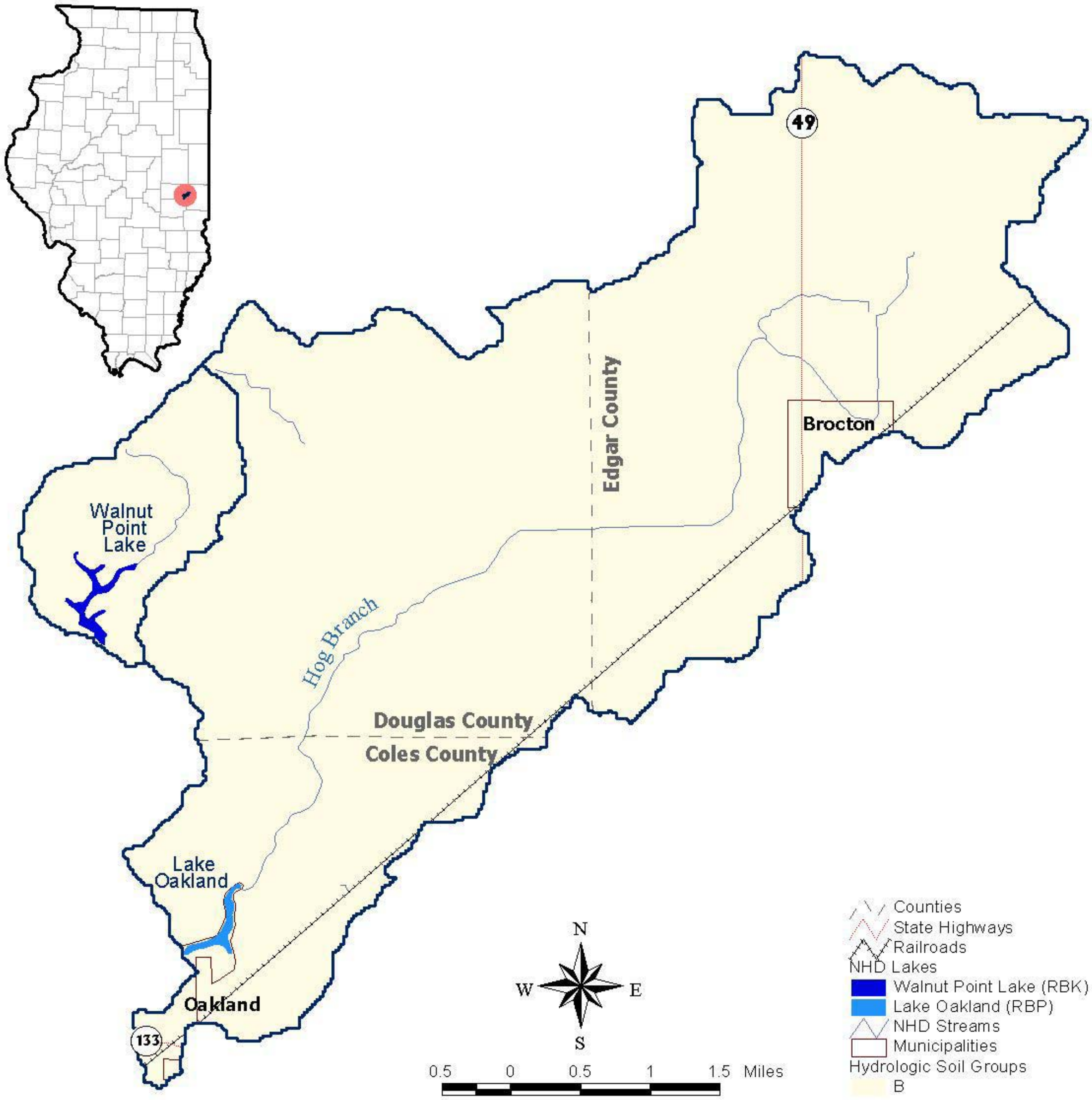

Figure 2-5. Hydrologic soil group distribution in the Lake Oakland and Walnut Point Lake watersheds.

2.4.2 K-Factor

A commonly used soil attribute is the K-factor, a component of the USLE (Wischmeier and Smith, 1978). The K-factor is a dimensionless measure of a soil's natural susceptibility to erosion, and factor values may range from 0 for water surfaces to 1.00 (although in practice, maximum factor values do not generally exceed 0.67). Large K-factor values reflect greater inherent soil erodibility. The distribution of K-factor values in the Lake Oakland and Walnut Point Lake watersheds is shown in Figure 2-6. The figure indicates that soils in the watershed have moderate erosion potential (e.g., K-factors ranging from 0.20 to 0.37). The areas directly adjacent to the two lakes are reported to have the highest K-factors.

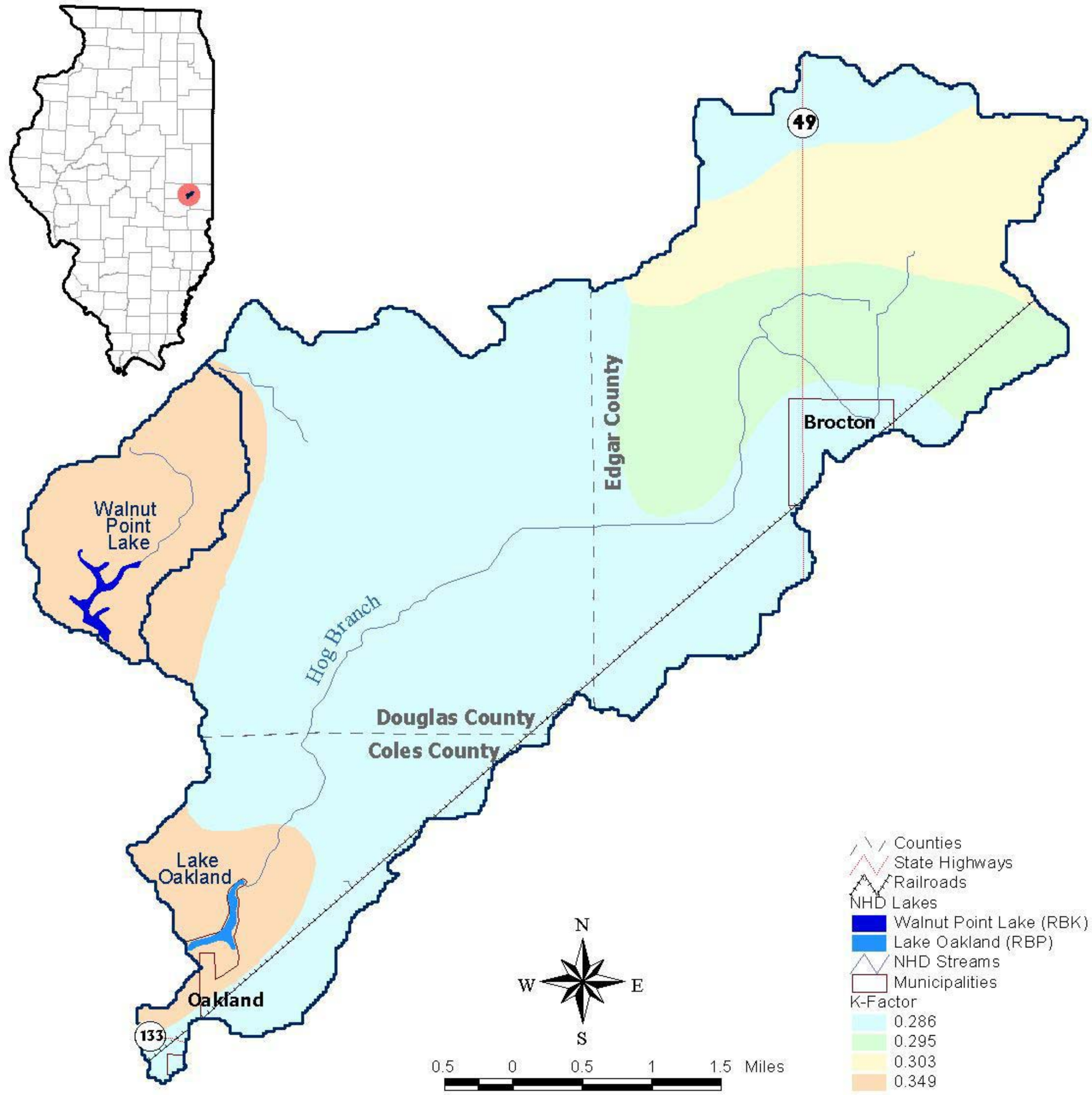

Figure 2-6. USLE K-Factor distribution in the Lake Oakland and Walnut Point Lake watersheds.

2.4.3 Depth to Water Table

Water table depth as described in the STATSGO database is the range in depth to the seasonally high water table level for a specified month. The STATSGO database reports depth to water table as both a minimum and maximum depth. Values were summarized to reflect the weighted sum of the minimum depth to water table for the surface layer of all soil sequences composing a single STATSGO map unit. Figure 2-7 displays the distribution of depth to water table for the basin and shows that depths range from 2.45 feet to 4.28 feet with maximum depths occurring adjacent to Lake Oakland and Walnut Point Lake.

Depths in the central portion of the basin are approximately 2.45 feet with a smaller area near Brocton (2.89 feet). Water table depths in the northern headwaters region are reported as 4.21 feet.

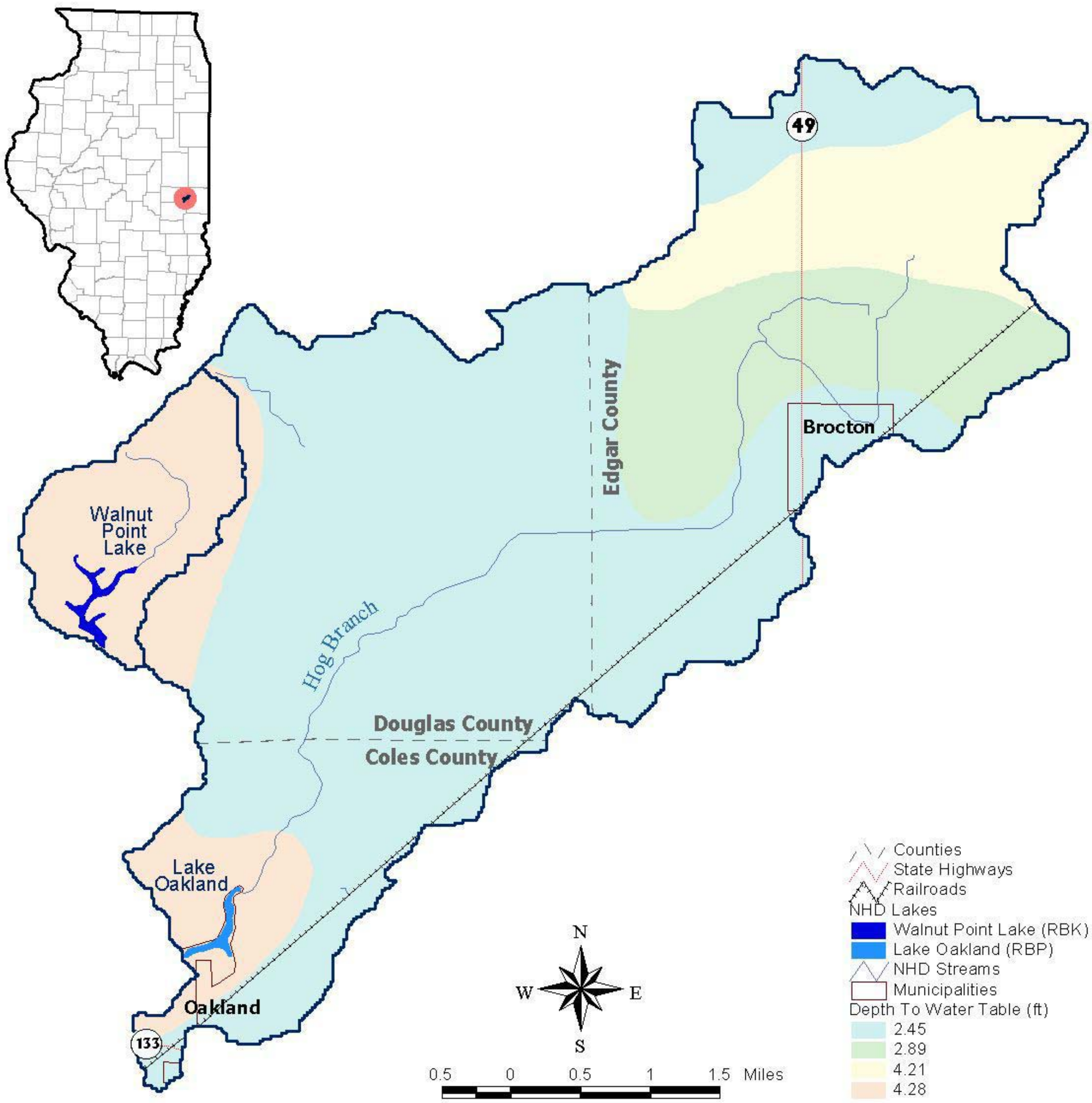

Figure 2-7. Depth to water table in the Lake Oakland and Walnut Point Lake watersheds.

2.5 Population

The populations of the Lake Oakland and Walnut Point Lake watersheds are not directly available but may be estimated from the 2000 U.S. Census data. The 2000 U.S. Census data were downloaded for all towns, cities, and counties whose boundaries lie wholly or partially in the watershed (U.S. Census, 2000).

Urban and nonurban populations were estimated for the watershed area and were summed to estimate the total watershed population (Table 2-5). Using this methodology approximately 700 people are estimated to reside in the Lake Oakland watershed and less than 30 people are estimated to reside in the Walnut Point Lake watershed.

Table 2-5. ILBEZX01 Watershed Population Summarized by Waterbody Segment and County

Waterbody	County	Watershed Population	Nonurban Population	Urban Population
Lake Oakland	Edgar County	414	75	339
	Coles County	299	107	192
	Total	**713**	**182**	**531**
Walnut Point Lake	Douglas County	29	29	0
	Total	**29**	**29**	**0**

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

The 1990 U.S. Census data were compiled to estimate population change for the ten-year period between 1990 and 2000 for both watersheds. Population in the Lake Oakland watershed is estimated to have increased from 706 people in 1990 to 713 people in 2000. The population of the Walnut Point Lake watershed is estimated to have increased by one person.

3 Climate and Hydrology

This section provides information on the climate and hydrology of the two watersheds.

3.1 Climate

No meteorological stations are located in the ILBEZX01 watershed; data from the Tuscola station (station ID 118684) were therefore used to assess climate. The Tuscola station is located approximately 13.75 miles to the northwest of Walnut Point Lake and approximately 15.5 miles northwest of Oakland Lake. Average annual precipitation at this station is 40.66 inches and, on average, there are 124 days with at least 0.01 inches of precipitation. The annual average snowfall is 23.1inches. The monthly variation in precipitation and temperatures is presented in Figure 3-1 and illustrates that June and July are typically the months with the most rainfall and that January and December typically receive the greatest amount of snowfall.

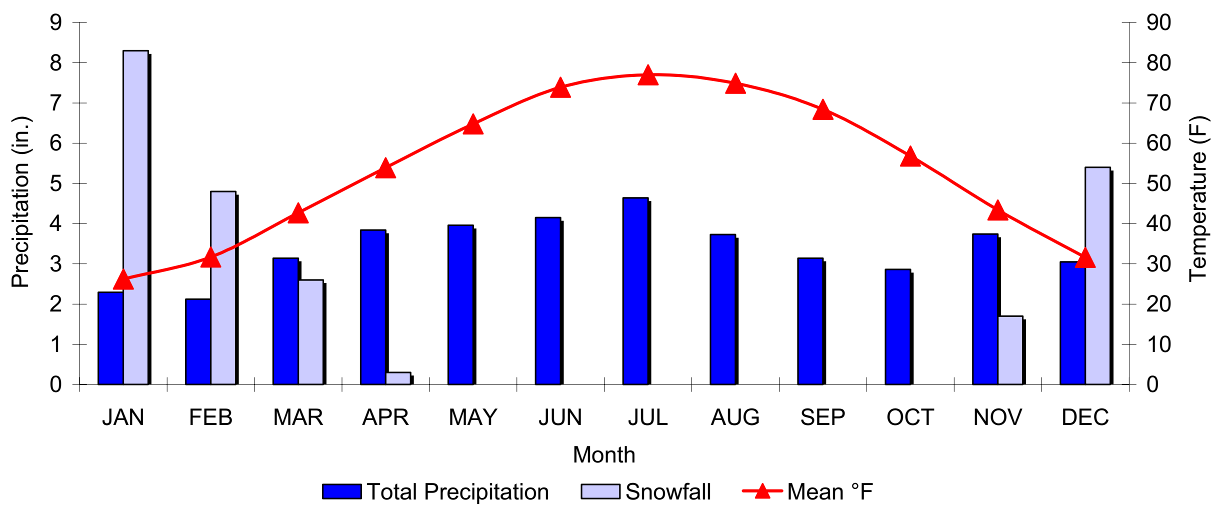

Figure 3-1. Climate Summary for Tuscola Station (118684). Data cover the period 1971 to 2000.

3.2 Hydrology

This section of the report presents information on the stream types and flow data available in the two watersheds.

3.2.1 Stream Types

The National Hydrography Database (NHD) maintained by USEPA and USGS identifies only a few waterbodies in the two watersheds (Figure 3-2). The largest waterbody (other than the two lakes) is Hog Branch, portions of which are classified as a canal/ditch. Several intermittent and perennial streams are also located in the two watersheds (Table 3-1 and Figure 3-2).

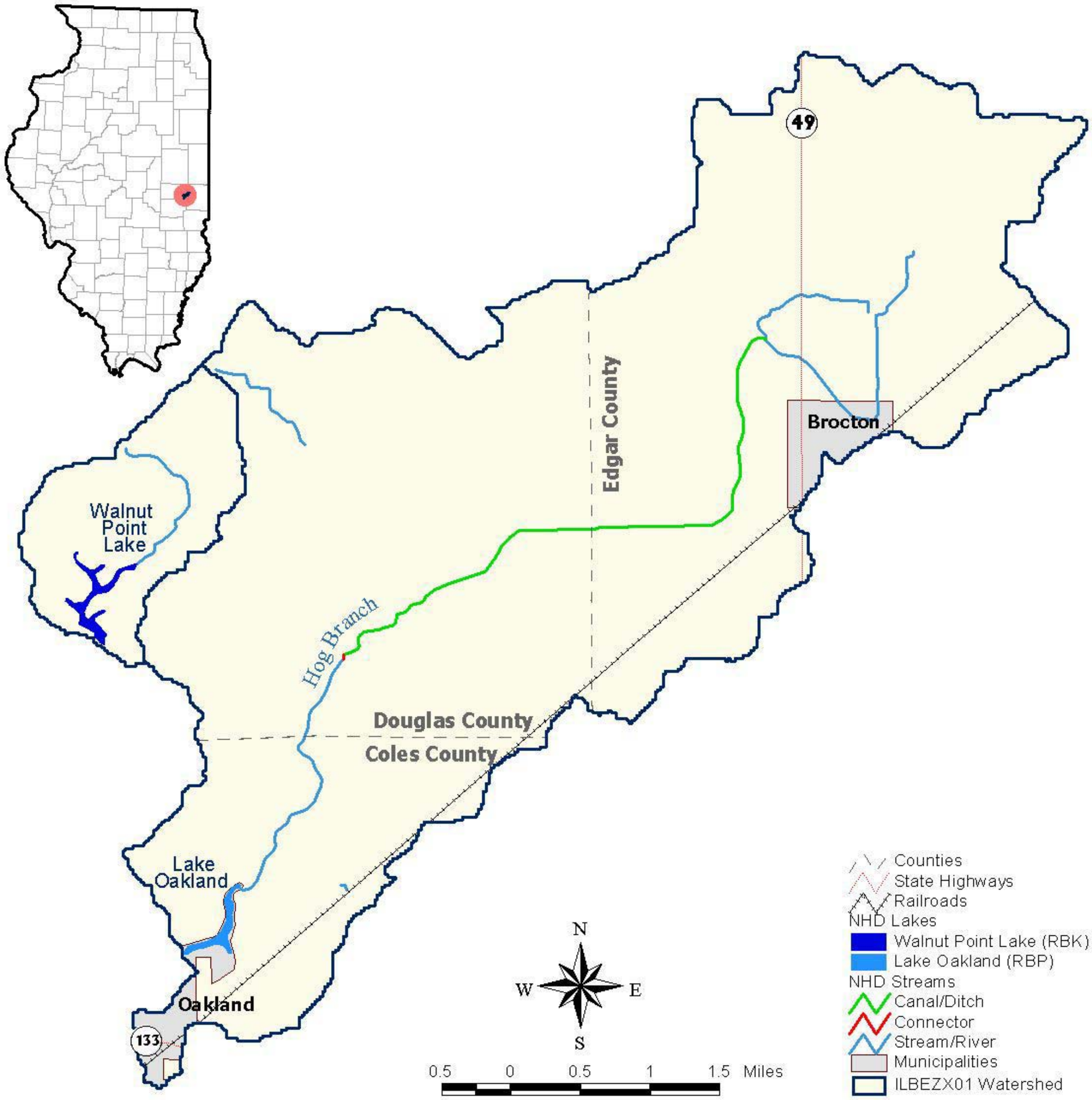

Figure 3-2. Stream types in the Lake Oakland and Walnut Point Lake Watersheds.

Table 3-1. Summary of Stream Types in the combined Lake Oakland and Walnut Point Lake Watershed.

Stream Type	Stream Length (ft)	Percent
Canal/Ditch	24,307	38.98
Intermittent Stream	18,193	29.17
Perennial Stream	11,311	18.14
Artificial Path	8,381	13.44
Connector	173	0.28
Total	62,364	100

3.2.2 Tile Drainage

Both the Lake Oakland and Walnut Point Lake watersheds are underlain by drain tile designed to remove standing water from the soil surface. Subsurface drainage is designed to remove excess water from the soil profile. The water table level is controlled through a series of drainage pipes (tile or tubing) that are installed below the soil surface, usually just below the root zone. In Illinois, subsurface drainage pipes are typically installed at a depth of 3 to 4 feet and at a spacing of 80 to 120 feet. The subsurface drainage network generally outlets to an open ditch or stream.

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

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

3.2.3 Flow Data

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

4 Inventory and Assessment of Water Quality Data

This section of the document presents the 2002 303(d) list information for the Lake Oakland and Walnut Point Lake watersheds followed by a description of the parameters of concern, the applicable water quality standards, and a review of water quality data for each waterbody.

4.1 Illinois 303(d) List Status

Both Lake Oakland and Walnut Point Lake are listed for total phosphorus (TP), excessive algal growth, suspended solids, and sedimentation/siltation. Walnut Point Lake is also listed for nitrates, dissolved oxygen, and aquatic plants (native) (Illinois EPA, 2002). These impairments result in both non- and partial-support of primary contact (swimming), secondary contact (recreation), and aquatic life designated uses.

4.2 Previous Studies

Several previous studies of Lake Oakland, Walnut Point Lake, and their respective watersheds have been conducted. A committee made up of the City of Oakland, local landowners, the Coles County Soil and Water Conservation District, the Edgar County Soil and Water Conservation District, and the Natural Resources Conservation Service released the Lake Oakland Watershed Management Plan in March 1997 (Lake Oakland Watershed Committee, 1997). The purpose of the plan was to improve water quality and quantity; reduce soil erosion; improve drainage in the watershed; improve wildlife and woodland habitat; create incentives for new programs; and promote a healthy and adequate water supply for the City of Oakland. Among the conclusions and recommendations of the Lake Oakland Watershed Management Plan are:

- Sheet and rill erosion is the largest source of erosion in the watershed.
- 29,000 tons of soil per year is lost in the watershed and 7,000 tons of soil per year enters the lake (based on a preliminary erosion inventory completed by the Natural Resources Conservation Service)
- Landowners are concerned that raising the lake water level could obstruct tile drainage from fields
- The report estimated that approximately $340,000 in conservation measures was needed to significantly reduce the rate and amount of soil erosion into Oakland Lake. The identified measures included: waterways, filter strips, terraces, nutrient and pesticide management, and ditch work.

The Illinois Department of Conservation also estimated erosion in the Walnut Point Lake watershed in 1985 (Shafer, 1985). Sediment yield to Walnut Point Lake was estimated at 3,584 tons annually which resulted in a lake volume loss of 2.5 acre feet per year. The sources of erosion were reported to be sheet and rill erosion (84%) megarill erosion (12%), and gully, streambank, and roadside erosion (4%).

4.3 Parameters of Concern

The following sections provide a summary of the parameters identified on Illinois 2002 303(d) list for Lake Oakland and Walnut Point Lake. The purpose of these sections of the report is to provide an overview of the parameters, units, sampling methods, and potential sources. The relevance of the parameter to the various beneficial uses is also briefly discussed.

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

The term *nutrients* usually refers to the various forms of nitrogen and phosphorus found in a waterbody. Both nitrogen and phosphorus are necessary for aquatic life, and both elements are needed at some level in a waterbody to sustain life. The natural amount of nutrients in a waterbody varies depending on the type of system. A pristine mountain spring might have little to almost no nutrients, whereas a lowland, mature stream flowing through wetland areas might have naturally high nutrient concentrations. Various forms of nitrogen and phosphorus can exist at one time in a waterbody, although not all forms can be used by aquatic life. Common phosphorus sampling parameters are total phosphorus (TP), dissolved phosphorus, and orthophosphate. Common nitrogen sampling parameters are total nitrogen (TN), nitrite (NO_2), nitrate (NO_3), total Kjeldahl nitrogen (TKN), and ammonia (NH_3). Concentrations are measured in the lab and are typically reported in milligrams per liter.

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

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

4.3.2 Suspended Solids and Sedimentation/Siltation

Excess total suspended solids (TSS) in a stream or lake can pose a threat to aquatic organisms. Turbid waters created by excess TSS concentrations reduce light penetration, which can adversely affect aquatic organisms. TSS can also interfere with fish feeding patterns because of the turbidity. Prolonged periods of very high TSS concentrations can be fatal to aquatic organisms (Newcombe and Jensen, 1996). As TSS settles to the bottom of a stream, critical habitats such as spawning sites and macroinvertebrate habitats can be covered in sediment. This is referred to as *siltation*. Excess sediment in a stream bottom can reduce dissolved oxygen concentrations in stream bottom substrates, and it can reduce the quality and quantity of habitats for aquatic organisms. TSS can also pose a threat to recreational uses because of murky conditions.

Erosion and overland flow contribute some natural TSS to most streams and lakes. In watersheds with highly erodible soils and steep slopes, natural TSS concentrations can be very high. Excess TSS in overland flow can occur when poor land use and land cover practices are in place. This potentially includes grazing, row crops, construction activities, road runoff, and mining. Grazing and other practices that can degrade stream channels are other possible sources of TSS. Shoreline erosion in lakes can contribute significant TSS loads due to wave action.

4.4 Applicable Water Quality Standards

A description of the designated use support for waters within Illinois and a narrative of Illinois EPA's water quality standards are presented in this section. Additionally, numeric water quality criteria for the parameters of interest in this TMDL are provided.

4.4.1 Use Support Guidelines

To assess the designated use support for Illinois waterbodies the Illinois EPA uses rules and regulations adopted by the Illinois Pollution Control Board (IPCB). The General Use Standards apply to both Lake Oakland and Walnut Point Lake.

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

4.4.2 Numeric Standards

Numeric water quality standards for the State of Illinois for general use and public and food processing and water supply are presented in Table 4-1. These standards form the basis for determining whether the lakes are currently impaired and will also be used in the development of any necessary TMDLs.

Table 4-1. Illinois Numeric Water Quality Standards

Parameter	Units	General Use
Nutrients/Organic Enrichment/Low DO/Excessive Algal Growth		
Total Phosphorus[1]	mg/L	0.05
Nitrates	mg/L	None
Dissolved Oxygen	mg/L	5.0 minimum
Chlorophyll-a	μg/L	None
Sedimentation/Siltation		
Sedimentation/Siltation		None
Total Suspended Solids		
Total Suspended Solids		None

[1]The total phosphorus standard applies to all depths but is typically assessed using only the sample taken at one foot.

4.5 Water Quality Data Assessment

Water quality data for Lake Oakland and Walnut Point Lake were downloaded from the STORET and USGS NWIS databases and were also provided by Illinois EPA. The locations of the monitoring stations within the watershed are shown in Figure 4-1. Data are only available for the two lakes and a closer view of the lake monitoring stations is shown in Figure 4-2. An analysis of the available water quality data important to the TMDL development process is presented in this section.

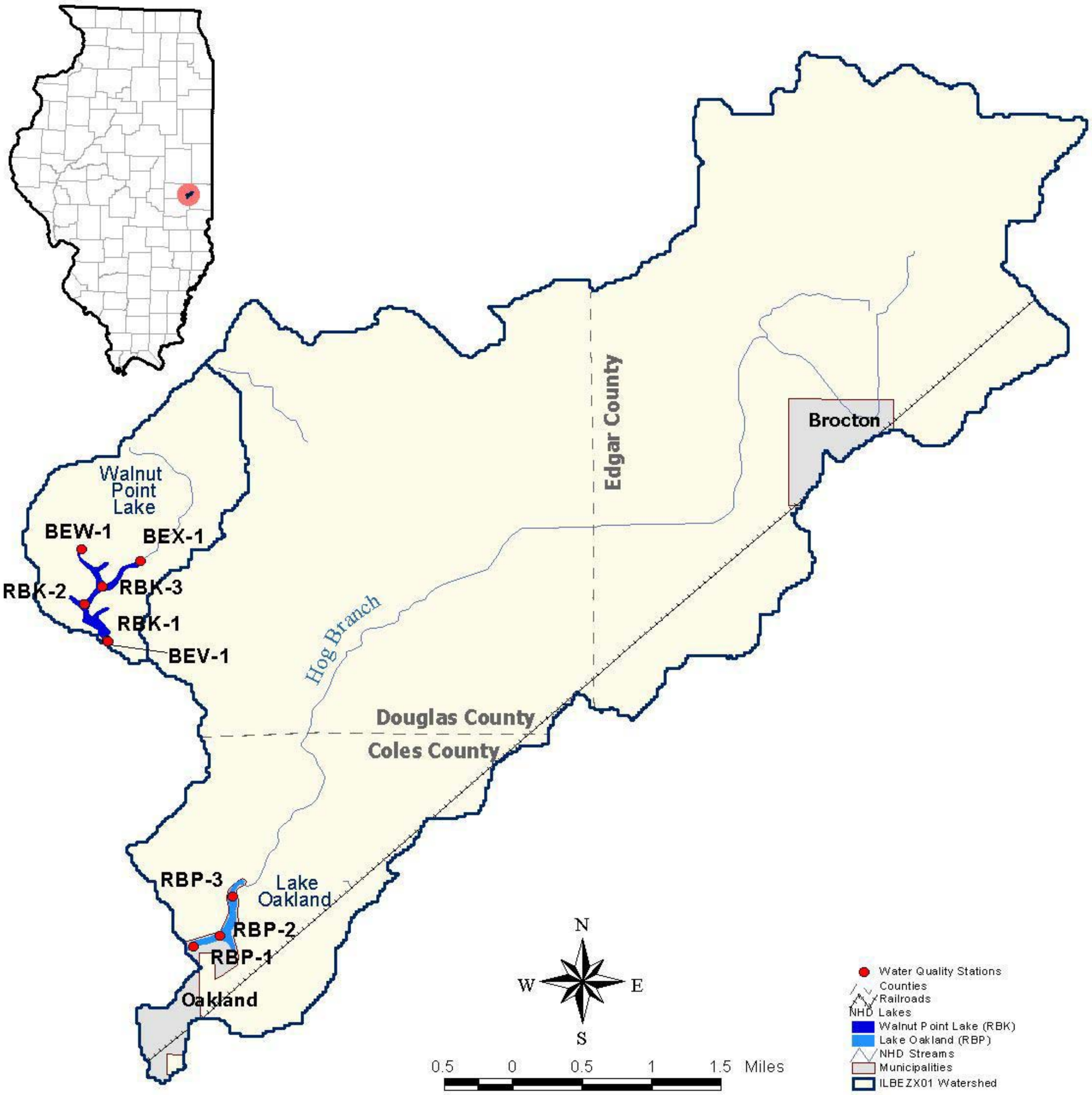

Figure 4-1. Monitoring stations in the Lake Oakland and Walnut Point Lake watersheds.

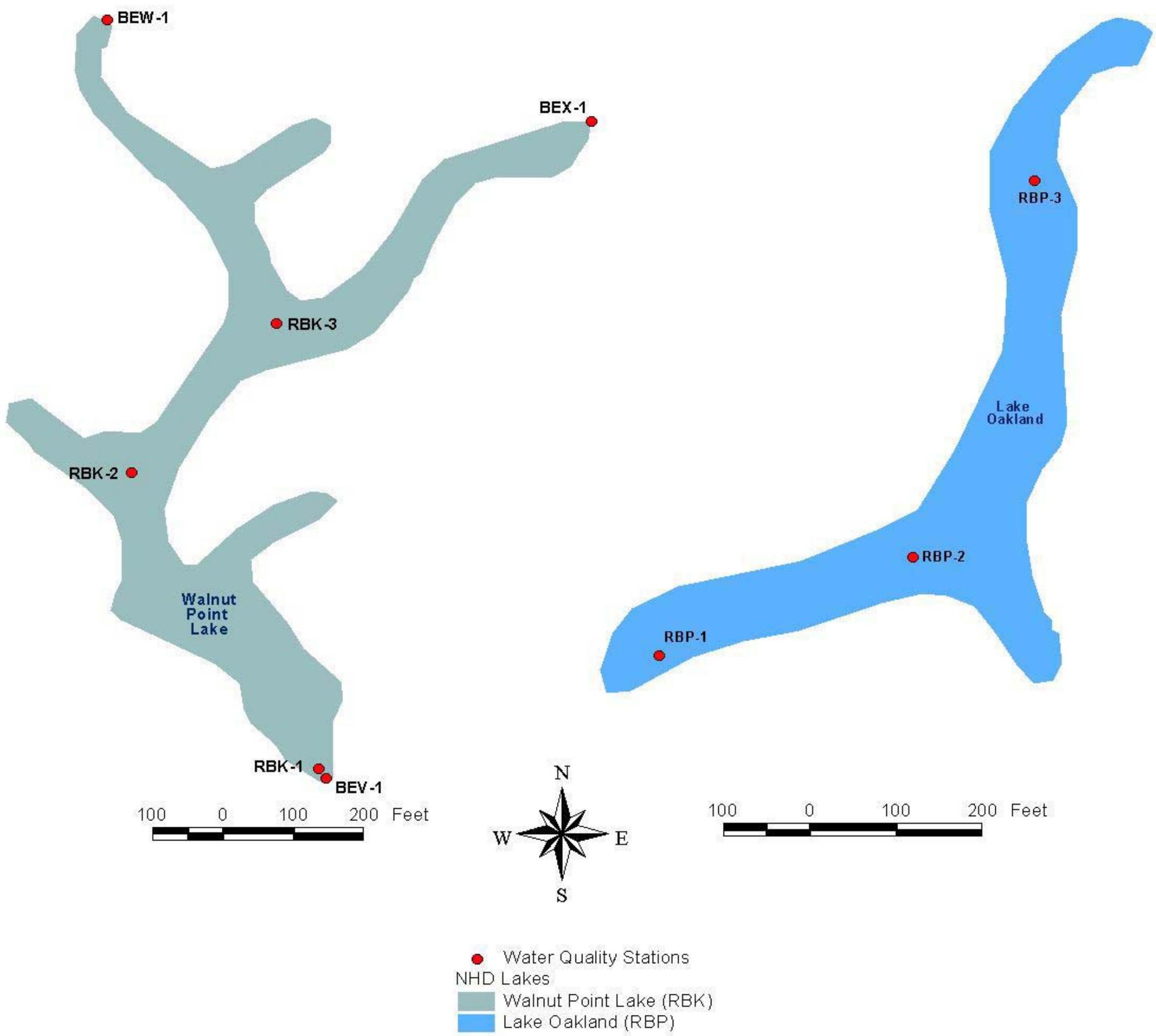

Figure 4-2. Monitoring stations in Lake Oakland and Walnut Point Lake.

4.5.1 Lake Oakland (Segment RBP)

Lake Oakland is a shallow 27.6 acre lake listed as being impaired due to total phosphorus, excessive algal growth, suspended solids, and sedimentation/siltation. The available water quality data are summarized below.

4.5.1.1 Total Phosphorus

Table 4-2 summarizes the available total phosphorus and other nutrient data for Lake Oakland. The available dissolved and total phosphorus data are also shown graphically in Figure 4-3. Data are available for the period 1981 to 2001 and no increasing or decreasing trend in TP concentrations is apparent, although the oldest data exhibit the lowest concentrations. Almost all of the samples exceed the 0.05 mg/L TP water quality standard, including all samples taken during the past six years (Table 4-3).

Table 4-2. Summary of total phosphorus and other nutrient-related parameters for Lake Oakland.

Parameter	Samples (Count)	Start	End	Minimum (mg/L)	Average (mg/L)	Maximum (mg/L)	CV*
Total Phosphorus	80	6/3/1981	10/15/2001	0.01	0.18	0.49	0.66
Dissolved Phosphorus	46	6/3/1981	10/15/2001	0.00	0.06	0.37	1.56

*CV = standard deviation/average

Table 4-3. Violations of the TP standard in Lake Oakland.

Parameter	Samples (Count)	Violations (Count)	Percent Violating	Samples (Count), 1998 to Present	Violations (Count), 1998 to present	Percent Violating, 1998 to Present
Total Phosphorus (All Depths)	80	77	96%	39	39	100%
Total Phosphorus (1-Foot Depth)	71	68	96%	31	31	100%

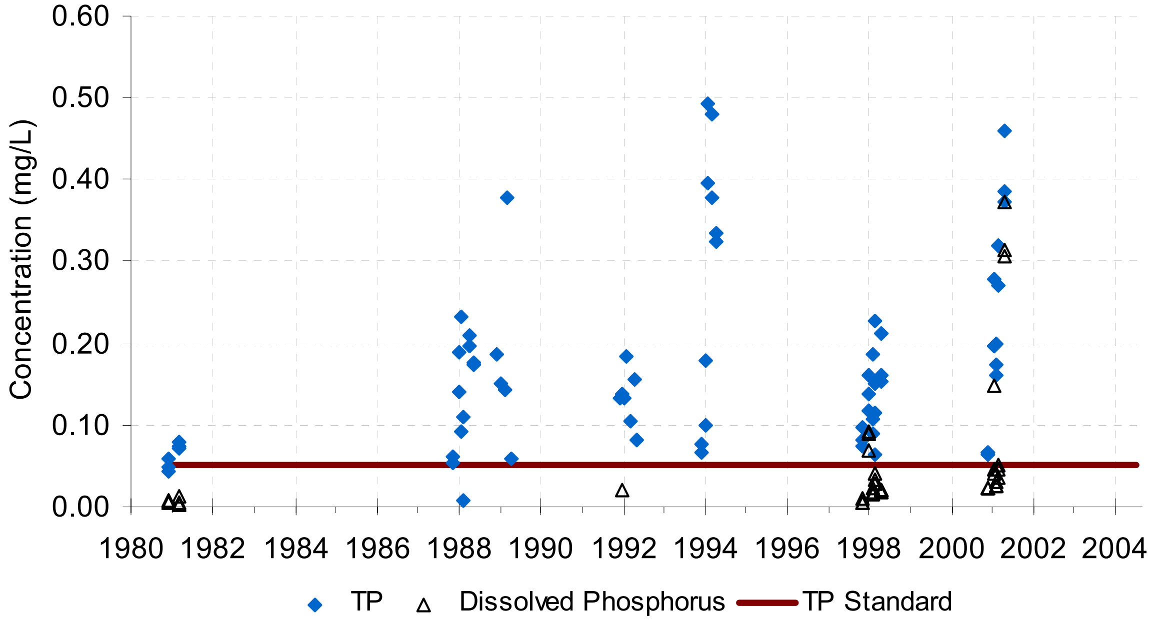

Figure 4-3. All total and dissolved phosphorus data for Lake Oakland.

Monthly median and mean TP concentrations for the period of record are presented in Figure 4-4 and Figure 4-5. Data are not available for the winter. The figure shows that the water quality standard of 0.05 mg/L is exceeded in all months. Additionally, median and mean monthly TP concentrations display seasonal variability, increasing from May to July, declining in August, and increasing again in September and October. Figure 4-5 indicates that the limited TP samples at depths greater than one foot increase consistently from May to October.

The dissolved phosphorus data exhibit a similar pattern (Figure 4-6 and Figure 4-7), although fewer data are available.

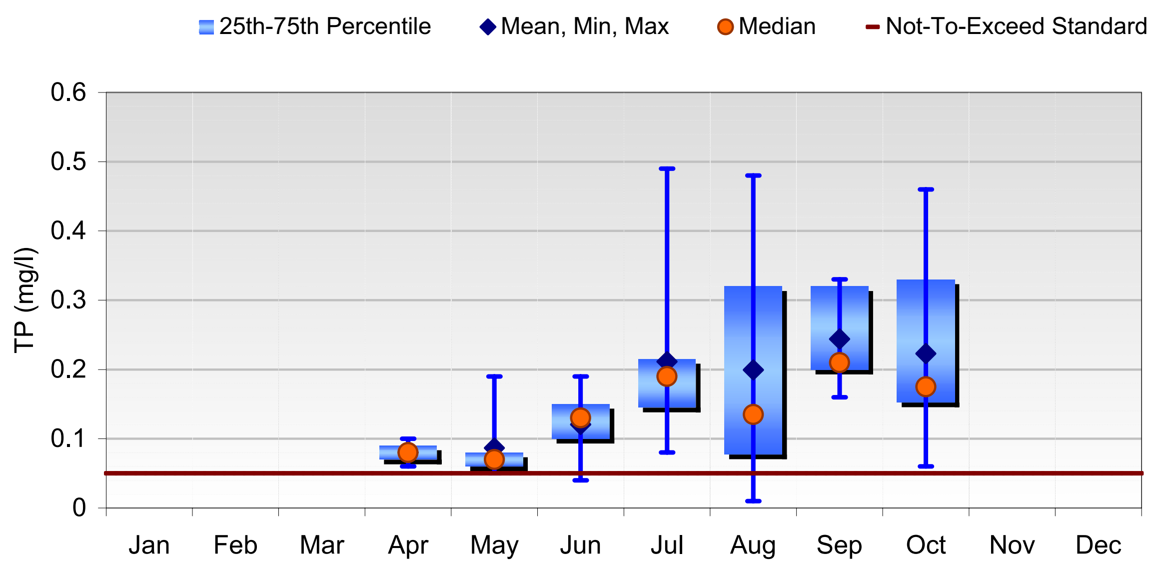

Figure 4-4. Seasonal variation of total phosphorus in Lake Oakland (all data at 1-foot depth).

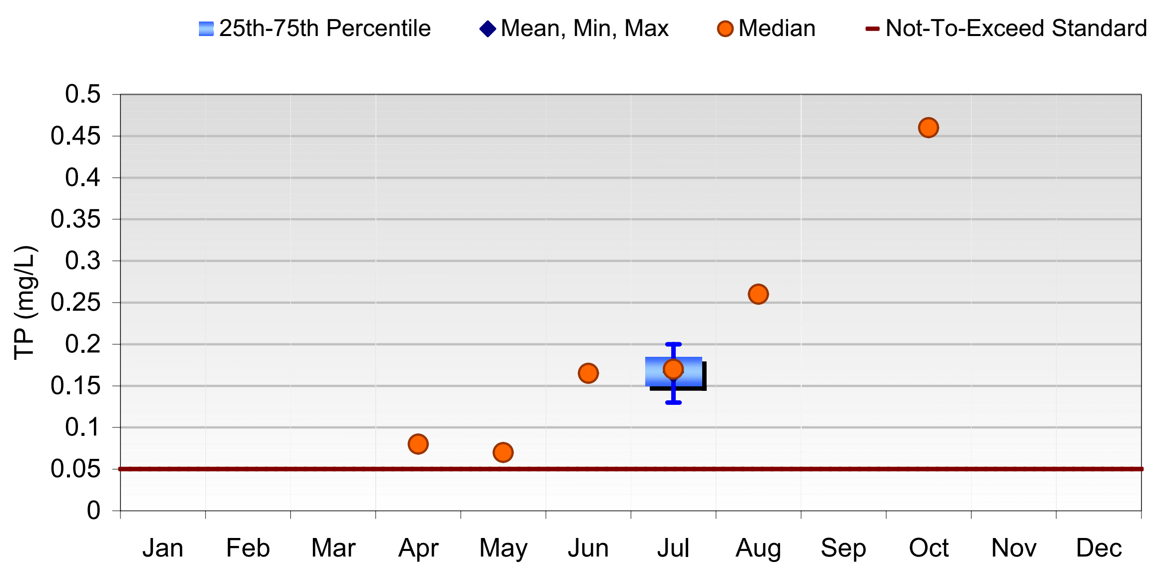

Figure 4-5. Seasonal variation of total phosphorus in Lake Oakland (all data at greater than 1-foot depth).

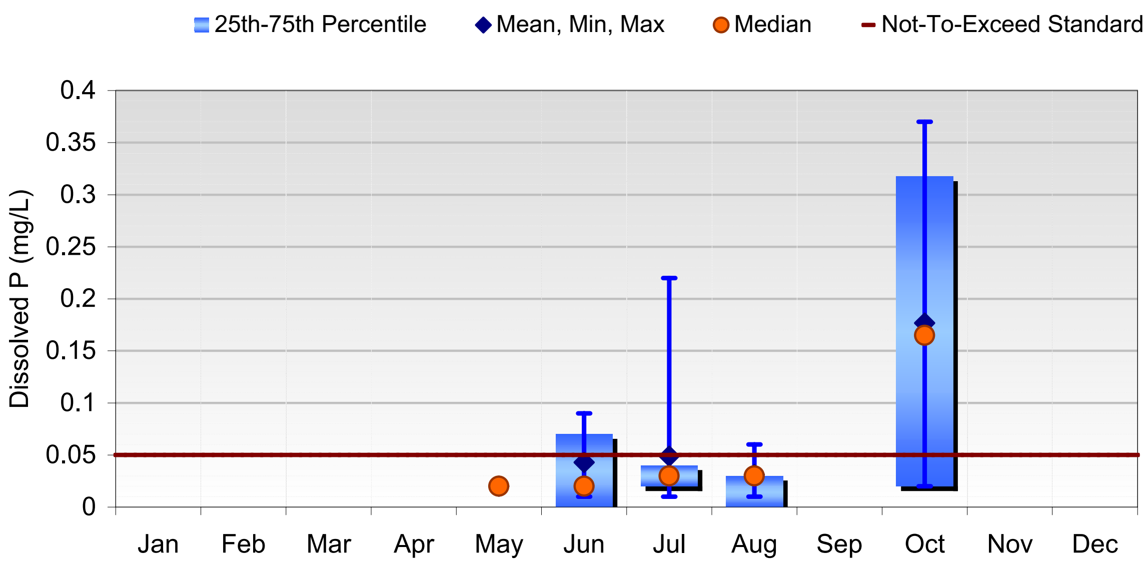

Figure 4-6. Seasonal variation of dissolved phosphorus in Lake Oakland (all data at 1-foot depth).

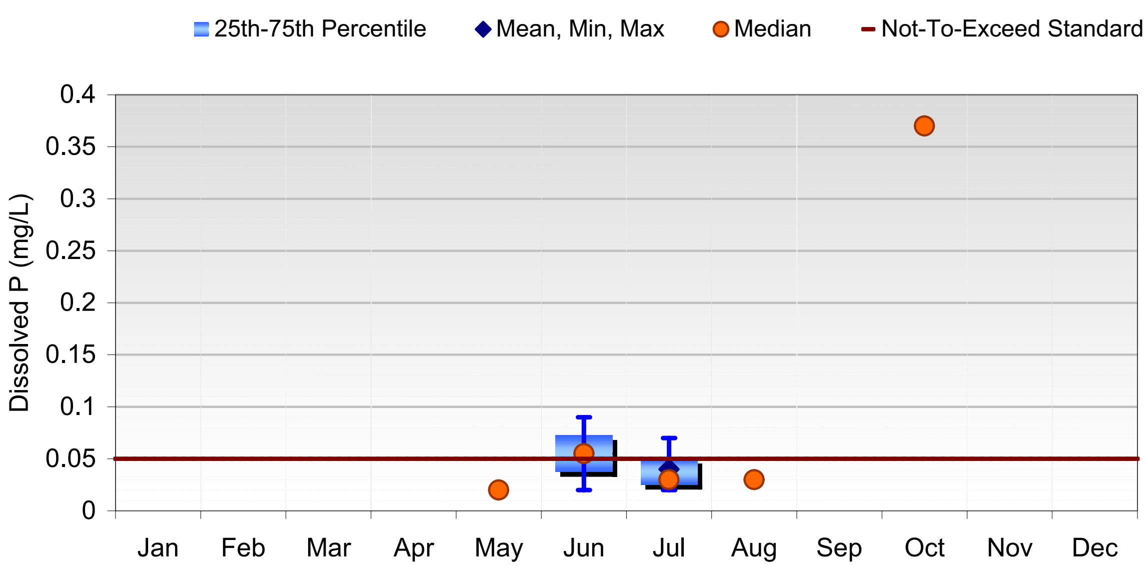

Figure 4-7. Seasonal variation of dissolved phosphorus in Lake Oakland (all data at greater than 1-foot depth).

Dissolved phosphorus as a proportion of total phosphorus can be an important value because it can often be used to help determine the source of the phosphorus loading. Samples that are relatively high in dissolved phosphorus can indicate anthropogenic sources such as wastewater treatment plants, failing septic systems, or fertilizer drained through agricultural tiles. Samples that are relatively low in dissolved phosphorus (and thus high in particulate phosphorus) are more likely to indicate sources associated with soil erosion.

Comparisons of dissolved and total phosphorus concentrations are shown in Figure 4-8 and Figure 4-9. The data indicate that dissolved phosphorus is a relatively small fraction of total phosphorus for all months except October (Figure 4-8). This could be due algal uptake. However, there appears to be a great deal of variability in the relationship (Figure 4-9).

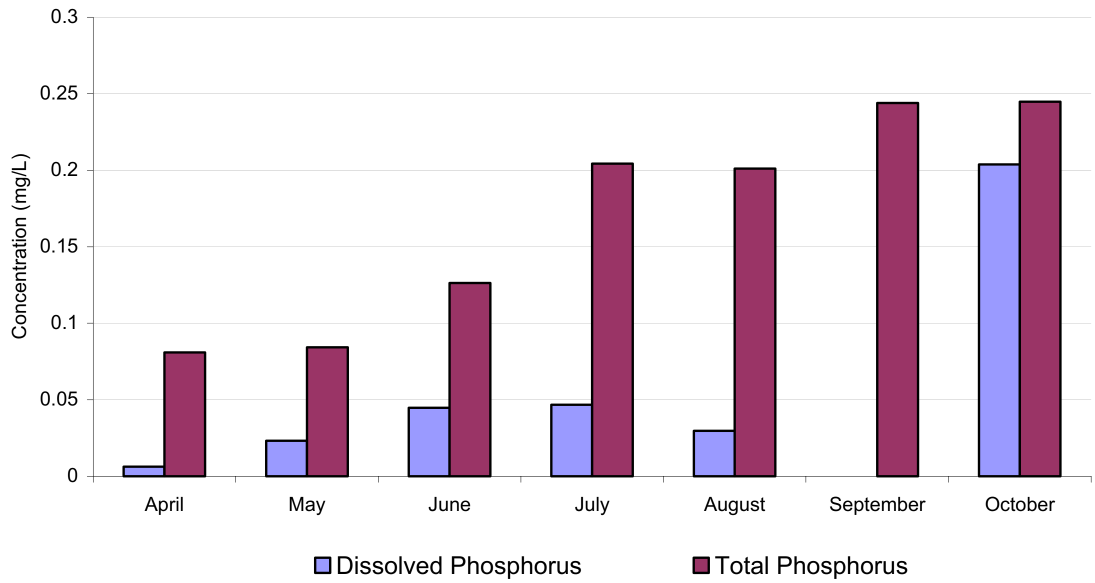

Figure 4-8. Comparison of seasonal dissolved and total phosphorus data for Lake Oakland (all data).

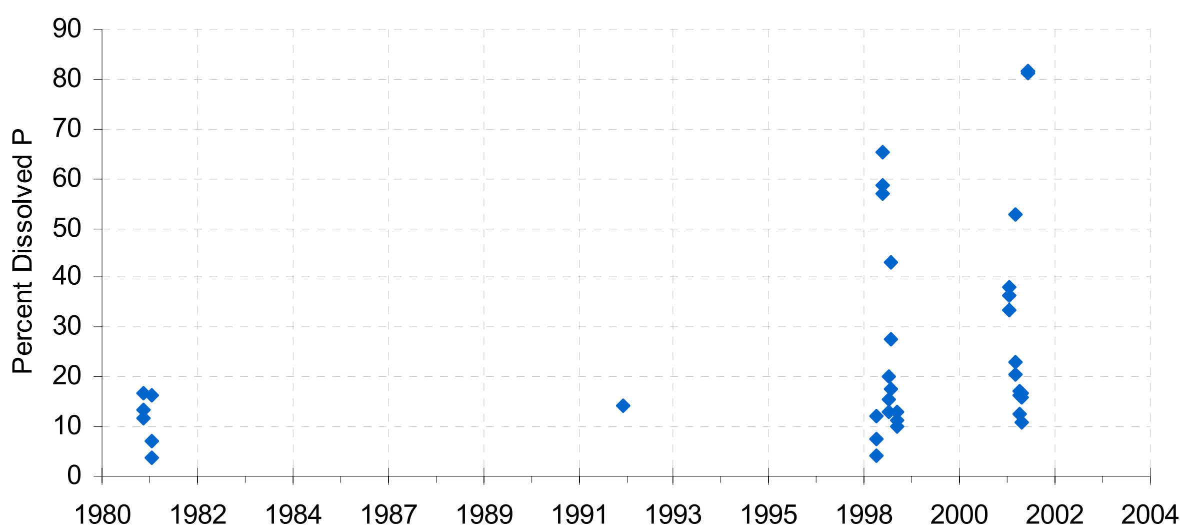

Figure 4-9. Proportion of dissolved phosphorus for Lake Oakland.

4.5.1.2 Total Nitrogen (TN)-to-Total Phosphorus (TP) Ratio

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

The TN:TP ratios in Lake Oakland are presented in Figure 4-10. TN:TP ratios are somewhat variable over the period of record but are generally much higher than 10. This suggests that phosphorus is the limiting nutrient in Lake Oakland. The high variability might be due to multiple algal species (some that are nitrogen limited and some that are phosphorus limited) outcompeting one another during different periods of the year.

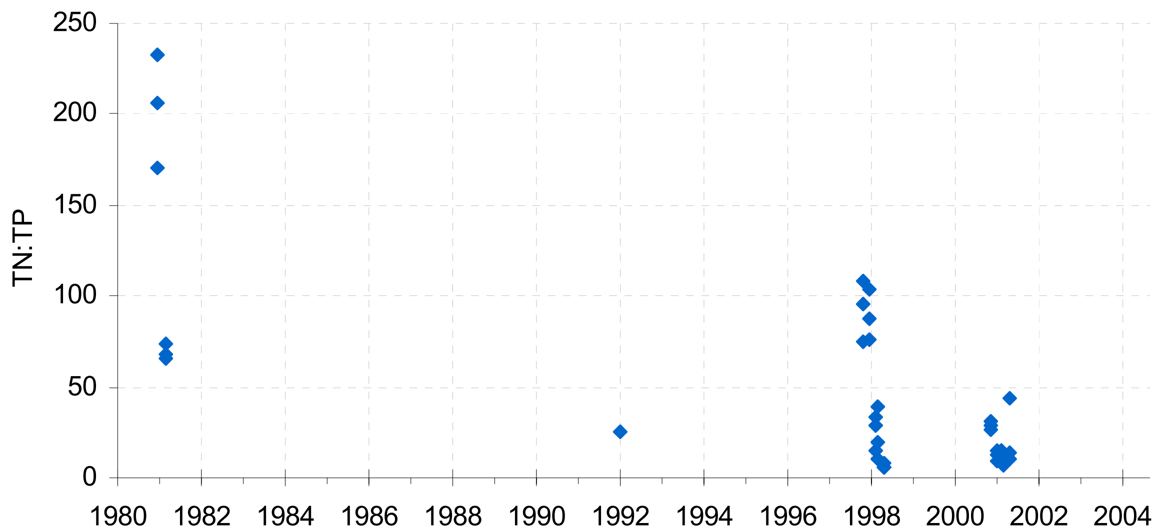

Figure 4-10. TN:TP ratios over the period of record in Lake Oakland.

4.5.1.3 Excessive Algal Growth

The dominant pigment in algal cells is chlorophyll-a, which is easy to measure and is a valuable surrogate measure for algal biomass. Chlorophyll-a is desirable as an indicator because algae are either the direct (e.g. nuisance algal blooms) or indirect (e.g. high/low dissolved oxygen, pH, and high turbidity) cause of most problems related to excessive nutrient enrichment. The Illinois water quality standard for general use states that "waters of the state shall be free from algal growth of other than natural origin" (Section 302.203).

Table 4-4 presents a summary of the chlorophyll-a data collected in Lake Oakland. Figure 4-11 displays the data graphically and indicates that recent values are greater than data from the early 1980s. Monthly median and mean chlorophyll-a concentrations are presented in Figure 4-12, which shows that chlorophyll-a concentrations are highest in August. The relationship between TP and chlorophyll-a is displayed in Figure 4-13 and the relationship between TSS and chlorophyll-a is displayed in Figure 4-14. The figures indicate that there is a weak positive relationship between both TP and chlorophyll-a and TSS and chlorophyll-a.

Table 4-4. Summary of chlorophyll-a data for Lake Oakland.

Parameter	Samples (Count)	Start	End	Minimum (µg/L)	Average (µg/L)	Maximum (µg/L)	CV*
Chlorophyll-a	34	6/3/1981	10/15/2001	2.32	62.31	248.31	0.88

*CV = standard deviation/average

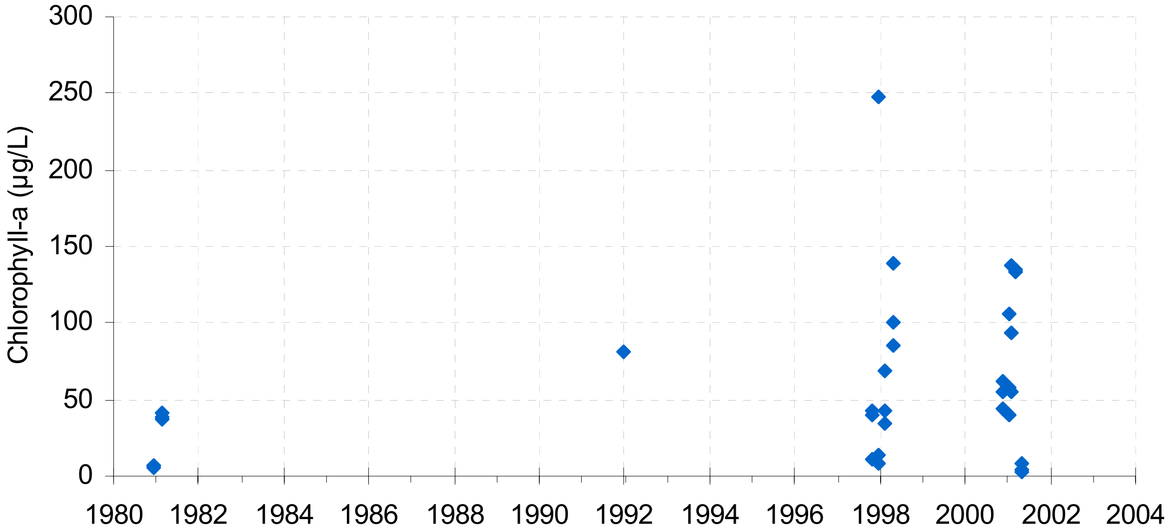

Figure 4-11. All chlorophyll-a data for Lake Oakland.

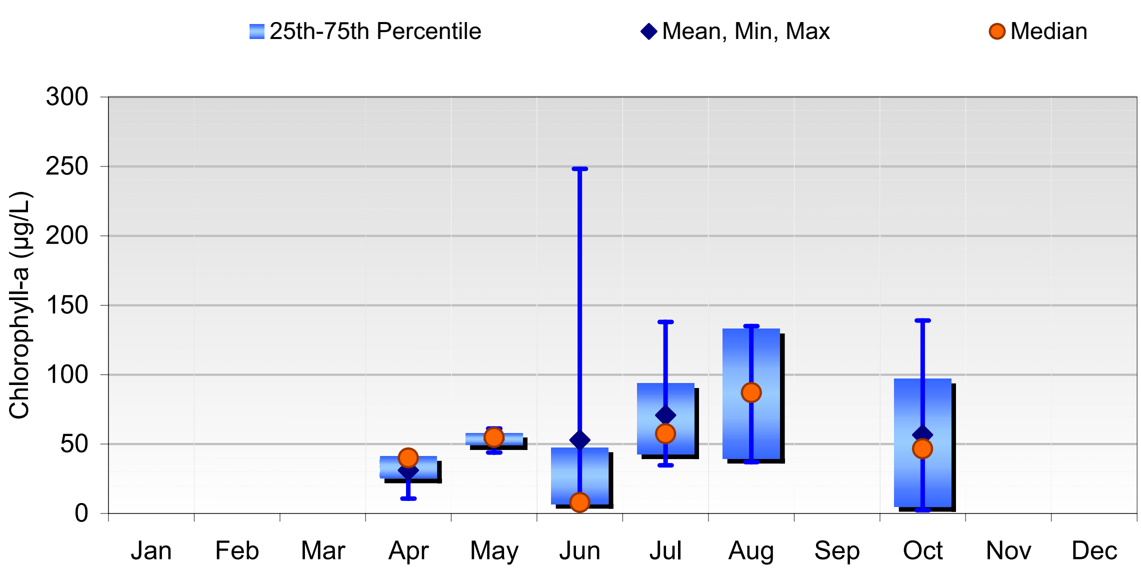

Figure 4-12. Seasonal variation of chlorophyll-a for Lake Oakland (all data).

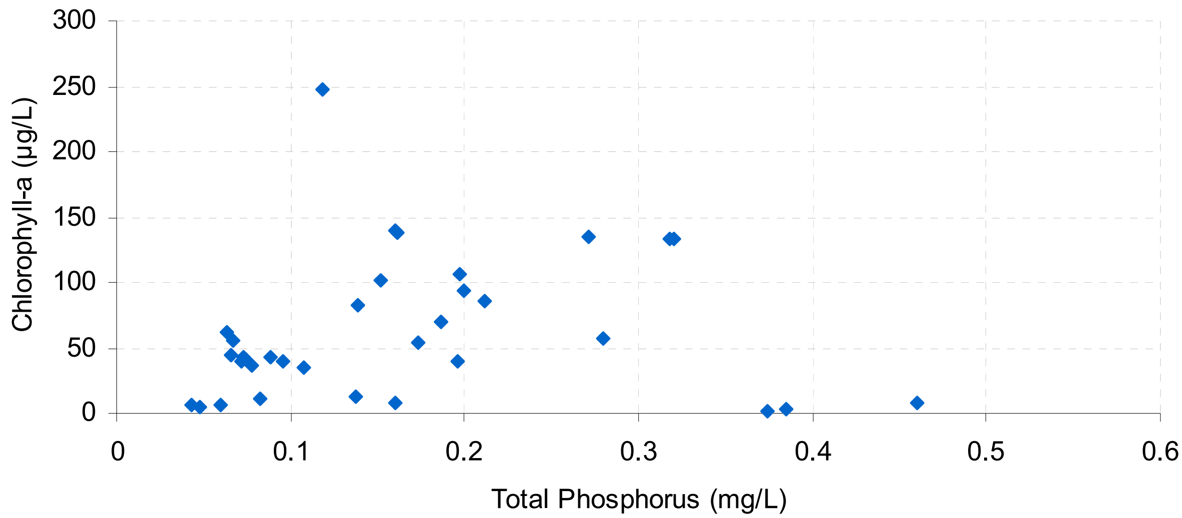

Figure 4-13. Correlation between TP and chlorophyll-a for Lake Oakland.

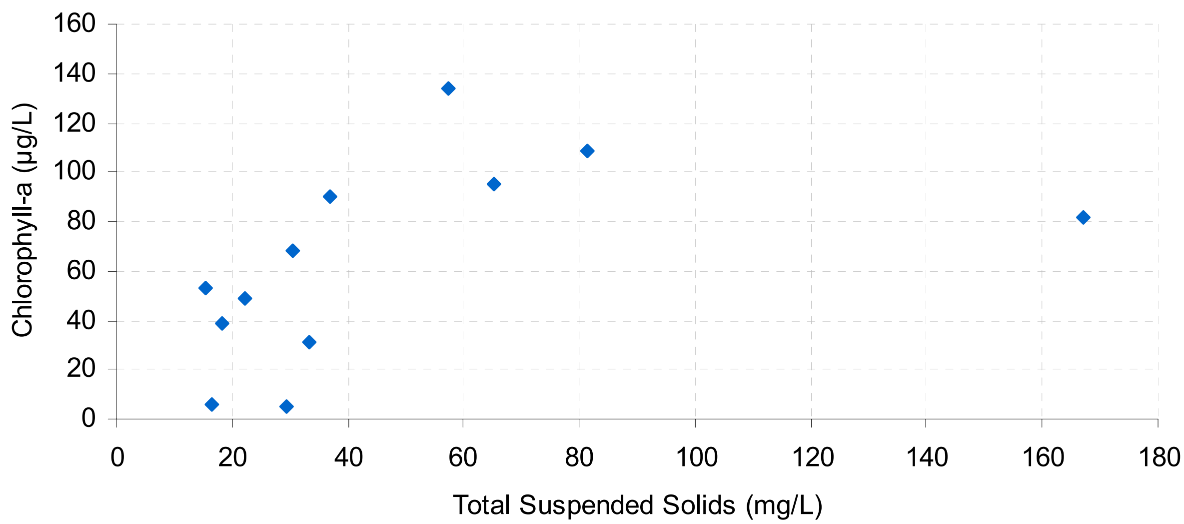

Figure 4-14. Correlation between TSS and chlorophyll-a for Lake Oakland.

Carlson developed a frequently used biomass-related trophic status index in 1977. His trophic status index (TSI) uses Secchi depth (SD), chlorophyll-a (Chl) and TP, each producing an independent measure of trophic state. Index values range from approximately 0 (ultraoligotrophic) to 100 (hypereutrophic). The index is scaled so that TSI = 0 represents secchi depth transparency of 64 meters. Each halving of transparency represents an increase of 10 TSI units. For example, a TSI of 50 represents a transparency of 2 meters. A TSI is calculated from each of secchi depth, chlorophyll *a* concentration, and TP concentration (Carlson, 1977; Carlson and Simpson, 1996). Each variable is used to estimate algal biomass independently, and the values should not be averaged (Carlson, 1983). Chlorophyll-a is a better predictor of trophic state than either of the other two variables.

The long-term average chlorophyll-a concentration for Lake Oakland (62 µg/L) results in a Carlson TSI of 71. This value is indicative of hyper-eutrophic conditions. TSI values above 60 suggest the presence of blue-green algae during the summer, algal scum, and a considerable macrophyte problem.

4.5.1.4 Suspended Solids

The total suspended solids (TSS) data for Lake Oakland are summarized in Table 4-5 and are shown in Figure 4-15. Data are available for the period 1981 to 2001 and no long-term increasing or decreasing trends are apparent. Monthly median and mean TSS concentrations are presented in Figure 4-16 and indicate that concentrations typically increase during the summer and peak in September. There is also a high degree of variability in observed TSS concentrations.

Table 4-5. Summary of suspended solids data for Lake Oakland.

Parameter	Samples (Count)	Start	End	Minimum (mg/L)	Average (mg/L)	Maximum (mg/L)	CV*
Suspended Solids	80	6/3/1981	10/15/2001	4.00	40.44	178.00	0.85

*CV = standard deviation/average

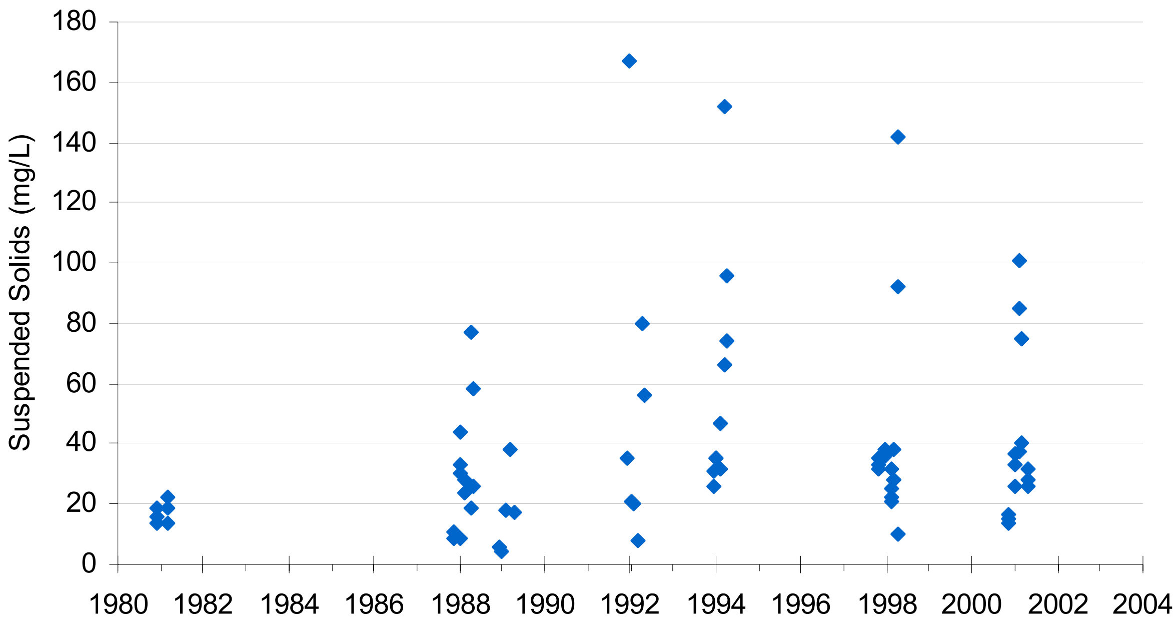

Figure 4-15. All suspended solids data for Lake Oakland.

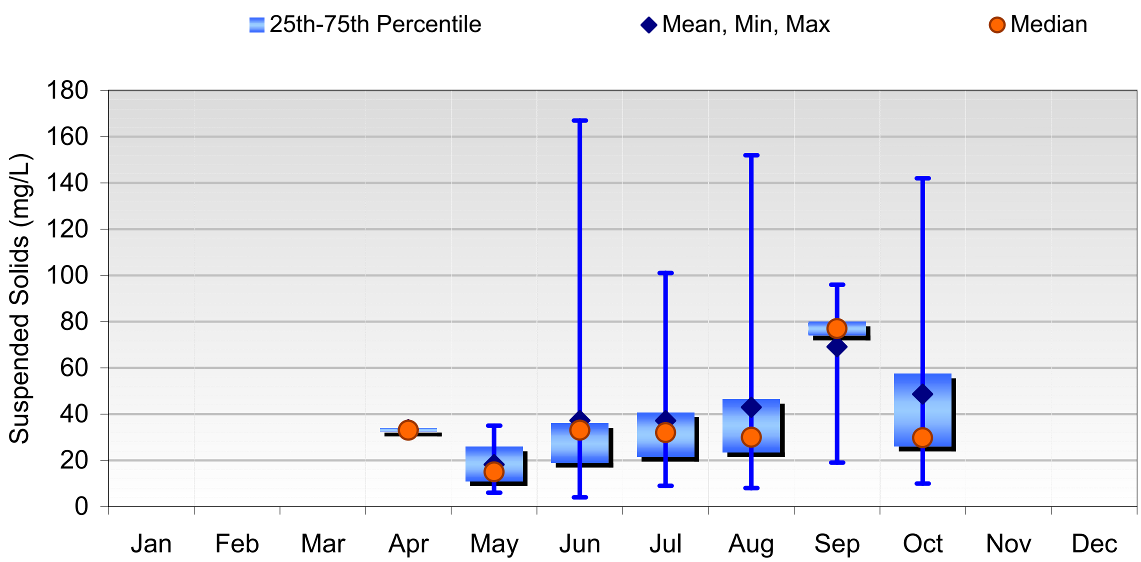

Figure 4-16. Seasonal variation in suspended solids data for Lake Oakland (all data).

4.5.2 Walnut Point Lake (Segment RBK)

Walnut Point Lake is a 41.6 acre lake listed as impaired due total phosphorus, nitrate, sedimentation/siltation, suspended solids, dissolved oxygen, native aquatic plants, and excess algal growth. The fishery is good with high catch rates of bass and bluegill (Mike Mounce, Illinois Department of Natural Resources, personal communications, October 26, 2004). The available water quality data are summarized below.

4.5.2.1 Total Phosphorus

Table 4-6 summarizes the available dissolved phosphorus and total phosphorus data for Walnut Point Lake. The available TP data are also shown graphically in Figure 4-17 and indicate a slight increasing trend. Data are only available for the period 1979 to 1995 and more than 75 percent of the samples exceed the 0.05 mg/L TP water quality standard (Table 4-7). Seasonal concentrations of dissolved and total phosphorus do not exhibit any apparent pattern (Figure 4-18 to Figure 4-21), although samples taken at deeper depths have considerably higher TP and dissolved phosphorus concentrations.

Table 4-6. Summary of total phosphorus and other nutrient-related parameters for Walnut Point Lake.

Parameter	Samples (Count)	Start	End	Minimum (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
Dissolved Phosphorus	56	6/18/1979	10/4/1995	0.00	0.23	2.45	2.26
Total Phosphorus	57	6/18/1979	10/4/1995	0.02	0.28	2.88	2.02

*CV = standard deviation/average

Table 4-7. Violations of the TP standard in Walnut Point Lake.

	Samples (Count)	Violations (Count)	Percent Violating	Samples (Count), 1998 to Present	Violations (Count), 1998 to present	Percent Violating, 1998 to Present
Total Phosphorus (All Depths)	57	44	77%	0	NA	NA
Total Phosphorus (1-Foot Depth)	40	30	75%	0	NA	NA

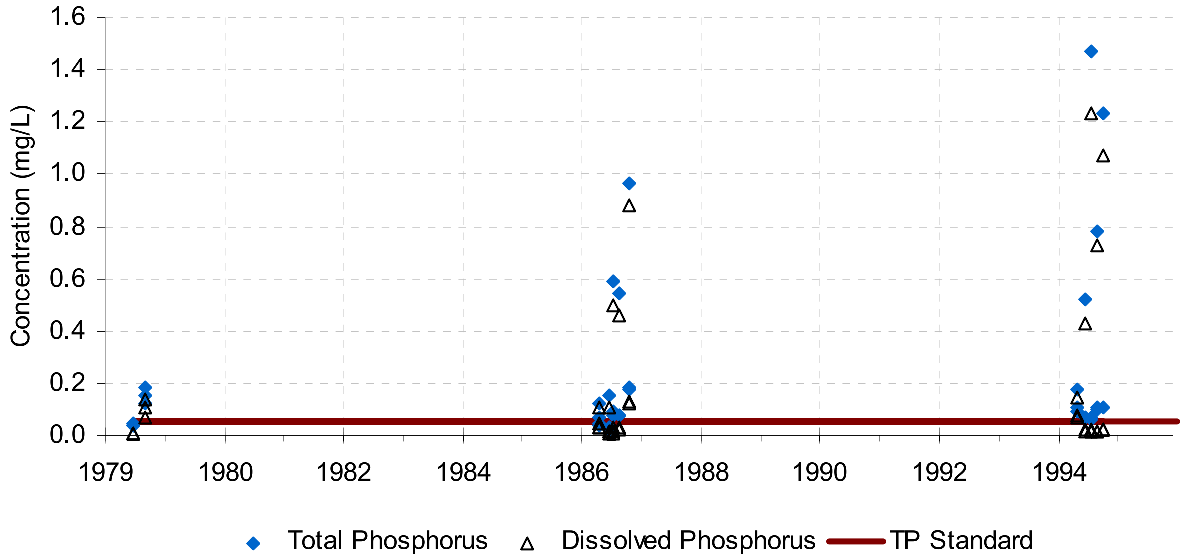

Figure 4-17. All total phosphorus and dissolved phosphorus data for Walnut Point Lake.

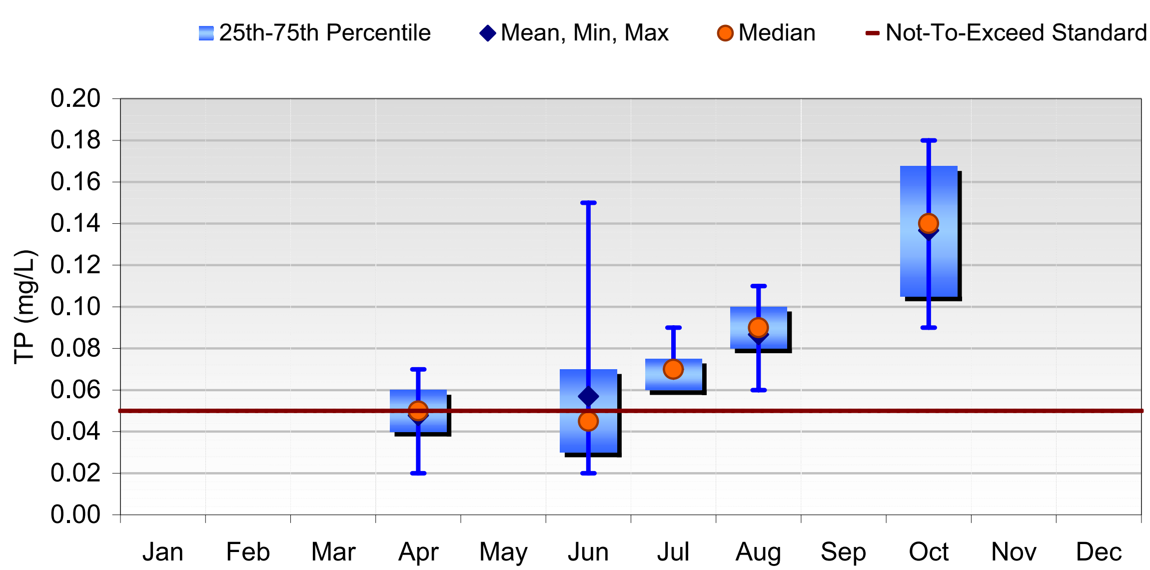

Figure 4-18. Seasonal variation of TP in Walnut Point Lake (all data at 1-foot depth).

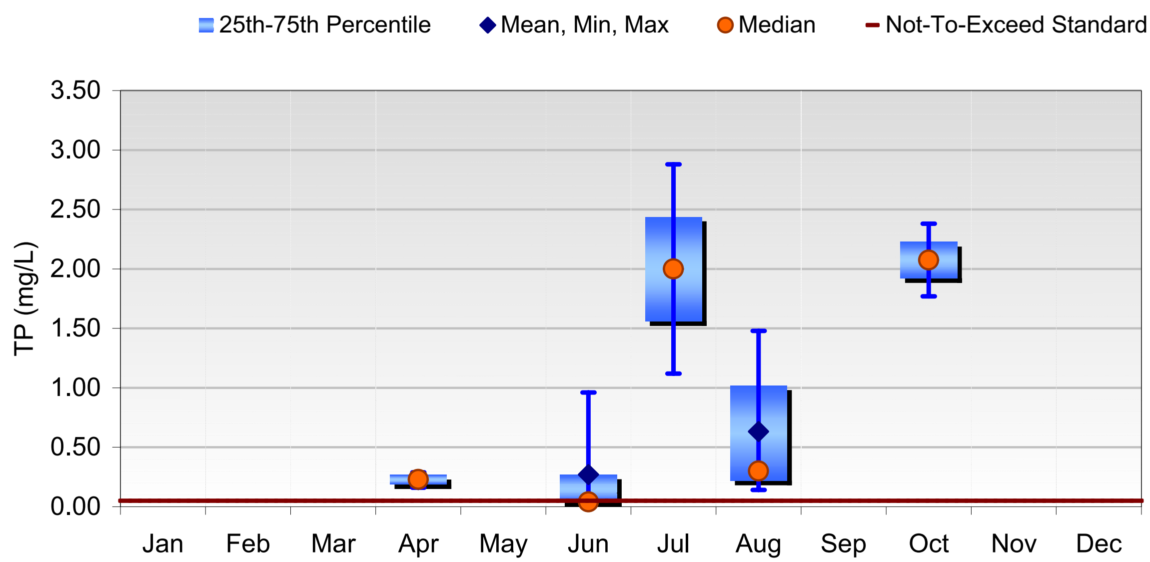

Figure 4-19. Seasonal variation of TP in Walnut Point Lake (all data at greater than 1-foot depth).

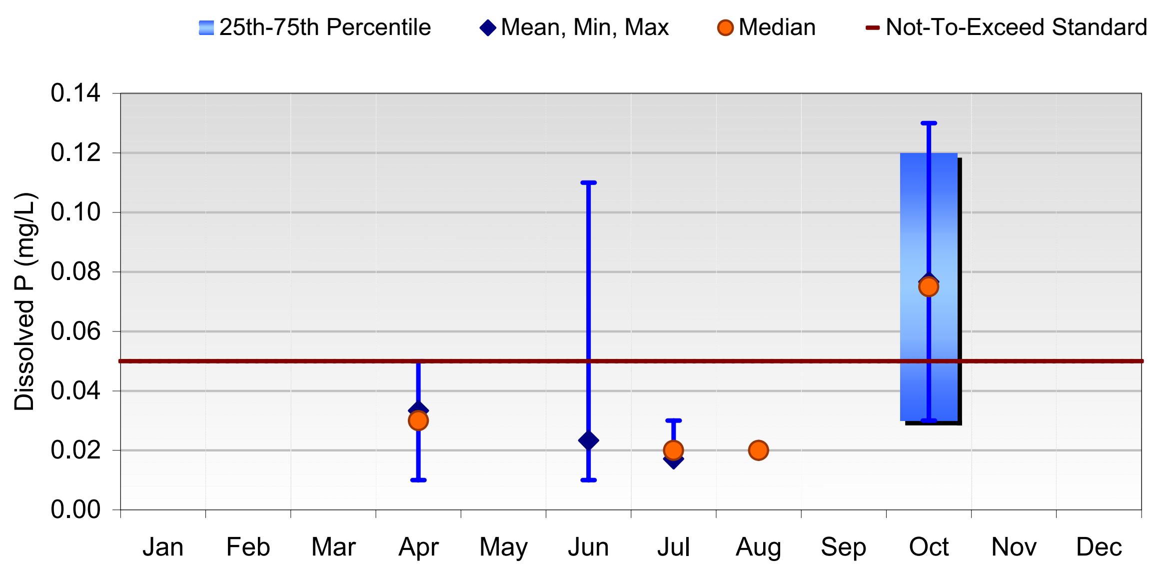

Figure 4-20. Seasonal variation of dissolved phosphorus in Walnut Point Lake (all data at 1-foot depth).

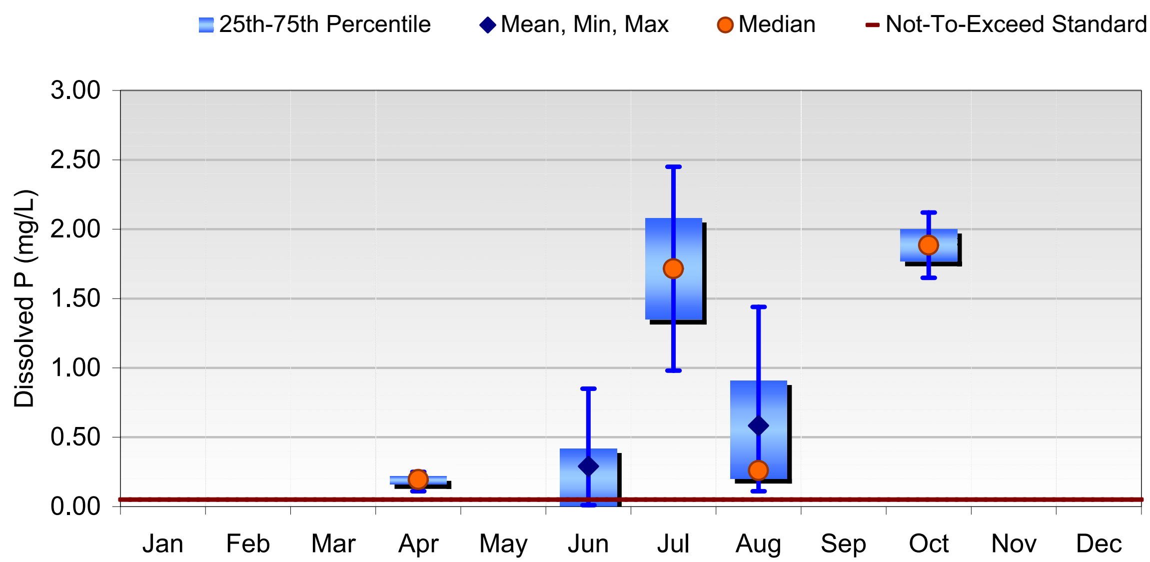

Figure 4-21. Seasonal variation of dissolved phosphorus in Walnut Point Lake (all data at greater than 1-foot depth).

Figure 4-22 and Figure 4-23 display the relationship between dissolved and total phosphorus in Walnut Point Lake. The data indicate that dissolved phosphorus is a much higher proportion of total phosphorus compared to Lake Oakland.

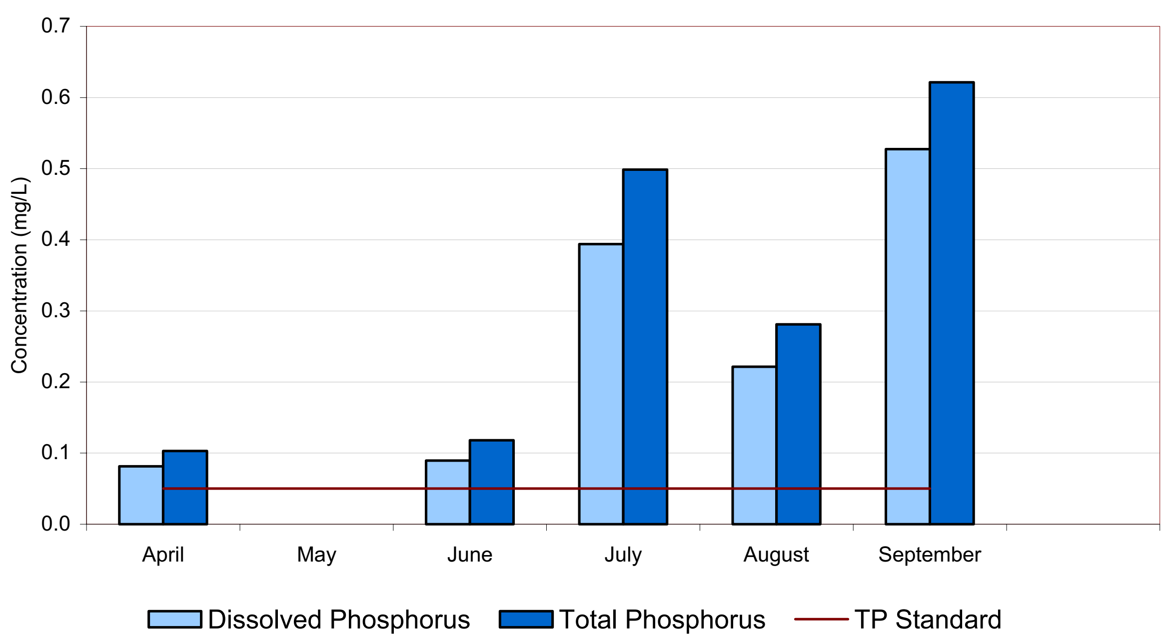

Figure 4-22. Comparison of seasonal dissolved and total phosphorus data for Walnut Point Lake (all data).

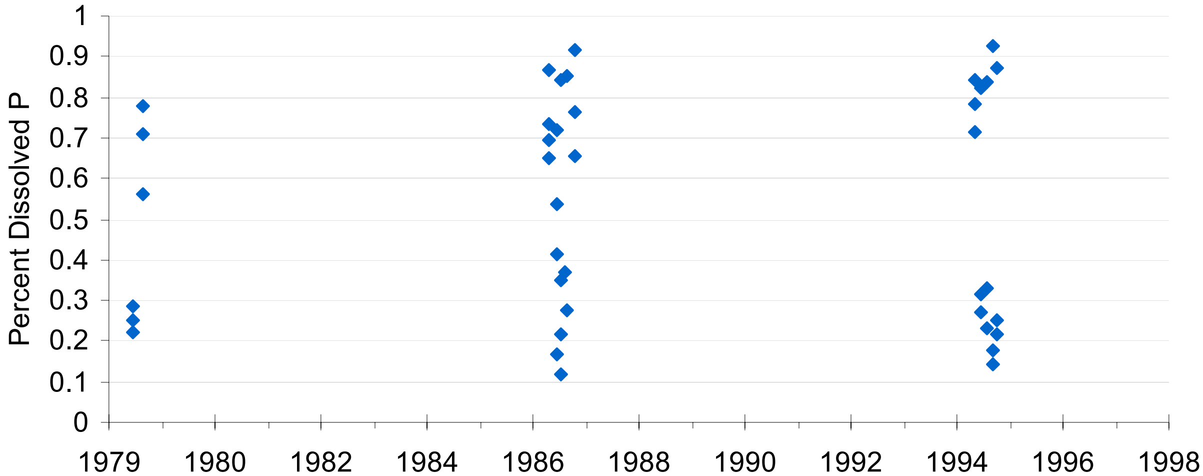

Figure 4-23. Proportion of dissolved phosphorus in Walnut Point Lake.

4.5.2.2 Total Nitrogen (TN)-to-Total Phosphorus (TP) Ratio

The TN:TP ratios in Walnut Point Lake are presented in Figure 4-24. TN:TP ratios are fairly consistent over the period of record and are generally higher than 10. The average of all ratios is 24, which suggests that phosphorus is the limiting nutrient in Walnut Point Lake.

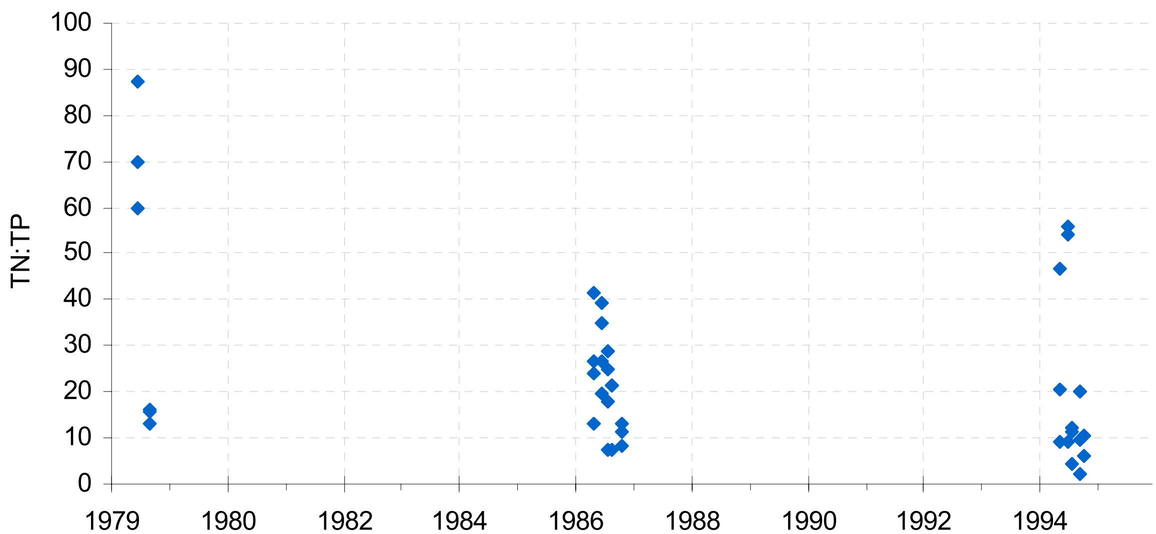

Figure 4-24. TN:TP ratios over the period of record for Walnut Point Lake.

4.5.2.3 Nitrate Nitrogen

Walnut Point Lake is listed as being impaired due to nitrate nitrogen. The nitrate water quality standard for public and food processing water supplies is 10 mg/L. Table 4-8 summarizes the available nitrate+nitrite data and indicates that no values have exceeded the 10 mg/L standard[1]. The nitrate+nitrite data are also presented in Figure 4-25 and do not indicate any clear increasing or decreasing trends. It is recommended that Walnut Point Lake be de-listed for nitrate nitrogen based on the fact it is not a public and food processing water supply and the available data do not indicate high nitrate concentrations.

Table 4-8. Summary of nitrogen parameters for Walnut Point Lake.

Parameter	Samples (Count)	Start	End	Minimum (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
Nitrate + Nitrite	53	6/18/1979	10/4/1995	0.01	0.65	8.00	2.11

*CV = standard deviation/average

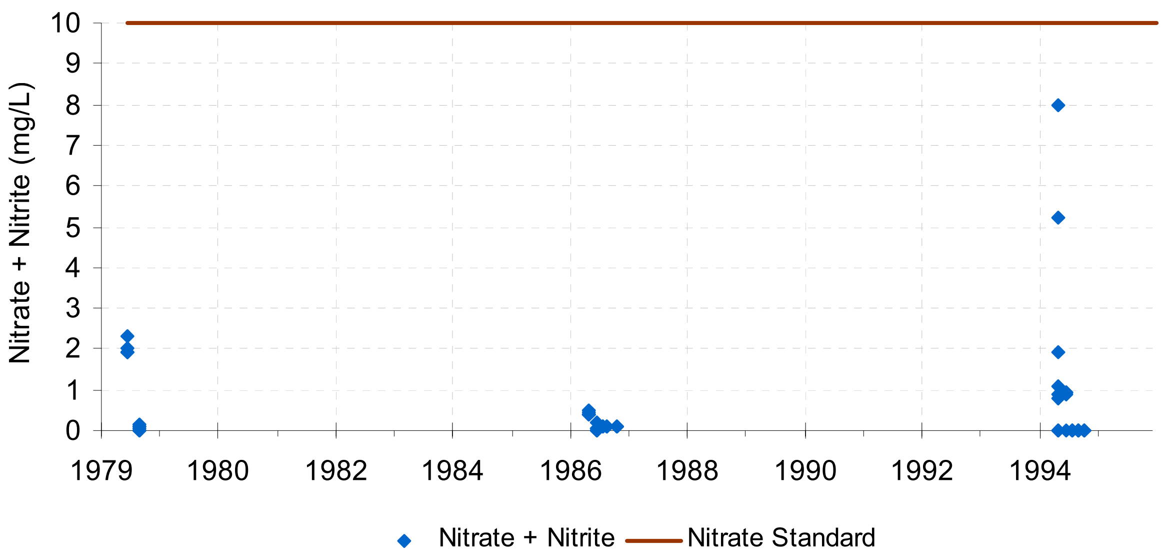

Figure 4-25. All nitrate+nitrite data for Walnut Point Lake.

4.5.2.4 Excessive Algal Growth

The chlorophyll-a data for Walnut Point Lake are summarized in Table 4-9 and presented graphically in Figure 4-26. The 1995 values appear to be slightly higher than the samples taken in 1979 and 1987. No recent (post 1998) data are available. Monthly median and mean chlorophyll-a concentrations are presented in Figure 4-27, which shows that chlorophyll-a concentrations increase from June to October. The relationship between chlorophyll-a and TP is graphically displayed in Figure 4-28. The figure shows that there is a weak positive relationship between TP and chlorophyll-a. The relationship between TSS and chlorophyll-a is graphically displayed in Figure 4-29 and indicates a relatively strong correlation between the two variables.

[1] Only nitrate+nitrite data are reported for Walnut Point Lake. These data are used to compare to the nitrate standard based on the assumption that nitrite is quickly converted to nitrate through the process of nitrification.

Table 4-9. Summary of the chlorophyll-a data for Walnut Point Lake.

Parameter	Samples (Count)	Start	End	Minimum (µg/L)	Average (µg/L)	Maximum (µg/L)	CV*
Chlorophyll-a	36	6/18/1979	10/4/1995	1.60	64.03	301.92	0.96

*CV = standard deviation/average

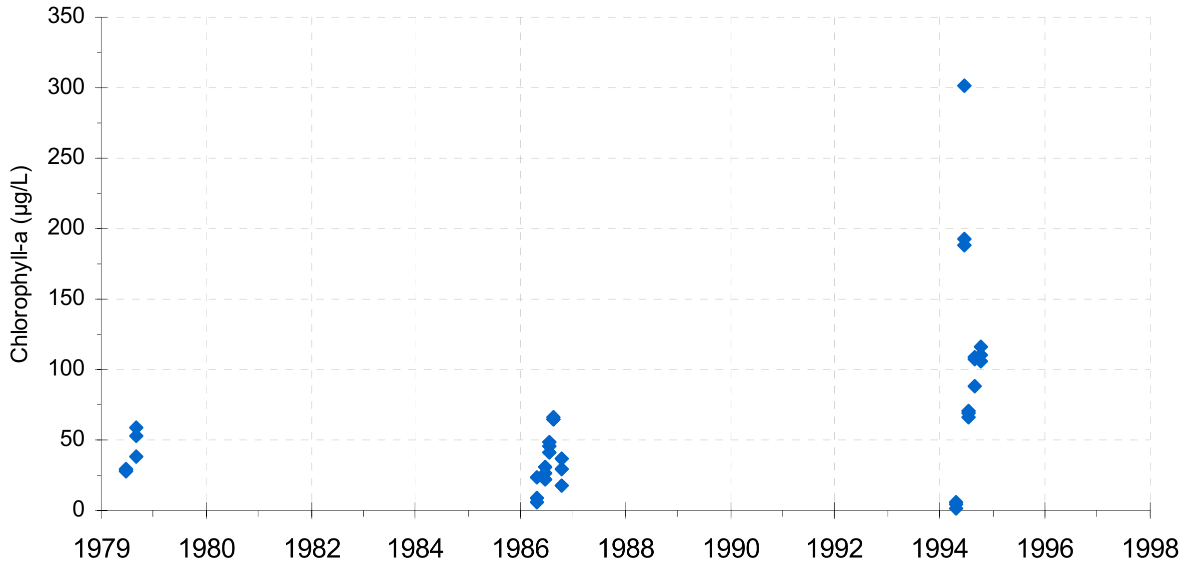

Figure 4-26. All chlorophyll-a data for Walnut Point Lake.

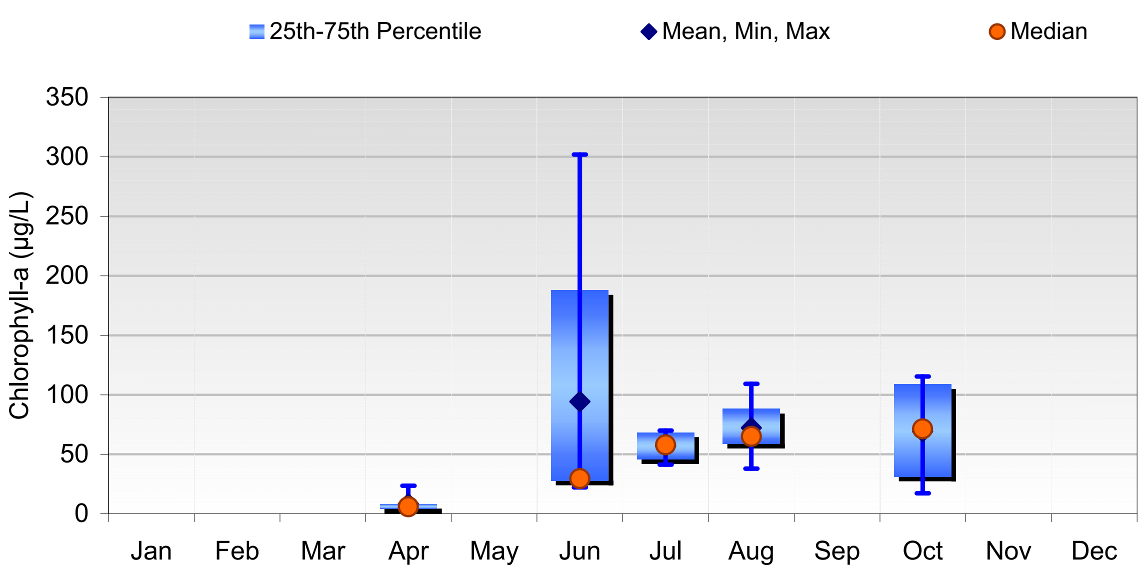

Figure 4-27. Seasonal variation in chlorophyll-a data for Walnut Point Lake (all data).

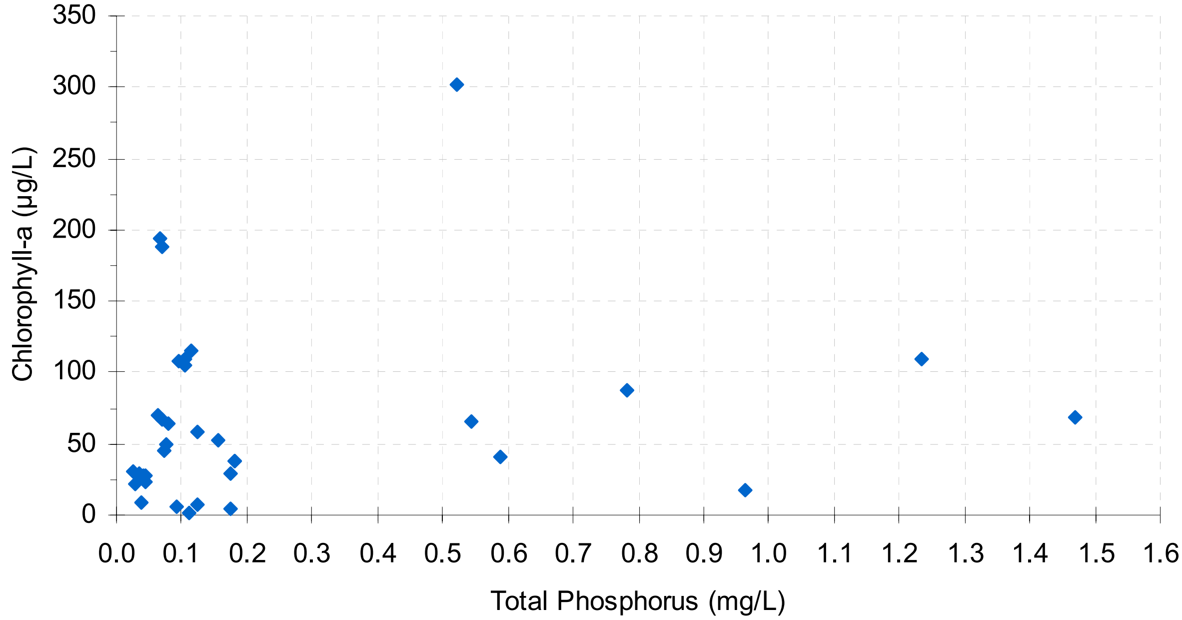

Figure 4-28. Correlation between TP and chlorophyll-a for Walnut Point Lake.

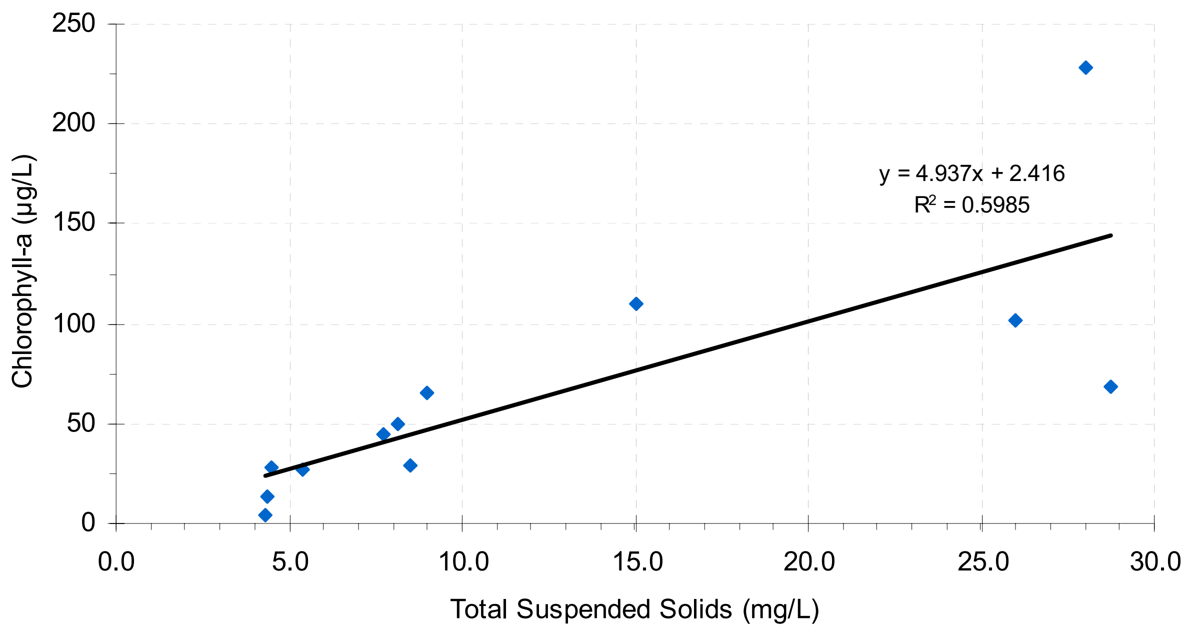

Figure 4-29. Correlation between TSS and chlorophyll-a for Walnut Point Lake.

The long-term average chlorophyll-a concentration for Walnut Point Lake (64 µg/L) results in a Carlson TSI of 71. This value is indicative of hyper-eutrophic conditions.

4.5.2.5 Suspended Solids

The total suspended solids (TSS) data for Walnut Point Lake are summarized in Table 4-10 and shown in Figure 4-30. Data are available for the period 1979 to 1995 and the more recent data appear to be slightly greater than the older data. Monthly median and mean TSS concentrations are presented in Figure 4-31 and indicate that concentrations are typically greatest in July and August, although no data are available for several months of the year.

Table 4-10. Summary of the suspended solids data for Walnut Point Lake.

Parameter	Samples (Count)	Start	End	Minimum (mg/L)	Average (mg/L)	Maximum (mg/L)	CV*
Suspended Solids	57	6/18/1979	10/4/1995	1.00	11.46	80.00	1.10

*CV = standard deviation/average

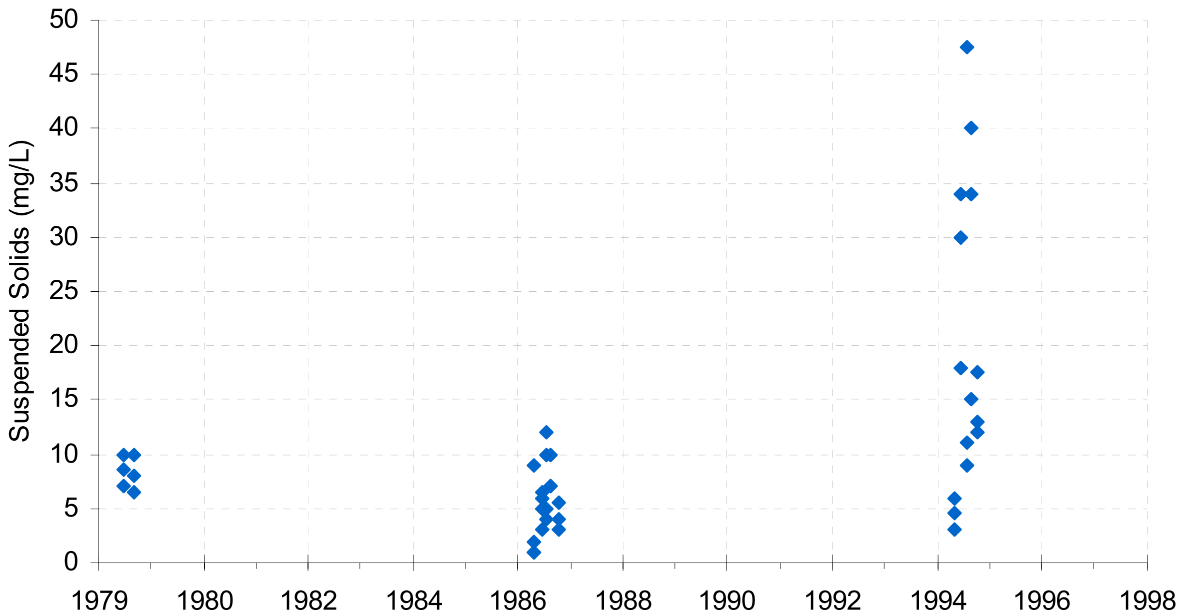

Figure 4-30. All suspended solids data for Walnut Point Lake.

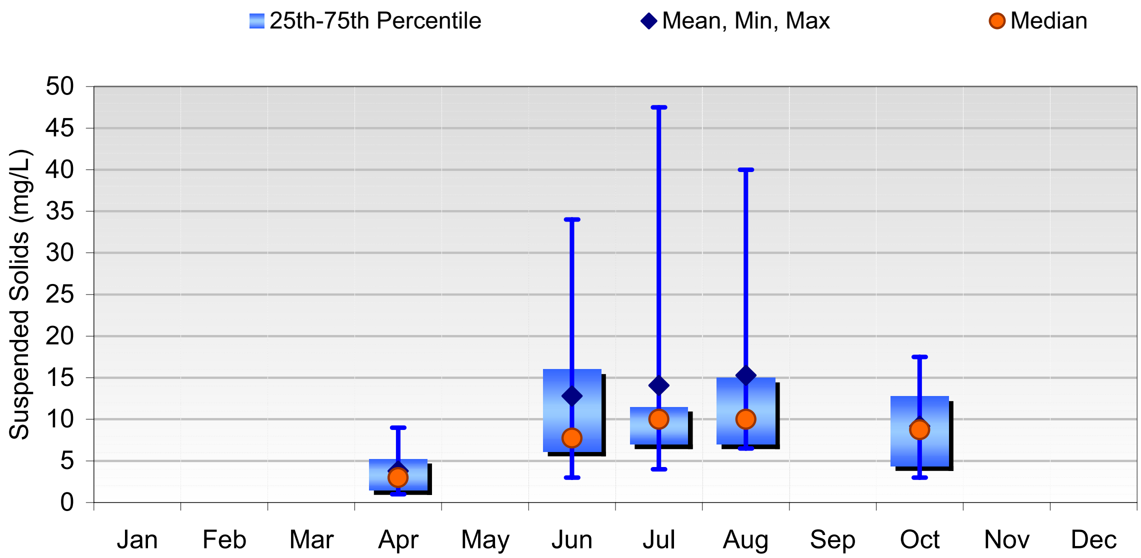

Figure 4-31. Seasonal variation in suspended solids data for Walnut Point Lake (all data).

4.5.2.6 Dissolved Oxygen

Walnut Point Lake is listed as being impaired due to dissolved oxygen. Table 4-11 summarizes the available dissolved oxygen for Walnut Point Lake. These data are shown graphically in Figure 4-32. Data are available for the period 1979 to 1995 and no increasing or decreasing trend in DO concentrations is apparent throughout the record. Dissolved oxygen concentrations decrease with increasing depth (Table 4-3). In addition, the percent of samples violating the 5.0 mg/L minimum numeric water quality standard increases with increasing depth.

Table 4-11. Summary of dissolved oxygen data in Walnut Point Lake.

Sample Depth (ft)	Start	End	Samples (Count)	Violations (Count)	Percent Violating	Minimum (mg/L)	Average (mg/L)	Maximum (mg/L)	CV*
0	6/18/1979	10/4/1995	28	3	10.7	3.2	10.5	14.2	0.3
1	6/18/1979	10/13/1987	16	2	12.5	3.3	10.2	13.6	0.3
2	6/15/1995	10/4/1995	9	0	0.0	8.5	13.3	16.6	0.2
3	6/18/1979	10/13/1987	18	2	11.1	3.8	10.0	13.8	0.3
4	4/25/1995	10/4/1995	14	1	7.1	3.5	9.4	14.3	0.4
5	6/18/1979	10/13/1987	17	5	29.4	2.4	8.8	14.3	0.4
6	4/25/1995	10/4/1995	14	7	50.0	0.3	5.2	12.0	0.8
7	6/18/1979	10/13/1987	17	7	41.2	0.1	6.3	12.3	0.7
8	4/25/1995	10/4/1995	10	6	60.0	0.3	3.5	11.3	1.1
9	6/18/1979	10/13/1987	16	10	62.5	0.0	4.0	11.2	1.1
10	4/25/1995	10/4/1995	9	6	66.7	0.2	2.6	9.3	1.3
11	6/18/1979	10/13/1987	10	6	60.0	0.5	3.8	10.5	1.0
12	4/25/1995	10/4/1995	7	5	71.4	0.2	1.7	7.3	1.6
13	6/18/1979	10/13/1987	8	5	62.5	0.6	3.8	9.0	0.9
14	4/25/1995	10/4/1995	5	5	100.0	0.1	1.6	5.0	1.2
15	6/18/1979	10/13/1987	8	6	75.0	0.7	3.8	7.5	0.7
16	4/25/1995	6/15/1995	3	3	100.0	0.1	0.6	1.5	1.0
17	6/18/1979	10/13/1987	7	5	71.4	0.8	3.8	6.9	0.7
18	10/13/1987	4/25/1995	2	2	100.0	0.5	2.1	3.7	1.1
19	6/18/1979	10/13/1987	8	6	75.0	0.8	2.9	6.2	0.8
20	4/25/1995	4/25/1995	2	2	100.0	0.4	0.5	0.5	0.2
21	6/18/1979	10/13/1987	7	6	85.7	0.4	2.5	5.7	0.8
22	4/20/1987	4/25/1995	4	4	100.0	0.3	1.1	3.4	1.2
23	6/18/1979	4/20/1987	2	2	100.0	2.3	2.7	3.1	0.2
24	4/25/1995	4/25/1995	2	2	100.0	0.2	0.2	0.2	0.0
25	6/18/1979	8/18/1987	3	3	100.0	1.1	1.7	2.1	0.3
26	4/25/1995	4/25/1995	1	1	100.0	0.1	0.1	0.1	NA
27	6/18/1979	10/13/1987	4	4	100.0	0.3	1.3	2.0	0.6
28	4/20/1987	4/20/1987	1	1	100.0	1.4	1.4	1.4	NA
29	4/20/1987	4/20/1987	1	1	100.0	1.1	1.1	1.1	NA

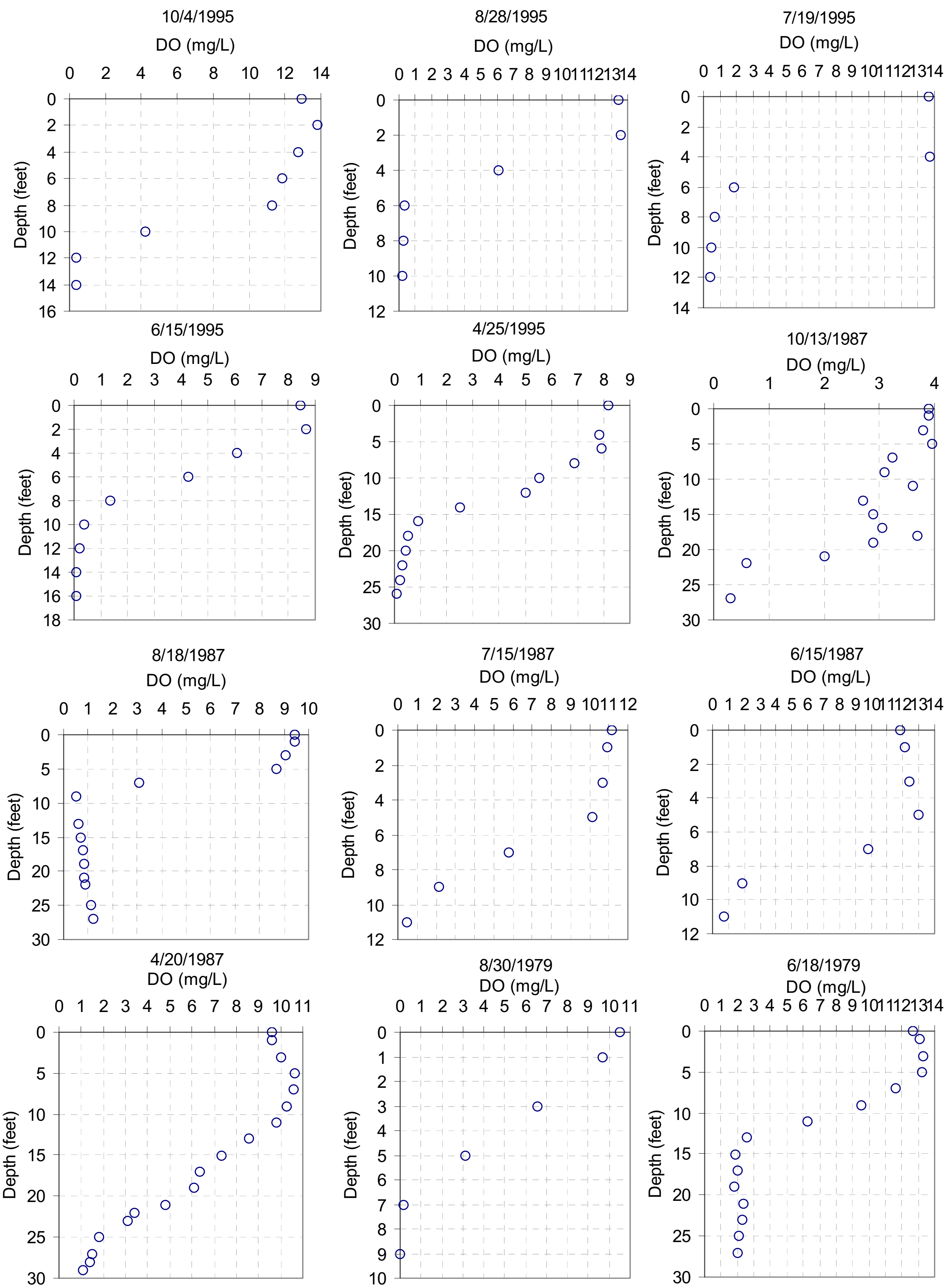

Figure 4-32. Dissolved oxygen concentrations in Walnut Point Lake, 1979 to 1995.

4.5.2.7 Aquatic Plants Native

Walnut Point Lake is listed as being impaired due to native aquatic plants; however, no data on plant types or densities are currently available.

4.5.3 Potential Pollutant Sources

4.5.3.1 Point Sources

A query of the National Pollutant Discharge Elimination System (NPDES) data provided by Illinois EPA revealed no point source dischargers in either the Lake Oakland or Walnut Point Lake watersheds.

4.5.3.2 Nonpoint Sources

Potential nonpoint sources of sediments and nutrients to Lake Oakland and Walnut Point Lake include sheet and rill erosion, lake shoreline erosion, stream channel erosion, fertilizer use, livestock operations, storm water runoff, atmospheric deposition, internal lake recycling, and natural sources. The campground at Walnut Point Lake is a potential source of nutrients because it has a pumpout area which is believed to discharge to a leach field and then the lake (Mike Mounts, Illinois Department of Natural Resources, personal communications, October 26, 2004). Septic systems are not considered a significant source of nutrients to Lake Oakland because the houses around the lake were connected to the city's sewer system approximately fifteen years ago (Dan Stretch, Coles County Health Department, personal communications, October 26, 2004). The relative magnitude the various nonpoint sources has not yet been estimated and will be the focus of Stage 2 and 3 activities.

5 Identification of Data Gaps and Sampling Plan

Several data gaps have been identified in the Lake Oakland and Walnut Point Lake watersheds that will have implications for TMDL development. First, no continuous flow data exist in either watershed. The lack of flow data limits the extent to which loads from tributaries can be estimated. Tributary flows at the mouth of Hog Branch for Lake Oakland and at the mouth of the tributary to Walnut Point Lake will need to be estimated based on observed data at a nearby flow gage. For example, if a tributary drains 10 percent of the area drained by a gage, the tributary flows can estimated to be 10 percent of the flows observed at the gage. A major assumption of this approach is therefore that streamflow in the tributaries is linearly related to the flows measured at the flow gage.

Sufficient water quality are available to develop the necessary TMDLs for Lake Oakland. However, additional water quality sampling is recommended for Walnut Point Lake since no recent data are available. Water quality sampling in Walnut Point Lake should be conducted at the historical Illinois EPA monitoring stations (Figure 4-2). The lake should be sampled two times a month from April through October. This schedule will capture the expected seasonal variation in water quality parameters related to nutrient loading, eutrophication and oxygen-demanding processes. Water samples should be analyzed to determine concentrations of TP, soluble reactive phosphorus, chlorophyll a, nitrate/nitrite nitrogen, total Kjeldahl nitrogen, and zooplankton (Table 5-1). In the field, measurements should be made throughout the lake water column using a Hydrolab to obtain vertical profiles of pH, temperature and dissolved oxygen. Hydrolab profiles should be collected at additional lake stations if reconnaissance shows vertical profiles to vary according to lake location. Secchi depth should also be measured at each lake sampling station. Nutrient samples should be collected at three depths at each station if stratification is observed. Single mid-depth samples should be collected at each station when the lakes are not stratified. Chlorophyll-a should be measured in a composite sample of water collected within the photic zone, from the water surface to twice the Secchi depth.

Surficial (i.e., top 10 cm) sediment samples should also be collected using a dredge at the deepest sampling stations, and should be analyzed for total phosphorus and total organic carbon. These data may be important for estimating the release of phosphorus from the sediment if dissolved oxygen concentrations are depleted near the lake bottom.

Tributary water quality data is also lacking and should be collected at the mouth of the tributary to Walnut Point Lake if access can be obtained. The extent of the tributary sampling is summarized in Table 5-1 and Table 5-2.

Another source of potential sediment and nutrient loadings to Walnut Point Lake is from shoreline erosion. Information should be collected regarding the current potential extent of such erosion, such as length and height of eroding banks. Persons with historical knowledge of the lake should also be contacted to determine the extent to which shoreline erosion has been a significant factor in the past.

Lastly, detailed bathymetric data do not appear to be available for either lake and should be collected during one of the sampling events.

A summary of the sampling plan is provided in Table 5-2. Sampling should be conducted by qualified personnel and might include representatives from Illinois EPA, local government agencies, or private consulting companies. A cost estimate can be made once Illinois EPA has decided on the extent of the sampling effort and the responsible party.

Table 5-1. Identification of parameters to be analyzed in Walnut Point Lake.

Parameter	Water column profiles	Lake samples	Tributary	Lake Sediment
Temperature	x			
pH	x			
Dissolved Oxygen	x			
Secchi disk depth	x			
Total Phosphorus		x	x	x
Soluble Reactive P		x	x	
Nitrate/nitrite N		x		
Total Kjeldahl N		x		
Chlorophyll a		x		
TOC				x

Table 5-2. Summary of sampling for Walnut Point Lake.

	April	May	June	July	Aug	Sept	Oct
Water Column							
Number of sampling events	2	2	2	2	2	2	2
Number of stations in each lake	3	3	3	3	3	3	3
Number of depths	3	3	3	3	3	3	3
Major Tributaries							
Number of sampling events	2	2	2	1	1	1	1

6 Technical Approach

Illinois EPA is currently developing TMDLs for pollutants that have numeric water quality standards. Of the pollutants impairing Lake Oakland and Walnut Point Lake, phosphorus, nitrate, and dissolved oxygen are the only parameters with numeric water quality standards for lakes. 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. Technical approaches for developing phosphorus, nitrate, and dissolved oxygen TMDLs for Lake Oakland and Walnut Point Lake are presented in this section. Both simple and more advanced technical approaches are presented.

6.1 Simple Approach

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

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

6.2 Detailed Approach

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

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

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

SWAT is proposed because it:

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

Calibrating the hydrologic component of SWAT presents a challenge since there are no flow gauges located within the basin. However, daily mean stream flow and water quality information is available for watersheds with similar physical characteristics (e.g. land use, soils, topography, agricultural practices). Consequently, a SWAT model can be built for a watershed with similar characteristics, and the calibrated hydrologic and water quality parameters can be used for Lake Oakland and Walnut Point Lake.

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

An additional potential source of nutrients and sediment to the two lakes is shoreline erosion. Existing models have limited capability of estimating shoreline erosion and therefore a non-modeling approach will be taken for this project. This non-modeling approach will require obtaining representative data on the extent of shoreline erosion in each lake by taking quantitative measurements and also discussing the issue with knowledgeable individuals.

Establishing the relationship between the in-lake water quality targets and source loading is a critical component in the development of a TMDL. It allows for the evaluation of management options that will achieve the desired outcome in terms of water quality. The link can be established through a range of techniques, from simple mass balance analyses to sophisticated computer modeling. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain waterbody responses with flow and loading conditions. The LAKE2K model is recommended for establishing this linkage for Lake Oakland and Walnut Point Lake.

LAKE2K is a model that is designed to compute seasonal trends of water quality in stratified lakes (Chapra and Martin, 2004). A beta version of the model has recently been released and is supported by the U.S. EPA Office of Research and Development. LAKE2K is implemented within the Microsoft Windows environment and uses Microsoft Excel as the graphical user interface. The model requires information on lake elevation, area, volume, inflows, meteorology, and initial water quality conditions. Daily water quality output is provided for three vertical layers (epilminion, metalimnion, and hypolimnion), including daily predictions of TP, dissolved oxygen, and three phytoplankton groups. LAKE2K also includes a sediment diagenesis model for nutrient release during low dissolved oxygen conditions

LAKE2K is recommended for the Lake Oakland and Walnut Point Lake projects because it is sufficiently detailed to provide the output necessary to compare to numeric water quality standards, and yet is not so complex as to require an extensive amount of data to set up and run. It falls between the less complex BATHTUB model and the more rigorous and data-intensive CE-QUAL-W2 or Environmental Fluid Dynamics Code (EFDC) models. A comparison of the BATHTUB and LAKE2K models is provided in Table 6-1

Table 6-1. Comparison of the BATHTUB and LAKE2K models.

	BATHTUB	**LAKE-2K**
Model Basis	Empirical	Physically -based (complicated water quality kinetics, no hydrodynamics)
Time Step	Steady State	Dynamic
Vertical Segmentation	Depth Averaged	Vertically segmented into 3 layers (each constituent simulated for each layer, epi, meta, hypo)
Longitudinal Segmentation	Spatially segmented network	Cannot represent spatially segmented network (may not be appropriate if data show spatial variablity in the lake)
Chlorophyll-a Simulation	Can only provide seasonal average predictions; unable to evaluate maximums. Cannot simulate more than one species	Able to simulate 3 types of phytoplankton.
DO Simulation	Meta and Hypolimnetic Depletion Rate	Predicts for each vertical layer
Sediment Diagenisis	No	Yes
Predictive Capability/Scenario Testing	Short-term responses and effects related to structural modifications or responses to variables other than nutrients cannot be evaluated	Represents whole-lake as one box. Model may not be predictive of local impacts due to loadings or in-lake management measures are to be evaluated

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Appendix A: Illinois GAP Land Cover Description

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

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

Appendix B: Water Quality Data for Lake Oakland and Walnut Point Lakes

Table B-1. Results of nutrient, dissolved oxygen, and suspended solids sampling in Lake Oakland and Walnut Point Lakes.

Waterbody	Station ID	Date	Parameter	Sample Depth (ft)	Value	Units
RBK	RBK-1	6/18/1979	Dissolved Oxygen	0	12.2	mg/L
RBK	RBK-1	6/18/1979	Dissolved Oxygen	1	12.6	mg/L
RBK	RBK-1	6/18/1979	Dissolved Oxygen	3	12.9	mg/L
RBK	RBK-1	6/18/1979	Dissolved Oxygen	7	12.3	mg/L
RBK	RBK-1	6/18/1979	Dissolved Oxygen	9	11.2	mg/L
RBK	RBK-1	6/18/1979	Dissolved Oxygen	11	7.9	mg/L
RBK	RBK-1	6/18/1979	Dissolved Oxygen	13	4.6	mg/L
RBK	RBK-1	6/18/1979	Dissolved Oxygen	15	3.4	mg/L
RBK	RBK-1	6/18/1979	Dissolved Oxygen	17	3	mg/L
RBK	RBK-1	6/18/1979	Dissolved Oxygen	19	2.6	mg/L
RBK	RBK-1	6/18/1979	Dissolved Oxygen	21	2.4	mg/L
RBK	RBK-1	6/18/1979	Dissolved Oxygen	23	2.3	mg/L
RBK	RBK-1	6/18/1979	Dissolved Oxygen	25	2.1	mg/L
RBK	RBK-1	6/18/1979	Dissolved Oxygen	27	2	mg/L
RBK	RBK-1	8/30/1979	Dissolved Oxygen	0	9.3	mg/L
RBK	RBK-1	8/30/1979	Dissolved Oxygen	1	8.7	mg/L
RBK	RBK-1	8/30/1979	Dissolved Oxygen	3	8.3	mg/L
RBK	RBK-1	8/30/1979	Dissolved Oxygen	5	2.4	mg/L
RBK	RBK-1	8/30/1979	Dissolved Oxygen	7	0.2	mg/L
RBK	RBK-1	8/30/1979	Dissolved Oxygen	9	0	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	0	9.6	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	3	9.9	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	5	10.1	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	7	9.7	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	9	9.4	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	11	9.1	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	13	8.2	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	15	7.5	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	17	6.9	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	19	6.2	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	21	5.7	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	23	3.1	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	25	1.8	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	27	1.5	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	28	1.4	mg/L
RBK	RBK-1	4/20/1987	Dissolved Oxygen	29	1.1	mg/L
RBK	RBK-1	6/15/1987	Dissolved Oxygen	0	12.1	mg/L
RBK	RBK-1	6/15/1987	Dissolved Oxygen	1	12.3	mg/L
RBK	RBK-1	6/15/1987	Dissolved Oxygen	3	12.2	mg/L
RBK	RBK-1	6/15/1987	Dissolved Oxygen	5	10.9	mg/L
RBK	RBK-1	6/15/1987	Dissolved Oxygen	9	1.7	mg/L
RBK	RBK-1	6/15/1987	Dissolved Oxygen	11	0.7	mg/L
RBK	RBK-1	7/15/1987	Dissolved Oxygen	0	10.6	mg/L

RBK	RBK-1	7/15/1987	Dissolved Oxygen	1	10.4	mg/L
RBK	RBK-1	7/15/1987	Dissolved Oxygen	3	10	mg/L
RBK	RBK-1	7/15/1987	Dissolved Oxygen	5	9.8	mg/L
RBK	RBK-1	7/15/1987	Dissolved Oxygen	7	5.6	mg/L
RBK	RBK-1	7/15/1987	Dissolved Oxygen	9	2.2	mg/L
RBK	RBK-1	7/15/1987	Dissolved Oxygen	11	0.5	mg/L
RBK	RBK-1	8/18/1987	Dissolved Oxygen	0	9.4	mg/L
RBK	RBK-1	8/18/1987	Dissolved Oxygen	1	9.5	mg/L
RBK	RBK-1	8/18/1987	Dissolved Oxygen	3	8.7	mg/L
RBK	RBK-1	8/18/1987	Dissolved Oxygen	5	8.2	mg/L
RBK	RBK-1	8/18/1987	Dissolved Oxygen	7	2	mg/L
RBK	RBK-1	8/18/1987	Dissolved Oxygen	9	0.5	mg/L
RBK	RBK-1	8/18/1987	Dissolved Oxygen	13	0.6	mg/L
RBK	RBK-1	8/18/1987	Dissolved Oxygen	15	0.7	mg/L
RBK	RBK-1	8/18/1987	Dissolved Oxygen	17	0.8	mg/L
RBK	RBK-1	8/18/1987	Dissolved Oxygen	19	0.9	mg/L
RBK	RBK-1	8/18/1987	Dissolved Oxygen	21	1	mg/L
RBK	RBK-1	8/18/1987	Dissolved Oxygen	25	1.1	mg/L
RBK	RBK-1	8/18/1987	Dissolved Oxygen	27	1.2	mg/L
RBK	RBK-1	10/13/1987	Dissolved Oxygen	0	3.2	mg/L
RBK	RBK-1	10/13/1987	Dissolved Oxygen	1	3.3	mg/L
RBK	RBK-1	10/13/1987	Dissolved Oxygen	7	3.1	mg/L
RBK	RBK-1	10/13/1987	Dissolved Oxygen	9	3	mg/L
RBK	RBK-1	10/13/1987	Dissolved Oxygen	11	2.9	mg/L
RBK	RBK-1	10/13/1987	Dissolved Oxygen	13	2.7	mg/L
RBK	RBK-1	10/13/1987	Dissolved Oxygen	15	2.5	mg/L
RBK	RBK-1	10/13/1987	Dissolved Oxygen	17	2	mg/L
RBK	RBK-1	10/13/1987	Dissolved Oxygen	19	1.8	mg/L
RBK	RBK-1	10/13/1987	Dissolved Oxygen	21	0.4	mg/L
RBK	RBK-1	10/13/1987	Dissolved Oxygen	27	0.3	mg/L
RBK	RBK-1	4/25/1995	Dissolved Oxygen	0	7.9	mg/L
RBK	RBK-1	4/25/1995	Dissolved Oxygen	4	7.7	mg/L
RBK	RBK-1	4/25/1995	Dissolved Oxygen	6	7.6	mg/L
RBK	RBK-1	4/25/1995	Dissolved Oxygen	8	5.8	mg/L
RBK	RBK-1	4/25/1995	Dissolved Oxygen	10	2.3	mg/L
RBK	RBK-1	4/25/1995	Dissolved Oxygen	12	1.2	mg/L
RBK	RBK-1	4/25/1995	Dissolved Oxygen	14	0.9	mg/L
RBK	RBK-1	4/25/1995	Dissolved Oxygen	16	0.6	mg/L
RBK	RBK-1	4/25/1995	Dissolved Oxygen	20	0.5	mg/L
RBK	RBK-1	4/25/1995	Dissolved Oxygen	22	0.3	mg/L
RBK	RBK-1	4/25/1995	Dissolved Oxygen	24	0.2	mg/L
RBK	RBK-1	4/25/1995	Dissolved Oxygen	26	0.1	mg/L
RBK	RBK-1	6/15/1995	Dissolved Oxygen	0	8.5	mg/L
RBK	RBK-1	6/15/1995	Dissolved Oxygen	2	8.8	mg/L
RBK	RBK-1	6/15/1995	Dissolved Oxygen	4	5.3	mg/L
RBK	RBK-1	6/15/1995	Dissolved Oxygen	6	2.9	mg/L
RBK	RBK-1	6/15/1995	Dissolved Oxygen	8	1	mg/L
RBK	RBK-1	6/15/1995	Dissolved Oxygen	10	0.3	mg/L
RBK	RBK-1	6/15/1995	Dissolved Oxygen	12	0.2	mg/L

RBK	RBK-1	6/15/1995	Dissolved Oxygen	14	0.1	mg/L
RBK	RBK-1	7/19/1995	Dissolved Oxygen	0	13.5	mg/L
RBK	RBK-1	7/19/1995	Dissolved Oxygen	2	14.9	mg/L
RBK	RBK-1	7/19/1995	Dissolved Oxygen	4	12.9	mg/L
RBK	RBK-1	7/19/1995	Dissolved Oxygen	6	1	mg/L
RBK	RBK-1	7/19/1995	Dissolved Oxygen	10	0.4	mg/L
RBK	RBK-1	8/28/1995	Dissolved Oxygen	0	12.3	mg/L
RBK	RBK-1	8/28/1995	Dissolved Oxygen	4	3.5	mg/L
RBK	RBK-1	8/28/1995	Dissolved Oxygen	6	0.3	mg/L
RBK	RBK-1	10/4/1995	Dissolved Oxygen	0	14	mg/L
RBK	RBK-1	10/4/1995	Dissolved Oxygen	2	14.7	mg/L
RBK	RBK-1	10/4/1995	Dissolved Oxygen	4	13.1	mg/L
RBK	RBK-1	10/4/1995	Dissolved Oxygen	6	11.9	mg/L
RBK	RBK-1	10/4/1995	Dissolved Oxygen	10	0.5	mg/L
RBK	RBK-1	10/4/1995	Dissolved Oxygen	12	0.3	mg/L
RBK	RBK-1	6/18/1979	Suspended Solids	1	9	mg/L
RBK	RBK-1	6/18/1979	Suspended Solids	27	11	mg/L
RBK	RBK-1	8/30/1979	Suspended Solids	1	6	mg/L
RBK	RBK-1	8/30/1979	Suspended Solids	27	7	mg/L
RBK	RBK-1	4/20/1987	Suspended Solids	1	8	mg/L
RBK	RBK-1	4/20/1987	Suspended Solids	28	10	mg/L
RBK	RBK-1	6/15/1987	Suspended Solids	1	7	mg/L
RBK	RBK-1	6/15/1987	Suspended Solids	29	6	mg/L
RBK	RBK-1	7/15/1987	Suspended Solids	29	12	mg/L
RBK	RBK-1	8/18/1987	Suspended Solids	1	8	mg/L
RBK	RBK-1	8/18/1987	Suspended Solids	26	12	mg/L
RBK	RBK-1	10/13/1987	Suspended Solids	1	2	mg/L
RBK	RBK-1	10/13/1987	Suspended Solids	28	9	mg/L
RBK	RBK-1	4/25/1995	Suspended Solids	1	2	mg/L
RBK	RBK-1	4/25/1995	Suspended Solids	1	4	mg/L
RBK	RBK-1	4/25/1995	Suspended Solids	30	3	mg/L
RBK	RBK-1	6/15/1995	Suspended Solids	1	28	mg/L
RBK	RBK-1	6/15/1995	Suspended Solids	26	32	mg/L
RBK	RBK-1	7/19/1995	Suspended Solids	1	15	mg/L
RBK	RBK-1	7/19/1995	Suspended Solids	25	80	mg/L
RBK	RBK-1	8/28/1995	Suspended Solids	1	10	mg/L
RBK	RBK-1	8/28/1995	Suspended Solids	25	20	mg/L
RBK	RBK-1	10/4/1995	Suspended Solids	1	15	mg/L
RBK	RBK-1	10/4/1995	Suspended Solids	26	20	mg/L
RBK	RBK-1	6/18/1979	Ammonia	1	0.01	mg/L
RBK	RBK-1	6/18/1979	Ammonia	27	0.63	mg/L
RBK	RBK-1	8/30/1979	Ammonia	1	0.12	mg/L
RBK	RBK-1	8/30/1979	Ammonia	27	3.3	mg/L
RBK	RBK-1	4/20/1987	Ammonia	1	0.1	mg/L
RBK	RBK-1	4/20/1987	Ammonia	28	0.64	mg/L
RBK	RBK-1	6/15/1987	Ammonia	1	0.1	mg/L
RBK	RBK-1	7/15/1987	Ammonia	1	0.1	mg/L
RBK	RBK-1	7/15/1987	Ammonia	29	6	mg/L
RBK	RBK-1	8/18/1987	Ammonia	1	0.1	mg/L

RBK	RBK-1	8/18/1987	Ammonia	26	5.2	mg/L
RBK	RBK-1	10/13/1987	Ammonia	1	0.76	mg/L
RBK	RBK-1	10/13/1987	Ammonia	28	11	mg/L
RBK	RBK-1	4/25/1995	Ammonia	1	0.03	mg/L
RBK	RBK-1	4/25/1995	Ammonia	1	0.09	mg/L
RBK	RBK-1	4/25/1995	Ammonia	1	0.27	mg/L
RBK	RBK-1	4/25/1995	Ammonia	30	1.9	mg/L
RBK	RBK-1	6/15/1995	Ammonia	1	0.02	mg/L
RBK	RBK-1	6/15/1995	Ammonia	26	4.4	mg/L
RBK	RBK-1	7/19/1995	Ammonia	1	0.01	mg/L
RBK	RBK-1	7/19/1995	Ammonia	25	17	mg/L
RBK	RBK-1	8/28/1995	Ammonia	1	0.01	mg/L
RBK	RBK-1	8/28/1995	Ammonia	25	9.1	mg/L
RBK	RBK-1	10/4/1995	Ammonia	1	0.07	mg/L
RBK	RBK-1	10/4/1995	Ammonia	26	17	mg/L
RBK	RBK-1	6/18/1979	Un-inonized Ammonia	1	0	mg/L
RBK	RBK-1	6/18/1979	Un-inonized Ammonia	27	0	mg/L
RBK	RBK-1	8/30/1979	Un-inonized Ammonia	1	0.02	mg/L
RBK	RBK-1	8/30/1979	Un-inonized Ammonia	27	0	mg/L
RBK	RBK-1	4/20/1987	Un-inonized Ammonia	1	0	mg/L
RBK	RBK-1	4/20/1987	Un-inonized Ammonia	28	0	mg/L
RBK	RBK-1	6/15/1987	Un-inonized Ammonia	1	0.01	mg/L
RBK	RBK-1	6/15/1987	Un-inonized Ammonia	29	0	mg/L
RBK	RBK-1	7/15/1987	Un-inonized Ammonia	1	0.02	mg/L
RBK	RBK-1	7/15/1987	Un-inonized Ammonia	29	0	mg/L
RBK	RBK-1	8/18/1987	Un-inonized Ammonia	1	0.03	mg/L
RBK	RBK-1	10/13/1987	Un-inonized Ammonia	1	0	mg/L
RBK	RBK-1	10/13/1987	Un-inonized Ammonia	28	0	mg/L
RBK	RBK-1	4/25/1995	Un-inonized Ammonia	30	0.01	mg/L
RBK	RBK-1	10/4/1995	Un-inonized Ammonia	26	0.02	mg/L
RBK	RBK-1	6/18/1979	TKN	1	0.6	mg/L
RBK	RBK-1	6/18/1979	TKN	27	1.2	mg/L
RBK	RBK-1	8/30/1979	TKN	1	1.6	mg/L
RBK	RBK-1	8/30/1979	TKN	27	4	mg/L
RBK	RBK-1	4/20/1987	TKN	1	0.8	mg/L
RBK	RBK-1	4/20/1987	TKN	28	1.6	mg/L
RBK	RBK-1	6/15/1987	TKN	1	1.4	mg/L
RBK	RBK-1	6/15/1987	TKN	29	0.9	mg/L
RBK	RBK-1	7/15/1987	TKN	1	1.5	mg/L
RBK	RBK-1	7/15/1987	TKN	29	7	mg/L
RBK	RBK-1	8/18/1987	TKN	1	1.5	mg/L
RBK	RBK-1	8/18/1987	TKN	26	6.6	mg/L
RBK	RBK-1	10/13/1987	TKN	1	2	mg/L
RBK	RBK-1	10/13/1987	TKN	28	14	mg/L
RBK	RBK-1	4/25/1995	TKN	1	0.1	mg/L
RBK	RBK-1	4/25/1995	TKN	1	0.21	mg/L
RBK	RBK-1	4/25/1995	TKN	1	0.71	mg/L
RBK	RBK-1	4/25/1995	TKN	30	2.1	mg/L
RBK	RBK-1	6/15/1995	TKN	1	2.3	mg/L

RBK	RBK-1	6/15/1995	TKN	26	6.2	mg/L
RBK	RBK-1	7/19/1995	TKN	1	0.82	mg/L
RBK	RBK-1	7/19/1995	TKN	25	11.4	mg/L
RBK	RBK-1	8/28/1995	TKN	1	1.8	mg/L
RBK	RBK-1	8/28/1995	TKN	25	1.6	mg/L
RBK	RBK-1	10/4/1995	TKN	1	0.98	mg/L
RBK	RBK-1	10/4/1995	TKN	26	13.8	mg/L
RBK	RBK-1	6/18/1979	Nitrate + Nitrite	1	1.9	mg/L
RBK	RBK-1	8/30/1979	Nitrate + Nitrite	1	0.08	mg/L
RBK	RBK-1	8/30/1979	Nitrate + Nitrite	27	0.01	mg/L
RBK	RBK-1	4/20/1987	Nitrate + Nitrite	1	0.46	mg/L
RBK	RBK-1	4/20/1987	Nitrate + Nitrite	28	0.37	mg/L
RBK	RBK-1	6/15/1987	Nitrate + Nitrite	1	0.04	mg/L
RBK	RBK-1	6/15/1987	Nitrate + Nitrite	29	0.03	mg/L
RBK	RBK-1	7/15/1987	Nitrate + Nitrite	1	0.1	mg/L
RBK	RBK-1	8/18/1987	Nitrate + Nitrite	1	0.1	mg/L
RBK	RBK-1	10/13/1987	Nitrate + Nitrite	1	0.1	mg/L
RBK	RBK-1	4/25/1995	Nitrate + Nitrite	1	0.77	mg/L
RBK	RBK-1	4/25/1995	Nitrate + Nitrite	1	5.2	mg/L
RBK	RBK-1	4/25/1995	Nitrate + Nitrite	1	8	mg/L
RBK	RBK-1	4/25/1995	Nitrate + Nitrite	30	0.01	mg/L
RBK	RBK-1	6/15/1995	Nitrate + Nitrite	1	0.9	mg/L
RBK	RBK-1	6/15/1995	Nitrate + Nitrite	26	0.01	mg/L
RBK	RBK-1	7/19/1995	Nitrate + Nitrite	1	0.01	mg/L
RBK	RBK-1	8/28/1995	Nitrate + Nitrite	1	0.01	mg/L
RBK	RBK-1	8/28/1995	Nitrate + Nitrite	25	0.02	mg/L
RBK	RBK-1	10/4/1995	Nitrate + Nitrite	1	0.01	mg/L
RBK	RBK-1	6/18/1979	Total Phosphorus	1	0.04	mg/L
RBK	RBK-1	8/30/1979	Total Phosphorus	1	0.06	mg/L
RBK	RBK-1	8/30/1979	Total Phosphorus	27	0.3	mg/L
RBK	RBK-1	4/20/1987	Total Phosphorus	1	0.04	mg/L
RBK	RBK-1	4/20/1987	Total Phosphorus	28	0.2	mg/L
RBK	RBK-1	6/15/1987	Total Phosphorus	1	0.02	mg/L
RBK	RBK-1	6/15/1987	Total Phosphorus	29	0.04	mg/L
RBK	RBK-1	7/15/1987	Total Phosphorus	1	0.06	mg/L
RBK	RBK-1	7/15/1987	Total Phosphorus	29	1.12	mg/L
RBK	RBK-1	8/18/1987	Total Phosphorus	1	0.07	mg/L
RBK	RBK-1	8/18/1987	Total Phosphorus	26	1.02	mg/L
RBK	RBK-1	10/13/1987	Total Phosphorus	1	0.16	mg/L
RBK	RBK-1	10/13/1987	Total Phosphorus	28	1.77	mg/L
RBK	RBK-1	4/25/1995	Total Phosphorus	1	0.02	mg/L
RBK	RBK-1	4/25/1995	Total Phosphorus	1	0.03	mg/L
RBK	RBK-1	4/25/1995	Total Phosphorus	1	0.06	mg/L
RBK	RBK-1	4/25/1995	Total Phosphorus	30	0.26	mg/L
RBK	RBK-1	6/15/1995	Total Phosphorus	1	0.08	mg/L
RBK	RBK-1	6/15/1995	Total Phosphorus	26	0.96	mg/L
RBK	RBK-1	7/19/1995	Total Phosphorus	1	0.06	mg/L
RBK	RBK-1	7/19/1995	Total Phosphorus	25	2.88	mg/L
RBK	RBK-1	8/28/1995	Total Phosphorus	1	0.09	mg/L

RBK	RBK-1	8/28/1995	Total Phosphorus	25	1.48	mg/L
RBK	RBK-1	10/4/1995	Total Phosphorus	1	0.09	mg/L
RBK	RBK-1	10/4/1995	Total Phosphorus	26	2.38	mg/L
RBK	RBK-1	6/18/1979	Dissolved Phosphorus	27	0.01	mg/L
RBK	RBK-1	8/30/1979	Dissolved Phosphorus	1	0.02	mg/L
RBK	RBK-1	8/30/1979	Dissolved Phosphorus	27	0.26	mg/L
RBK	RBK-1	4/20/1987	Dissolved Phosphorus	1	0.03	mg/L
RBK	RBK-1	4/20/1987	Dissolved Phosphorus	28	0.18	mg/L
RBK	RBK-1	6/15/1987	Dissolved Phosphorus	1	0	mg/L
RBK	RBK-1	6/15/1987	Dissolved Phosphorus	29	0.01	mg/L
RBK	RBK-1	7/15/1987	Dissolved Phosphorus	1	0.01	mg/L
RBK	RBK-1	7/15/1987	Dissolved Phosphorus	29	0.98	mg/L
RBK	RBK-1	8/18/1987	Dissolved Phosphorus	1	0.01	mg/L
RBK	RBK-1	8/18/1987	Dissolved Phosphorus	26	0.91	mg/L
RBK	RBK-1	10/13/1987	Dissolved Phosphorus	1	0.12	mg/L
RBK	RBK-1	10/13/1987	Dissolved Phosphorus	28	1.65	mg/L
RBK	RBK-1	4/25/1995	Dissolved Phosphorus	1	0.01	mg/L
RBK	RBK-1	4/25/1995	Dissolved Phosphorus	1	0.02	mg/L
RBK	RBK-1	4/25/1995	Dissolved Phosphorus	1	0.04	mg/L
RBK	RBK-1	4/25/1995	Dissolved Phosphorus	30	0.21	mg/L
RBK	RBK-1	6/15/1995	Dissolved Phosphorus	1	0.01	mg/L
RBK	RBK-1	6/15/1995	Dissolved Phosphorus	26	0.85	mg/L
RBK	RBK-1	7/19/1995	Dissolved Phosphorus	1	0.01	mg/L
RBK	RBK-1	7/19/1995	Dissolved Phosphorus	25	2.45	mg/L
RBK	RBK-1	8/28/1995	Dissolved Phosphorus	1	0.01	mg/L
RBK	RBK-1	8/28/1995	Dissolved Phosphorus	25	1.44	mg/L
RBK	RBK-1	10/4/1995	Dissolved Phosphorus	1	0.03	mg/L
RBK	RBK-1	10/4/1995	Dissolved Phosphorus	26	2.12	mg/L
RBK	RBK-1	6/18/1979	Fecal Coliform	1	2	#/100 mL
RBK	RBK-1	8/30/1979	Fecal Coliform	1	18	#/100 mL
RBK	RBK-1	6/18/1979	Chlorophyll-a	4	28	µg/L
RBK	RBK-1	8/30/1979	Chlorophyll-a	6	38	µg/L
RBK	RBK-1	4/20/1987	Chlorophyll-a	30	6.61	µg/L
RBK	RBK-1	6/15/1987	Chlorophyll-a	8	22.3	µg/L
RBK	RBK-1	7/15/1987	Chlorophyll-a	5	41.37	µg/L
RBK	RBK-1	8/18/1987	Chlorophyll-a	4	66.16	µg/L
RBK	RBK-1	10/13/1987	Chlorophyll-a	13	17.24	µg/L
RBK	RBK-1	4/25/1995	Chlorophyll-a	30	5.34	µg/L
RBK	RBK-1	6/15/1995	Chlorophyll-a	2	301.92	µg/L
RBK	RBK-1	7/19/1995	Chlorophyll-a	3	68.89	µg/L
RBK	RBK-1	8/28/1995	Chlorophyll-a	3	88.11	µg/L
RBK	RBK-1	10/4/1995	Chlorophyll-a	4	110.01	µg/L
RBK	RBK-2	6/18/1979	Dissolved Oxygen	0	12.6	mg/L
RBK	RBK-2	6/18/1979	Dissolved Oxygen	1	13.1	mg/L
RBK	RBK-2	6/18/1979	Dissolved Oxygen	3	13.3	mg/L
RBK	RBK-2	6/18/1979	Dissolved Oxygen	5	13.2	mg/L
RBK	RBK-2	6/18/1979	Dissolved Oxygen	7	12	mg/L
RBK	RBK-2	6/18/1979	Dissolved Oxygen	9	10.6	mg/L
RBK	RBK-2	6/18/1979	Dissolved Oxygen	11	7.8	mg/L

RBK	RBK-2	6/18/1979	Dissolved Oxygen	13	1.9	mg/L
RBK	RBK-2	6/18/1979	Dissolved Oxygen	15	1.3	mg/L
RBK	RBK-2	6/18/1979	Dissolved Oxygen	17	1.1	mg/L
RBK	RBK-2	6/18/1979	Dissolved Oxygen	19	1	mg/L
RBK	RBK-2	8/30/1979	Dissolved Oxygen	0	10.8	mg/L
RBK	RBK-2	8/30/1979	Dissolved Oxygen	1	8.5	mg/L
RBK	RBK-2	8/30/1979	Dissolved Oxygen	3	5	mg/L
RBK	RBK-2	8/30/1979	Dissolved Oxygen	5	3.6	mg/L
RBK	RBK-2	8/30/1979	Dissolved Oxygen	7	0.1	mg/L
RBK	RBK-2	8/30/1979	Dissolved Oxygen	9	0	mg/L
RBK	RBK-2	4/20/1987	Dissolved Oxygen	0	9.5	mg/L
RBK	RBK-2	4/20/1987	Dissolved Oxygen	1	9.6	mg/L
RBK	RBK-2	4/20/1987	Dissolved Oxygen	3	10.1	mg/L
RBK	RBK-2	4/20/1987	Dissolved Oxygen	5	11	mg/L
RBK	RBK-2	4/20/1987	Dissolved Oxygen	7	10.6	mg/L
RBK	RBK-2	4/20/1987	Dissolved Oxygen	9	10.3	mg/L
RBK	RBK-2	4/20/1987	Dissolved Oxygen	13	8.5	mg/L
RBK	RBK-2	4/20/1987	Dissolved Oxygen	15	7.5	mg/L
RBK	RBK-2	4/20/1987	Dissolved Oxygen	17	6.9	mg/L
RBK	RBK-2	4/20/1987	Dissolved Oxygen	19	6	mg/L
RBK	RBK-2	4/20/1987	Dissolved Oxygen	21	3.9	mg/L
RBK	RBK-2	4/20/1987	Dissolved Oxygen	22	3.4	mg/L
RBK	RBK-2	6/15/1987	Dissolved Oxygen	0	11.6	mg/L
RBK	RBK-2	6/15/1987	Dissolved Oxygen	1	11.7	mg/L
RBK	RBK-2	6/15/1987	Dissolved Oxygen	3	12.3	mg/L
RBK	RBK-2	6/15/1987	Dissolved Oxygen	5	13.8	mg/L
RBK	RBK-2	6/15/1987	Dissolved Oxygen	7	8.6	mg/L
RBK	RBK-2	6/15/1987	Dissolved Oxygen	9	2	mg/L
RBK	RBK-2	6/15/1987	Dissolved Oxygen	11	0.7	mg/L
RBK	RBK-2	7/15/1987	Dissolved Oxygen	0	11.1	mg/L
RBK	RBK-2	7/15/1987	Dissolved Oxygen	3	11	mg/L
RBK	RBK-2	7/15/1987	Dissolved Oxygen	5	10.6	mg/L
RBK	RBK-2	7/15/1987	Dissolved Oxygen	7	3.4	mg/L
RBK	RBK-2	7/15/1987	Dissolved Oxygen	9	1.5	mg/L
RBK	RBK-2	7/15/1987	Dissolved Oxygen	11	0.5	mg/L
RBK	RBK-2	8/18/1987	Dissolved Oxygen	0	9.5	mg/L
RBK	RBK-2	8/18/1987	Dissolved Oxygen	1	9.4	mg/L
RBK	RBK-2	8/18/1987	Dissolved Oxygen	3	9.3	mg/L
RBK	RBK-2	8/18/1987	Dissolved Oxygen	5	8.8	mg/L
RBK	RBK-2	8/18/1987	Dissolved Oxygen	7	2.2	mg/L
RBK	RBK-2	8/18/1987	Dissolved Oxygen	9	0.5	mg/L
RBK	RBK-2	8/18/1987	Dissolved Oxygen	13	0.6	mg/L
RBK	RBK-2	8/18/1987	Dissolved Oxygen	19	0.8	mg/L
RBK	RBK-2	8/18/1987	Dissolved Oxygen	21	0.7	mg/L
RBK	RBK-2	8/18/1987	Dissolved Oxygen	22	0.9	mg/L
RBK	RBK-2	10/13/1987	Dissolved Oxygen	0	3.9	mg/L
RBK	RBK-2	10/13/1987	Dissolved Oxygen	3	3.8	mg/L
RBK	RBK-2	10/13/1987	Dissolved Oxygen	5	3.5	mg/L
RBK	RBK-2	10/13/1987	Dissolved Oxygen	7	3.4	mg/L

RBK	RBK-2	10/13/1987	Dissolved Oxygen	9	3.2	mg/L
RBK	RBK-2	10/13/1987	Dissolved Oxygen	11	3.1	mg/L
RBK	RBK-2	10/13/1987	Dissolved Oxygen	15	3.3	mg/L
RBK	RBK-2	10/13/1987	Dissolved Oxygen	19	4	mg/L
RBK	RBK-2	10/13/1987	Dissolved Oxygen	21	3.6	mg/L
RBK	RBK-2	10/13/1987	Dissolved Oxygen	22	0.6	mg/L
RBK	RBK-2	4/25/1995	Dissolved Oxygen	0	8.3	mg/L
RBK	RBK-2	4/25/1995	Dissolved Oxygen	4	8	mg/L
RBK	RBK-2	4/25/1995	Dissolved Oxygen	6	7.9	mg/L
RBK	RBK-2	4/25/1995	Dissolved Oxygen	8	7.2	mg/L
RBK	RBK-2	4/25/1995	Dissolved Oxygen	10	6.8	mg/L
RBK	RBK-2	4/25/1995	Dissolved Oxygen	12	6.5	mg/L
RBK	RBK-2	4/25/1995	Dissolved Oxygen	14	1.7	mg/L
RBK	RBK-2	4/25/1995	Dissolved Oxygen	16	0.6	mg/L
RBK	RBK-2	4/25/1995	Dissolved Oxygen	18	0.5	mg/L
RBK	RBK-2	4/25/1995	Dissolved Oxygen	20	0.4	mg/L
RBK	RBK-2	4/25/1995	Dissolved Oxygen	22	0.3	mg/L
RBK	RBK-2	4/25/1995	Dissolved Oxygen	24	0.2	mg/L
RBK	RBK-2	6/15/1995	Dissolved Oxygen	0	8.4	mg/L
RBK	RBK-2	6/15/1995	Dissolved Oxygen	2	8.5	mg/L
RBK	RBK-2	6/15/1995	Dissolved Oxygen	4	6.4	mg/L
RBK	RBK-2	6/15/1995	Dissolved Oxygen	6	4.8	mg/L
RBK	RBK-2	6/15/1995	Dissolved Oxygen	8	1.4	mg/L
RBK	RBK-2	6/15/1995	Dissolved Oxygen	10	0.5	mg/L
RBK	RBK-2	6/15/1995	Dissolved Oxygen	12	0.2	mg/L
RBK	RBK-2	6/15/1995	Dissolved Oxygen	16	0.1	mg/L
RBK	RBK-2	7/19/1995	Dissolved Oxygen	0	13.4	mg/L
RBK	RBK-2	7/19/1995	Dissolved Oxygen	2	15.9	mg/L
RBK	RBK-2	7/19/1995	Dissolved Oxygen	4	13.9	mg/L
RBK	RBK-2	7/19/1995	Dissolved Oxygen	6	1.1	mg/L
RBK	RBK-2	7/19/1995	Dissolved Oxygen	8	0.9	mg/L
RBK	RBK-2	7/19/1995	Dissolved Oxygen	10	0.5	mg/L
RBK	RBK-2	8/28/1995	Dissolved Oxygen	0	14.2	mg/L
RBK	RBK-2	8/28/1995	Dissolved Oxygen	2	13.5	mg/L
RBK	RBK-2	8/28/1995	Dissolved Oxygen	4	5.8	mg/L
RBK	RBK-2	8/28/1995	Dissolved Oxygen	6	0.4	mg/L
RBK	RBK-2	8/28/1995	Dissolved Oxygen	8	0.3	mg/L
RBK	RBK-2	8/28/1995	Dissolved Oxygen	10	0.2	mg/L
RBK	RBK-2	10/4/1995	Dissolved Oxygen	0	12.6	mg/L
RBK	RBK-2	10/4/1995	Dissolved Oxygen	2	12.9	mg/L
RBK	RBK-2	10/4/1995	Dissolved Oxygen	4	13	mg/L
RBK	RBK-2	10/4/1995	Dissolved Oxygen	6	12	mg/L
RBK	RBK-2	10/4/1995	Dissolved Oxygen	10	9.3	mg/L
RBK	RBK-2	10/4/1995	Dissolved Oxygen	12	0.5	mg/L
RBK	RBK-2	10/4/1995	Dissolved Oxygen	14	0.4	mg/L
RBK	RBK-2	6/18/1979	Suspended Solids	1	10	mg/L
RBK	RBK-2	6/18/1979	Suspended Solids	20	7	mg/L
RBK	RBK-2	8/30/1979	Suspended Solids	1	10	mg/L
RBK	RBK-2	8/30/1979	Suspended Solids	20	6	mg/L

RBK	RBK-2	4/20/1987	Suspended Solids	1	1	mg/L
RBK	RBK-2	6/15/1987	Suspended Solids	1	5	mg/L
RBK	RBK-2	7/15/1987	Suspended Solids	1	4	mg/L
RBK	RBK-2	8/11/1987	Suspended Solids	1	7	mg/L
RBK	RBK-2	10/13/1987	Suspended Solids	1	3	mg/L
RBK	RBK-2	4/25/1995	Suspended Solids	1	1	mg/L
RBK	RBK-2	4/25/1995	Suspended Solids	22	8	mg/L
RBK	RBK-2	6/15/1995	Suspended Solids	1	34	mg/L
RBK	RBK-2	7/19/1995	Suspended Solids	1	11	mg/L
RBK	RBK-2	8/28/1995	Suspended Solids	1	40	mg/L
RBK	RBK-2	10/4/1995	Suspended Solids	1	13	mg/L
RBK	RBK-2	6/18/1979	Ammonia	1	0.02	mg/L
RBK	RBK-2	6/18/1979	Ammonia	20	0.44	mg/L
RBK	RBK-2	8/30/1979	Ammonia	1	0.07	mg/L
RBK	RBK-2	8/30/1979	Ammonia	20	1.8	mg/L
RBK	RBK-2	4/20/1987	Ammonia	1	0.1	mg/L
RBK	RBK-2	6/15/1987	Ammonia	1	0.1	mg/L
RBK	RBK-2	7/15/1987	Ammonia	1	0.1	mg/L
RBK	RBK-2	8/11/1987	Ammonia	1	0.1	mg/L
RBK	RBK-2	10/13/1987	Ammonia	1	0.76	mg/L
RBK	RBK-2	4/25/1995	Ammonia	1	0.28	mg/L
RBK	RBK-2	4/25/1995	Ammonia	22	1.7	mg/L
RBK	RBK-2	6/15/1995	Ammonia	1	0.06	mg/L
RBK	RBK-2	7/19/1995	Ammonia	1	0.01	mg/L
RBK	RBK-2	8/28/1995	Ammonia	1	0.03	mg/L
RBK	RBK-2	10/4/1995	Ammonia	1	0.09	mg/L
RBK	RBK-2	6/18/1979	Un-inonized Ammonia	1	0	mg/L
RBK	RBK-2	6/18/1979	Un-inonized Ammonia	20	0	mg/L
RBK	RBK-2	8/30/1979	Un-inonized Ammonia	1	0.01	mg/L
RBK	RBK-2	8/30/1979	Un-inonized Ammonia	20	0	mg/L
RBK	RBK-2	4/20/1987	Un-inonized Ammonia	1	0	mg/L
RBK	RBK-2	6/15/1987	Un-inonized Ammonia	1	0.02	mg/L
RBK	RBK-2	7/15/1987	Un-inonized Ammonia	1	0.02	mg/L
RBK	RBK-2	10/13/1987	Un-inonized Ammonia	1	0	mg/L
RBK	RBK-2	4/25/1995	Un-inonized Ammonia	22	0.01	mg/L
RBK	RBK-2	6/18/1979	TKN	1	0.8	mg/L
RBK	RBK-2	6/18/1979	TKN	20	1.1	mg/L
RBK	RBK-2	8/30/1979	TKN	1	1.7	mg/L
RBK	RBK-2	8/30/1979	TKN	20	2.3	mg/L
RBK	RBK-2	4/20/1987	TKN	1	0.8	mg/L
RBK	RBK-2	6/15/1987	TKN	1	0.9	mg/L
RBK	RBK-2	7/15/1987	TKN	1	1.8	mg/L
RBK	RBK-2	8/11/1987	TKN	1	1.6	mg/L
RBK	RBK-2	10/13/1987	TKN	1	2.2	mg/L
RBK	RBK-2	4/25/1995	TKN	1	0.59	mg/L
RBK	RBK-2	4/25/1995	TKN	22	1.8	mg/L
RBK	RBK-2	6/15/1995	TKN	1	3	mg/L
RBK	RBK-2	7/19/1995	TKN	1	0.78	mg/L
RBK	RBK-2	8/28/1995	TKN	1	1.9	mg/L

RBK	RBK-2	10/4/1995	TKN	1	1.1	mg/L
RBK	RBK-2	6/18/1979	Nitrate + Nitrite	1	1.9	mg/L
RBK	RBK-2	6/18/1979	Nitrate + Nitrite	20	2.3	mg/L
RBK	RBK-2	8/30/1979	Nitrate + Nitrite	1	0.1	mg/L
RBK	RBK-2	8/30/1979	Nitrate + Nitrite	20	0.01	mg/L
RBK	RBK-2	4/20/1987	Nitrate + Nitrite	1	0.4	mg/L
RBK	RBK-2	6/15/1987	Nitrate + Nitrite	1	0.01	mg/L
RBK	RBK-2	7/15/1987	Nitrate + Nitrite	1	0.1	mg/L
RBK	RBK-2	8/11/1987	Nitrate + Nitrite	1	0.1	mg/L
RBK	RBK-2	10/13/1987	Nitrate + Nitrite	1	0.1	mg/L
RBK	RBK-2	4/25/1995	Nitrate + Nitrite	1	0.87	mg/L
RBK	RBK-2	4/25/1995	Nitrate + Nitrite	22	0.01	mg/L
RBK	RBK-2	6/15/1995	Nitrate + Nitrite	1	0.92	mg/L
RBK	RBK-2	7/19/1995	Nitrate + Nitrite	1	0.01	mg/L
RBK	RBK-2	8/28/1995	Nitrate + Nitrite	1	0.01	mg/L
RBK	RBK-2	10/4/1995	Nitrate + Nitrite	1	0.01	mg/L
RBK	RBK-2	6/18/1979	Total Phosphorus	1	0.03	mg/L
RBK	RBK-2	6/18/1979	Total Phosphorus	20	0.04	mg/L
RBK	RBK-2	8/30/1979	Total Phosphorus	1	0.09	mg/L
RBK	RBK-2	8/30/1979	Total Phosphorus	20	0.22	mg/L
RBK	RBK-2	4/20/1987	Total Phosphorus	1	0.05	mg/L
RBK	RBK-2	6/15/1987	Total Phosphorus	1	0.03	mg/L
RBK	RBK-2	7/15/1987	Total Phosphorus	1	0.08	mg/L
RBK	RBK-2	8/11/1987	Total Phosphorus	1	0.08	mg/L
RBK	RBK-2	10/13/1987	Total Phosphorus	1	0.17	mg/L
RBK	RBK-2	4/25/1995	Total Phosphorus	1	0.06	mg/L
RBK	RBK-2	4/25/1995	Total Phosphorus	22	0.29	mg/L
RBK	RBK-2	6/15/1995	Total Phosphorus	1	0.07	mg/L
RBK	RBK-2	7/19/1995	Total Phosphorus	1	0.07	mg/L
RBK	RBK-2	8/28/1995	Total Phosphorus	1	0.1	mg/L
RBK	RBK-2	10/4/1995	Total Phosphorus	1	0.1	mg/L
RBK	RBK-2	6/18/1979	Dissolved Phosphorus	1	0.01	mg/L
RBK	RBK-2	8/30/1979	Dissolved Phosphorus	1	0.02	mg/L
RBK	RBK-2	8/30/1979	Dissolved Phosphorus	20	0.2	mg/L
RBK	RBK-2	4/20/1987	Dissolved Phosphorus	1	0.03	mg/L
RBK	RBK-2	6/15/1987	Dissolved Phosphorus	1	0.01	mg/L
RBK	RBK-2	7/15/1987	Dissolved Phosphorus	1	0.01	mg/L
RBK	RBK-2	8/11/1987	Dissolved Phosphorus	1	0.03	mg/L
RBK	RBK-2	10/13/1987	Dissolved Phosphorus	1	0.13	mg/L
RBK	RBK-2	4/25/1995	Dissolved Phosphorus	1	0.05	mg/L
RBK	RBK-2	4/25/1995	Dissolved Phosphorus	22	0.25	mg/L
RBK	RBK-2	6/15/1995	Dissolved Phosphorus	1	0.02	mg/L
RBK	RBK-2	7/19/1995	Dissolved Phosphorus	1	0.02	mg/L
RBK	RBK-2	8/28/1995	Dissolved Phosphorus	1	0.02	mg/L
RBK	RBK-2	10/4/1995	Dissolved Phosphorus	1	0.03	mg/L
RBK	RBK-2	6/18/1979	Fecal Coliform	1	2	#/100 mL
RBK	RBK-2	8/30/1979	Fecal Coliform	1	4	#/100 mL
RBK	RBK-2	6/18/1979	Chlorophyll-a	4	29.5	µg/L
RBK	RBK-2	8/30/1979	Chlorophyll-a	5	53	µg/L

RBK	RBK-2	4/20/1987	Chlorophyll-a	22	23.58	µg/L
RBK	RBK-2	6/15/1987	Chlorophyll-a	8	26.99	µg/L
RBK	RBK-2	7/15/1987	Chlorophyll-a	5	49	µg/L
RBK	RBK-2	8/18/1987	Chlorophyll-a	4	65.09	µg/L
RBK	RBK-2	10/13/1987	Chlorophyll-a	11	29.36	µg/L
RBK	RBK-2	4/25/1995	Chlorophyll-a	22	4.01	µg/L
RBK	RBK-2	6/15/1995	Chlorophyll-a	2	187.97	µg/L
RBK	RBK-2	7/19/1995	Chlorophyll-a	3	66.75	µg/L
RBK	RBK-2	8/28/1995	Chlorophyll-a	3	107.69	µg/L
RBK	RBK-2	10/4/1995	Chlorophyll-a	5	105.28	µg/L
RBK	RBK-3	6/18/1979	Dissolved Oxygen	0	13.3	mg/L
RBK	RBK-3	6/18/1979	Dissolved Oxygen	1	13.6	mg/L
RBK	RBK-3	6/18/1979	Dissolved Oxygen	3	13.8	mg/L
RBK	RBK-3	6/18/1979	Dissolved Oxygen	7	10.5	mg/L
RBK	RBK-3	6/18/1979	Dissolved Oxygen	9	6.9	mg/L
RBK	RBK-3	6/18/1979	Dissolved Oxygen	11	3.2	mg/L
RBK	RBK-3	6/18/1979	Dissolved Oxygen	13	1.2	mg/L
RBK	RBK-3	6/18/1979	Dissolved Oxygen	15	1	mg/L
RBK	RBK-3	8/30/1979	Dissolved Oxygen	0	11.4	mg/L
RBK	RBK-3	8/30/1979	Dissolved Oxygen	1	11.9	mg/L
RBK	RBK-3	8/30/1979	Dissolved Oxygen	3	6.4	mg/L
RBK	RBK-3	8/30/1979	Dissolved Oxygen	5	3.4	mg/L
RBK	RBK-3	8/30/1979	Dissolved Oxygen	7	0.2	mg/L
RBK	RBK-3	8/30/1979	Dissolved Oxygen	9	0	mg/L
RBK	RBK-3	4/20/1987	Dissolved Oxygen	0	9.7	mg/L
RBK	RBK-3	4/20/1987	Dissolved Oxygen	3	10	mg/L
RBK	RBK-3	4/20/1987	Dissolved Oxygen	5	10.8	mg/L
RBK	RBK-3	4/20/1987	Dissolved Oxygen	7	11.4	mg/L
RBK	RBK-3	4/20/1987	Dissolved Oxygen	9	11.1	mg/L
RBK	RBK-3	4/20/1987	Dissolved Oxygen	11	10.5	mg/L
RBK	RBK-3	4/20/1987	Dissolved Oxygen	13	9	mg/L
RBK	RBK-3	4/20/1987	Dissolved Oxygen	15	7	mg/L
RBK	RBK-3	4/20/1987	Dissolved Oxygen	17	5.2	mg/L
RBK	RBK-3	6/15/1987	Dissolved Oxygen	0	11.8	mg/L
RBK	RBK-3	6/15/1987	Dissolved Oxygen	1	12.4	mg/L
RBK	RBK-3	6/15/1987	Dissolved Oxygen	3	12.8	mg/L
RBK	RBK-3	6/15/1987	Dissolved Oxygen	5	14.3	mg/L
RBK	RBK-3	6/15/1987	Dissolved Oxygen	7	11	mg/L
RBK	RBK-3	6/15/1987	Dissolved Oxygen	9	1.9	mg/L
RBK	RBK-3	6/15/1987	Dissolved Oxygen	11	0.7	mg/L
RBK	RBK-3	7/15/1987	Dissolved Oxygen	0	11.8	mg/L
RBK	RBK-3	7/15/1987	Dissolved Oxygen	1	11.5	mg/L
RBK	RBK-3	7/15/1987	Dissolved Oxygen	3	11.1	mg/L
RBK	RBK-3	7/15/1987	Dissolved Oxygen	5	10.1	mg/L
RBK	RBK-3	7/15/1987	Dissolved Oxygen	7	8.3	mg/L
RBK	RBK-3	7/15/1987	Dissolved Oxygen	9	2.7	mg/L
RBK	RBK-3	7/15/1987	Dissolved Oxygen	11	0.5	mg/L
RBK	RBK-3	8/18/1987	Dissolved Oxygen	0	9.4	mg/L
RBK	RBK-3	8/18/1987	Dissolved Oxygen	3	9.2	mg/L

RBK	RBK-3	8/18/1987	Dissolved Oxygen	5	9.1	mg/L
RBK	RBK-3	8/18/1987	Dissolved Oxygen	7	5	mg/L
RBK	RBK-3	8/18/1987	Dissolved Oxygen	9	0.5	mg/L
RBK	RBK-3	8/18/1987	Dissolved Oxygen	13	0.6	mg/L
RBK	RBK-3	10/13/1987	Dissolved Oxygen	0	4.6	mg/L
RBK	RBK-3	10/13/1987	Dissolved Oxygen	1	4.5	mg/L
RBK	RBK-3	10/13/1987	Dissolved Oxygen	5	4.4	mg/L
RBK	RBK-3	10/13/1987	Dissolved Oxygen	11	4.8	mg/L
RBK	RBK-3	10/13/1987	Dissolved Oxygen	17	4.1	mg/L
RBK	RBK-3	10/13/1987	Dissolved Oxygen	18	3.7	mg/L
RBK	RBK-3	4/25/1995	Dissolved Oxygen	0	8.3	mg/L
RBK	RBK-3	4/25/1995	Dissolved Oxygen	6	8.2	mg/L
RBK	RBK-3	4/25/1995	Dissolved Oxygen	8	7.6	mg/L
RBK	RBK-3	4/25/1995	Dissolved Oxygen	10	7.5	mg/L
RBK	RBK-3	4/25/1995	Dissolved Oxygen	12	7.3	mg/L
RBK	RBK-3	4/25/1995	Dissolved Oxygen	14	5	mg/L
RBK	RBK-3	4/25/1995	Dissolved Oxygen	16	1.5	mg/L
RBK	RBK-3	6/15/1995	Dissolved Oxygen	0	8.5	mg/L
RBK	RBK-3	6/15/1995	Dissolved Oxygen	4	6.5	mg/L
RBK	RBK-3	6/15/1995	Dissolved Oxygen	6	5.1	mg/L
RBK	RBK-3	6/15/1995	Dissolved Oxygen	8	1.7	mg/L
RBK	RBK-3	6/15/1995	Dissolved Oxygen	10	0.3	mg/L
RBK	RBK-3	6/15/1995	Dissolved Oxygen	12	0.2	mg/L
RBK	RBK-3	6/15/1995	Dissolved Oxygen	16	0.1	mg/L
RBK	RBK-3	7/19/1995	Dissolved Oxygen	0	14	mg/L
RBK	RBK-3	7/19/1995	Dissolved Oxygen	2	16.6	mg/L
RBK	RBK-3	7/19/1995	Dissolved Oxygen	4	14.3	mg/L
RBK	RBK-3	7/19/1995	Dissolved Oxygen	6	3.4	mg/L
RBK	RBK-3	7/19/1995	Dissolved Oxygen	8	0.5	mg/L
RBK	RBK-3	7/19/1995	Dissolved Oxygen	12	0.4	mg/L
RBK	RBK-3	8/28/1995	Dissolved Oxygen	0	13.9	mg/L
RBK	RBK-3	8/28/1995	Dissolved Oxygen	2	13.7	mg/L
RBK	RBK-3	8/28/1995	Dissolved Oxygen	4	9.1	mg/L
RBK	RBK-3	8/28/1995	Dissolved Oxygen	6	0.4	mg/L
RBK	RBK-3	8/28/1995	Dissolved Oxygen	8	0.3	mg/L
RBK	RBK-3	10/4/1995	Dissolved Oxygen	0	12.2	mg/L
RBK	RBK-3	10/4/1995	Dissolved Oxygen	4	12.1	mg/L
RBK	RBK-3	10/4/1995	Dissolved Oxygen	6	11.6	mg/L
RBK	RBK-3	10/4/1995	Dissolved Oxygen	8	11.3	mg/L
RBK	RBK-3	10/4/1995	Dissolved Oxygen	10	2.9	mg/L
RBK	RBK-3	10/4/1995	Dissolved Oxygen	12	0.4	mg/L
RBK	RBK-3	6/18/1979	Suspended Solids	1	8	mg/L
RBK	RBK-3	6/18/1979	Suspended Solids	13	6	mg/L
RBK	RBK-3	8/30/1979	Suspended Solids	1	9	mg/L
RBK	RBK-3	8/30/1979	Suspended Solids	16	11	mg/L
RBK	RBK-3	4/20/1987	Suspended Solids	1	1	mg/L
RBK	RBK-3	6/15/1987	Suspended Solids	1	6	mg/L
RBK	RBK-3	7/15/1987	Suspended Solids	1	5	mg/L
RBK	RBK-3	8/18/1987	Suspended Solids	1	7	mg/L

RBK	RBK-3	10/13/1987	Suspended Solids	1	4	mg/L
RBK	RBK-3	4/25/1995	Suspended Solids	1	1	mg/L
RBK	RBK-3	4/25/1995	Suspended Solids	14	11	mg/L
RBK	RBK-3	6/15/1995	Suspended Solids	1	18	mg/L
RBK	RBK-3	7/19/1995	Suspended Solids	1	9	mg/L
RBK	RBK-3	8/28/1995	Suspended Solids	1	34	mg/L
RBK	RBK-3	10/4/1995	Suspended Solids	1	12	mg/L
RBK	RBK-3	6/18/1979	Ammonia	1	0.02	mg/L
RBK	RBK-3	6/18/1979	Ammonia	13	0.05	mg/L
RBK	RBK-3	8/30/1979	Ammonia	1	0.06	mg/L
RBK	RBK-3	8/30/1979	Ammonia	16	1.1	mg/L
RBK	RBK-3	4/20/1987	Ammonia	1	0.1	mg/L
RBK	RBK-3	6/15/1987	Ammonia	1	0.1	mg/L
RBK	RBK-3	7/15/1987	Ammonia	1	0.1	mg/L
RBK	RBK-3	8/18/1987	Ammonia	1	0.1	mg/L
RBK	RBK-3	10/13/1987	Ammonia	1	0.67	mg/L
RBK	RBK-3	4/25/1995	Ammonia	1	0.28	mg/L
RBK	RBK-3	4/25/1995	Ammonia	14	0.72	mg/L
RBK	RBK-3	6/15/1995	Ammonia	1	0.03	mg/L
RBK	RBK-3	7/19/1995	Ammonia	1	0.01	mg/L
RBK	RBK-3	8/28/1995	Ammonia	1	0.01	mg/L
RBK	RBK-3	10/4/1995	Ammonia	1	0.07	mg/L
RBK	RBK-3	6/18/1979	Un-inonized Ammonia	1	0	mg/L
RBK	RBK-3	6/18/1979	Un-inonized Ammonia	13	0	mg/L
RBK	RBK-3	8/30/1979	Un-inonized Ammonia	1	0.01	mg/L
RBK	RBK-3	8/30/1979	Un-inonized Ammonia	16	0.01	mg/L
RBK	RBK-3	4/20/1987	Un-inonized Ammonia	1	0	mg/L
RBK	RBK-3	6/15/1987	Un-inonized Ammonia	1	0.02	mg/L
RBK	RBK-3	7/15/1987	Un-inonized Ammonia	1	0.01	mg/L
RBK	RBK-3	8/18/1987	Un-inonized Ammonia	1	0.02	mg/L
RBK	RBK-3	10/13/1987	Un-inonized Ammonia	1	0	mg/L
RBK	RBK-3	4/25/1995	Un-inonized Ammonia	14	0.01	mg/L
RBK	RBK-3	6/18/1979	TKN	1	0.7	mg/L
RBK	RBK-3	6/18/1979	TKN	13	0.8	mg/L
RBK	RBK-3	8/30/1979	TKN	1	2	mg/L
RBK	RBK-3	8/30/1979	TKN	16	1.8	mg/L
RBK	RBK-3	4/20/1987	TKN	1	1.2	mg/L
RBK	RBK-3	6/15/1987	TKN	1	0.9	mg/L
RBK	RBK-3	7/15/1987	TKN	1	2	mg/L
RBK	RBK-3	8/18/1987	TKN	1	1.6	mg/L
RBK	RBK-3	10/13/1987	TKN	1	2	mg/L
RBK	RBK-3	4/25/1995	TKN	1	0.65	mg/L
RBK	RBK-3	4/25/1995	TKN	14	0.9	mg/L
RBK	RBK-3	6/15/1995	TKN	1	2.7	mg/L
RBK	RBK-3	7/19/1995	TKN	1	0.78	mg/L
RBK	RBK-3	8/28/1995	TKN	1	0.98	mg/L
RBK	RBK-3	10/4/1995	TKN	1	1.2	mg/L
RBK	RBK-3	6/18/1979	Nitrate + Nitrite	1	1.9	mg/L
RBK	RBK-3	6/18/1979	Nitrate + Nitrite	13	2	mg/L

RBK	RBK-3	8/30/1979	Nitrate + Nitrite	1	0.17	mg/L
RBK	RBK-3	8/30/1979	Nitrate + Nitrite	16	0.06	mg/L
RBK	RBK-3	4/20/1987	Nitrate + Nitrite	1	0.41	mg/L
RBK	RBK-3	6/15/1987	Nitrate + Nitrite	1	0.01	mg/L
RBK	RBK-3	7/15/1987	Nitrate + Nitrite	1	0.1	mg/L
RBK	RBK-3	8/18/1987	Nitrate + Nitrite	1	0.1	mg/L
RBK	RBK-3	10/13/1987	Nitrate + Nitrite	1	0.1	mg/L
RBK	RBK-3	4/25/1995	Nitrate + Nitrite	1	1.09	mg/L
RBK	RBK-3	4/25/1995	Nitrate + Nitrite	14	1.94	mg/L
RBK	RBK-3	6/15/1995	Nitrate + Nitrite	1	0.93	mg/L
RBK	RBK-3	7/19/1995	Nitrate + Nitrite	1	0.01	mg/L
RBK	RBK-3	8/28/1995	Nitrate + Nitrite	1	0.01	mg/L
RBK	RBK-3	10/4/1995	Nitrate + Nitrite	1	0.01	mg/L
RBK	RBK-3	6/18/1979	Total Phosphorus	1	0.05	mg/L
RBK	RBK-3	6/18/1979	Total Phosphorus	13	0.04	mg/L
RBK	RBK-3	8/30/1979	Total Phosphorus	1	0.11	mg/L
RBK	RBK-3	8/30/1979	Total Phosphorus	16	0.14	mg/L
RBK	RBK-3	4/20/1987	Total Phosphorus	1	0.04	mg/L
RBK	RBK-3	6/15/1987	Total Phosphorus	1	0.03	mg/L
RBK	RBK-3	7/15/1987	Total Phosphorus	1	0.07	mg/L
RBK	RBK-3	8/18/1987	Total Phosphorus	1	0.08	mg/L
RBK	RBK-3	10/13/1987	Total Phosphorus	1	0.18	mg/L
RBK	RBK-3	4/25/1995	Total Phosphorus	1	0.06	mg/L
RBK	RBK-3	4/25/1995	Total Phosphorus	14	0.16	mg/L
RBK	RBK-3	6/15/1995	Total Phosphorus	1	0.07	mg/L
RBK	RBK-3	7/19/1995	Total Phosphorus	1	0.06	mg/L
RBK	RBK-3	8/28/1995	Total Phosphorus	1	0.1	mg/L
RBK	RBK-3	10/4/1995	Total Phosphorus	1	0.12	mg/L
RBK	RBK-3	6/18/1979	Dissolved Phosphorus	1	0.01	mg/L
RBK	RBK-3	8/30/1979	Dissolved Phosphorus	1	0.03	mg/L
RBK	RBK-3	8/30/1979	Dissolved Phosphorus	16	0.11	mg/L
RBK	RBK-3	4/20/1987	Dissolved Phosphorus	1	0.03	mg/L
RBK	RBK-3	6/15/1987	Dissolved Phosphorus	1	0.01	mg/L
RBK	RBK-3	7/15/1987	Dissolved Phosphorus	1	0.02	mg/L
RBK	RBK-3	8/18/1987	Dissolved Phosphorus	1	0.02	mg/L
RBK	RBK-3	10/13/1987	Dissolved Phosphorus	1	0.12	mg/L
RBK	RBK-3	4/25/1995	Dissolved Phosphorus	1	0.05	mg/L
RBK	RBK-3	4/25/1995	Dissolved Phosphorus	14	0.11	mg/L
RBK	RBK-3	6/15/1995	Dissolved Phosphorus	1	0.02	mg/L
RBK	RBK-3	7/19/1995	Dissolved Phosphorus	1	0.02	mg/L
RBK	RBK-3	8/28/1995	Dissolved Phosphorus	1	0.02	mg/L
RBK	RBK-3	10/4/1995	Dissolved Phosphorus	1	0.03	mg/L
RBK	RBK-3	6/18/1979	Fecal Coliform	1	4	#/100 mL
RBK	RBK-3	8/30/1979	Fecal Coliform	1	4	#/100 mL
RBK	RBK-3	6/18/1979	Chlorophyll-a	4	28.1	µg/L
RBK	RBK-3	8/30/1979	Chlorophyll-a	5	59	µg/L
RBK	RBK-3	4/20/1987	Chlorophyll-a	17	8.71	µg/L
RBK	RBK-3	6/15/1987	Chlorophyll-a	8	31.15	µg/L
RBK	RBK-3	7/15/1987	Chlorophyll-a	5	44.97	µg/L

RBK	RBK-3	8/18/1987	Chlorophyll-a		4	64.03	µg/L
RBK	RBK-3	10/13/1987	Chlorophyll-a		10	37.38	µg/L
RBK	RBK-3	4/25/1995	Chlorophyll-a		14	1.6	µg/L
RBK	RBK-3	6/15/1995	Chlorophyll-a		3	193.31	µg/L
RBK	RBK-3	7/19/1995	Chlorophyll-a		3	69.95	µg/L
RBK	RBK-3	8/28/1995	Chlorophyll-a		3	109.3	µg/L
RBK	RBK-3	10/4/1995	Chlorophyll-a		5	115.46	µg/L
RBP	RBP-1	6/3/1981	Dissolved Oxygen		0	9	mg/L
RBP	RBP-1	6/3/1981	Dissolved Oxygen		3	6.6	mg/L
RBP	RBP-1	6/3/1981	Dissolved Oxygen		5	3.4	mg/L
RBP	RBP-1	6/3/1981	Dissolved Oxygen		7	1.7	mg/L
RBP	RBP-1	8/24/1981	Dissolved Oxygen		0	16.8	mg/L
RBP	RBP-1	8/24/1981	Dissolved Oxygen		1	16.6	mg/L
RBP	RBP-1	8/24/1981	Dissolved Oxygen		3	9	mg/L
RBP	RBP-1	8/24/1981	Dissolved Oxygen		5	5	mg/L
RBP	RBP-1	8/24/1981	Dissolved Oxygen		7	1	mg/L
RBP	RBP-1	6/22/1992	Dissolved Oxygen		0	12.4	mg/L
RBP	RBP-1	6/22/1992	Dissolved Oxygen		1	11.4	mg/L
RBP	RBP-1	6/22/1992	Dissolved Oxygen		2	11.2	mg/L
RBP	RBP-1	6/22/1992	Dissolved Oxygen		3	11.1	mg/L
RBP	RBP-1	6/22/1992	Dissolved Oxygen		5	10.8	mg/L
RBP	RBP-1	6/22/1992	Dissolved Oxygen		6	10.7	mg/L
RBP	RBP-1	6/22/1992	Dissolved Oxygen		7	10.4	mg/L
RBP	RBP-1	6/22/1992	Dissolved Oxygen		8	10.3	mg/L
RBP	RBP-1	6/22/1992	Dissolved Oxygen		9	10.2	mg/L
RBP	RBP-1	4/21/1998	Dissolved Oxygen		0	12.6	mg/L
RBP	RBP-1	4/21/1998	Dissolved Oxygen		1	12.3	mg/L
RBP	RBP-1	4/21/1998	Dissolved Oxygen		3	12	mg/L
RBP	RBP-1	4/21/1998	Dissolved Oxygen		5	9	mg/L
RBP	RBP-1	6/11/1998	Dissolved Oxygen		0	7.2	mg/L
RBP	RBP-1	6/11/1998	Dissolved Oxygen		1	6.7	mg/L
RBP	RBP-1	6/11/1998	Dissolved Oxygen		2	6.1	mg/L
RBP	RBP-1	7/29/1998	Dissolved Oxygen		0	10.6	mg/L
RBP	RBP-1	7/29/1998	Dissolved Oxygen		3	9.3	mg/L
RBP	RBP-1	7/29/1998	Dissolved Oxygen		4	5.7	mg/L
RBP	RBP-1	7/29/1998	Dissolved Oxygen		5	3.3	mg/L
RBP	RBP-1	7/29/1998	Dissolved Oxygen		6	2.4	mg/L
RBP	RBP-1	8/17/1998	Dissolved Oxygen		0	6.3	mg/L
RBP	RBP-1	8/17/1998	Dissolved Oxygen		3	5.6	mg/L
RBP	RBP-1	10/7/1998	Dissolved Oxygen		0	6.8	mg/L
RBP	RBP-1	10/7/1998	Dissolved Oxygen		1	6	mg/L
RBP	RBP-1	10/7/1998	Dissolved Oxygen		3	6.1	mg/L
RBP	RBP-1	6/3/1981	Suspended Solids		1	16	mg/L
RBP	RBP-1	8/24/1981	Suspended Solids		1	14	mg/L
RBP	RBP-1	5/9/1988	Suspended Solids		1	9	mg/L
RBP	RBP-1	6/30/1988	Suspended Solids		1	33	mg/L
RBP	RBP-1	7/11/1988	Suspended Solids		1	9	mg/L
RBP	RBP-1	8/8/1988	Suspended Solids		1	28	mg/L
RBP	RBP-1	9/27/1988	Suspended Solids		1	19	mg/L

RBP	RBP-1	10/25/1988	Suspended Solids	1	26	mg/L
RBP	RBP-1	5/30/1989	Suspended Solids	1	6	mg/L
RBP	RBP-1	6/26/1989	Suspended Solids	1	4	mg/L
RBP	RBP-1	7/31/1989	Suspended Solids	1	18	mg/L
RBP	RBP-1	8/29/1989	Suspended Solids	1	38	mg/L
RBP	RBP-1	10/3/1989	Suspended Solids	1	17	mg/L
RBP	RBP-1	5/26/1992	Suspended Solids	1	35	mg/L
RBP	RBP-1	6/22/1992	Suspended Solids	1	156	mg/L
RBP	RBP-1	6/22/1992	Suspended Solids	7	178	mg/L
RBP	RBP-1	6/29/1992	Suspended Solids	1	21	mg/L
RBP	RBP-1	7/28/1992	Suspended Solids	1	20	mg/L
RBP	RBP-1	8/25/1992	Suspended Solids	1	8	mg/L
RBP	RBP-1	9/30/1992	Suspended Solids	1	80	mg/L
RBP	RBP-1	10/28/1992	Suspended Solids	1	56	mg/L
RBP	RBP-1	5/31/1994	Suspended Solids	1	26	mg/L
RBP	RBP-1	6/29/1994	Suspended Solids	1	35	mg/L
RBP	RBP-1	7/26/1994	Suspended Solids	1	32	mg/L
RBP	RBP-1	8/31/1994	Suspended Solids	1	66	mg/L
RBP	RBP-1	9/28/1994	Suspended Solids	1	74	mg/L
RBP	RBP-1	4/21/1998	Suspended Solids	1	37	mg/L
RBP	RBP-1	4/21/1998	Suspended Solids	3	29	mg/L
RBP	RBP-1	6/11/1998	Suspended Solids	1	39	mg/L
RBP	RBP-1	6/11/1998	Suspended Solids	2	37	mg/L
RBP	RBP-1	7/29/1998	Suspended Solids	1	12	mg/L
RBP	RBP-1	7/29/1998	Suspended Solids	4	30	mg/L
RBP	RBP-1	8/4/1998	Suspended Solids	1	32	mg/L
RBP	RBP-1	8/17/1998	Suspended Solids	1	28	mg/L
RBP	RBP-1	10/7/1998	Suspended Solids	1	92	mg/L
RBP	RBP-1	5/7/2001	Suspended Solids	1	16	mg/L
RBP	RBP-1	5/7/2001	Suspended Solids	2	17	mg/L
RBP	RBP-1	7/2/2001	Suspended Solids	1	24	mg/L
RBP	RBP-1	7/2/2001	Suspended Solids	2	28	mg/L
RBP	RBP-1	7/26/2001	Suspended Solids	1	35	mg/L
RBP	RBP-1	7/26/2001	Suspended Solids	2	40	mg/L
RBP	RBP-1	8/21/2001	Suspended Solids	1	42	mg/L
RBP	RBP-1	8/21/2001	Suspended Solids	2	38	mg/L
RBP	RBP-1	10/15/2001	Suspended Solids	1	30	mg/L
RBP	RBP-1	10/15/2001	Suspended Solids	3	33	mg/L
RBP	RBP-1	6/3/1981	Ammonia	1	0.12	mg/L
RBP	RBP-1	8/24/1981	Ammonia	1	1.7	mg/L
RBP	RBP-1	5/9/1988	Ammonia	1	0.1	mg/L
RBP	RBP-1	6/30/1988	Ammonia	1	0.47	mg/L
RBP	RBP-1	7/11/1988	Ammonia	1	0.1	mg/L
RBP	RBP-1	8/8/1988	Ammonia	1	0.1	mg/L
RBP	RBP-1	9/27/1988	Ammonia	1	0.1	mg/L
RBP	RBP-1	10/25/1988	Ammonia	1	0.1	mg/L
RBP	RBP-1	5/30/1989	Ammonia	1	0.24	mg/L
RBP	RBP-1	6/26/1989	Ammonia	1	0.25	mg/L
RBP	RBP-1	7/31/1989	Ammonia	1	0.38	mg/L

RBP	RBP-1	8/29/1989	Ammonia	1	0.1	mg/L
RBP	RBP-1	10/3/1989	Ammonia	1	0.3	mg/L
RBP	RBP-1	5/26/1992	Ammonia	1	0.04	mg/L
RBP	RBP-1	6/22/1992	Ammonia	1	0.28	mg/L
RBP	RBP-1	6/22/1992	Ammonia	7	0.19	mg/L
RBP	RBP-1	6/29/1992	Ammonia	1	0.05	mg/L
RBP	RBP-1	7/28/1992	Ammonia	1	0.13	mg/L
RBP	RBP-1	8/25/1992	Ammonia	1	0.63	mg/L
RBP	RBP-1	9/30/1992	Ammonia	1	0.45	mg/L
RBP	RBP-1	10/28/1992	Ammonia	1	0.24	mg/L
RBP	RBP-1	5/31/1994	Ammonia	1	0.01	mg/L
RBP	RBP-1	6/29/1994	Ammonia	1	0.03	mg/L
RBP	RBP-1	7/26/1994	Ammonia	1	0.04	mg/L
RBP	RBP-1	8/31/1994	Ammonia	1	0.21	mg/L
RBP	RBP-1	9/28/1994	Ammonia	1	0.01	mg/L
RBP	RBP-1	4/21/1998	Ammonia	1	0.39	mg/L
RBP	RBP-1	4/21/1998	Ammonia	3	0.42	mg/L
RBP	RBP-1	6/11/1998	Ammonia	1	0.29	mg/L
RBP	RBP-1	6/11/1998	Ammonia	2	0.21	mg/L
RBP	RBP-1	7/29/1998	Ammonia	1	0.22	mg/L
RBP	RBP-1	7/29/1998	Ammonia	4	0.46	mg/L
RBP	RBP-1	8/4/1998	Ammonia	1	0.38	mg/L
RBP	RBP-1	8/17/1998	Ammonia	1	0.55	mg/L
RBP	RBP-1	10/7/1998	Ammonia	1	0.01	mg/L
RBP	RBP-1	5/7/2001	Ammonia	1	0.44	mg/L
RBP	RBP-1	5/7/2001	Ammonia	2	0.42	mg/L
RBP	RBP-1	7/2/2001	Ammonia	1	0.11	mg/L
RBP	RBP-1	7/2/2001	Ammonia	2	0.07	mg/L
RBP	RBP-1	7/26/2001	Ammonia	1	0.29	mg/L
RBP	RBP-1	7/26/2001	Ammonia	2	0.3	mg/L
RBP	RBP-1	8/21/2001	Ammonia	1	0.01	mg/L
RBP	RBP-1	8/21/2001	Ammonia	2	0.01	mg/L
RBP	RBP-1	10/15/2001	Ammonia	1	0.01	mg/L
RBP	RBP-1	10/15/2001	Ammonia	3	0.01	mg/L
RBP	RBP-1	6/3/1981	Un-inonized Ammonia	1	0.01	mg/L
RBP	RBP-1	8/24/1981	Un-inonized Ammonia	1	0.07	mg/L
RBP	RBP-1	4/21/1998	Un-inonized Ammonia	1	0.01	mg/L
RBP	RBP-1	4/21/1998	Un-inonized Ammonia	3	0.01	mg/L
RBP	RBP-1	6/11/1998	Un-inonized Ammonia	1	0	mg/L
RBP	RBP-1	6/11/1998	Un-inonized Ammonia	2	0	mg/L
RBP	RBP-1	7/29/1998	Un-inonized Ammonia	1	0	mg/L
RBP	RBP-1	7/29/1998	Un-inonized Ammonia	4	0.01	mg/L
RBP	RBP-1	8/17/1998	Un-inonized Ammonia	1	0.04	mg/L
RBP	RBP-1	10/7/1998	Un-inonized Ammonia	1	0	mg/L
RBP	RBP-1	6/3/1981	TKN	1	0.7	mg/L
RBP	RBP-1	8/24/1981	TKN	1	1.2	mg/L
RBP	RBP-1	6/22/1992	TKN	1	1.3	mg/L
RBP	RBP-1	6/22/1992	TKN	7	1.5	mg/L
RBP	RBP-1	4/21/1998	TKN	1	0.78	mg/L

RBP	RBP-1	4/21/1998	TKN	3	0.92	mg/L
RBP	RBP-1	6/11/1998	TKN	1	0.7	mg/L
RBP	RBP-1	7/29/1998	TKN	1	0.67	mg/L
RBP	RBP-1	7/29/1998	TKN	4	1.2	mg/L
RBP	RBP-1	8/17/1998	TKN	1	1.6	mg/L
RBP	RBP-1	10/7/1998	TKN	1	1.1	mg/L
RBP	RBP-1	5/7/2001	TKN	1	1.73	mg/L
RBP	RBP-1	5/7/2001	TKN	2	1.43	mg/L
RBP	RBP-1	7/2/2001	TKN	1	1.61	mg/L
RBP	RBP-1	7/2/2001	TKN	2	1.55	mg/L
RBP	RBP-1	7/26/2001	TKN	1	2.57	mg/L
RBP	RBP-1	7/26/2001	TKN	2	1.38	mg/L
RBP	RBP-1	8/21/2001	TKN	1	1.71	mg/L
RBP	RBP-1	8/21/2001	TKN	2	3.16	mg/L
RBP	RBP-1	10/15/2001	TKN	1	1.69	mg/L
RBP	RBP-1	10/15/2001	TKN	3	2.13	mg/L
RBP	RBP-1	6/3/1981	Nitrate + Nitrite	1	9.3	mg/L
RBP	RBP-1	8/24/1981	Nitrate + Nitrite	1	4.1	mg/L
RBP	RBP-1	5/9/1988	Nitrate + Nitrite	1	4.2	mg/L
RBP	RBP-1	6/30/1988	Nitrate + Nitrite	1	0.1	mg/L
RBP	RBP-1	7/11/1988	Nitrate + Nitrite	1	0.1	mg/L
RBP	RBP-1	8/8/1988	Nitrate + Nitrite	1	0.1	mg/L
RBP	RBP-1	9/27/1988	Nitrate + Nitrite	1	0.1	mg/L
RBP	RBP-1	10/25/1988	Nitrate + Nitrite	1	0.1	mg/L
RBP	RBP-1	5/30/1989	Nitrate + Nitrite	1	8.8	mg/L
RBP	RBP-1	6/26/1989	Nitrate + Nitrite	1	6.1	mg/L
RBP	RBP-1	7/31/1989	Nitrate + Nitrite	1	0.7	mg/L
RBP	RBP-1	8/29/1989	Nitrate + Nitrite	1	1.9	mg/L
RBP	RBP-1	10/3/1989	Nitrate + Nitrite	1	1.2	mg/L
RBP	RBP-1	5/26/1992	Nitrate + Nitrite	1	10	mg/L
RBP	RBP-1	6/22/1992	Nitrate + Nitrite	1	2	mg/L
RBP	RBP-1	6/22/1992	Nitrate + Nitrite	7	2.1	mg/L
RBP	RBP-1	6/29/1992	Nitrate + Nitrite	1	0.96	mg/L
RBP	RBP-1	7/28/1992	Nitrate + Nitrite	1	4.8	mg/L
RBP	RBP-1	8/25/1992	Nitrate + Nitrite	1	0.12	mg/L
RBP	RBP-1	9/30/1992	Nitrate + Nitrite	1	0.01	mg/L
RBP	RBP-1	10/28/1992	Nitrate + Nitrite	1	1.16	mg/L
RBP	RBP-1	5/31/1994	Nitrate + Nitrite	1	3.3	mg/L
RBP	RBP-1	6/29/1994	Nitrate + Nitrite	1	0.01	mg/L
RBP	RBP-1	7/26/1994	Nitrate + Nitrite	1	0.01	mg/L
RBP	RBP-1	8/31/1994	Nitrate + Nitrite	1	0.02	mg/L
RBP	RBP-1	9/28/1994	Nitrate + Nitrite	1	0.01	mg/L
RBP	RBP-1	4/21/1998	Nitrate + Nitrite	1	7.07	mg/L
RBP	RBP-1	4/21/1998	Nitrate + Nitrite	3	7.08	mg/L
RBP	RBP-1	6/11/1998	Nitrate + Nitrite	1	11.52	mg/L
RBP	RBP-1	6/11/1998	Nitrate + Nitrite	2	11.61	mg/L
RBP	RBP-1	7/29/1998	Nitrate + Nitrite	1	2.2	mg/L
RBP	RBP-1	7/29/1998	Nitrate + Nitrite	4	2.11	mg/L
RBP	RBP-1	8/4/1998	Nitrate + Nitrite	1	1.5	mg/L

RBP	RBP-1	8/17/1998	Nitrate + Nitrite	1	0.98	mg/L
RBP	RBP-1	10/7/1998	Nitrate + Nitrite	1	0.01	mg/L
RBP	RBP-1	5/7/2001	Nitrate + Nitrite	1	0.34	mg/L
RBP	RBP-1	5/7/2001	Nitrate + Nitrite	2	0.31	mg/L
RBP	RBP-1	7/2/2001	Nitrate + Nitrite	1	0.99	mg/L
RBP	RBP-1	7/2/2001	Nitrate + Nitrite	2	1	mg/L
RBP	RBP-1	7/26/2001	Nitrate + Nitrite	1	0.42	mg/L
RBP	RBP-1	7/26/2001	Nitrate + Nitrite	2	0.52	mg/L
RBP	RBP-1	8/21/2001	Nitrate + Nitrite	1	0.05	mg/L
RBP	RBP-1	8/21/2001	Nitrate + Nitrite	2	0.04	mg/L
RBP	RBP-1	10/15/2001	Nitrate + Nitrite	1	2.6	mg/L
RBP	RBP-1	10/15/2001	Nitrate + Nitrite	3	2.6	mg/L
RBP	RBP-1	6/3/1981	Total Phosphorus	1	0.04	mg/L
RBP	RBP-1	8/24/1981	Total Phosphorus	1	0.07	mg/L
RBP	RBP-1	5/9/1988	Total Phosphorus	1	0.06	mg/L
RBP	RBP-1	6/30/1988	Total Phosphorus	1	0.14	mg/L
RBP	RBP-1	7/11/1988	Total Phosphorus	1	0.09	mg/L
RBP	RBP-1	8/8/1988	Total Phosphorus	1	0.01	mg/L
RBP	RBP-1	9/27/1988	Total Phosphorus	1	0.21	mg/L
RBP	RBP-1	10/25/1988	Total Phosphorus	1	0.18	mg/L
RBP	RBP-1	5/30/1989	Total Phosphorus	1	0.19	mg/L
RBP	RBP-1	6/26/1989	Total Phosphorus	1	0.15	mg/L
RBP	RBP-1	7/31/1989	Total Phosphorus	1	0.14	mg/L
RBP	RBP-1	8/29/1989	Total Phosphorus	1	0.38	mg/L
RBP	RBP-1	10/3/1989	Total Phosphorus	1	0.06	mg/L
RBP	RBP-1	5/26/1992	Total Phosphorus	1	0.13	mg/L
RBP	RBP-1	6/22/1992	Total Phosphorus	1	0.11	mg/L
RBP	RBP-1	6/22/1992	Total Phosphorus	7	0.16	mg/L
RBP	RBP-1	6/29/1992	Total Phosphorus	1	0.13	mg/L
RBP	RBP-1	7/28/1992	Total Phosphorus	1	0.18	mg/L
RBP	RBP-1	8/25/1992	Total Phosphorus	1	0.11	mg/L
RBP	RBP-1	9/30/1992	Total Phosphorus	1	0.16	mg/L
RBP	RBP-1	10/28/1992	Total Phosphorus	1	0.08	mg/L
RBP	RBP-1	5/31/1994	Total Phosphorus	1	0.07	mg/L
RBP	RBP-1	6/29/1994	Total Phosphorus	1	0.18	mg/L
RBP	RBP-1	7/26/1994	Total Phosphorus	1	0.4	mg/L
RBP	RBP-1	8/31/1994	Total Phosphorus	1	0.38	mg/L
RBP	RBP-1	9/28/1994	Total Phosphorus	1	0.33	mg/L
RBP	RBP-1	4/21/1998	Total Phosphorus	1	0.06	mg/L
RBP	RBP-1	4/21/1998	Total Phosphorus	3	0.08	mg/L
RBP	RBP-1	6/11/1998	Total Phosphorus	1	0.16	mg/L
RBP	RBP-1	6/11/1998	Total Phosphorus	2	0.17	mg/L
RBP	RBP-1	7/29/1998	Total Phosphorus	1	0.08	mg/L
RBP	RBP-1	7/29/1998	Total Phosphorus	4	0.13	mg/L
RBP	RBP-1	8/4/1998	Total Phosphorus	1	0.15	mg/L
RBP	RBP-1	8/17/1998	Total Phosphorus	1	0.07	mg/L
RBP	RBP-1	10/7/1998	Total Phosphorus	1	0.21	mg/L
RBP	RBP-1	5/7/2001	Total Phosphorus	1	0.07	mg/L
RBP	RBP-1	5/7/2001	Total Phosphorus	2	0.07	mg/L

RBP	RBP-1	7/2/2001	Total Phosphorus	1	0.36	mg/L
RBP	RBP-1	7/2/2001	Total Phosphorus	2	0.2	mg/L
RBP	RBP-1	7/26/2001	Total Phosphorus	1	0.15	mg/L
RBP	RBP-1	7/26/2001	Total Phosphorus	2	0.17	mg/L
RBP	RBP-1	8/21/2001	Total Phosphorus	1	0.29	mg/L
RBP	RBP-1	8/21/2001	Total Phosphorus	2	0.26	mg/L
RBP	RBP-1	10/15/2001	Total Phosphorus	1	0.46	mg/L
RBP	RBP-1	10/15/2001	Total Phosphorus	3	0.46	mg/L
RBP	RBP-1	6/3/1981	Dissolved Phosphorus	1	0.01	mg/L
RBP	RBP-1	8/24/1981	Dissolved Phosphorus	1	0.01	mg/L
RBP	RBP-1	6/22/1992	Dissolved Phosphorus	1	0.02	mg/L
RBP	RBP-1	6/22/1992	Dissolved Phosphorus	7	0.02	mg/L
RBP	RBP-1	4/21/1998	Dissolved Phosphorus	1	0.01	mg/L
RBP	RBP-1	4/21/1998	Dissolved Phosphorus	3	0	mg/L
RBP	RBP-1	6/11/1998	Dissolved Phosphorus	1	0.09	mg/L
RBP	RBP-1	6/11/1998	Dissolved Phosphorus	2	0.09	mg/L
RBP	RBP-1	7/29/1998	Dissolved Phosphorus	1	0.01	mg/L
RBP	RBP-1	7/29/1998	Dissolved Phosphorus	4	0.02	mg/L
RBP	RBP-1	8/17/1998	Dissolved Phosphorus	1	0.03	mg/L
RBP	RBP-1	10/7/1998	Dissolved Phosphorus	1	0.02	mg/L
RBP	RBP-1	5/7/2001	Dissolved Phosphorus	1	0.02	mg/L
RBP	RBP-1	5/7/2001	Dissolved Phosphorus	2	0.02	mg/L
RBP	RBP-1	7/2/2001	Dissolved Phosphorus	1	0.22	mg/L
RBP	RBP-1	7/2/2001	Dissolved Phosphorus	2	0.07	mg/L
RBP	RBP-1	7/26/2001	Dissolved Phosphorus	1	0.02	mg/L
RBP	RBP-1	7/26/2001	Dissolved Phosphorus	2	0.03	mg/L
RBP	RBP-1	8/21/2001	Dissolved Phosphorus	1	0.06	mg/L
RBP	RBP-1	8/21/2001	Dissolved Phosphorus	2	0.03	mg/L
RBP	RBP-1	10/15/2001	Dissolved Phosphorus	1	0.37	mg/L
RBP	RBP-1	10/15/2001	Dissolved Phosphorus	3	0.37	mg/L
RBP	RBP-1	6/3/1981	Chlorophyll-a	3	6.7	µg/L
RBP	RBP-1	8/24/1981	Chlorophyll-a	3	38.92	µg/L
RBP	RBP-1	6/22/1992	Chlorophyll-a	2	81.88	µg/L
RBP	RBP-1	4/21/1998	Chlorophyll-a	2	42.72	µg/L
RBP	RBP-1	6/11/1998	Chlorophyll-a	2	8.01	µg/L
RBP	RBP-1	7/29/1998	Chlorophyll-a	3	34.7	µg/L
RBP	RBP-1	10/7/1998	Chlorophyll-a	2	85.4	µg/L
RBP	RBP-1	5/7/2001	Chlorophyll-a	2	54.8	µg/L
RBP	RBP-1	7/2/2001	Chlorophyll-a	3	57.5	µg/L
RBP	RBP-1	7/26/2001	Chlorophyll-a	2	138	µg/L
RBP	RBP-1	8/21/2001	Chlorophyll-a	2	135	µg/L
RBP	RBP-1	10/15/2001	Chlorophyll-a	2	7.96	µg/L
RBP	RBP-2	6/3/1981	Dissolved Oxygen	0	9.1	mg/L
RBP	RBP-2	6/3/1981	Dissolved Oxygen	3	9	mg/L
RBP	RBP-2	8/24/1981	Dissolved Oxygen	0	17.1	mg/L
RBP	RBP-2	8/24/1981	Dissolved Oxygen	1	17	mg/L
RBP	RBP-2	8/24/1981	Dissolved Oxygen	3	13.6	mg/L
RBP	RBP-2	4/21/1998	Dissolved Oxygen	0	12.6	mg/L
RBP	RBP-2	4/21/1998	Dissolved Oxygen	1	11	mg/L

RBP	RBP-2	4/21/1998	Dissolved Oxygen	3	9.3	mg/L
RBP	RBP-2	6/11/1998	Dissolved Oxygen	0	7.5	mg/L
RBP	RBP-2	6/11/1998	Dissolved Oxygen	1	7.2	mg/L
RBP	RBP-2	6/11/1998	Dissolved Oxygen	2	6.8	mg/L
RBP	RBP-2	8/17/1998	Dissolved Oxygen	0	8.8	mg/L
RBP	RBP-2	10/7/1998	Dissolved Oxygen	0	8.3	mg/L
RBP	RBP-2	6/3/1981	Suspended Solids	1	14	mg/L
RBP	RBP-2	8/24/1981	Suspended Solids	1	19	mg/L
RBP	RBP-2	4/21/1998	Suspended Solids	1	32	mg/L
RBP	RBP-2	6/11/1998	Suspended Solids	1	36	mg/L
RBP	RBP-2	7/29/1998	Suspended Solids	1	22	mg/L
RBP	RBP-2	8/17/1998	Suspended Solids	1	38	mg/L
RBP	RBP-2	10/7/1998	Suspended Solids	1	142	mg/L
RBP	RBP-2	5/7/2001	Suspended Solids	1	15	mg/L
RBP	RBP-2	7/2/2001	Suspended Solids	1	33	mg/L
RBP	RBP-2	7/26/2001	Suspended Solids	1	85	mg/L
RBP	RBP-2	8/21/2001	Suspended Solids	1	75	mg/L
RBP	RBP-2	10/15/2001	Suspended Solids	1	28	mg/L
RBP	RBP-2	6/3/1981	Ammonia	1	0.14	mg/L
RBP	RBP-2	8/24/1981	Ammonia	1	0.01	mg/L
RBP	RBP-2	4/21/1998	Ammonia	1	0.57	mg/L
RBP	RBP-2	6/11/1998	Ammonia	1	0.16	mg/L
RBP	RBP-2	7/29/1998	Ammonia	1	0.25	mg/L
RBP	RBP-2	8/17/1998	Ammonia	1	0.56	mg/L
RBP	RBP-2	10/7/1998	Ammonia	1	0.11	mg/L
RBP	RBP-2	5/7/2001	Ammonia	1	0.49	mg/L
RBP	RBP-2	7/2/2001	Ammonia	1	0.04	mg/L
RBP	RBP-2	7/26/2001	Ammonia	1	0.08	mg/L
RBP	RBP-2	8/21/2001	Ammonia	1	0.01	mg/L
RBP	RBP-2	10/15/2001	Ammonia	1	0.01	mg/L
RBP	RBP-2	6/3/1981	Un-inonized Ammonia	1	0.01	mg/L
RBP	RBP-2	8/24/1981	Un-inonized Ammonia	1	0	mg/L
RBP	RBP-2	4/21/1998	Un-inonized Ammonia	1	0.02	mg/L
RBP	RBP-2	6/11/1998	Un-inonized Ammonia	1	0	mg/L
RBP	RBP-2	10/7/1998	Un-inonized Ammonia	1	0.01	mg/L
RBP	RBP-2	6/3/1981	TKN	1	0.6	mg/L
RBP	RBP-2	8/24/1981	TKN	1	1.1	mg/L
RBP	RBP-2	4/21/1998	TKN	1	0.43	mg/L
RBP	RBP-2	6/11/1998	TKN	1	0.6	mg/L
RBP	RBP-2	7/29/1998	TKN	1	0.81	mg/L
RBP	RBP-2	8/17/1998	TKN	1	1.5	mg/L
RBP	RBP-2	10/7/1998	TKN	1	1	mg/L
RBP	RBP-2	5/7/2001	TKN	1	1.6	mg/L
RBP	RBP-2	7/2/2001	TKN	1	1.95	mg/L
RBP	RBP-2	7/26/2001	TKN	1	1.95	mg/L
RBP	RBP-2	8/21/2001	TKN	1	2.26	mg/L
RBP	RBP-2	10/15/2001	TKN	1	1.52	mg/L
RBP	RBP-2	6/3/1981	Nitrate + Nitrite	1	9.3	mg/L
RBP	RBP-2	8/24/1981	Nitrate + Nitrite	1	4	mg/L

RBP	RBP-2	4/21/1998	Nitrate + Nitrite	1	6.77	mg/L
RBP	RBP-2	6/11/1998	Nitrate + Nitrite	1	11.54	mg/L
RBP	RBP-2	7/29/1998	Nitrate + Nitrite	1	2.14	mg/L
RBP	RBP-2	8/17/1998	Nitrate + Nitrite	1	0.91	mg/L
RBP	RBP-2	10/7/1998	Nitrate + Nitrite	1	0.01	mg/L
RBP	RBP-2	5/7/2001	Nitrate + Nitrite	1	0.44	mg/L
RBP	RBP-2	7/2/2001	Nitrate + Nitrite	1	0.94	mg/L
RBP	RBP-2	7/26/2001	Nitrate + Nitrite	1	0.75	mg/L
RBP	RBP-2	8/21/2001	Nitrate + Nitrite	1	0.01	mg/L
RBP	RBP-2	10/15/2001	Nitrate + Nitrite	1	3.6	mg/L
RBP	RBP-2	6/3/1981	Total Phosphorus	1	0.05	mg/L
RBP	RBP-2	8/24/1981	Total Phosphorus	1	0.08	mg/L
RBP	RBP-2	4/21/1998	Total Phosphorus	1	0.1	mg/L
RBP	RBP-2	6/11/1998	Total Phosphorus	1	0.14	mg/L
RBP	RBP-2	7/29/1998	Total Phosphorus	1	0.09	mg/L
RBP	RBP-2	8/17/1998	Total Phosphorus	1	0.23	mg/L
RBP	RBP-2	10/7/1998	Total Phosphorus	1	0.16	mg/L
RBP	RBP-2	5/7/2001	Total Phosphorus	1	0.07	mg/L
RBP	RBP-2	7/2/2001	Total Phosphorus	1	0.2	mg/L
RBP	RBP-2	7/26/2001	Total Phosphorus	1	0.2	mg/L
RBP	RBP-2	8/21/2001	Total Phosphorus	1	0.32	mg/L
RBP	RBP-2	10/15/2001	Total Phosphorus	1	0.39	mg/L
RBP	RBP-2	6/3/1981	Dissolved Phosphorus	1	0.01	mg/L
RBP	RBP-2	8/24/1981	Dissolved Phosphorus	1	0	mg/L
RBP	RBP-2	4/21/1998	Dissolved Phosphorus	1	0	mg/L
RBP	RBP-2	6/11/1998	Dissolved Phosphorus	1	0.09	mg/L
RBP	RBP-2	7/29/1998	Dissolved Phosphorus	1	0.02	mg/L
RBP	RBP-2	8/17/1998	Dissolved Phosphorus	1	0.04	mg/L
RBP	RBP-2	10/7/1998	Dissolved Phosphorus	1	0.02	mg/L
RBP	RBP-2	5/7/2001	Dissolved Phosphorus	1	0.02	mg/L
RBP	RBP-2	7/2/2001	Dissolved Phosphorus	1	0.05	mg/L
RBP	RBP-2	7/26/2001	Dissolved Phosphorus	1	0.03	mg/L
RBP	RBP-2	8/21/2001	Dissolved Phosphorus	1	0.05	mg/L
RBP	RBP-2	10/15/2001	Dissolved Phosphorus	1	0.32	mg/L
RBP	RBP-2	6/3/1981	Chlorophyll-a	3	4.86	µg/L
RBP	RBP-2	8/24/1981	Chlorophyll-a	3	37.03	µg/L
RBP	RBP-2	4/21/1998	Chlorophyll-a	2	40.05	µg/L
RBP	RBP-2	6/11/1998	Chlorophyll-a	2	13.35	µg/L
RBP	RBP-2	7/29/1998	Chlorophyll-a	3	42.7	µg/L
RBP	RBP-2	10/7/1998	Chlorophyll-a	2	139	µg/L
RBP	RBP-2	5/7/2001	Chlorophyll-a	2	43.9	µg/L
RBP	RBP-2	7/2/2001	Chlorophyll-a	2	40.4	µg/L
RBP	RBP-2	7/26/2001	Chlorophyll-a	2	93.7	µg/L
RBP	RBP-2	8/21/2001	Chlorophyll-a	2	133	µg/L
RBP	RBP-2	10/15/2001	Chlorophyll-a	2	3.76	µg/L
RBP	RBP-3	6/3/1981	Dissolved Oxygen	0	9.2	mg/L
RBP	RBP-3	6/3/1981	Dissolved Oxygen	3	7	mg/L
RBP	RBP-3	8/24/1981	Dissolved Oxygen	0	15.8	mg/L
RBP	RBP-3	8/24/1981	Dissolved Oxygen	1	15.2	mg/L

RBP	RBP-3	8/24/1981	Dissolved Oxygen	3	12.2	mg/L
RBP	RBP-3	4/21/1998	Dissolved Oxygen	0	9.3	mg/L
RBP	RBP-3	4/21/1998	Dissolved Oxygen	1	8.6	mg/L
RBP	RBP-3	6/11/1998	Dissolved Oxygen	0	7	mg/L
RBP	RBP-3	6/11/1998	Dissolved Oxygen	1	6.8	mg/L
RBP	RBP-3	7/29/1998	Dissolved Oxygen	0	10.8	mg/L
RBP	RBP-3	7/29/1998	Dissolved Oxygen	0	11.7	mg/L
RBP	RBP-3	7/29/1998	Dissolved Oxygen	1	11.3	mg/L
RBP	RBP-3	7/29/1998	Dissolved Oxygen	2	11	mg/L
RBP	RBP-3	7/29/1998	Dissolved Oxygen	3	8.8	mg/L
RBP	RBP-3	7/29/1998	Dissolved Oxygen	4	8.4	mg/L
RBP	RBP-3	8/17/1998	Dissolved Oxygen	0	9.7	mg/L
RBP	RBP-3	8/17/1998	Dissolved Oxygen	1	9.3	mg/L
RBP	RBP-3	10/7/1998	Dissolved Oxygen	0	6.7	mg/L
RBP	RBP-3	10/7/1998	Dissolved Oxygen	1	6.2	mg/L
RBP	RBP-3	6/3/1981	Suspended Solids	1	19	mg/L
RBP	RBP-3	8/24/1981	Suspended Solids	1	22	mg/L
RBP	RBP-3	5/9/1988	Suspended Solids	1	11	mg/L
RBP	RBP-3	6/30/1988	Suspended Solids	1	30	mg/L
RBP	RBP-3	7/11/1988	Suspended Solids	1	44	mg/L
RBP	RBP-3	8/8/1988	Suspended Solids	1	24	mg/L
RBP	RBP-3	9/27/1988	Suspended Solids	1	77	mg/L
RBP	RBP-3	10/25/1988	Suspended Solids	1	58	mg/L
RBP	RBP-3	5/31/1994	Suspended Solids	1	31	mg/L
RBP	RBP-3	6/29/1994	Suspended Solids	1	35	mg/L
RBP	RBP-3	7/26/1994	Suspended Solids	1	47	mg/L
RBP	RBP-3	8/31/1994	Suspended Solids	1	152	mg/L
RBP	RBP-3	9/28/1994	Suspended Solids	1	96	mg/L
RBP	RBP-3	4/21/1998	Suspended Solids	1	35	mg/L
RBP	RBP-3	6/11/1998	Suspended Solids	1	36	mg/L
RBP	RBP-3	7/29/1998	Suspended Solids	1	25	mg/L
RBP	RBP-3	8/17/1998	Suspended Solids	1	28	mg/L
RBP	RBP-3	10/7/1998	Suspended Solids	1	10	mg/L
RBP	RBP-3	5/7/2001	Suspended Solids	1	14	mg/L
RBP	RBP-3	7/2/2001	Suspended Solids	1	37	mg/L
RBP	RBP-3	7/26/2001	Suspended Solids	1	101	mg/L
RBP	RBP-3	8/21/2001	Suspended Solids	1	75	mg/L
RBP	RBP-3	10/15/2001	Suspended Solids	1	26	mg/L
RBP	RBP-3	6/3/1981	Ammonia	1	0.06	mg/L
RBP	RBP-3	8/24/1981	Ammonia	1	0.17	mg/L
RBP	RBP-3	5/9/1988	Ammonia	1	0.1	mg/L
RBP	RBP-3	6/30/1988	Ammonia	1	0.74	mg/L
RBP	RBP-3	7/11/1988	Ammonia	1	0.1	mg/L
RBP	RBP-3	8/8/1988	Ammonia	1	0.1	mg/L
RBP	RBP-3	9/27/1988	Ammonia	1	0.1	mg/L
RBP	RBP-3	10/25/1988	Ammonia	1	0.13	mg/L
RBP	RBP-3	5/31/1994	Ammonia	1	0.01	mg/L
RBP	RBP-3	6/29/1994	Ammonia	1	0.1	mg/L
RBP	RBP-3	7/26/1994	Ammonia	1	0.01	mg/L

RBP	RBP-3	8/31/1994	Ammonia	1	0.02	mg/L
RBP	RBP-3	9/28/1994	Ammonia	1	0.03	mg/L
RBP	RBP-3	4/21/1998	Ammonia	1	0.41	mg/L
RBP	RBP-3	6/11/1998	Ammonia	1	0.16	mg/L
RBP	RBP-3	7/29/1998	Ammonia	1	0.29	mg/L
RBP	RBP-3	8/17/1998	Ammonia	1	0.55	mg/L
RBP	RBP-3	10/7/1998	Ammonia	1	0.42	mg/L
RBP	RBP-3	5/7/2001	Ammonia	1	0.48	mg/L
RBP	RBP-3	7/2/2001	Ammonia	1	0.01	mg/L
RBP	RBP-3	7/26/2001	Ammonia	1	0.19	mg/L
RBP	RBP-3	8/21/2001	Ammonia	1	0.01	mg/L
RBP	RBP-3	10/15/2001	Ammonia	1	0.01	mg/L
RBP	RBP-3	6/3/1981	Un-inonized Ammonia	1	0	mg/L
RBP	RBP-3	8/24/1981	Un-inonized Ammonia	1	0.01	mg/L
RBP	RBP-3	4/21/1998	Un-inonized Ammonia	1	0	mg/L
RBP	RBP-3	6/11/1998	Un-inonized Ammonia	1	0	mg/L
RBP	RBP-3	7/29/1998	Un-inonized Ammonia	1	0.01	mg/L
RBP	RBP-3	8/17/1998	Un-inonized Ammonia	1	0.11	mg/L
RBP	RBP-3	10/7/1998	Un-inonized Ammonia	1	0.01	mg/L
RBP	RBP-3	6/3/1981	TKN	1	0.9	mg/L
RBP	RBP-3	8/24/1981	TKN	1	1	mg/L
RBP	RBP-3	4/21/1998	TKN	1	0.59	mg/L
RBP	RBP-3	6/11/1998	TKN	1	0.8	mg/L
RBP	RBP-3	7/29/1998	TKN	1	0.71	mg/L
RBP	RBP-3	8/17/1998	TKN	1	1.4	mg/L
RBP	RBP-3	10/7/1998	TKN	1	1.2	mg/L
RBP	RBP-3	5/7/2001	TKN	1	1.33	mg/L
RBP	RBP-3	7/2/2001	TKN	1	1.7	mg/L
RBP	RBP-3	7/26/2001	TKN	1	1.75	mg/L
RBP	RBP-3	8/21/2001	TKN	1	2.76	mg/L
RBP	RBP-3	10/15/2001	TKN	1	13.2	mg/L
RBP	RBP-3	6/3/1981	Nitrate + Nitrite	1	9.3	mg/L
RBP	RBP-3	8/24/1981	Nitrate + Nitrite	1	4	mg/L
RBP	RBP-3	5/9/1988	Nitrate + Nitrite	1	4.6	mg/L
RBP	RBP-3	6/30/1988	Nitrate + Nitrite	1	0.1	mg/L
RBP	RBP-3	7/11/1988	Nitrate + Nitrite	1	0.1	mg/L
RBP	RBP-3	8/8/1988	Nitrate + Nitrite	1	0.1	mg/L
RBP	RBP-3	9/27/1988	Nitrate + Nitrite	1	0.1	mg/L
RBP	RBP-3	10/25/1988	Nitrate + Nitrite	1	0.13	mg/L
RBP	RBP-3	5/31/1994	Nitrate + Nitrite	1	3.6	mg/L
RBP	RBP-3	6/29/1994	Nitrate + Nitrite	1	0.05	mg/L
RBP	RBP-3	7/26/1994	Nitrate + Nitrite	1	0.01	mg/L
RBP	RBP-3	8/31/1994	Nitrate + Nitrite	1	0.01	mg/L
RBP	RBP-3	9/28/1994	Nitrate + Nitrite	1	0.01	mg/L
RBP	RBP-3	4/21/1998	Nitrate + Nitrite	1	7.23	mg/L
RBP	RBP-3	6/11/1998	Nitrate + Nitrite	1	11.5	mg/L
RBP	RBP-3	7/29/1998	Nitrate + Nitrite	1	2.14	mg/L
RBP	RBP-3	8/17/1998	Nitrate + Nitrite	1	0.91	mg/L
RBP	RBP-3	10/7/1998	Nitrate + Nitrite	1	0.01	mg/L

RBP	RBP-3	5/7/2001	Nitrate + Nitrite		1	0.33	mg/L
RBP	RBP-3	7/2/2001	Nitrate + Nitrite		1	0.82	mg/L
RBP	RBP-3	7/26/2001	Nitrate + Nitrite		1	0.8	mg/L
RBP	RBP-3	8/21/2001	Nitrate + Nitrite		1	0.01	mg/L
RBP	RBP-3	10/15/2001	Nitrate + Nitrite		1	3.1	mg/L
RBP	RBP-3	6/3/1981	Total Phosphorus		1	0.06	mg/L
RBP	RBP-3	8/24/1981	Total Phosphorus		1	0.07	mg/L
RBP	RBP-3	5/9/1988	Total Phosphorus		1	0.05	mg/L
RBP	RBP-3	6/30/1988	Total Phosphorus		1	0.19	mg/L
RBP	RBP-3	7/11/1988	Total Phosphorus		1	0.23	mg/L
RBP	RBP-3	8/8/1988	Total Phosphorus		1	0.11	mg/L
RBP	RBP-3	9/27/1988	Total Phosphorus		1	0.2	mg/L
RBP	RBP-3	10/25/1988	Total Phosphorus		1	0.17	mg/L
RBP	RBP-3	5/31/1994	Total Phosphorus		1	0.08	mg/L
RBP	RBP-3	6/29/1994	Total Phosphorus		1	0.1	mg/L
RBP	RBP-3	7/26/1994	Total Phosphorus		1	0.49	mg/L
RBP	RBP-3	8/31/1994	Total Phosphorus		1	0.48	mg/L
RBP	RBP-3	9/28/1994	Total Phosphorus		1	0.32	mg/L
RBP	RBP-3	4/21/1998	Total Phosphorus		1	0.08	mg/L
RBP	RBP-3	6/11/1998	Total Phosphorus		1	0.12	mg/L
RBP	RBP-3	7/29/1998	Total Phosphorus		1	0.19	mg/L
RBP	RBP-3	8/17/1998	Total Phosphorus		1	0.12	mg/L
RBP	RBP-3	10/7/1998	Total Phosphorus		1	0.15	mg/L
RBP	RBP-3	5/7/2001	Total Phosphorus		1	0.06	mg/L
RBP	RBP-3	7/2/2001	Total Phosphorus		1	0.2	mg/L
RBP	RBP-3	7/26/2001	Total Phosphorus		1	0.17	mg/L
RBP	RBP-3	8/21/2001	Total Phosphorus		1	0.32	mg/L
RBP	RBP-3	10/15/2001	Total Phosphorus		1	0.37	mg/L
RBP	RBP-3	6/3/1981	Dissolved Phosphorus		1	0.01	mg/L
RBP	RBP-3	8/24/1981	Dissolved Phosphorus		1	0.01	mg/L
RBP	RBP-3	4/21/1998	Dissolved Phosphorus		1	0.01	mg/L
RBP	RBP-3	6/11/1998	Dissolved Phosphorus		1	0.07	mg/L
RBP	RBP-3	7/29/1998	Dissolved Phosphorus		1	0.02	mg/L
RBP	RBP-3	8/17/1998	Dissolved Phosphorus		1	0.03	mg/L
RBP	RBP-3	10/7/1998	Dissolved Phosphorus		1	0.02	mg/L
RBP	RBP-3	5/7/2001	Dissolved Phosphorus		1	0.02	mg/L
RBP	RBP-3	7/2/2001	Dissolved Phosphorus		1	0.04	mg/L
RBP	RBP-3	7/26/2001	Dissolved Phosphorus		1	0.03	mg/L
RBP	RBP-3	8/21/2001	Dissolved Phosphorus		1	0.04	mg/L
RBP	RBP-3	10/15/2001	Dissolved Phosphorus		1	0.31	mg/L
RBP	RBP-3	6/3/1981	Chlorophyll-a		3	7.1	µg/L
RBP	RBP-3	8/24/1981	Chlorophyll-a		3	41.3	µg/L
RBP	RBP-3	4/21/1998	Chlorophyll-a		2	10.68	µg/L
RBP	RBP-3	6/11/1998	Chlorophyll-a		1	248.31	µg/L
RBP	RBP-3	7/29/1998	Chlorophyll-a		1	69.4	µg/L
RBP	RBP-3	10/7/1998	Chlorophyll-a		1	101	µg/L
RBP	RBP-3	5/7/2001	Chlorophyll-a		2	61.3	µg/L
RBP	RBP-3	7/2/2001	Chlorophyll-a		2	106	µg/L
RBP	RBP-3	7/26/2001	Chlorophyll-a		2	54.7	µg/L

RBP	RBP-3	8/21/2001	Chlorophyll-a		1	133	µg/L
RBP	RBP-3	10/15/2001	Chlorophyll-a		2	2.32	µg/L

Attachment 2
Stage Two Report
Tetra Tech, 2007

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STAGE 2 – WATER QUALITY SAMPLING REPORT

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

Final Report

Prepared for

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
BUREAU OF WATER

Prepared by

TETRA TECH, INC.

February 22, 2007

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CONTENTS

1.0 INTRODUCTION

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

2.0 DATA COLLECTION

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

2.1 QAPP PREPARATION

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

2.2 SAMPLING SITE IDENTIFICATION

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

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

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

Notes:

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

FIGURE 1
HOOPESTON BRANCH SAMPLING SITES

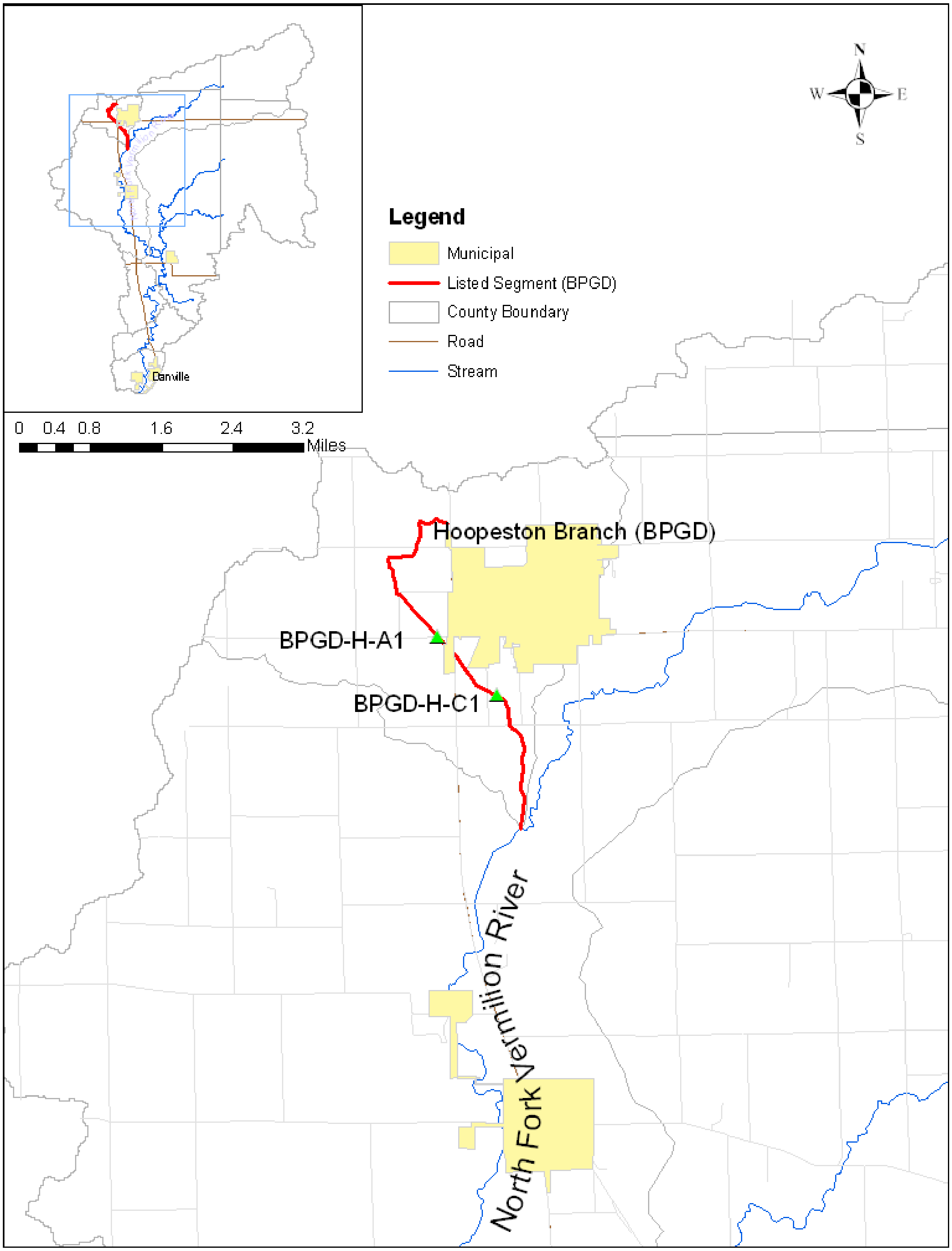


FIGURE 2
SALT FORK VERMILION RIVER AND TRIBUTARY SAMPLING SITES

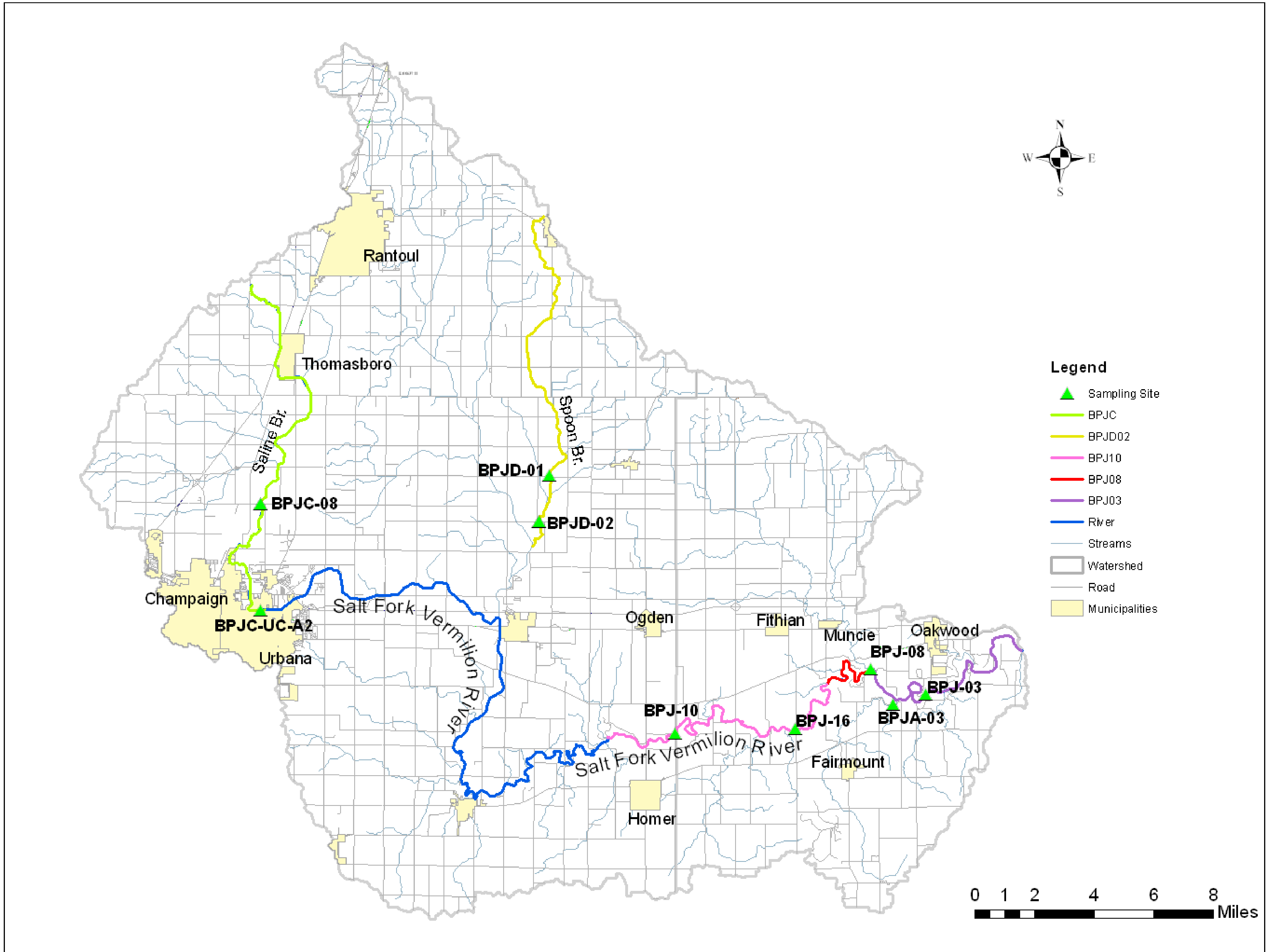


FIGURE 3
SUGAR CREEK SAMPLING SITE

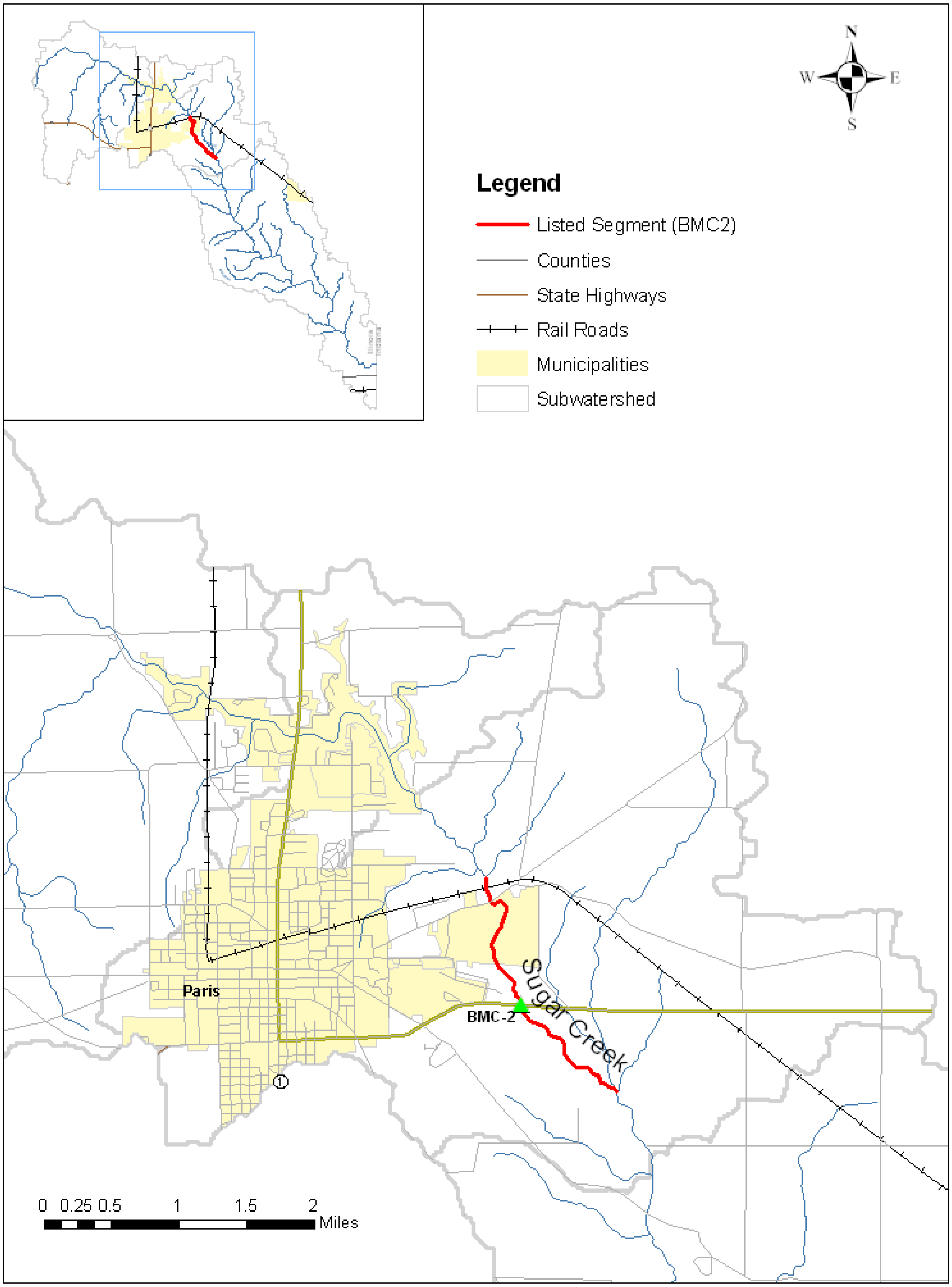
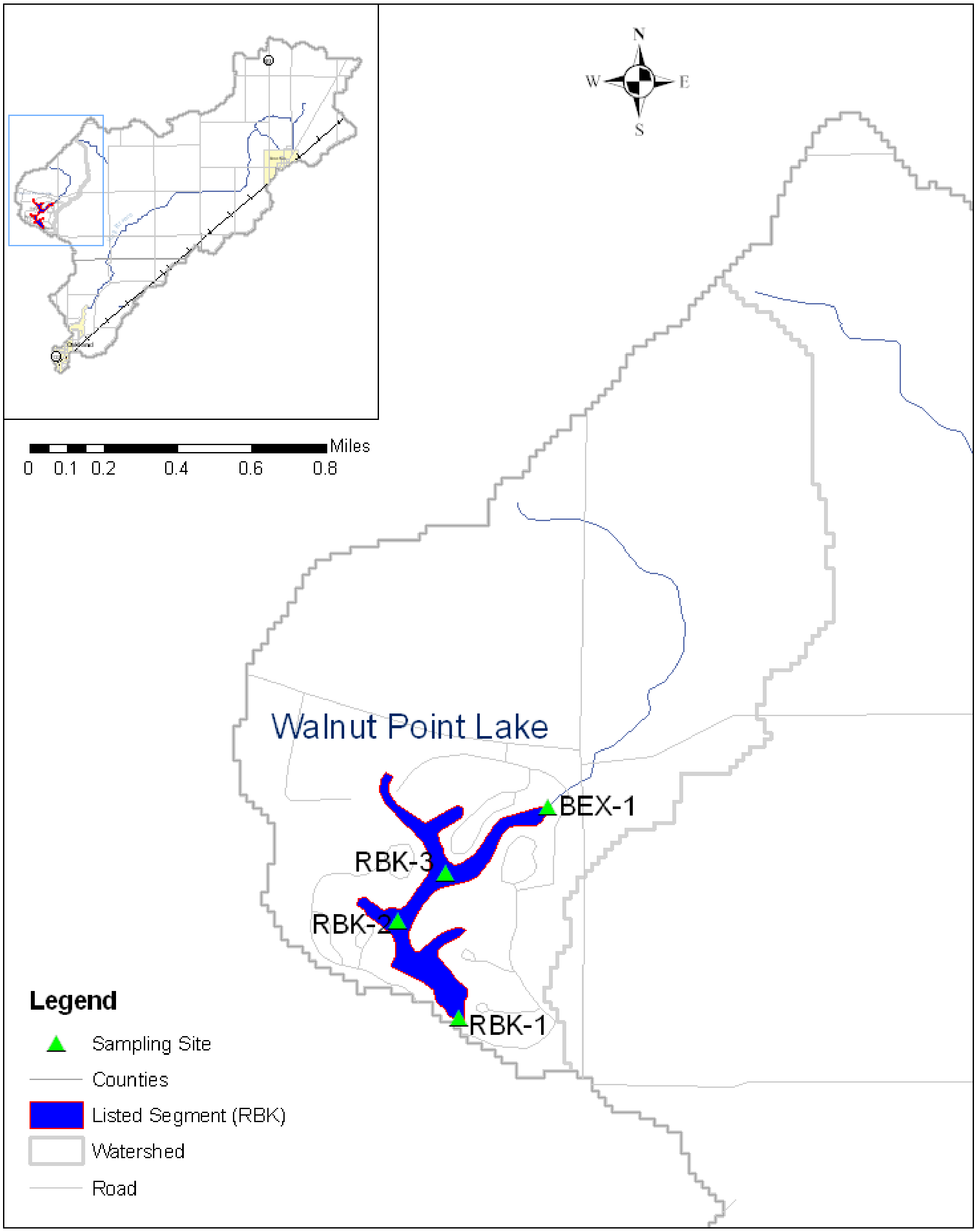


FIGURE 4
WALNUT POINT LAKE SAMPLING SITES



2.3 FIELD SAMPLING PROCEDURES

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

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

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

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

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

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

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

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

2.4 LABORATORY SAMPLE ANALYSIS

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

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

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

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

2.5 DATA SUMMARY

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

2.6 PROBLEMS

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

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

3.0 DATA ANALYSIS

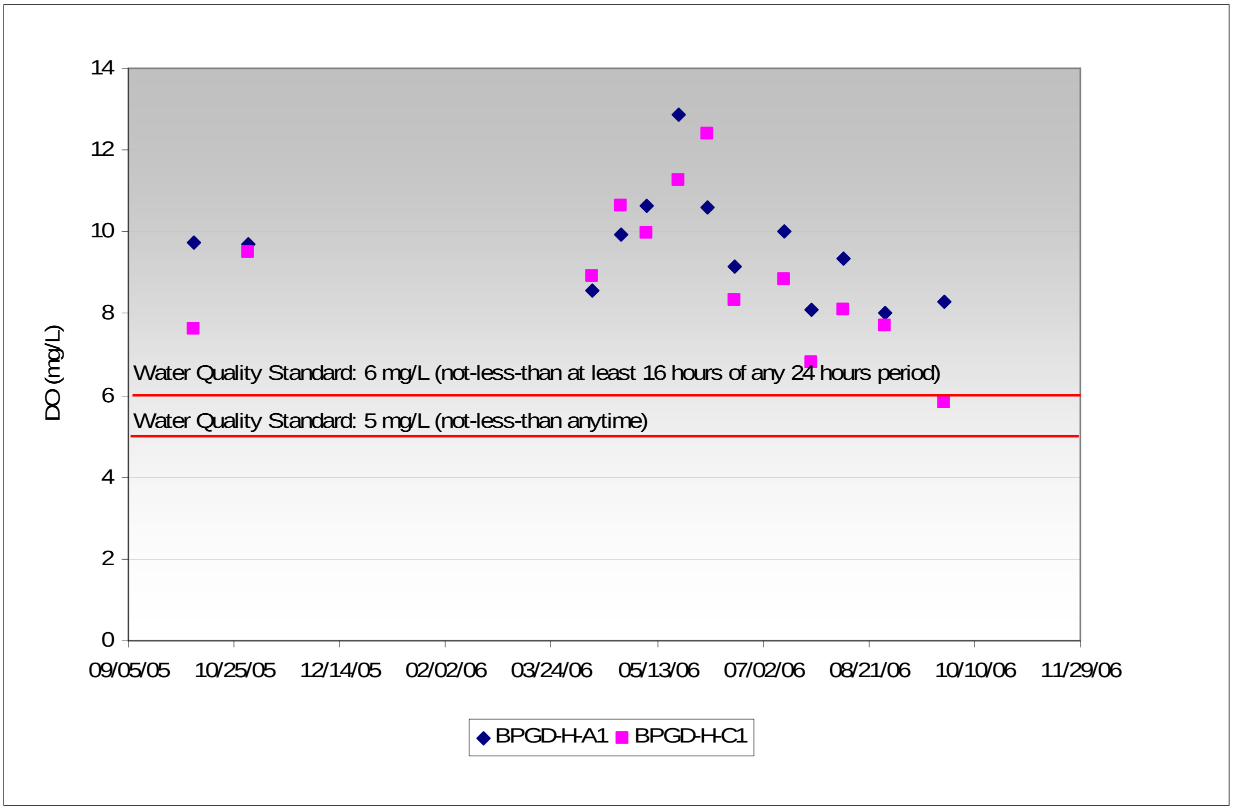
This section discusses the preliminary data analysis for each water body sampled, with a focus on the listed impairments.

3.1 HOOPESTON BRANCH IN NORTH FORK VERMILION RIVER

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

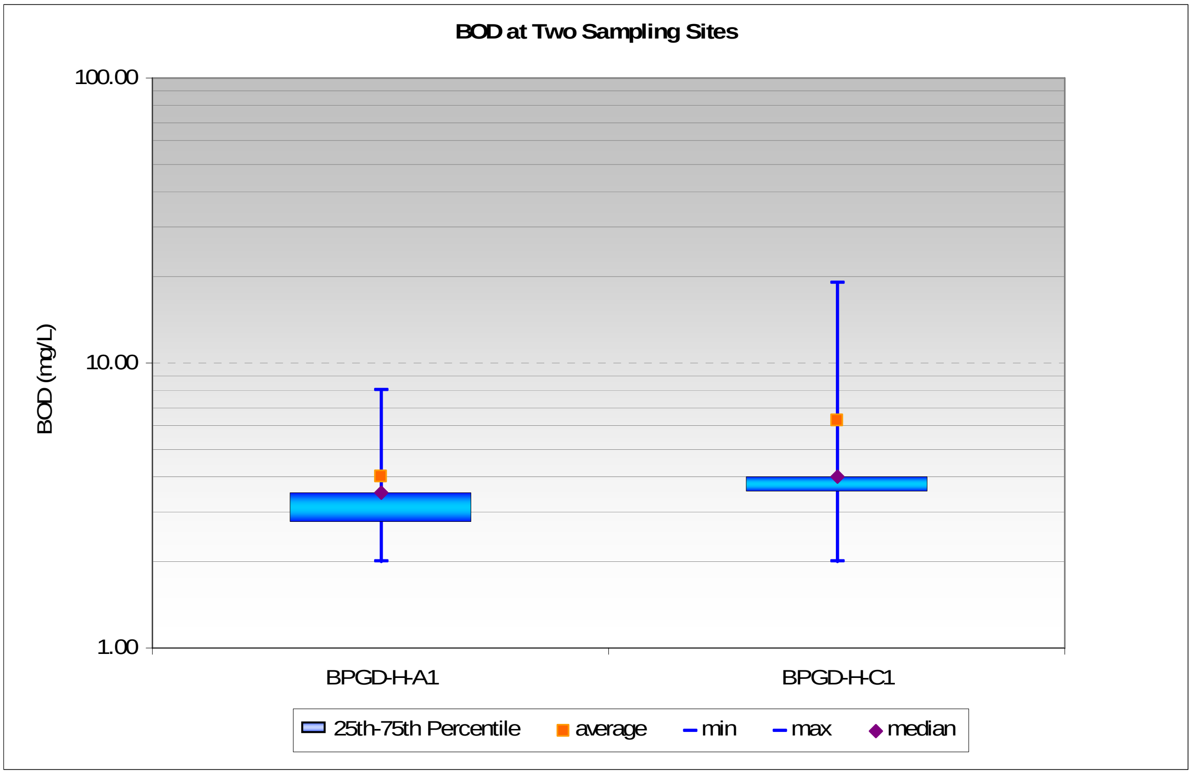
Figure 5 compares the DO measurements at the two sites during the sampling period. All data points met the DO standard of not-less-than 5.0 mg/L at any time. It is evident that BPGD-H-A1 contained higher average DO concentrations than BPGD-H-C1.

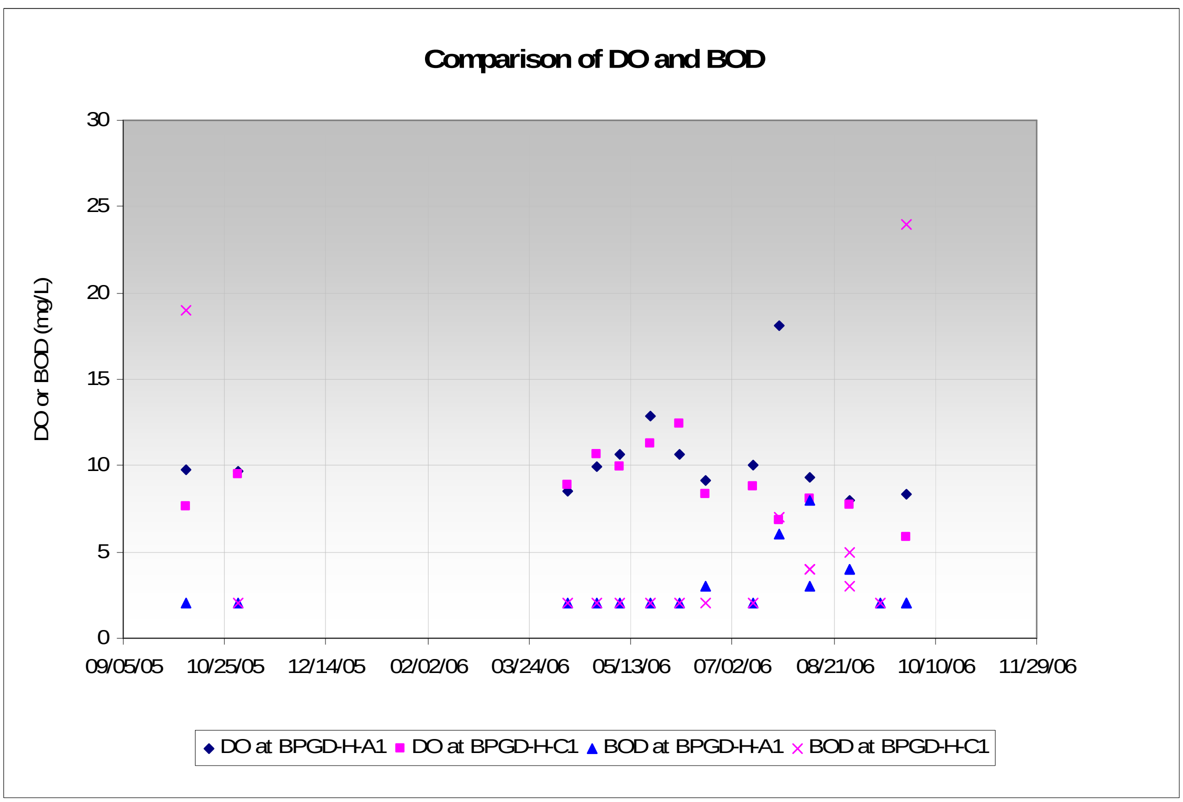
FIGURE 5
DO CONCENTRATIONS IN HOOPESTON BRANCH



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

FIGURE 6
BOD CONCENTRATIONS IN HOOPESTON BRANCH

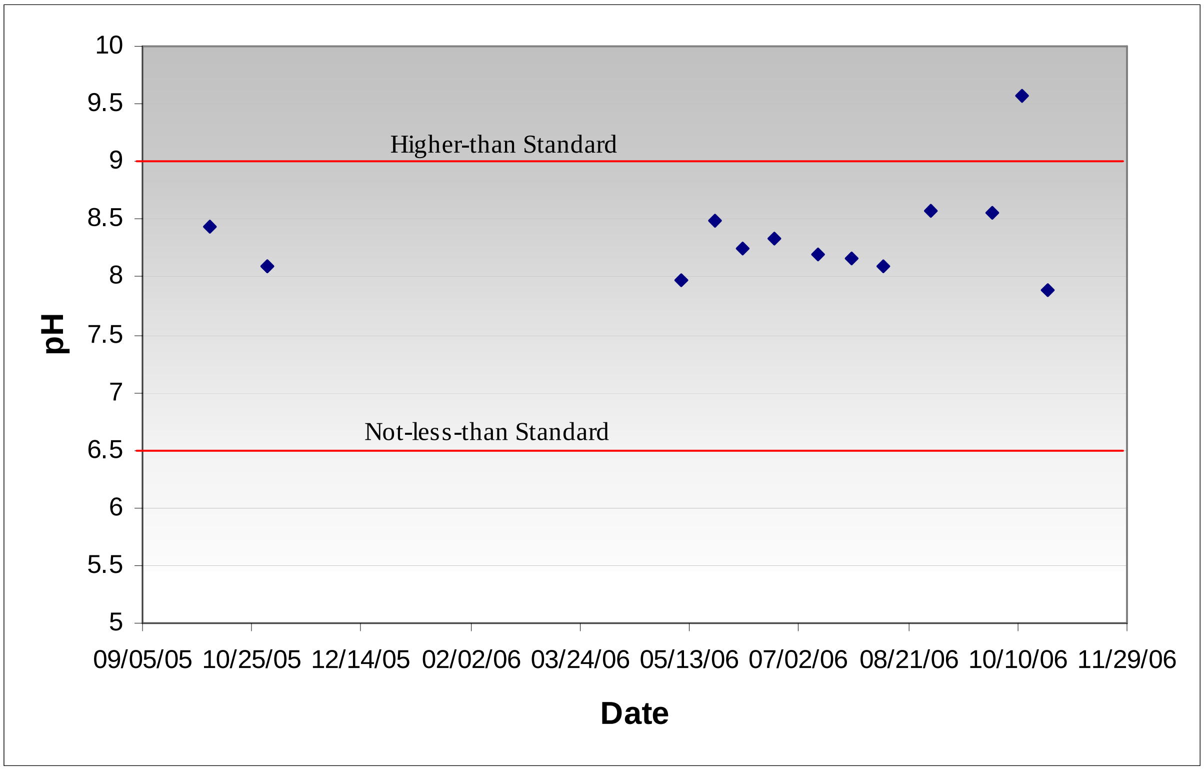




3.2 SALT FORK VERMILION RIVER

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

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



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

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

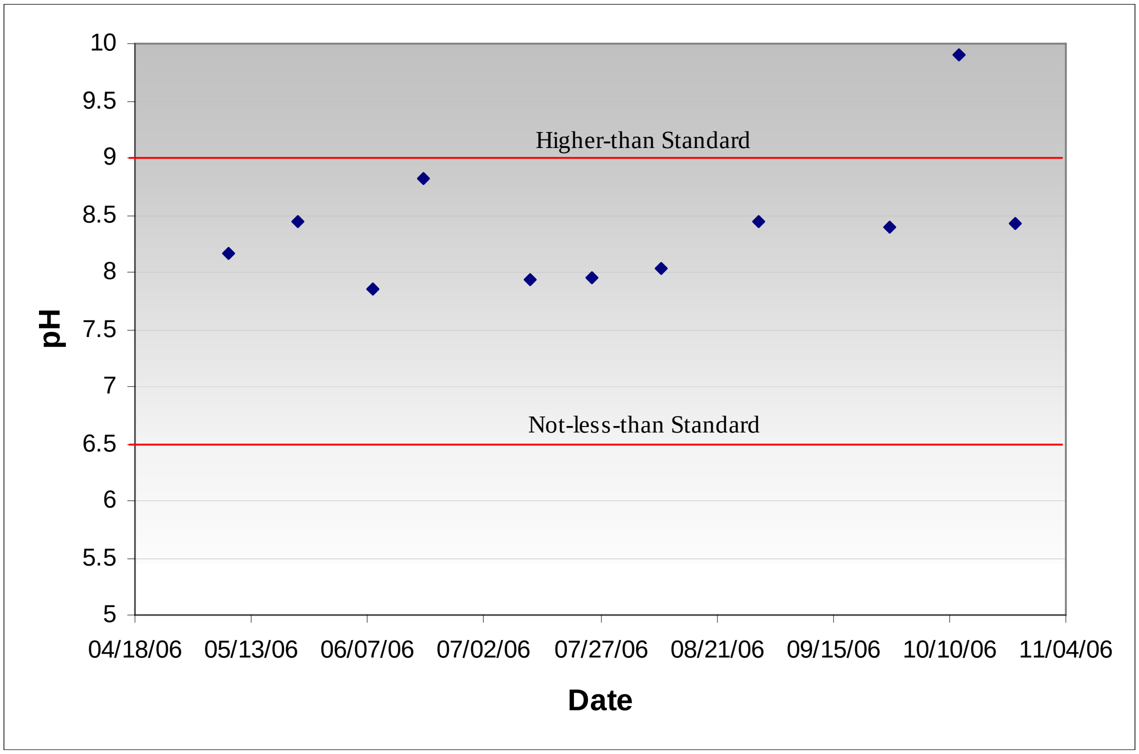
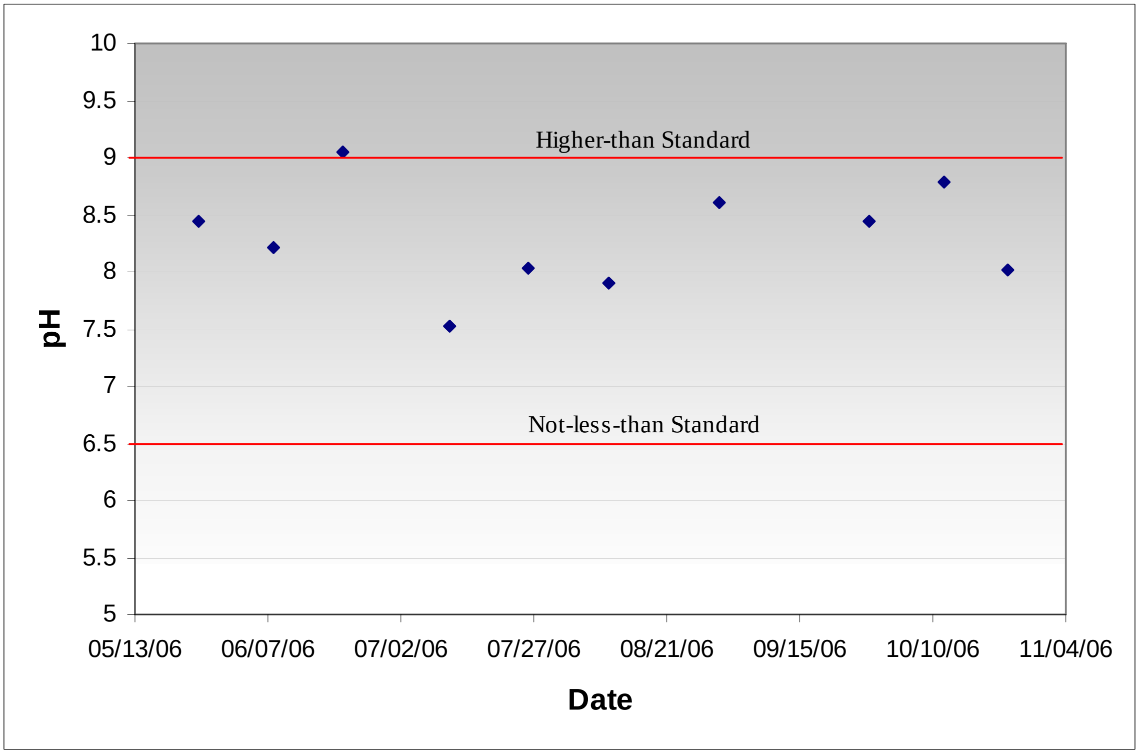
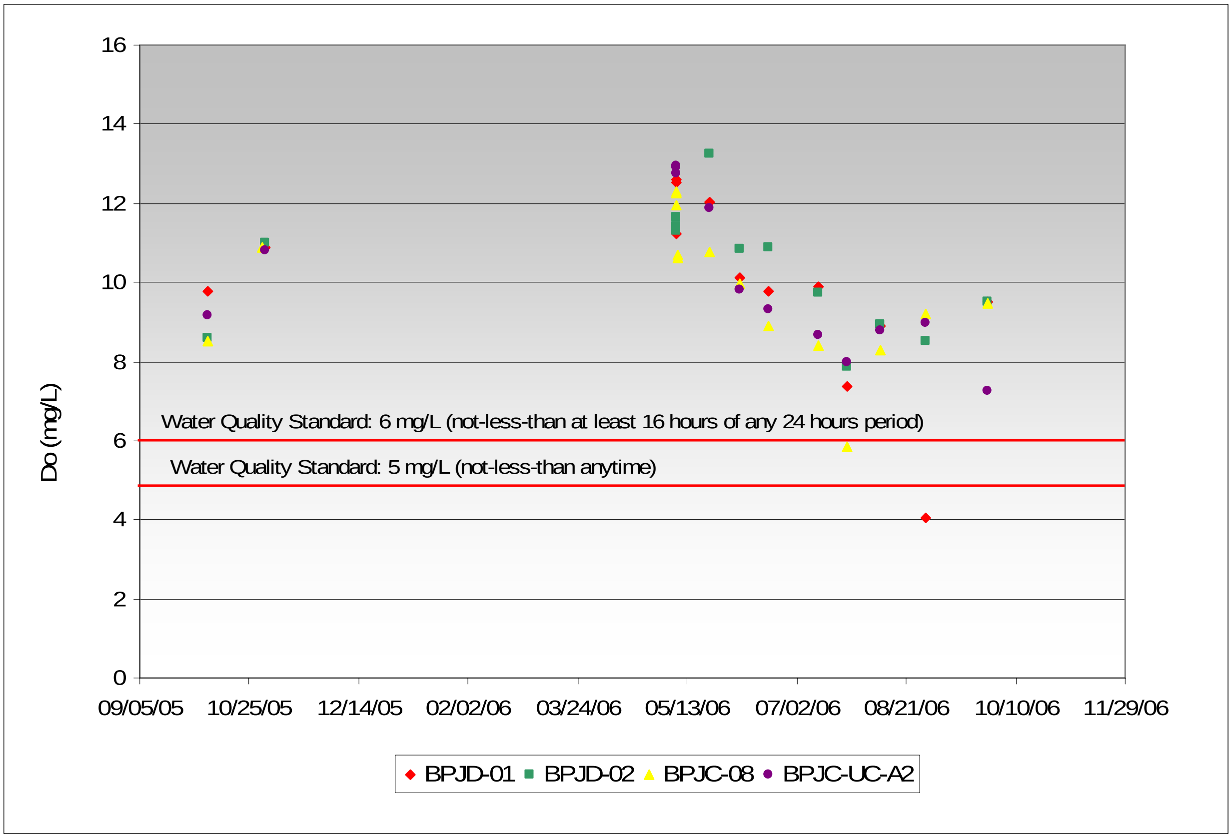


FIGURE 9
pH AT BPJ-16 IN SALT FORK VERMILLION RIVER



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

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



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

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

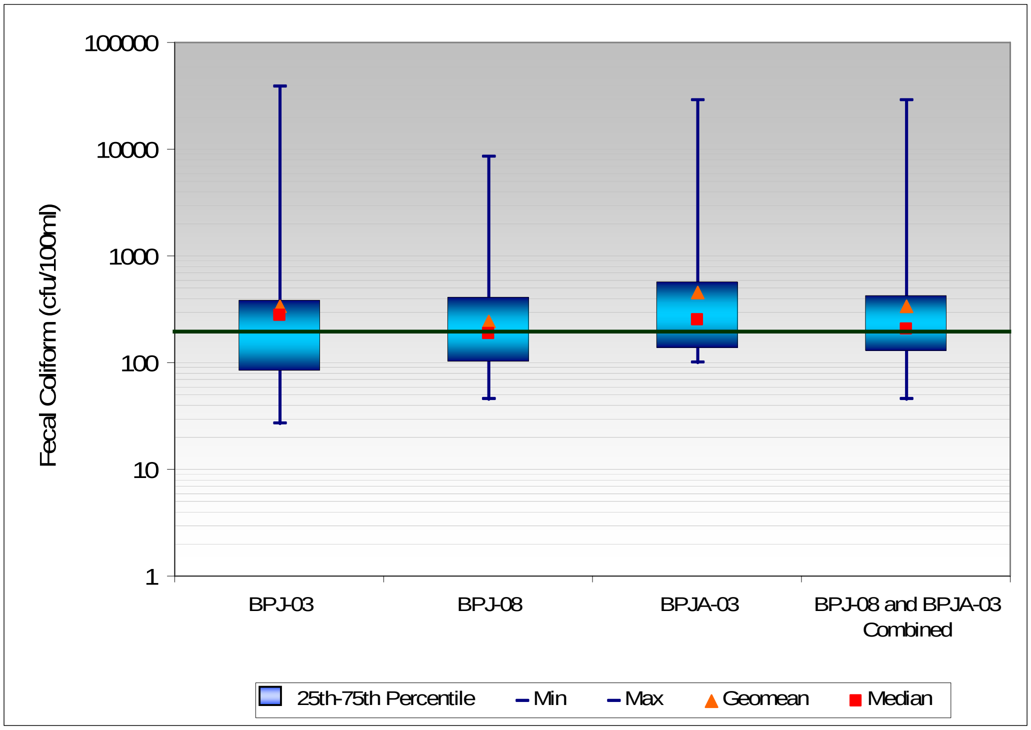
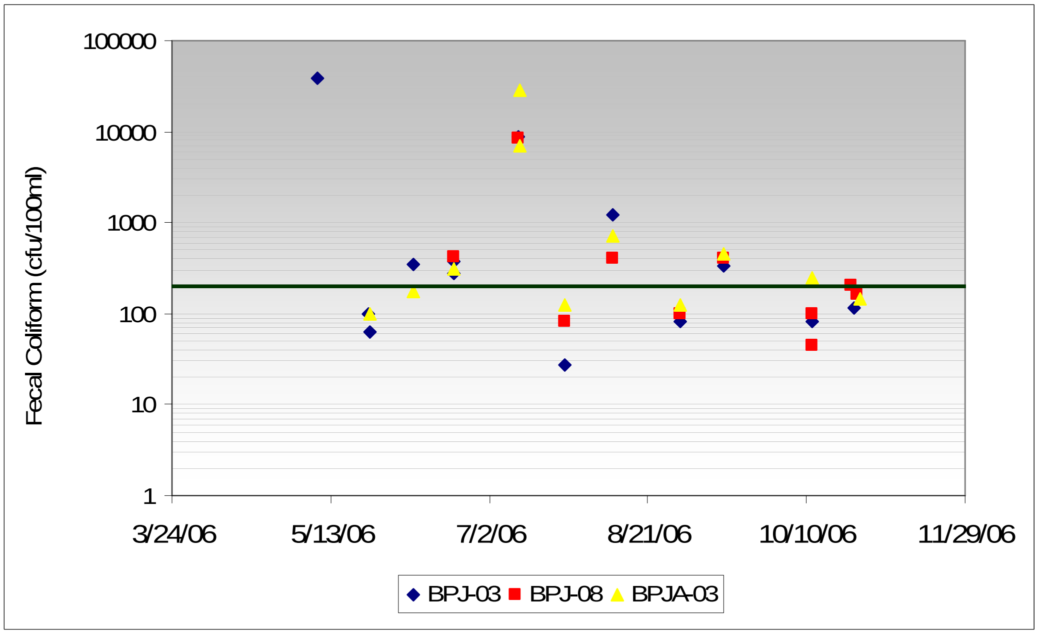


FIGURE 12
MONTHLY VARIATIONS IN FECAL COLIFORM CONCENTRATIONS
AT BPJ-03, BPJ-08, AND BPJA-03
IN SALT FORK VERMILLION RIVER



3.3 SUGAR CREEK

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

FIGURE 13
DO CONCENTRATIONS IN SUGAR CREEK

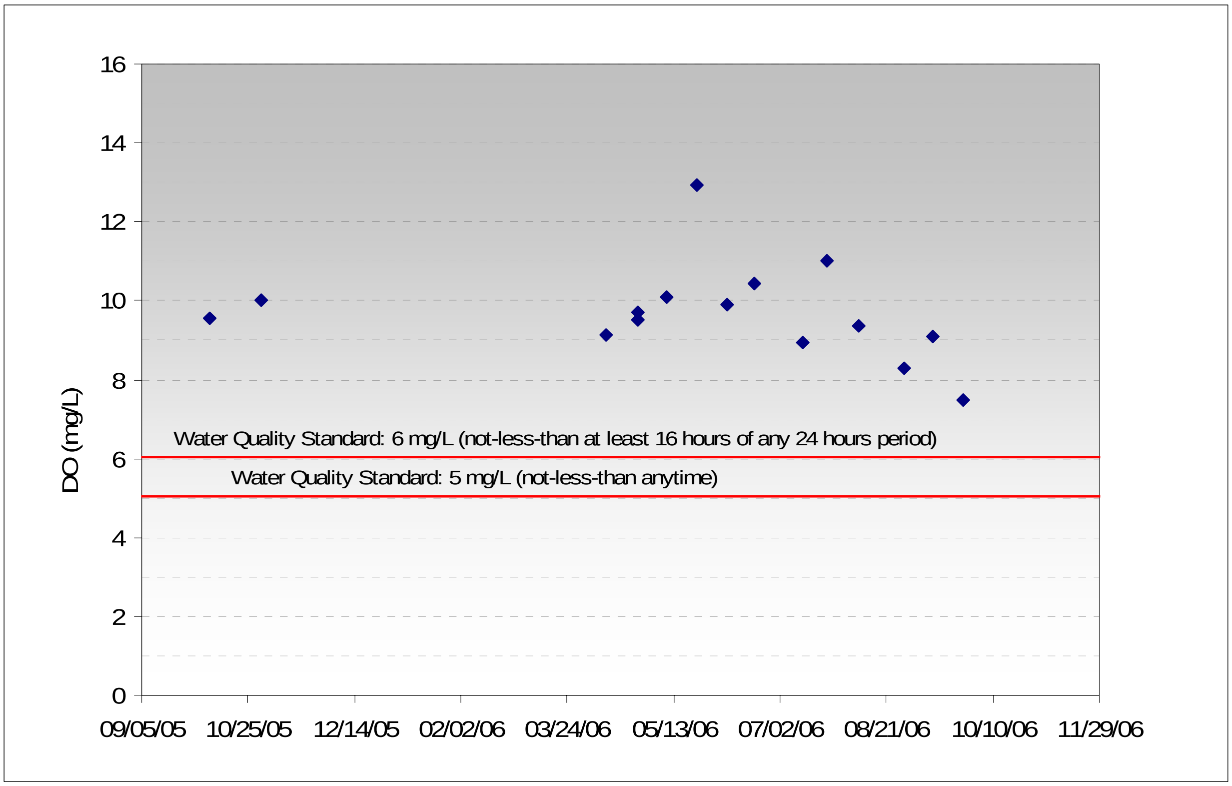
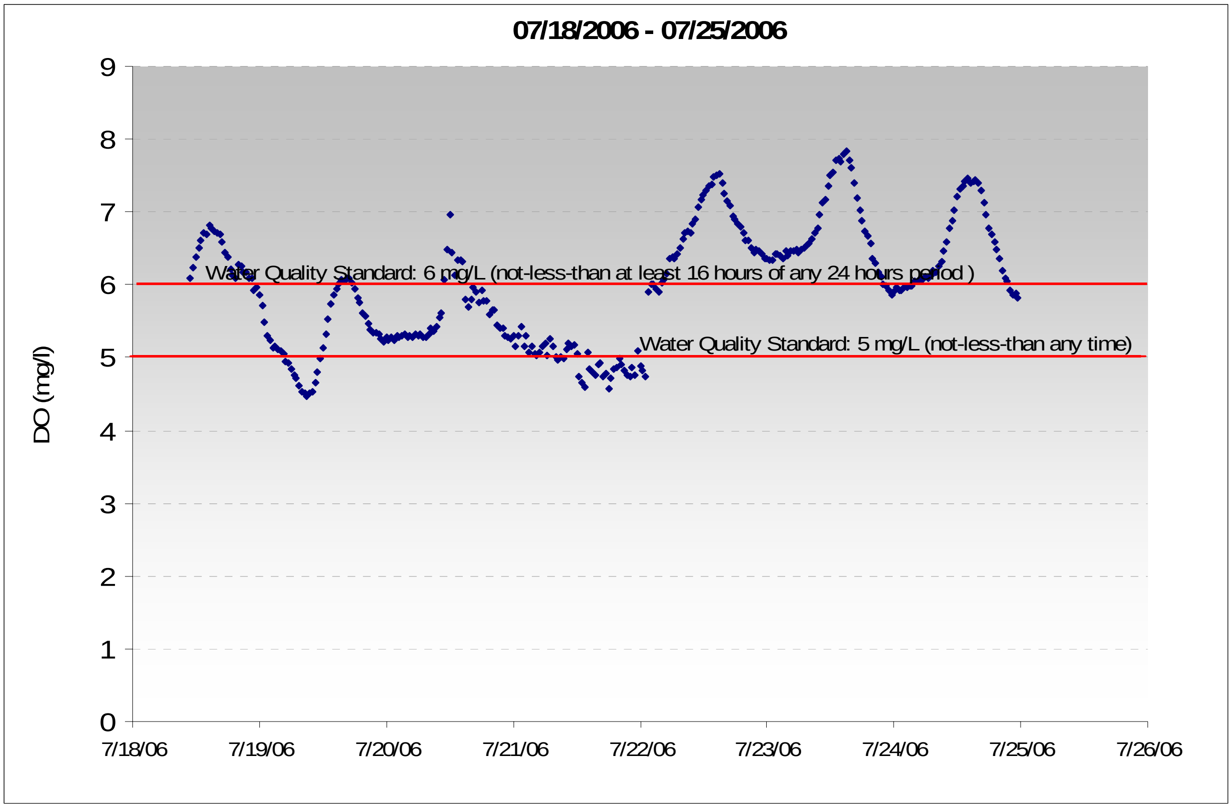
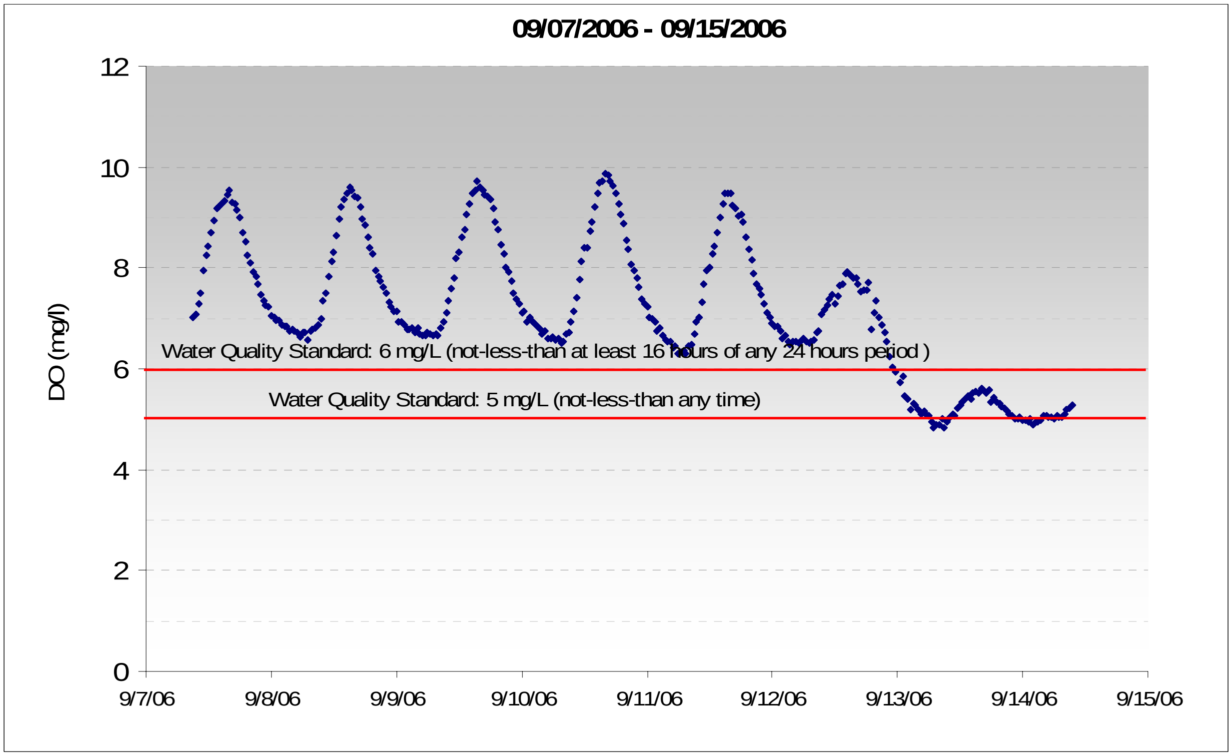


FIGURE 14
CONTINUOUS DO CONCENTRATIONS IN SUGAR CREEK
(Collected by IEPA)





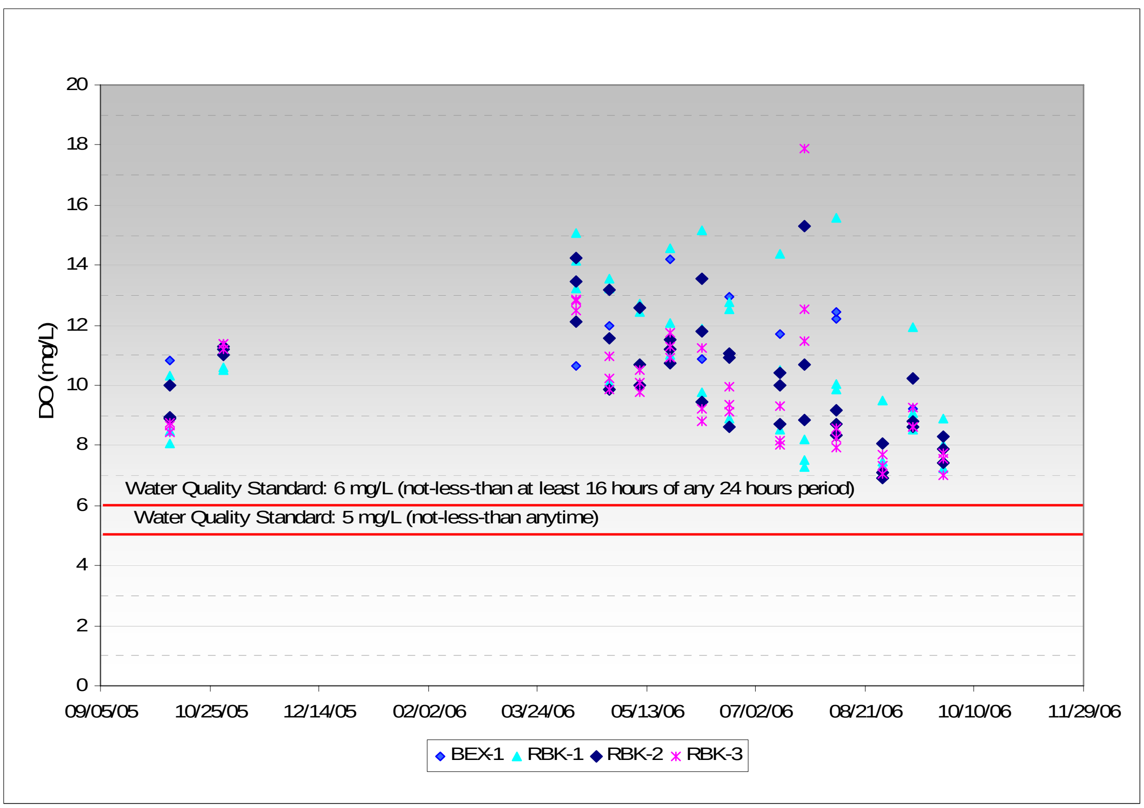
3.4 WALNUT POINT LAKE

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

DO

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

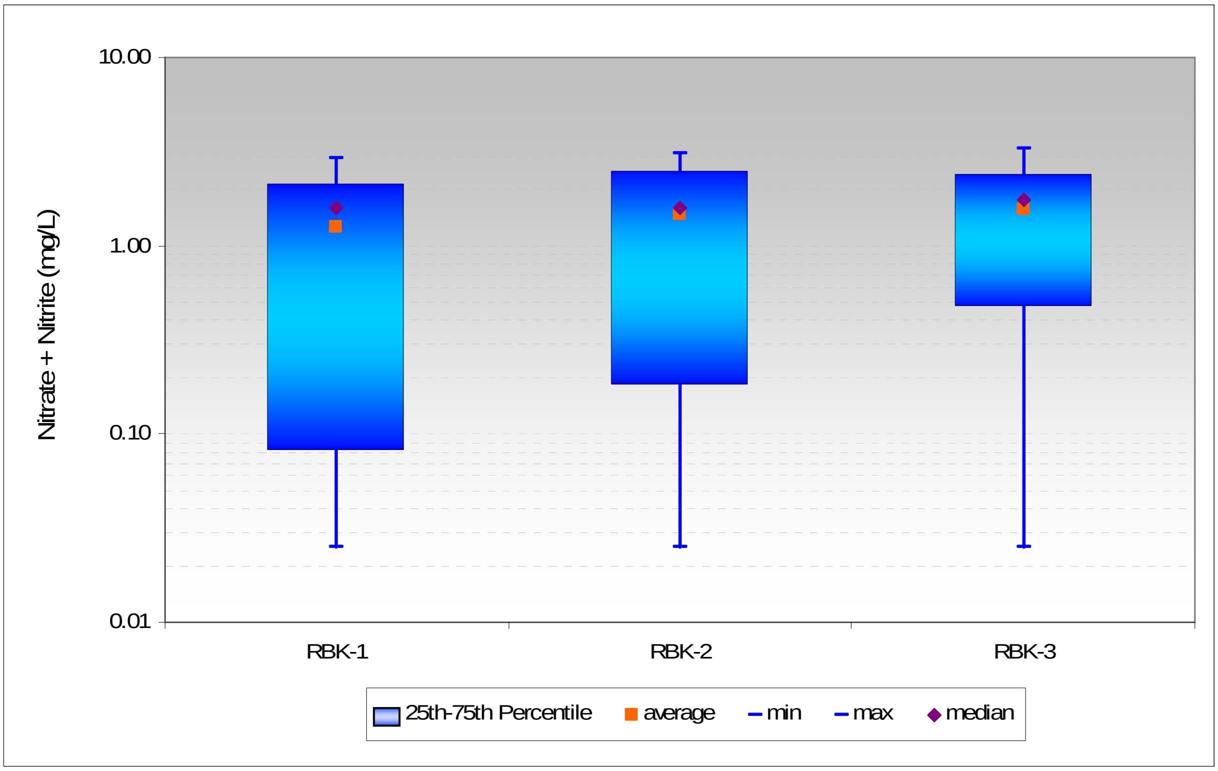
FIGURE 15
DO CONCENTRATIONS IN WALNUT POINT LAKE



NO_2 + NO_3

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

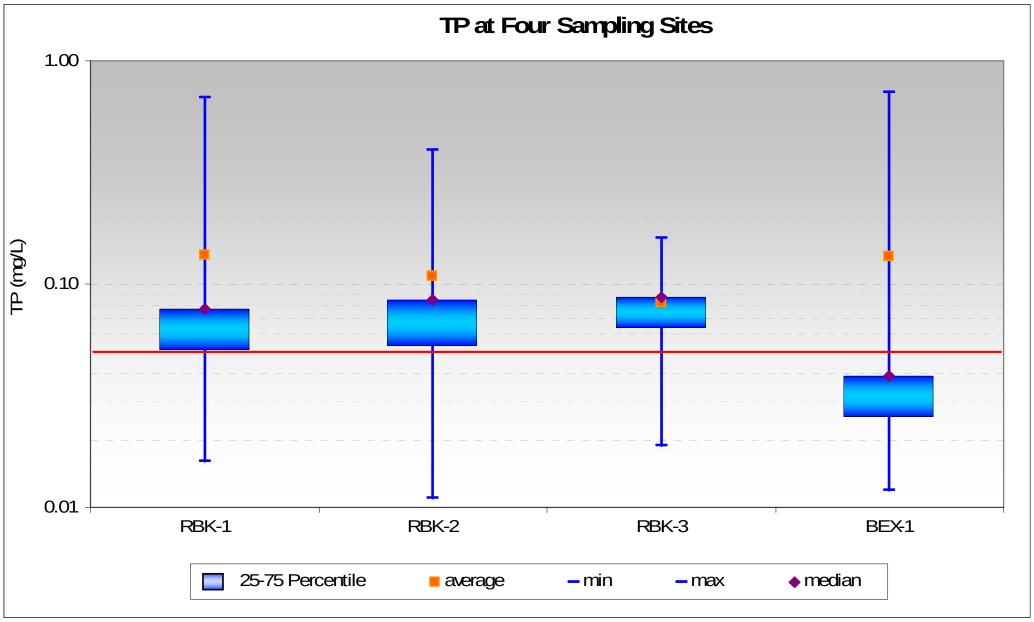
FIGURE 16
NO_2 + NO_3 CONCENTRATIONS IN WALNUT POINT LAKE



TP

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

FIGURE 17
TP CONCENTRATIONS IN WALNUT POINT LAKE



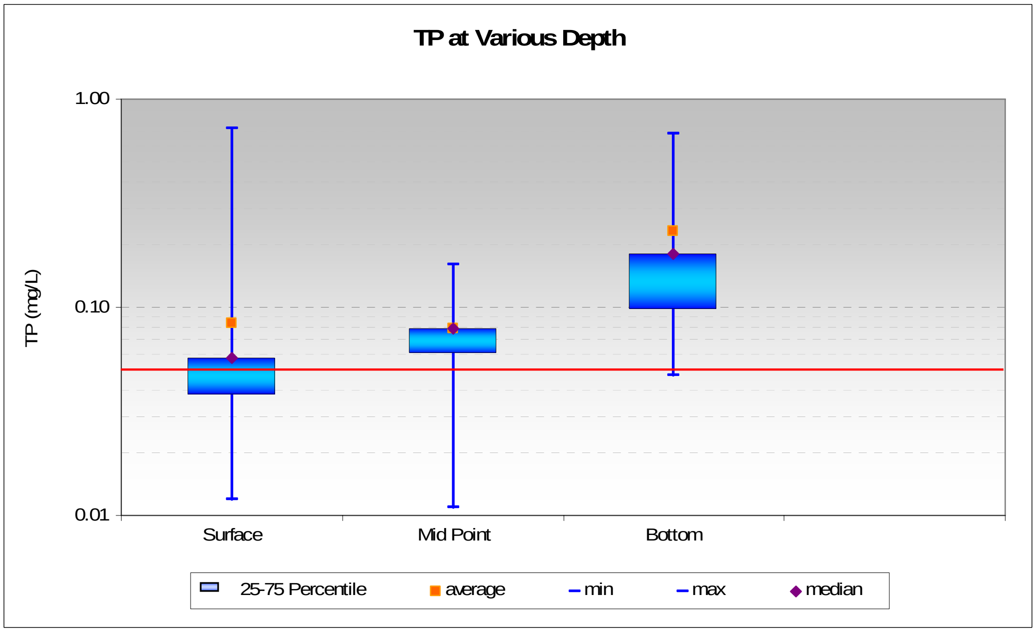
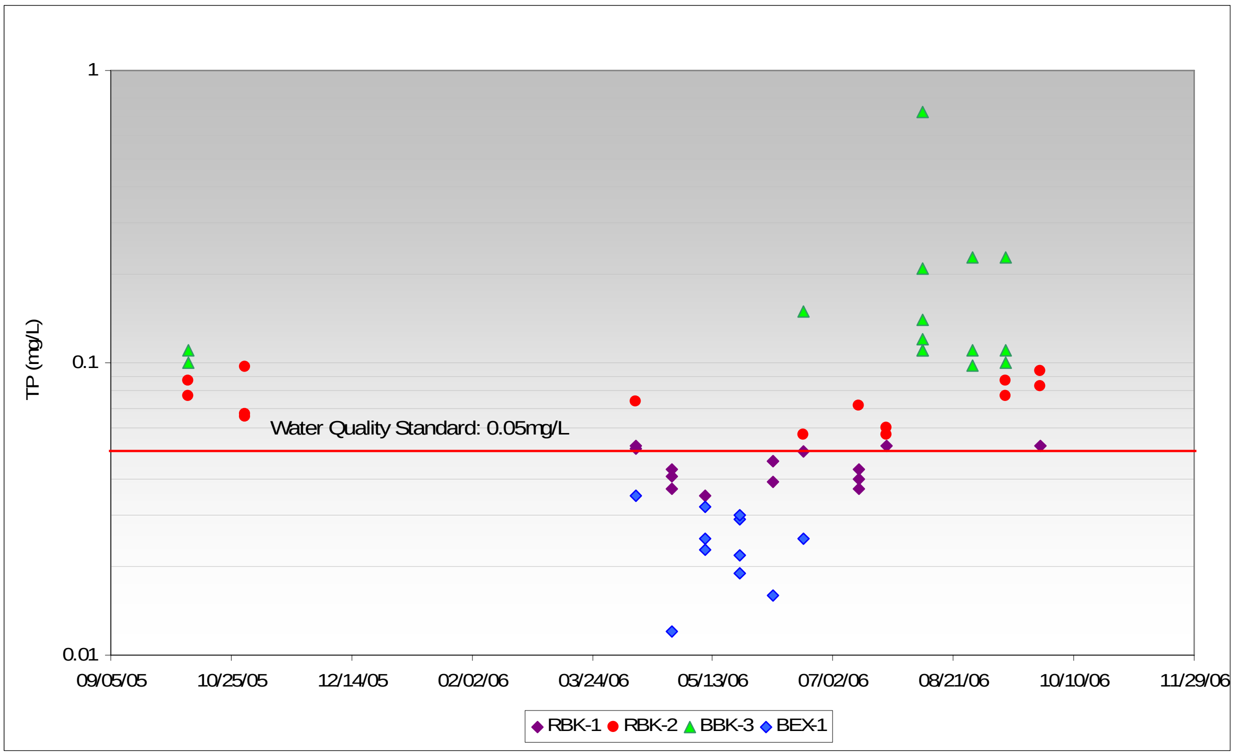


Figure 18 presents the TP data points for 1 foot below the water surface in Walnut Point Lake at all four sampling sites. Out of the 55 data points, 34 violated the 0.05-mg/L standard. The highest TP concentrations occurred in August and September.

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



Chlorophyll-*a*

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

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

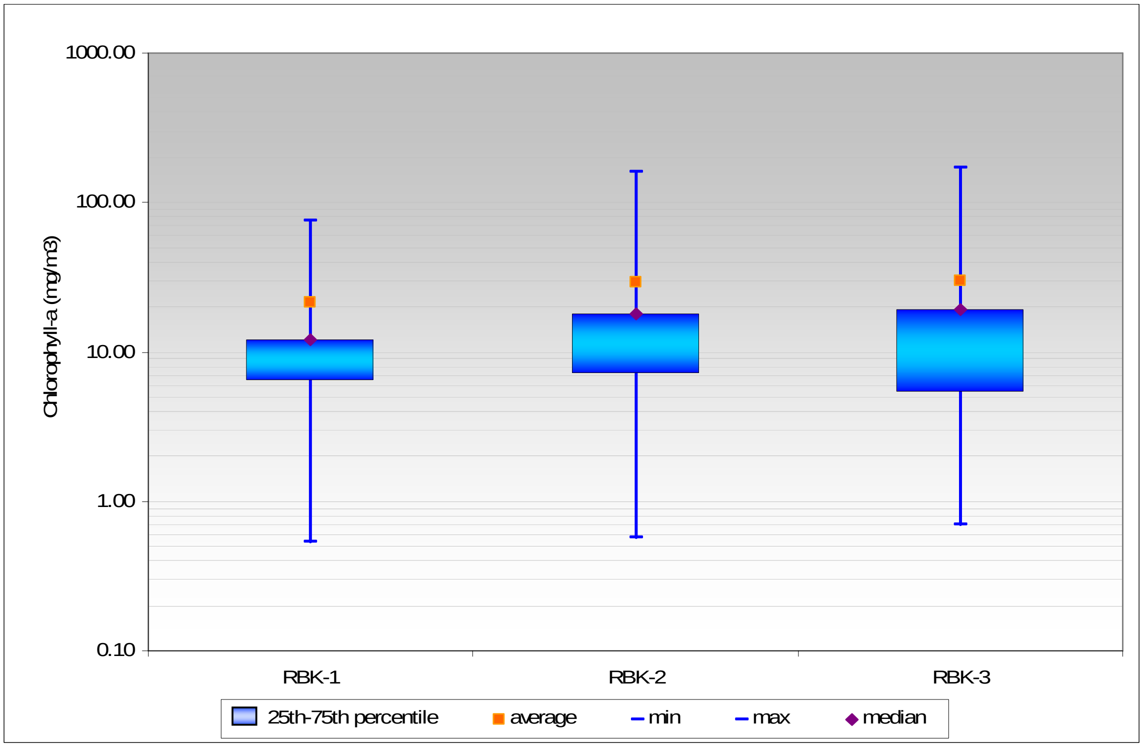
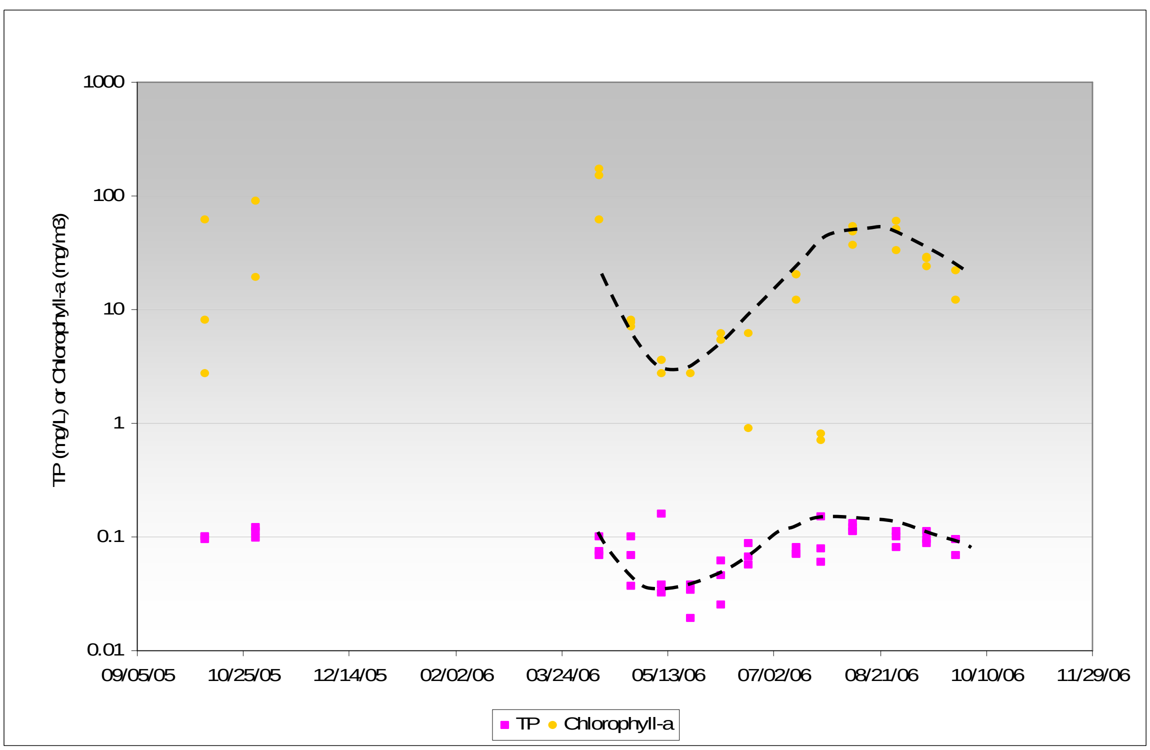


FIGURE 20
TP AND CHLOROPHYLL-*a* CONCENTRATIONS AT RBK-3
IN WALNUT POINT LAKE



4.0 RECOMMENDATIONS

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

NORTH FORK VERMILLION RIVER WATERSHED

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

SALT FORK VERMILION RIVER WATERSHED

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

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

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

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

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

SUGAR CREEK WATERSHED

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

WALNUT POINT LAKE WATERSHED

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

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

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

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

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

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

Notes:

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

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

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

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Attachment 3
Stage Three Report
CDM 2007

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CDM

Illinois Environmental
Protection Agency

Walnut Point Lake Watershed
Stage 3 Report
Total Maximum Daily Load

December 2007

Final Report

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Contents

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Acronyms

%	percent
BMP	best management practice
BOD	biochemical oxygen demand
CCC	Commodity Credit Corporation
CCX	Chicago Climate Exchange
cfs	cubic feet per second
CPP	Conservation Practices Program
CRP	Conservation Reserve Program
CWA	Clean Water Act
DNR	Department of Natural Resources
DO	dissolved oxygen
EQIP	Environmental Quality Incentive Program
ft	foot
FSA	Farm Service Agency
GIS	geographic information system
IAH	Illinois Agronomy Handbook
ICCI	Illinois Conservation and Climate Initiative
IDA	Illinois Department of Agriculture
IDNR	Illinois Department of Natural Resources
Illinois EPA	Illinois Environmental Protection Agency
kg	kilogram
km	kilometer
LA	load allocation
lbs	pounds
LC	loading capacity
m	meter
mg/L	milligrams per liter
MOS	margin of safety
NPS	Nonpoint source
NRCS	National Resource Conservation Service
SSRP	Streambank Stabilization and Restoration Practice
STORET	Storage and Retrieval
SWCD	Soil and Water Conservation District
TMDL	total maximum daily load

TP	total phosphorus
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VLMP	Volunteer Lake Monitoring Program
WASCOB	Water and Sediment Control Basin
WHIP	Wildlife Habitat Incentives Program
WLA	waste load allocation
WRP	Wetland Reserve Program

Section 1
Model Development

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 Walnut Point Lake Watershed

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

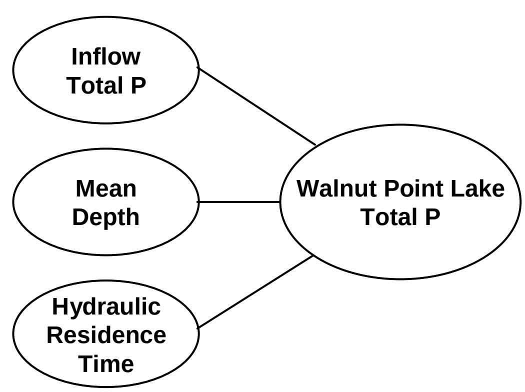
- Stage 1 – Watershed Characterization, Data Analysis, Methodology Selection
- Stage 2 – Data Collection (optional)
- Stage 3 – Model Calibration, TMDL Scenarios, Implementation Plan

Sections 1 through 4 of this report address Stage 3 TMDL development for the Walnut Point Lake watershed. Stage 1 of the TMDL (Attachment 1, Tetra Tech 2005) was completed in 2005. The lake was originally listed on the Illinois 1998 303(d) List for Total Phosphorus, Nitrogen Nitrate, Sedimentation/Siltation, Dissolved Oxygen, Suspended Solids, Aquatic Plants Native, and Excess Algal Growth. Illinois develops TMDLs for impairments with numeric water quality standards. Of the impairments listed in 1998, Total Phosphorus, Nitrogen/Nitrate, and Dissolved Oxygen have numeric water quality standards. In addition, Illinois EPA now only assesses nitrate concentrations for waterbodies that are used as a public water supply. Because Walnut Point Lake is not used as a public water supply, nitrate has been delisted as a cause of impairment and a TMDL will not be developed for nitrate. Also, because of insufficient data available for Walnut Point Lake to characterize current conditions and identify lake impairment, additional data were collected by Tetra Tech for Stage 2 in 2005 and 2006. The Stage 2 report is available as Attachment 2. The data collected during Stage 2 showed that the dissolved oxygen (DO) levels were no longer causing impairment but that total phosphorus levels were still recorded above the applicable water quality standard. Sections 1 through 4 of this Stage 3 report summarize the TMDL developed for total phosphorus in Walnut Point Lake and present implementation actions available within the watershed.

1.3 Model Overview

To develop the total phosphorus TMDL for Walnut Point Lake, a model called BATHTUB was utilized. Model selection was discussed in the Stage 1 report (Tetra Tech 2005).

Schematic 1 shows that by using total phosphorus concentrations, the resulting in-lake total phosphorus concentrations can be predicted. The BATHTUB model uses empirical relationships between mean reservoir depth, total phosphorus inflow into the lake, and the hydraulic residence time to determine in-reservoir concentrations.



Schematic 1
BATHTUB Model Schematic

1.4 BATHTUB Model Development and Input

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.

1.4.1 Global Inputs

Global inputs represent atmospheric contributions of precipitation, evaporation, and atmospheric phosphorus. Based on precipitation and evaporation rates discussed in the previous sections, the average annual precipitation input to the model was 40.7 inches, and the average annual evaporation input to the model was 36.3 inches. 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 kilograms per square kilometer ($kg/km^{2)}$-year (U.S. Army Corps of Engineers [USACE] 1999).

1.4.2 Reservoir Segment Inputs

Reservoir segment inputs in BATHTUB are used for physical characterization of the reservoir. Walnut Point Lake is modeled with three segments (RBK-1, RBK-2, and RBK-3) in BATHTUB. The segment boundaries are shown on Figure 1-1. Segmentation was established based on available water quality and lake morphologic data.

Segment inputs to the model include surface area, average depth, segment length, and depth to the metalimnion. The lake depth was represented by the averaged data from the data collected during Stage 2 of TMDL development (Tetra Tech 2007). These data are shown below (Table 1-1) for reference. Segment lengths and surface area were determined in geographic information system (GIS).

Table 1-1 Average Depths (ft) for Walnut Point Lake (Tetra Tech 2006)

Year	RBK-1	RBK-2	RBK-3
2005	30	21	17
2006	30	23	16
Average	30	23	17

1.4.3 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 with GIS analyses. See Figure 1-1 for subbasin boundaries. The watershed was broken up into five tributaries for purposes of the model. There are two tributaries that flow into the upstream lake segment (both unnamed tributaries). The remaining tributary areas are those contributing direct overland flow to each lake segment. The tributary areas are shown in Table 1-2.

Table 1-2 Walnut Point Lake Tributary Subbasin Information

Tributary Name	**Lake Segment Receiving Drainage**	**Subbasin Area (acres)**	**Estimated Subbasin flow (cfs)**	**Percent Contribution to Total External Load**
BEX-1 (Northeast Unnamed Tributary)	RBK-3	576	0.62	19%
Unnamed Tributary (Northwestt)	RBK-3	214	0.23	52%
Direct Runoff : RBK-3	RBK-3	182	0.20	16%
Direct Runoff : RBK-2	RBK-2	93	0.10	8%
Direct Runoff : RBK-1	RBK-1	49	0.05	4%
	Total	1114	1.2	

As discussed in the Stage One report, there are no U.S. Geological Survey (USGS) stream gages within the watersheds that have current, or even recent, streamflow data. Therefore, the drainage area ratio method, represented by the following equation, was used to estimate flows.

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

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

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

USGS gage 03336900 (Salt Fork near St. Joseph, Illinois) was chosen as an appropriate gage from which to estimate flows in the Walnut Point Lake watershed. The Salt Fork watershed is approximately 31 miles north of Walnut Point Lake. The gage drains an area that contains similar landuses and receives comparable precipitation throughout the year. Gage 03336900 captures flow from a drainage area of 134 square miles while the Walnut Point Lake watershed is relatively small (approximately two square miles). Estimated flow values were compared to flow data collected at BEX-1 during Stage Two to determine usability.

The total mean daily flow into Walnut Point Lake was determined to be 1.2 cubic feet per second (cfs). As discussed above, the flow contribution from the northeast unnamed tributary was documented during Stage 2 activities. The flow contributions for the remaining subbasins were estimated using the known flows in the northeast tributary and each subbasin's respective areas. The estimated flows from each tributary are shown in Table 1-2.

The surface area of the lake was listed as 41.6 acres in the Stage 1 report. Local officials suggested that the lake was larger than 41.6 acres. Aerial photographs were used to reevaluate the surface area of the lake for this Stage 3 analysis. The total surface area of the lake was determined to be 48 acres while the total watershed area was delineated to 1,160 acres. Figure 1-1 shows both the lake and its drainage area. The watershed area to lake area ratio is approximately 24:1 meaning that for every one acre of lake there are 24 acres of basin drainage area. The ratio of lake watershed area to lake surface area affects sediment and nutrient loadings and retention time. Generally, external loads of nutrients increase as the watershed to surface area ratio increases. A ratio of 24:1 is considered to be somewhere between a seepage lake (typically less than 10:1 ratio and dominated by groundwater influences) and a drainage lake (typically high ratio lakes that are dominated by tributary inflows).

The storage volume for Walnut Point Lake was available through historic U.S. Environmental Protection Agency (USEPA) Storage and Retrieval (STORET) data and was confirmed through communications with Walnut State Park Department of Natural Resources (DNR) representatives. The storage volume for Walnut Point Lake is 673 acre-feet. Based on this storage volume and the estimated inflow of 1.2 cfs, the lake residence time is approximately 280 days.

Stage Two data showed that average phosphorus concentrations at BEX-1 on the northeast tributary were 0.13 mg/L. This information was coupled with flow data provided in Table 1-2 and were used to estimate loadings from each tributary subbasin.

1.5 BATHTUB Confirmatory Analysis

Available lake and tributary water quality data are summarized in the reports for Stages One and Two (Attachments 1 and 2; Tetra Tech 2005 and 2007). Although data are available from 1995, only data from Stage Two were used to set up and to help confirm model calculations. The data collected during Stage Two are more recent and considered to be more representative of current in-lake conditions. In addition, tributary concentration data were only available from Stage Two. In order to confirm the BATHTUB model for Walnut Point Lake, 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
- Secchi Depth: Not computed
- Longitudinal Dispersion: Fischer-Numeric
- Error Analysis: Not computed
- Phosphorus Calibration: None
- 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 initial 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. Table 1-4 shows the results of the confirmatory analysis performed in BATHTUB for Walnut Point Lake.

Table 1-4 Summary of Model Confirmatory Analysis: Lake Total Phosphorus (mg/L)

Lake Segment	Predicted Concentration	Observed Concentration	Internal Loading Rate (mg/m^2-day)
RBK-1	0.080	0.083	15 (nearest to dam)
RBK-2	0.106	0.109	12
RBK-3	0.108	0.108	3
Lake Average	0.096	0.096	

Based on the confirmatory analysis internal cycling is occurring nearest the dam where oxygen levels could be depleted at lower levels, which indicates favorable conditions for internal cycling. A review of data collected in 1995 indicates that DO levels at all sites experienced DO levels near zero at sampling depths near the bottom of the lake during each sampling event (April, June, July, August, and October 1995). DO samples were only collected at the surface during Stage 2 data collection. The near zero DO levels recorded in 1995 confirm that favorable conditions exist for internal cycling. Phosphorus samples collected at depths near the lake bottom were much higher than surface samples, also lending confidence to the possibility of significant internal loading.

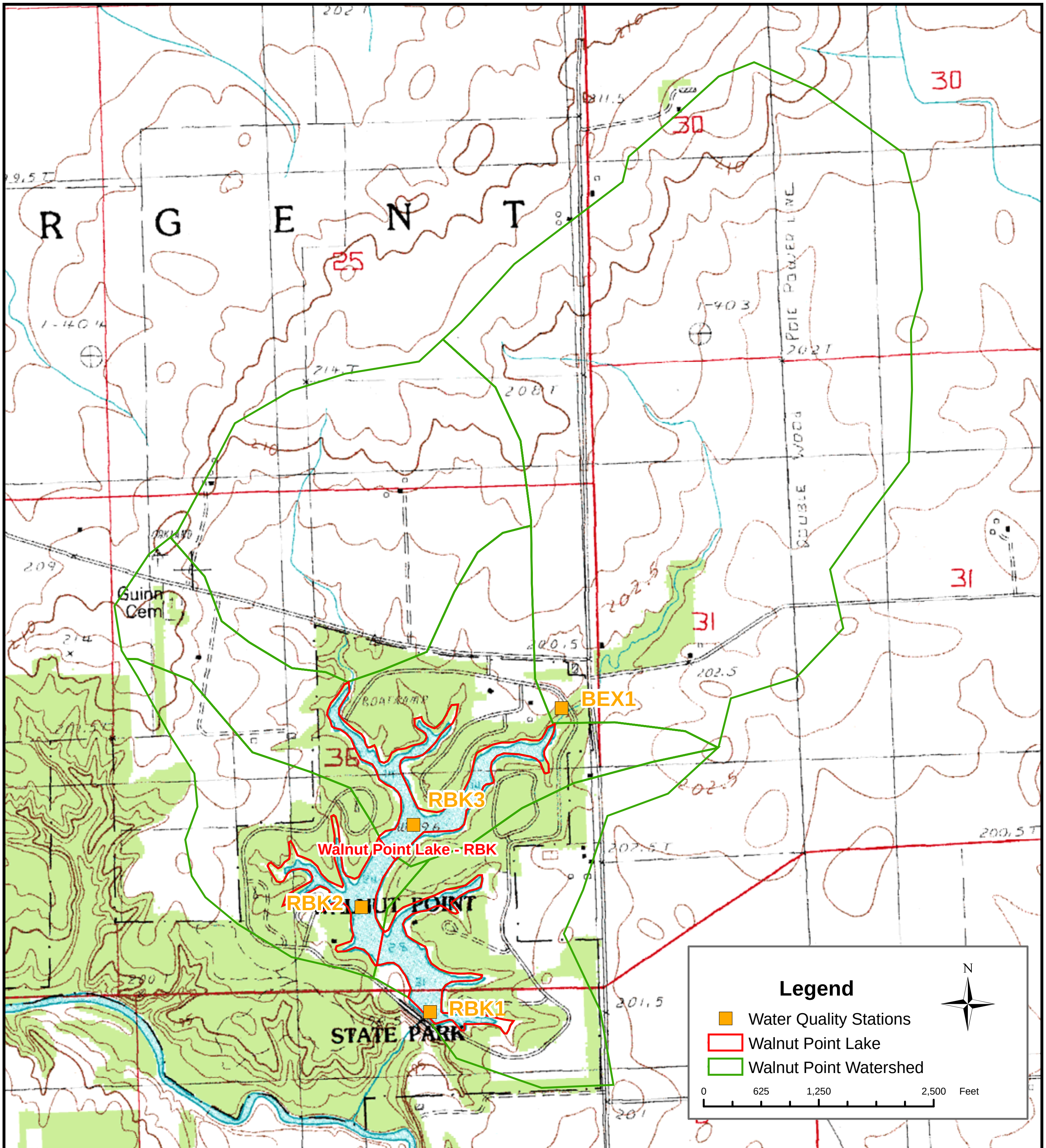


Figure 1-1:
BATHTUB Segmentation
Walnut Point Lake Watershed

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Section 2
TMDL Development

2.1 TMDL Calculations

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. The desired in-lake water quality concentration for total phosphorus is less than or equal to 0.05 mg/L (*302.205*). The Stage One and Two reports summarized the average total phosphorus concentrations sampled in the Walnut Point Lake watershed. As noted in the previous reports, observed in-lake total phosphorus averages have exceeded the target. Phosphorus is a concern as nuisance plant and algae growth in many freshwater lakes is enhanced by the availability of phosphorus. Additionally, this enhanced plant growth can result in large DO fluctuations.

2.2 Pollutant Sources and Linkages

Pollutant sources and their linkages to Walnut Point Lake were established through the BATHTUB modeling and loading calculations discussed in Section 1. Modeling indicated that loads of total phosphorus originate from internal and external sources. Potential sources of total phosphorus in the watershed include nonpoint sources such as runoff from cropping areas (overland runoff or drainage through field tiles), runoff from surrounding grassland, forest and parkland, septic systems and internal loading from lake sediments. The Stage 1 report (Attachment 1) did not indicate any large animal operations located within the watershed. The supervisor at Walnut State Park indicated that there are two septic systems in the park which drain to the lake. The septic systems service the shower building and the concession area. In addition, there are a number of farm houses on the east side of the lake, just outside the park, which are thought to be on septic systems. These systems could be significant contributors of phosphorus to the lake. Because a watershed model was not run for this watershed, the load associated with the septic systems would be accounted for in the internal load calculated in BATHTUB. The TMDL explained throughout the remainder of this section will examine how much the loads need to be reduced in order to meet the total phosphorus water quality standard of 0.05 mg/L in Walnut Point Lake.

2.3 TMDL Allocations for Walnut Point Lake

As explained in Section 1, the TMDL for Walnut Point Lake addresses the following equation:

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

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.

2.3.1 Loading Capacity

The loading capacity (LC) of Walnut Point Lake is the pounds of total phosphorus that can be allowed as input to the lake per day 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 model that was set up and confirmed as discussed in Section 1. To accomplish this, the loads calculated using average values from the Stage Two data 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 Walnut Point Lake. The allowable annual phosphorus load determined by reducing modeled inputs to Walnut Point Lake through BATHTUB was determined to be 1.3 pounds (lbs)/day. This analysis is included as Appendix A.

2.3.2 Seasonal Variation

A season is represented by changes in weather; for example, a season can be classified as warm or cold as well as wet or dry. Seasonal variation is represented in the Walnut Point Lake TMDL as conditions were modeled on an annual basis. Modeling on an annual basis takes into account the seasonal effects the lake will undergo during a given year. Since the pollutant source can be expected to contribute loadings in different quantities during different time periods (e.g., various portions of the agricultural season resulting in different runoff characteristics), the loadings for this TMDL will focus on average annual loadings converted to daily loads rather than specifying different loadings by season. The Walnut Point Lake watershed would most likely experience critical conditions annually based on the growing season. Because an average annual basis was used for TMDL development, it is assumed that the critical condition is accounted for within the analysis.

2.3.3 Margin of Safety

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

- In the absence of site-specific data, an atmospheric loading rate of 30 mg/m2-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 high amount of conservation tillage practices in the watershed the atmospheric loading is most likely negligible.

- 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 and a factor of 3 for nitrogen. 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.

2.3.4 Waste Load Allocation

There are no point sources within the Walnut Point Lake watershed. Therefore, the waste load allocation (WLA) is set to zero for this TMDL.

2.3.5 Load Allocation and TMDL Summary

Table 2-1 shows a summary of the TMDL for Walnut Point Lake. On average, a total reduction of 72 percent of total phosphorus loads to Walnut Point Lake would result in compliance with the water quality standard of 0.05 mg/L total phosphorus. The 72 percent reduction would need to come from the sources discussed above. Table 2-1 also shows where load reductions could be achieved from either internal cycling or from external watershed loadings.

Table 2-1 TMDL Summary for Walnut Point Lake

Load Source	LC (lb/day)	WLA (lb/day)	LA (lb/day)	MOS (lb/day)	Current Load (lb/day)	Reduction Needed (lb/day)	Reduction Needed (percent)
Total	1.3	0	1.3	0	4.7	3.4	72%
Internal	0.97	0	0.97	0	3.8	2.8	74%
External	0.33	0	0.33	0	0.8	0.5	63%

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Section 3
Implementation Plan for Walnut Point Lake

3.1 Implementation Actions and Management Measures for Phosphorus

Phosphorus loads in the Walnut Point Lake watershed originate from both external and internal sources. As identified by the 2004 303(d) list, possible sources of total phosphorus in the watershed include runoff from surrounding forest, grassland and parkland areas, crop production, and internal loading from lake sediments. In addition, two septic systems located in the park are thought to be contributors of phosphorus load to the lake. There are no significant animal operations located within the watershed. The phosphorus TMDL determined that the total allowable load to Walnut Point Lake is 1.3 lbs/day. Of the total allowable load, approximately one-quarter of the allowable load was allocated to external sources while the other three-quarters of the allowable load were allocated to internal sources. A total reduction of 72 percent of total phosphorus loads will need to be achieved for Walnut Point Lake to be in compliance with the water quality standard of 0.05 mg/L. To achieve a reduction of total phosphorus for Walnut Point Lake, management measures must address loading through sediment and surface runoff controls and internal nutrient cycling through in-lake management.

Implementation actions, management measures, or best management practices (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 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). The remainder of this section will discuss implementation actions and management measures for phosphorus sources in the watershed.

3.1.1 Point Sources of Phosphorus

There are no point sources contributing discharge to Walnut Point Lake.

3.1.2 Nonpoint Sources of Phosphorus

Potential sources of nonpoint source phosphorus pollution identified by the 303(d) list include crop production, runoff from grassland/forest/parkland, and contaminated sediments. In addition, tile drainage and septic systems in the watershed have also been identified as potential sources of nutrients to the lake. BMPs evaluated that could be utilized to treat these nonpoint sources are:

- Conservation tillage practices
- Filter strips
- Wetlands
- Nutrient management
- Drainage control structures for tile drain outlets
- Septic system maintenance

Total phosphorus originating from cropland is most efficiently treated with a combination of nutrient management, no-till or conservation tillage practices and grass filter strips. Phosphorus reaching tributaries through tile drains can be treated by drainage control structures installed for drain outlets. Wetlands located upstream of the reservoir could provide further reductions in total and dissolved phosphorus in runoff from croplands. Better septic system maintenance may help to reduce nutrient loading from the in-park systems.

3.1.2.1 Conservation Tillage Practices

For the Walnut Point Lake watershed, where 76 percent of the watershed consists of agricultural land uses, conservation tillage practices could help reduce nutrient loads in the lake. The lake potentially receives nonpoint source runoff from approximately 918 acres of row crops and small grain agriculture. 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); however, filter strips are less effective at removing dissolved phosphorus only. The 2006 Illinois Department of Agriculture's (IDA's) Soil Transect Survey estimated that conventional till currently accounts for 83 percent of corn, 18 percent of soybean, and 80 percent of small grain tillage practices in Douglas County, and these percentages were assumed to apply to the Walnut Point Lake watershed as well. To achieve TMDL load allocations, tillage practices already in place should be continued, and practices should be assessed and improved upon for all 918 agricultural acres in the Walnut Point Lake watershed.

3.1.2.2 Filter Strips

Filter strips can be used as a control to reduce pollutant loads, including nutrients and sediment, to Walnut Point Lake. Filter strips implemented along stream segments slow and filter nutrients and sediment out of runoff and provide bank stabilization decreasing erosion and deposition. Additionally, filter strips mitigate nutrient loads to lakes. The following paragraphs focus on the implementation of filter strips in the

Walnut Point Lake watershed. Design criteria and size selection of filter strips are also discussed.

Grass and riparian buffer strips filter out nutrients and organic matter associated with sediment loads to a water body. Filter strips reduce nutrient and sediment loads to lakes by establishing ground depressions and roughness that settle sediment out of runoff and providing vegetation to filter nutrients out of overland flow. In addition, filter strips should be harvested periodically in accordance with the federal and/or state conservation program in which the practice was enrolled, so that removal rate efficiencies over extended periods of time remain high (USEPA 1993).

Table 3-1 Filter Strip Flow Lengths Based on Land Slope

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

According to the National Resource Conservation Service (NRCS) Planning and Design Manual, the majority of sediment is removed in the first 25 percent of the width of the filter strip (NRCS 1994). Table 3-1 above outlines the guidance for filter strip flow length by slope (NRCS 1999). Some of the land adjacent to tributaries of Walnut Point Lake is agricultural. GIS land use data described in the Stage 1 report were used in conjunction with soil slope data to provide an estimate of acreage where filter strips could be installed. As discussed in the Stage 1 report, the most predominant soil type in the watershed is Flanagan silt loam on 0 to 2 percent slopes. Based on these slope values, filter strip widths of 36 to 144 feet could be incorporated into lands adjacent to the tributaries. Mapping software was then used to buffer stream segments to determine the total area found within 144 feet of tributaries in the watershed. Figure 3-1 shows an aerial photograph of the watershed as well as buffered areas used for this analysis. There are approximately 175 total acres within this buffer distance. The landuse data were then clipped to the buffer area to determine the amount of this land that is agricultural. There are approximately 80 acres of agricultural land that could potentially be converted to filter strips. Landowners should evaluate their land near the tributaries to Walnut Point Lake and install or extend filter strips according to the NRCS guidance provided in Table 3-1. Programs available to fund the construction of these buffer strips are discussed in Section 3.2.

3.1.2.3 Wetlands

The use of wetlands as a structural control is applicable to nutrient reduction from agricultural lands in the Walnut Point Lake watershed. To treat loads from agricultural runoff, a wetland could be constructed on the upstream end of the reservoir. 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 (U.S. Department of Agriculture [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 to75 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 3-2 Acres of Wetland for Walnut Point Lake Watershed

Subbasin	Area (acres)	Recommended Wetlands (acre)	Existing Wetlands (acre)
Unnamed Tributary (Northwest)	131.4	0.8	1.75
Unnamed Tributary (Northeast – BEX-1)	564.6	3.4	8.59
Direct Runoff : RBK-3	290.3	1.7	1.75
Direct Runoff : RBK-2	108.4	0.7	0
Direct Runoff : RBK-1	83.1	0.5	0
Total	1,178	7.1	12.63

Guidelines for wetland design suggest a wetland to watershed ratio of 0.6 percent for nutrient and sediment removal from agricultural runoff. Table 3-2 outlines estimated wetland areas for each subbasin based on these recommendations. A wetland system to treat agricultural runoff from the five subbasins comprising the 1,178-acre Walnut Point Lake watershed would range between one-half an acre to approximately 3.5 acres (Denison and Tilton 1993).

According to the U.S. Division of Fish and Wildlife's National Wetland Inventory, there are approximately 12.63 acres of freshwater forested/shrub wetlands currently existing within the watershed. Wetlands are defined as by the Inventory as

"lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of the year."

Figure 3-2 shows the wetlands identified by the inventory in the vicinity of Walnut Point Lake (where the majority of acreage is located). Table 3-2 further categorizes the wetlands by subbasin for reference. Restoring or improving these areas can potentially improve the quality of agricultural runoff that reaches Walnut Point Lake.

3.1.2.4 Nutrient Management

Nutrient management could result in reduced nutrient loads to Walnut Point Lake. A nutrient management plan should address fertilizer application rates, methods, and timing. Initial soil phosphorus concentrations are determined by onsite soil testing, which is available from local vendors. Losses through plant uptake are subtracted, and gains from organic sources such as manure application or industrial/municipal wastewater are added. The resulting phosphorus content is then compared to local guidelines to determine if fertilizer should be added to support crop growth and maintain current phosphorus levels. In some cases, the soil phosphorus content is too high, and no fertilizer should be added until stores are reduced by crop uptake to target levels.

The Illinois Agronomy Handbook (IAH) lists guidelines for fertilizer application rates based on the inherent properties of the soil (typical regional soil phosphorus concentrations, root penetration, pH, etc.), the starting soil test phosphorus concentration for the field, and the crop type and expected yield.

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 (IAH recommends soil testing every four years)
- 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

Band placement should occur prior to or during corn planting, depending on the type of field equipment available. Fertilizer should be applied when the chance of a large precipitation event is low. Researchers in Iowa found that runoff concentrations of phosphorus were 60 percent lower when the next precipitation event occurred 10 days after fertilizer application, as opposed to 24 hours after application. Application to frozen ground or snow cover is strongly discouraged. Researchers studying loads from agricultural fields in east-central Illinois found that fertilizer application to frozen ground or snow followed by a rain event could transport 40 percent of the total annual phosphorus load (Gentry et al. 2007).

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

The effectiveness of nutrient management plans (application rates, methods, and timing) in reducing phosphorus loading from agricultural land will be site specific.

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

3.1.2.5 Drainage Control Structures for Tile Drain Outlets

As discussed in the Stage One report, the Walnut Point Lake watershed is underlain by drain tile designed to remove standing water from the soil surface. Subsurface drainage is designed to remove excess water from the soil profile. The water table level is controlled through a series of drainage pipes (tiles or tubing) that are installed below the soil surface, usually just below the root zone. In Illinois, subsurface drainage pipes are typically installed at a depth of three to four feet and at spacing of 80 to 120 feet. The subsurface drainage network generally outlets to an open ditch or stream.

A conventional tile drain system collects infiltrated water below the root zone and transports the water quickly to a down-gradient surface outlet. Placement of a water-level control structure at the outlet allows for storage of the collected water to a predefined elevation. The stored water becomes a source of moisture for plants during dry conditions and undergoes biological, chemical, and physical processes that result in lower nutrient concentrations in the final effluent. Use of control structures on conventional tile drain systems in the coastal plains has resulted in reductions of total phosphorus loading of 35 percent (Gilliam et al. 1997). Researchers at the University of Illinois also report reductions in phosphorus loading with tile drainage control structures. Concentrations of phosphate were reduced by 82 percent, although total phosphorus reductions were not quantified in this study (Cooke 2005). Going from a surface draining system to a tile drain system with outlet control reduces phosphorus loading by 65 percent (Gilliam et al. 1997). Storage of tiled drained water for later use via subsurface irrigation has shown decreases in dissolved phosphorus loading of approximately 50 percent (Tan et al. 2003). However, accumulated salts in reuse water may eventually exceed plant tolerance and result in reduced crop yields. Mixing stored drain water with fresh water or alternating irrigation with natural precipitation events will reduce the negative impacts of reuse. Salinity thresholds for each crop should be considered and compared to irrigation water concentrations.

3.1.2.6 Septic System Maintenance and Sanitary System

Septic systems are a potential source of nonpoint source phosphorus loading. The supervisor at Walnut State Park indicated that there are two septic systems in the park which drain to the lake. The septic systems service the shower building and the concession area and are located on the north and south sides of the Shady boat ramp. Detailed information on the systems is unknown; however, these systems could be significant contributors of phosphorus to the lake.

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 biochemical oxygen demand (BOD) loading to the septic system. Reduction of solids to the tank can be achieved via limiting garbage disposals use and water conservation.

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

- Maintaining a vegetative cover over the drainfield to prevent erosion
- Avoiding construction over the system
- Protecting the area down slope of the system from excavation
- Landscape the area to divert surface flow away from the drainfield (Johnson 1998)

3.1.3 In-Lake Phosphorus

The Walnut Point Lake phosphorus TMDL allocated approximately 75 percent of the total allowable phosphorus load to internal cycling. Reduction of phosphorus from in-lake cycling through management strategies is necessary for attainment of the TMDL load allocation. Internal phosphorus loading occurs when the water above the sediments become anoxic causing the release of phosphorus from the sediment in a form which 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.

For lakes experiencing high rates of phosphorus inputs from bottom sediments, several management measures are available to control internal loading. Three BMP options for the control of internal loading include the installation of an aerator, the addition of aluminum, and dredging. Hypolimnetic (bottom water) aeration involves an aerator air-release that can be positioned at a selected depth or at multiple depths to increase oxygen transfer efficiencies in the water column and reduce internal loading by establishing aerobic conditions at the sediment-water interface. Hypolimnetic aeration effectiveness in reducing phosphorus concentration depends in part on the presence of sufficient iron to bind phosphorus in the oxygenated waters. A mean hypolimnetic iron:phosphorus ratio greater than 3.0 is optimal to promote iron phosphate precipitation (Stauffer 1981). The iron:phosphorus ratio in the sediments should be greater than 15 to bind phosphorus (Welch 1992).

Phosphorus inactivation by aluminum addition (specifically aluminum sulfate or alum) to lakes has been the most widely-used technique to control internal phosphorus loading. Alum forms a polymer that binds phosphorus and organic matter. The aluminum hydroxide-phosphate complex (commonly called alum floc) is insoluble and settles to the bottom, carrying suspended and colloidal particles with it. Once on the sediment surface, alum floc retards phosphate diffusion from the sediment to the water (Cooke et al.1993).

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. However, dredging is more costly than other management options (NRCS 1992).

3.2 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 are currently in practice to some degree within the watershed. The discussion in Section 3.1 provided information on available BMPs for reducing phosphorus loads from nonpoint sources. The remainder of this section discusses an estimate of costs to the watershed for implementing these practices and programs available to assist with funding.

3.2.1 Available Cost-Share Programs

Approximately 76 percent of the Walnut Point Lake watershed is classified as agricultural row crop, and small grains land. There are several voluntary conservation programs established through the 2002 U.S. Farm Bill (the 2007 Farm Bill is currently being developed), which encourage landowners to implement resource-conserving practices for water quality and erosion control purposes. These programs would apply to crop fields and rural grasslands that are presently used as pasture land. Each program is discussed separately in the following paragraphs.

3.2.1.1 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.

3.2.1.2 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)

3.2.1.3 Clean Water Act Section 319 Grants

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

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

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

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

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

3.2.1.4 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 3-3 (USDA 2006).

Table 3-3 Costs for Enrollment Options of WRP Program

Option	Permanent Easement	30-year Easement	Restoration Agreement
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

3.2.1.5 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 which includes a specific conservation and environmental objective, one or more conservation practices in the conservation management system to be implemented to achieve the conservation and environmental objectives, and the schedule for implementing the conservation practices. This plan becomes the basis of the cost-share agreement between NRCS and the participant. NRCS provides cost-share payments to landowners under these agreements that can be up to 10 years in duration.

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

3.2.1.6 Wildlife Habitat Incentives Program (WHIP)

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

3.2.1.7 Streambank Stabilization and Restoration Practice

Although erosion from lake tributaries is not thought to be a significant contributor of nutrients to the lake, 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, roads; stream capacity reduction through sediment deposition; and degraded water quality, fish, and wildlife habitat. The primary goals of the SSRP are to develop and demonstrate vegetative, stone structure and other low cost bio-engineering techniques for stabilizing streambanks and to encourage the adoption of low-cost streambank stabilization practices by making available financial incentives, technical assistance, and educational information to landowners with critically eroding streambanks. A cost share of 75 percent is available for approved project components; such as willow post installation, bendway weirs, rock riffles, stream barbs/rock, vanes, lunker structures, gabion baskets, and stone toe protection techniques. There is no limit on the total program payment for cost-share projects that a landowner can receive in a fiscal year. However, maximum cost per foot of bank treated is used to cap the payment assistance on a per foot basis and maintain the program's objectives of funding low-cost techniques (IDA 2000).

3.2.1.8 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.

3.2.1.9 Illinois Conservation and Climate Initiative (ICCI)

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

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

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

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

3.2.1.10 Local Program Information

The FSA administers the CRP. NRCS administers the EQIP, WRP, and WHIP. Local NRCS contact information in Douglas County are listed in the Table 3-4 below.

Table 3-4 Douglas County USDA Service Center Contact Information

Contact	Address	Phone
Local SWCD Office		
Butch Fisher	900 South Washington Tuscola, IL 61953	217-253-2022
Local FSA Office		
Steve Niemann	900 South Washington Tuscola, IL 61953	217-253-2022
Local NRCS Office		
Ben Mingo	900 South Washington Tuscola, IL 61953	217-253-2022

3.2.2 Cost Estimates of BMPs

Cost estimates for different best management practices and individual practice prices such as filter strip installation are detailed in the following sections. Table 3-5 outlines the estimated cost of implementation measures in the Walnut Point Lake watershed.

3.2.2.1 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.

3.2.2.2 Filter Strips and Riparian Buffers

Filter strips can either be seeded with grass or sodded for immediate function. The seeded filter strips cost approximately $0.30 per square foot to construct, and sodded filter strips cost approximately $0.70 per square foot to construct. Generally, it is assumed that the required filter strip area is 2 percent of the area drained. This means that 870 square feet of filter strip are required for each acre of agricultural land treated. The construction cost to treat one acre of land is therefore $261/acre for a seeded filter strip and $609/acre for a sodded strip. At an assumed system life of 20 years (Weiss et al. 2007), the annualized construction costs are $13/acre/year for seeded and $30.50/acre/year for sodded strips. Annual maintenance of filter strips is estimated at $0.01 per square foot (USEPA 2002b) for an additional cost of $8.70/acre/year of agricultural land treated. In addition, the area converted from agricultural production to filter strip will result in a net annual income loss of $3.50.

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

Assuming a buffer width of 90 feet on either side of the stream channel and an adjacent treated width of 300 feet of agricultural land, one acre of buffer will treat approximately 3.3 acres of adjacent agricultural land. The cost per treated area is thus $30/acre to construct and $142.50/acre to maintain over the life of the buffer. Assuming a system life of 30 years results in an annualized cost of $59.25/year for each acre of agricultural land treated.

3.2.2.3 Nutrient Management Plan - NRCS

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

3.2.2.4 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.

3.2.2.5 Conservation Tillage

Conservation tillage practices generally require fewer trips to the field, saving on labor, fuel, and equipment repair costs, though increased weed production may result in higher pesticide costs relative to conventional till (USDA 1999). In general, conservation tillage results in increased profits relative to conventional tillage (Olson and Senjem 2002; Buman et al. 2004; Czapar 2006). The HRWCI (2005) lists the cost for conservation tillage at $0/acre.

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

Depending on the type of equipment currently used, replacing conventional till equipment with no-till equipment can either result in a net savings or slight cost to the producer. Al-Kaisi et al. (2000) estimate that converting conventional equipment to no-till equipment costs approximately $1.25 to $2.25/acre/year, but that is for new equipment.

Other researchers report a net gain when conventional equipment is sold to purchase no-till equipment (Harman et al. 2003).

3.2.2.6 Drainage Control Structures for Tile Drain Outlets

Area Soil and Water Conservation Districts may offer tile mapping services. Typically, these services cost approximately $2.25/acre and use color infrared photography to assist farmers in identifying the exact location of their tile drain lines.

Cooke (2005) estimates that the cost of retrofitting tile drain systems with outlet control structures ranges from $20 to $40 per acre. Construction of new tile drain systems with outlet control is approximately $75/acre. The yield increases associated with installation of tile drain systems are expected to offset the cost of installation (Cooke 2005). It is assumed that outlet control structures have a system life of 30 years.

3.2.2.7 Septic System Maintenance

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

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

The cost of developing and maintaining a watershed-wide database of the onsite wastewater treatment systems in the Walnut Point Lake watershed depends on the number of systems that need to be inspected. A recent inspection program in South Carolina found that inspections cost approximately $160 per system (Hajjar 2000).

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

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

3.2.2.8 Internal Cycling

Controls of internal phosphorus cycling in lakes are costly. The in-lake controls have been converted to year 2004 dollars assuming an average annual inflation rate of 3 percent. The number and size of hypolimnetic aerators used in a waterbody depend on lake morphology, bathymetry, and hypolimnetic oxygen demand. Total cost for successful systems has ranged from $170,000 to $1.7 million (Tetra Tech 2002).

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

Alum treatments are effective on average for approximately 8 years per application and can reduce internal loading by 80 percent. Treatment cost ranges from $290/acre to $720/acre (WIDNR 2003). The surface area of Walnut Point Lake is 41.6 acre, so total application costs for the lake would likely range from $12,100 to $29,950.

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).

3.2.2.9 Planning Level Cost Estimates for Implementation Measures

Cost estimates for different implementation measures are presented in Table 3-5. Cost estimates shown in Table 3-5 are the total estimated cost per acre and many costs could be reduced through cost share opportunities discussed in Section 3.2.1. The column labeled Program or Sponsor lists the financial assistance program or sponsor available for various BMPs. The programs and sponsors represented in the table are the Soil Stabilization and Restoration Practice (SSRP), 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 Illinois EPA 319 Grants are applicable to all of these practices.

Table 3-5 Cost Estimate of Various BMP Measures

Source	Program	Sponsor	BMP	Installation Mean $/acre
Nonpoint	CRP/CPP	NRCS and IDA	Seeded filter strip	$25
	CRP/CPP	NRCS and IDA	Sodded filter strip	$43
	CRP/CPP	NRCS and IDA	Riparian Buffer	$60
	WRP	NRCS	Wetland	varies
		NRCS	Nutrient Management Plan	$6-18
		IDA and Illinois EPA	Nutrient Management Plan	$13
	CRP/CPP/ICCI	NRCS, IDA, CCX	Conservation Tillage	varies
Internal Cycling			Dredging	$8,000
			Aerator	varies
			Alum	$290-$720

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

3.3 Monitoring Plan

The purpose of the monitoring plan for Walnut Point Lake 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
- Continued volunteer monitoring of Walnut Point Lake
- Investigation of tile line flow and associated water quality
- Storm-based monitoring of high flow events
- Tributary monitoring
- Septic system inventory within the watershed

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

- Determine the extent to which management measures and practices have been implemented compared to action needed to meet TMDL endpoints

- Establish a baseline from which decisions can be made regarding the need for additional incentives for implementation efforts

- Measure the extent of voluntary implementation efforts

- Support work-load and costing analysis for assistance or regulatory programs

- Determine the extent to which management measures are properly maintained and operated

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

Walnut Point Lake is not a core lake in Illinois. This means that it is not regularly sampled by Illinois EPA as part of the rotating basin ambient monitoring program. Illinois does administer the Volunteer Lake Monitoring Program (VLMP). The VLMP has a three tiered approach. The three tiers are described below:

- Tier 1 – In this tier, volunteers perform Secchi disk transparency monitoring and field observations only. Monitoring is conducted twice per month from May through October typically at 3 in-lake sites.

- Tier 2 – In addition to the tasks of Tier 1, Tier 2 volunteers collect water samples for nutrient and suspended solid analysis at the representative lake site: Site 1. Water quality samples are taken only once per month, May through August, and October in conjunction with one Secchi transparency monitoring trip.

- Tier 3 – This is the most intensive tier. In addition to the tasks of Tier 1, Tier 3 volunteers collect water samples at up to three sites on their lake (depending on lake size and shape). Their samples are analyzed for nutrients and suspended solids. They also collect and filter their own chlorophyll samples. This component may also include DO and temperature profiles as equipment is available. As in Tier 2, water quality samples are taken only once per month, May through August, and October in conjunction with one Secchi transparency monitoring trip.

Data collected in either Tier 1 or Tier 2 is considered educational. It is used to make general water quality assessments while data collected in Tier 3 is used in the Integrated Report and is subject to the impaired waters listing. A volunteer monitoring team could be enacted in the Walnut Point Lake watershed in order to regularly monitor lake water quality and assess progress over time. Stakeholders interested in participating in the VLMP can contact Sandy Nickel of the Illinois EPA Surface Water Monitoring Section at (217) 782-3362.

Continued tributary monitoring is needed to further assess the contribution of internal loading to Walnut Point Lake. By having more knowledge on actual contributions from external loads a more precise estimate of internal loads could occur. Along with this tributary monitoring, a stage discharge relationship could be developed with the reservoir spillway so that flows into the reservoir could be paired with tributary water quality data to determine total phosphorus load from the watershed. Data on the different forms of phosphorus (dissolved, total, or orthophosphate) would also be beneficial to better assess reservoir response to phosphorus loading.

3.4 Implementation Time Line

Implementing the actions outlined in this section for the Walnut Point 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 Walnut Point Lake 10 years or more to reach its water quality standard target of 0.05 mg/L (Wetzel 1983). If internal loads are not effectively controlled, this time frame could be even greater as the reservoir will take time to "flush" out the phosphorus bound to bottom sediments as reductions in external loads take place. In summary, it may take up to 20 years for Walnut Point Lake to meet the total phosphorus water quality standard.

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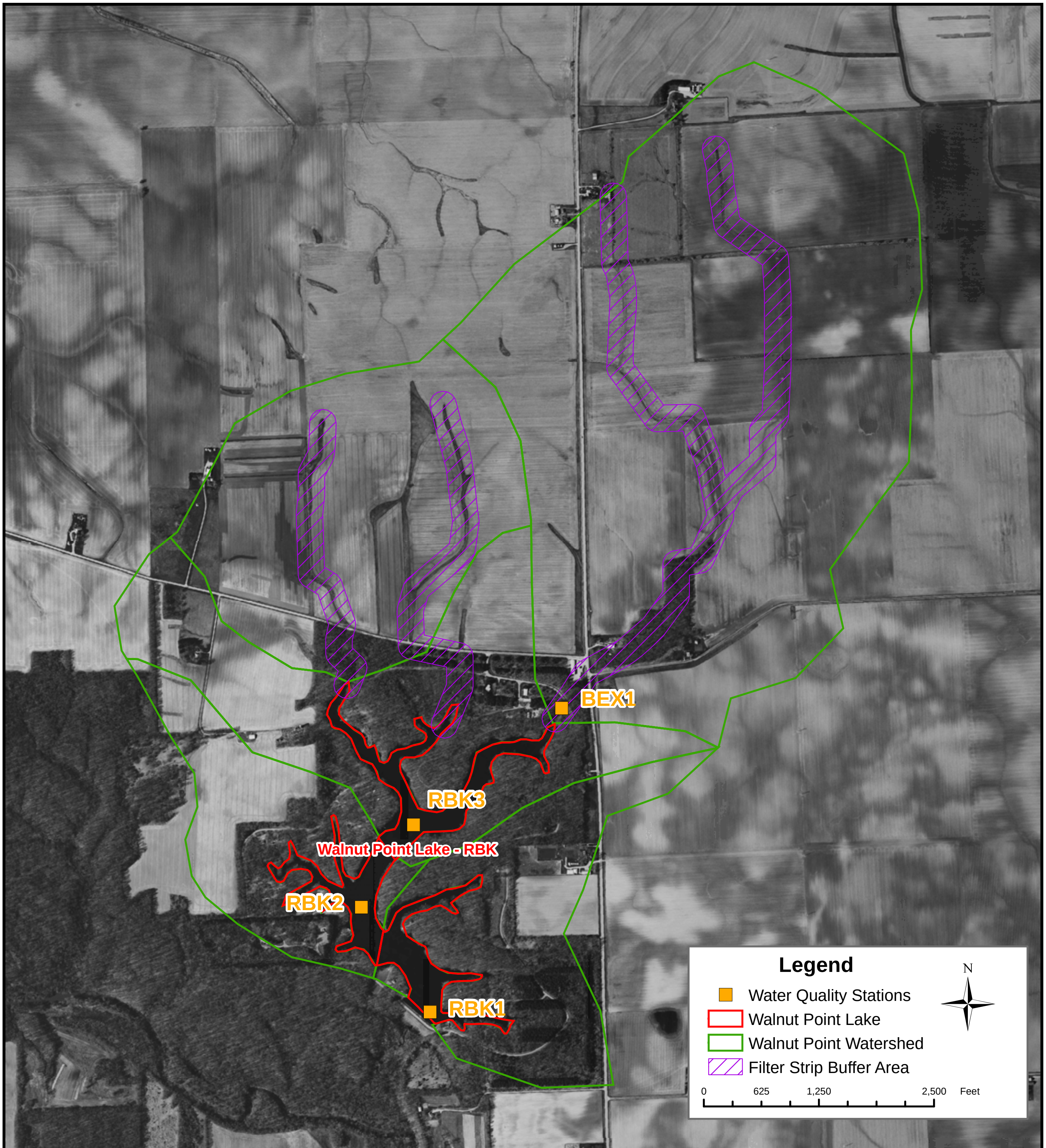

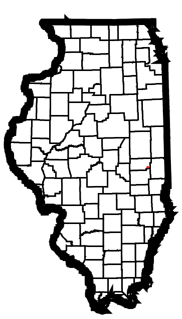

Figure 3-1:
Potential Filter Strip Buffer Areas
Walnut Point Lake Watershed

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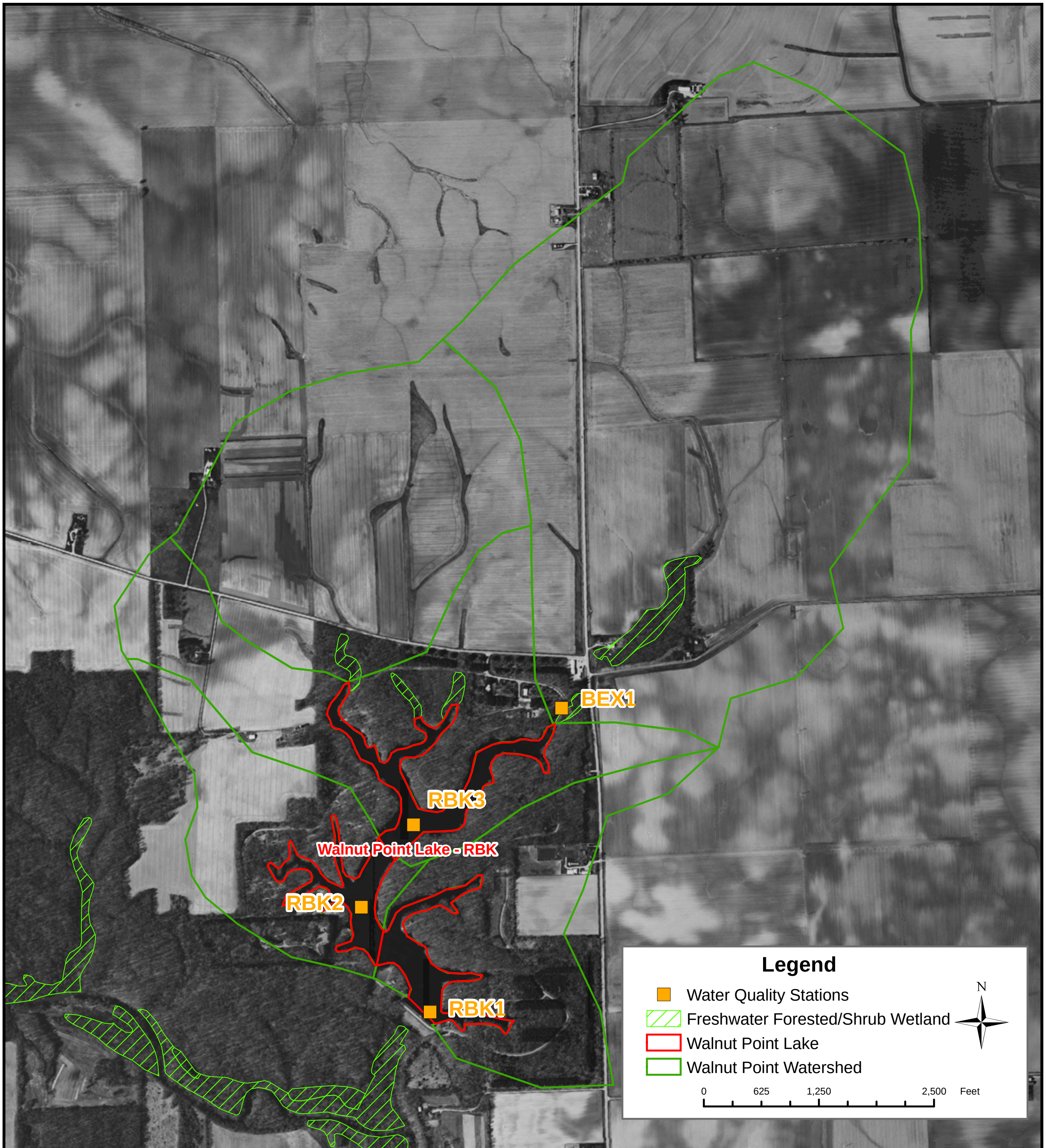

Figure 3-2:
National Wetland Inventory
Walnut Point Lake Watershed

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Section 4
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Appendix A
BATHTUB Files
Walnut Point Lake

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GLOBAL INPUTS

Title: Walnut Point
Notes:

	Historic Data	Units	Model Input	Model units
Averaging Period:	NA		1	yr
Precipitation	40.7	inches	1.03378	meters
Evaporation	36.3	inches	0.92202	meters
Increase in Storage	NA	NA		meters
Atmospheric Loads	NA	NS		

	inches to meters
Conversions:	0.0254

SEGMENT INPUTS

Total Lake Segments	3		CONVERSIONS	ft to m 0.3048	
Segment Name:	Segment 1: RBK-3			acre to km2	
Outflow Segment:	Segment 2: RBK-2			0.004047	
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	19.809532	acres	0.080169176	km2	
Mean Depth		ft	5.18	meters	Average Total Depth
Length	0.64	km	0.64	km	Length in GIS
Mixed Layer Depth		ft	2.4384	m	Depth where DO changes
Hypolimnetic Depth	0	ft	0	m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	see TP for Model	mg/L	see TP for Model	ug/L	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model
Segment Name:	Segment 2: RBK-2				
Outflow Segment:	Segment 3: RBK-1				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	14.316749	acres	0.057939883	km2	
Mean Depth		ft	7.01	meters	Total Depth
Length		km	0.326	km	Length in GIS
Mixed Layer Depth		ft	2.4384	m	Depth where DO changes
Hypolimnetic Depth		ft	0	m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	see TP for Model	mg/L	see TP for Model	ug/L	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model
Segment Name:	Segment 3: RBK-1				
Outflow Segment:	Out of Reservoir				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	13.632729	acres	0.055171654	km2	
Mean Depth		ft	9.144	m	Total Depth
Length		km	0.323	km	Length in GIS
Mixed Layer Depth		ft	2.4384	m	Depth where DO changes
Hypolimnetic Depth		ft	0	m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity	1		1	1/m	
Total Phosphorus	0.18833	mg/L	188.33	ug/L	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model
Segment 1: RBK-3			15		
Segment 2: RBK-2			15		
Segment 3: RBK-1			15		

TRIBUTARY INPUTS

Data may need to be generated from Unit Area Loads sheet if no trib concentration data are available
Flow data may need to be calculated if no gage data exists

Number of Tributaries 5

Tributary Name:	Unnamed Trib NW				
Segment:	Segment 1: RBK-3				
Tributary Type:	Monitored Inflow				
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	214.069		0.86633724	km2	
Flow Rate		cfs	0.20611503	million meters3/yr	
TP Conc		mg/L	125.8	ug/L	

Tributary Name:	BEX1				
Segment:	Segment 1: RBK-3				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	575.552085		2.32925929	km2	
Flow Rate		cfs	0.5541668	million meters3/yr	
TP Conc		mg/L	125.8	ug/L	

Tributary Name:	Overland Flow to RBK-3				
Segment:	Segment 1: RBK-3				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	182.1754221		0.73726393	km2	
Flow Rate		cfs	0.17540649	million meters3/yr	
TP Conc		mg/L	125.8	ug/L	

Tributary Name:	Overland Flow to RBK-2				
Segment:	Segment 2: RBK-2				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	92.796371		0.37554691	km2	
Flow Rate		cfs	0.08934842	million meters3/yr	
TP Conc		mg/L	125.8	ug/L	

Tributary Name:	Overland Flow to RBK-1				
Segment:	Segment 3: RBK-1				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	49.107921		0.19873976	km2	
Flow Rate		cfs	0.04728326	million meters3/yr	
TP Conc		mg/L	125.8	ug/L	

TRIBUTARY INPUTS

Tributary Name	Area (km2)	Percent of Total Area	Estimated Flow	hm3/yr
Unnamed Trib NW	0.866337243	19%	0.2307	0.206115027
BEX1	2.329259288	52%	0.6202	0.554166803
Overland Flow to RBK-3	0.737263933	16%	0.1963	0.17540649
Overland Flow to RBK-2	0.375546913	8%	0.1000	0.089348418
Overland Flow to RBK-1	0.198739756	4%	0.0529	0.047283261
Total Area	4.507147134	Total Flow	1.2	

Total Acres = 1113.700799
Acres including lake = 1161.459809

EXISTING SCENARIO

WalnutPointLake
File: C:\BATHTUB\Walnut-stage2data.btb
Variable: TOTAL P MG/M3

Segment	Predicted Mean	CV	Observed Mean	CV	INTERNAL LOADS
RBK3	80.1	0.03	82.0	0.00	3
RBK2	106.2	0.01	109.0	0.00	12
RBk1	108.0	0.01	107.5	0.00	15
Area-Wtd M	95.9	0.01	97.4	0.00	

WalnutPointLake
File: C:\BATHTUB\Walnut-stage2data.btb

Overall Water & Nutrient Balances

Overall Water Balance **Averaging Period = 1.00 years**

Trb	Type	Seg	Name	Area km^2	Flow hm^3/yr	Variance $(hm3/yr)^2$	CV -	Runoff m/yr
1	1	1	Unnamed N	0.9	0.2	0.00E+00	0.00	0.24
2	1	1	BEX1	2.3	0.6	0.00E+00	0.00	0.24
3	1	1	Direct Runo	0.7	0.2	0.00E+00	0.00	0.24
4	1	2	Direct Runo	0.4	0.1	0.00E+00	0.00	0.24
5	1	3	Direct Runo	0.2	0.0	0.00E+00	0.00	0.24
PRECIPITATION				0.2	0.2	0.00E+00	0.00	1.03
TRIBUTARY INFLOW				4.5	1.1	0.00E+00	0.00	0.24
***TOTAL INFLOW				4.7	1.3	0.00E+00	0.00	0.27
ADVECTIVE OUTFLOW				4.7	1.1	0.00E+00	0.00	0.23
***TOTAL OUTFLOW				4.7	1.1	0.00E+00	0.00	0.23
***EVAPORATION					0.2	0.00E+00	0.00	

EXISTING SCENARIO

Overall Mass Balance Based Upon Component: **Predicted TOTAL P**

Outflow & Reservoir Concentrations

Trb	Type	Seg	Name	Load kg/yr	%Total	Load Variance $(kg/yr)^2$	%Total	CV	Conc mg/m^3	Export $kg/km^2/yr$
1	1	1	Unnamed N	25.9	3.3%	0.00E+00		0.00	125.8	29.9
2	1	1	BEX1	69.7	8.9%	0.00E+00		0.00	125.8	29.9
3	1	1	Direct Runo	22.1	2.8%	0.00E+00		0.00	125.8	29.9
4	1	2	Direct Runo	11.2	1.4%	0.00E+00		0.00	125.8	29.9
5	1	3	Direct Runo	5.9	0.8%	0.00E+00		0.00	125.8	29.9
PRECIPITATION				5.8	0.7%	8.39E+00	100.0%	0.50	29.0	30.0
INTERNAL LOAD				643.9	82.1%	0.00E+00		0.00		
TRIBUTARY INFLOW				134.9	17.2%	0.00E+00		0.00	125.8	29.9
***TOTAL INFLOW				784.6	100.0%	8.39E+00	100.0%	0.00	616.8	166.9
ADVECTIVE OUTFLOW				118.2	15.1%	5.26E-01		0.01	108.0	25.1
***TOTAL OUTFLOW				118.2	15.1%	5.26E-01		0.01	108.0	25.1
***RETENTION				666.4	84.9%	7.86E+00		0.00		

Overflow Rate (m/yr)	5.7	Nutrient Resid. Time (yrs)	0.1620
Hydraulic Resid. Time (yrs)	1.2113	Turnover Ratio	6.2
Reservoir Conc (mg/m3)	96	Retention Coef.	0.849

	Percent Reduction										
Tributary Concentrations		50	60	65	70	75	80	85	86	87	88
	125.8	62.9	**50.32**	44.03	37.74	31.45	25.16	18.87	17.612	16.354	15.096
Internal Loading											
	3	1.5	1.2	1.05	0.9	0.75	0.6	0.45	0.42	0.39	0.36
	12	6	4.8	4.2	3.6	3	2.4	1.8	1.68	1.56	1.44
	15	7.5	6	5.25	4.5	3.75	3	2.25	2.1	1.95	1.8

	Reductions Needed
Tribs	**60**
Internal RBK3	**75**
Internal RBK2	**75**
Internal RBK 1	**75**
Internal Average	**75**

Change Segment Concentrations to 50

WalnutPointLake
File: **C:\BATHTUB\walnutpointTMDL.btb**

Overall Water & Nutrient Balances

Overall Water Balance — **Averaging Period = 1.00 years**

Trb	**Type**	**Seg**	**Name**	**Area** km^2	**Flow** hm^3/yr	**Variance** $(hm3/yr)^2$	**CV** -	**Runoff** m/yr
1	1	1	Unnamed NW Trib	0.9	0.2	0.00E+00	0.00	0.24
2	1	1	BEX1	2.3	0.6	0.00E+00	0.00	0.24
3	1	1	Direct Runoff - RBK3	0.7	0.2	0.00E+00	0.00	0.24
4	1	2	Direct Runoff - RBK-2	0.4	0.1	0.00E+00	0.00	0.24
5	1	3	Direct Runoff	0.2	0.0	0.00E+00	0.00	0.24
PRECIPITATION				0.2	0.2	0.00E+00	0.00	1.03
TRIBUTARY INFLOW				4.5	1.1	0.00E+00	0.00	0.24
***TOTAL INFLOW				4.7	1.3	0.00E+00	0.00	0.27
ADVECTIVE OUTFLOW				4.7	1.1	0.00E+00	0.00	0.23
***TOTAL OUTFLOW				4.7	1.1	0.00E+00	0.00	0.23
***EVAPORATION					0.2	0.00E+00	0.00	

Overall Mass Balance Based Upon — **Predicted** — **Outflow & Reservoir Concentrations**
Component: — **TOTAL P**

	Load	**Load Variance**	**Conc**	**Export**

TMDL - WALNUT POINT LAKE

Trb	Type	Seq	Name	kg/yr	%Total	$(kg/yr)^2$	%Total	CV	mg/m^3	$g/km^2/yr$
1	1	1	Unnamed NW Trib	10.4	4.7%	0.00E+00		0.00	50.3	12.0
2	1	1	BEX1	27.9	12.6%	0.00E+00		0.00	50.3	12.0
3	1	1	Direct Runoff - RBK3	8.8	4.0%	0.00E+00		0.00	50.3	12.0
4	1	2	Direct Runoff - RBK-2	4.5	2.0%	0.00E+00		0.00	50.3	12.0
5	1	3	Direct Runoff	2.4	1.1%	0.00E+00		0.00	50.3	12.0
PRECIPITATION				5.8	2.6%	8.39E+00	100.0%	0.50	29.0	30.0
INTERNAL LOAD				161.0	72.9%	0.00E+00		0.00		
TRIBUTARY INFLOW				53.9	24.4%	0.00E+00		0.00	50.3	12.0
***TOTAL INFLOW				220.7	100.0%	8.39E+00	100.0%	0.01	173.5	47.0
ADVECTIVE OUTFLOW				58.3	26.4%	5.24E-01		0.01	53.3	12.4
***TOTAL OUTFLOW				58.3	26.4%	5.24E-01		0.01	53.3	12.4
***RETENTION				162.4	73.6%	6.75E+00		0.02		

Overflow Rate (m/yr)	5.7	Nutrient Resid. Time (yrs)	0.2853
Hydraulic Resid. Time (yrs)	1.2113	Turnover Ratio	3.5
Reservoir Conc (mg/m3)	48	Retention Coef.	0.736

Appendix B
Stage 2 Data

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STAGE TWO DATA
WALNUT POINT LAKE

Station ID	Date	Parameter	Sample Depth (ft)	Value	Units
RBK-1	10/07/05	Dissolved Phosphorus	0	0.02	mg/L
RBK-1	10/07/05	Dissolved Phosphorus	14	0.021	mg/L
RBK-1	10/07/05	Dissolved Phosphorus	26	0.53	mg/L
RBK-1	10/31/05	Dissolved Phosphorus	26	0.69	mg/L
RBK-1	10/31/05	Dissolved Phosphorus	0	0.06	mg/L
RBK-1	10/31/05	Dissolved Phosphorus	14	0.061	mg/L
RBK-1	04/11/06	Dissolved Phosphorus	0	0.028	mg/L
RBK-1	04/11/06	Dissolved Phosphorus	13	0.031	mg/L
RBK-1	04/11/06	Dissolved Phosphorus	26	0.026	mg/L
RBK-1	04/26/06	Dissolved Phosphorus	0	0.025	mg/L
RBK-1	04/26/06	Dissolved Phosphorus	15	0.03	mg/L
RBK-1	04/26/06	Dissolved Phosphorus	23	0.025	mg/L
RBK-1	05/10/06	Dissolved Phosphorus	0	0.022	mg/L
RBK-1	05/10/06	Dissolved Phosphorus	12	0.029	mg/L
RBK-1	05/10/06	Dissolved Phosphorus	22	0.046	mg/L
RBK-1	05/24/06	Dissolved Phosphorus	0	0.026	mg/L
RBK-1	05/24/06	Dissolved Phosphorus	14	0.054	mg/L
RBK-1	05/24/06	Dissolved Phosphorus	27	0.17	mg/L
RBK-1	06/07/06	Dissolved Phosphorus	0	0.038	mg/L
RBK-1	06/07/06	Dissolved Phosphorus	12	0.031	mg/L
RBK-1	06/07/06	Dissolved Phosphorus	25	0.21	mg/L
RBK-1	06/20/06	Dissolved Phosphorus	0	0.011	mg/L
RBK-1	06/20/06	Dissolved Phosphorus	14	0.011	mg/L
RBK-1	06/20/06	Dissolved Phosphorus	28	0.016	mg/L
RBK-1	07/13/06	Dissolved Phosphorus		0.0096	mg/L
RBK-1	07/13/06	Dissolved Phosphorus	MD	0.0096	mg/L
RBK-1	07/13/06	Dissolved Phosphorus	BT	0.098	mg/L
RBK-1	07/24/06	Dissolved Phosphorus		0.041	mg/L
RBK-1	07/24/06	Dissolved Phosphorus	MID	0.019	mg/L
RBK-1	07/24/06	Dissolved Phosphorus	BOT	0.17	mg/L
RBK-1	08/08/06	Dissolved Phosphorus		0.06	mg/L
RBK-1	08/08/06	Dissolved Phosphorus	11	0.065	mg/L
RBK-1	08/08/06	Dissolved Phosphorus	23	0.3	mg/L
RBK-1	08/29/06	Dissolved Phosphorus		0.022	mg/L
RBK-1	08/29/06	Dissolved Phosphorus	13	0.026	mg/L
RBK-1	08/29/06	Dissolved Phosphorus	25	0.36	mg/L
RBK-1	09/12/06	Dissolved Phosphorus		0.032	mg/L
RBK-1	09/12/06	Dissolved Phosphorus	12.5	0.025	mg/L
RBK-1	09/12/06	Dissolved Phosphorus	25	0.15	mg/L
RBK-1	09/26/06	Dissolved Phosphorus		0.01	mg/L
RBK-1	09/26/06	Dissolved Phosphorus	13	0.03	mg/L
RBK-1	09/26/06	Dissolved Phosphorus	26	0.034	mg/L
RBK-1	10/07/05	Total Phosphorus	0	0.077	mg/L
RBK-1	10/07/05	Total Phosphorus	14	0.08	mg/L
RBK-1	10/07/05	Total Phosphorus	26	0.068	mg/L
RBK-1	10/31/05	Total Phosphorus	26	0.061	mg/L
RBK-1	10/31/05	Total Phosphorus	0	0.067	mg/L
RBK-1	10/31/05	Total Phosphorus	14	0.11	mg/L
RBK-1	04/11/06	Total Phosphorus	0	0.051	mg/L
RBK-1	04/11/06	Total Phosphorus	13	0.036	mg/L
RBK-1	04/11/06	Total Phosphorus	26	0.047	mg/L
RBK-1	04/26/06	Total Phosphorus	0	0.043	mg/L

STAGE TWO DATA
WALNUT POINT LAKE

Station ID	Date	Parameter	Sample Depth (ft)	Value	Units
RBK-1	04/26/06	Total Phosphorus	15	0.047	mg/L
RBK-1	04/26/06	Total Phosphorus	23	0.05	mg/L
RBK-1	05/10/06	Total Phosphorus	0	0.035	mg/L
RBK-1	05/10/06	Total Phosphorus	12	0.04	mg/L
RBK-1	05/10/06	Total Phosphorus	22	0.067	mg/L
RBK-1	05/24/06	Total Phosphorus	0	0.03	mg/L
RBK-1	05/24/06	Total Phosphorus	14	0.061	mg/L
RBK-1	05/24/06	Total Phosphorus	27	0.23	mg/L
RBK-1	06/07/06	Total Phosphorus	0	0.016	mg/L
RBK-1	06/07/06	Total Phosphorus	12	0.05	mg/L
RBK-1	06/07/06	Total Phosphorus	25	0.13	mg/L
RBK-1	06/20/06	Total Phosphorus	0	0.05	mg/L
RBK-1	06/20/06	Total Phosphorus	14	0.081	mg/L
RBK-1	06/20/06	Total Phosphorus	28	0.061	mg/L
RBK-1	07/13/06	Total Phosphorus		0.037	mg/L
RBK-1	07/13/06	Total Phosphorus	MD	0.068	mg/L
RBK-1	07/13/06	Total Phosphorus	BT	0.19	mg/L
RBK-1	07/24/06	Total Phosphorus		0.057	mg/L
RBK-1	07/24/06	Total Phosphorus	MID	0.079	mg/L
RBK-1	07/24/06	Total Phosphorus	BOT	0.27	mg/L
RBK-1	08/08/06	Total Phosphorus		0.11	mg/L
RBK-1	08/08/06	Total Phosphorus	11	0.12	mg/L
RBK-1	08/08/06	Total Phosphorus	23	0.15	mg/L
RBK-1	08/29/06	Total Phosphorus		0.23	mg/L
RBK-1	08/29/06	Total Phosphorus	13	0.067	mg/L
RBK-1	08/29/06	Total Phosphorus	25	0.58	mg/L
RBK-1	09/12/06	Total Phosphorus		0.1	mg/L
RBK-1	09/12/06	Total Phosphorus	12.5	0.08	mg/L
RBK-1	09/12/06	Total Phosphorus	25	0.13	mg/L
RBK-1	09/26/06	Total Phosphorus		0.052	mg/L
RBK-1	09/26/06	Total Phosphorus	13	0.077	mg/L
RBK-1	09/26/06	Total Phosphorus	26	0.53	mg/L
RBK-2	10/07/05	Dissolved Phosphorus	0	0.023	mg/L
RBK-2	10/07/05	Dissolved Phosphorus	11	0.021	mg/L
RBK-2	10/07/05	Dissolved Phosphorus	20	0.33	mg/L
RBK-2	10/31/05	Dissolved Phosphorus	0	0.052	mg/L
RBK-2	10/31/05	Dissolved Phosphorus	11	0.051	mg/L
RBK-2	10/31/05	Dissolved Phosphorus	20	0.057	mg/L
RBK-2	04/11/06	Dissolved Phosphorus	0	0.022	mg/L
RBK-2	04/11/06	Dissolved Phosphorus	10	0.026	mg/L
RBK-2	04/11/06	Dissolved Phosphorus	21	0.033	mg/L
RBK-2	04/26/06	Dissolved Phosphorus	0	0.028	mg/L
RBK-2	04/26/06	Dissolved Phosphorus	11	0.047	mg/L
RBK-2	04/26/06	Dissolved Phosphorus	21	0.025	mg/L
RBK-2	05/10/06	Dissolved Phosphorus	0	0.032	mg/L
RBK-2	05/10/06	Dissolved Phosphorus	11	0.043	mg/L
RBK-2	05/10/06	Dissolved Phosphorus	20	0.054	mg/L
RBK-2	05/24/06	Dissolved Phosphorus	0	0.026	mg/L
RBK-2	05/24/06	Dissolved Phosphorus	9	0.028	mg/L
RBK-2	05/24/06	Dissolved Phosphorus	18	0.1	mg/L
RBK-2	06/07/06	Dissolved Phosphorus	0	0.019	mg/L
RBK-2	06/07/06	Dissolved Phosphorus	14	0.02	mg/L

STAGE TWO DATA
WALNUT POINT LAKE

Station ID	Date	Parameter	Sample Depth (ft)	Value	Units
RBK-2	06/07/06	Dissolved Phosphorus	28	0.13	mg/L
RBK-2	06/20/06	Dissolved Phosphorus	0	0.083	mg/L
RBK-2	06/20/06	Dissolved Phosphorus	10.5	0.011	mg/L
RBK-2	06/20/06	Dissolved Phosphorus	20.5	0.035	mg/L
RBK-2	07/13/06	Dissolved Phosphorus		0.026	mg/L
RBK-2	07/13/06	Dissolved Phosphorus	MD	0.02	mg/L
RBK-2	07/13/06	Dissolved Phosphorus	BT	0.059	mg/L
RBK-2	07/24/06	Dissolved Phosphorus		0.03	mg/L
RBK-2	07/24/06	Dissolved Phosphorus	MID	0.055	mg/L
RBK-2	07/24/06	Dissolved Phosphorus	BOT	0.071	mg/L
RBK-2	08/08/06	Dissolved Phosphorus		0.1	mg/L
RBK-2	08/08/06	Dissolved Phosphorus	10	0.084	mg/L
RBK-2	08/08/06	Dissolved Phosphorus	20	0.24	mg/L
RBK-2	08/29/06	Dissolved Phosphorus		0.023	mg/L
RBK-2	08/29/06	Dissolved Phosphorus	10	0.018	mg/L
RBK-2	08/29/06	Dissolved Phosphorus	20	0.18	mg/L
RBK-2	09/12/06	Dissolved Phosphorus		0.027	mg/L
RBK-2	09/12/06	Dissolved Phosphorus	10.5	0.033	mg/L
RBK-2	09/12/06	Dissolved Phosphorus	21	0.16	mg/L
RBK-2	09/26/06	Dissolved Phosphorus		0.017	mg/L
RBK-2	09/26/06	Dissolved Phosphorus	11	0.0096	mg/L
RBK-2	09/26/06	Dissolved Phosphorus	21	0.28	mg/L
RBK-2	10/07/05	Total Phosphorus	0	0.087	mg/L
RBK-2	10/07/05	Total Phosphorus	11	0.011	mg/L
RBK-2	10/07/05	Total Phosphorus	20	0.39	mg/L
RBK-2	10/31/05	Total Phosphorus	0	0.065	mg/L
RBK-2	10/31/05	Total Phosphorus	11	0.12	mg/L
RBK-2	10/31/05	Total Phosphorus	20	0.11	mg/L
RBK-2	04/11/06	Total Phosphorus	0	0.052	mg/L
RBK-2	04/11/06	Total Phosphorus	10	0.052	mg/L
RBK-2	04/11/06	Total Phosphorus	21	0.067	mg/L
RBK-2	04/26/06	Total Phosphorus	0	0.041	mg/L
RBK-2	04/26/06	Total Phosphorus	11	0.078	mg/L
RBK-2	04/26/06	Total Phosphorus	21	0.062	mg/L
RBK-2	05/10/06	Total Phosphorus	0	0.023	mg/L
RBK-2	05/10/06	Total Phosphorus	11	0.042	mg/L
RBK-2	05/10/06	Total Phosphorus	20	0.15	mg/L
RBK-2	05/24/06	Total Phosphorus	0	0.029	mg/L
RBK-2	05/24/06	Total Phosphorus	9	0.034	mg/L
RBK-2	05/24/06	Total Phosphorus	18	0.1	mg/L
RBK-2	06/07/06	Total Phosphorus	0	0.046	mg/L
RBK-2	06/07/06	Total Phosphorus	14	0.046	mg/L
RBK-2	06/07/06	Total Phosphorus	28	0.097	mg/L
RBK-2	06/20/06	Total Phosphorus	0	0.15	mg/L
RBK-2	06/20/06	Total Phosphorus	10.5	0.07	mg/L
RBK-2	06/20/06	Total Phosphorus	20.5	0.098	mg/L
RBK-2	07/13/06	Total Phosphorus		0.043	mg/L
RBK-2	07/13/06	Total Phosphorus	MD	0.082	mg/L
RBK-2	07/13/06	Total Phosphorus	BT	0.18	mg/L
RBK-2	07/24/06	Total Phosphorus		0.052	mg/L
RBK-2	07/24/06	Total Phosphorus	MID	0.11	mg/L
RBK-2	07/24/06	Total Phosphorus	BOT	0.19	mg/L

STAGE TWO DATA
WALNUT POINT LAKE

Station ID	Date	Parameter	Sample Depth (ft)	Value	Units
RBK-2	08/08/06	Total Phosphorus		0.14	mg/L
RBK-2	08/08/06	Total Phosphorus	10	0.11	mg/L
RBK-2	08/08/06	Total Phosphorus	20	0.3	mg/L
RBK-2	08/29/06	Total Phosphorus		0.098	mg/L
RBK-2	08/29/06	Total Phosphorus	10	0.09	mg/L
RBK-2	08/29/06	Total Phosphorus	20	0.27	mg/L
RBK-2	09/12/06	Total Phosphorus		0.077	mg/L
RBK-2	09/12/06	Total Phosphorus	10.5	0.098	mg/L
RBK-2	09/12/06	Total Phosphorus	21	0.18	mg/L
RBK-2	09/26/06	Total Phosphorus		0.083	mg/L
RBK-2	09/26/06	Total Phosphorus	11	0.055	mg/L
RBK-2	09/26/06	Total Phosphorus	21	0.4	mg/L
RBK-3	10/07/05	Dissolved Phosphorus	0	0.028	mg/L
RBK-3	10/07/05	Dissolved Phosphorus	7	0.028	mg/L
RBK-3	10/07/05	Dissolved Phosphorus	14	0.021	mg/L
RBK-3	10/31/05	Dissolved Phosphorus	0	0.051	mg/L
RBK-3	10/31/05	Dissolved Phosphorus	7	0.056	mg/L
RBK-3	10/31/05	Dissolved Phosphorus	14	0.056	mg/L
RBK-3	04/11/06	Dissolved Phosphorus	0	0.028	mg/L
RBK-3	04/11/06	Dissolved Phosphorus	6	0.033	mg/L
RBK-3	04/11/06	Dissolved Phosphorus	13	0.034	mg/L
RBK-3	04/26/06	Dissolved Phosphorus	0	0.035	mg/L
RBK-3	04/26/06	Dissolved Phosphorus	7	0.059	mg/L
RBK-3	04/26/06	Dissolved Phosphorus	15	0.042	mg/L
RBK-3	05/10/06	Dissolved Phosphorus	0	0.028	mg/L
RBK-3	05/10/06	Dissolved Phosphorus	8	0.031	mg/L
RBK-3	05/10/06	Dissolved Phosphorus	14	0.11	mg/L
RBK-3	05/24/06	Dissolved Phosphorus	6	0.03	mg/L
RBK-3	05/24/06	Dissolved Phosphorus	12	0.038	mg/L
RBK-3	05/24/06	Dissolved Phosphorus	0	0.025	mg/L
RBK-3	06/07/06	Dissolved Phosphorus	0	0.041	mg/L
RBK-3	06/07/06	Dissolved Phosphorus	7	0.036	mg/L
RBK-3	06/07/06	Dissolved Phosphorus	13	0.028	mg/L
RBK-3	06/20/06	Dissolved Phosphorus	0	0.017	mg/L
RBK-3	06/20/06	Dissolved Phosphorus	6.5	0.021	mg/L
RBK-3	06/20/06	Dissolved Phosphorus	13	0.013	mg/L
RBK-3	07/13/06	Dissolved Phosphorus		0.012	mg/L
RBK-3	07/13/06	Dissolved Phosphorus	MD	0.012	mg/L
RBK-3	07/13/06	Dissolved Phosphorus	BT	0.0096	mg/L
RBK-3	07/24/06	Dissolved Phosphorus		0.03	mg/L
RBK-3	07/24/06	Dissolved Phosphorus	MID	0.052	mg/L
RBK-3	07/24/06	Dissolved Phosphorus	BOT	0.038	mg/L
RBK-3	08/08/06	Dissolved Phosphorus		0.076	mg/L
RBK-3	08/08/06	Dissolved Phosphorus	6	0.057	mg/L

STAGE TWO DATA
WALNUT POINT LAKE

Station ID	Date	Parameter	Sample Depth (ft)	Value	Units
RBK-3	08/08/06	Dissolved Phosphorus	12	0.052	mg/L
RBK-3	08/29/06	Dissolved Phosphorus		0.025	mg/L
RBK-3	08/29/06	Dissolved Phosphorus	8	0.03	mg/L
RBK-3	08/29/06	Dissolved Phosphorus	13	0.043	mg/L
RBK-3	09/12/06	Dissolved Phosphorus		0.029	mg/L
RBK-3	09/12/06	Dissolved Phosphorus	7.5	0.026	mg/L
RBK-3	09/12/06	Dissolved Phosphorus	15	0.031	mg/L
RBK-3	09/26/06	Dissolved Phosphorus		0.0096	mg/L
RBK-3	09/26/06	Dissolved Phosphorus	7	0.017	mg/L
RBK-3	09/26/06	Dissolved Phosphorus	13.5	0.023	mg/L
RBK-3	10/07/05	Total Phosphorus	0	0.1	mg/L
RBK-3	10/07/05	Total Phosphorus	7	0.096	mg/L
RBK-3	10/07/05	Total Phosphorus	14	0.1	mg/L
RBK-3	10/31/05	Total Phosphorus	0	0.097	mg/L
RBK-3	10/31/05	Total Phosphorus	7	0.12	mg/L
RBK-3	10/31/05	Total Phosphorus	14	0.11	mg/L
RBK-3	04/11/06	Total Phosphorus	0	0.074	mg/L
RBK-3	04/11/06	Total Phosphorus	6	0.068	mg/L
RBK-3	04/11/06	Total Phosphorus	13	0.1	mg/L
RBK-3	04/26/06	Total Phosphorus	0	0.037	mg/L
RBK-3	04/26/06	Total Phosphorus	7	0.069	mg/L
RBK-3	04/26/06	Total Phosphorus	15	0.099	mg/L
RBK-3	05/10/06	Total Phosphorus	0	0.032	mg/L
RBK-3	05/10/06	Total Phosphorus	8	0.038	mg/L
RBK-3	05/10/06	Total Phosphorus	14	0.16	mg/L
RBK-3	05/24/06	Total Phosphorus	6	0.034	mg/L
RBK-3	05/24/06	Total Phosphorus	12	0.038	mg/L
RBK-3	05/24/06	Total Phosphorus	0	0.019	mg/L
RBK-3	06/07/06	Total Phosphorus	0	0.046	mg/L
RBK-3	06/07/06	Total Phosphorus	7	0.025	mg/L
RBK-3	06/07/06	Total Phosphorus	13	0.061	mg/L
RBK-3	06/20/06	Total Phosphorus	0	0.057	mg/L
RBK-3	06/20/06	Total Phosphorus	6.5	0.066	mg/L
RBK-3	06/20/06	Total Phosphorus	13	0.087	mg/L
RBK-3	07/13/06	Total Phosphorus		0.071	mg/L
RBK-3	07/13/06	Total Phosphorus	MD	0.071	mg/L
RBK-3	07/13/06	Total Phosphorus	BT	0.08	mg/L
RBK-3	07/24/06	Total Phosphorus		0.06	mg/L
RBK-3	07/24/06	Total Phosphorus	MID	0.079	mg/L
RBK-3	07/24/06	Total Phosphorus	BOT	0.15	mg/L
RBK-3	08/08/06	Total Phosphorus		0.12	mg/L
RBK-3	08/08/06	Total Phosphorus	6	0.13	mg/L
RBK-3	08/08/06	Total Phosphorus	12	0.11	mg/L
RBK-3	08/29/06	Total Phosphorus		0.11	mg/L
RBK-3	08/29/06	Total Phosphorus	8	0.08	mg/L
RBK-3	08/29/06	Total Phosphorus	13	0.1	mg/L
RBK-3	09/12/06	Total Phosphorus		0.087	mg/L
RBK-3	09/12/06	Total Phosphorus	7.5	0.11	mg/L
RBK-3	09/12/06	Total Phosphorus	15	0.094	mg/L
RBK-3	09/26/06	Total Phosphorus		0.094	mg/L
RBK-3	09/26/06	Total Phosphorus	7	0.096	mg/L
RBK-3	09/26/06	Total Phosphorus	13.5	0.069	mg/L

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Appendix C
Responsiveness Summary

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Responsiveness Summary

This responsiveness summary responds to substantive questions and comments received during the public comment period from July 26 through August 22, 2007 postmarked, including those from the August 15, 2007 public meeting discussed below.

What is a TMDL?

A Total Maximum Daily Load (TMDL) is the sum of the allowable amount of a pollutant that a water body can receive from all contributing sources and still meet water quality standards or designated uses. The Walnut Point Lake watershed TMDL report contains a plan detailing the actions necessary to reduce pollutant loads to the impaired water bodies and ensure compliance with applicable water quality standards. The Illinois EPA implements the TMDL program in accordance with Section 303(d) of the federal Clean Water Act and regulations thereunder.

Background

The watershed targeted for TMDL development is Walnut Point Lake (RBK), located in Douglas County. The watershed encompasses an area of approximately 1,207 acres (1.9 square miles) Land use in the watershed is predominately agriculture. Walnut Point Lake consists of 48 surface acres and is located in the Walnut Point State Park. The water body is listed on the Illinois EPA 2006 Section 303(d) List as being impaired for total phosphorus and total suspended solids. The Clean Water Act and USEPA regulations require that states develop TMDLs for waters on the Section 303(d) List. Illinois EPA is currently developing TMDLs for pollutants that have numeric water quality standards. Therefore, a TMDL was developed for total phosphorus. The Illinois EPA contracted with Tetra Tech, Inc. to prepare the Stage 1 and Stage 2 reports, and with CDM to prepare the Stage 3 TMDL report for the Walnut Point Lake watershed.

Public Meetings

Public meetings were held at Lakecrest Junior High on March 7, 2005, and August 15, 2007. The Illinois EPA provided public notice for both meetings by placing display ads in the Paris Beacon News. This notice gave the date, time, location, and purpose of the meeting. The notice also provided references to obtain additional information about this specific site, the TMDL Program and other related issues. Approximately 78 individuals and organizations were also sent the public notice by first class mail. The draft TMDL Report was available for review at the Douglas County Soil and Water Conservation District office, Oakland City Hall, and also on the Agency's web page at http://www.epa.state.il.us/public-notices/.

A public meeting started at 6:00 p.m. on Wednesday, August 15, 2007. It was attended by approximately 4 people and concluded at 7:30 p.m. with the meeting record remaining open until midnight, August 22, 2007.

Questions and Comments

1. IDNR believes that the size of the lake may be 52.3 acres, not 41.6 acres as stated in the report.

   Response: Aerial photographs were reviewed and the lake was determined to be 48 acres using GIS analysis. This value was used in the report.

2. Define "internal load".
3.

   Response: Internal load is discussed in Section 1 of the report. Internal loading is the load to the lake generated through internal cycling of nutrients from nutrient rich sediments in the lake bottom.

4. Provide an explanation of pounds/day vs. pounds/year (which was originally used in TMDL modeling).

   Response: The model is set up to analyze the system on an annual time step. Because a TMDL represents a total maximum DAILY load, model results were divided by 365 to provide a lbs/day result. This is also discussed in Section 2.

5. Sampling location RBK-2 is near the septic system discharge, which may result in higher phosphorus readings at that site.

   Response: Thank you for your comment. Continued sampling at this site, as well as the rest of the lake, may help quantify the phosphorus loading from the park's septic system discharge.

6. Why are the highest concentrations of phosphorus in the deepest part of the lake?

   Response: Because internal cycling is occurring in the lake, it is likely that conditions in the deepest portion of the lake experience the most stratification with the lowest levels of dissolved oxygen near the bottom. Low levels of DO close to the lake sediments promote internal cycling.

7. How are "wetlands" defined based on the map in Figure 3-2?

   Response: The definition of wetlands by the National Wetland Inventory was added to Section 3.

8. Are the decreasing number of macrophytes in the lake due to the high concentrations of phosphorus?

   Response: Information on macrophyte populations in the lake were not a component of TMDL development. Typically, high nutrients would promote plant growth. Other factors that could be contributing to the decreasing numbers include erosion and sedimentation.

9. Is the “external load” considered high compared to other lakes in Illinois?

   Response: No. The external load is in the typical range for this watershed size and landuse type.

10. Are the data used in the Stage 3 modeling based on sampling conducted in 2005-2006?

    Response: Yes. The reductions needed to meet the total phosphorus water quality standard were based on the loads resulting from the Stage 2 sampling performed by Tetra Tech, Inc. in the fall of 2005, and spring through fall of 2006.

11. How is the annual rainfall calculated into the model?

    Response: Annual rainfall is a global input within the BATHTUB model. Data collected during Stage 1 from the Tuscola, IL station was used for precipitation values in the model.

12. If the lake were to be dredged, where would the dredged materials be deposited?

    Response: Where the dredged material is deposited is determined through the U.S. Army Corps of Engineers 404 certification process.