Illinois
Environmental
Protection Agency

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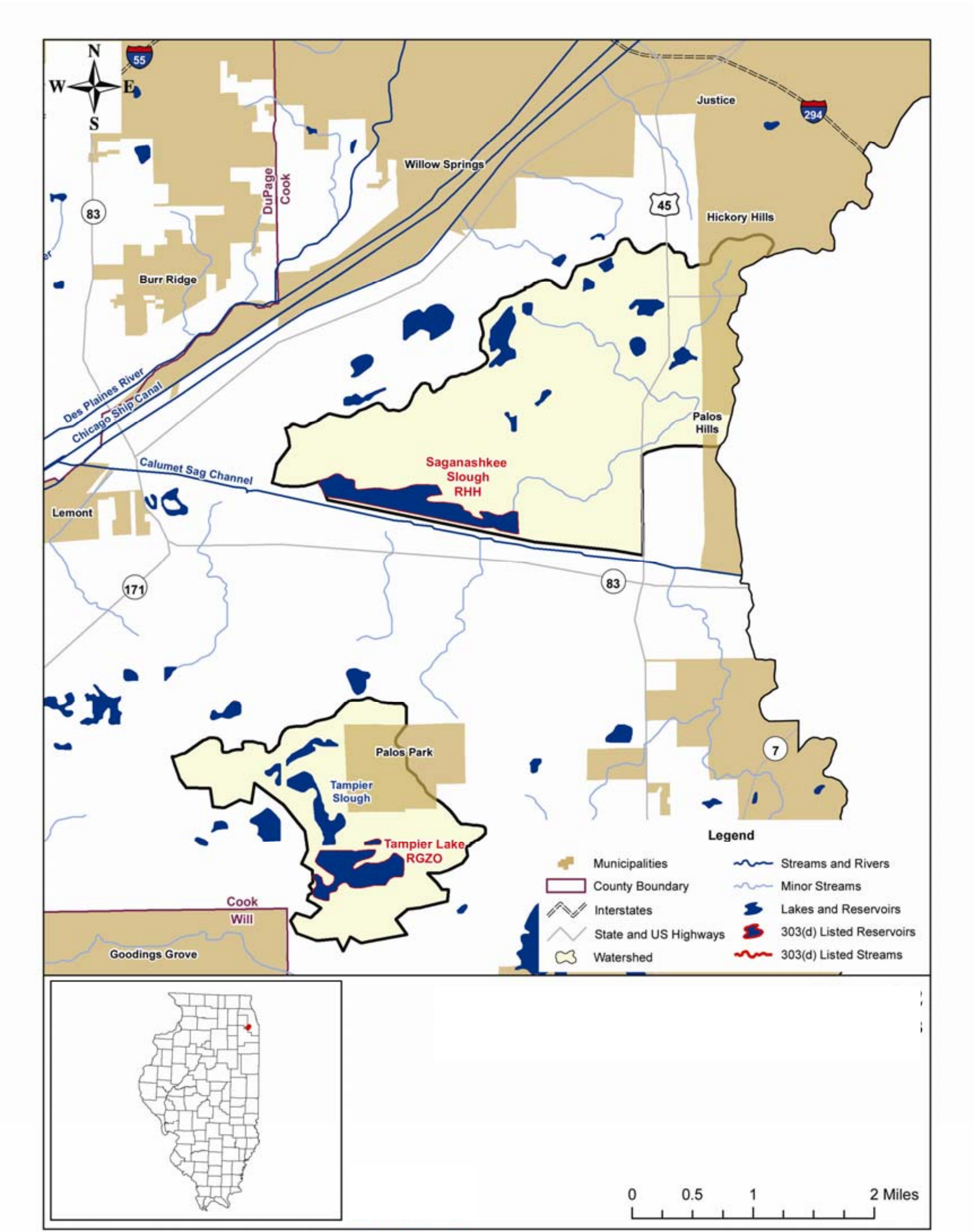
Tampier Lake/Saganashkee Slough Watersheds TMDL Report



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Section 1

Goals and Objectives for Tampier Lake/ Saganashkee Slough Watersheds

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 develops a list known as the "303(d) list" of water bodies not meeting water quality standards every two years, and it is included in the Integrated Water Quality Report. Water bodies on the 303(d) list are then targeted for TMDL development. The Illinois EPA's most recent Integrated Water Quality Report was issued in March 2008. In accordance with USEPA's guidance, the report assigns all waters of the state to one of five categories. 303(d) listed water bodies make up category five in the integrated report.

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

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

- Restore and maintain the chemical, physical, and biological integrity of the nation's waters

- Where attainable, to achieve water quality that promotes protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water

Water quality standards consist of three elements:

- The designated beneficial use or uses of a water body or segment of a water body;

- The water quality criteria necessary to protect the use or uses of that particular water body; and

- An antidegradation policy.

Examples of designated uses are primary contact (swimming), protection of aquatic life, and public and food processing water supply. Water quality criteria describe the quality of water that will support a designated use. Water quality criteria can be expressed as numeric limits or as a narrative statement. Antidegradation policies are adopted so that water quality improvements are conserved, maintained, and protected.

1.2 TMDL Goals and Objectives for Tampier Lake/Saganashkee Slough Watersheds

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

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

This report addresses Stages 1 and 3 of TMDL development for the Tampier Lake and Saganashkee Slough watersheds. Stage 2 was optional and it was determined that further data collection was not necessary.

The TMDL goals and objectives for the Tampier Lake/Saganashkee Slough watersheds included developing TMDLs for all impaired water bodies within the watersheds, describing all of the necessary elements of the TMDL, developing an implementation plan for each TMDL, and gaining public acceptance of the process. Following are the impaired water body segments in the Tampier Lake/Saganashkee Slough watersheds for which TMDLs were developed:

- Tampier Lake (RGZO)
- Saganashkee Slough (RHH)

It should be noted that TMDLs are prioritized and developed at the ten-digit hydrologic unit code (HUC10) level. This HUC10 code is identified on the 303(d) list as a medium priority watershed for TMDL development. As shown in Figure 1-1, HUC 0712000407, which contains Tampier Lake and Saganashkee Slough also includes Fiddyment Creek (GHC), which has use impairments caused by ammonia and low dissolved oxygen as listed in Table 1-1. However, Illinois EPA will use the National Pollutant Discharge Elimination System (NPDES) permit process to address this impairment and therefore, a TMDL was not developed for Fiddyment Creek.

TMDLs were developed for Tampier Lake and Saganashkee Slough, as discussed above. Both impaired water body segments are shown on Figure 1-2, and Table 1-1 lists the water body segment, water body size, and potential causes of impairment for the water body.

Table 1-1 Impaired Water Bodies in Lower Des Plaines/ Fiddyment Creek Watershed

Water Body Segment ID	**Water Body Name**	**Size**	**Impaired Use**	**Cause of Impairment[2]**	**Potential Sources**
GHC	Fiddyment Creek[1]	4.86 miles	Aquatic Life	Ammonia (Total). Dissolved Oxygen, *Phosphorus (Total), Sedimentation/ Siltation*	Municipal Point Source Discharges
RGZO	Tampier Lake	161.6 acres	Aesthetic Quality	**Phosphorus (Total),** *Sedimentation/ Siltation, Aquatic Algae, Aquatic Plants (Macrophytes)*	Runoff from Forest/Grassland/Parkland Agriculture, Urban Runoff/Storm Sewers
RHH	Saganashkee Slough	325.4 acres	Aesthetic Quality	**Phosphorus (Total),** *Sedimentation/ Siltation*	Runoff from Forest/Grassland/Parkland Agriculture, Urban Runoff/Storm Sewers
			Aquatic Life	**Phosphorus (Total), Dissolved Oxygen,** *Sedimentation/ Siltation, Aquatic Algae*	Runoff from Forest/Grassland/Parkland Agriculture, Urban Runoff/Storm Sewers
				Nickel	Contaminated Sediments
				Silver	Contaminated Sediments
			Fish Consumption	*Polychlorinated biphenyls*	Unknown

(1) The source causing impairment is believed to originate solely from municipal point source discharges. Illinois EPA will regulate this pollutant in point sources within the watershed at the water quality standard. Based on the information available to Illinois EPA, this should result in the water quality standard being attained after all point source dischargers have installed the appropriate controls. Illinois EPA will not be doing a TMDL for these pollutants at this time, but will assess the stream again after the appropriate point source controls have been operational.

(2) **Bold Causes of Impairment have numeric water quality standard and TMDLs will be developed.** *Italicized Causes of Impairment do not have numeric water quality standard.*

For these TMDLs, allocations and reductions were made specifically for total phosphorus. Other impairments such as TSS and sedimentation/siltation are addressed in the implementation plan where practices used to reduce phosphorus and increase dissolved oxygen will also address these other parameters.

The TMDLs for the segments listed above specify the following elements:

- Loading Capacity (LC) or the maximum amount of pollutant loading a water body can receive without violating water quality standards

- Waste Load Allocation (WLA) or the portion of the TMDL allocated to existing or future point sources

- Load Allocation (LA) or the portion of the TMDL allocated to existing or future nonpoint sources and natural background

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

These elements are combined into the following equation:

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

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

1.3 Report Overview

The remaining sections of this report contain:

- **Section 2 Tampier Lake/Saganashkee Slough Watersheds Characteristics** provides a description of the watershed's location, topography, geology, land use, soils, population, and hydrology.
- **Section 3 Public Participation and Involvement** discusses public participation activities that will occur throughout the TMDL development.
- **Section 4 Tampier Lake/Saganashkee Slough Watersheds Water Quality Standards** defines the water quality standards for the impaired water bodies.
- **Section 5 Tampier Lake/Saganashkee Slough Watersheds Characterization** presents the available water quality data needed to develop TMDLs, discusses the characteristics of the impaired reservoirs in the watershed, and also describes the point and non-point sources with potential to contribute to the watershed load.
- **Section 6 Approach to Developing TMDL and Identification of Data Needs** makes recommendations for the models and analysis that will be needed for TMDL development and also suggests segments for Stage 2 data collection.
- **Section 7 Model Development** provides an explanation of modeling tools used to develop the TMDLs for the impaired segment and potential cause of impairment within the watersheds.
- **Section 8 Total Maximum Daily Loads for Total Phosphorus in Tampier Lake and Saganashkee Slough** discusses the calculated allowable loading to the waterbodies in order to meet water quality standard and the reductions in existing loadings needed to meet the determined allowable loads.

- **Section 9 Implementation Plan** includes recommendations for implementing BMPs and continued monitoring throughout the watershed
- **Section 10 References**

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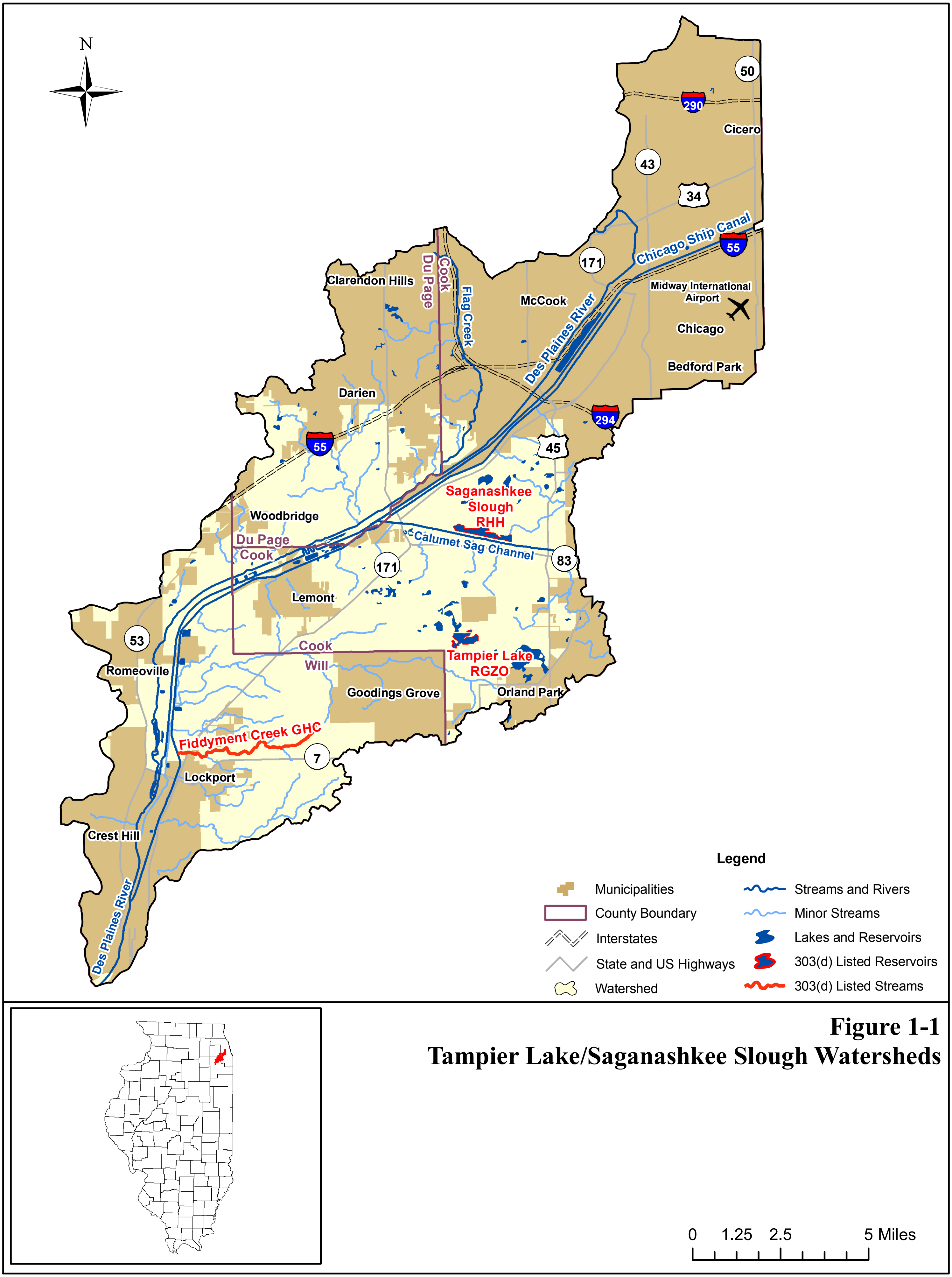

Figure 1-1
Tampier Lake/Saganashkee Slough Watersheds

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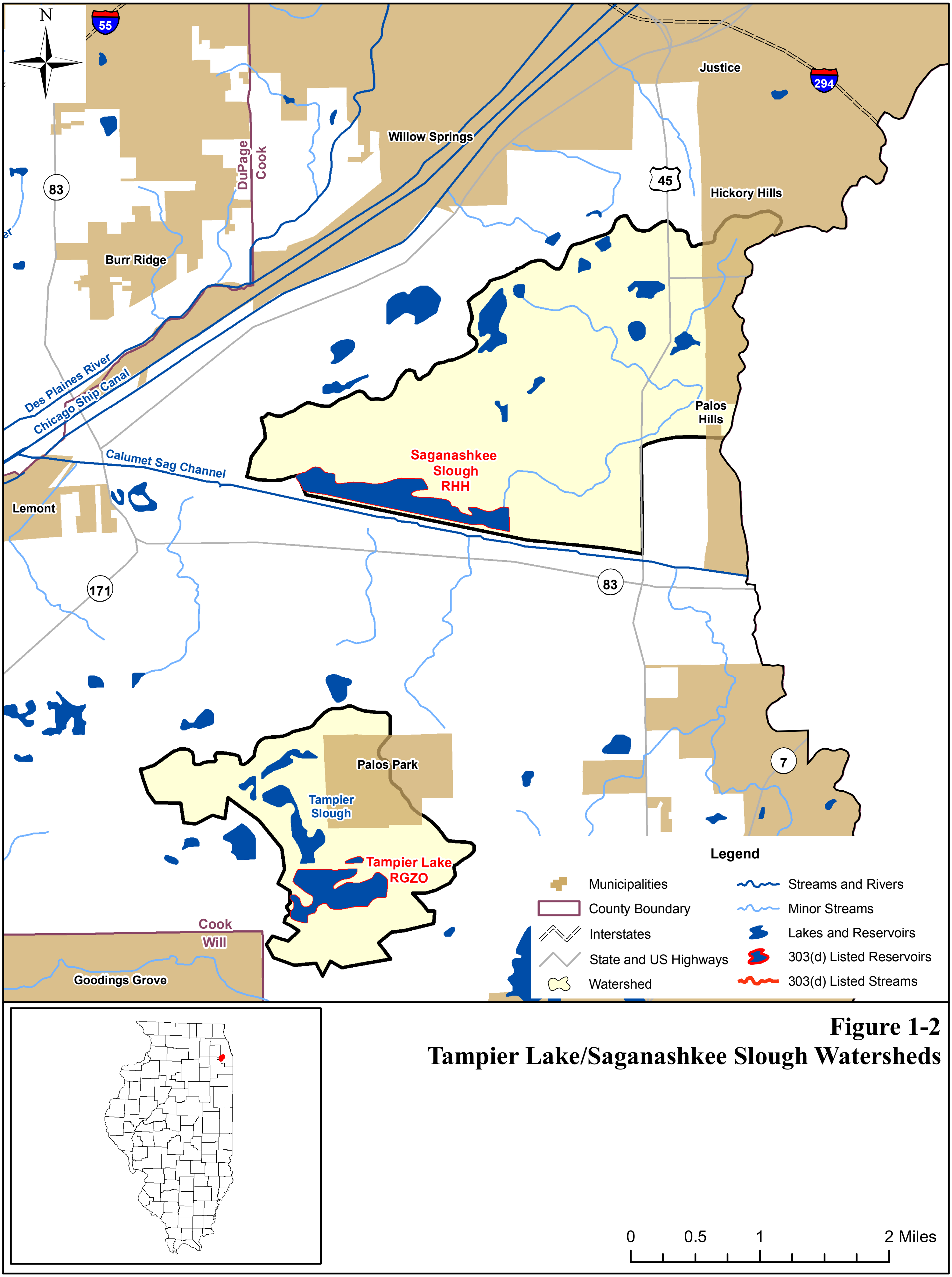

Figure 1-2
Tampier Lake/Saganashkee Slough Watersheds

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Section 2

Tampier Lake/Saganashkee Slough Watersheds Description

2.1 Tampier Lake/Saganashkee Slough Watersheds Location

The Tampier Lake and Saganashkee Slough watersheds (Figure 1-2) are located in northeastern Illinois, southwest of the city of Chicago. Both the Tampier Lake watershed and the Saganashkee Slough watershed are located in Cook County. The Tampier Lake watershed drains approximately 1,581 acres from various directions. The Saganashkee Slough watershed is approximately 3,658 acres in size and flow is generally directed south toward the lake.

2.2 Topography

Topography is an important factor in watershed management because stream types, precipitation, and soil types can vary dramatically by elevation. National Elevation Dataset (NED) coverages containing 10-meter grid resolution elevation data are available from the U.S. Geological Survey (USGS) for each 1:24,000-topographic quadrangle in the United States. Elevation data for the Tampier Lake and Saganashkee Slough watersheds were obtained by overlaying the NED grid onto the GIS-delineated watershed. Figure 2-1 shows the elevations found within the watersheds.

Elevation in the Tampier Lake watershed ranges from 786 feet above sea level in the northeastern portion of the watershed to 685 feet near the lake. Elevation in the Saganashkee Slough watershed ranges from 747 feet above sea level in the northern part of the watershed near Route 45 to 584 feet near the slough.

2.3 Land Use

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

The land use of the Tampier Lake and Saganashkee Slough watersheds was determined by overlaying the IL-GAP Land Cover data layer onto the GIS-delineated watershed. Tables 2-1 and 2-2 contain the land uses contributing to the Tampier Lake and Saganashkee Slough watersheds, based on the IL-GAP land cover categories and also include the area of each land cover category and percentage of the watershed area. Figure 2-2 illustrates the land uses of the watershed.

The land cover data reveal that the Tampier Lake watershed is dominated by upland forest and rural grassland, with combined cover of approximately 767 acres, nearly half of the watershed area. Another 23 percent of the watershed is comprised of surface water and surrounding marshes, while 18 percent of the watershed is urban area.

Over half of the Saganashkee Slough watershed is covered by upland forest. Another 15 percent of the watershed is comprised of surface water and surrounding marshes, while 9 percent of the watershed is urban area.

Table 2-1. Land Cover and Land Use in Tampier Lake Watershed

Land Cover Category	Area (Acres)	Percentage
Upland Forest	389.1	24.61
Rural Grassland	377.8	23.89
Surface Water	242.0	15.31
Urban Open Space	153.3	9.69
Low/Medium Density	123.7	7.82
Shallow Marsh/Wet Meadow	123.6	7.82
Partial Canopy/Savannah Upland	99.1	6.27
Corn	41.9	2.65
Soybeans	23.2	1.47
High Density	4.3	0.27
Floodplain Forest	2.8	0.18
Deep Marsh	0.4	0.03
Total	**1581.3**	**100.00**

Table 2-2. Land Cover and Land Use in Saganashkee Slough Watershed

Land Cover Category	Area (Acres)	Percentage
Upland Forest	1,897.9	51.88
Surface Water	436.3	11.93
Partial Canopy/Savannah Upland	424.2	11.60
Rural Grassland	374.9	10.25
Low/Medium Density	245.8	6.72
Shallow Marsh/Wet Meadow	124.0	3.39
Floodplain Forest	73.6	2.01
Urban Open Space	57.2	1.56
High Density	11.8	0.32
Shallow Water	6.7	0.18
Soybeans	2.8	0.08
Barren & Exposed Land	1.5	0.04
Corn	0.9	0.02
Deep Marsh	0.4	0.01
Total	**3,658.0**	**100.00**

2.4 Soils

Soil information is available through the Soil Survey Geographic (SSURGO) database. For SSURGO data, field mapping methods using national standards are used to construct the soil maps. Mapping scales generally range from 1:12,000 to 1:63,360 making SSURGO the most detailed level of soil mapping done by the NRCS.

Attributes of the spatial coverage can be linked to the SSURGO databases, which provide information on various chemical and physical soil characteristics for each map unit and soil series. Of particular interest for TMDL development are the hydrologic soil groups as well as the K-factor of the Universal Soil Loss Equation. The hydrologic soil group is available for each SSURGO soil series. The following sections describe and summarize the specified soil characteristics for the Tampier Lake and Saganashkee Slough watersheds.

2.4.1 Tampier Lake/Saganashkee Slough Watersheds Soil Characteristics

Figure 2-3 shows the hydrologic soils groups found within the Tampier Lake and Saganashkee Slough watersheds. Hydrologic soil groups are used to estimate runoff from precipitation. Soils are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms. The Saganashkee Slough and Tampier Lake watersheds are dominated by C soils, with B/D soils surrounding the water bodies. There are also B soils surrounding the Saganashkee Slough. Group C soils are defined as having "moderately high runoff potential when thoroughly wet." These soils have a low rate of water transmission. Group B soils are defined as having "moderately low runoff potential when thoroughly wet." These soils have a moderate rate of water transmission. Group B/D soils are "placed in group D based solely on the presence of a water table within 24 inches of the surface", however these soils have a low rate of water transmission.

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

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

The distribution of K-factor values in the Tampier Lake and Saganashkee Slough watersheds ranges from 0.10 to 0.43.

2.5 Population

The major municipalities in the watershed are shown in Figure 1-1. Population data were retrieved from the U.S. Census Bureau. Table 2-3 summarizes the population of the municipalities within the Tampier Lake and Saganashkee Slough watersheds. About half of the Tampier Lake watershed lies in Palos Park, whose population has grown by approximately 1.3 percent from 2000 to 2006. Although a small area in the northeast corner of the Saganashkee Slough watershed lies in Hickory Hills, most of the eastern border of the watershed lies in Palos Hills. The population of Palos Hills has been relatively constant and future growth is not anticipated to be an issue within the watersheds.

Table 2-3 Population of Municipalities in the Tampier Lake/Saganashkee Slough Watersheds (U.S. Census Bureau, 2008)

Watershed	Municipality	1990 Population	2000 Population	2006 Population
Tampier Lake	Palos Park	4,199	4,689	4,752
Saganashkee Slough	Palos Hills	17,803	17,665	17,146

2.6 Climate and Pan Evaporation

2.6.1 Climate

Northeastern Illinois has a temperate climate with hot summers and cold, snowy winters. Monthly precipitation data from Chicago Midway International Airport (station id. 1577) in Cook County were extracted from the NCDC database for the years of 1901 through 2006. The data station at Chicago Midway International Airport was chosen to be representative of precipitation throughout the Tampier Lake and Saganashkee Slough watersheds.

Table 2-4 contains the average monthly precipitation along with average high and low temperatures for the period of record. The average annual precipitation is approximately 33.8 inches.

Table 2-4 Average Monthly Climate Data at Chicago Midway International Airport, IL

Month	Total Precipitation (inches)	Maximum Temperature (degrees F)	Minimum Temperature (degrees F)
January	2.9	31	17
February	0	35	21
March	1.8	46	29
April	3.1	58	40
May	3.3	71	50
June	4.5	81	60
July	4.8	84	64
August	2.2	83	65
September	4.0	76	57
October	1.5	64	45
November	1.6	48	33
December	4.1	36	22
Total	**33.8**	**59 (Average)**	**42 (Average)**

2.6.2 Pan Evaporation

Through the Illinois State Water Survey (ISWS) website, pan evaporation data are available from nine locations across Illinois (ISWS 2007). The Chicago Botanical Garden station was chosen to be representative of pan evaporation conditions for Tampier Lake and Saganashkee Slough. The Chicago Botanical Garden station is located approximately 9 miles north northwest of the Tampier Lake and Saganashkee Slough. The station was chosen for its proximity to the 303(d)-listed water bodies and the completeness of the dataset.

The average monthly pan evaporation at the Chicago Botanical Garden station for the years 1980 to 2006 yields an average annual pan evaporation of 40.14 inches. Actual evaporation is typically less than pan evaporation, so the average annual pan evaporation was multiplied by 0.75 to calculate an average annual evaporation of 30.1 inches (ISWS 2007).

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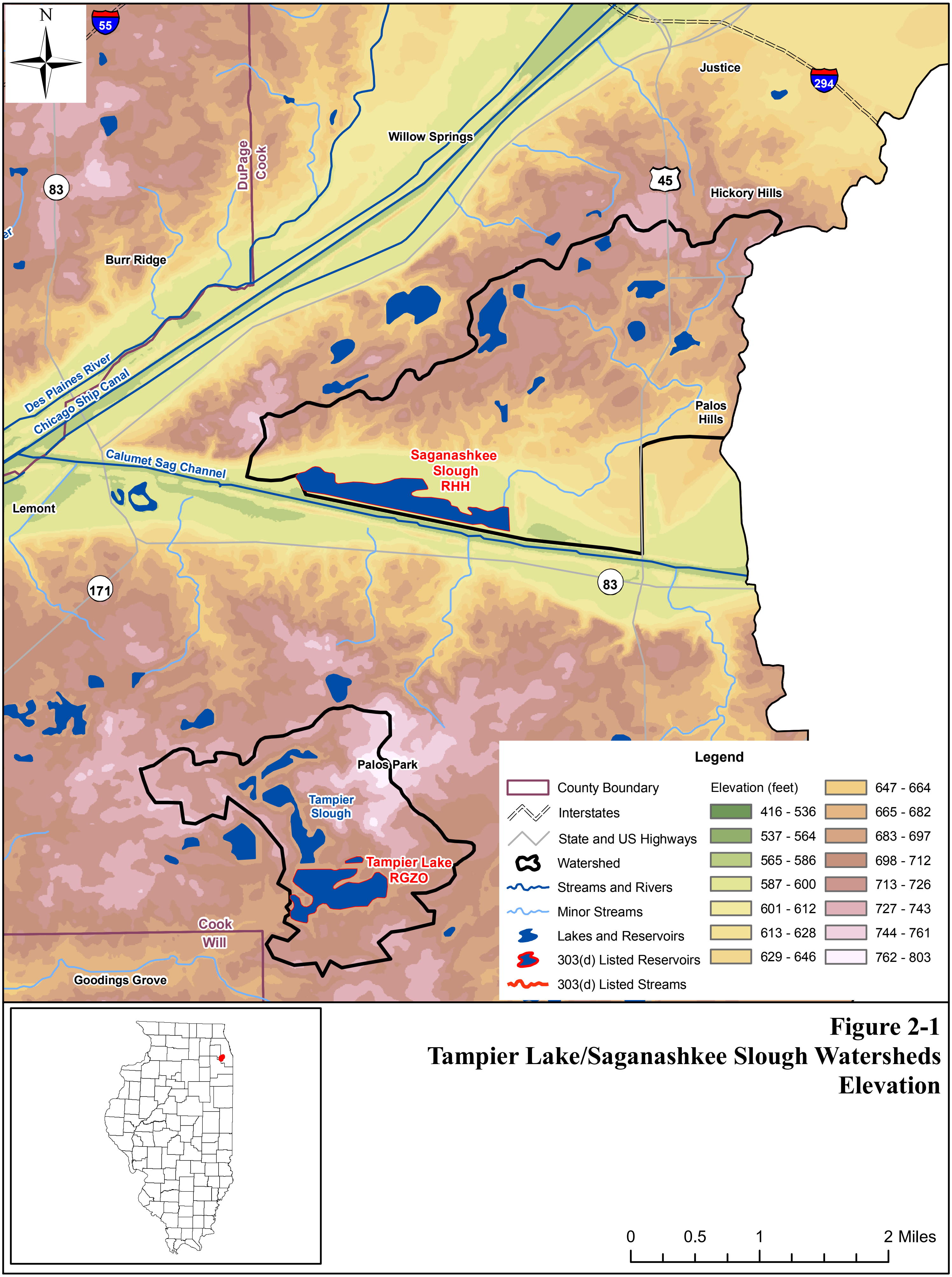

Figure 2-1
Tampier Lake/Saganashkee Slough Watersheds Elevation

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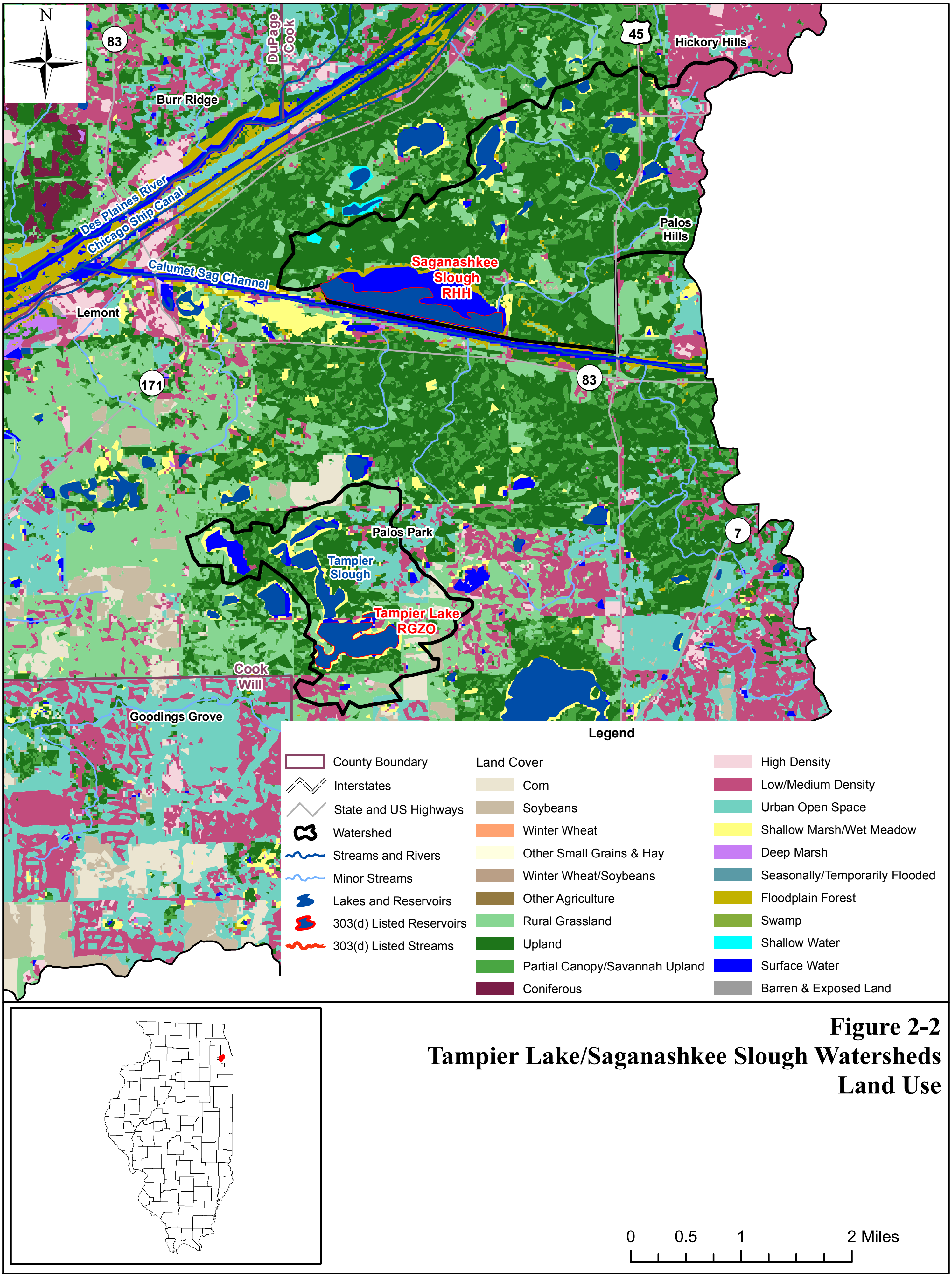

Figure 2-2
Tampier Lake/Saganashkee Slough Watersheds
Land Use

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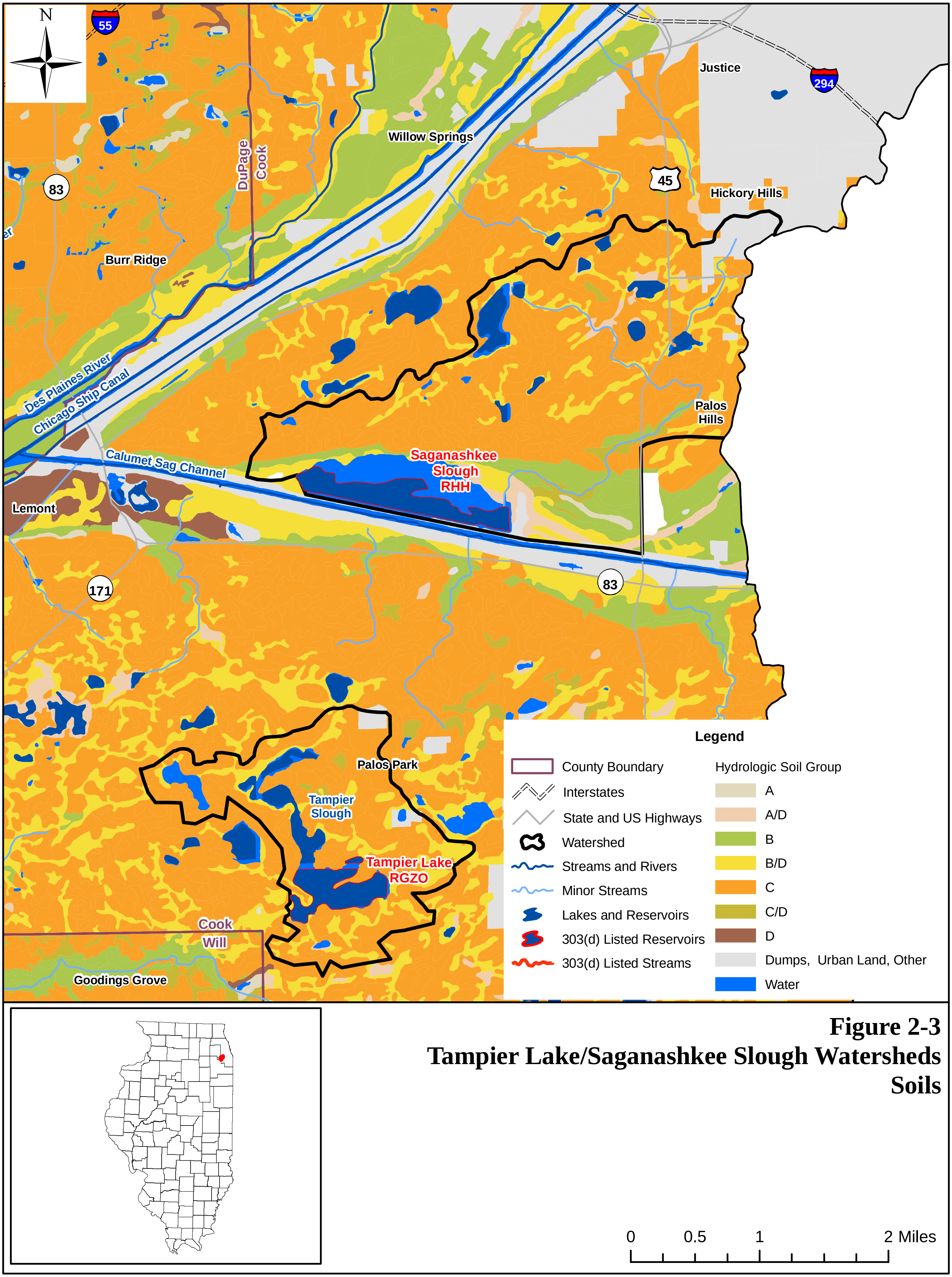

Figure 2-3
Tampier Lake/Saganashkee Slough Watersheds
Soils

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Section 3
Public Participation and Involvement

3.1 Tampier Lake/Saganashkee Slough Watersheds Public Participation and Involvement

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

Illinois EPA, along with CDM, held two public meetings within the watershed throughout the course of the TMDL development. The first meeting was held on November 6, 2008 at the Palos Park Village Council Meeting Room in Palos Park, Illinois. The first meeting was held to inform the public about the TMDL process and present Stage 1 of TMDL development which included watershed characterization and historic data review (Sections 1 through 6 of this document). A final meeting was held on August 25, 2009 in the same location to present Stage 3 of the TMDL (Sections 7 through 9 of this document) which included model development, TMDL calculation and implementation planning. Public notices were included in the Palos Citizen newspaper and were sent out to stakeholders in the watersheds. Fifteen people attended the first meeting and two people attended the final meeting. No comments were submitted for these TMDLs.

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Section 4
Tampier Lake/Saganashkee Slough Watersheds Water Quality Standards

4.1 Illinois Water Quality Standards

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

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

4.2 Designated Use

The waters of Illinois are classified by designated uses, which include: General Use, Public and Food Processing Water Supplies, Lake Michigan, and Secondary Contact and Indigenous Aquatic Life Use (Illinois EPA 2008). The General Use classification is applicable to both Tampier Lake and Saganashkee Slough.

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

4.3 Illinois Water Quality Standards

To make 303(d) listing determinations for aquatic life uses, Illinois EPA first collects biological data and if this data suggests that an impairment to aquatic life exists, a comparison of available water quality data with water quality standards will then occur. Table 4-1 presents the numeric water quality standards of the potential causes of impairment for Tampier Lake and Saganashkee Slough. Only constituents with numeric water quality standards will have TMDLs developed at this time.

Table 4-1 Summary of Applicable Numeric Water Quality Standards for Tampier Lake and Saganashkee Slough

Parameter	Units	General Use Water Quality Standard	Regulatory Reference
Dissolved Oxygen	mg/L	*March through July* ≥5.0 minimum & ≥6.0 7-day mean; *August through February* ≥3.5 minimum, ≥4.0 7-day mean & ≥5.5 30-day mean	302.206
Phosphorus (Total)	mg/L	0.05(1)	302.205

mg/L = milligrams per liter
NA = Not Applicable
(1) Standard applies in particular to inland lakes and reservoirs (greater than 20 acres) and in any stream at the point where it enters any such lake or reservoir.

Section 302.205 of the Illinois Water Quality Standards states that "phosphorus as P shall not exceed 0.05 mg/l in any reservoir or lake with a surface area of 8.1 hectares (20 acres) or more, or in any stream at the point where it enters any such reservoir or lake".

Section 302.206 for Title 35 states that "the dissolved oxygen concentration in the main body of all streams, in the water above the thermocline of thermally stratified lakes and reservoirs, and in the entire water column of unstratified lakes and reservoirs must not be less than the following:

1) During the period of March through July,

   A) 5.0 mg/L at any time; and
   B) 6.0 mg/L as a daily mean averaged over 7 days.

2) During the period of August through February,

   A) 3.5 mg/L at any time;
   B) 4.0 mg/L as a daily minimum averaged over 7 days; and
   C) 5.5 mg/L as a daily mean averaged over 30 days.

4.4 Potential Pollutant Sources

In order to properly address the conditions within the Tampier Lake and Saganashkee Slough watersheds, potential pollution sources must be investigated for the pollutants where TMDLs will be developed. The following is a summary of the potential sources associated with the listed potential causes for the 303(d) listed segments in this watershed.

Table 4-2 Summary of Potential Pollutant Sources in Tampier Lake and Saganashkee Slough

Segment ID	Segment Name	Potential Causes of Impairment	Potential Sources (as identified by the 2008 303(d) list)
RGZO	Tampier Lake	**Phosphorus (Total)**, Total Suspended Solids, Aquatic Algae, Aquatic Plants (Macrophytes)	Runoff from Forest/Grassland/Parkland, Agriculture, Urban Runoff/Storm Sewers
RHH	Saganashkee Slough	**Phosphorus (Total)**, Total Suspended Solids, Nickel, **Dissolved Oxygen**, Aquatic Algae, Sedimentation/Siltation, Silver, Polychlorinated biphenyls	Runoff from Forest/Grassland/Parkland, Agriculture, Urban Runoff/Storm Sewers, Contaminated Sediments, Unknown

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

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Section 5
Tampier Lake/Saganashkee Slough Watersheds Characterization

Data were collected and reviewed from many sources in order to further characterize the Tampier Lake and Saganashkee Slough watersheds. Data have been collected in regards to water quality, reservoirs, and both point and nonpoint sources. This information is presented and discussed in further detail in the remainder of this section.

5.1 Water Quality Data

There are 6 historic water quality stations within the Tampier Lake and Saganashkee Slough watersheds that were used for this report. Figure 5-1 shows the water quality data stations within the watershed that contain data relevant to the impaired segments.

The impaired waterbody segments in the Tampier Lake and Saganashkee Slough watersheds were presented in Section 1. Refer to Table 1-1 for impairment information specific to each segment. Data are summarized by impairment cause and discussed in relation to the relevant Illinois numeric water quality standard. Data analysis is focused on all available data collected since 1990. The information presented in this section is a combination of USEPA Storage and Retrieval (STORET) database and Illinois EPA database data. STORET data are available for stations sampled prior to January 1, 1999 while Illinois EPA data (electronic and hard copy) are available for stations sampled after that date.

5.1.1 Lake Water Quality Data

The data summarized in this section include water quality data for Tampier Lake and Saganashkee Slough. Data for the parameters causing impairment as well as parameters that could be useful in future modeling and analysis efforts and presented below. All historic water quality data are available in Appendix B.

5.1.1.1 Tampier Lake

Tampier Lake is listed for impairment of aesthetic quality by total phosphorous. There are three active stations in Tampier Lake (see Figure 5-1). An inventory of all available phosphorus data at all depths is presented in Table 5-1.

Table 5-1 Tampier Lake Data Inventory for Impairments

Tampier Lake Segment RGZO; Sample Locations RGZO-1, RGZO-2, and RGZO-3		
RGZO-1	**Period of Record**	**Number of Samples**
Dissolved Phosphorus	1992-2006	11
Total Phosphorus	1992-2006	12
RGZO-2		
Dissolved Phosphorus	2001-2006	10
Total Phosphorus	2001-2006	10
RGZO-3		
Dissolved Phosphorus	2001-2006	10
Total Phosphorus	2001-2006	11

Table 5-2 contains information on data availability for other parameters that may be useful in data needs analysis and future modeling efforts. The inventory presented in Table 5-2 represents data collected at varying depths.

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

Tampier Lake Segment RGZO; Sample Locations RGZO-1, RGZO-2, and RGZO-3		
RGZO-1	**Period of Record**	**Number of Samples**
Chlorophyll-a Corrected	1992-2006	10
Chlorophyll-a Uncorrected	1992-2006	11
Depth of Pond or Reservoir in Feet	2001	5
Dissolved Oxygen	1992-2006	51
Temperature, Water	1992-2006	51
RGZO-2		
Chlorophyll-a Corrected	2001-2006	7
Chlorophyll-a Uncorrected	2001-2006	7
Depth of Pond or Reservoir in Feet	2001	5
Dissolved Oxygen	2001-2006	33
Temperature, Water	2001-2006	33
RGZO-3		
Chlorophyll-a Corrected	2001-2006	9
Chlorophyll-a Uncorrected	2001-2006	9
Depth of Pond or Reservoir in Feet	2001	5
Dissolved Oxygen	2001-2006	39
Temperature, Water	2001-2006	39

5.1.1.1.1 Total Phosphorus

The water quality standard for total phosphorus is a concentration less than 0.05 mg/L. Compliance with the total phosphorus standard is assessed using samples collected at a one-foot depth from the lake surface. All data available for each year at each monitoring site collected at a depth of 1 foot in Tampier Lake are presented in Table 5-3.

Table 5-3 Average Total Phosphorus Concentrations (mg/L) in Tampier Lake at 1-foot depth

	RGZO-1		**RGZO-2**		**RGZO-3**		**Lake Average**	
Year	**Data Count; Number of Violations**	**Average**	**Data Count; Number of Violations**	**Average**	**Data Count; Number of Violations**	**Average**	**Data Count; Number of Violations**	**Average**
1992	1;1	0.107	0; NA	NA	0; NA	NA	1;1	0.107
2001	1;0	0.040	5;3	0.073	5;3	0.075	11;6	0.071
2006	5;5	0.074	5;5	0.078	5;5	0.086	15;15	0.079

As shown in the table, the majority of samples from 1992-2006 exceeded the total phosphorous water quality standard of 0.05 mg/L. Figure 5-2 shows each total phosphorus sample collected in Tampier Lake at one-foot depth.

5.1.1.2 Saganashkee Slough

Saganashkee Slough is listed for impairment of the aquatic life and aesthetic quality uses by total phosphorous and dissolved oxygen. There are three active stations in Saganashkee Slough (see Figure 5-1). An inventory of all available data associated with impairments at all depths is presented in Table 5-4.

Table 5-4 Saganashkee Slough Data Inventory for Impairments

Saganashkee Slough Segment RHH; Sample Locations RHH-1, RHH-2, and RHH-3		
RHH-1	**Period of Record**	**Number of Samples**
Dissolved Oxygen	1992-2001	25
Dissolved Phosphorus	1992-2001	5
Total Phosphorus	1992-2001	5
Total Phosphorus in Bottom Deposits	2001	1
RHH-2		
Dissolved Oxygen	2001	14
Dissolved Phosphorus	2001	4
Total Phosphorus	2001	4
Total Phosphorus in Bottom Deposits	-	0
RHH-3		
Dissolved Oxygen	2001	13
Dissolved Phosphorus	2001	5
Total Phosphorus	2001	5
Total Phosphorus in Bottom Deposits	2001	1

Table 5-5 contains information on data availability for other parameters that may be useful in data needs analysis and future modeling efforts. The inventory presented in Table 5-5 represents data collected at varying depths.

Table 5-5 Saganashkee Slough Data Availability for Data Needs Analysis and Future Modeling Efforts

Saganashkee Slough Segment RHH; Sample Locations RHH-1, RHH-2, and RHH-3		
RHH-1	**Period of Record**	**Number of Samples**
Carbon, Total Organic (Toc)	2001	1
Chlorophyll a, corrected	1992-2001	6
Chlorophyll a, uncorrected	1992-2001	6
COD	1992	1
Depth, bottom	1992-2001	5
Dissolved Oxygen, Percent of Saturation	1992	6
Nitrogen, ammonia (NH3) as NH3	1992-2001	3
Nitrogen, Kjeldahl	1992-2001	6
Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	1992-2001	4
Temperature, Water	1992-2001	25

Table 5-5 Saganashkee Slough Data Availability for Data Needs Analysis and Future Modeling Efforts

RHH-2		
Chlorophyll a, corrected	2001	3
Chlorophyll a, uncorrected	2001	3
Depth, bottom	2001	4
Nitrogen, ammonia (NH3) as NH3	2001	3
Nitrogen, Kjeldahl	2001	4
Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	2001	3
Temperature, Water	2001	14
RHH-3		
Carbon, Total Organic (Toc)	2001	1
Chlorophyll a, corrected	2001	5
Chlorophyll a, uncorrected	2001	5
Depth, bottom	2001	5
Nitrogen, ammonia (NH3) as NH3	2001	4
Nitrogen, Kjeldahl	2001	6
Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	2001	4
Temperature, Water	2001	13

5.1.1.2.1 Total Phosphorus

The water quality standard for total phosphorus is a concentration less than 0.05 mg/L. Compliance with the total phosphorus standard is assessed using samples collected at a one-foot depth from the lake surface. All data available for each year at each monitoring site collected at a depth of 1 foot in Saganashkee Slough are presented in Table 5-6.

Table 5-6 Average Total Phosphorus Concentrations (mg/L) in Saganashkee Slough at 1-foot depth

	RHH-1		RHH-2		RHH-3		Lake Average	
Year	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average
1992	1;1	0.142	0; NA	NA	0; NA	NA	1;1	0.142
2001	1;1	0.114	4;4	0.133	4;4	0.107	9;9	0.119

As shown in the table, all of the samples collected in 1992 and 2001 exceeded the total phosphorous water quality standard of 0.05 mg/L. Figure 5-3 shows the total phosphorous concentrations of all available samples collected at one-foot depth in Saganashkee Slough.

5.1.1.2.2 DO

The average DO concentrations at a one-foot depth for each year of available data at each monitoring site on Saganashkee Slough are presented in Table 5-7. The water quality standard for DO is a 5.0 mg/L instantaneous minimum in the months of March through July and 3.5 mg/L instantaneous minimum in the months of August through February. Compliance is determined at a one-foot depth from the lake surface. All data available for each year at each monitoring site collected at a depth of 1 foot in Saganashkee Slough are presented in Table 5-7.

Table 5-7 Average Dissolved Oxygen Concentrations (mg/L) in Saganashkee Slough at 1-foot Depth

	RHH-1		RHH-2		RHH-3		Lake Average	
Year	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average
1992	1;0	7.40	0; NA	NA	0; NA	NA	1;0	7.40
2001	5;1	8.64	5;0	9.90	5;0	9.40	15;1	9.31

The annual averages for DO at all three sites as well as the lake average are above the instantaneous DO standard. Figure 5-4 shows DO sampling results over time. One violation (4.7 mg/L on 8/6/2001) was recorded at RHH-1. It should be noted that under the current DO standard found in Title 35, this would no longer be considered a standard violation.

5.2 Reservoir Information

5.2.1 Tampier Lake

Tampier Lake has a surface area of approximately 160 acres, a maximum depth of 16 feet, an average depth of 6 feet and is on a tributary of Long Run Creek in Cook County. The lake is used for recreation purposes. It is located approximately 3.5 miles southwest of Palos Park on the south side of 131st Street just west of Wolf Road. The lake basin was originally a series of shallow sloughs which were dug out of the peat creating a series of ponds around 1958 when the Forest Preserve District of Cook County purchased the surrounding property. In 1962 the Forest Preserve District dug a number of channels around the proposed lake area and a dam was constructed creating a lake of approximately 75 acres. Wolf Road and 131st Street were raised approximately five feet and a three foot cap was added to the dam in 1964. The Tampier Lake Dam, is a gravity dam with a height of 9 feet and a length of 240 feet. Its capacity is 859 acre feet. Normal storage is 668 acre feet. Fishes present include largemouth bass, northern pike, walleye, bluegill, sunfishes, crappie, bullhead, carp, channel catfish and white bass (http://www.fpdcc.com/tier3.php?content_id=67). Tampier Lake has moderate to heavy recreational use by the public and boat rental is available. There is a fishing wall at the launch ramp.

5.2.2 Saganashkee Slough

The Saganashkee Slough is located on a tributary of Calumet Sag Channel and is also used for recreation purposes. It is a remnant of the prehistoric outlet of early Lake Chicago. It is located north of the Sag Canal, south of 107th Street and west of 104th Street. It was the first of four Forest Preserve District of Cook County impoundments constructed in Cook County with federal funds allocated to the Illinois Department of Conservation under the Dingell-Johnson Act. On the first map of Cook County issued in 1851, Saganashkee was the name of the swamp that extended from west of Willow Springs Road almost to Blue Island. In early documents, the areas was known as "Ausagaunashkee" which meant "slush of the earth", presumably referring to the underlying peat. The Saganashkee Swamp, abundant with fish and wildlife, was largely destroyed by draining to provide feeder water for the Illinois and Michigan Canal and later for the Calumet-Sag Channel. The present water area was created in 1948-1949 by the construction of a dam at the east end of the remaining slough and also a levee at the west end of the same slough. There are a number of earthen dams surrounding the lake. The slough has a maximum capacity of 2,375 acre feet and a normal storage of 718 acre feet. The slough has a maximum depth of 10 feet and an average depth of 3 feet. Fishes present are largemouth bass, bluegill, northern pike, channel catfish, crappie, bullhead, sunfishes and carp (http://www.fpdcc.com/tier3.php?content_id=67). This lake has heavy recreational use by the public and private. Rowboats and canoes are allowed.

5.3 Point Sources

There are no point sources located within the Tampier Lake or Saganashkee Slough watershed.

5.4 Nonpoint Sources

This section discusses nonpoint sources of pollution in the surrounding watershed areas. Typically, nonpoint source discussions include information on area septic systems, however, because these watersheds are in urban settings, septic system information is not applicable. Data were collected through communication with the local NRCS and Soil and Water Conservation District (SWCD).

5.4.1 Surrounding Area Information

Both Tampier Lake and Saganashkee Slough are located just south of Chicago in urban settings. The area surrounding Tampier Lake has only light farming with an estimated maximum of 75 acres used for agricultural purposes. The additional area surrounding the lake is 75% forested, with the remaining land being urban area. Saganashkee Slough is completely surrounded by the Cook County Forest Preserves.

5.4.2 Animal Operations

Communications with local NRCS officials indicated that animal operations are very uncommon within the Tampier Lake and Saganashkee Slough watersheds. Officials were not aware of any animal operations that would be a potential source of impairment to any water bodies.

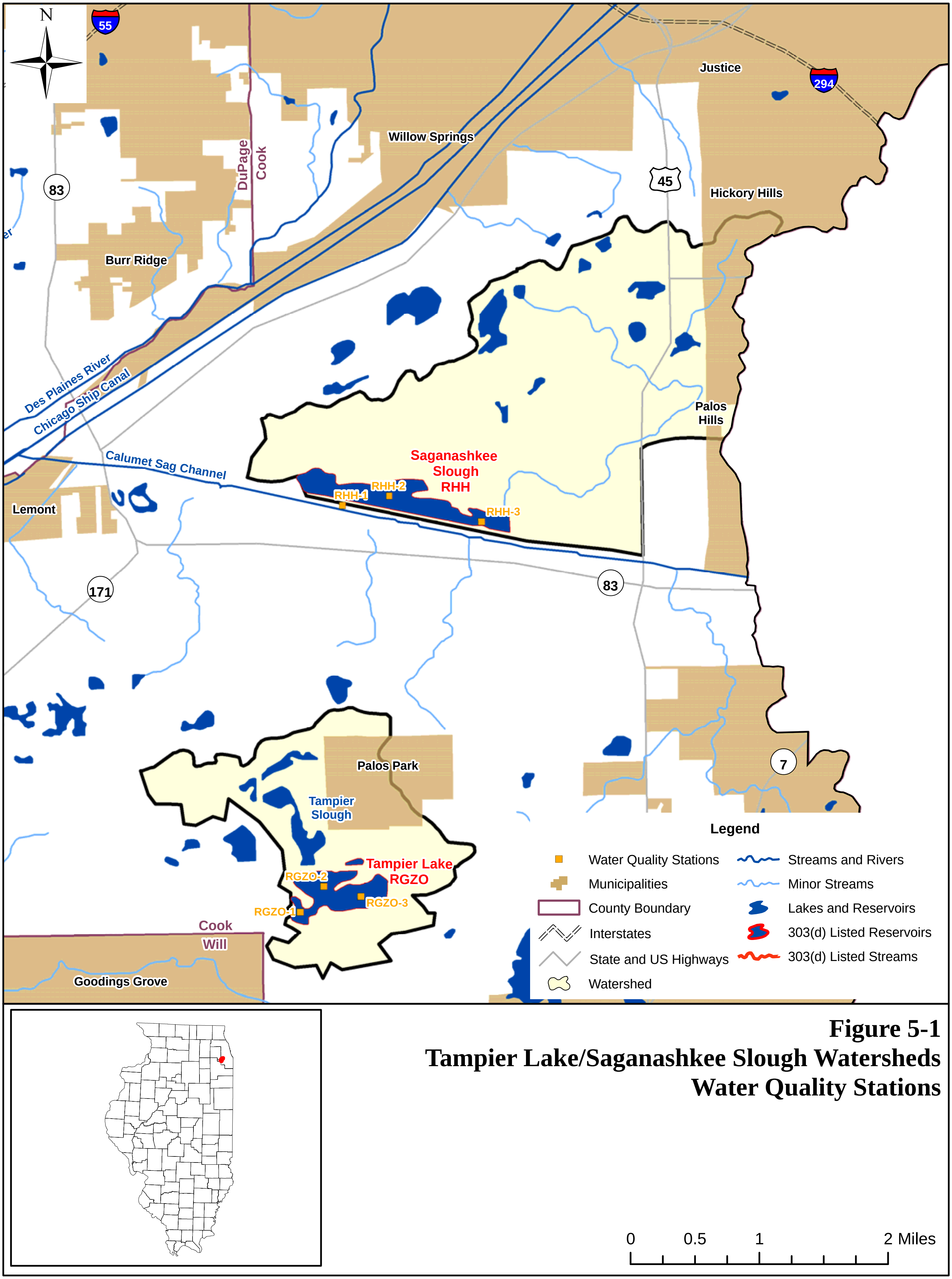

Figure 5-1
Tampier Lake/Saganashkee Slough Watersheds Water Quality Stations

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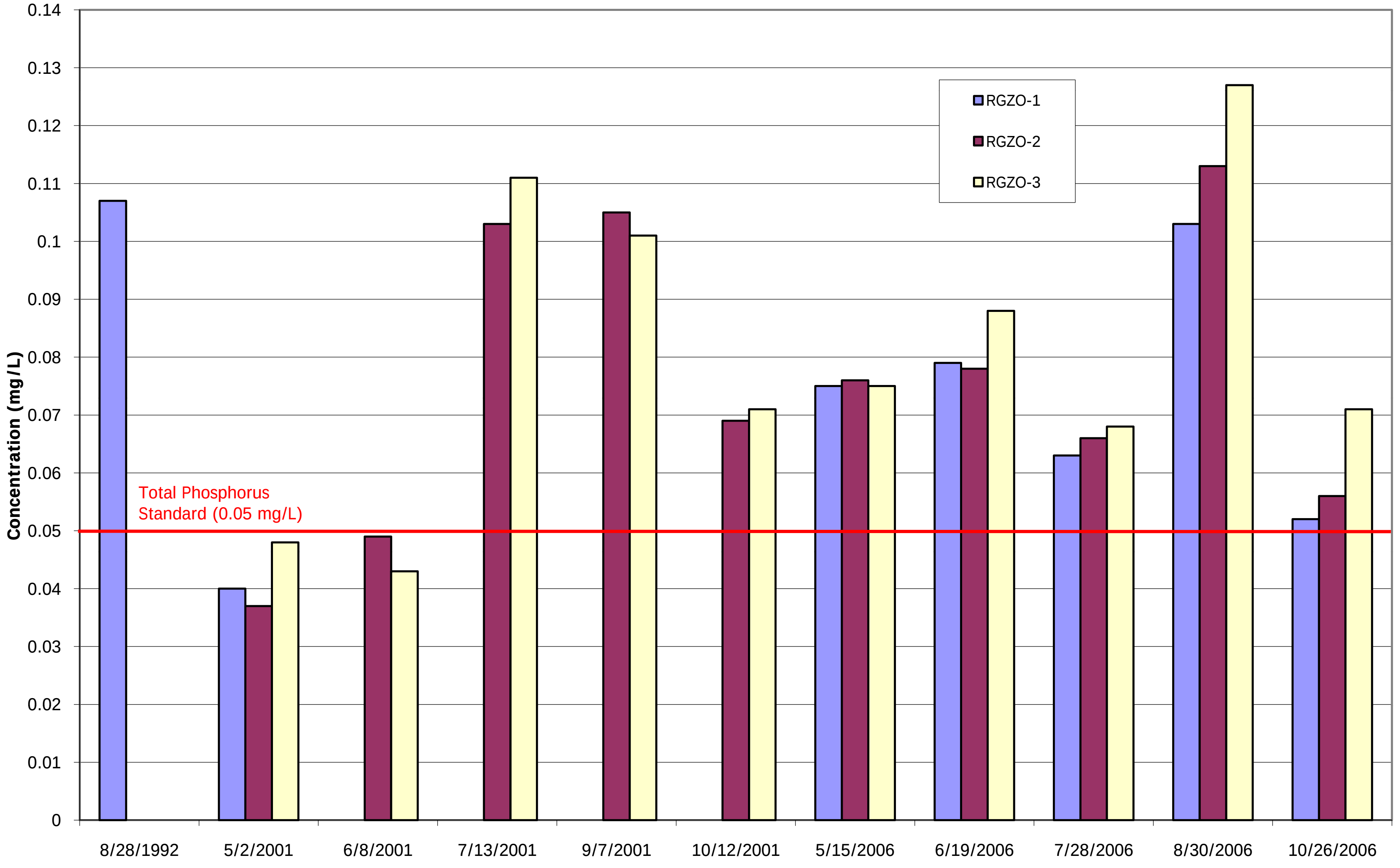

Figure 5-2:
Total Phosphorus Samples
at One-Foot Depth
Tampier Lake

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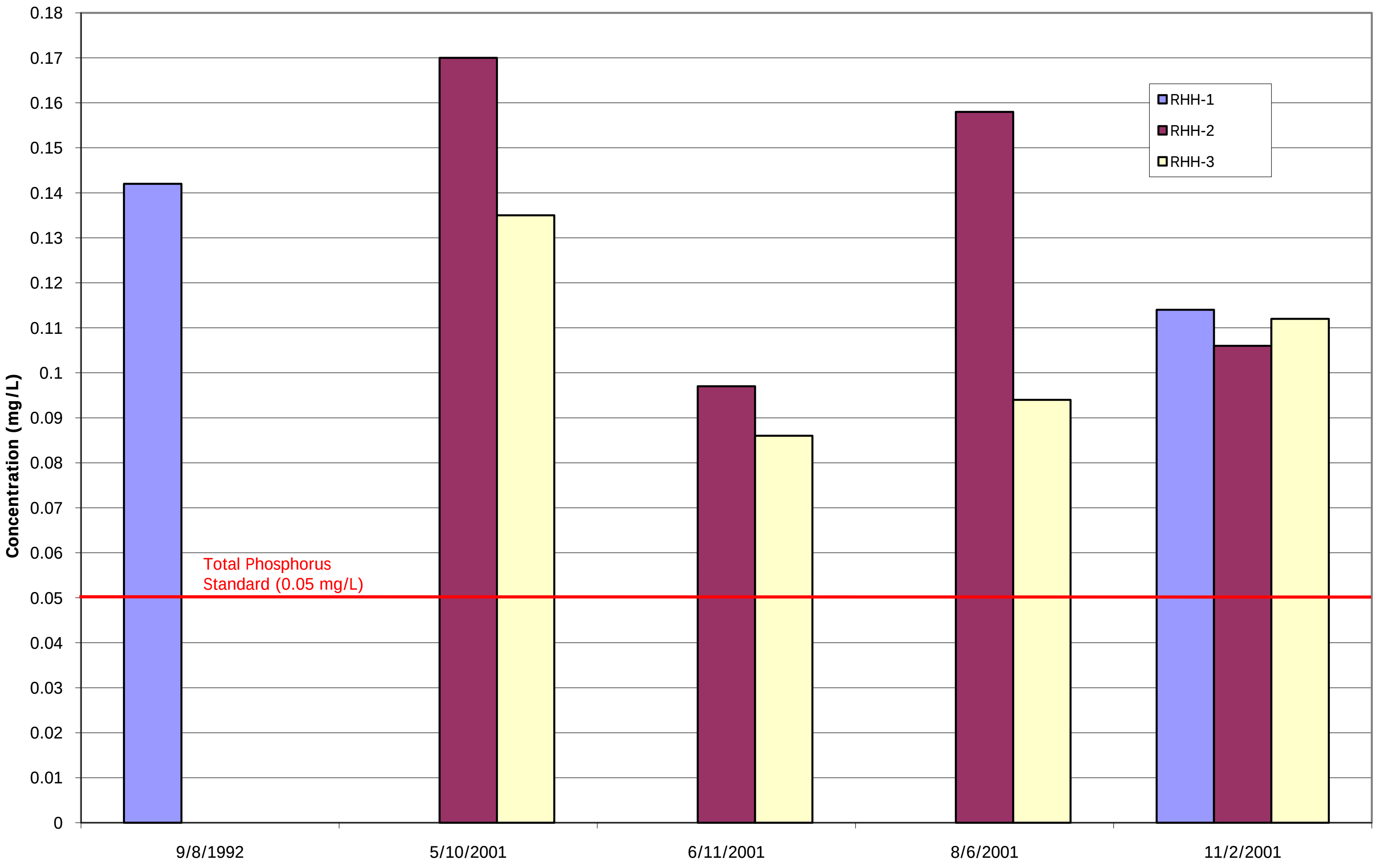

Figure 5-3:
Total Phosphorus Concentrations
at One-Foot Depth
Saganashkee Slough

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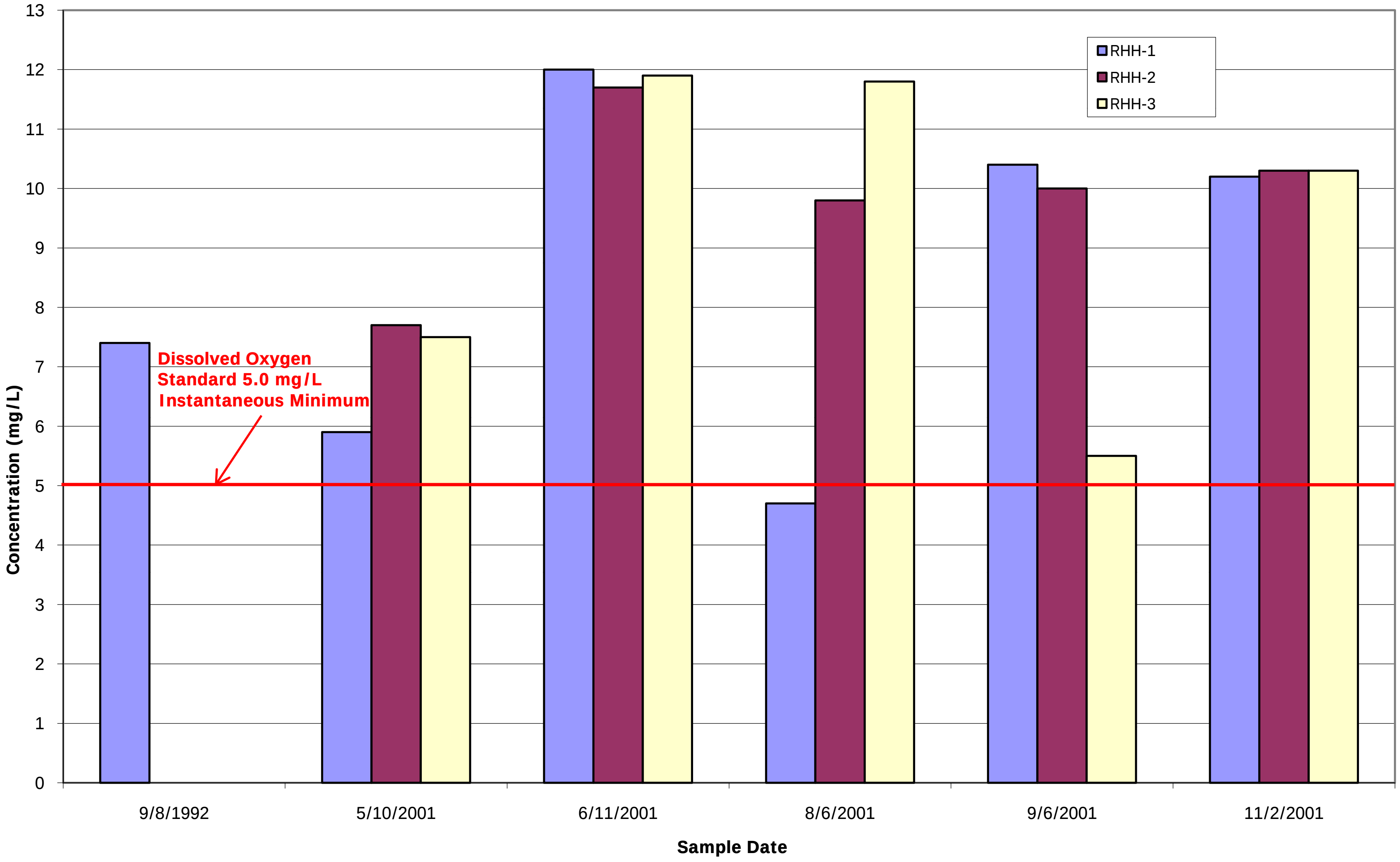

Figure 5-4:
Dissolved Oxygen Concentrations
at One-Foot Depth
Saganashkee Slough

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Section 6
Approach to Developing TMDL and Identification of Data Needs

Illinois EPA is currently developing TMDLs for pollutants that have numeric water quality standards. Refer to Table 1-1 for a list of all pollutants potentially causing impairment within the watersheds. Total phosphorus will be addressed by TMDLs developed for the Tampier Lake and Saganashkee Slough watersheds. Illinois EPA believes that addressing these impairments should lead to an overall improvement in water quality due to the interrelated nature of the other listed pollutants. Recommended technical approaches for developing these TMDLs are presented below. Additional data needs are also discussed.

6.1 Simple and Detailed Approaches for Developing TMDLs

The range of analyses used for developing TMDLs varies from simple to complex. Examples of a simple approach include mass-balance, load-duration, and simple watershed and receiving water models. Detailed approaches incorporate the use of complex watershed and receiving water models. Simple approaches typically require less data than detailed approaches and therefore, due to limited data availability, are the analyses recommended for the Tampier Lake and Saganashkee Slough watersheds. Establishing a link between pollutant loads and resulting water quality is one of the most important steps in developing a TMDL. As discussed above, this link can be established through a variety of techniques. The objective of the remainder of this section is to recommend approaches for establishing these links for the constituents of concern in each impaired water body.

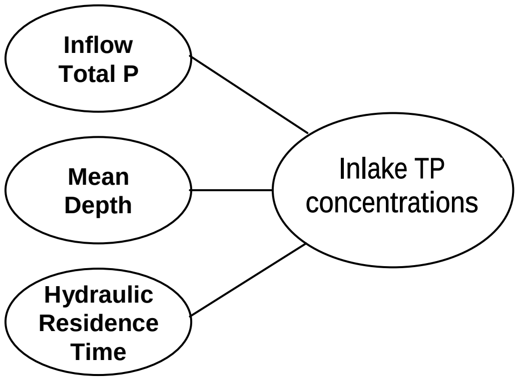
6.2 Approaches for Developing TMDLs for Tampier Lake and Saganashkee Slough

Both Tampier Lake and Saganashkee Slough have impairments caused by total phosphorus. In addition, Saganashkee Slough is 303(d) listed for impairment caused by DO. The DO impairment was listed based on the previous standard of a 5.0 mg/L minimum concentration throughout the year. The updated standard includes provisions for a 3.5 mg/L minimum concentration from August to September. A single sample was collected that fell below the previous 5.0 mg/L standard. It was collected on 8/6/06 and would no longer be considered a violation of the standard.

The BATHTUB model is regularly used for lake phosphorus assessments and was selected for this application to address site-specific impairments. The BATHTUB model performs steady-state water and nutrient balance calculations in a spatially segmented hydraulic network that accounts for advective and diffusive transport and nutrient sedimentation. The model relies on empirical relationships to predict lake trophic conditions and subsequent DO conditions as functions of total phosphorus and nitrogen loads, residence time, and mean depth (USEPA 1997). Oxygen conditions in the model are simulated as meta- and hypolimnetic depletion rates, rather than explicit concentrations. Although watershed data are limited, data are adequate to build a simple model for each watershed. Watershed loadings to the lakes will be estimated using event mean concentrations (EMCs) or a similar methodology that relates loading to watershed land uses.

Section 7
Model Development

7.1 Model Overview



Schematic 1
BATHTUB Model Schematic

To develop the total phosphorus TMDLs for Tampier Lake and Saganashkee Slough, a model called BATHTUB was utilized. As discussed in Section 6, The BATHTUB model performs steady-state water and nutrient balance calculations in a spatially segmented hydraulic network that accounts for advective and diffusive transport and nutrient sedimentation. The model relies on empirical relationships to predict lake trophic conditions as functions of total phosphorus loads, residence time, and mean depth (USEPA 1997).

7.2 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.

7.2.1 Global Inputs

Global inputs represent atmospheric contributions of precipitation, evaporation, and atmospheric phosphorus. Based on precipitation and evaporation rates discussed in section 2.6, the average annual precipitation input to the models for each waterbody was 33.8 inches, and the average annual evaporation input to the models was 30.1 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). This value is based on a compilation of available historic data and Illinois EPA believes that it is appropriate for use in this watershed where site-specific rates of deposition are not available.

7.4.2 Reservoir Segment Inputs

Reservoir segment inputs in BATHTUB are used for physical characterization of the reservoir. Tampier Lake and Saganashkee Slough are each modeled with three segments (RGZO-1, RGZO-2, RGZO-3 and RHH-1, RHH-2, RHH-3, respectively) in BATHTUB. The segment boundaries for the Tampier Lake watershed are shown on Figure 7-1. The segment boundaries for the Saganashkee Slough are shown in Figure 7-2. Segmentation was established based on available water quality and lake depth data for each sampling location as presented in Section 5.

Segment inputs to the model include surface area, average depth, segment length, and depth to the metalimnion. The lake depth was represented by the data collected by Illinois EPA during sampling events at Tampier Lake in 2001 and at Saganashkee Slough in 1992 and 2001. These data are shown below (Table 7-1) for reference. Segment lengths and surface area were determined in a geographic information system (GIS).

Table 7-1 Average Depths (ft) for Tampier Lake and Saganashkee Slough

Lake Section	1992	2001	Average
Tampier Lake			
RGZO-1		9.1	9.1
RGZO-2		6.6	6.6
RGZO-3		8.2	8.2
Saganashkee Slough			
RHH-1	6	6.75	6.375
RHH-2		3.75	3.75
RHH-3		3.7	3.7

7.4.3 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 7-1 and Figure 7-2 for subbasin boundaries. Each watershed was broken up into three tributaries for purposes of the model. There are no major tributaries to Tampier Lake; however, lake section RGZO-2 receives flow from a small upgradient waterbody (Tampier Slough). The main tributary to Saganashkee Slough is Crooked Creek, which is a small stream that is not currently assessed by Illinois EPA and flows into section RHH-3 of the lake. As shown in Table 7-3, it is estimated that the subbasin containing this tributary contributes approximately 74% of the external load to the Saganashkee Slough.The remaining subbasins are those contributing direct overland flow to each lake segment and contribute the remaining 26% of the external load.. The subbasins used in the BATHTUB model for Tampier Lake are shown in Table 7-2. The tributary areas for Saganashkee Slough are shown in Table 7-3.

Table 7-2 Tampier Lake Tributary Subbasin Information

Tributary Name	Lake Segment Receiving Drainage	Subbasin Area (acres)	Estimated Subbasin flow (cfs)	Percent Contribution to Total External Load
Direct Runoff : RGZO-3	RGZO-3	413	0.59	26.1%
Direct Runoff and outfall from Tampier Slough: RGZO-2	RGZO-2	1007	1.43	63.7%
Direct Runoff : RGZO-1	RGZO-1	162	0.23	10.2%
	Total	**1581**	**2.25**	

Table 7-3 Saganashkee Slough Tributary Subbasin Information

Tributary Name	Lake Segment Receiving Drainage	Subbasin Area (acres)	Estimated Subbasin flow (cfs)	Percent Contribution to Total External Load
Crooked Creek and Direct Runoff: RHH-3	RHH-3	2700	3.84	73.8%
Direct Runoff : RHH-2	RHH-2	538	0.77	14.7%
Direct Runoff : RHH-1	RHH-1	421	0.60	11.5%
	Total	**3658**	**5.21**	

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

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

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

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

USGS gage 5537500 (Long Run near Lemont, Illinois) was chosen as an appropriate gage from which to estimate flows in the Tampier Lake/Saganashkee Slough watersheds. This gage is located approximately 4.75 miles west of Tampier Lake and approximately 6.25 miles southwest of Saganashkee Slough. The Tampier Lake watershed is located within the Long Run watershed, and the outfall from Tampier Lake enters a tributary to Long Run approximately 5.3 miles upstream of the gaging station. The watershed upgradient of the gage drains an area that contains similar land uses and receives comparable precipitation throughout the year. Gage 5537500 captures flow from a drainage area of 20.9 square miles while the Tampier Lake and Saganashkee Slough watersheds are relatively small (approximately 2.5 and 5.7 square miles, respectively).

The total mean daily flow into Tampier Lake was estimated to be 2.25 cubic feet per second (cfs). The flow contributions estimated using the known flows and area of the USGS gage 5537500 watershed and each subbasin's respective areas. The estimated flows from each tributary are shown in Table 7-2. Likewise, the total mean daily flow into Saganashkee Slough was estimated to be 5.21 cfs and was calculated using the known flows and area of the USGS gage 5537500 watershed and each subbasin's respective areas (see discussion above). The estimated flows into each section of Saganashkee Slough are shown in Table 7-3. Historic flow data and flow calculations are available in Appendix C.

The surface area of Tampier Lake was listed as 160 acres in the Stage 1 report based on data provided by the Illinois EPA and the Forest Preserve District of Cook County Illinois. However, GIS analysis of aerial photos showing Tampier Lake determined the current (as of 2006) lake surface area to be 124.9 acres. This revised figure was used in the BATHTUB model. Tampier Lake has a total watershed area of 1,581 acres, providing a watershed area to lake area ratio of approximately 13:1. Aerial photographs were also used to evaluate the surface area of Saganashkee Slough. The total surface area of the lake was determined to be 372.6 acres while the total watershed area was delineated to 3,658 acres. These figures produce a watershed area to lake area ratio of approximately 10:1 for Saganashkee Slough. The ratio of 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 13:1 as seen in Tampier Lake is considered to be somewhere between a seepage lake (typically less than 10:1 ratio and dominated by groundwater and internal loading influences) and a drainage lake (typically high ratio lakes that are dominated by tributary inflows and associated nonpoint source loading from the surrounding watershed). A ratio of 10:1, as seen in Saganashkee Slough, would be considered in the high range for a seepage lake.

The storage volume for Tampier Lake was presented in Section 5 as being approximately 859 acre-feet, with a normal storage of 668 acre-feet. Based on this storage volume and the estimated inflow of 2.25 cfs, the lake residence time in Tampier Lake is ranges from approximately 150 days (at 668 acre-feet) to 192 days (at 859 acre-feet) days. The storage volume for Saganashkee Slough is approximately 2,375 acre-feet. Based on this storage volume and the estimated inflow of 5.21 cfs, the lake residence time for Saganashkee Slough is approximately 229 days.

Phosphorus loadings to both lakes from the surrounding watersheds were estimated using the unit area load method, also known as the "export coefficient" method (USEPA 2001). For the load estimates performed for these watersheds, median unit area loads were applied by land use from the high end of reported median ranges in the literature (USEPA 2001). Empirical data showing a full range of unit area loads were used from a small watershed with similar land use and regional characteristics. All BATHTUB model files including unit area calculations for both lakes are provided in Appendix D.

The total watershed phosphorus loading for Tampier Lake was calculated as ranging from 203 to 493 lbs/yr, with a median of 347 lbs/yr or 0.95 lbs/day. The total watershed phosphorus loading for Saganashkee Slough was calculated as ranging from 324 lbs/yr to 728 lbs/yr, with a median of 556 lbs/year or 1.5 lbs/day.

The phosphorus loads from each tributary were determined by multiplying the total phosphorus load by the ratio of the subbasin areas. To obtain phosphorus concentrations for the watersheds, the nutrient mass was divided by the volume of flow. The estimated inflow concentration of total phosphorus in the Tampier Lake watershed is 0.078 mg/L while the estimated concentration of total phosphorus in the Saganashkee Slough watershed is 0.054 mg/L.

7.5 BATHTUB Confirmatory Analysis

Available lake and tributary water quality data are summarized in section 5. In order to confirm the BATHTUB models for Tampier Lake and Saganashkee Slough, the available data were entered and model defaults were unchanged. The resulting inlake modeled concentrations were compared to historic concentrations recorded by Illinois EPA. When using these initial loadings, the BATHTUB models 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 from the model default of zero. Table 7-4 shows the results of the confirmatory analysis performed in BATHTUB for Tampier Lake. The results of the confirmatory analysis for the Saganashkee Slough model are shown in Table 7-5.

Table 7-4 Summary of Model Confirmatory Analysis: Tampier Lake Total Phosphorus (mg/L)

Lake Segment	Predicted Concentration	Observed Concentration	Internal Loading Rate (mg/m^2-day)
RGZO-1	0.077	0.078	1.5
RGZO-2	0.077	0.075	1.2
RGZO-3	0.078	0.080	1.7
Lake Average	0.078	0.078	

Table 7-5 Summary of Model Confirmatory Analysis: Saganashkee Slough Total Phosphorus (mg/L)

Lake Segment	Predicted Concentration	Observed Concentration	Internal Loading Rate (mg/m^2-day)
RHH-1	0.136	0.141	3.75 (nearest to dam)
RHH-2	0.136	0.133	2.5
RHH-3	0.133	0.131	2.5
Lake Average	0.135	0.134	

It is possible that internal cycling or loading within Tampier Lake and Saganashkee Slough could be significant due to the relatively shallow depths of both reservoirs in comparison to the BATHTUB model empirical data set. The BATHTUB Manual notes that internal cycling can be significant in shallow reservoirs (USACE 1999b, 2003).The maximum depth of Tampier Lake is approximately 15 feet and the maximum depth of Saganashkee Slough is approximately 10 feet, which places both waterbodies in the category of shallow reservoir. Literature sources suggest that internal loading for deeper, more stratified lakes could be in the range of 10 to 30 percent of total loadings and that values for shallower reservoirs could be much higher (Wetzel 1983). Additionally, the average inlake concentrations in Tampier Lake were 0.085 mg/L. This is slightly higher than the estimated tributary concentration of

0.078 mg/L. Average inlake concentrations in Saganashkee Slough were 0.13 mg/L which is also higher than the estimated tributary concentration of 0.054 mg/L. This data indicates the potential for internal loading in both reservoirs with higher internal loads likely found in Saganashkee Slough.

In addition, the confirmatory analysis indicates that higher internal cycling at Saganashkee Slough is occurring nearest the dam where oxygen levels could be depleted at increased depths, which indicates favorable conditions for internal cycling. A review of data collected in 2001 indicates that the site nearest the dam (RHH-1) experienced relatively low DO levels at sampling depths near the bottom. The low DO levels recorded in 2001 suggest that at times the DO concentrations at the greatest depths may approach zero, creating favorable conditions for internal cycling. Phosphorus samples collected at depths near the lake bottom were considerably higher than surface samples, also lending confidence to the possibility of significant internal loading.

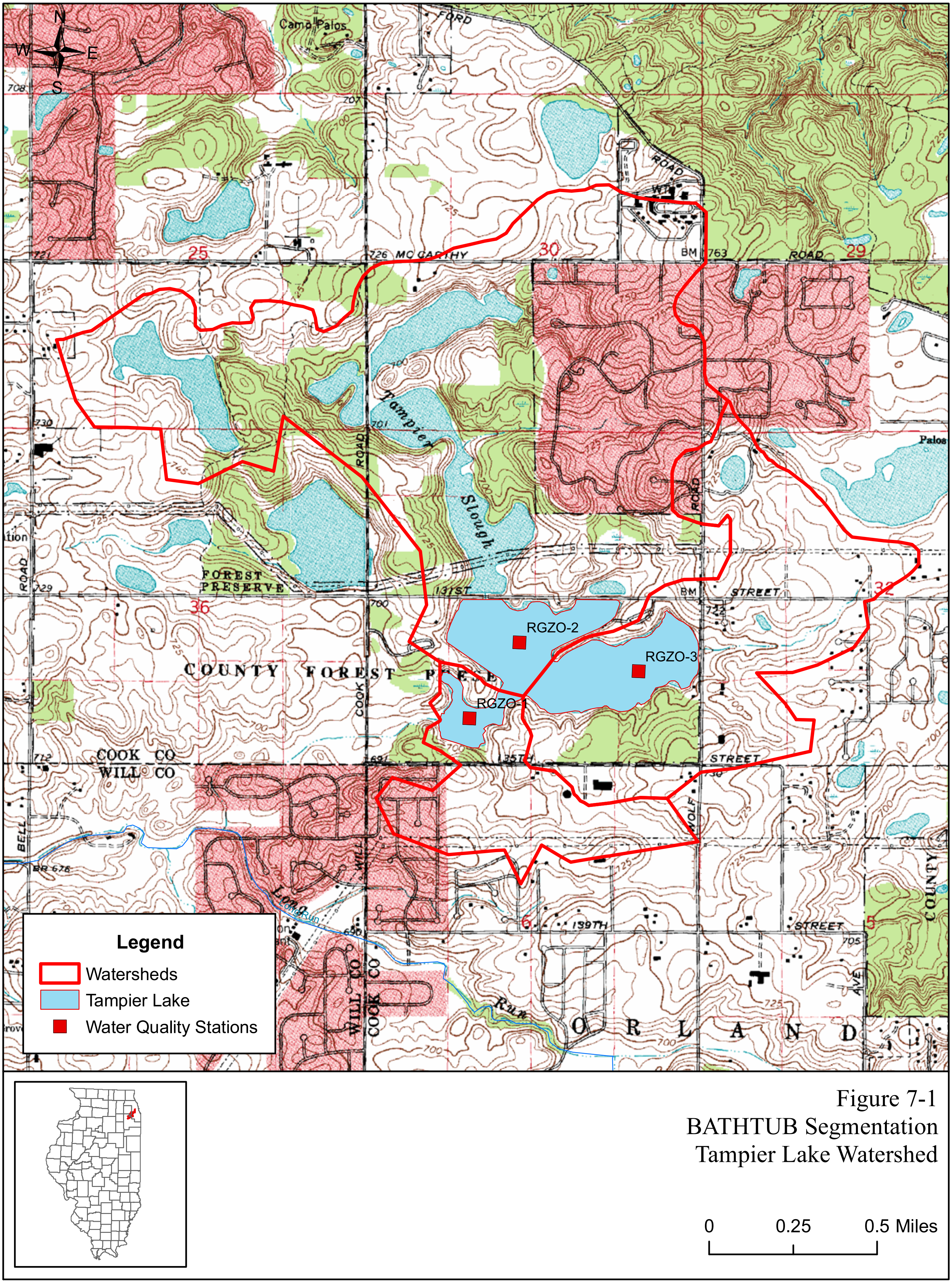


Figure 7-1
BATHTUB Segmentation
Tampier Lake Watershed

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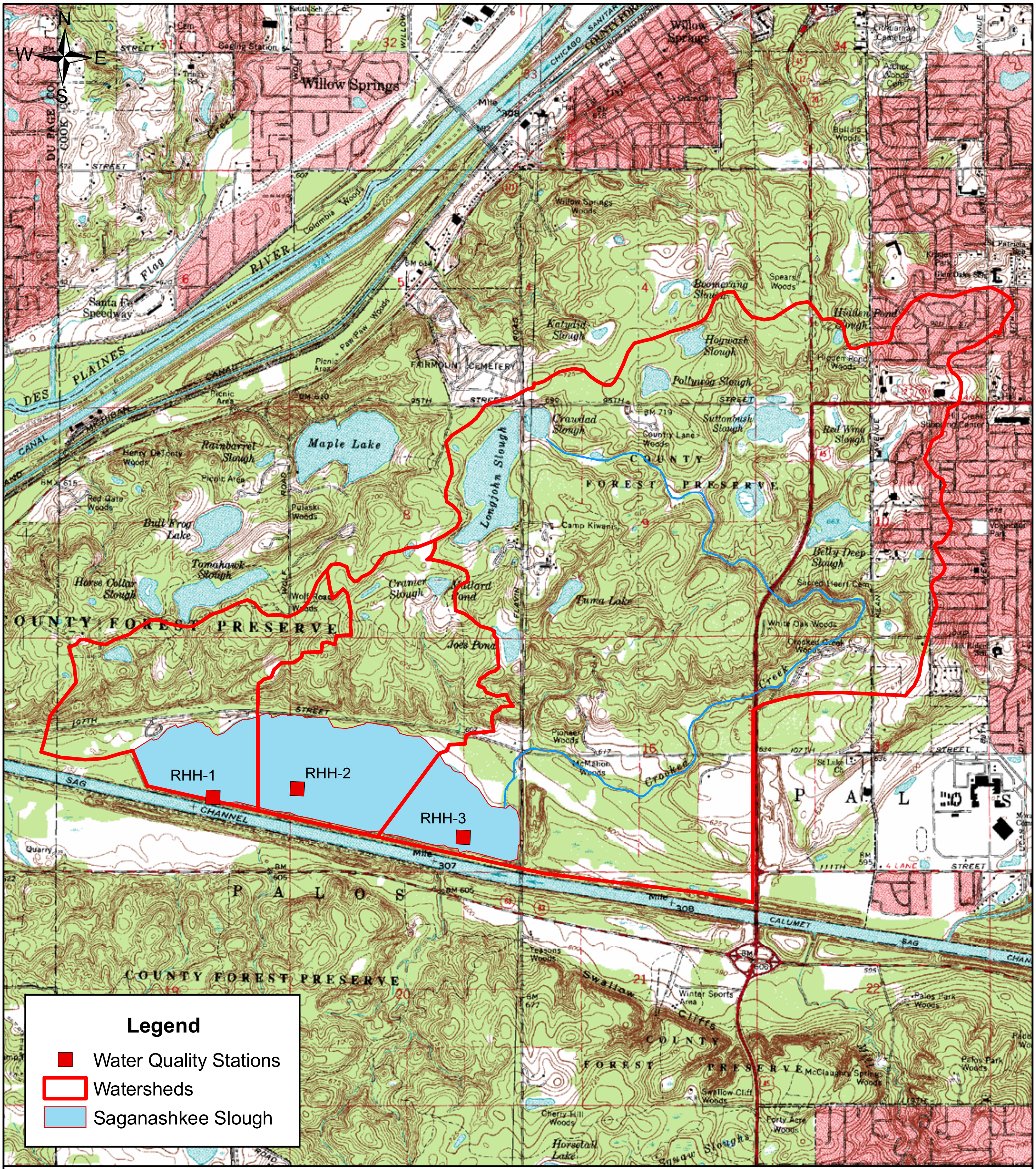

Figure 7-2
BATHTUB Segmentation
Saganashkee Slough Watershed

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Section 8
TMDL Development

8.1 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. Table 8-1 contains the standards for dissolved oxygen and total phosphorus.

Table 8-1 Summary of Applicable Numeric Water Quality Standards for Tampier Lake and Saganashkee Slough

Parameter	Units	General Use Water Quality Standard	Regulatory Reference
Dissolved Oxygen	mg/L	*March through July* ≥5.0 minimum & ≥6.0 7-day mean; *August through February* ≥3.5 minimum, ≥4.0 7-day mean & ≥5.5 30-day mean	302.206
Phosphorus (Total)	mg/L	0.05(1)	302.205

mg/L = milligrams per liter

NA = Not Applicable

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

Section 5 summarized the average total phosphorus concentrations sampled in Tampier Lake and the average total phosphorus and dissolved oxygen concentrations for Saganashkee Slough. As noted throughout this report, observed in-lake total phosphorus averages have exceeded the target for both waterbodies and observed in-lake DO concentrations have been below the instantaneous minimum concentration in Saganashkee Slough. 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. Low DO concentrations are of concern to the aquatic life within the waterbody. Reductions in total phosphorus will likely reduce excess algal growth resulting in higher DO levels within the lake.

8.2 Pollutant Sources and Linkages

Pollutant sources and their linkages to Tampier Lake and Saganashkee Slough 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 watersheds include nonpoint sources such as runoff from surrounding grassland, forest and parkland, and internal loading from lake sediments. Nutrients bound in eroded soils and plant materials are introduced to the lakes through precipitation events. Once in the waterbodies, nutrients are introduced to the water column and/or nutrient rich soils and plant materials settle to the bottom perpetuating the internal cycling of nutrients.

Further discussion of sources and source controls are provided in Section 9. As discussed above, the likely cause of low dissolved oxygen concentrations seen in Saganashkee Slough are the increased total phosphorus concentrations that promote excessive algal growth. The inherent relationship between low DO and high total phosphorus concentrations allow for the DO impairment to be assessed primarily through assessment of total phosphorus concentrations. It is expected that a reduction in total phosphorus concentrations within Saganashkee Slough would increase the low DO concentrations within the lake to concentrations above the water quality standard. Therefore, 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 Tampier Lake and Saganashkee Slough.

8.3 TMDL Allocations for Tampier Lake and Saganashkee Slough

As explained in Section 1, the TMDLs for Tampier Lake and Saganashkee Slough both address the following equation:

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

where LC = Maximum amount of pollutant loading a water body can receive without violating water quality standards

WLA = The portion of the TMDL allocated to existing or future point sources

LA = Portion of the TMDL allocated to existing or future nonpoint sources and natural background

MOS = An accounting of uncertainty about the relationship between pollutant loads and receiving water quality

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

8.3.1 Loading Capacity

The loading capacity (LC) of each waterbody is the amount of total phosphorus that can be allowed as input to each 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 models that were set up and confirmed as discussed in Section 7. To accomplish this, the internal and tributary loads calculated using the methods described in Section 7 were iteratively reduced and entered into the BATHTUB models until the water quality standard of 0.05-mg/L total phosphorus was met in both Lake Tampier and Saganashkee Slough. The allowable phosphorus load determined by reducing modeled inputs to Tampier Lake through BATHTUB was determined to be 1.3 pounds (lbs)/day. The allowable total phosphorus load determined in BATHTUB for Saganashkee Slough was 2.4 lbs/day. These analyses are included as Appendix D.

8.3.2 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 Tampier Lake and Saganashkee Slough TMDLs 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 growing season resulting in different runoff characteristics), the loadings for these TMDLs will focus on average annual loadings converted to daily loads rather than specifying different loadings by season. Both the Tampier Lake and Saganashkee Slough watersheds would most likely experience critical conditions annually based on the growing season when high nutrients would promote excess algal growth which would in turn consume DO. Available empirical data for each lake were available during summer and fall months which correspond to the growing season. Because these data were used for TMDL development, the critical condition has been accounted for within the analyses.

8.3.3 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 Tampier Lake and Saganashkee Slough TMDLs are both implicit and explicit. An explicit MOS of 10% was included to account for the lack of site-specific data available within these watershed. Additionally, the analyses completed for these waterbodies were conservative because of the following:

- In the absence of site-specific data, an atmospheric loading rate of 30 mg/m^2-yr total phosphorus (USACE 1999) was taken from literature values and used in the BATHTUB model. This is a conservative value because atmospheric loadings of phosphorus are attributed to erosion that becomes wind borne and because of the low amount of agricultural practices in the surrounding area, the atmospheric loading is most likely negligible. This conservative value likely overestimates loading resulting in a conservatively high percentage reduction needed to meet the TMDL endpoints.

- Default values were used in the BATHTUB model, which in absence of site-specific information are 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 as discussed in Section 7. Higher estimates of internal loading than the model defaults are included in the implicit margin of safety.

8.3.4 Waste Load Allocation

There are no point sources within either the Tampier Lake or Saganashkee Slough watersheds. Therefore, the waste load allocations (WLA) were set to zero for these TMDLs.

8.3.5 Load Allocation and TMDL Summary

Table 8-1 shows a summary of the TMDL for Tampier Lake. On average, a total reduction of 51 percent of total phosphorus loads to Tampier Lake would result in compliance with the water quality standard of 0.05 mg/L total phosphorus. The 51 percent reduction would need to come from the sources discussed above. Table 8-1 also shows where load reductions could be achieved from either internal cycling or from external watershed loadings.

Table 8-1 TMDL Summary for Tampier 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	1.17	0.13	2.7	1.4	51
Internal	0.8	0	0.69	0.08	1.6	0.9	53
External	0.5	0	0.49	0.05	1.0	0.5	48

A summary of the TMDL for Saganashkee Slough is shown in Table 8-2. An average total reduction of 79 percent of total phosphorus loads to Saganashkee Slough would result in compliance with the water quality standard of 0.05 mg/L total phosphorus. The 79 percent reduction would need to come from the sources discussed above. Table 8-2 also shows where load reductions could be achieved from either internal cycling or from external watershed loadings.

Table 8-2 TMDL Summary for Saganashkee Slough

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	2.4	0	2.16	0.24	11.2	8.8	79
Internal	1	0	0.90	0.10	9.4	8.4	89
External	1.4	0	1.26	0.14	1.8	0.4	22

Section 9

Implementation Plan for Tampier Lake and Saganashkee Slough

9.1 Implementation Actions and Management Measures for Phosphorus in the Tampier Lake and Saganashkee Slough Watersheds

Phosphorus loads in the Tampier Lake and Saganashkee Slough watersheds originate from both external and internal sources. As identified by the 2008 303(d) list, possible sources of total phosphorus in the Tampier Lake and Saganashkee Slough watersheds include runoff from surrounding forest, grassland and parkland areas, agriculture, urban runoff /storm sewers and internal loading from lake sediments. The phosphorus TMDLs determined that the total allowable load to Tampier Lake is 1.3 lbs/day and the total allowable load to Saganashkee Slough is 2.4 lbs/day. For Tampier Lake, approximately 41 percent of the total allowable load was allocated to external sources while the other 59 percent of the allowable load was allocated to internal sources. A total reduction of 51 percent of total phosphorus loads will need to be achieved for Tampier Lake to be in compliance with the water quality standard of 0.05 mg/L. Approximately 42 percent of the total allowable load of phosphorus to Saganashkee Slough was allocated to internal sources, with the remaining 58 percent allocated to external sources. A total reduction of 79 percent of total phosphorus loads will need to be achieved for Saganashkee Slough to be in compliance with the 0.05 mg/L water quality standard. To achieve a reduction of total phosphorus for Tampier Lake and Saganashkee Slough, 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, or filter strips; or managerial, such as conservation tillage, nutrient management plans, or public outreach and education. 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.

9.1.1 Municipal/Industrial Point Sources of Phosphorus

There are no municipal or industrial point sources permitted to discharge within the Tampier Lake or Saganashkee Slough watersheds.

9.1.2 Stormwater Sources of Phosphorus

No municipal stormwater permits list waters within the Tampier Lake or Saganashkee Slough watersheds as receiving waters. However, the 2008 Integrated Report identified urban runoff as potential pollutant sources of total phosphorus for both waterbodies. Approximately 125 acres within the Tampier Lake watershed are urbanized and consist of low to medium density residential land uses, as shown in Figure 2-2 of the TMDL Stage 1 Report (CDM 2008). In addition, approximately 4 acres of high density urban development and 153 acres of urban open space occur within the Tampier Lake watershed and may also contribute to stormwater runoff entering the lake. Figure 2-2 of the Stage 1 report also shows that while the majority of the Saganashkee Slough watershed is undeveloped, approximately 250 acres of land in the northeast portion of the watershed consists of low and medium density residential land use. An additional 11.8 acres of high density land use and 58 acres of urban open space are also found within the Saganashkee Slough watershed. Runoff from the residential developments within these watersheds likely contributes stormwater loading to Tampier Lake and Saganashkee Slough. Section 9.1.3 discusses management measures that can be implemented within the watersheds for treating phosphorus in overland runoff.

9.1.3 Nonpoint Sources of Phosphorus

In addition to urban stormwater, potential sources of nonpoint source phosphorus pollution identified in the 2008 Integrated Report included crop production, runoff from grassland/forest/parkland, and sediments. BMPs evaluated that could be utilized to treat these nonpoint sources are:

- Filter strips
- Riparian Buffers
- Wetlands
- Nutrient management
- In-lake management measures

9.1.3.1 Filter Strips

Filter strips can be used as a structural control to reduce pollutant loads, including nutrients and sediment, to Tampier Lake and Saganashkee Slough. Filter strips implemented along stream segments and around waterbodies 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 Tampier Lake and Saganashkee Slough watersheds. Design criteria and size selection of filter strips are also discussed.

Grass and riparian filter 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 9-1 Filter Strip Flow Lengths Based on Land Slope

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

According to the 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 9-1 above outlines the guidance for filter strip flow length by slope (NRCS 1999). There are limited areas within each watershed that could be converted to filter strips. Figure 9-1 provides an example of the area found within a 234-foot buffer of Crooked Creek (the main tributary to Saganashkee Slough). Landowners and property managers should evaluate the land near tributaries and surrounding the lakes and consider installation of filter strips according to the NRCS guidance provided in Table 9-1. Programs available to fund the construction of these filter strips are discussed in Section 9.2.

9.1.3.2 Riparian Buffers

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

Even more important than the filtering capacity of the buffers is the protection they provide to streambanks. The rooting systems of the vegetation serve as reinforcements in streambank soils, which help to hold streambank material in place and minimize erosion. Due to the increase in stormwater runoff volume and peak rates of runoff associated with agriculture and development, stream channels are subject to greater erosional forces during stormflow events. Thus, preserving natural vegetation along stream channels minimizes the potential for water quality and habitat degradation due to streambank erosion and enhances the pollutant removal of sheet flow runoff from developed areas that passes through the buffer.

Converting land adjacent to waterbodies for the creation of riparian buffers will provide stream bank stabilization, stream shading, and nutrient uptake and trapping from adjacent areas. Minimum buffer widths of 25 feet are required for water quality benefits. Higher removal rates are provided with greater buffer widths. NCSU (2002) reports phosphorus removal rates of approximately 25 to 30 percent for 30 ft wide buffers and 70 to 80 percent for 60 to 90 ft wide buffers. Riparian corridors typically treat a maximum of 300 ft of adjacent land before runoff forms small channels that short circuit treatment. In addition to the treated area, any land converted from agricultural land to buffer will generate 90 percent less nutrients based on data presented in Haith et al. (1992).

9.1.3.3 Wetlands

The use of wetlands as a structural control is applicable to nutrient reduction from overland runoff in the Tampier Lake and Saganashkee Slough watersheds. To treat loads from runoff, existing wetlands could be enhanced upstream of each 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)

Table 9-2 Acres of Wetland for Tampier Lake Watershed

Subbasin	**Watershed Size (Acres)**	**Existing Wetland Area (acres)**
RGZO-1	413	**4.9**
RGZO-2	1,007	**43.5**
RGZO-3	162	**8.2**
Total	**1,581**	**56.6**

Table 9-3 Acres of Wetland for Saganashkee Slough Watershed

Subbasin	**Watershed Size (Acres)**	**Existing Wetland Area (acres)**
RHH-1	2,700	**2.1**
RHH-2	538	**8.4**
RHH-3	421	**32.2**
Total	**3,658**	**42.7**

According to the U.S. Division of Fish and Wildlife's National Wetland Inventory, there are approximately 56.6 acres of freshwater forested/shrub wetlands and freshwater emergent wetlands currently existing within the Tampier Lake watershed and approximately 42.7 acres of these wetland types within the Saganashkee Slough watershed. In addition, approximately 112 acres of open water in the form of freshwater ponds and lakes occur within the Tampier Lake watershed, not including Tampier Lake itself. Approximately 73 acres of open water exists within the Saganashkee Slough watershed. For the purposes of these analyses, only the freshwater emergent and freshwater forested/shrub wetlands were considered as potential nutrient reduction sources. 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."*

Figures 9-2 and 9-3 show the freshwater emergent and freshwater forested/shrub wetlands identified by the inventory in the vicinity of Tampier Lake and Saganashkee Slough, respectively. Tables 9-2 and 9-3 categorize the wetlands by subbasin for reference. Restoring or improving these areas can potentially improve the quality of runoff that reaches Tampier Lake and Saganashkee Slough.

9.1.3.4 Nutrient Management

Nutrient management could result in reduced nutrient loads to Tampier Lake and Saganashkee Slough. 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 or maintained parkland should increase the efficiency of phosphorus use by balancing phosphorus inputs in feed and fertilizer with outputs in crops and grasslands as well as managing the level of phosphorus in the soil. Reducing phosphorus loss in runoff may be brought about by source and transport control measures, such as filter strips or riparian buffers (discussed above). 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

Although agricultural land within both watersheds is limited, nutrient management information has been included for reference. 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).

9.1.4 In-Lake Phosphorus

The Tampier Lake phosphorus TMDL allocated approximately 58 percent of the total allowable phosphorus load to internal cycling. Approximately 42 percent of the total allowable phosphorus load is attributed to internal cycling in the Saganashkee Slough TMDL. Reduction of phosphorus from in-lake cycling through management strategies is necessary for attainment of the TMDL load allocation. Internal phosphorus loading can occur 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 may perpetuate or create anoxic conditions and enhance the subsequent release of phosphorus into the water. Internal phosphorus loading can also occur in shallow lakes through release from sediments by the physical mixing and reintroduction of sediments into the water column as a result of wave action, winds, boating activity, and other means. As discussed in section 1 of this report, there is some evidence of hypolimnetic anoxia potentially occurring in waters near the dam at Saganashkee Slough, which may contribute to the internal cycling of phosphorus.

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. This option may be viable for section RHH-1(nearest the dam) in Saganashkee Slough if it is determined that fully anoxic conditions do occur periodically in the hypolimnion.

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. Dredging may also contribute to reductions in internal phosphorus loading by increasing the depth of large portions of the waterbody, reducing the degree of reintroduction of sediments into the water column through physical mixing. However, dredging is more costly than other management options (NRCS 1992).

9.2 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 may currently be in practice to some degree within the watershed. The discussion in Section 9.1 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.

9.2.1 Available Cost-Share Programs

A small portion of the Saganashkee Slough and Tampier Lake watersheds are classified as agricultural land. There are several voluntary conservation programs established through the 2008 U.S. Farm, which encourage landowners to implement resource-conserving practices for water quality and erosion control purposes. These programs would apply to agricultural land and rural grasslands in the watershed. In addition, Illinois EPA has grant programs that can assist in implementation of nonpoint source controls. Each program is discussed separately in the following paragraphs.

9.2.1.1 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 phosphorus identified as a cause for impairment (as is the case in these watersheds), are eligible for cost-share assistance in implementing traditional erosion control practices through the Nutrient Management Plan project.

9.2.1.2 Conservation Reserve Program (CRP)

http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=crp
The CRP is a voluntary program for agricultural landowners. Through CRP, landowners can receive annual rental payments and cost-share assistance to establish long-term, resource conserving covers on eligible farmland.

The Commodity Credit Corporation (CCC) makes annual rental payments based on the agriculture rental value of the land, and it provides cost-share assistance for up to

50 percent of the participant's costs in establishing approved conservation practices. Participants enroll in CRP contracts for 10 to 15 years.

CRP protects millions of acres of American topsoil from erosion and is designed to safeguard natural resources. By reducing water runoff and sedimentation, CRP protects groundwater and helps improve the condition of lakes, rivers, ponds, and streams. Acreage enrolled in the CRP is planted to resource-conserving vegetative covers, making the program a major contributor to increased wildlife populations in many parts of the country.

The Farm Service Agency (FSA) administers CRP, while technical support functions are provided by NRCS, USDA's Cooperative State Research, Education, and Extension Service, State forestry agencies, local soil and water conservation districts, and private sector providers of technical assistance. Producers can offer land for CRP general sign-up enrollment only during designated sign-up periods. Environmentally desirable land devoted to certain conservation practices may be enrolled at any time under CRP continuous sign-up. Certain eligibility requirements still apply, but offers are not subject to competitive bidding. Further information on CRP continuous sign-up is available in the FSA fact sheet "Conservation Reserve Program Continuous Sign-up."

To be eligible for placement in CRP, land must be either:

- Cropland (including field margins) that is planted or considered planted to an agricultural commodity 4 of the previous 6 crop years from 1996 to 2001, and which is physically and legally capable of being planted in a normal manner to an agricultural commodity; or

- Certain marginal pastureland that is suitable for use as a riparian buffer or for similar water quality purposes.

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

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

FSA provides CRP participants with annual rental payments, including certain incentive payments, and cost-share assistance:

- Rental Payments – In return for establishing long-term, resource-conserving covers, FSA provides annual rental payments to participants. FSA bases rental rates on the relative productivity of the soils within each county and the average dry land cash rent or cash-rent equivalent. The maximum CRP rental rate for each offer is calculated in advance of enrollment. Producers may offer land at that rate or offer a lower rental rate to increase the likelihood that their offer will be accepted.

- Maintenance Incentive Payments – CRP annual rental payments may include an additional amount up to $4 per acre per year as an incentive to perform certain maintenance obligations.

- Cost-share Assistance – FSA provides cost-share assistance to participants who establish approved cover on eligible cropland. The cost-share assistance can be an amount not more than 50 percent of the participants' costs in establishing approved practices.

- Other Incentives – FSA may offer additional financial incentives of up to 20 percent of the annual payment for certain continuous sign-up practices.

Conservation practices eligible for CRP funding which are recommended BMPs for this watershed TMDL include but are not limited to filter strips, grass waterways, riparian buffers, wetland restoration, and tree plantings.

9.2.1.3 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.

9.2.1.4 Wetlands Reserve Program (WRP)

http://www.nrcs.usda.gov/programs/wrp/
The WRP is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The USDA NRCS provides technical and financial support to help landowners with their wetland restoration efforts. The NRCS goal is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection.

The program offers three enrollment options:

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

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

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

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

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

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

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

- Eligible acres are limited to private and Tribal lands.

9.2.1.5 Environmental Quality Incentive Program (EQIP)

http://www.il.nrcs.usda.gov/programs/eqip/index.html
EQIP is a voluntary conservation program that provides financial and technical assistance to farmers and ranchers who face threats to soil, water, air, and related natural resources on their land. Through EQIP, the NRCS develops contracts with agricultural producers to implement conservation practices to address environmental natural resource problems. Payments are made to producers once conservation practices are completed according to NRCS requirements.

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

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

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

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

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

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

9.2.1.6 Wildlife Habitat Incentives Program (WHIP)

http://www.il.nrcs.usda.gov/programs/whip/index.html
WHIP is a voluntary program for people who want to develop and improve wildlife habitat primarily on private lands and nonindustrial private forest land. It provides both technical assistance and cost share payments to help:

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

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

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

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

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

9.2.1.7 Illinois Conservation and Climate Initiative (ICCI)

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

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

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

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

9.2.1.8 Local Program Information

Local NRCS contact information for Southern Cook County is listed in the Table 9-4 below.

Table 9-4 South Cook County USDA Service Center Contact Information

Contact	Address	Phone
Local SWCD Office		
Kimberly Mitchell	1201 Gougar Road New Lenox, IL 60451	815-462-3106
Local FSA Office		
Stephen A. Rustman	1201 Gougar Road New Lenox, IL 60451	815-485-0068
Local NRCS Office		
Robert Jankowski	1201 Gougar Road New Lenox, IL 60451	815-462-3106 ext. 3

9.2.2 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 9-5 outlines the estimated cost of implementation measures in the Tampier Lake and Saganashkee Slough watersheds.

9.2.2.1 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. EQIP program cost documentation for Illinois for 2009 estimates $1,700/acre for wetland excavation, earthwork, and native seeding. ftp://ftp-fc.sc.egov.usda.gov/IL/farmbill/EQIPpaymnt_schdl_Tradtnl_0509.pdf

9.2.2.2 Filter Strips and Riparian Buffers

The same Illinois EQIP document was used to provide filter strip and riparian buffer cost estimates. Filter strip implementation that includes seedbed preparation and native seed was estimated at $88/acre while riparian buffers ranged from $130/acre for herbaceous cover up to $800/acre for forested buffers. ftp://ftp-fc.sc.egov.usda.gov/IL/farmbill/EQIPpaymnt_schdl_Tradtnl_0509.pdf

9.2.2.3 Nutrient Management Plan - NRCS

A small portion of the agricultural land in the Tampier Lake and Saganashkee Slough watersheds are comprised of cropland. The service for developing a nutrient management plan averages $6 to $18/acre. This includes soil testing, manure analysis, scaled maps, and site specific recommendations for fertilizer management.

9.2.2.4 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.

9.2.2.5 Internal Cycling

Controls of internal phosphorus cycling in lakes are costly. The in-lake controls have been converted to year 2009 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 $197,000 to $1.97 million (Tetra Tech 2002). USEPA (1993) reports initial costs ranging from $394,000 to $962,000 plus annual operating costs of $69,500. 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 $336/acre to $834/acre (WIDNR 2003). The surface area of Tampier Lake is approximately 125 acres, so total application costs for the lake would likely range from $42,000 to $104,300 for Tampier Lake and $125,400 to $311,300 for the 373 acre Saganashkee Slough.

Dredging is typically the most expensive management practice averaging $9,274/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).

9.2.2.6 Planning Level Cost Estimates for Implementation Measures

Cost estimates for different implementation measures are presented in Table 9-5. Cost estimates shown in Table 9-5 are the total estimated cost per acre and many costs could be reduced through cost share opportunities discussed in Section 9.2.1. 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 Wetlands Reserve Program (WRP), the Conservation Reserve Program (CRP), National Resource Conservation Service (NRCS), 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 9-5 Cost Estimate of Various BMP Measures

Source	Program	Sponsor	BMP	Installation Mean $
Nonpoint	CRP	NRCS and IDA	Filter strip (seeded)	$88/acre
	CRP	NRCS and IDA	Riparian Buffer	$130-$800/acre
	WRP	NRCS	Wetland	$1,700/acre
		NRCS	Nutrient Management Plan	$6-18
		IDA and Illinois EPA	Nutrient Management Plan	$13
Internal Cycling			Dredging	$9,000/acre
			Aerator	varies
			Alum	$300-$800/acre

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

9.3 Monitoring Plan

The purpose of the monitoring plan for Tampier Lake and Saganashkee Slough 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 monitoring of Tampier Lake/Saganashkee Slough
- Storm-based monitoring of high flow events
- Tributary monitoring

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

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

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

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

Illinois EPA monitors lakes every three years and conducts Intensive Basin Surveys every five years. Continuation of this state monitoring program will assess lake water quality as improvements in the watersheds are completed. Any available future sampling data can be used to assess whether water quality standards in Tampier Lake and Saganashkee Slough are being attained.

Tributary monitoring is needed to further assess the contribution of internal loading to Tampier Lake and Saganashkee Slough. 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.

9.4 Implementation Time Line

Implementing the actions outlined in this section for the Tampier Lake and Saganashkee Slough watersheds should occur in phases and assess 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 Tampier Lake and Saganashkee Slough 10 years or more to reach its water quality standard target of 0.05 mg/L. If internal loads are not effectively controlled, this time frame could be even greater as the reservoirs 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 Tampier Lake and Saganashkee Slough to meet the total phosphorus water quality standard.

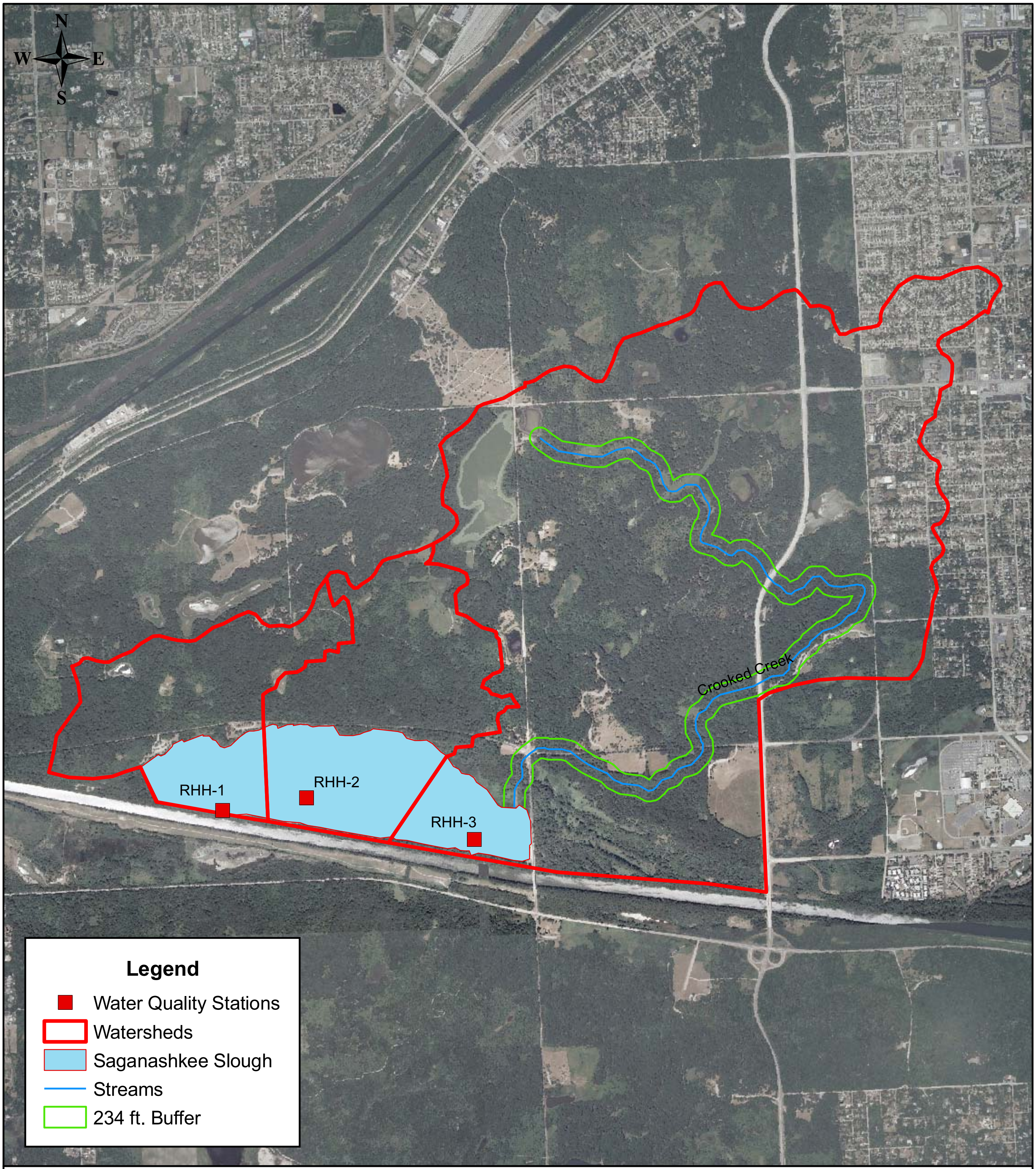

Figure 9-1
Buffer Zone for Filter Strip Analysis
Saganashkee Slough Watershed

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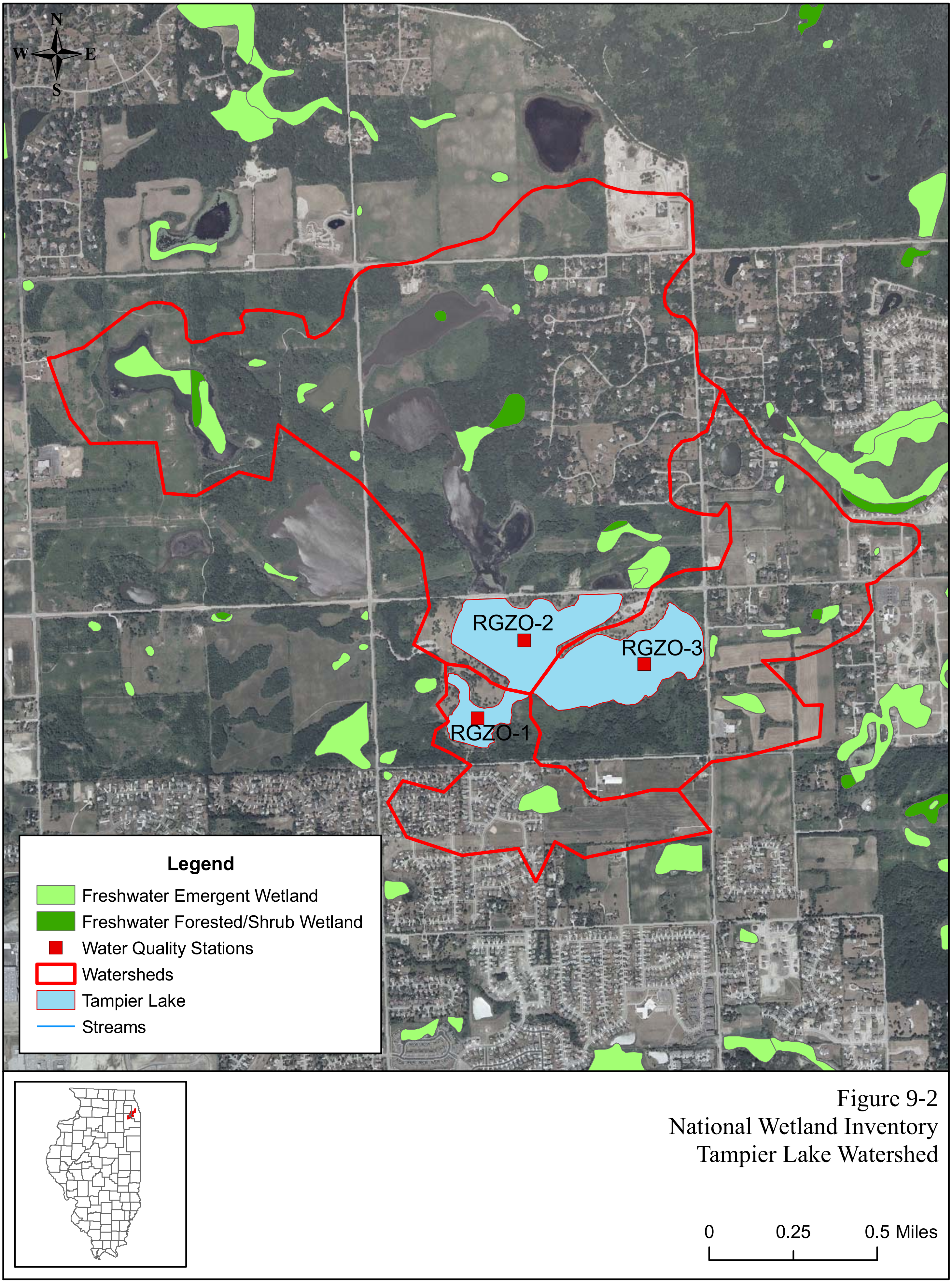

Figure 9-2
National Wetland Inventory
Tampier Lake Watershed

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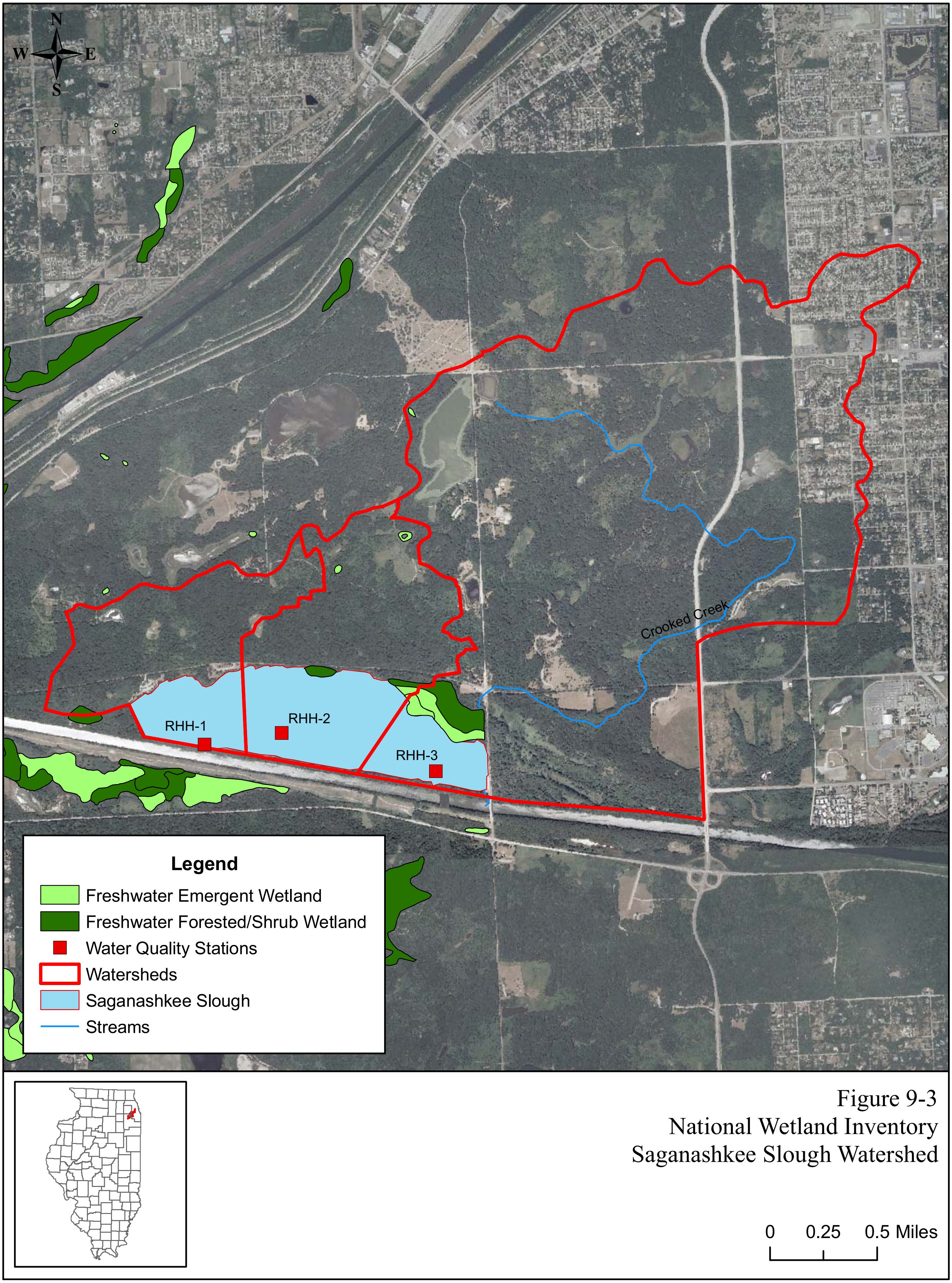

Figure 9-3
National Wetland Inventory
Saganashkee Slough Watershed

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Section 10
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Appendix A
Land Use Categories

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File names and descriptions:

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

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

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Appendix B
Water Quality Data

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STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RGZO-1	6/19/2006	Water	Chlorophyll a, Corrected	47.2	ug/L
RGZO-1	7/28/2006	Water	Chlorophyll a, Corrected	75.6	ug/L
RGZO-1	8/30/2006	Water	Chlorophyll a, Corrected	154	ug/L
RGZO-1	10/26/2006	Water	Chlorophyll a, Corrected	34.4	ug/L
RGZO-2	6/19/2006	Water	Chlorophyll a, Corrected		ug/L
RGZO-2	7/28/2006	Water	Chlorophyll a, Corrected	78.2	ug/L
RGZO-2	8/30/2006	Water	Chlorophyll a, Corrected	186	ug/L
RGZO-3	6/19/2006	Water	Chlorophyll a, Corrected	43	ug/L
RGZO-3	7/28/2006	Water	Chlorophyll a, Corrected	71.7	ug/L
RGZO-3	8/30/2006	Water	Chlorophyll a, Corrected	175	ug/L
RGZO-3	10/26/2006	Water	Chlorophyll a, Corrected	44.7	ug/L
RGZO-1	5/15/2006	Water	Chlorophyll a, uncorrected	48.9	ug/L
RGZO-1	6/19/2006	Water	Chlorophyll a, uncorrected	53.4	ug/L
RGZO-1	7/28/2006	Water	Chlorophyll a, uncorrected	81	ug/L
RGZO-1	8/30/2006	Water	Chlorophyll a, uncorrected	158	ug/L
RGZO-1	10/26/2006	Water	Chlorophyll a, uncorrected	37.6	ug/L
RGZO-2	6/19/2006	Water	Chlorophyll a, uncorrected		ug/L
RGZO-2	7/28/2006	Water	Chlorophyll a, uncorrected	83.2	ug/L
RGZO-2	8/30/2006	Water	Chlorophyll a, uncorrected	192	ug/L
RGZO-3	6/19/2006	Water	Chlorophyll a, uncorrected	46.8	ug/L
RGZO-3	7/28/2006	Water	Chlorophyll a, uncorrected	75.8	ug/L
RGZO-3	8/30/2006	Water	Chlorophyll a, uncorrected	179	ug/L
RGZO-3	10/26/2006	Water	Chlorophyll a, uncorrected	50.7	ug/L
RGZO-1	5/15/2006	Water	Chlorophyll-b	3.27	ug/L
RGZO-1	6/19/2006	Water	Chlorophyll-b	2.61	ug/L
RGZO-1	7/28/2006	Water	Chlorophyll-b	1.71	ug/L
RGZO-1	8/30/2006	Water	Chlorophyll-b	ND	ug/L
RGZO-1	10/26/2006	Water	Chlorophyll-b	ND	ug/L
RGZO-2	6/19/2006	Water	Chlorophyll-b		ug/L
RGZO-2	7/28/2006	Water	Chlorophyll-b	1.55	ug/L
RGZO-2	8/30/2006	Water	Chlorophyll-b	ND	ug/L
RGZO-3	6/19/2006	Water	Chlorophyll-b	2.6	ug/L
RGZO-3	7/28/2006	Water	Chlorophyll-b	ND	ug/L
RGZO-3	8/30/2006	Water	Chlorophyll-b	ND	ug/L
RGZO-3	10/26/2006	Water	Chlorophyll-b	ND	ug/L
RGZO-1	5/15/2006	Water	Chlorophyll-c	2.86	ug/L
RGZO-1	6/19/2006	Water	Chlorophyll-c	4.73	ug/L
RGZO-1	7/28/2006	Water	Chlorophyll-c	4.37	ug/L
RGZO-1	8/30/2006	Water	Chlorophyll-c	5.96	ug/L
RGZO-1	10/26/2006	Water	Chlorophyll-c	2.83	ug/L
RGZO-2	6/19/2006	Water	Chlorophyll-c		ug/L
RGZO-2	7/28/2006	Water	Chlorophyll-c	4.41	ug/L
RGZO-2	8/30/2006	Water	Chlorophyll-c	6.85	ug/L
RGZO-3	6/19/2006	Water	Chlorophyll-c	3.91	ug/L
RGZO-3	7/28/2006	Water	Chlorophyll-c	3.84	ug/L
RGZO-3	8/30/2006	Water	Chlorophyll-c	6.92	ug/L
RGZO-3	10/26/2006	Water	Chlorophyll-c	4.97	ug/L
RGZO-1	5/15/2006	Water	Dissolved Phosphorus	0.019	mg/L
RGZO-1	6/19/2006	Water	Dissolved Phosphorus	0.024	mg/L
RGZO-1	7/28/2006	Water	Dissolved Phosphorus	0.012	mg/L
RGZO-1	8/30/2006	Water	Dissolved Phosphorus	0.014	mg/L
RGZO-1	10/26/2006	Water	Dissolved Phosphorus	0.018	mg/L
RGZO-2	5/15/2006	Water	Dissolved Phosphorus	0.013	mg/L
RGZO-2	6/19/2006	Water	Dissolved Phosphorus	0.018	mg/L
RGZO-2	7/28/2006	Water	Dissolved Phosphorus	0.011	mg/L
RGZO-2	8/30/2006	Water	Dissolved Phosphorus	0.013	mg/L
RGZO-2	10/26/2006	Water	Dissolved Phosphorus	0.028	mg/L
RGZO-3	5/15/2006	Water	Dissolved Phosphorus	0.025	mg/L
RGZO-3	6/19/2006	Water	Dissolved Phosphorus	0.025	mg/L
RGZO-3	7/28/2006	Water	Dissolved Phosphorus	0.01	mg/L

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RGZO-3	8/30/2006	Water	Dissolved Phosphorus	0.013	mg/L
RGZO-3	10/26/2006	Water	Dissolved Phosphorus	0.021	mg/L
RGZO-1	5/15/2006	Water	Nitrogen, ammonia (NH3) as NH3	ND	mg/L
RGZO-1	6/19/2006	Water	Nitrogen, ammonia (NH3) as NH3	ND	mg/L
RGZO-1	7/28/2006	Water	Nitrogen, ammonia (NH3) as NH3	ND	mg/L
RGZO-1	8/30/2006	Water	Nitrogen, ammonia (NH3) as NH3	ND	mg/L
RGZO-1	10/26/2006	Water	Nitrogen, ammonia (NH3) as NH3	ND	mg/L
RGZO-2	5/15/2006	Water	Nitrogen, ammonia (NH3) as NH3	ND	mg/L
RGZO-2	6/19/2006	Water	Nitrogen, ammonia (NH3) as NH3	0.027	mg/L
RGZO-2	7/28/2006	Water	Nitrogen, ammonia (NH3) as NH3	ND	mg/L
RGZO-2	8/30/2006	Water	Nitrogen, ammonia (NH3) as NH3	ND	mg/L
RGZO-2	10/26/2006	Water	Nitrogen, ammonia (NH3) as NH3	ND	mg/L
RGZO-3	5/15/2006	Water	Nitrogen, ammonia (NH3) as NH3	ND	mg/L
RGZO-3	6/19/2006	Water	Nitrogen, ammonia (NH3) as NH3	0.032	mg/L
RGZO-3	7/28/2006	Water	Nitrogen, ammonia (NH3) as NH3	ND	mg/L
RGZO-3	8/30/2006	Water	Nitrogen, ammonia (NH3) as NH3	ND	mg/L
RGZO-3	10/26/2006	Water	Nitrogen, ammonia (NH3) as NH3	ND	mg/L
RGZO-1	5/15/2006	Water	Nitrogen, Kjeldahl	1.1	mg/L
RGZO-1	6/19/2006	Water	Nitrogen, Kjeldahl	1.6	mg/L
RGZO-1	7/28/2006	Water	Nitrogen, Kjeldahl	1.67	mg/L
RGZO-1	8/30/2006	Water	Nitrogen, Kjeldahl	0.851	mg/L
RGZO-1	10/26/2006	Water	Nitrogen, Kjeldahl	1.26	mg/L
RGZO-2	5/15/2006	Water	Nitrogen, Kjeldahl	1.15	mg/L
RGZO-2	6/19/2006	Water	Nitrogen, Kjeldahl	1.54	mg/L
RGZO-2	7/28/2006	Water	Nitrogen, Kjeldahl	1.64	mg/L
RGZO-2	8/30/2006	Water	Nitrogen, Kjeldahl	1.47	mg/L
RGZO-2	10/26/2006	Water	Nitrogen, Kjeldahl	1.3	mg/L
RGZO-3	5/15/2006	Water	Nitrogen, Kjeldahl	0.899	mg/L
RGZO-3	6/19/2006	Water	Nitrogen, Kjeldahl	1.74	mg/L
RGZO-3	7/28/2006	Water	Nitrogen, Kjeldahl	1.72	mg/L
RGZO-3	8/30/2006	Water	Nitrogen, Kjeldahl	1.51	mg/L
RGZO-3	10/26/2006	Water	Nitrogen, Kjeldahl	0.807	mg/L
RGZO-1	5/15/2006	Water	Nitrogen, Nitrate + Nitrite	ND	mg/L
RGZO-1	6/19/2006	Water	Nitrogen, Nitrate + Nitrite	ND	mg/L
RGZO-1	7/28/2006	Water	Nitrogen, Nitrate + Nitrite	0.076	mg/L
RGZO-1	8/30/2006	Water	Nitrogen, Nitrate + Nitrite	ND	mg/L
RGZO-1	10/26/2006	Water	Nitrogen, Nitrate + Nitrite	ND	mg/L
RGZO-2	5/15/2006	Water	Nitrogen, Nitrate + Nitrite	0.032	mg/L
RGZO-2	6/19/2006	Water	Nitrogen, Nitrate + Nitrite	ND	mg/L
RGZO-2	7/28/2006	Water	Nitrogen, Nitrate + Nitrite	0.068	mg/L
RGZO-2	8/30/2006	Water	Nitrogen, Nitrate + Nitrite	ND	mg/L
RGZO-2	10/26/2006	Water	Nitrogen, Nitrate + Nitrite	ND	mg/L
RGZO-3	5/15/2006	Water	Nitrogen, Nitrate + Nitrite	0.023	mg/L
RGZO-3	6/19/2006	Water	Nitrogen, Nitrate + Nitrite	ND	mg/L
RGZO-3	7/28/2006	Water	Nitrogen, Nitrate + Nitrite	0.073	mg/L
RGZO-3	8/30/2006	Water	Nitrogen, Nitrate + Nitrite	ND	mg/L
RGZO-3	10/26/2006	Water	Nitrogen, Nitrate + Nitrite	ND	mg/L
RGZO-1	7/13/2001	Sediment	Carbon, Total Organic (Toc)	1.78	%
RGZO-3	7/13/2001	Sediment	Carbon, Total Organic (Toc)	0.43	%
RGZO-1	7/13/2001	Sediment	Depth	9	ft
RGZO-1	7/13/2001	Sediment	Depth	9	ft
RGZO-3	7/13/2001	Sediment	Depth	9	ft
RGZO-3	7/13/2001	Sediment	Depth	9	ft
RGZO-1	7/13/2001	Sediment	Nitrogen, Kjeldahl	8490	mg/kg
RGZO-3	7/13/2001	Sediment	Nitrogen, Kjeldahl	5550	mg/kg
RGZO-3	7/13/2001	Sediment	Total Phosphorus	553	mg/kg
RGZO-1	5/2/2001	Water	Chlorophyll (a+b+c)	250	ug/l
RGZO-1	6/8/2001	Water	Chlorophyll (a+b+c)	300	ug/l
RGZO-1	7/13/2001	Water	Chlorophyll (a+b+c)	150	ug/l
RGZO-1	9/7/2001	Water	Chlorophyll (a+b+c)	200	ug/l

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RGZO-1	10/12/2001	Water	Chlorophyll (a+b+c)	260	ug/l
RGZO-2	5/2/2001	Water	Chlorophyll (a+b+c)	250	ug/l
RGZO-2	6/8/2001	Water	Chlorophyll (a+b+c)	300	ug/l
RGZO-2	7/13/2001	Water	Chlorophyll (a+b+c)	150	ug/l
RGZO-2	9/7/2001	Water	Chlorophyll (a+b+c)	150	ug/l
RGZO-2	10/12/2001	Water	Chlorophyll (a+b+c)	240	ug/l
RGZO-3	5/2/2001	Water	Chlorophyll (a+b+c)	250	ug/l
RGZO-3	6/8/2001	Water	Chlorophyll (a+b+c)	300	ug/l
RGZO-3	7/13/2001	Water	Chlorophyll (a+b+c)	150	ug/l
RGZO-3	9/7/2001	Water	Chlorophyll (a+b+c)	150	ug/l
RGZO-3	10/12/2001	Water	Chlorophyll (a+b+c)	240	ug/l
RGZO-1	8/28/1992	Water	Chlorophyll a, Corrected	51.62	µg/L
RGZO-1	5/2/2001	Water	Chlorophyll a, Corrected	10	ug/l
RGZO-1	6/8/2001	Water	Chlorophyll a, Corrected	35.7	ug/l
RGZO-1	7/13/2001	Water	Chlorophyll a, Corrected	42.9	ug/l
RGZO-1	9/7/2001	Water	Chlorophyll a, Corrected	58.4	ug/l
RGZO-1	10/12/2001	Water	Chlorophyll a, Corrected	38.2	ug/l
RGZO-2	5/2/2001	Water	Chlorophyll a, Corrected	10	ug/l
RGZO-2	6/8/2001	Water	Chlorophyll a, Corrected	33.4	ug/l
RGZO-2	7/13/2001	Water	Chlorophyll a, Corrected	40.6	ug/l
RGZO-2	9/7/2001	Water	Chlorophyll a, Corrected	52.4	ug/l
RGZO-2	10/12/2001	Water	Chlorophyll a, Corrected	37.6	ug/l
RGZO-3	5/2/2001	Water	Chlorophyll a, Corrected	9.45	ug/l
RGZO-3	6/8/2001	Water	Chlorophyll a, Corrected	31.6	ug/l
RGZO-3	7/13/2001	Water	Chlorophyll a, Corrected	29.1	ug/l
RGZO-3	9/7/2001	Water	Chlorophyll a, Corrected	59.2	ug/l
RGZO-3	10/12/2001	Water	Chlorophyll a, Corrected	43.3	ug/l
RGZO-1	8/28/1992	Water	Chlorophyll a, uncorrected	52.6	µg/L
RGZO-1	5/2/2001	Water	Chlorophyll a, uncorrected	10.3	ug/l
RGZO-1	6/8/2001	Water	Chlorophyll a, uncorrected	42.5	ug/l
RGZO-1	7/13/2001	Water	Chlorophyll a, uncorrected	56.4	ug/l
RGZO-1	9/7/2001	Water	Chlorophyll a, uncorrected	60.8	ug/l
RGZO-1	10/12/2001	Water	Chlorophyll a, uncorrected	40.3	ug/l
RGZO-2	5/2/2001	Water	Chlorophyll a, uncorrected	10.8	ug/l
RGZO-2	6/8/2001	Water	Chlorophyll a, uncorrected	37.5	ug/l
RGZO-2	7/13/2001	Water	Chlorophyll a, uncorrected	43.8	ug/l
RGZO-2	9/7/2001	Water	Chlorophyll a, uncorrected	54.4	ug/l
RGZO-2	10/12/2001	Water	Chlorophyll a, uncorrected	38.6	ug/l
RGZO-3	5/2/2001	Water	Chlorophyll a, uncorrected	10	ug/l
RGZO-3	6/8/2001	Water	Chlorophyll a, uncorrected	33.6	ug/l
RGZO-3	7/13/2001	Water	Chlorophyll a, uncorrected	31.7	ug/l
RGZO-3	9/7/2001	Water	Chlorophyll a, uncorrected	61.4	ug/l
RGZO-3	10/12/2001	Water	Chlorophyll a, uncorrected	43.4	ug/l
RGZO-1	5/2/2001	Water	Chlorophyll-b	0	ug/l
RGZO-1	6/8/2001	Water	Chlorophyll-b	8.79	ug/l
RGZO-1	7/13/2001	Water	Chlorophyll-b	4.25	ug/l
RGZO-1	9/7/2001	Water	Chlorophyll-b		
RGZO-1	10/12/2001	Water	Chlorophyll-b		
RGZO-2	5/2/2001	Water	Chlorophyll-b	0.21	ug/l
RGZO-2	6/8/2001	Water	Chlorophyll-b	7.79	ug/l
RGZO-2	7/13/2001	Water	Chlorophyll-b	2.79	ug/l
RGZO-2	9/7/2001	Water	Chlorophyll-b		
RGZO-2	10/12/2001	Water	Chlorophyll-b		
RGZO-3	5/2/2001	Water	Chlorophyll-b	0.57	ug/l
RGZO-3	6/8/2001	Water	Chlorophyll-b	6.9	ug/l
RGZO-3	7/13/2001	Water	Chlorophyll-b	2.39	ug/l
RGZO-3	9/7/2001	Water	Chlorophyll-b		
RGZO-3	10/12/2001	Water	Chlorophyll-b		
RGZO-1	5/2/2001	Water	Chlorophyll-c	1.33	ug/l
RGZO-1	6/8/2001	Water	Chlorophyll-c	5.42	ug/l

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RGZO-1	7/13/2001	Water	Chlorophyll-c	3.19	ug/l
RGZO-1	9/7/2001	Water	Chlorophyll-c	2.25	ug/l
RGZO-1	10/12/2001	Water	Chlorophyll-c	3.71	ug/l
RGZO-2	5/2/2001	Water	Chlorophyll-c	1.14	ug/l
RGZO-2	6/8/2001	Water	Chlorophyll-c	2.43	ug/l
RGZO-2	7/13/2001	Water	Chlorophyll-c	2.74	ug/l
RGZO-2	9/7/2001	Water	Chlorophyll-c	1.04	ug/l
RGZO-2	10/12/2001	Water	Chlorophyll-c	4	ug/l
RGZO-3	5/2/2001	Water	Chlorophyll-c	1.41	ug/l
RGZO-3	6/8/2001	Water	Chlorophyll-c	2.08	ug/l
RGZO-3	7/13/2001	Water	Chlorophyll-c	1.58	ug/l
RGZO-3	9/7/2001	Water	Chlorophyll-c	1.64	ug/l
RGZO-3	10/12/2001	Water	Chlorophyll-c	4.09	ug/l
RGZO-1	6/8/2001	Water	Depth	0	
RGZO-1	6/8/2001	Water	Depth	1	
RGZO-1	6/8/2001	Water	Depth	3	
RGZO-1	6/8/2001	Water	Depth	5	
RGZO-1	6/8/2001	Water	Depth	7	
RGZO-1	7/13/2001	Water	Depth	0	
RGZO-1	7/13/2001	Water	Depth	1	
RGZO-1	7/13/2001	Water	Depth	3	
RGZO-1	7/13/2001	Water	Depth	5	
RGZO-1	7/13/2001	Water	Depth	7	
RGZO-1	9/7/2001	Water	Depth	0	
RGZO-1	9/7/2001	Water	Depth	1	
RGZO-1	9/7/2001	Water	Depth	3	
RGZO-1	9/7/2001	Water	Depth	5	
RGZO-1	9/7/2001	Water	Depth	6.5	
RGZO-1	10/12/2001	Water	Depth	0	
RGZO-1	10/12/2001	Water	Depth	1	
RGZO-1	10/12/2001	Water	Depth	3	
RGZO-1	10/12/2001	Water	Depth	5	
RGZO-1	10/12/2001	Water	Depth	7	
RGZO-1	10/12/2001	Water	Depth	9	
RGZO-1	5/2/2001	Water	Depth	1	ft
RGZO-1	5/2/2001	Water	Depth	1	ft
RGZO-1	6/8/2001	Water	Depth	4	ft
RGZO-1	6/8/2001	Water	Depth	1	ft
RGZO-1	7/13/2001	Water	Depth	1	ft
RGZO-1	7/13/2001	Water	Depth	3	ft
RGZO-1	9/7/2001	Water	Depth	1	ft
RGZO-1	9/7/2001	Water	Depth	3	ft
RGZO-1	10/12/2001	Water	Depth	1	ft
RGZO-1	10/12/2001	Water	Depth	4.5	ft
RGZO-2	6/8/2001	Water	Depth	0	
RGZO-2	6/8/2001	Water	Depth	1	
RGZO-2	6/8/2001	Water	Depth	3	
RGZO-2	6/8/2001	Water	Depth	5	
RGZO-2	7/13/2001	Water	Depth	0	
RGZO-2	7/13/2001	Water	Depth	1	
RGZO-2	7/13/2001	Water	Depth	3	
RGZO-2	7/13/2001	Water	Depth	5	
RGZO-2	9/7/2001	Water	Depth	0	
RGZO-2	9/7/2001	Water	Depth	1	
RGZO-2	9/7/2001	Water	Depth	3	
RGZO-2	9/7/2001	Water	Depth	4	
RGZO-2	10/12/2001	Water	Depth	0	
RGZO-2	10/12/2001	Water	Depth	1	
RGZO-2	10/12/2001	Water	Depth	3	
RGZO-2	10/12/2001	Water	Depth	5	

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RGZO-2	5/2/2001	Water	Depth	1	ft
RGZO-2	5/2/2001	Water	Depth	1	ft
RGZO-2	6/8/2001	Water	Depth	4	ft
RGZO-2	6/8/2001	Water	Depth	1	ft
RGZO-2	7/13/2001	Water	Depth	1	ft
RGZO-2	7/13/2001	Water	Depth	2	ft
RGZO-2	9/7/2001	Water	Depth	2	ft
RGZO-2	9/7/2001	Water	Depth	1	ft
RGZO-2	10/12/2001	Water	Depth	1	ft
RGZO-2	10/12/2001	Water	Depth	4	ft
RGZO-3	6/8/2001	Water	Depth	0	
RGZO-3	6/8/2001	Water	Depth	1	
RGZO-3	6/8/2001	Water	Depth	3	
RGZO-3	6/8/2001	Water	Depth	5	
RGZO-3	6/8/2001	Water	Depth	6	
RGZO-3	7/13/2001	Water	Depth	0	
RGZO-3	7/13/2001	Water	Depth	1	
RGZO-3	7/13/2001	Water	Depth	3	
RGZO-3	7/13/2001	Water	Depth	5	
RGZO-3	7/13/2001	Water	Depth	7	
RGZO-3	9/7/2001	Water	Depth	0	
RGZO-3	9/7/2001	Water	Depth	1	
RGZO-3	9/7/2001	Water	Depth	3	
RGZO-3	9/7/2001	Water	Depth	5	
RGZO-3	10/12/2001	Water	Depth	0	
RGZO-3	10/12/2001	Water	Depth	1	
RGZO-3	10/12/2001	Water	Depth	3	
RGZO-3	10/12/2001	Water	Depth	5	
RGZO-3	10/12/2001	Water	Depth	7	
RGZO-3	5/2/2001	Water	Depth	1	ft
RGZO-3	5/2/2001	Water	Depth	1	ft
RGZO-3	6/8/2001	Water	Depth	1	ft
RGZO-3	6/8/2001	Water	Depth	4	ft
RGZO-3	7/13/2001	Water	Depth	1	ft
RGZO-3	7/13/2001	Water	Depth	2	ft
RGZO-3	9/7/2001	Water	Depth	1	ft
RGZO-3	9/7/2001	Water	Depth	3	ft
RGZO-3	10/12/2001	Water	Depth	1	ft
RGZO-3	10/12/2001	Water	Depth	4	ft
RGZO-1	5/2/2001	Water	Depth, bottom	9	ft
RGZO-1	6/8/2001	Water	Depth, bottom	9	ft
RGZO-1	7/13/2001	Water	Depth, bottom	9	ft
RGZO-1	9/7/2001	Water	Depth, bottom	8.5	ft
RGZO-1	10/12/2001	Water	Depth, bottom	10	ft
RGZO-2	5/2/2001	Water	Depth, bottom	7	ft
RGZO-2	6/8/2001	Water	Depth, bottom	7	ft
RGZO-2	7/13/2001	Water	Depth, bottom	7	ft
RGZO-2	9/7/2001	Water	Depth, bottom	6	ft
RGZO-2	10/12/2001	Water	Depth, bottom	6	ft
RGZO-3	5/2/2001	Water	Depth, bottom	8	ft
RGZO-3	6/8/2001	Water	Depth, bottom	8	ft
RGZO-3	7/13/2001	Water	Depth, bottom	9	ft
RGZO-3	9/7/2001	Water	Depth, bottom	7	ft
RGZO-3	10/12/2001	Water	Depth, bottom	9	ft
RGZO-1	8/28/1992	Water	Dissolved Oxygen	5.8	mg/l
RGZO-1	8/28/1992	Water	Dissolved Oxygen	5.7	mg/l
RGZO-1	8/28/1992	Water	Dissolved Oxygen	5.7	mg/l
RGZO-1	8/28/1992	Water	Dissolved Oxygen	5.6	mg/l
RGZO-1	8/28/1992	Water	Dissolved Oxygen	5.6	mg/l
RGZO-1	8/28/1992	Water	Dissolved Oxygen	5.3	mg/l

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RGZO-1	8/28/1992	Water	Dissolved Oxygen	5	mg/l
RGZO-1	8/28/1992	Water	Dissolved Oxygen	4.5	mg/l
RGZO-1	8/28/1992	Water	Dissolved Oxygen	4.4	mg/l
RGZO-1	6/8/2001	Water	Dissolved Oxygen	12	
RGZO-1	6/8/2001	Water	Dissolved Oxygen	12.9	
RGZO-1	6/8/2001	Water	Dissolved Oxygen	11.2	
RGZO-1	6/8/2001	Water	Dissolved Oxygen	9	
RGZO-1	6/8/2001	Water	Dissolved Oxygen	5	
RGZO-1	7/13/2001	Water	Dissolved Oxygen	8.6	
RGZO-1	7/13/2001	Water	Dissolved Oxygen	7.9	
RGZO-1	7/13/2001	Water	Dissolved Oxygen	7.3	
RGZO-1	7/13/2001	Water	Dissolved Oxygen	6.1	
RGZO-1	7/13/2001	Water	Dissolved Oxygen	3.1	
RGZO-1	9/7/2001	Water	Dissolved Oxygen	8.6	
RGZO-1	9/7/2001	Water	Dissolved Oxygen	8	
RGZO-1	9/7/2001	Water	Dissolved Oxygen	7.2	
RGZO-1	9/7/2001	Water	Dissolved Oxygen	4.3	
RGZO-1	9/7/2001	Water	Dissolved Oxygen	2.5	
RGZO-1	10/12/2001	Water	Dissolved Oxygen	10.2	
RGZO-1	10/12/2001	Water	Dissolved Oxygen	10.1	
RGZO-1	10/12/2001	Water	Dissolved Oxygen	9.6	
RGZO-1	10/12/2001	Water	Dissolved Oxygen	9	
RGZO-1	10/12/2001	Water	Dissolved Oxygen	7.6	
RGZO-1	10/12/2001	Water	Dissolved Oxygen	6.5	
RGZO-2	6/8/2001	Water	Dissolved Oxygen	11.9	
RGZO-2	6/8/2001	Water	Dissolved Oxygen	12	
RGZO-2	6/8/2001	Water	Dissolved Oxygen	12.3	
RGZO-2	6/8/2001	Water	Dissolved Oxygen	10.8	
RGZO-2	7/13/2001	Water	Dissolved Oxygen	6.8	
RGZO-2	7/13/2001	Water	Dissolved Oxygen	6.7	
RGZO-2	7/13/2001	Water	Dissolved Oxygen	6.3	
RGZO-2	7/13/2001	Water	Dissolved Oxygen	5.9	
RGZO-2	9/7/2001	Water	Dissolved Oxygen	6.5	
RGZO-2	9/7/2001	Water	Dissolved Oxygen	6.4	
RGZO-2	9/7/2001	Water	Dissolved Oxygen	6.3	
RGZO-2	9/7/2001	Water	Dissolved Oxygen	6.2	
RGZO-2	10/12/2001	Water	Dissolved Oxygen	9.7	
RGZO-2	10/12/2001	Water	Dissolved Oxygen	9.7	
RGZO-2	10/12/2001	Water	Dissolved Oxygen	9.5	
RGZO-2	10/12/2001	Water	Dissolved Oxygen	8.6	
RGZO-3	6/8/2001	Water	Dissolved Oxygen	13.5	
RGZO-3	6/8/2001	Water	Dissolved Oxygen	12.7	
RGZO-3	6/8/2001	Water	Dissolved Oxygen	12.3	
RGZO-3	6/8/2001	Water	Dissolved Oxygen	6.3	
RGZO-3	6/8/2001	Water	Dissolved Oxygen	3.9	
RGZO-3	7/13/2001	Water	Dissolved Oxygen	6.8	
RGZO-3	7/13/2001	Water	Dissolved Oxygen	6.7	
RGZO-3	7/13/2001	Water	Dissolved Oxygen	6.7	
RGZO-3	7/13/2001	Water	Dissolved Oxygen	6.6	
RGZO-3	7/13/2001	Water	Dissolved Oxygen	4.3	
RGZO-3	9/7/2001	Water	Dissolved Oxygen	9.2	
RGZO-3	9/7/2001	Water	Dissolved Oxygen	8.1	
RGZO-3	9/7/2001	Water	Dissolved Oxygen	8	
RGZO-3	9/7/2001	Water	Dissolved Oxygen	7.8	
RGZO-3	10/12/2001	Water	Dissolved Oxygen	9.6	
RGZO-3	10/12/2001	Water	Dissolved Oxygen	9.5	
RGZO-3	10/12/2001	Water	Dissolved Oxygen	9.4	
RGZO-3	10/12/2001	Water	Dissolved Oxygen	9.2	
RGZO-3	10/12/2001	Water	Dissolved Oxygen	8.8	
RGZO-1	8/28/1992	Water	Dissolved Phosphorus	0.014	mg/l

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RGZO-1	5/2/2001	Water	Dissolved Phosphorus	0.019	mg/l
RGZO-1	6/8/2001	Water	Dissolved Phosphorus	0.018	mg/l
RGZO-1	7/13/2001	Water	Dissolved Phosphorus	0.017	mg/l
RGZO-1	9/7/2001	Water	Dissolved Phosphorus	0.011	mg/l
RGZO-1	10/12/2001	Water	Dissolved Phosphorus	0.016	mg/l
RGZO-2	5/2/2001	Water	Dissolved Phosphorus	0.019	mg/l
RGZO-2	6/8/2001	Water	Dissolved Phosphorus	0.015	mg/l
RGZO-2	7/13/2001	Water	Dissolved Phosphorus	0.105	mg/l
RGZO-2	9/7/2001	Water	Dissolved Phosphorus	0.014	mg/l
RGZO-2	10/12/2001	Water	Dissolved Phosphorus	0.012	mg/l
RGZO-3	5/2/2001	Water	Dissolved Phosphorus	0.022	mg/l
RGZO-3	6/8/2001	Water	Dissolved Phosphorus	0.019	mg/l
RGZO-3	7/13/2001	Water	Dissolved Phosphorus	0.011	mg/l
RGZO-3	9/7/2001	Water	Dissolved Phosphorus	0.013	mg/l
RGZO-3	10/12/2001	Water	Dissolved Phosphorus	0.013	mg/l
RGZO-1	5/2/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.12	mg/l
RGZO-1	6/8/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.03	mg/l
RGZO-1	7/13/2001	Water	Nitrogen, ammonia (NH3) as NH3		
RGZO-1	9/7/2001	Water	Nitrogen, ammonia (NH3) as NH3		
RGZO-1	10/12/2001	Water	Nitrogen, ammonia (NH3) as NH3		
RGZO-2	5/2/2001	Water	Nitrogen, ammonia (NH3) as NH3		
RGZO-2	6/8/2001	Water	Nitrogen, ammonia (NH3) as NH3		
RGZO-2	7/13/2001	Water	Nitrogen, ammonia (NH3) as NH3		
RGZO-2	9/7/2001	Water	Nitrogen, ammonia (NH3) as NH3		
RGZO-2	10/12/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.2	mg/l
RGZO-3	5/2/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.1	mg/l
RGZO-3	6/8/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.05	mg/l
RGZO-3	7/13/2001	Water	Nitrogen, ammonia (NH3) as NH3		
RGZO-3	9/7/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.02	mg/l
RGZO-3	10/12/2001	Water	Nitrogen, ammonia (NH3) as NH3		
RGZO-1	5/2/2001	Water	Nitrogen, Kjeldahl	1.22	mg/l
RGZO-1	6/8/2001	Water	Nitrogen, Kjeldahl	1.15	mg/l
RGZO-1	7/13/2001	Water	Nitrogen, Kjeldahl	1.77	mg/l
RGZO-1	9/7/2001	Water	Nitrogen, Kjeldahl	1.34	mg/l
RGZO-1	10/12/2001	Water	Nitrogen, Kjeldahl	1.19	mg/l
RGZO-2	5/2/2001	Water	Nitrogen, Kjeldahl	0.94	mg/l
RGZO-2	6/8/2001	Water	Nitrogen, Kjeldahl	1.19	mg/l
RGZO-2	7/13/2001	Water	Nitrogen, Kjeldahl	1.02	mg/l
RGZO-2	9/7/2001	Water	Nitrogen, Kjeldahl	1.67	mg/l
RGZO-2	10/12/2001	Water	Nitrogen, Kjeldahl	1.54	mg/l
RGZO-3	5/2/2001	Water	Nitrogen, Kjeldahl	1.03	mg/l
RGZO-3	6/8/2001	Water	Nitrogen, Kjeldahl	1.03	mg/l
RGZO-3	7/13/2001	Water	Nitrogen, Kjeldahl	1	mg/l
RGZO-3	9/7/2001	Water	Nitrogen, Kjeldahl	1.41	mg/l
RGZO-3	10/12/2001	Water	Nitrogen, Kjeldahl	1.71	mg/l
RGZO-1	5/2/2001	Water	Nitrogen, Nitrate + Nitrite	0.01	mg/l
RGZO-1	6/8/2001	Water	Nitrogen, Nitrate + Nitrite	0.11	mg/l
RGZO-1	7/13/2001	Water	Nitrogen, Nitrate + Nitrite	0.02	mg/l
RGZO-1	9/7/2001	Water	Nitrogen, Nitrate + Nitrite		
RGZO-1	10/12/2001	Water	Nitrogen, Nitrate + Nitrite		
RGZO-2	5/2/2001	Water	Nitrogen, Nitrate + Nitrite		
RGZO-2	6/8/2001	Water	Nitrogen, Nitrate + Nitrite	0.1	mg/l
RGZO-2	7/13/2001	Water	Nitrogen, Nitrate + Nitrite	0.02	mg/l
RGZO-2	9/7/2001	Water	Nitrogen, Nitrate + Nitrite		
RGZO-2	10/12/2001	Water	Nitrogen, Nitrate + Nitrite	0.02	mg/l
RGZO-3	5/2/2001	Water	Nitrogen, Nitrate + Nitrite	0.01	mg/l
RGZO-3	6/8/2001	Water	Nitrogen, Nitrate + Nitrite	0.11	mg/l
RGZO-3	7/13/2001	Water	Nitrogen, Nitrate + Nitrite	0.02	mg/l
RGZO-3	9/7/2001	Water	Nitrogen, Nitrate + Nitrite		
RGZO-3	10/12/2001	Water	Nitrogen, Nitrate + Nitrite		

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RGZO-1	8/28/1992	Water	Temperature, Water	21	deg C
RGZO-1	8/28/1992	Water	Temperature, Water	20.8	deg C
RGZO-1	8/28/1992	Water	Temperature, Water	20.8	deg C
RGZO-1	8/28/1992	Water	Temperature, Water	20.7	deg C
RGZO-1	8/28/1992	Water	Temperature, Water	20.7	deg C
RGZO-1	8/28/1992	Water	Temperature, Water	20.7	deg C
RGZO-1	8/28/1992	Water	Temperature, Water	20.4	deg C
RGZO-1	8/28/1992	Water	Temperature, Water	20.3	deg C
RGZO-1	8/28/1992	Water	Temperature, Water	20.3	deg C
RGZO-1	6/8/2001	Water	Temperature, Water	20.6	
RGZO-1	6/8/2001	Water	Temperature, Water	18.6	
RGZO-1	6/8/2001	Water	Temperature, Water	16.8	
RGZO-1	6/8/2001	Water	Temperature, Water	16.1	
RGZO-1	6/8/2001	Water	Temperature, Water	15.3	
RGZO-1	7/13/2001	Water	Temperature, Water	29.2	
RGZO-1	7/13/2001	Water	Temperature, Water	28.3	
RGZO-1	7/13/2001	Water	Temperature, Water	26.8	
RGZO-1	7/13/2001	Water	Temperature, Water	26.2	
RGZO-1	7/13/2001	Water	Temperature, Water	24.4	
RGZO-1	9/7/2001	Water	Temperature, Water	25.4	
RGZO-1	9/7/2001	Water	Temperature, Water	25.3	
RGZO-1	9/7/2001	Water	Temperature, Water	25	
RGZO-1	9/7/2001	Water	Temperature, Water	24.4	
RGZO-1	9/7/2001	Water	Temperature, Water	23.9	
RGZO-1	10/12/2001	Water	Temperature, Water	15.2	
RGZO-1	10/12/2001	Water	Temperature, Water	15.2	
RGZO-1	10/12/2001	Water	Temperature, Water	16	
RGZO-1	10/12/2001	Water	Temperature, Water	14.7	
RGZO-1	10/12/2001	Water	Temperature, Water	14.4	
RGZO-1	10/12/2001	Water	Temperature, Water	14.2	
RGZO-2	6/8/2001	Water	Temperature, Water	19	
RGZO-2	6/8/2001	Water	Temperature, Water	18.3	
RGZO-2	6/8/2001	Water	Temperature, Water	16.8	
RGZO-2	6/8/2001	Water	Temperature, Water	16.1	
RGZO-2	7/13/2001	Water	Temperature, Water	26.4	
RGZO-2	7/13/2001	Water	Temperature, Water	26.3	
RGZO-2	7/13/2001	Water	Temperature, Water	26.2	
RGZO-2	7/13/2001	Water	Temperature, Water	25.9	
RGZO-2	9/7/2001	Water	Temperature, Water	24.8	
RGZO-2	9/7/2001	Water	Temperature, Water	24.7	
RGZO-2	9/7/2001	Water	Temperature, Water	24.7	
RGZO-2	9/7/2001	Water	Temperature, Water	24.7	
RGZO-2	10/12/2001	Water	Temperature, Water	14.8	
RGZO-2	10/12/2001	Water	Temperature, Water	14.7	
RGZO-2	10/12/2001	Water	Temperature, Water	14.6	
RGZO-2	10/12/2001	Water	Temperature, Water	14.2	
RGZO-3	6/8/2001	Water	Temperature, Water	19.1	
RGZO-3	6/8/2001	Water	Temperature, Water	18.8	
RGZO-3	6/8/2001	Water	Temperature, Water	17.3	
RGZO-3	6/8/2001	Water	Temperature, Water	15.6	
RGZO-3	6/8/2001	Water	Temperature, Water	15.3	
RGZO-3	7/13/2001	Water	Temperature, Water	26.2	
RGZO-3	7/13/2001	Water	Temperature, Water	26.2	
RGZO-3	7/13/2001	Water	Temperature, Water	26.1	
RGZO-3	7/13/2001	Water	Temperature, Water	26	
RGZO-3	7/13/2001	Water	Temperature, Water	25.9	
RGZO-3	9/7/2001	Water	Temperature, Water	24.8	
RGZO-3	9/7/2001	Water	Temperature, Water	24.8	
RGZO-3	9/7/2001	Water	Temperature, Water	24.8	
RGZO-3	9/7/2001	Water	Temperature, Water	24.7	

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RGZO-3	10/12/2001	Water	Temperature, Water	14.5	
RGZO-3	10/12/2001	Water	Temperature, Water	14.5	
RGZO-3	10/12/2001	Water	Temperature, Water	14.5	
RGZO-3	10/12/2001	Water	Temperature, Water	14.2	
RGZO-3	10/12/2001	Water	Temperature, Water	14.2	
RGZO-1	8/28/1992	Water	Total Phosphorus	0.107	mg/l
RGZO-1	5/15/2006	Water	Total Phosphorus	0.075	mg/L
RGZO-1	6/19/2006	Water	Total Phosphorus	0.079	mg/L
RGZO-1	7/28/2006	Water	Total Phosphorus	0.063	mg/L
RGZO-1	8/30/2006	Water	Total Phosphorus	0.103	mg/L
RGZO-1	10/26/2006	Water	Total Phosphorus	0.052	mg/L
RGZO-1	5/2/2001	Water	Total Phosphorus	0.04	mg/l
RGZO-1	6/8/2001	Water	Total Phosphorus	0.054	mg/l
RGZO-1	7/13/2001	Water	Total Phosphorus	0.137	mg/l
RGZO-1	7/13/2001	Water	Total Phosphorus	662	mg/kg
RGZO-1	9/7/2001	Water	Total Phosphorus	0.086	mg/l
RGZO-1	10/12/2001	Water	Total Phosphorus	0.064	mg/l
RGZO-2	5/15/2006	Water	Total Phosphorus	0.076	mg/L
RGZO-2	6/19/2006	Water	Total Phosphorus	0.078	mg/L
RGZO-2	7/28/2006	Water	Total Phosphorus	0.066	mg/L
RGZO-2	8/30/2006	Water	Total Phosphorus	0.113	mg/L
RGZO-2	10/26/2006	Water	Total Phosphorus	0.056	mg/L
RGZO-2	5/2/2001	Water	Total Phosphorus	0.037	mg/l
RGZO-2	6/8/2001	Water	Total Phosphorus	0.049	mg/l
RGZO-2	7/13/2001	Water	Total Phosphorus	0.103	mg/l
RGZO-2	9/7/2001	Water	Total Phosphorus	0.105	mg/l
RGZO-2	10/12/2001	Water	Total Phosphorus	0.069	mg/l
RGZO-3	5/15/2006	Water	Total Phosphorus	0.075	mg/L
RGZO-3	6/19/2006	Water	Total Phosphorus	0.088	mg/L
RGZO-3	7/28/2006	Water	Total Phosphorus	0.068	mg/L
RGZO-3	8/30/2006	Water	Total Phosphorus	0.127	mg/L
RGZO-3	10/26/2006	Water	Total Phosphorus	0.071	mg/L
RGZO-3	5/2/2001	Water	Total Phosphorus	0.048	mg/l
RGZO-3	6/8/2001	Water	Total Phosphorus	0.043	mg/l
RGZO-3	7/13/2001	Water	Total Phosphorus	0.111	mg/l
RGZO-3	9/7/2001	Water	Total Phosphorus	0.101	mg/l
RGZO-3	10/12/2001	Water	Total Phosphorus	0.071	mg/l
RGZO-1	5/15/2006	Water	Dissolved Oxygen	9.8	
RGZO-1	5/15/2006	Water	Dissolved Oxygen	9.9	
RGZO-1	5/15/2006	Water	Dissolved Oxygen	9.5	
RGZO-1	6/19/2006	Water	Dissolved Oxygen	8.1	
RGZO-1	6/19/2006	Water	Dissolved Oxygen	7.5	
RGZO-1	6/19/2006	Water	Dissolved Oxygen	5.5	
RGZO-1	6/19/2006	Water	Dissolved Oxygen	3.8	
RGZO-1	7/28/2006	Water	Dissolved Oxygen	8.6	
RGZO-1	7/28/2006	Water	Dissolved Oxygen	8.1	
RGZO-1	7/28/2006	Water	Dissolved Oxygen	6.6	
RGZO-1	7/28/2006	Water	Dissolved Oxygen	4.7	
RGZO-1	8/30/2006	Water	Dissolved Oxygen	5.8	
RGZO-1	8/30/2006	Water	Dissolved Oxygen	5.5	
RGZO-1	8/30/2006	Water	Dissolved Oxygen	5.4	
RGZO-1	8/30/2006	Water	Dissolved Oxygen	5.2	
RGZO-1	8/30/2006	Water	Dissolved Oxygen	4.2	
RGZO-1	10/26/2006	Water	Dissolved Oxygen	7.8	
RGZO-1	10/26/2006	Water	Dissolved Oxygen	7.8	
RGZO-1	10/26/2006	Water	Dissolved Oxygen	7.7	
RGZO-1	10/26/2006	Water	Dissolved Oxygen	7.6	
RGZO-1	10/26/2006	Water	Dissolved Oxygen	7.6	
RGZO-2	5/15/2006	Water	Dissolved Oxygen	9.5	
RGZO-2	5/15/2006	Water	Dissolved Oxygen	9.4	

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RGZO-2	5/15/2006	Water	Dissolved Oxygen	9.2	
RGZO-2	6/19/2006	Water	Dissolved Oxygen	6.5	
RGZO-2	6/19/2006	Water	Dissolved Oxygen	6.5	
RGZO-2	6/19/2006	Water	Dissolved Oxygen	6.4	
RGZO-2	6/19/2006	Water	Dissolved Oxygen	6.3	
RGZO-2	7/28/2006	Water	Dissolved Oxygen	8.6	
RGZO-2	7/28/2006	Water	Dissolved Oxygen	8.8	
RGZO-2	7/28/2006	Water	Dissolved Oxygen	5.7	
RGZO-2	7/28/2006	Water	Dissolved Oxygen	4.5	
RGZO-2	8/30/2006	Water	Dissolved Oxygen	7.1	
RGZO-2	8/30/2006	Water	Dissolved Oxygen	6.3	
RGZO-2	8/30/2006	Water	Dissolved Oxygen	6.2	
RGZO-2	8/30/2006	Water	Dissolved Oxygen	5.9	
RGZO-2	10/26/2006	Water	Dissolved Oxygen	8.6	
RGZO-2	10/26/2006	Water	Dissolved Oxygen	8.6	
RGZO-3	5/15/2006	Water	Dissolved Oxygen	10.2	
RGZO-3	5/15/2006	Water	Dissolved Oxygen	9.9	
RGZO-3	5/15/2006	Water	Dissolved Oxygen	9.8	
RGZO-3	5/15/2006	Water	Dissolved Oxygen	9.7	
RGZO-3	6/19/2006	Water	Dissolved Oxygen	7.5	
RGZO-3	6/19/2006	Water	Dissolved Oxygen	7.4	
RGZO-3	6/19/2006	Water	Dissolved Oxygen	7.2	
RGZO-3	6/19/2006	Water	Dissolved Oxygen	6.9	
RGZO-3	7/28/2006	Water	Dissolved Oxygen	8.3	
RGZO-3	7/28/2006	Water	Dissolved Oxygen	8.1	
RGZO-3	7/28/2006	Water	Dissolved Oxygen	6.3	
RGZO-3	7/28/2006	Water	Dissolved Oxygen	5	
RGZO-3	8/30/2006	Water	Dissolved Oxygen	6	
RGZO-3	8/30/2006	Water	Dissolved Oxygen	5.8	
RGZO-3	8/30/2006	Water	Dissolved Oxygen	5.5	
RGZO-3	8/30/2006	Water	Dissolved Oxygen	4.4	
RGZO-3	10/26/2006	Water	Dissolved Oxygen	9.1	
RGZO-3	10/26/2006	Water	Dissolved Oxygen	9.1	
RGZO-3	10/26/2006	Water	Dissolved Oxygen	9	
RGZO-3	10/26/2006	Water	Dissolved Oxygen	9	
RGZO-1	5/15/2006	Water	Temperature, Water	13.5	
RGZO-1	5/15/2006	Water	Temperature, Water	13.4	
RGZO-1	5/15/2006	Water	Temperature, Water	13.4	
RGZO-1	6/19/2006	Water	Temperature, Water	24.5	
RGZO-1	6/19/2006	Water	Temperature, Water	24.4	
RGZO-1	6/19/2006	Water	Temperature, Water	23.5	
RGZO-1	6/19/2006	Water	Temperature, Water	23.1	
RGZO-1	7/28/2006	Water	Temperature, Water	27.3	
RGZO-1	7/28/2006	Water	Temperature, Water	27	
RGZO-1	7/28/2006	Water	Temperature, Water	26.1	
RGZO-1	7/28/2006	Water	Temperature, Water	25.8	
RGZO-1	8/30/2006	Water	Temperature, Water	22.1	
RGZO-1	8/30/2006	Water	Temperature, Water	22.1	
RGZO-1	8/30/2006	Water	Temperature, Water	22	
RGZO-1	8/30/2006	Water	Temperature, Water	21.9	
RGZO-1	8/30/2006	Water	Temperature, Water	21.9	
RGZO-1	10/26/2006	Water	Temperature, Water	7.6	
RGZO-1	10/26/2006	Water	Temperature, Water	7.6	
RGZO-1	10/26/2006	Water	Temperature, Water	7.6	
RGZO-1	10/26/2006	Water	Temperature, Water	7.6	
RGZO-1	10/26/2006	Water	Temperature, Water	7.6	
RGZO-2	5/15/2006	Water	Temperature, Water	12.8	
RGZO-2	5/15/2006	Water	Temperature, Water	12.7	
RGZO-2	5/15/2006	Water	Temperature, Water	12.7	
RGZO-2	6/19/2006	Water	Temperature, Water	24.8	

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RGZO-2	6/19/2006	Water	Temperature, Water	24.8	
RGZO-2	6/19/2006	Water	Temperature, Water	24.8	
RGZO-2	6/19/2006	Water	Temperature, Water	24.8	
RGZO-2	7/28/2006	Water	Temperature, Water	29.3	
RGZO-2	7/28/2006	Water	Temperature, Water	29	
RGZO-2	7/28/2006	Water	Temperature, Water	26.6	
RGZO-2	7/28/2006	Water	Temperature, Water	26.5	
RGZO-2	8/30/2006	Water	Temperature, Water	22.3	
RGZO-2	8/30/2006	Water	Temperature, Water	22.3	
RGZO-2	8/30/2006	Water	Temperature, Water	22.3	
RGZO-2	8/30/2006	Water	Temperature, Water	22.2	
RGZO-2	10/26/2006	Water	Temperature, Water	7.8	
RGZO-2	10/26/2006	Water	Temperature, Water	7.8	
RGZO-3	5/15/2006	Water	Temperature, Water	13	
RGZO-3	5/15/2006	Water	Temperature, Water	13	
RGZO-3	5/15/2006	Water	Temperature, Water	12.9	
RGZO-3	5/15/2006	Water	Temperature, Water	12.9	
RGZO-3	6/19/2006	Water	Temperature, Water	24.8	
RGZO-3	6/19/2006	Water	Temperature, Water	24.7	
RGZO-3	6/19/2006	Water	Temperature, Water	24.7	
RGZO-3	6/19/2006	Water	Temperature, Water	24.7	
RGZO-3	7/28/2006	Water	Temperature, Water	28.8	
RGZO-3	7/28/2006	Water	Temperature, Water	28.2	
RGZO-3	7/28/2006	Water	Temperature, Water	26.6	
RGZO-3	7/28/2006	Water	Temperature, Water	26.4	
RGZO-3	8/30/2006	Water	Temperature, Water	22.2	
RGZO-3	8/30/2006	Water	Temperature, Water	22.2	
RGZO-3	8/30/2006	Water	Temperature, Water	22.2	
RGZO-3	8/30/2006	Water	Temperature, Water	22.1	
RGZO-3	10/26/2006	Water	Temperature, Water	7.3	
RGZO-3	10/26/2006	Water	Temperature, Water	7.3	
RGZO-3	10/26/2006	Water	Temperature, Water	7.3	
RGZO-3	10/26/2006	Water	Temperature, Water	7.3	
RHH-1	09/06/2001	Sediment	Carbon, Total Organic (Toc)	2.8	mg/L
RHH-3	09/06/2001	Sediment	Carbon, Total Organic (Toc)	4.8	mg/L
RHH-1	05/10/2001	Water	Chlorophyll (a+b+c)	102	ug/l
RHH-2	05/10/2001	Water	Chlorophyll (a+b+c)	100	ug/l
RHH-3	05/10/2001	Water	Chlorophyll (a+b+c)	94	ug/l
RHH-1	06/11/2001	Water	Chlorophyll (a+b+c)	164	ug/l
RHH-3	06/11/2001	Water	Chlorophyll (a+b+c)	200	ug/l
RHH-1	08/06/2001	Water	Chlorophyll (a+b+c)	300	ug/l
RHH-2	08/06/2001	Water	Chlorophyll (a+b+c)	200	ug/l
RHH-3	08/06/2001	Water	Chlorophyll (a+b+c)	250	ug/l
RHH-1	09/06/2001	Water	Chlorophyll (a+b+c)	200	ug/l
RHH-3	09/06/2001	Water	Chlorophyll (a+b+c)	100	ug/l
RHH-1	11/02/2001	Water	Chlorophyll (a+b+c)	130	ug/l
RHH-3	11/02/2001	Water	Chlorophyll (a+b+c)	140	ug/l
RHH-2	11/02/2001	Water	Chlorophyll (a+b+c)	170	ug/l
RHH-2	5/10/2001		CHLOROPHYLL (A+B+C),Filterable	100	ug/l
RHH-3	5/10/2001		CHLOROPHYLL (A+B+C),Filterable	94	ug/l
RHH-1	5/10/2001		CHLOROPHYLL (A+B+C),Filterable	102	ug/l
RHH-3	6/11/2001		CHLOROPHYLL (A+B+C),Filterable	200	ug/l
RHH-1	6/11/2001		CHLOROPHYLL (A+B+C),Filterable	164	ug/l
RHH-1	05/10/2001	Water	Chlorophyll a, corrected for pheophytin	32	ug/l
RHH-2	05/10/2001	Water	Chlorophyll a, corrected for pheophytin	41.7	ug/l
RHH-3	05/10/2001	Water	Chlorophyll a, corrected for pheophytin	38.6	ug/l
RHH-1	06/11/2001	Water	Chlorophyll a, corrected for pheophytin	48.5	ug/l
RHH-3	06/11/2001	Water	Chlorophyll a, corrected for pheophytin	20.8	ug/l
RHH-1	08/06/2001	Water	Chlorophyll a, corrected for pheophytin	34.8	ug/l
RHH-2	08/06/2001	Water	Chlorophyll a, corrected for pheophytin	62.8	ug/l

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RHH-3	08/06/2001	Water	Chlorophyll a, corrected for pheophytin	32	ug/l
RHH-1	09/06/2001	Water	Chlorophyll a, corrected for pheophytin	65.3	ug/l
RHH-3	09/06/2001	Water	Chlorophyll a, corrected for pheophytin	93.8	ug/l
RHH-1	11/02/2001	Water	Chlorophyll a, corrected for pheophytin	6.71	ug/l
RHH-3	11/02/2001	Water	Chlorophyll a, corrected for pheophytin	27.8	ug/l
RHH-2	11/02/2001	Water	Chlorophyll a, corrected for pheophytin	21.5	ug/l
RHH-1	9/8/1992	Water	Chlorophyll a, corrected for pheophytin	101.46	ug/l
RHH-1	05/10/2001	Water	Chlorophyll a, uncorrected for pheophytin	38	ug/l
RHH-2	05/10/2001	Water	Chlorophyll a, uncorrected for pheophytin	48.8	ug/l
RHH-3	05/10/2001	Water	Chlorophyll a, uncorrected for pheophytin	42.2	ug/l
RHH-1	06/11/2001	Water	Chlorophyll a, uncorrected for pheophytin	53	ug/l
RHH-3	06/11/2001	Water	Chlorophyll a, uncorrected for pheophytin	22.4	ug/l
RHH-1	08/06/2001	Water	Chlorophyll a, uncorrected for pheophytin	42.2	ug/l
RHH-2	08/06/2001	Water	Chlorophyll a, uncorrected for pheophytin	69.3	ug/l
RHH-3	08/06/2001	Water	Chlorophyll a, uncorrected for pheophytin	37.7	ug/l
RHH-1	09/06/2001	Water	Chlorophyll a, uncorrected for pheophytin	74.7	ug/l
RHH-3	09/06/2001	Water	Chlorophyll a, uncorrected for pheophytin	104	ug/l
RHH-1	11/02/2001	Water	Chlorophyll a, uncorrected for pheophytin	5.9	ug/l
RHH-3	11/02/2001	Water	Chlorophyll a, uncorrected for pheophytin	29.3	ug/l
RHH-2	11/02/2001	Water	Chlorophyll a, uncorrected for pheophytin	21.9	ug/l
RHH-1	9/8/1992	Water	Chlorophyll a, uncorrected for pheophytin	99.73	ug/l
RHH-1	05/10/2001	Water	Chlorophyll-b	6.68	ug/l
RHH-2	05/10/2001	Water	Chlorophyll-b	8.71	ug/l
RHH-3	05/10/2001	Water	Chlorophyll-b	7.88	ug/l
RHH-1	06/11/2001	Water	Chlorophyll-b	6.79	ug/l
RHH-3	06/11/2001	Water	Chlorophyll-b	3.22	ug/l
RHH-1	08/06/2001	Water	Chlorophyll-b	5.3	ug/l
RHH-2	08/06/2001	Water	Chlorophyll-b	3.95	ug/l
RHH-3	08/06/2001	Water	Chlorophyll-b	4.3	ug/l
RHH-1	09/06/2001	Water	Chlorophyll-b	15.7	ug/l
RHH-3	09/06/2001	Water	Chlorophyll-b	29.7	ug/l
RHH-1	11/02/2001	Water	Chlorophyll-b		ug/l
RHH-3	11/02/2001	Water	Chlorophyll-b	3.31	ug/l
RHH-2	11/02/2001	Water	Chlorophyll-b	1.59	ug/l
RHH-1	05/10/2001	Water	Chlorophyll-c	5.09	ug/l
RHH-2	05/10/2001	Water	Chlorophyll-c	8.09	ug/l
RHH-3	05/10/2001	Water	Chlorophyll-c	3.96	ug/l
RHH-1	06/11/2001	Water	Chlorophyll-c	2.83	ug/l
RHH-3	06/11/2001	Water	Chlorophyll-c	1.03	ug/l
RHH-1	08/06/2001	Water	Chlorophyll-c	1.09	ug/l
RHH-2	08/06/2001	Water	Chlorophyll-c	9.21	ug/l
RHH-3	08/06/2001	Water	Chlorophyll-c	2.33	ug/l
RHH-1	09/06/2001	Water	Chlorophyll-c	4.28	ug/l
RHH-3	09/06/2001	Water	Chlorophyll-c	4.55	ug/l
RHH-1	11/02/2001	Water	Chlorophyll-c		ug/l
RHH-3	11/02/2001	Water	Chlorophyll-c	1.7	ug/l
RHH-2	11/02/2001	Water	Chlorophyll-c		ug/l
RHH-1	9/8/1992	Water	Chlorophyll-c	6.02	ug/l
RHH-1	9/8/1992	Water	COD, .025N K2CR2O7 MG/L	62	mg/L
RHH-2	05/10/2001	Water	Depth	1	Feet
RHH-1	05/10/2001	Water	Depth	1.5	Feet
RHH-1	05/10/2001	Water	Depth	1	Feet
RHH-2	05/10/2001	Water	Depth	1	Feet
RHH-3	05/10/2001	Water	Depth	1	Feet
RHH-3	05/10/2001	Water	Depth	1	Feet
RHH-1	06/11/2001	Water	Depth	1	Feet
RHH-1	06/11/2001	Water	Depth	1	Feet
RHH-2	06/11/2001	Water	Depth	1	Feet
RHH-3	06/11/2001	Water	Depth	2	Feet
RHH-3	06/11/2001	Water	Depth	1	Feet

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RHH-1	08/06/2001	Water	Depth	2.5	Feet
RHH-1	08/06/2001	Water	Depth	1	Feet
RHH-2	08/06/2001	Water	Depth	1.5	Feet
RHH-2	08/06/2001	Water	Depth	1	Feet
RHH-3	08/06/2001	Water	Depth	2	Feet
RHH-3	08/06/2001	Water	Depth	1	Feet
RHH-1	09/06/2001	Sediment	Depth	6	Feet
RHH-1	09/06/2001	Water	Depth	2	Feet
RHH-3	09/06/2001	Sediment	Depth	3	Feet
RHH-3	09/06/2001	Water	Depth	1	Feet
RHH-3	09/06/2001	Sediment	Depth	3	Feet
RHH-3	09/06/2001	Water	Depth	1	Feet
RHH-1	11/02/2001	Water	Depth	2	Feet
RHH-2	11/02/2001	Water	Depth	1	Feet
RHH-3	11/02/2001	Water	Depth	1.5	Feet
RHH-1	11/02/2001	Water	Depth	1	Feet
RHH-2	11/02/2001	Water	Depth	1.5	Feet
RHH-3	11/02/2001	Water	Depth	1	Feet
RHH-1	05-10-2001	WATER	Depth	0	Feet
RHH-1	05-10-2001	WATER	Depth	1	Feet
RHH-1	05-10-2001	WATER	Depth	2	Feet
RHH-1	05-10-2001	WATER	Depth	3	Feet
RHH-1	05-10-2001	WATER	Depth	4	Feet
RHH-1	06-11-2001	WATER	Depth	0	Feet
RHH-1	06-11-2001	WATER	Depth	1	Feet
RHH-1	06-11-2001	WATER	Depth	2	Feet
RHH-1	06-11-2001	WATER	Depth	3	Feet
RHH-1	06-11-2001	WATER	Depth	4	Feet
RHH-1	06-11-2001	WATER	Depth	5	Feet
RHH-1	08-06-2001	WATER	Depth	0	Feet
RHH-1	08-06-2001	WATER	Depth	1	Feet
RHH-1	08-06-2001	WATER	Depth	3	Feet
RHH-1	08-06-2001	WATER	Depth	4	Feet
RHH-1	09-06-2001	WATER	Depth	0	Feet
RHH-1	09-06-2001	WATER	Depth	1	Feet
RHH-1	09-06-2001	WATER	Depth	3	Feet
RHH-1	09-06-2001	WATER	Depth	4	Feet
RHH-1	11-02-2001	WATER	Depth	0	Feet
RHH-1	11-02-2001	WATER	Depth	1	Feet
RHH-1	11-02-2001	WATER	Depth	3	Feet
RHH-1	11-02-2001	WATER	Depth	5	Feet
RHH-2	05-10-2001	WATER	Depth	0	Feet
RHH-2	05-10-2001	WATER	Depth	1	Feet
RHH-2	05-10-2001	WATER	Depth	2	Feet
RHH-2	05-10-2001	WATER	Depth	3	Feet
RHH-2	06-11-2001	WATER	Depth	0	Feet
RHH-2	06-11-2001	WATER	Depth	1	Feet
RHH-2	06-11-2001	WATER	Depth	2	Feet
RHH-2	08-06-2001	WATER	Depth	0	Feet
RHH-2	08-06-2001	WATER	Depth	1	Feet
RHH-2	09-06-2001	WATER	Depth	0	Feet
RHH-2	09-06-2001	WATER	Depth	1	Feet
RHH-2	11-02-2001	WATER	Depth	0	Feet
RHH-2	11-02-2001	WATER	Depth	1	Feet
RHH-2	11-02-2001	WATER	Depth	2	Feet
RHH-3	05-10-2001	WATER	Depth	0	Feet
RHH-3	05-10-2001	WATER	Depth	1	Feet
RHH-3	05-10-2001	WATER	Depth	2	Feet
RHH-3	06-11-2001	WATER	Depth	0	Feet
RHH-3	06-11-2001	WATER	Depth	1	Feet

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RHH-3	06-11-2001	WATER	Depth	2	Feet
RHH-3	08-06-2001	WATER	Depth	0	Feet
RHH-3	08-06-2001	WATER	Depth	1	Feet
RHH-3	09-06-2001	WATER	Depth	0	Feet
RHH-3	09-06-2001	WATER	Depth	1	Feet
RHH-3	11-02-2001	WATER	Depth	0	Feet
RHH-3	11-02-2001	WATER	Depth	1	Feet
RHH-3	11-02-2001	WATER	Depth	2	Feet
RHH-2	05/10/2001	Water	Depth, bottom	3.5	Feet
RHH-1	05/10/2001	Water	Depth, bottom	6.5	Feet
RHH-3	05/10/2001	Water	Depth, bottom	3.5	Feet
RHH-1	06/11/2001	Water	Depth, bottom	7	Feet
RHH-2	06/11/2001	Water	Depth, bottom	4	Feet
RHH-3	06/11/2001	Water	Depth, bottom	4	Feet
RHH-1	08/06/2001	Water	Depth, bottom	6.5	Feet
RHH-2	08/06/2001	Water	Depth, bottom	3.5	Feet
RHH-3	08/06/2001	Water	Depth, bottom	4	Feet
RHH-3	09/06/2001	Water	Depth, bottom	3	Feet
RHH-2	11/02/2001	Water	Depth, bottom	4	Feet
RHH-3	11/02/2001	Water	Depth, bottom	4	Feet
RHH-1	11/02/2001	Water	Depth, bottom	7	Feet
RHH-1	9/8/1992	Water	Depth, bottom	6	Feet
RHH-2	05/10/2001	Water	Depth, Secchi Disk Depth	4	Feet
RHH-1	05/10/2001	Water	Depth, Secchi Disk Depth	9	Feet
RHH-3	05/10/2001	Water	Depth, Secchi Disk Depth	8	Feet
RHH-1	06/11/2001	Water	Depth, Secchi Disk Depth	12	Feet
RHH-2	06/11/2001	Water	Depth, Secchi Disk Depth	12	Feet
RHH-3	06/11/2001	Water	Depth, Secchi Disk Depth	12	Feet
RHH-1	08/06/2001	Water	Depth, Secchi Disk Depth	16	Feet
RHH-2	08/06/2001	Water	Depth, Secchi Disk Depth	13	Feet
RHH-3	08/06/2001	Water	Depth, Secchi Disk Depth	19	Feet
RHH-3	09/06/2001	Water	Depth, Secchi Disk Depth	6	Feet
RHH-2	11/02/2001	Water	Depth, Secchi Disk Depth	8	Feet
RHH-1	11/02/2001	Water	Depth, Secchi Disk Depth	10	Feet
RHH-3	11/02/2001	Water	Depth, Secchi Disk Depth	8	Feet
RHH-1	9/8/1992	Water	Dissolved Oxygen	7.5	mg/L
RHH-1	9/8/1992	Water	Dissolved Oxygen	7.4	mg/L
RHH-1	05-10-2001	WATER	Dissolved Oxygen	6.1	mg/L
RHH-1	05-10-2001	WATER	Dissolved Oxygen	5.9	mg/L
RHH-1	05-10-2001	WATER	Dissolved Oxygen	5.7	mg/L
RHH-1	05-10-2001	WATER	Dissolved Oxygen	4.9	mg/L
RHH-1	05-10-2001	WATER	Dissolved Oxygen	4.1	mg/L
RHH-1	06-11-2001	WATER	Dissolved Oxygen	11.3	mg/L
RHH-1	06-11-2001	WATER	Dissolved Oxygen	12	mg/L
RHH-1	06-11-2001	WATER	Dissolved Oxygen	11.4	mg/L
RHH-1	06-11-2001	WATER	Dissolved Oxygen	9.3	mg/L
RHH-1	06-11-2001	WATER	Dissolved Oxygen	8	mg/L
RHH-1	06-11-2001	WATER	Dissolved Oxygen	6	mg/L
RHH-1	08-06-2001	WATER	Dissolved Oxygen	6.1	mg/L
RHH-1	08-06-2001	WATER	Dissolved Oxygen	4.7	mg/L
RHH-1	08-06-2001	WATER	Dissolved Oxygen	2.7	mg/L
RHH-1	08-06-2001	WATER	Dissolved Oxygen	1.3	mg/L
RHH-1	09-06-2001	WATER	Dissolved Oxygen	10.7	mg/L
RHH-1	09-06-2001	WATER	Dissolved Oxygen	10.4	mg/L
RHH-1	09-06-2001	WATER	Dissolved Oxygen	9.4	mg/L
RHH-1	09-06-2001	WATER	Dissolved Oxygen	9	mg/L
RHH-1	11-02-2001	WATER	Dissolved Oxygen	10.4	mg/L
RHH-1	11-02-2001	WATER	Dissolved Oxygen	10.2	mg/L
RHH-1	11-02-2001	WATER	Dissolved Oxygen	10.2	mg/L
RHH-1	11-02-2001	WATER	Dissolved Oxygen	10.1	mg/L

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RHH-2	05-10-2001	WATER	Dissolved Oxygen	8	mg/L
RHH-2	05-10-2001	WATER	Dissolved Oxygen	7.7	mg/L
RHH-2	05-10-2001	WATER	Dissolved Oxygen	7.6	mg/L
RHH-2	05-10-2001	WATER	Dissolved Oxygen	7.4	mg/L
RHH-2	06-11-2001	WATER	Dissolved Oxygen	11.3	mg/L
RHH-2	06-11-2001	WATER	Dissolved Oxygen	11.7	mg/L
RHH-2	06-11-2001	WATER	Dissolved Oxygen	10.4	mg/L
RHH-2	08-06-2001	WATER	Dissolved Oxygen	10	mg/L
RHH-2	08-06-2001	WATER	Dissolved Oxygen	9.8	mg/L
RHH-2	09-06-2001	WATER	Dissolved Oxygen	10.2	mg/L
RHH-2	09-06-2001	WATER	Dissolved Oxygen	10	mg/L
RHH-2	11-02-2001	WATER	Dissolved Oxygen	10.4	mg/L
RHH-2	11-02-2001	WATER	Dissolved Oxygen	10.3	mg/L
RHH-2	11-02-2001	WATER	Dissolved Oxygen	10.3	mg/L
RHH-3	05-10-2001	WATER	Dissolved Oxygen	7.7	mg/L
RHH-3	05-10-2001	WATER	Dissolved Oxygen	7.5	mg/L
RHH-3	05-10-2001	WATER	Dissolved Oxygen	7.5	mg/L
RHH-3	06-11-2001	WATER	Dissolved Oxygen	12.3	mg/L
RHH-3	06-11-2001	WATER	Dissolved Oxygen	11.9	mg/L
RHH-3	06-11-2001	WATER	Dissolved Oxygen	11.5	mg/L
RHH-3	08-06-2001	WATER	Dissolved Oxygen	11.7	mg/L
RHH-3	08-06-2001	WATER	Dissolved Oxygen	11.8	mg/L
RHH-3	09-06-2001	WATER	Dissolved Oxygen	7.3	mg/L
RHH-3	09-06-2001	WATER	Dissolved Oxygen	5.5	mg/L
RHH-3	11-02-2001	WATER	Dissolved Oxygen	10.4	mg/L
RHH-3	11-02-2001	WATER	Dissolved Oxygen	10.3	mg/L
RHH-3	11-02-2001	WATER	Dissolved Oxygen	10.3	mg/L
RHH-2	05/10/2001	Water	Dissolved Phosphorus	0.036	mg/L
RHH-1	05/10/2001	Water	Dissolved Phosphorus	0.025	mg/L
RHH-3	05/10/2001	Water	Dissolved Phosphorus	0.033	mg/L
RHH-1	06/11/2001	Water	Dissolved Phosphorus	0.019	mg/L
RHH-2	06/11/2001	Water	Dissolved Phosphorus	0.023	mg/L
RHH-3	06/11/2001	Water	Dissolved Phosphorus	0.03	mg/L
RHH-1	08/06/2001	Water	Dissolved Phosphorus	0.019	mg/L
RHH-2	08/06/2001	Water	Dissolved Phosphorus	0.019	mg/L
RHH-3	08/06/2001	Water	Dissolved Phosphorus	0.02	mg/L
RHH-3	09/06/2001	Water	Dissolved Phosphorus	0.034	mg/L
RHH-2	11/02/2001	Water	Dissolved Phosphorus	0.014	mg/L
RHH-1	11/02/2001	Water	Dissolved Phosphorus	0.014	mg/L
RHH-3	11/02/2001	Water	Dissolved Phosphorus	0.014	mg/L
RHH-1	9/8/1992	Water	Dissolved Phosphorus	0.02	mg/L
RHH-2	05/10/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.48	mg/L
RHH-1	05/10/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.67	mg/L
RHH-3	05/10/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.42	mg/L
RHH-1	06/11/2001	Water	Nitrogen, ammonia (NH3) as NH3		mg/L
RHH-2	06/11/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.07	mg/L
RHH-3	06/11/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.12	mg/L
RHH-1	08/06/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.06	mg/L
RHH-2	08/06/2001	Water	Nitrogen, ammonia (NH3) as NH3		mg/L
RHH-3	08/06/2001	Water	Nitrogen, ammonia (NH3) as NH3		mg/L
RHH-3	09/06/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.03	mg/L
RHH-2	11/02/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.03	mg/L
RHH-1	11/02/2001	Water	Nitrogen, ammonia (NH3) as NH3		mg/L
RHH-3	11/02/2001	Water	Nitrogen, ammonia (NH3) as NH3	0.01	mg/L
RHH-1	9/8/1992	Water	Nitrogen, ammonia (NH3) as NH3	0.03	mg/L
RHH-2	05/10/2001	Water	Nitrogen, Kjeldahl	2.2	mg/L
RHH-1	05/10/2001	Water	Nitrogen, Kjeldahl	2.06	mg/L
RHH-3	05/10/2001	Water	Nitrogen, Kjeldahl	1.63	mg/L
RHH-1	06/11/2001	Water	Nitrogen, Kjeldahl	1.44	mg/L
RHH-2	06/11/2001	Water	Nitrogen, Kjeldahl	1.55	mg/L

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RHH-3	06/11/2001	Water	Nitrogen, Kjeldahl	1.17	mg/L
RHH-1	08/06/2001	Water	Nitrogen, Kjeldahl	2.44	mg/L
RHH-2	08/06/2001	Water	Nitrogen, Kjeldahl	3.13	mg/L
RHH-3	08/06/2001	Water	Nitrogen, Kjeldahl	2.84	mg/L
RHH-1	09/06/2001	Sediment	Nitrogen, Kjeldahl	7940	mg/L
RHH-3	09/06/2001	Sediment	Nitrogen, Kjeldahl	5130	mg/L
RHH-3	09/06/2001	Water	Nitrogen, Kjeldahl	3.5	mg/L
RHH-2	11/02/2001	Water	Nitrogen, Kjeldahl	2.15	mg/L
RHH-1	11/02/2001	Water	Nitrogen, Kjeldahl	3.03	mg/L
RHH-3	11/02/2001	Water	Nitrogen, Kjeldahl	1.6	mg/L
RHH-1	9/8/1992	Water	Nitrogen, Kjeldahl	2.2	mg/L
RHH-2	05/10/2001	Water	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	0.06	mg/L
RHH-1	05/10/2001	Water	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	0.04	mg/L
RHH-3	05/10/2001	Water	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	0.07	mg/L
RHH-1	06/11/2001	Water	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	0.2	mg/L
RHH-2	06/11/2001	Water	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	0.18	mg/L
RHH-3	06/11/2001	Water	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	0.13	mg/L
RHH-1	08/06/2001	Water	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N		mg/L
RHH-2	08/06/2001	Water	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N		mg/L
RHH-3	08/06/2001	Water	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N		mg/L
RHH-3	09/06/2001	Water	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	0.03	mg/L
RHH-2	11/02/2001	Water	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	0.04	mg/L
RHH-1	11/02/2001	Water	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	0.02	mg/L
RHH-3	11/02/2001	Water	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	0.04	mg/L
RHH-1	9/8/1992	Water	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	0.1	mg/L
RHH-1	9/8/1992	Water	OXYGEN, DISSOLVED, PERCENT OF SATURATIO	83.5294	%
RHH-1	9/8/1992	Water	OXYGEN, DISSOLVED, PERCENT OF SATURATIO	80	%
RHH-1	9/8/1992	Water	OXYGEN, DISSOLVED, PERCENT OF SATURATIO	88.2353	%
RHH-1	9/8/1992	Water	OXYGEN, DISSOLVED, PERCENT OF SATURATIO	87.0588	%
RHH-1	9/8/1992	Water	OXYGEN, DISSOLVED, PERCENT OF SATURATIO	81.1764	%
RHH-1	9/8/1992	Water	OXYGEN, DISSOLVED, PERCENT OF SATURATIO	81.1764	%
RHH-1	9/8/1992	Water	Temperature, Water	24.1	Deg. C.
RHH-1	9/8/1992	Water	Temperature, Water	24.1	Deg. C.
RHH-1	05-10-2001	WATER	Temperature, Water	19.4	Deg. C.
RHH-1	05-10-2001	WATER	Temperature, Water	19.4	Deg. C.
RHH-1	05-10-2001	WATER	Temperature, Water	19.3	Deg. C.
RHH-1	05-10-2001	WATER	Temperature, Water	19.2	Deg. C.
RHH-1	05-10-2001	WATER	Temperature, Water	18.9	Deg. C.
RHH-1	06-11-2001	WATER	Temperature, Water	26.4	Deg. C.
RHH-1	06-11-2001	WATER	Temperature, Water	25	Deg. C.
RHH-1	06-11-2001	WATER	Temperature, Water	23	Deg. C.
RHH-1	06-11-2001	WATER	Temperature, Water	22.3	Deg. C.
RHH-1	06-11-2001	WATER	Temperature, Water	21.6	Deg. C.
RHH-1	06-11-2001	WATER	Temperature, Water	20	Deg. C.
RHH-1	08-06-2001	WATER	Temperature, Water	27.3	Deg. C.
RHH-1	08-06-2001	WATER	Temperature, Water	26.4	Deg. C.
RHH-1	08-06-2001	WATER	Temperature, Water	26	Deg. C.
RHH-1	08-06-2001	WATER	Temperature, Water	25.7	Deg. C.
RHH-1	09-06-2001	WATER	Temperature, Water	25.7	Deg. C.
RHH-1	09-06-2001	WATER	Temperature, Water	25.4	Deg. C.
RHH-1	09-06-2001	WATER	Temperature, Water	24.7	Deg. C.
RHH-1	09-06-2001	WATER	Temperature, Water	24.5	Deg. C.
RHH-1	11-02-2001	WATER	Temperature, Water	11.3	Deg. C.
RHH-1	11-02-2001	WATER	Temperature, Water	11.3	Deg. C.
RHH-1	11-02-2001	WATER	Temperature, Water	11.2	Deg. C.
RHH-1	11-02-2001	WATER	Temperature, Water	11.1	Deg. C.
RHH-2	05-10-2001	WATER	Temperature, Water	21	Deg. C.
RHH-2	05-10-2001	WATER	Temperature, Water	21	Deg. C.
RHH-2	05-10-2001	WATER	Temperature, Water	21	Deg. C.
RHH-2	05-10-2001	WATER	Temperature, Water	21	Deg. C.

STATION_ID	ACTIVITY_START_DATE	ACTIVITY_MEDIUM	CHARACTERISTIC_NAME	RESULT_VALUE	RESULT_UNIT
RHH-2	06-11-2001	WATER	Temperature, Water	28.9	Deg. C.
RHH-2	06-11-2001	WATER	Temperature, Water	25.6	Deg. C.
RHH-2	06-11-2001	WATER	Temperature, Water	23.4	Deg. C.
RHH-2	08-06-2001	WATER	Temperature, Water	28.9	Deg. C.
RHH-2	08-06-2001	WATER	Temperature, Water	27.9	Deg. C.
RHH-2	09-06-2001	WATER	Temperature, Water	24.9	Deg. C.
RHH-2	09-06-2001	WATER	Temperature, Water	24.6	Deg. C.
RHH-2	11-02-2001	WATER	Temperature, Water	11.5	Deg. C.
RHH-2	11-02-2001	WATER	Temperature, Water	11.5	Deg. C.
RHH-2	11-02-2001	WATER	Temperature, Water	11.5	Deg. C.
RHH-3	05-10-2001	WATER	Temperature, Water	20.8	Deg. C.
RHH-3	05-10-2001	WATER	Temperature, Water	20.7	Deg. C.
RHH-3	05-10-2001	WATER	Temperature, Water	20.7	Deg. C.
RHH-3	06-11-2001	WATER	Temperature, Water	30.6	Deg. C.
RHH-3	06-11-2001	WATER	Temperature, Water	30.2	Deg. C.
RHH-3	06-11-2001	WATER	Temperature, Water	25.9	Deg. C.
RHH-3	08-06-2001	WATER	Temperature, Water	28.7	Deg. C.
RHH-3	08-06-2001	WATER	Temperature, Water	28.6	Deg. C.
RHH-3	09-06-2001	WATER	Temperature, Water	24.9	Deg. C.
RHH-3	09-06-2001	WATER	Temperature, Water	23.8	Deg. C.
RHH-3	11-02-2001	WATER	Temperature, Water	11.9	Deg. C.
RHH-3	11-02-2001	WATER	Temperature, Water	11.8	Deg. C.
RHH-3	11-02-2001	WATER	Temperature, Water	11.8	Deg. C.
RHH-2	05/10/2001	Water	Total Phosphorus	0.17	ug/l
RHH-1	05/10/2001	Water	Total Phosphorus	0.219	ug/l
RHH-3	05/10/2001	Water	Total Phosphorus	0.135	ug/l
RHH-1	06/11/2001	Water	Total Phosphorus	0.112	ug/l
RHH-2	06/11/2001	Water	Total Phosphorus	0.097	ug/l
RHH-3	06/11/2001	Water	Total Phosphorus	0.086	ug/l
RHH-1	08/06/2001	Water	Total Phosphorus	0.119	ug/l
RHH-2	08/06/2001	Water	Total Phosphorus	0.158	ug/l
RHH-3	08/06/2001	Water	Total Phosphorus	0.094	ug/l
RHH-1	09/06/2001	Sediment	Total Phosphorus	580	ug/l
RHH-3	09/06/2001	Water	Total Phosphorus	0.227	ug/l
RHH-3	09/06/2001	Sediment	Total Phosphorus	429	ug/l
RHH-2	11/02/2001	Water	Total Phosphorus	0.106	ug/l
RHH-1	11/02/2001	Water	Total Phosphorus	0.114	ug/l
RHH-3	11/02/2001	Water	Total Phosphorus	0.112	ug/l
RHH-1	9/8/1992	Water	Total Phosphorus	0.142	ug/l

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Appendix C
Historic Flow Data

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TAMPIER LAKE/SAGANASHKEE SLOUGH AREA RATIO FLOW ESTIMATION SUMMARY

USGS gage 5537500 - LONG RUN NEAR LEMONT, IL				
latitude =	41.642531			
longitude =	-87.9999225			
Drainage area =	20.9	sq miles	13376	acres

Q ungaged = (Area ungaged/Area gaged)*Q gaged
where Qgaged = Streamflow of the gaged basin
Qungaged = Streamflow of the ungaged basin
Areagaged = Area of the gaged basin
Areaungaged = Area of the ungaged basin

Monthly Average Flow Values - TAMPIER		
Month	Gaged (cfs)	Ungaged (cfs)
January	18.35	2.17
February	23.08	2.73
March	35.49	4.20
April	36.39	4.30
May	24.42	2.89
June	18.82	2.22
July	11.79	1.39
August	7.71	0.91
September	9.67	1.14
October	10.53	1.24
November	14.35	1.70
December	18.61	2.20
Average Flow	19.04	2.25

	Ungaged Flow (cfs)	Ungaged Flow (million meters3/yr)*	WS acres
Average (daily) (Tampier WS)	**2.251015245**	**2.01015681**	**1581.27**
RGZO-3	0.587441709	0.524585497	412.66
RGZO-2	1.433314494	1.279949968	1006.86
RGZO-1	0.230259042	0.205621345	161.75

Monthly Average Flow Values - SAGANASHKEE		
Month	Gaged (cfs)	Ungaged (cfs)
January	18.35	5.02
February	23.08	6.31
March	35.49	9.71
April	36.39	9.95
May	24.42	6.68
June	18.82	5.15
July	11.79	3.22
August	7.71	2.11
September	9.67	2.65
October	10.53	2.88
November	14.35	3.92
December	18.61	5.09
Average Flow	19.04	5.21

	Ungaged Flow (cfs)	Ungaged Flow (million meters3/yr)*	WS acres
Average (daily) (Saganashkee WS)	**5.207398995**	**4.650207755**	**3658.04**
RHH-3	3.842970034	3.431772575	2699.57
RHH-2	0.765442269	0.683540013	537.7
RHH-1	0.598986691	0.534895167	420.77

Full Historical Record of Daily Flows for USGS gage 5537500 available from 7/1/1951 to present

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Appendix D
BATHTUB Files

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Title: Tampier Lake
Notes: Global Inputs

	Historic Data	Units	Model Input	Model units
Averaging Period:	NA		1	yr
Precipitation	33.8	inches	0.85852	meters
Evaporation	30.1	inches	0.76454	meters
Increase in Storage	NA	NA		meters
Atmospheric Loads	NA	NS		
	inches to meters			
Conversions:	0.0254			

TAMPIER					
SEGMENT INPUTS					
Total Lake Segments		3	CONVERSIONS	ft to m	
				0.3048	

Segment Name:	Segment 1: RGZO-3				
Outflow Segment:	Segment 2: RGZO-2				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	**0.232**	km2	**0.232**	km2	
Mean Depth	**8.2**	ft	**2.49936**	meters	Total Depth
Length	**0.8000**	km	**0.8000**	km	Length in GIS
Mixed Layer Depth				m	Depth where DO changes
Hypolimnetic Depth				m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	**0.0803**	mg/L	**80.3**	ug/L or ppb	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model

Segment Name:	Segment 2: RGZO-2				
Outflow Segment:	Segment 3: RGZO-1				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	**0.211**	km2	**0.211**	km2	
Mean Depth	**6.6**	ft	**2.01168**	meters	Total Depth
Length	**0.2200**		**0.2200**	km	Length in GIS
Mixed Layer Depth				m	Depth where DO changes
Hypolimnetic Depth				m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	**0.0752**	mg/L	**75.2**	ug/L or ppb	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model

TAMPIER
SEGMENT INPUTS

Segment Name:	Segment 3: RGZO-1
Outflow Segment:	Out of Reservoir

	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	**0.0620**	km2	**0.0620**	km2	
Mean Depth	**9.1**	ft	**2.77368**	m	Total Depth
Length	**0.3860**	km	**0.3860**	km	Length in GIS
Mixed Layer Depth		ft		m	Depth where DO changes
Hypolimnetic Depth		ft		m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity	1		1	1/m	
Total Phosphorus	**0.0782**	mg/L	**78.2**	ug/L or ppb	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model

Segment 1: RJN-3
Segment 2: RJN-2
Segment 3: RJN-1

Lake	Section	Acres	sqKm
Tampier Lake	RGZO-1	15.34	0.062
Tampier Lake	RGZO-2	52.26	0.211
Tampier Lake	RGZO-3	57.33	0.232
		124.93	

TAMPIER
TRIB INPUTS

Number of Tributaries	**3**	
Total area of the watershed =	**1581.27**	acres
Total annual estimated flow in the watershed =	**2.0101568**	mil m^3/yr

Tributary Name:	Direct Flow 1				
Segment:	Segment 1: RGZO-3				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	**412.7**	acres	**1.67**	km2	
Flow Rate	**0.587441709**	cfs	**0.5245855**	million meters3/yr	
TP Conc		mg/L	**78.24**	ug/L	

Tributary Name:	Direct Flow 2				
Segment:	Segment 2: RGZO-2				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	**1006.9**	acres	**4.08**	km2	
Flow Rate	**1.433314494**	cfs	**1.27995**	million meters3/yr	
TP Conc		mg/L	**78.24**	ug/L	

Tributary Name:	Direct Flow 3				
Segment:	Segment 3: RGZO-1				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	**161.8**	acres	**0.66**	km2	
Flow Rate	**0.230259042**	cfs	**0.2056213**	million meters3/yr	
TP Conc		mg/L	**78.24**	ug/L	

TAMPIER
TRIB INPUTS

Tributary Name	Section	Acres	sqKm	Percent of WS	Estimated Flow (million meters3/yr)
Direct Flow 1	RGZO-3	412.66	1.67	26.09%	0.5245
Direct Flow 2	RGZO-2	1006.86	4.075	63.67%	1.2799
Direct Flow 3	RGZO-1	161.75	0.655	10.23%	0.2057
TOTAL		**1581.3**	**6.4**	**100%**	**2.0102**

Unit Conversions:

1 acre= 0.004046856 square kilometer
1cfs = 0.893000087 mil m^3/yr

CDM	Client:	Illinois EPA	Job No.	1681-70711	Computed By:	Brian Bennett	
	Project:	TMDL Tampier Lake Watershed	Dated Checked:		Date:		4/21/2009
	Calculations:	**Total Phosphorus Loads**	Checked By:		Page No.		

References:

1. "Illinois EPA Total Maximum Daily Tampier Lake/Saganashkee Slough Watersheds" prepared by CDM dated 2008
2. USEPA PLOAD Version 3.0 User's Manual dated January 2001

3. USGS Fact Sheet FS-195-97: "Unit-Area Loads of Suspended Sediment, Suspended Solid, And Total Phosphorus From Small Watersheds in Wisconsin" prepared by Corsi, Graczik, Owens, and Bannerman

Methodology:

Tampier Lake Watershed is predominantly rural grassland and upland forest. (Reference 1, pg. 2-1)
Therefore, the export coefficient method described on Page 3 of Reference 2 is used to calculate median total phosphorus loads.
The minimum and maximum phosphorus loads are calculated using the procedure described in "Estimating Loads" section of Reference 3.

1. Calculate Median Total Phosphorus Load

Assumptions:

Export coefficients per land use (lb/ac/yr) are given in Appendix IV of Reference 2. The export coeffients for the Wisconsin area located in Appendix IV are most appropriate for the Tampier Lake watershed due to similar climate characteristics. The land use distribution for Tampier Lake watershed is given on page 5-7 of Reference 1. Export coeficients were assumed for the Tampier Lake Land Use categories that are not listed in the Wisconsin categories. Assumed values are indicated with bold and italics.

Tampier Lake Watershed Information		**Total Phosphorus Export Coefficients**		**Phosphorus Loads**		
Land Use	Area	High*	Low*	High	Low	
	acres	lb/ac/yr	lb/ac/yr	lb/yr	lb/yr	
Barren & Exposed Land	0	0.16	0.16	0.0	0.0	0.0
Corn	42	0.92	0.92	38.6	38.6	38.6
Deep Marsh	0	**0.22**	***0.08***	0.1	0.0	0.1
Floodplain Forest	3	**0.13**	0.08	0.4	0.2	0.3
High Density	4	**2**	1	8.6	4.3	6.5
Low/Medium Density	124	0.52	0.04	64.3	4.9	34.6
Other Agriculture	0	0.92	0.92	0.0	0.0	0.0
Other Small Grains & Hay	0	0.92	0.92	0.0	0.0	0.0
Partial Canopy/Savannah Upland	99	0.13	0.08	12.9	7.9	10.4
Rural Grassland	378	0.5	**0.16**	188.9	60.4	124.7
Seasonally/Temporarily Flood	0	0.22	0.08	0.0	0.0	0.0
Shallow Marsh/Wet Meadow	124	**0.22**	***0.08***	27.2	9.9	18.5
Shallow Water	0	**0.22**	***0.08***	0.0	0.0	0.0
Soybeans	23	0.92	0.92	21.3	21.3	21.3
Surface Water	242	**0.22**	***0.08***	53.3	19.4	36.3
Upland	389	**0.13**	0.08	50.6	31.1	40.9
Urban Open Space	153	**0.16**	0.03	24.5	4.6	0.0
Winter Wheat	0	0.92	0.92	0.0	0.0	0.0
Winter Wheat/Soybeans	0	0.92	0.92	0.0	0.0	346.7
TOTAL	**1,581**			**491**	**203**	

*Export coefficient valuus listed in Appendix IV are MEDIAN values. The ranges for each land use are assumed.

Bold: No category for this land use in Wisconsin unit area loads. Use Florida unit area loads

Bold Italic: No category for this land use in Appendix IV. Use forest land use value.

Results:

The export coefficient values lised in Appendix IV of Reference 2 are median values. Therefore, the range calculated with this method is a range for the median, rather than a range between the minimum and maximum loads. The results show that the Tampier Lake watershed median Phosphorus load ranges between 203 - 491 lb/yr.

KAW
6/21/2005
1 of

Trib Name	Trib Area (acres)	Percent of Total	Trib Flow (mil m^3/yr)	Trib Concentration (lbs/yr)	Trib Concentration (ug/L)
Direct Flow 1 : RGZO-3	412.66	26%	0.5246	90.48345746	78.24
Direct Flow 2 : RGZO-2	1006.86	64%	1.2799	220.7729704	78.24
Direct Flow 3 : RGZO-1	161.75	10%	0.2056	35.46672623	78.24
TOTAL	1581.27	100.00%	2.01015681	346.7231541	234.71

Unit Conversions: 0.94992645 lbs/day

1 cu m = 1000 liters
I pound = 453.59237 grams or 10^6 ug
(1 lb/yr) **/** (1 mil m^3/yr) = 0.45359237 ug/L

Median phosphorous load in the watershed = 346.7231541 lb/yr
Total average annual estimated flow in the watershed = 2.01015681 mil m^3/yr

Tributary Name	Section	Acres	sqKm	Percent of WS	Estimated Flow (million meters3/yr)
Direct Flow 1	RGZO-3	412.66	1.67	26%	0.5245
Direct Flow 2	RGZO-2	1006.86	4.075	64%	1.2799
Direct Flow 3	RGZO-1	161.75	0.655	10%	0.2057
		1581.27			

Tampier Lake - EXISTING CONDITIONS - MODEL CONFIRMATION

File: **C:\Documents and Settings\bennettbj\My Documents\BATHTUB\bath\Tampier_existing_v1.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	Trib 1	1.7	0.5	0.00E+00	0.00	0.31
2	1	1	Trib 2	4.1	1.3	0.00E+00	0.00	0.31
3	1	1	Trib 3	0.7	0.2	0.00E+00	0.00	0.31
PRECIPITATION				0.5	0.4	0.00E+00	0.00	0.86
TRIBUTARY INFLOW				6.4	2.0	0.00E+00	0.00	0.31
***TOTAL INFLOW				6.9	2.4	0.00E+00	0.00	0.35
ADVECTIVE OUTFLOW				6.9	2.1	0.00E+00	0.00	0.30
***TOTAL OUTFLOW				6.9	2.1	0.00E+00	0.00	0.30
***EVAPORATION					0.4	0.00E+00	0.00	

Tampier Lake - EXISTING CONDITIONS - MODEL CONFIRMATION

Overall Mass Balance Based Upon **Predicted** **Outflow & Reservoir Concentrations**

Component: **TOTAL P**

Trb	Type	Seq	Name	Load kg/yr	%Total	Load Variance (kg/yr)^2	%Total	CV	Conc mg/m^3	Export kg/km^2/yr
1	1	1	Trib 1	41.0	9.3%	0.00E+00		0.00	78.2	24.6
2	1	1	Trib 2	100.1	22.6%	0.00E+00		0.00	78.2	24.5
3	1	1	Trib 3	16.1	3.6%	0.00E+00		0.00	78.2	24.4
PRECIPITATION				15.1	3.4%	5.74E+01	100.0%	0.50	34.9	30.0
INTERNAL LOAD				270.5	61.1%	0.00E+00		0.00		
TRIBUTARY INFLOW				157.3	35.5%	0.00E+00		0.00	78.2	24.5
***TOTAL INFLOW				442.9	100.0%	5.74E+01	100.0%	0.02	181.3	64.1
ADVECTIVE OUTFLOW				159.1	35.9%	8.12E+02		0.18	77.3	23.0
***TOTAL OUTFLOW				159.1	35.9%	8.12E+02		0.18	77.3	23.0
***RETENTION				283.8	64.1%	8.43E+02		0.10		

Overflow Rate (m/yr)	4.1	Nutrient Resid. Time (yrs)	0.2065
Hydraulic Resid. Time (yrs)	0.5717	Turnover Ratio	4.8
Reservoir Conc (mg/m3)	78	Retention Coef.	0.641

Current Load	kg/yr	lbs/yr	lbs/day	% of total
Total	442.9	976.4911	2.675318062	100%
Internal	270.5	596.3597	1.633862114	61%
External	172.4	380.1314	1.041455891	39%

2.204623 lbs/kg

TAMPIER - TMDL

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

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	Trib 1	19.3	8.9%	0.00E+00		0.00	36.8	11.6
2	1	1	Trib 2	47.1	21.8%	0.00E+00		0.00	36.8	11.5
3	1	1	Trib 3	7.6	3.5%	0.00E+00		0.00	36.8	11.5
PRECIPITATION				15.1	7.0%	5.74E+01	100.0%	0.50	34.9	30.0
INTERNAL LOAD				127.1	58.8%	0.00E+00		0.00		
TRIBUTARY INFLOW				73.9	34.2%	0.00E+00		0.00	36.8	11.5
***TOTAL INFLOW				216.2	100.0%	5.74E+01	100.0%	0.04	88.5	31.3
ADVECTIVE OUTFLOW				102.2	47.3%	2.62E+02		0.16	49.7	14.8
***TOTAL OUTFLOW				102.2	47.3%	2.62E+02		0.16	49.7	14.8
***RETENTION				114.0	52.7%	2.83E+02		0.15		

Reservoir Conc (mg/m3) **49**

Current Load	% of total	lbs/day	LC	% reduction		% of total
Total	100%	2.675318062	1.30589	-0.51188	1.36943	1
Internal	61%	1.633862114	0.76792	-0.53	0.86595	0.58804045
External	39%	1.041455891	0.53797	-0.48344	0.50348	0.41195954

2.204623 lbs/kg

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Title: Saganashkee Slough
Notes: Global Inputs

	Historic Data	Units	Model Input	Model units
Averaging Period:	NA		1	yr
Precipitation	33.8	inches	0.85852	meters
Evaporation	30.1	inches	0.76454	meters
Increase in Storage	NA	NA		meters
Atmospheric Loads	NA	NS		

	inches to meters
Conversions:	0.0254

Note: Data extracted from Stage 1 report

SAGANASHKEE SLOUGH
SEGMENT INPUTS

Total Lake Segments	3		CONVERSION	ft to m	
				0.3048	

Segment Name:	Segment 1: RHH-3				
Outflow Segment:	Segment 2: RHH-2				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	**0.378**	km	**0.378**	km2	
Mean Depth	**3.7**	ft	**1.12776**	meters	Total Depth
Length	**0.8572**	km	**0.8572**	km	Length in GIS
Mixed Layer Depth				m	Depth where DO changes
Hypolimnetic Depth				m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	**0.1308**	mg/L	**130.8**	ug/L or ppb	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model

Segment Name:	Segment 2: RHH-2				
Outflow Segment:	Segment 3: RHH-1				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	**0.748**	km2	**0.748**	km2	
Mean Depth	**3.75**	ft	**1.143**	meters	Total Depth
Length	**1.0601**	km	**1.0601**	km	Length in GIS
Mixed Layer Depth				m	Depth where DO changes
Hypolimnetic Depth				m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	**0.13275**	mg/L	**132.75**	ug/L or ppb	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model

SAGANASHKEE SLOUGH
SEGMENT INPUTS

Segment Name:	Segment 3: RHH-1
Outflow Segment:	Out of Reservoir

	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	**0.382**	km2	**0.382**	km2	
Mean Depth	**6.375**	ft	**1.9431**	m	Total Depth
Length	**0.8048**	km	**0.8048**	km	Length in GIS
Mixed Layer Depth		ft		m	Depth where DO changes
Hypolimnetic Depth		ft		m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	**0.1412**	mg/L	**141.2**	ug/L or ppb	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model
Segment 1: RHH-3					
Segment 2: RHH-2					
Segment 3: RHH-1					

Lake	Section	Area (ac)	SqMeter	sqKm	Perimeter (km)
Saganashkee Slough	RHH-3	93.48	378302.78	0.378	2.744
Saganashkee Slough	RHH-2	184.85	748060.84	0.748	3.58
Saganashkee Slough	RHH-1	94.3	381617.34	0.382	2.689
		372.63			

SAGANASHKEE SLOUGH
TRIB INPUTS

Number of Tributaries	**3**	
Total area of the watershed =	**3658.0**	acres
Total annual estimated flow in the watershed =	**4.650207755**	mil m^3/yr

Tributary Name:	Crooked Creek					
Segment:	Segment 1: RHH-3					
Tributary Type:						
	Historic Data	Units	Model Input	Model units	Notes	
Total Watershed Area	**2699.6**	acres	**10.9**	km2		*from GIS*
Flow Rate	**3.842970034**	cfs	**3.431772575**	million meters3/yr		*from 'Surrogate Gage Calculati*
TP Conc		mg/L	54.26	ug/L		

Tributary Name:	Overland Flow -2					
Segment:	Segment 2: RHH-2					
Tributary Type:						
	Historic Data	Units	Model Input	Model units	Notes	
Total Watershed Area	**537.7**	acres	**2.2**	km2		*from GIS*
Flow Rate	**0.765442269**	cfs	**0.683540013**	million meters3/yr		*from 'Surrogate Gage Calculati*
TP Conc		mg/L	54.26	ug/L		

Tributary Name:	Overland Flow -1					
Segment:	Segment 3: RHH-1					
Tributary Type:						
	Historic Data	Units	Model Input	Model units	Notes	
Total Watershed Area	**420.8**	acres	**1.7**	km2		*from GIS*
Flow Rate	**0.598986691**	cfs	**0.534895167**	million meters3/yr		*from 'Surrogate Gage Calculati*
TP Conc		mg/L	54.26	ug/L		

SAGANASHKEE SLOUGH
TRIB INPUTS

Lake	Section	Acres	sqKm	million meters3/yr	
Saganashkee Shed	RHH-3	2699.57	10.925	3.431772575	74%
Saganashkee Shed	RHH-2	537.7	2.176	0.683540013	15%
Saganashkee Shed	RHH-1	420.77	1.703	0.534895167	12%
TOTAL		**3658.0**	**14.8**	**4.650207755**	

Unit Conversions:

1 acre= 0.004046856 square kilometer

1cfs = 0.893000087 mil m^3/yr

CDM						
Client:	Illinois EPA	Job No.	1681-70711	Computed By:	Brian Bennett	
Project:	TMDL Saganashkee Slough Watershed	Dated Checked:		Date:		4/13/2009
Calculations:	**Total Phosphorus Loads**	Checked By:		Page No.		

References:
1. "Illinois EPA Total Maximum Daily Load Tampier Lake/Saganashkee Slough Watersheds" prepared by CDM dated 2008
2. USEPA PLOAD Version 3.0 User's Manual dated January 2001
3. USGS Fact Sheet FS-195-97: "Unit-Area Loads of Suspended Sediment, Suspended Solid, And Total Phosphorus From Small Watersheds in Wisconsin" prepared by Corsi, Graczik, Owens, and

Methodology:
Saganashkee Slough Watershed is predominantly upland forest. (Reference 1, pg. 2-2)
Therefore, the export coefficient method described on Page 3 of Reference 2 is used to calculate median total phosphorus loads.
The minimum and maximum phosphorus loads are calculated using the procedure described in "Estimating Loads" section of Reference 3.

1. Calculate Median Total Phosphorus Load
Assumptions:

Export coefficients per land use (lb/ac/yr) are given in Appendix IV of Reference 2. The export coeffients for the Wisconsin area located in Appendix IV are most appropriate for the Saganashkee Slough watershed due to similar climate characteristics. The land use distribution for Saganshkee Slough watershed is given on page 5-7 of Reference 1. Export coeficients were assumed for the Saganashkee Slough Land Use categories that are not listed in the Wisconsin categories. Assumed values are indicated with bold and italics.

Saganashkee Slough Lake Watershed Information		**Total Phosphorus Export Coefficients**		**Phosphorus Loads**					Land Cover Category	Area (Acres)
Land Use	Area	High*	Low*	High	Low					
	acres	lb/ac/yr	lb/ac/yr	lb/yr	lb/yr	Source Categories				
Barren & Exposed Land	1.5	**0.16**	**0.16**	0.2	0.2	open lands	0.2		Barren & Exposed Land	1.5
Corn	0.9	0.92	0.92	0.8	0.8	95% ag	0.8		Corn	0.9
Deep Marsh	0.4	**0.22**	***0.08***	0.1	0.0	wetland (FL)) - forest	0.1		Deep Marsh	0.4
Floodplain Forest	73.6	**0.13**	***0.08***	9.6	5.9	oodland (FL) - fores	7.7		Floodplain Forest	73.6
High Density	11.8	**2.05**	1	24.1	11.8	nercial (FL) - High D	17.9		High Density	11.8
Low/Medium Density	245.8	0.52	0.04	127.8	9.8	Medium - Low density	68.8		Low/Medium Density	245.8
Other Agriculture	0	0.92	0.92	0.0	0.0	95% ag	0.0		Partial Canopy/Savannah Uplar	424.2
Other Small Grains & Hay	0	0.92	0.92	0.0	0.0	95% ag	0.0		Rural Grassland	374.9
Partial Canopy/Savannah Upland	424.2	0.13	0.08	55.1	33.9	oodland (FL) - fores	44.5		Shallow Marsh/Wet Meadow	124.0
Rural Grassland	374.9	0.5	**0.16**	187.4	60.0	% ag - open lands (F	123.7		Shallow Water	6.7
Seasonally/Temporarily Flood	0.0000	**0.22**	***0.08***	0.0	0.0	wetland (FL)) - forest	0.0		Soybeans	2.8
Shallow Marsh/Wet Meadow	124.0	**0.22**	***0.08***	27.3	9.9	wetland (FL)) - forest	18.6		Surface Water	436.3
Shallow Water	6.7	**0.22**	***0.08***	1.5	0.5	wetland (FL)) - forest	1.0		Upland	1,897.9
Soybeans	2.8	0.92	0.92	2.6	2.6	95% ag	2.6		Urban Open Space	57.2
Surface Water	436.3	**0.22**	***0.08***	96.0	34.9	wetland (FL)) - forest	65.4			3,658.0
Upland	1,897.9	**0.13**	0.08	246.7	151.8	oodland (FL) - fores	199.3			
Urban Open Space	57.2	**0.16**	0.03	9.2	1.7	pen lands (FL) - park	5.4			
Winter Wheat	0.0000	0.92	0.92	0.0	0.0	95% ag	0.0			
Winter Wheat/Soybeans	0	0.92	0.92	0.0	0.0	95% ag	0.0			
TOTAL	**3,658**			**788**	**324**		556.2			

*Export coefficient valuus listed in Appendix IV are MEDIAN values. The ranges for each land use are assumed.
Bold: No category for this land use in Wisconsin unit area loads. Use Florida unit area loads
Bold Italic: No category for this land use in Appendix IV. Use forest land use value.

Results:

The export coefficient values lised in Appendix IV of Reference 2 are median values. Therefore, the range calculated with this method is a range for the median, rather than a range between the minimum and maximum loads. The results show that the Saganashkee Slough watershed median Phosphorus load ranges between **324-788** lb/yr.

BJB
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Trib Name	Trib Area (acres)	Percent of Total	Trib Flow (mil m^3/yr)	Trib load (lbs/yr)	Trib Concentration(ug/L)
Crooked Creek (RHH-3)	2699.57	74%	3.431772575	410.487626	54.26
Direct Flow 2 (RHH-2)	537.7	15%	0.683540013	81.76087173	54.26
Direct Flow 1 (RHH-1)	420.77	12%	0.534895167	63.98088524	54.26
	3658.04	1.000010935	4.650207755	556.2293829	162.7678272

1.523916118 lbs/day

Unit Conversions:
1 cu m = 1000 liters
I pound = 453.59237 grams or 10^6 ug
(1 lb/yr) **/** (1 mil m^3/yr) = 0.45359237 ug/L

Median phosphorous load in the watershed = 556.2233007 lb/yr
Total average annual estimated flow in the watershed = 4.650207755 mil m^3/yr

Saganashkee Slough
File: **C:\BATHTUB\Saganashkee_existing_v2-cal.btb**
Variable: **TOTAL P MG/M3**

Segment	Predicted Mean	CV	Observed Mean	CV	Internal Load
Segment 1: RHH-3	133.5	0.45	130.8	0.00	**2.5**
Segment 2 : RHH-2	135.9	0.45	132.8	0.00	**2.5**
Segment 3: RHH-1	136.1	0.45	141.2	0.00	**3.75**
Area-Wtd Mean	135.4	0.45	134.4	0.00	

Saganashkee Slough
File: **C:\BATHTUB\Saganashkee_existing_v2-cal.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	Trib 1: Crooked	10.9	3.4	0.00E+00	0.00	0.31
2	1	2	Trib 2: Direct Fl	2.2	0.7	0.00E+00	0.00	0.31
3	1	3	Trib 3: Direct Fl	1.7	0.5	0.00E+00	0.00	0.31
PRECIPITATION				1.5	1.3	0.00E+00	0.00	0.86
TRIBUTARY INFLOW				14.8	4.7	0.00E+00	0.00	0.31
***TOTAL INFLOW				16.3	5.9	0.00E+00	0.00	0.36
ADVECTIVE OUTFLOW				16.3	4.8	0.00E+00	0.00	0.29
***TOTAL OUTFLOW				16.3	4.8	0.00E+00	0.00	0.29
***EVAPORATION					1.2	0.00E+00	0.00	

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

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	Trib 1: Crooked	186.2	10.1%	0.00E+00		0.00	54.3	17.1
2	1	2	Trib 2: Direct Fl	37.1	2.0%	0.00E+00		0.00	54.3	16.9
3	1	3	Trib 3: Direct Fl	29.0	1.6%	0.00E+00		0.00	54.3	17.1
PRECIPITATION				45.2	2.4%	5.12E+02	100.0%	0.50	34.9	30.0
INTERNAL LOAD				1551.4	83.9%	0.00E+00		0.00		
TRIBUTARY INFLOW				252.3	13.6%	0.00E+00		0.00	54.3	17.0
***TOTAL INFLOW				1849.0	100.0%	5.12E+02	100.0%	0.01	311.0	113.4
ADVECTIVE OUTFLOW				652.3	35.3%	8.62E+04		0.45	136.1	40.0
***TOTAL OUTFLOW				652.3	35.3%	8.62E+04		0.45	136.1	40.0
***RETENTION				1196.6	64.7%	8.65E+04		0.25		

Overflow Rate (m/yr)	3.2	Nutrient Resid. Time (yrs)	0.1481
Hydraulic Resid. Time (yrs)	0.4223	Turnover Ratio	6.8
Reservoir Conc (mg/m3)	135	Retention Coef.	0.647

Current Load	kg/yr	lbs/yr	lbs/day	% of total
Total	1849.0	4076.259	11.1678332	100%
Internal	1551.4	3420.251	9.37055022	84%
External	297.6	656.0082	1.797282864	16%

Saganashkee Slough
File: **C:\BATHTUB\Saganashkee_TMDL_v1.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	Trib 1: Crooked	10.9	3.4	0.00E+00	0.00	0.31
2	1	2	Trib 2: Direct Fl	2.2	0.7	0.00E+00	0.00	0.31
3	1	3	Trib 3: Direct Fl	1.7	0.5	0.00E+00	0.00	0.31
PRECIPITATION				1.5	1.3	0.00E+00	0.00	0.86
TRIBUTARY INFLOW				14.8	4.7	0.00E+00	0.00	0.31
***TOTAL INFLOW				16.3	5.9	0.00E+00	0.00	0.36
ADVECTIVE OUTFLOW				16.3	4.8	0.00E+00	0.00	0.29
***TOTAL OUTFLOW				16.3	4.8	0.00E+00	0.00	0.29
***EVAPORATION					1.2	0.00E+00	0.00	

Overall Mass Balance Based Upon Predicted Outflow & Reservoir Concentrations

Component: **TOTAL P**

Trb	Type	Seg	Name	Load kg/yr	%Total	Load Variance (kg/yr)^2	%Total	CV	Conc mg/m^3	Export g/km^2/yr
1	1	1	Trib 1: Crooked	137.3	34.6%	0.00E+00		0.00	40.0	12.6
2	1	2	Trib 2: Direct Fl	27.3	6.9%	0.00E+00		0.00	40.0	12.4
3	1	3	Trib 3: Direct Fl	21.4	5.4%	0.00E+00		0.00	40.0	12.6
PRECIPITATION				45.2	11.4%	5.12E+02	100.0%	0.50	34.9	30.0
INTERNAL LOAD				165.2	41.7%	0.00E+00		0.00		
TRIBUTARY INFLOW				186.0	46.9%	0.00E+00		0.00	40.0	12.6
***TOTAL INFLOW				396.5	100.0%	5.12E+02	100.0%	0.06	66.7	24.3
ADVECTIVE OUTFLOW				237.5	59.9%	1.15E+04		0.45	49.6	14.6
***TOTAL OUTFLOW				237.5	59.9%	1.15E+04		0.45	49.6	14.6
***RETENTION				159.0	40.1%	1.16E+04		0.68		

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Appendix E
Responsiveness Summary

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Appendix E: Tampier Lake and Saganashkee Slough TMDL Responsiveness Summary

This responsiveness summary responds to substantive questions and comments received during the public comment period from August 5, 2009 through September 24, 2009 postmarked, including those from the August 25, 2009 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. This TMDL is for the Tampier Lake and Saganashkee Slough watersheds and will address the phosphorus impairment in the lakes. This report details the watershed characteristics, impairment, sources, load and wasteload allocations, and reductions for each lake. The Illinois EPA implements the TMDL program in accordance with Section 303(d) of the federal Clean Water Act and its regulations.

Background

The Tampier Lake watershed is located in northern Illinois and drains approximately 1,581 acres within the state of Illinois. The Saganashkee Slough watershed drains approximately 3,658 acres. The land cover data reveal that the Tampier Lake watershed is dominated by upland forest and rural grassland which combined cover nearly half of the watershed. Another 23 percent of the watershed is comprised of surface water and surrounding marshes, while 18 percent is urban area. Over half of the Saganashkee Slough watershed is covered by upland forest. Another 15 percent of the watershed is comprised of surface water and surrounding marshes, while 9 percent of the watershed is urban area. Tampier Lake is impaired for aquatic life and aesthetic quality designated uses due to phosphorus, siltation/sedimentation, aquatic algae and aquatic plants (macrophytes). Saganashkee Slough is impaired for aquatic life and aesthetic quality designated uses due to dissolved oxygen, phosphorus, sedimentation/siltation and aquatic algae. The Clean Water Act and USEPA regulations require that states develop TMDLs for impaired waters.

Public Meetings

Public meetings were held in Palos Park on November 6, 2008 and August 24, 2009. Approximately 15 people attended the first meeting and two attended the final meeting. The Illinois EPA provided public notices for all meetings by placing a display ad in the *Palos Citizen*. Public notices were also sent to stakeholders in the watershed. These notices gave the date, time, location, and purpose of the meetings. It also provided references to obtain additional information about this specific site, the TMDL Program and other related issues. Individuals and organizations were sent the public notice by first class mail. The draft TMDL Report was available for review at the Palos Park Village Hall and on the Agency's web page at http://www.epa.state.il.us/water/tmdl .

Comments

There were no comments for this TMDL.

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