STAGE 1 DRAFT FOR PUBLIC REVIEW

Rock River and Pierce Lake Watershed TMDL HUC 0709000501 Draft Stage 1 Report

Prepared for Illinois EPA

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CDM Smith

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Acronyms

BMPs	best management practices
CBOD	carbonaceous biochemical oxygen demand
cfs	cubic feet per second
cfu	colony forming unit
CWA	Clean Water Act
DO	dissolved oxygen
GIS	geographic information system
IDA	Illinois Department of Agriculture
Illinois EPA	Illinois Environmental Protection Agency
IPCB	Illinois Pollution Control Board
ISWS	Illinois State Water Survey
LA	Load Allocation
LC	Loading Capacity
LRS	load reduction strategy
µg/L	micrograms per liter
mg/L	milligrams per liter
mL	milliliters
MOS	Margin of Safety
NA	not applicable
NASS	National Agricultural Statistics Service
NCDC	National Climatic Data Center
NCEI	National Centers for Environmental Information
NED	National Elevation Dataset
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
RC	Reserve Capacity
SOD	sediment oxygen demand
s.u.	standard units
SSURGO	Soil Survey Geographic
STORET	Storage and Retrieval
TMDL	total maximum daily load
TSS	total suspended solids
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	U.S. Geological Survey
USLE	Universal Soil Loss Equation
WLA	Waste Load Allocation

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Section 1

Goals and Objectives for the Rock River/Pierce Lake Watershed

1.1 Total Maximum Daily Load Overview

A total maximum daily load, or TMDL, is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs are a requirement of Section 303(d) of the Clean Water Act (CWA). To meet this requirement, the Illinois Environmental Protection Agency (Illinois EPA) must identify water bodies not meeting water quality standards and then establish TMDLs for restoration of water quality. Illinois EPA develops a list known as the "303(d) list" of water bodies not meeting water quality standards every two years, and it is included in the Integrated Water Quality Report. Water bodies on the 303(d) list are then targeted for TMDL development. Illinois EPA's most recent draft 2018 Integrated Water Quality Report was issued on November 14, 2018[1], and the Agency is working with USEPA to address comments received during the public notice period. Water bodies listed as impaired in this TMDL report are from the most recent final Integrated Water Quality Report and 303(d) List from 2016[2]. 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 (Appendix A of the final 2016 Integrated Water Quality Report[3]).

In general, a TMDL is a quantitative assessment of water quality impairments, contributing potential 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; and
- 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:

[1] https://www2.illinois.gov/epa/topics/water-quality/watershed-management/tmdls/Documents/Draft-2018-Integrated-Report-11-14-2018.pdf
[2] https://www2.illinois.gov/epa/Documents/iepa/water-quality/watershed-management/tmdls/2016/303-d-list/iwq-report-surface-water.pdf
[3] https://www2.illinois.gov/epa/topics/water-quality/watershed-management/tmdls/Pages/303d-list.aspx

- 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 the Rock River/Pierce Lake Watershed

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

Stage 1 – Watershed Characterization, Data Analysis, Methodology Selection

Stage 2 – Data Collection (optional)

Stage 3 – Model Calibration, TMDL Scenarios, Implementation Plan

Illinois EPA uses the US Geologic Survey (USGS) 10-digit hydrologic unit code (HUC) to group subbasins into TMDL watersheds. This report addresses Stage 1 TMDL development for the Rock River/Pierce Lake watershed (HUC 0709000501). Stages 2 and 3 will be conducted upon completion of Stage 1. Stage 2 is optional as data collection may not be necessary if additional data are not required to establish the TMDL.

Following this process, the TMDL goals and objectives for the Rock River/Pierce Lake watershed will include developing TMDLs for all impaired water bodies within the watershed, describing all of the necessary elements of the TMDL, developing a watershed-based plan (WBP) for each TMDL, and gaining public acceptance of the process. Following are the impaired water body segments in the Rock River/Pierce Lake watershed:

- Keith Creek (segments PR-01 and PR-99)
- North Fork Kent Creek (PSB-01)
- South Fork Kent Creek (PSA)
- North Kinnikinnick Creek (PU)
- South Kinnikinnick Creek (PT)
- Spring Creek – North (PZZG)
- Pierce Lake (RPC)

The impaired water body segments are shown on **Figure 1-1**. There are seven impaired stream segments and one impaired lake within the Rock River/Pierce Lake watershed addressed in this report. **Table 1-1** lists the water body segment, potential causes of impairment, use description and potential sources of impairment for the water body.

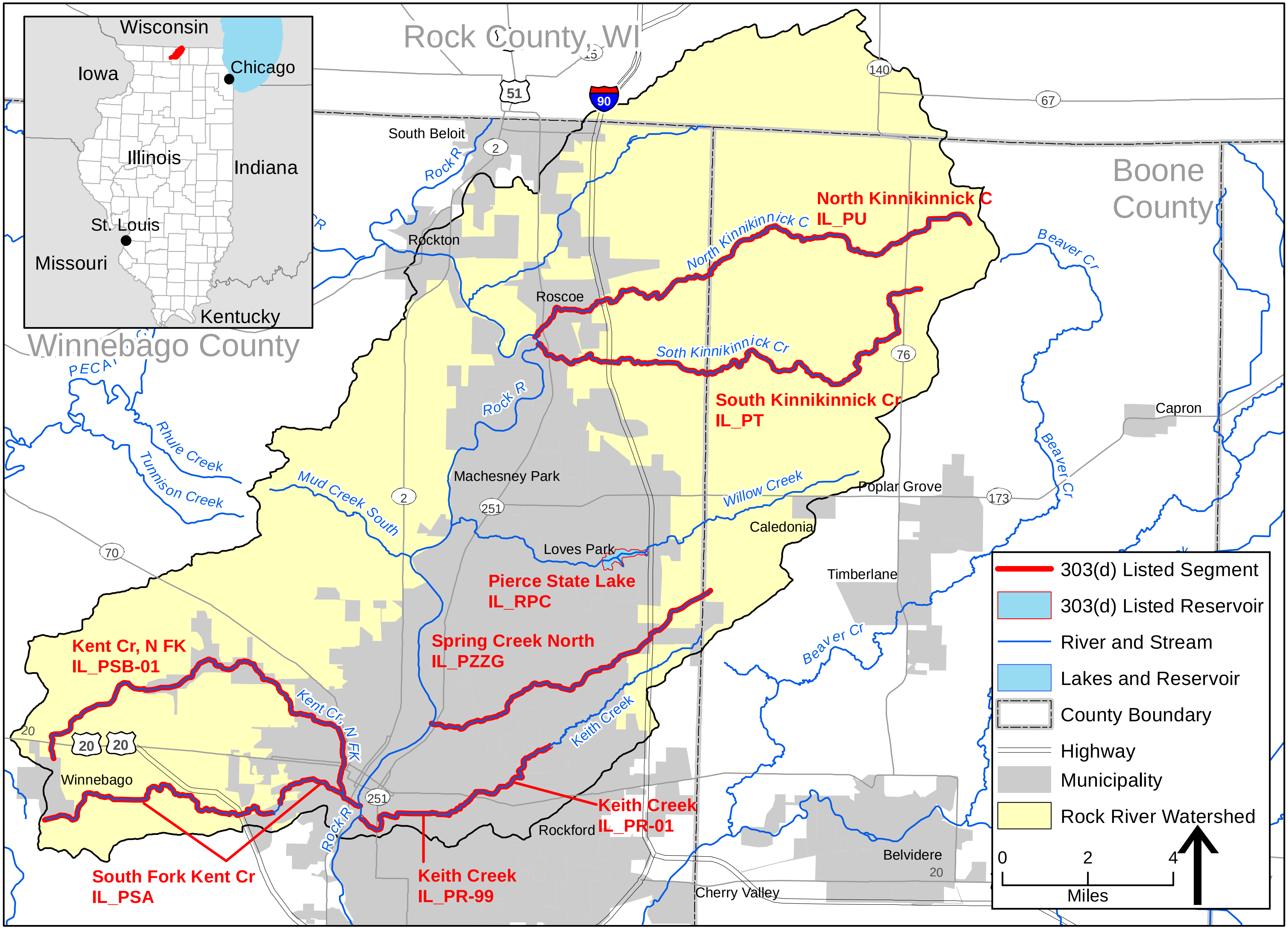

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Figure 1-1: Rock River/Pierce Lake Watershed
HUC 0709000501

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Table 1-1 Impaired Water Bodies in Rock River/Pierce Lake Watershed

Segment ID	Segment Name	Potential Causes of Impairment	Impaired Use	Potential Sources (as identified by the 2016 303(d) list)
PR-01	Keith Creek	**Fecal Coliform**	Primary Contact Recreation	Urban Runoff/Storm Sewers
PR-99	Keith Creek	**Fecal Coliform**	Primary Contact Recreation	Urban Runoff/Storm Sewers
		Arsenic	Aquatic Life	Channelization, Urban Runoff/Storm Sewers, Contaminated Sediments
		pH	Aquatic Life	Channelization, Urban Runoff/Storm Sewers
		Zinc	Aquatic Life	Channelization, Urban Runoff/Storm Sewers, Contaminated Sediments
PSB-01	North Fork Kent Creek	**Fecal Coliform**	Primary Contact Recreation	Source Unknown
PSA	South Fork Kent Creek	**Fecal Coliform**	Primary Contact Recreation	Source Unknown
PU	North Kinnikinnick Creek	**Fecal Coliform**	Primary Contact Recreation	Source Unknown
PT	South Kinnikinnick Creek	**Fecal Coliform**	Primary Contact Recreation	Source Unknown
PZZG	Spring Creek - North	**Fecal Coliform**	Primary Contact Recreation	Source Unknown
RPC	Pierce Lake	**Phosphorus (Total)**	Aesthetic Quality	Internal nutrient recycling, On-site treatment systems, Waterfowl, Crop production (crop land or dry land), Runoff from Forest/Grassland/Parkland

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

- Loading Capacity (LC) or the maximum amount of pollutant loading a water body can receive without violating water quality standards
- Waste Load Allocation (WLA) or the portion of the TMDL allocated to existing or future point sources
- Load Allocation (LA) or the portion of the TMDL allocated to existing or future nonpoint sources and natural background
- Margin of Safety (MOS) or an accounting of uncertainty about the relationship between pollutant loads and receiving water quality
- Reserve Capacity (RC) or a portion of the load explicitly set aside to account for growth in the watershed

These elements are combined into the following equation:

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

TMDLs will consider the seasonal variability of pollutant loads so that applicable water quality standards are met during all seasons of the year. Also, reasonable assurance that the TMDLs will be achieved will be described in the WBP. The WBP for the Rock River/Pierce Lake watershed will describe how water quality standards and goals will be met and attained. This WBP will include 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 Rock River/Pierce Lake Watershed Characteristics** provides a description of the watershed's location, topography, geology, land use, soils, population, and hydrology.
- **Section 3 Public Participation and Involvement** discusses public participation activities that will occur throughout TMDL development.
- **Section 4 Rock River/Pierce Lake Watershed Water Quality Standards and Guidelines** defines the water quality standards and water quality guidelines for the impaired water bodies.
- **Section 5 Rock River/Pierce Lake Watershed Data and Potential Pollutant Sources** presents the available water quality data needed to develop TMDLs, discusses the characteristics of the impaired stream segments in the watershed, and also describes the point and nonpoint sources with potential to contribute to the watershed load.
- **Section 6 Approach to Developing TMDL and Identification of Data Needs** makes recommendations for the models and analysis that are needed for TMDL development and suggests segments for Stage 2 data collection.
- **Section 7 References**

Section 2

Rock River/Pierce Lake Watershed Characteristics

2.1 Rock River/Pierce Lake Watershed Location

The Rock River/Pierce Lake watershed (HUC 0709000501 shown on **Figure 1-1**) is located in north-central Illinois and drains approximately 149,300 acres, roughly 139,100 acres of which drain land within Illinois, and the remaining 10,200 acres draining areas within the state of Wisconsin. In Illinois, approximately 107,000 acres (71.7 percent of the total watershed) lie in Winnebago County and 32,100 acres (21.5 percent of the total watershed) lie in Boone County. Note that the scope of this report is largely limited to the Illinois portion of the watershed and the impaired water bodies addressed are all in Illinois.

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)[1] coverages containing 30-meter grid resolution elevation data are available from the U.S. Geological Survey (USGS) for each 1:24,000-topographic quadrangle in the United States. Elevation data for the Rock River/Pierce Lake watershed were obtained by overlaying the NED grid onto the geographic information system (GIS)-delineated watershed. **Figure 2-1** shows the elevations found within the watershed. Elevation in the Rock River/Pierce Lake watershed ranges from approximately 1,000 feet above sea level in the north-central portion of the watershed to 670 feet above sea level near the confluence of Keith Creek and the Rock River.

2.3 Land Use

Land use data for the Rock River/Pierce Lake watershed were extracted from the U.S. Department of Agriculture's (USDA) National Agriculture Statistics Service (NASS) 2018 Cropland Data Layer (CDL)[2]. The CDL is a raster based, geo-referenced, crop-specific land cover data layer created to provide acreage estimates to the Agricultural Statistics Board for the state's major commodities and to produce digital, crop-specific, categorized geo-referenced output products. This information is made available to all agencies and to the public free of charge and represents the most accurate and up-to-date land cover datasets available at a national scale. The most recent available CDL dataset was produced in 2018 and includes 33 separate land use classes applicable to the watershed. The available resolution of the land cover dataset is 30 square meters.

Land use characteristics of the watershed were determined by overlaying the Illinois Statewide 2018 CDL data layers onto the GIS-delineated watershed. **Table 2-1** contains the main categories of land uses covering the Rock River/Pierce Lake watershed, based on the 2018 CDL land cover

[1] https://catalog.data.gov/dataset/usgs-national-elevation-dataset-ned
[2] https://www.nass.usda.gov/Research_and_Science/Cropland/Release/index.php

categories, and also includes the area of each land cover category and percentage of the watershed area. **Figure 2-2** illustrates the land uses of the watershed. Appendix A contains a table of all land uses in the watershed.

Table 2-1 Land Use and Land Cover in Rock River/Pierce Lake Watershed

USDA/NASS Land Use Cropland Category	Acres	Percentage
Corn	34,695	23.2%
Developed/Low Intensity	24,538	16.4%
Soybeans	22,030	14.7%
Deciduous Forest	16,110	10.8%
Developed/Open Space	14,494	9.7%
Developed/Med Intensity	9,777	6.5%
Grass/Pasture	9,453	6.3%
Background	8,908	6.0%
Developed/High Intensity	3,239	2.2%
Open Water	1,528	1.0%
Shrubland	1,379	0.9%
Alfalfa	914	0.6%
Winter Wheat	676	0.5%
Herbaceous Wetlands	595	0.4%
All Others	1,058	0.7%
Total	**149,394**	**100%**

The land cover data reveal that 58,315 acres, representing 39 percent of the total watershed area, are devoted to agricultural activities. Corn and soybean make up 97.3 percent of the agricultural land use within the watershed. Forests and woodlands cover 11.7 percent of the watershed (17,489 acres) and grasslands or pastures cover 6.3 percent (9,453 acres). Approximately 35 percent of the watershed area (52,048 acres) is developed, urbanized land. The remaining watershed is wetland or open water.

2.3.1 Subbasin Land Use

The subbasin areas draining to each impaired segment within the Rock River/Pierce Lake watershed were further delineated through GIS. Land cover data were then intersected with the subbasin boundaries to determine the land uses contributing runoff to each impaired waterbody, as shown in **Tables 2-2 through 2-9**. Note that each table includes data on all lands upgradient of an impaired segment, including areas that may contribute to other impaired segments upgradient.

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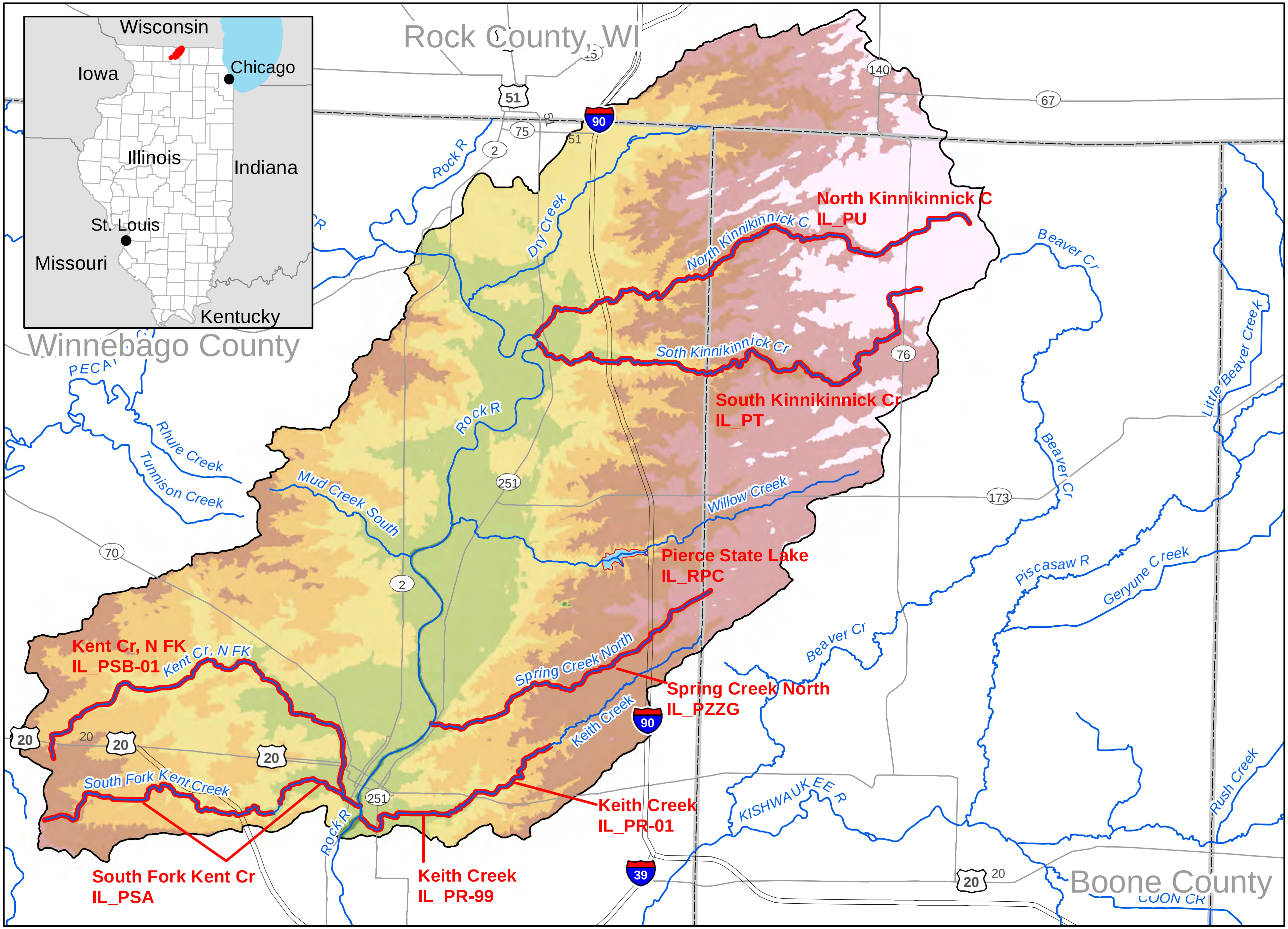

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Figure 2-1: Rock River/Pierce Lake Watershed Elevation

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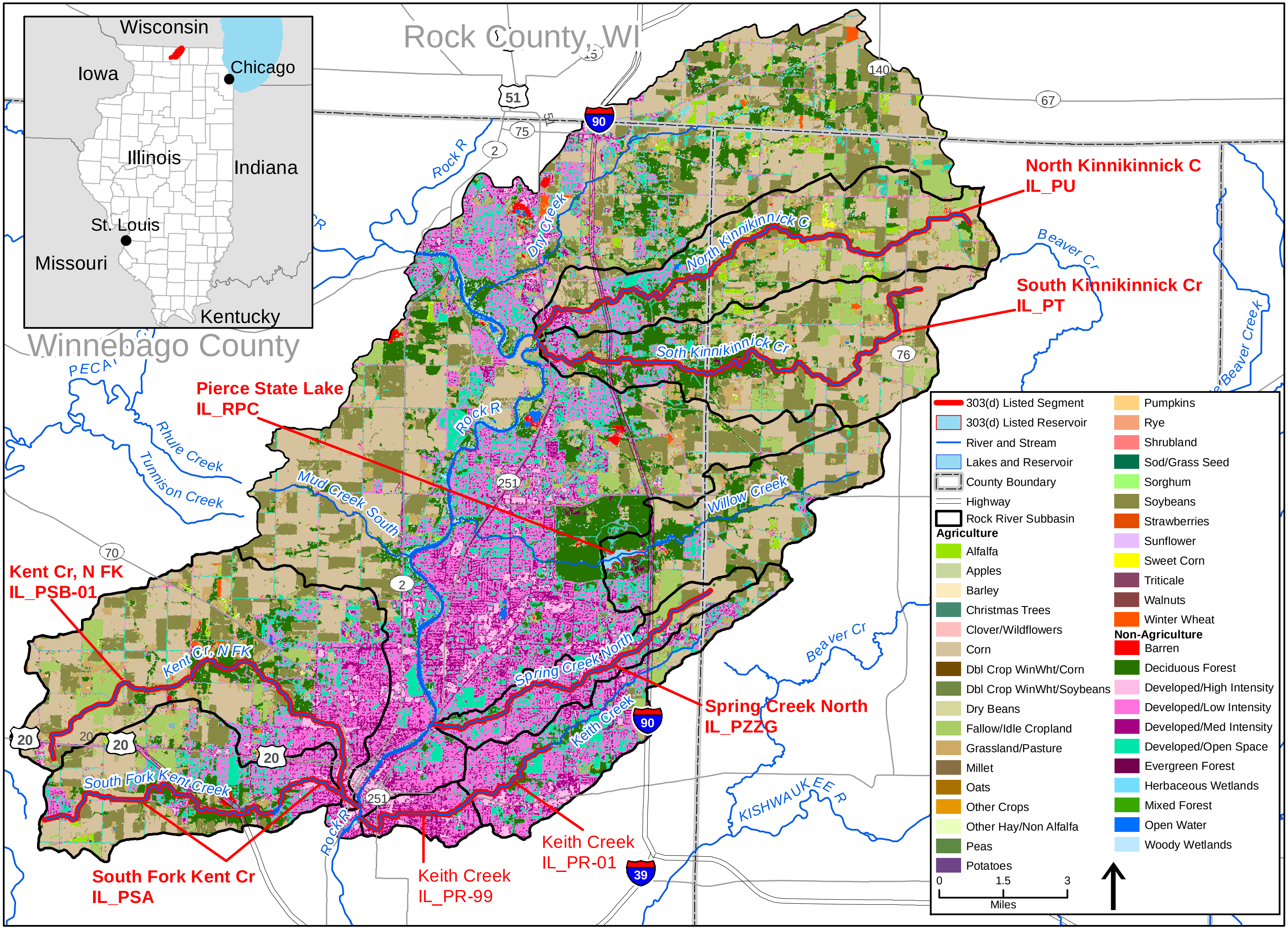

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Figure 2-2: Rock River/Pierce Lake Watershed Land Use

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Table 2-2 Land Use and Land Cover in the Pierce Lake (RPC) Watershed

Land Cover Category	Area (Acres)	Percentage
Corn	2,687	31.8%
Soybeans	2,232	26.5%
Deciduous Forest	1,518	18.0%
Developed/Open Space	620	7.3%
Developed/Low Intensity	515	6.1%
Grass/Pasture	337	4.0%
Open Water	198	2.3%
Developed/Med Intensity	103	1.2%
Alfalfa	76	0.9%
Shrubland	75	0.9%
Herbaceous Wetlands	17	0.2%
All Others	60	0.7%
Total	**8,438**	**100%**

Table 2-3 Land Use and Land Cover in the Keith Creek Segment PR-99 Watershed

Land Cover Category	Area (Acres)	Percentage
Developed/Low Intensity	3,290	37.2%
Developed/Open Space	1,608	18.2%
Developed/Med Intensity	1,599	18.1%
Developed/High Intensity	593	6.7%
Corn	509	5.7%
Soybeans	490	5.5%
Deciduous Forest	474	5.4%
Grass/Pasture	245	2.8%
All Others	46	0.5%
Total	**8,854**	**100%**

Table 2-4 Land Use and Land Cover in the Keith Creek Segment PR-01 Watershed

Land Cover Category	Area (Acres)	Percentage
Developed/Low Intensity	2,584	35.6%
Developed/Open Space	1,525	21.0%
Developed/Med Intensity	1,018	14.0%
Corn	509	7.0%
Soybeans	490	6.8%
Deciduous Forest	463	6.4%
Developed/High Intensity	372	5.1%
Grass/Pasture	245	3.4%
All Others	45	0.6%
Total	**7,251**	**100%**

Table 2-5 Land Use and Land Cover in the Spring Creek - North Segment PZZG Watershed

Land Cover Category	Area (Acres)	Percentage
Developed/Low Intensity	1,595	38.8%
Developed/Open Space	757	18.4%
Corn	734	17.9%
Developed/Med Intensity	510	12.4%
Soybeans	220	5.4%
Deciduous Forest	121	2.9%
Developed/High Intensity	86	2.1%
Grass/Pasture	66	1.6%
All Others	20	0.5%
Total	**4,109**	**100%**

Table 2-6 Land Use and Land Cover in the South Fork Kent Creek Segment PSA Watershed

Land Cover Category	Area (Acres)	Percentage
Corn	2,403	23.9%
Developed/Low Intensity	1,956	19.5%
Soybeans	1,519	15.1%
Deciduous Forest	1,298	12.9%
Developed/Open Space	1,185	11.8%
Grass/Pasture	685	6.8%
Developed/Med Intensity	551	5.5%
Developed/High Intensity	145	1.4%
Winter Wheat	99	1.0%
Alfalfa	57	0.6%
Barren	47	0.5%
All Others	94	0.9%
Total	**10,039**	**100%**

Table 2-7 Land Use and Land Cover in the North Fork Kent Creek Segment PSB-01 Watershed

Land Cover Category	Area (Acres)	Percentage
Corn	6,307	32.5%
Soybeans	3,423	17.6%
Developed/Low Intensity	2,927	15.1%
Deciduous Forest	1,823	9.4%
Grass/Pasture	1,481	7.6%
Developed/Open Space	1,375	7.1%
Developed/Med Intensity	1,189	6.1%
Developed/High Intensity	393	2.0%
Winter Wheat	125	0.6%
Shrubland	98	0.5%
Herbaceous Wetlands	76	0.4%
Alfalfa	69	0.4%
All Others	140	0.7%
Total	**19,426**	**100%**

Table 2-8 Land Use and Land Cover in the South Kinnikinnick Creek Segment PT Watershed

Land Cover Category	Area (Acres)	Percentage
Corn	4,346	32.0%
Soybeans	3,487	25.7%
Deciduous Forest	2,331	17.2%
Grass/Pasture	1,126	8.3%
Developed/Low Intensity	847	6.2%
Developed/Open Space	798	5.9%
Shrubland	287	2.1%
Alfalfa	110	0.8%
Developed/Med Intensity	94	0.7%
Herbaceous Wetlands	53	0.4%
All Others	104	0.8%
Total	**13,583**	**100%**

Table 2-9 Land Use and Land Cover in the North Kinnikinnick Creek Segment PU Watershed

Land Cover Category	Area (Acres)	Percentage
Corn	4,540	35.1%
Soybeans	2,203	17.0%
Deciduous Forest	1,635	12.6%
Grass/Pasture	1,581	12.2%
Developed/Open Space	1,008	7.8%

Developed/Low Intensity	944	7.3%
Alfalfa	280	2.2%
Shrubland	235	1.8%
Developed/Med Intensity	164	1.3%
Herbaceous Wetlands	108	0.8%
Winter Wheat	85	0.7%
Other Hay/Non Alfalfa	47	0.4%
Developed/High Intensity	41	0.3%
All Others	65	0.5%
Total	**12,936**	**100%**

2.4 Soils

Soils data are available through the Soil Survey Geographic (SSURGO) database[3]. 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 Natural Resources Conservation Service (NRCS).

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

2.4.1 Rock River/Pierce Lake Watershed Soil Characteristics

Appendix B contains a table of the SSURGO soil series for the Rock River/Pierce Lake watershed. A total of 162 soil types exist in the watershed. The most common type—Griswold loam (6 to 12 percent slopes) – covers 8 percent of the watershed. The second and third most common type – Comfrey loam (0 to 2 percent slopes) and Flagler sandy loam (0 to 2 percent slopes) each cover 4% of the watershed. All other individual soil types each represent less than 4 percent of the total watershed area. The table in Appendix B also contains the area, dominant hydrologic soil group, and k-factor range. Each of these characteristics is described in more detail in the following paragraphs.

Figure 2-3 shows the hydrologic soils groups found within the Rock River/Pierce Lake watershed. Hydrologic soil groups are used to estimate runoff from precipitation. Soils are assigned to one of four groups according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms:

- Group A: Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil.
- Group B: Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded.

[3] https://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=IL

- Group C: Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted.
- Group D: Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted.

While hydrologic soil groups A, B, C, D, A/D, and B/D are all found within the Rock River/Pierce Lake watershed, group B soils are the most common type representing about 61 percent of the watershed. Groups A/D and B/D are dual hydrologic soil group. Dual hydrologic soil groups can be adequately drained. The first letter applies to the drained condition and the second letter to the undrained condition. For the purpose of hydrologic soil group, adequately drained means that the seasonal high-water table is kept at 24 inches below the surface[4].

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 Rock River/Pierce Lake watershed range from 0.20 to 0.47 (**Figure 2-4**).

2.5 Population

The Census TIGER/Line data[5] from the U.S. Census Bureau were reviewed along with shapefiles of census blocks[6] that are available for the entire state of Illinois. All census blocks that have geographic center points (centroids) within the watershed were selected and tallied in order to provide an estimate of populations in all census blocks both completely and partially contained by the watershed boundary. Given that the optimal size of a census block group is 1,500 people, and 178 block group centroids are located within the watershed, it is estimated that approximately 267,000 people reside in the Rock River/Pierce Lake watershed. The major municipalities in the watershed are shown in **Figure 1-1**. The largest urban development in the watershed is the city of Rockford, which lies partially within the watershed and has an estimated population of approximately 147,651 people within the watershed.

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[4] Natural Resources Conservation Service. Part 360 Hydrology National Engineering Handbook. 2007.
[5] https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html
[6] https://www.census.gov/geographies/reference-maps/2010/geo/2010-census-block-maps.html

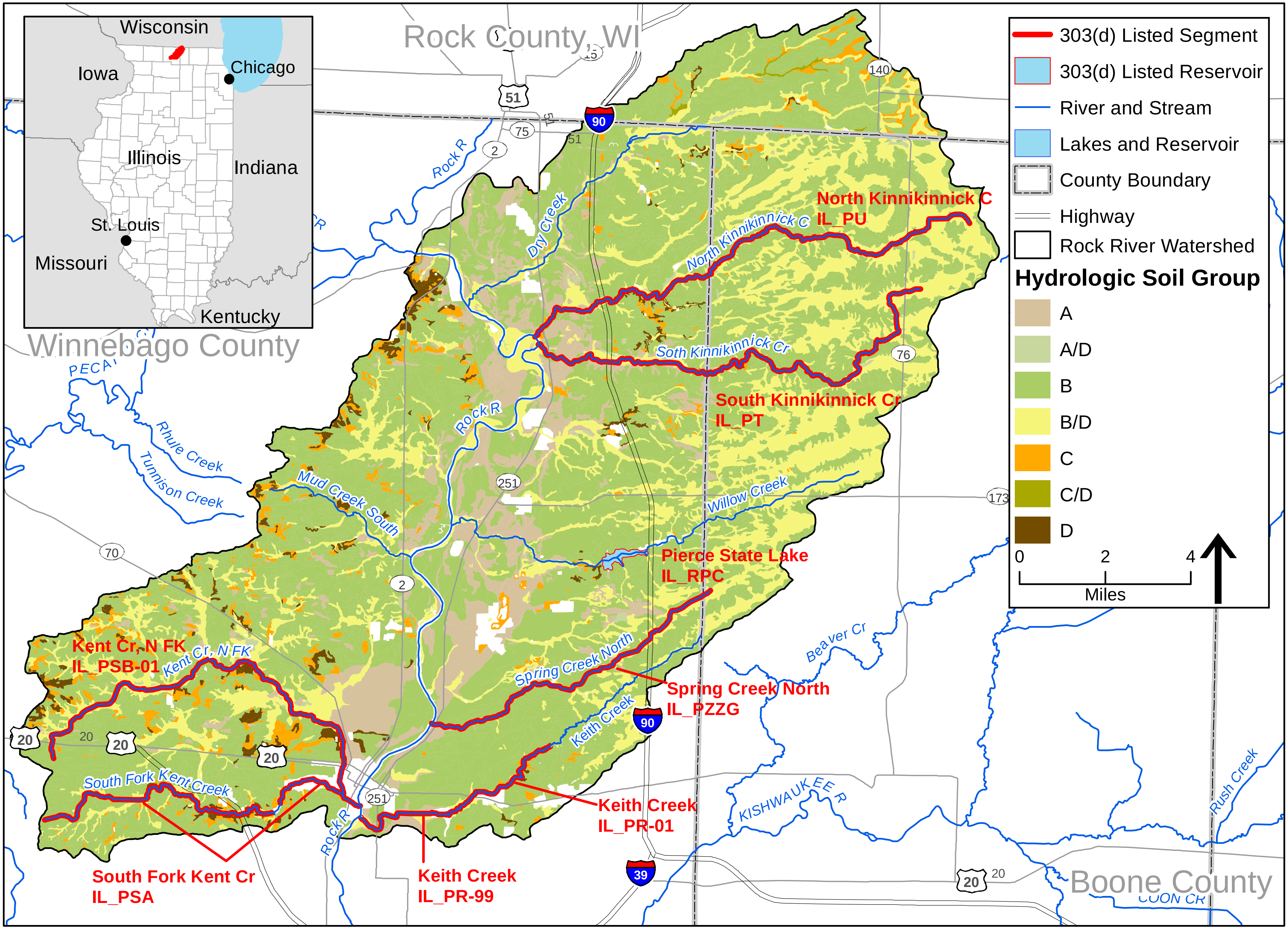

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Figure 2-3: Rock River/Pierce Lake Watershed Soils

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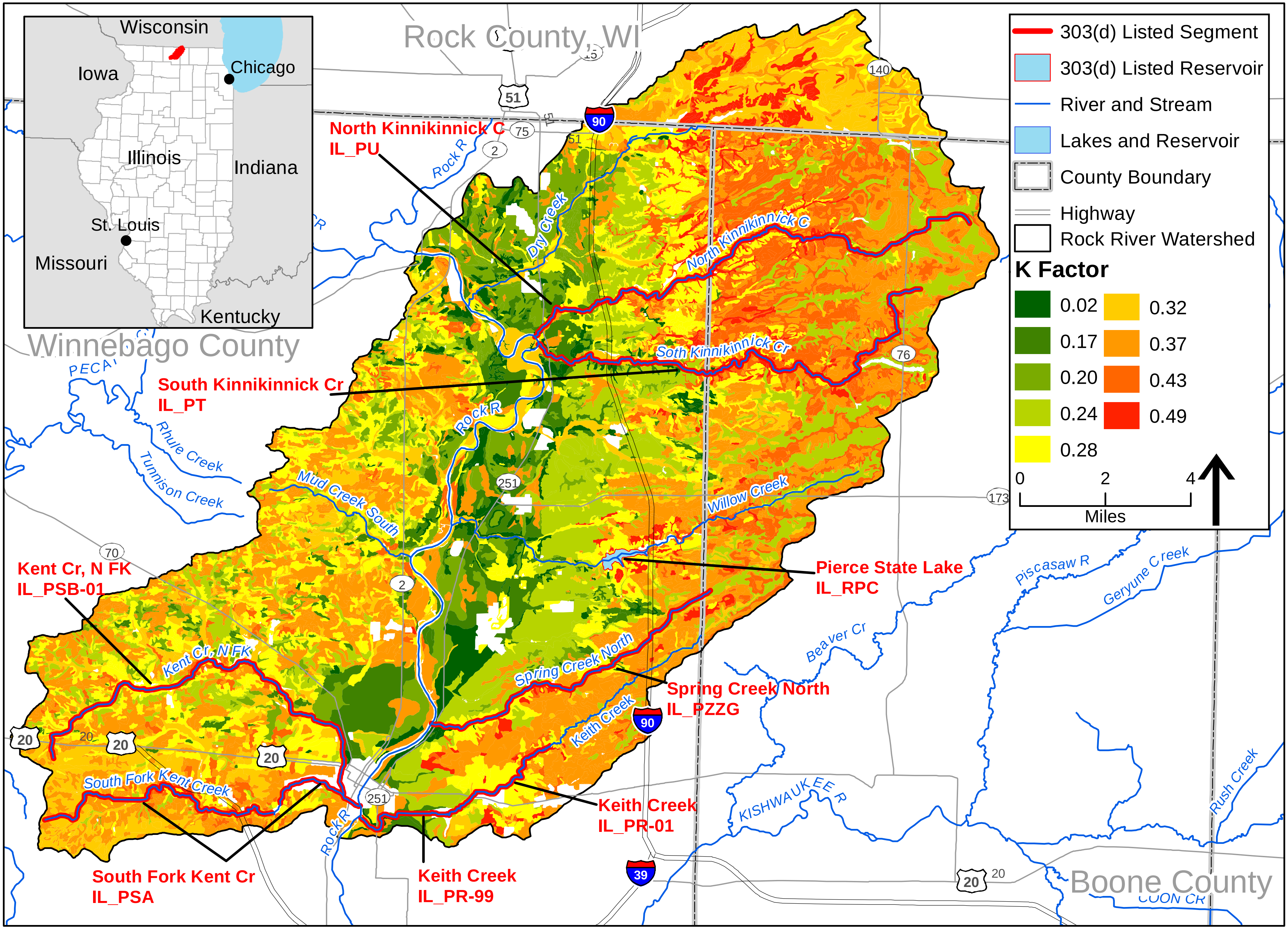

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Figure 2-4: Rock River/Pierce Lake Watershed K-Factor

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2.6 Climate, Pan Evaporation, and Streamflow

2.6.1 Climate

Northern Illinois has a temperate climate with hot summers and cold, moderately snowy winters. Monthly temperature and precipitation data from Greater Rockford Airport, Illinois (station ID USW00094822), located approximately 3.5 miles south of the watershed, were extracted from the National Centers for Environmental Information (NCEI) database[7] for the years 1951 through 2019. This station was selected due to its proximity to the watershed and completeness of its dataset.

Table 2-10 contains the average monthly precipitation along with average high and low temperatures for the period of record. The average annual precipitation is approximately 37 inches. Summer months are historically the wettest months while January and February are the driest.

Table 2-10 Average Monthly Climate Data for Greater Rockford Airport, Illinois

Month	Average Total Precipitation (inches)	Average Daily Maximum Temperature (degrees F)	Average Daily Minimum Temperature (degrees F)
January	1.4	28.0	11.7
February	1.4	32.7	16.0
March	2.4	44.6	26.4
April	3.8	59.3	37.6
May	3.9	71.1	48.2
June	4.8	80.4	58.2
July	4.2	84.0	62.7
August	4.2	81.9	60.9
September	3.5	75.0	52.4
October	2.8	62.6	40.9
November	2.4	46.6	29.3
December	2.0	33.0	17.8
Total	36.8*	58.3	38.5

* Average Annual Precipitation

2.6.2 Pan Evaporation

Through data request from the Illinois State Water Survey (ISWS) website, pan evaporation data are available from nine locations across Illinois (ISWS 2014)[8]. The DeKalb, Illinois station was chosen to be representative of pan evaporation conditions for the Rock River/Pierce Lake watershed. The DeKalb station is located approximately 30 miles south-southeast of the Rock River/Pierce Lake watershed. This station was chosen due to its being the closest pan evaporation station to the Rock River/Pierce Lake watershed. The average annual pan evaporation at the DeKalb station for the years 1987, 1988, 1990, and 1997 to 2014 is 37.3 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 27.0 inches.

[7] https://www.ncdc.noaa.gov/data-access/land-based-station-data

[8] https://www.isws.illinois.edu/warm/reservoirs/contact.asp.

2.6.3 Streamflow

Analysis of the Rock River/Pierce Lake watershed requires an understanding of flow throughout the drainage area. There are three active USGS stream gages[9] throughout the watershed that may be used to estimate stream flows for all impaired segments (**Figure 2-5**). **Table 2-11** summarizes the station information.

Table 2-11 USGS Stream Gages

Gage Number	Name	POR
USGS 05437641	Rock River at Auburn St. in Rockford[1]	2002-2020
USGS 05437610	Rock River at Latham Park, IL[1]	2002-2020
USGS 05437500	Rock River at Rockton, IL	1903-2020

[1] Gaging station includes gage height measurements only, no discharge values reported

Data from these gages will be used to estimate flow values for each impaired stream segment within the Rock River/Pierce Lake watershed for purposes of TMDL development. Estimates of flow values for impaired segments will be corrected for each segment's watershed size using the drainage area ratio method, represented by the following equation:

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

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.

[9] https://waterdata.usgs.gov/IL/nwis/current/?type=dailydischarge&group_key=basin_cd

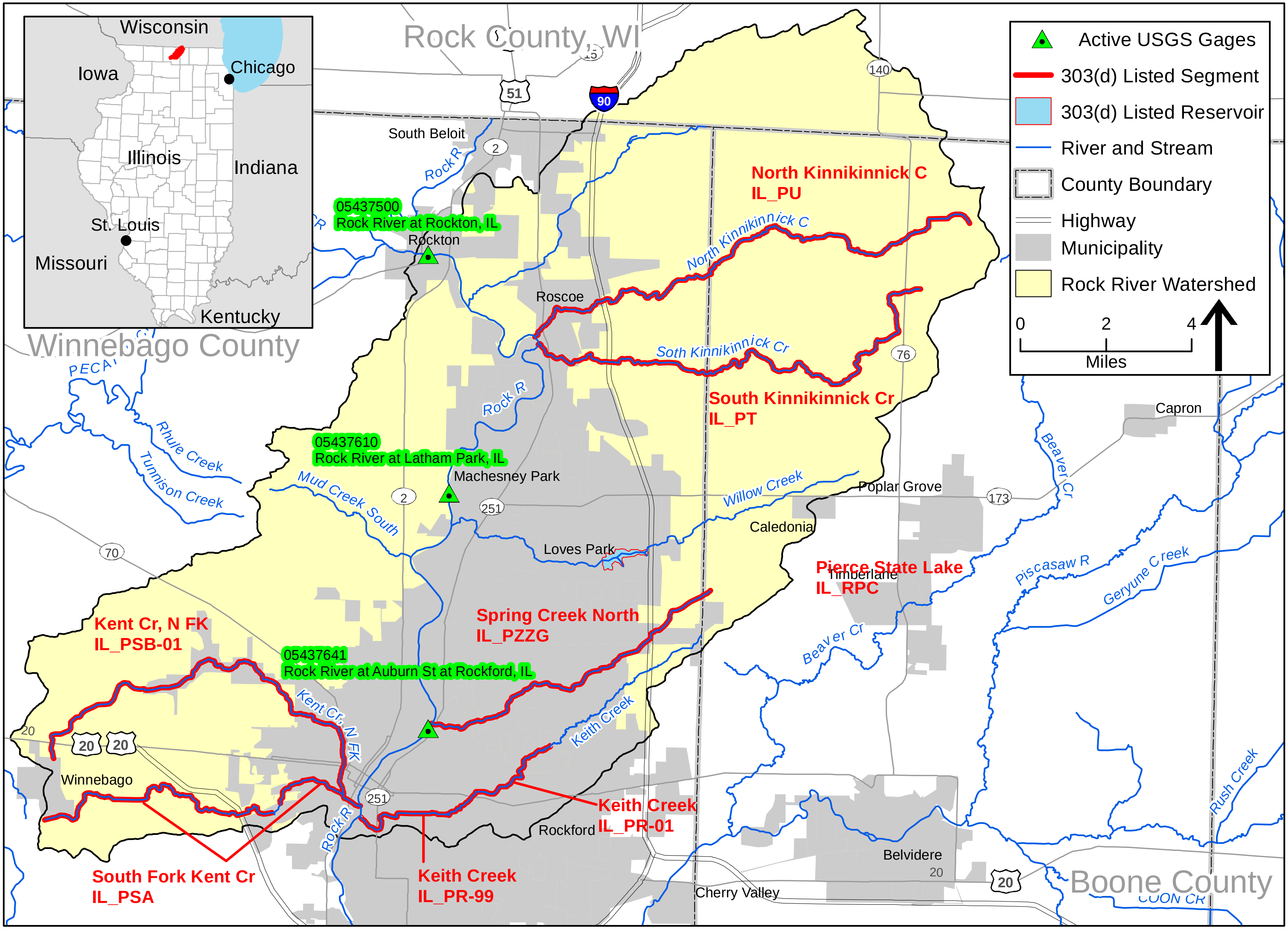

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Figure 2-5: Rock River/Pierce Lake Watershed Active USGS Gages

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Section 3

Rock River/Pierce Lake Watershed Public Participation

3.1 Rock River/Pierce Lake Watershed Public Participation and Involvement

Public knowledge, acceptance, and follow-through are necessary to implement a plan to meet recommended TMDLs and WBPs. 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 Smith, will hold a public meeting in the Rock River/Pierce Lake watershed at the completion of Stages 1 and 3. Comments received through the public meeting process will be included in an appendix. This section will be updated following each public meeting.

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Section 4

Rock River/Pierce Lake Watershed Water Quality Standards and Guidelines

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, water quality standards are established by 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[1].

4.2 Designated Uses

The waters of Illinois are classified by designated uses, which include: General Use, Public and Food Processing Water Supplies, Lake Michigan Basin, and Secondary Contact and Indigenous Aquatic Life Use[2]. The designated use applicable to the impairments within the Rock River/Pierce Lake watershed is General Use.

4.2.1 General Use

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

4.3 Water Quality Criteria

According to the Illinois EPA Integrated Report, aquatic life use assessments in streams are typically based on the interpretation of biological information, physicochemical water data, and physical habitat. The primary biological measures used are the fish Index of Biotic Integrity (fIBI), the macroinvertebrate Index of Biotic Integrity (mIBI) and the Macroinvertebrate Biotic Index (MBI). Physical-habitat information used in assessments includes quantitative or qualitative measures of stream-bottom composition and qualitative descriptors of channel and riparian conditions. Physicochemical water data used include

[1] https://pcb.illinois.gov/SLR/IPCBandIEPAEnvironmentalRegulationsTitle35

[2] Illinois EPA, 2016. Illinois Integrated Water Quality Report and Section 303(d) List. https://www2.illinois.gov/epa/topics/water-quality/watershed-management/tmdls/Pages/303d-list.aspx

measures of "conventional" parameters (e.g., dissolved oxygen [DO], pH, and temperature), priority pollutants, non-priority pollutants, and other pollutants.

Tables 4-1 and **4-2** present the numeric water quality standards of the potential causes of impairment for both lakes and streams in the Rock River/Pierce Lake watershed. Only constituents with numeric water quality standards will have TMDLs developed at this time.

Table 4-1 Summary of Numeric Water Quality Standards for Potential Causes of Lake Impairments in Rock River/Pierce Lake Watershed

Parameter	Units	General Use Water Quality Standard	Regulatory Reference
Phosphorus (Total)	mg/L	0.05(1)	302.205

mg/L = milligrams per liter
(1) Standard applies to inland lakes and reservoirs (greater than 20 acres) and in any stream at the point where it enters any such lake or reservoir.

Table 4-2 Summary of Numeric Water Quality Standards for Potential Causes of Stream Impairments in Rock River/Pierce Lake Watershed

Parameter	Units	General Use Water Quality Standard	Regulatory Reference
Arsenic	µg/L	*Trivalent, Dissolved:* Acute = 360 X 1.0* = 360 Chronic = 190 X 1.0* = 190	302.208(e)
pH	s.u.	6.5-9.0	302.204
Total Fecal Coliform	Count / 100 mL	*May through October* 200(1), 400(2)	302.209
Zinc	µg/L	*Dissolved:* Acute = $e^{A+B\ln(H)}$ X 0.978* where A = 0.9035 and B = 0.8473 Chronic = $e^{A+B\ln(H)}$ X 0.986* where A = -0.4456 and B = 0.8473	302.208(e)

µg/L = micrograms per liter
s.u. = standard units
H = hardness
* = Conversion factor multiplier for dissolved metals
(1) Geometric mean based on a minimum of five samples taken over not more than a 30-day period.
(2) Standard shall not be exceeded by more than 10 percent of the samples collected during any 30-day period.

4.4 Potential Pollutant Sources

In order to properly address the conditions within the Rock River/Pierce Lake watershed, potential pollutant 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 4-3 Impaired Water Bodies

Segment ID	Segment Name	Potential Causes of Impairment	Designated Use	Potential Sources (as identified by the 2016 303(d) list)
PR-01	Keith Creek	**Fecal Coliform**	Primary Contact Recreation	Urban Runoff/Storm Sewers
PR-99	Keith Creek	**Fecal Coliform**	Primary Contact Recreation	Urban Runoff/Storm Sewers
		pH	Aquatic Life	Urban Runoff/Storm Sewers
		Zinc	Aquatic Life	Urban Runoff/Storm Sewers
		Arsenic	Aquatic Life	Contaminated Sediments
PSB-01	North Fork Kent Creek	**Fecal Coliform**	Primary Contact Recreation	Source Unknown
PSA	South Fork Kent Creek	**Fecal Coliform**	Primary Contact Recreation	Source Unknown
PU	North Kinnikinnick Creek	**Fecal Coliform**	Primary Contact Recreation	Source Unknown
PT	South Kinnikinnick Creek	**Fecal Coliform**	Primary Contact Recreation	Source Unknown
PZZG	Spring Creek - North	**Fecal Coliform**	Primary Contact Recreation	Source Unknown
RPC	Pierce Lake	**Phosphorus (Total)**	Aesthetic Quality	Internal nutrient recycling, Waterfowl, Crop production (crop land or dry land), Runoff from Forest/Grassland/Parkland

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Section 5

Rock River/Pierce Lake Watershed Data and Potential Pollutant Sources

In order to further characterize the Rock River/Pierce Lake watershed, a wide range of pertinent data were collected and reviewed. Water quality data for streams and lakes, as well as information on potential point and nonpoint sources within the watershed, were compiled from a variety of data sources. This information is presented and discussed in further detail in the remainder of this section.

5.1 Water Quality Data

Data from numerous historical water quality stations within the Rock River/Pierce Lake watershed were located and reviewed for this report (**Figure 5-1**). These water quality data were primarily provided by the Illinois EPA. Stations RPC-1, RPC-2 and RPC-3 on Pierce Lake are part of the Illinois EPA Ambient Lakes Program and were sampled multiple times a year in 2001, 2004, 2011, and 2016. Stations on the impaired stream segments are part of Illinois EPA's Intensive Basin Survey Program which monitors stations on a 5-year cycle. Additional information on Illinois EPA's monitoring programs can be found on its "Water Monitoring Strategy" website[1].

The impaired water body segments in the Rock River/Pierce Lake watershed were presented in Section 1. Refer to **Table 1-1** for impairment information specific to each segment. Recent and historical data are included in this section and document historical trends and observations. The following sections address both stream and lake impairments. Data are summarized by impairment and discussed in relation to the relevant Illinois water quality standard. Data summaries provided in this section include all available date ranges of collected data. The following sections will first discuss data for the impaired stream segments in the Rock River/Pierce Lake watershed followed by data for the impaired lake in the watershed.

5.1.1 Stream Water Quality Data

Seven impaired stream segments exist within the Rock River/Pierce Lake watershed (Keith Creek segments PR-01 and PR-99, North Fork Kent Creek segment PSB-01, South Fork Kent Creek segment PSA, North Fork Kinnikinnick Creek segment PU, South Fork Kinnikinnick Creek segment PT, and Spring Creek - North segment PZZG). Data presented below summarize the available data for the parameters of concern for stream impairments in this watershed: pH, zinc, arsenic, and fecal coliform. Historical water quality data for the impaired segments of the Rock River/Pierce Lake watershed are available in Appendix D.

5.1.1.1 Fecal Coliform

All seven of the impaired stream segments (PR-01, PR-99, PSB-01, PSA, PU, PT, and PZZG) are listed for impairment of the primary contact recreation use caused by elevated fecal coliform concentrations. **Table 5-1** summarizes available historical fecal coliform data for this

[1] https://www2.illinois.gov/epa/topics/water-quality/monitoring/Pages/default.aspx

segment. The general use water quality standard for fecal coliform states that the standard of 200 colony forming units (cfu) per 100 milliliters (mL) shall not be exceeded by the geometric mean of at least five samples, nor can 10 percent of the samples collected exceed 400 cfu per 100 mL in protected waters, except as provided in 35 Ill. Adm. Code 302.209(b). Samples must be collected over a 30-day period or less during the months of May through October. Available samples collected between September and October of 2019 exceeded the currently applicable standard at all locations, as shown **Figure 5-2**. Note that Figure 5-2 shows single samples compared to statistics-based standards.

Table 5-1 Existing Fecal Coliform Data for Impaired Stream Segments

Stream Segment ID	Period of Record and Number of Data Points(1)	Geometric Mean of all Samples (cfu/100mL)	Maximum (cfu/100mL)	Minimum (cfu/100mL)	Number of samples > 200(1)	Number of samples > 400(1)
Keith Creek Segment PR-01	2019; 5	1500	11200	602	5	5
Keith Creek Segment PR-99(2)	2019; 5	856	1870	450	5	5
North Fork Kent Creek Segment PSB-01(3)	2019; 5	645	4610	72	5	5
South Fork Kent Creek Segment PSA	2019; 5	943	6490	134	4	3
North Kinnikinnick Segment PU	2019; 5	915	2480	295	5	4
South Kinnikinnick Segment PT	2019; 5	322	631	189	4	2
Spring Creek - North Segment PZZG	2019; 5	413	1720	108	4	3

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

(2) Samples collected at station PR-02

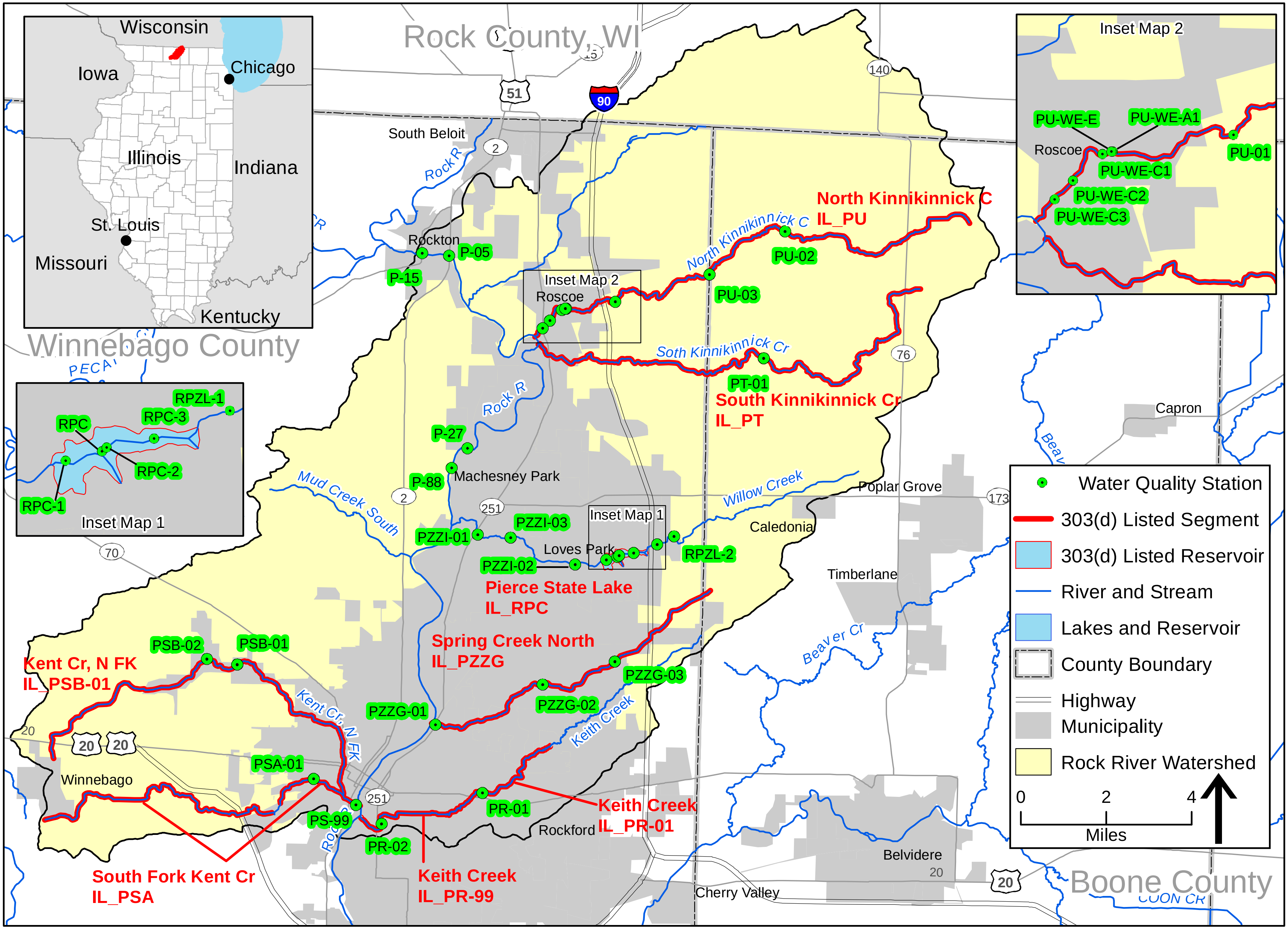

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Figure 5-1: Rock River/Pierce Lake Watershed Water Quality Stations

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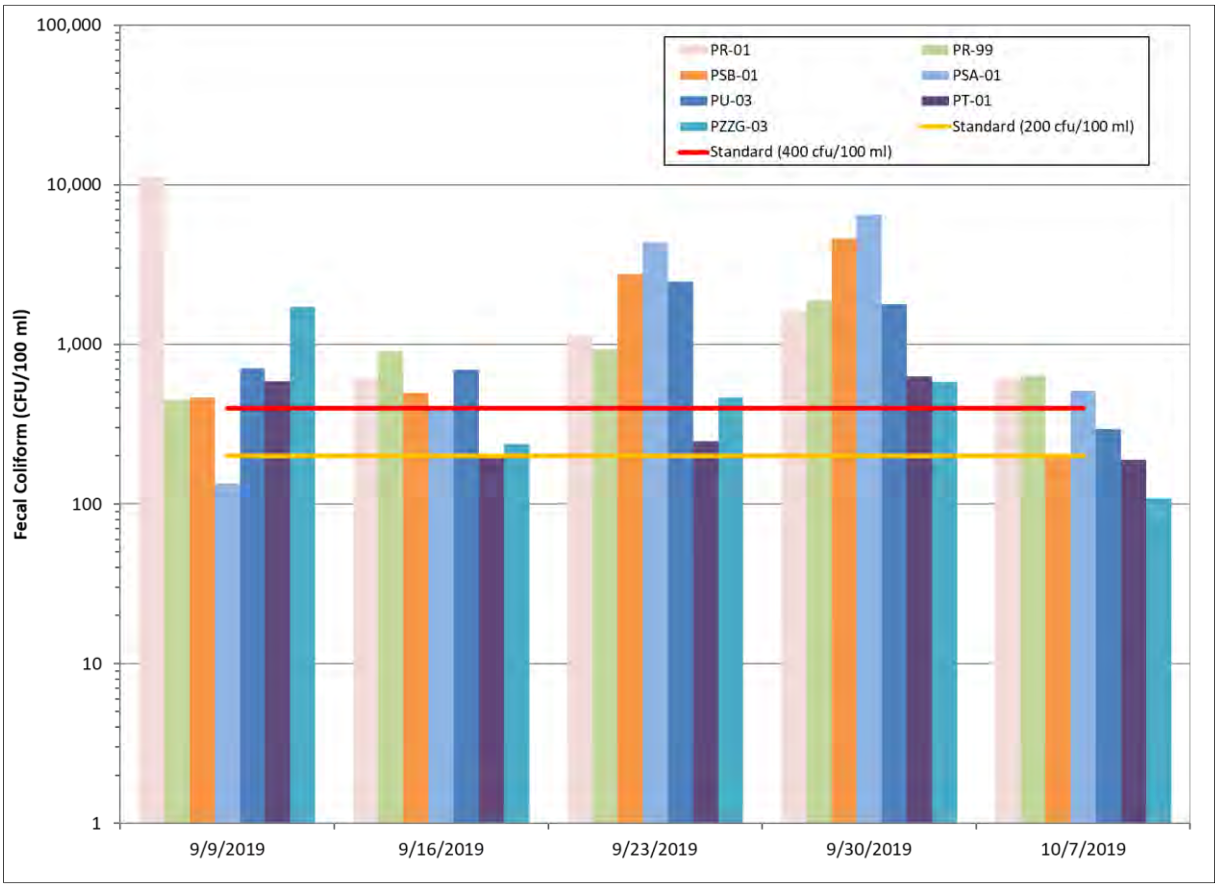

Figure 5-2 Fecal coliform in Impaired Stream Segments in the Rock River/Pierce Lake Watershed

5.1.1.2 Arsenic

Keith Creek segment PR-99 is listed for impairment of the aquatic life use caused by elevated arsenic concentrations. **Table 5-2,** along with **Figure 5-3,** summarize available historical arsenic data on this segment. The general use water quality standard for arsenic consists of an acute and chronic threshold. Sampling results for dissolved arsenic at this location are reported as non-detect. Therefore, the detection limit value for each sample was applied for the purposes of calculations; however, none exceed the acute or chronic water quality standard. The extremely limited dataset for arsenic in the impaired PR-99 segment does not allow for assessment of this segment's current compliance with arsenic standards. As no samples detected dissolved arsenic concentration, additional data collection is needed to confirm that impairment exists.

Table 5-2 Existing Arsenic Data for Keith Creek segment PR-99

Impaired Stream Segment Name & ID	Period of Record and Number of Data Points	Mean (µg/L)	Maximum (µg/L)	Minimum (µg/L)	Number of Acute Exceedances	Number of Chronic Exceedances
Keith Creek Segment PR-99	2008, 2013; 6	3.05[1]	4.45[1]	1.65[1]	0	0

[1] All dissolved arsenic sample results were reported as non-detect; therefore, the detection limit value was applied for calculations

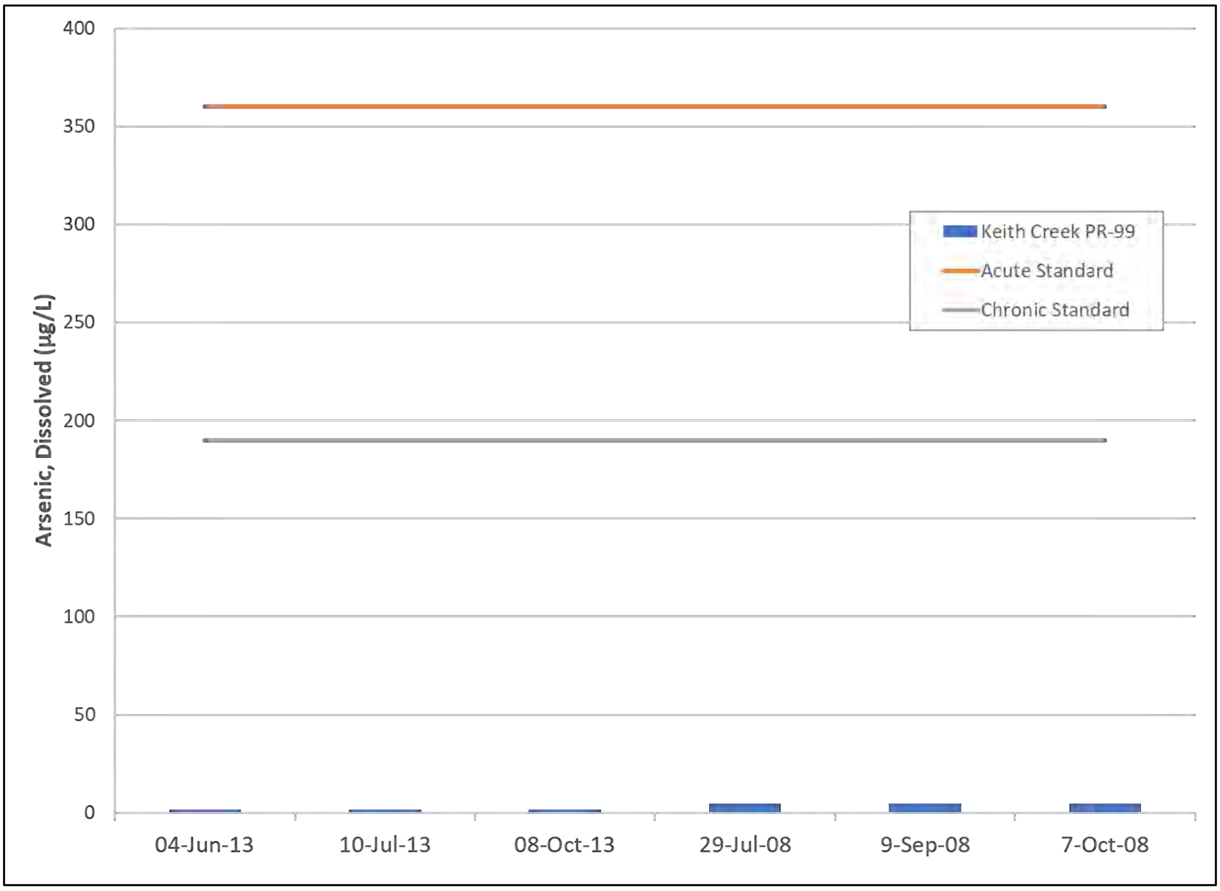

Figure 5-3 Arsenic in impaired stream segment PR-99 of Keith Creek.

5.1.1.3 pH

Keith Creek segment PR-99 is listed for impairment of the aquatic life use caused by pH. **Table 5-3,** along with **Figure 5-4,** summarize available historical pH data on this segment. A sample is considered an exceedance if it is below 6.5 or above 9.0 s.u. at any time. A total of three samples have been collected, all of which were collected in 2013, and none were outside the allowable pH range. Recent pH data are not available for this segment (pH was last sampled in 2013). Due to the lack of current pH data for this segment and limited extent of reported exceedances, additional data collection is suggested to confirm whether impairment still exists. If new data do not show pH values higher than 9.0 or below 6.0, then the segment may be considered for delisting.

Table 5-3 Existing pH Data for Keith Creek segment PR-99

Impaired Stream Segment Name & ID	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Exceedances
Keith Creek Segment PR-99	2013; 3	8.04	8.34	7.84	0

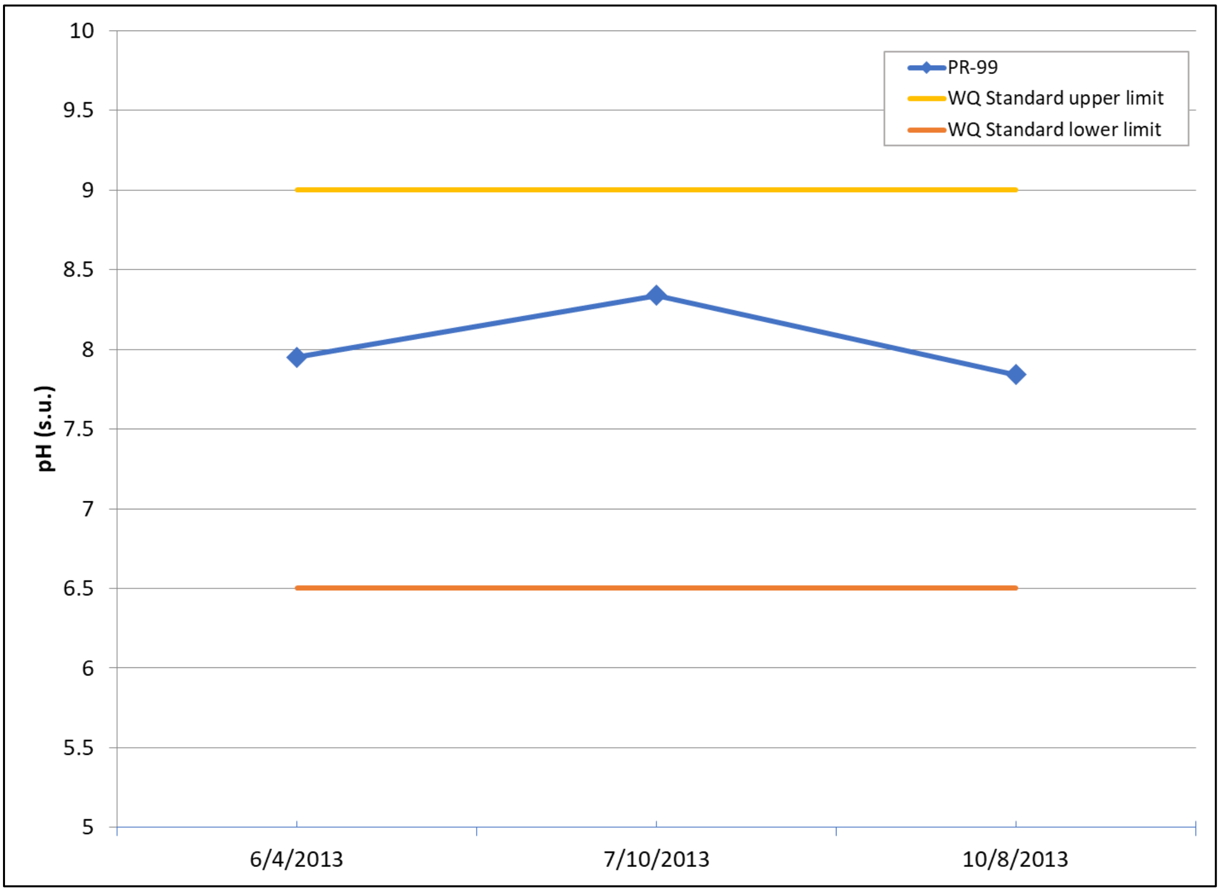

Figure 5-4 pH in impaired stream segment PR-99 of Keith Creek.

5.1.1.4 Zinc

Keith Creek segment PR-99 is listed for impairment of aquatic life use caused by elevated dissolved zinc concentrations. **Table 5-4** summarizes available historical zinc data on this segment. Both the acute and chronic general use water quality standards for dissolved zinc are calculated standards that vary with the total hardness of the sampled water. The summary of data presented in **Table 5-4** reflects single samples from the impaired segment compared to the hardness-dependent standard. No exceedances were noted in the available dataset for Keith Creek. Three of the six samples indicate that zinc concentrations were below the detection limit of the analytical method employed. For samples with not detected (ND) qualifiers, the method detection limits were applied. **Figure 5-5** shows the dissolved zinc measurements collected over time at the impaired segment. Additional data collection is necessary to assess current impairment.

Table 5-4 Existing Zinc Data for Keith Creek segment PR-99

Illinois WQ Standard (µg/L)	Period of Record and Number of Data Points	Mean (µg/L)	Maximum (µg/L)	Minimum (µg/L)	Number of Acute Exceedances	Number of Chronic Exceedances
varies[(1)]	2008, 2013; 6	2.9[(2)]	8.8	<0.35[(2)]	0[(2)]	0[(2)]

[(1)] Hardness-dependent
[(2)] Method detection limits applied for samples that did not detect concentrations (half of the samples)

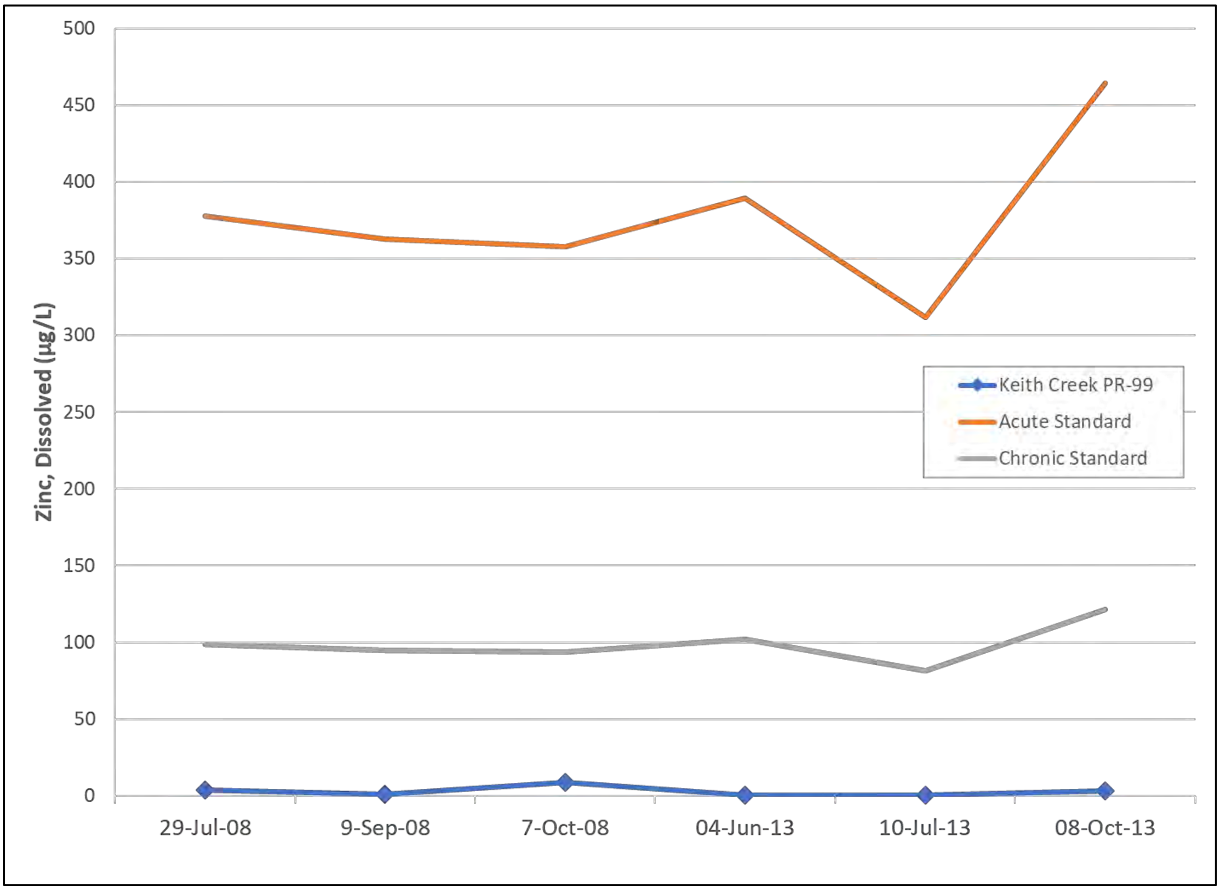

Figure 5-5 Dissolved Zinc in impaired stream segment PR-99 of Keith Creek.

5.1.2 Pierce Lake Water Quality Data

Pierce Lake is listed for impairment of aesthetic quality use caused by elevated total phosphorus concentrations. Data are available from three separate water quality monitoring locations within Pierce Lake. An inventory of all available data associated with the impairments in Pierce Lake is presented in **Table 5-5**.

Table 5-5 Data Inventory for Impairment at Pierce Lake

Pierce Lake Segment RPC; Sample locations RPC-1, RPC-2, RPC-3		
RPC-1	**Period of Record**	**Number of Samples**
Phosphorus, Total	1998,2001,2004,2011, 2016	40
Phosphorus, Dissolved	2001,2004,2011, 2016	34
Phosphorus in Bottom Deposits	1999,2001,2011	3
RPC-2		
Phosphorus, Total	1998,2001,2004,2011, 2016	19
Phosphorus, Dissolved	2001,2004,2011, 2016	16
Phosphorus in Bottom Deposits	-	-
RPC-3		
Phosphorus, Total	1998,2001,2004,2011, 2016	19
Phosphorus, Dissolved	2001,2004,2011, 2016	17
Phosphorus in Bottom Deposits	2001,2011	2

5.1.2.1 Total Phosphorus in Pierce Lake

The applicable water quality standard for total phosphorus in Pierce Lake is 0.05 mg/L. Compliance with the total phosphorus standard is assessed using samples collected at a 1-foot depth from the lake surface. The number of samples, a count of exceedances, and the average total phosphorus concentrations at a 1-foot depth for each year of available data at each monitoring location in Pierce Lake are presented in **Table 5-6** and shown on **Figure 5-6**. Based on the available dataset, total phosphorus concentrations collected at a 1-foot depth in Pierce Lake are consistently above the 0.05 mg/L water quality standard. Annual average phosphorus concentrations at all sampling stations decreased from 2011 to 2016. However, annual average phosphorus data from sampling station RPC-3 are consistently above the 0.05 mg/L water quality standard.

Table 5-6 Total Phosphorus at 1-ft[1] Depth in Pierce Lake (RPC)

Station ID	Period of Record and Number of Data Points	Mean (mg/L)	Maximum (mg/L)	Minimum (mg/L)	Number of Exceedances
RPC-1	2001, 2004, 2011, 2016; 13	0.094	0.584	0.026	5
RPC-2	2001, 2004, 2011, 2016; 17	0.053	0.115	0.01	7
RPC-3	2001, 2004, 2011, 2016; 17	0.069	0.128	0.029	12

[1] Excluding samples from 1998 and 1999 that did not specify collection depth

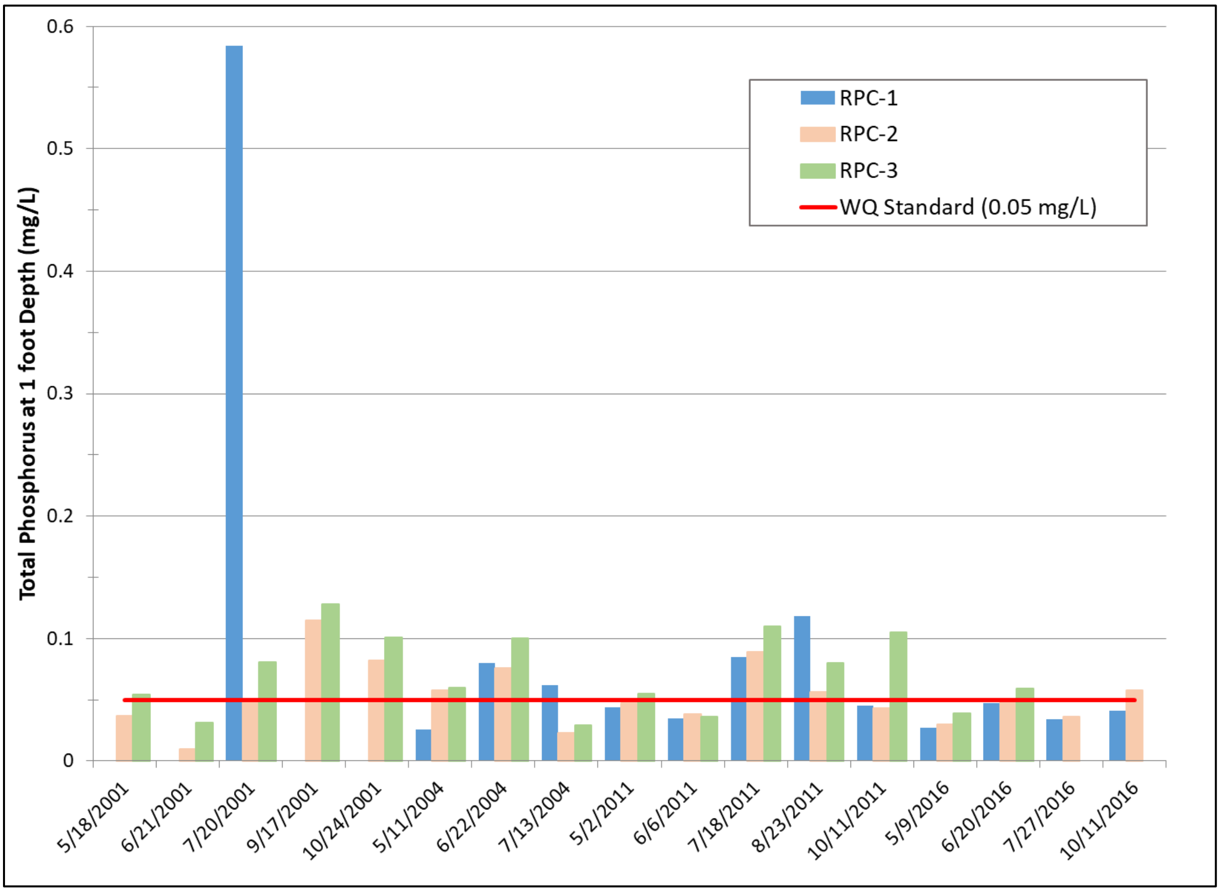

Figure 5-6 Total phosphorus in Pierce Lake.

5.2 Lake Characteristics

Pierce Lake is located within Winnebago County, approximately 7 miles northeast of Rockford, Illinois. Pierce Lake is fed by Willow Creek, a tributary of Rock River. As groundwater is the sole source of water supply for Rockford, the city does not use Pierce Lake as a source for its drinking water.

Pierce Lake has a surface area of 147 acres and a reported maximum depth of 36 feet. The overland watershed draining into Pierce Lake is approximately 8,150 acres. The lake is located in a park setting and is adjacent to campgrounds and just downstream of Olson Lake. The areas immediately adjacent to the lake are primarily grass and forest land. Further to the south, west, and northwest of the lake there is low and medium density development, while additional surrounding areas are primarily farmland. The lake is utilized for boating and fishing.

5.3 Point Sources

There are currently 22 individually permitted point sources that discharge to waterbodies within the Rock River/Pierce Lake watershed. **Table 5-7** contains permit information for each discharger while **Figure 5-7** shows the locations of each facility. Note that not all facilities within the watershed discharge upstream of impaired segments. In general, facilities discharging treated domestic wastewater have the potential to affect pathogen, metals, and nutrient concentrations in their receiving waters. Potential pollutants discharged from industrial facilities vary by industry and may or may not contain metals, nutrients, and/or pathogens. National Pollutant Discharge Elimination System (NPDES) facilities with permit limits are required to submit discharge monitoring reports (DMRs) to Illinois EPA. Stage 3 will include a summary of relevant DMR data from discharges with the potential to impact impaired streams.

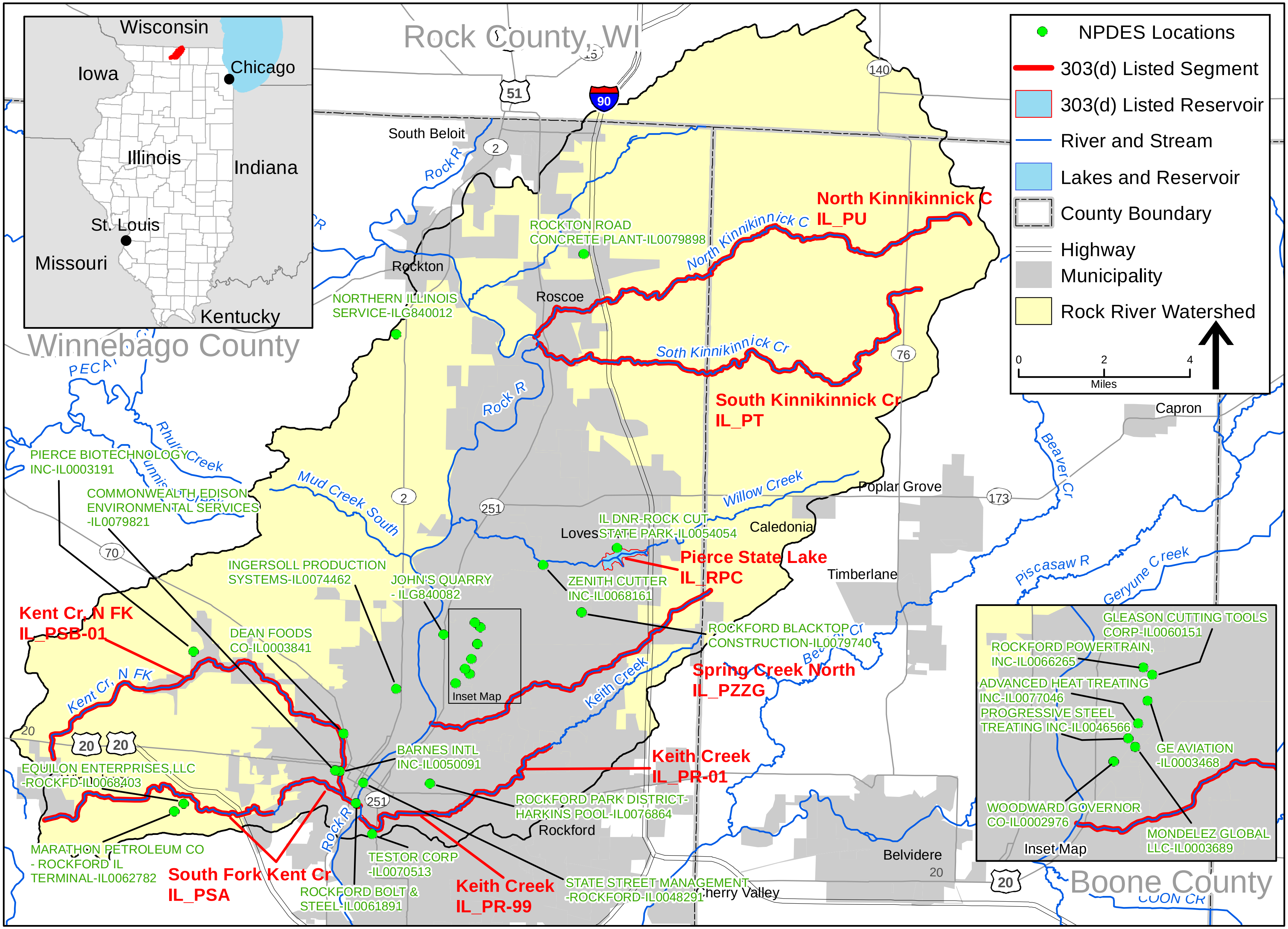

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Figure 5-7: Rock River/Pierce Lake Watershed NPDES Discharge Locations

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Table 5-7 Permitted Facilities Discharging within the Rock River/Pierce Lake watershed

Facility ID	Permittee/Facility Name	Design Average Flow/ Design Maximum Flow (mgd)	Receiving Water
IL0050091	Barnes Intl Inc	0.000053[1]	North Fork Kent Creek
IL0079821	Commonwealth Edison Environmental Services	0.80/4.32	North Fork Kent Creek
IL0003841	Dean Foods Co-STP	0.0263/0.106	North Fork Kent Creek
IL0068403	Equilon Enterprises, LCC-Rockfd	0.02/0.36	Drainage Ditch Tributary to Kent Creek
IL0003468	Schneider Electric Buildings, LLC	0.1024	Unnamed Tributary of the Rock River
IL0060151	Gleason Cutting Tools Corp	0.005[1]	Unnamed Ditch Tributary to Rock River
IL0054054	IL DNR-Rock Cut State Park	0.0058/0.0117	Unnamed Tributary to Willow Creek
IL0074462	Ingersoll Production Systems	0.0095	Rock River
IL0062782	Marathon Petroleum Co – Rockford IL Terminal	intermittent	Unnamed Tributary to South Fork Kent Creek
IL0003689	Mondelez Global LLC	0.071[1]	Unnamed Tributary of the Rock River
ILG840190	Northern Illinois Service Co	0.078[1]	Beaver Creek
IL0003191	Pierce Biotechnology Inc	0.0215[1]	Unnamed Tributary of North Fork of Kent Creek
IL0046566	Progressive Steel Treating Inc	0.005[1]	Storm Sewer Tributary to the Rock River
IL0079740	William Charles Construction	Intermittent	Unnamed Tributary of Kishwaukee River
IL0061891	Rockford Bolt & Steel	0.001[1]	North Fork Kent Creek
IL0076864	Rockford Park District -Harkins Pool	0.003[1]	Storm sewer tributary to North Fork of Kent Creek
IL0066265	GKN Rockford Inc	0.048[1]	Drainage Ditch Tributary to Rock River
IL0079898	Rockton Road Concrete Plant	intermittent	Unnamed Tributary to Dry Creek
IL0048291	State Street Management-Rockford	0.055[1]	Storm Sewer Tributary to Rock River
IL0070513	Testor Corp	0.003[1]	Keith Creek
IL0002976	Woodward Governor Co	1.30[1]	Unnamed Tributary to Rock River
IL0068161	Zenith Cutter Inc	0.028[1]	Willow Creek

[1] Design flow values are based on current NPDES permit on file.

5.4 Nonpoint Sources

There are many potential nonpoint sources of pollutant loading to the impaired segments in the Rock River/Pierce Lake watershed. This section will discuss site-specific cropping practices, animal operations, and area septic systems. Available data were collected through communications with the local NRCS, Illinois Soil and Water Conservation Districts (SWCDs), and public health departments.

5.4.1 Crop Information

Approximately 39 percent of the land within the Rock River/Pierce Lake watershed is devoted to agriculture. Because a significant portion of the watershed is under cultivation, soil loss from fields is likely the primary source of sediment and any pollutant attached to the sediment such as nutrients, pathogens, and potentially naturally-occurring metals. Tillage from fields is likely the primary source of sediment and any pollutant attached to the sediment such as nutrients, pathogens, and potentially naturally-occurring metals. Tillage practices for crops such as corn, soybeans, and grains can be categorized as conventional till, reduced till, mulch till, and no till. The percentage of each tillage practice for corn, soybeans, and small grains by county are generated from County Transect Surveys by the Illinois Department of Agriculture (IDA)[2]. Data from the 2015 and 2018 survey are presented in **Tables 5-8** through **5-9** for Boone and Winnebago Counties, respectively. Although Rock County, located in Wisconsin, does not have an IDA Transect Survey, the USDA 2017 Census of Agriculture for Wisconsin indicates that of the 302,797 acres of total crop land in Rock County, 39.6% use no-till practices in 2017 (compared to 25.5% in 2012); 31.7% use reduced-till practices in 2017 (compared to 36.4 % in 2012); and 17.0 % use intensive-till practices in 2017 (compared to 26.3% in 2012).

According to the County Transect Survey summary report, fields planted conventionally leave less than 15% of the soil surfaced covered with crop residue after planting while mulch-till leaves at least 30% of the residue from the previous crop remaining on the soil surface after being tilled and planted. Reduced-till falls between conventional and mulch (greater than 15% but less than 30%) and no-till practices leave the soil virtually undisturbed from harvest through planting. Residue is important because it shields the ground from the eroding effects of rain and helps retain moisture for crops.

Table 5-8 Tillage Practices in Boone County, Illinois

Tillage System	Corn		Soybean		Small Grain	
	2015	2018	2015	2018	2015	2018
Conventional	44.6%	62.5%	4.7%	10.8%	81.8%	NA
Reduced - Till	22.5%	18.7%	24.0%	17.6%	0.0%	NA
Mulch – Till	27.9%	15.1%	34.5%	46.6%	0.0%	NA
No - Till	5.0%	3.6%	36.8%	25.0%	18.2%	NA

NA (Not available) = zero survey data points, however, the 2017 survey indicates that only no-till practices were applied for small grain

Table 5-9 Tillage Practices in Winnebago County, Illinois

Tillage System	Corn		Soybean		Small Grain	
	2015	2018	2015	2018	2015	2018
Conventional	10.8%	9.6%	1.8%	0.8%	0.0%	0.0%
Reduced - Till	39.6%	27.2%	15.9%	10.0%	11.1%	40.0%
Mulch – Till	24.3%	29.5%	27.4%	36.4%	88.9%	20.0%
No - Till	25.3%	33.7%	54.9%	52.8%	0.0%	40.0%

Information on field drain tile practices was also sought as field drain tiles can influence the timing and amounts of water delivered to area streams and reservoirs as well as deliver dissolved nutrients from fields to receiving waters. Local NRCS offices reported that they currently do not keep records on which farms use tile drainage.

[2] IDA. 2015. Illinois Soil Conservation Transect Survey Reports. Retrieved from https://www2.illinois.gov/sites/agr/Resources/LandWater/Pages/Illinois-Soil-Conservation-Transect-Survey-Reports.aspx.

5.4.2 Animal Operations

Information on commercial animal operations is available from the NASS. Knowing the number of animal units in a watershed is useful in TMDL development as grazing animals have the potential to increase erosion and contribute nutrients and pathogens through manure. Although watershed-specific data are not available, countywide data for Boone, Rock, and Winnebago Counties are presented in **Tables 5--10** through **5-12**, respectively. Data from 2012 and 2017 have been published on the USDA website[3456].

Table 5-10 Boone County, Illinois Animal Population (2012 and 2017 Census of Agriculture)

Livestock Type	2012	2017	Percent Change
Cattle and Calves	5,603	7,040	25.6%
Beef	521	1,141	119.0%
Dairy	1,920	2,424	26.3%
Hogs and Pigs	7,431	6,025	-18.9%
Poultry(1)	1,542(2)	3,277	112.5%
Sheep and Lambs	443	467	5.4%
Horses and Ponies	735	677	-7.9%

(1) Poultry census data inclusive of broilers, layers, pullets, roosters and turkeys

(2) No data available for pullets, broilers, or turkeys; therefore, percent change may not be accurate

Table 5-11 Rock County, Wisconsin Animal Population (2012 and 2017 Census of Agriculture)

Livestock Type	2012	2017	Percent Change
Cattle and Calves	45,897	55,784	21.5%
Beef	3,149	4,267	35.5%
Dairy	17,432	19,182	10.0%
Hogs and Pigs	12,884	18,176	41.1%
Poultry(1)	9,272	5,129	-44.7%
Sheep and Lambs	2,878	3,311	15.0%
Horses and Ponies	2,309	1,610	-30.3%

(1) Poultry census data inclusive of broilers, layers, pullets, roosters and turkeys

[3]https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Illinois/

[4]https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Wisconsin/

[5]https://www.nass.usda.gov/Publications/AgCensus/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Illinois/

[6]https://www.nass.usda.gov/Publications/AgCensus/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Wisconsin/

Table 5-12 Winnebago County, Illinois Animal Population (2012 and 2017 Census of Agriculture)

Livestock Type	2012	2017	Percent Change
Cattle and Calves	11,556	12,333	6.7%
Beef	1,375	1,730	25.8%
Dairy	2,392	2,700	12.9%
Hogs and Pigs	4,807	3,550	-26.1%
Poultry(1)	4,339	3,036	-30.0%
Sheep and Lambs	512	588	14.8%
Horses and Ponies	1,241	871	-29.8%

(1) Poultry census data inclusive of broilers, layers, pullets, roosters and turkeys ND= No data

The tables above show significant cattle, hog and pig populations within the watershed counties. No concentrated animal feeding operations (CAFOs) were listed for the Boone or Winnebago counties under the general NPDES permit for CAFOs in Illinois (NPDES Permit No. ILA01)[7] and there are no documented CAFOs within the watershed.

5.4.3 Septic Systems

Most households in rural areas of Illinois that are not connected to municipal sewers make use of onsite sewage disposal systems, or septic systems. There are several types of septic systems, but the most common septic system is composed of a septic tank draining to a septic field, where nutrient removal occurs. However, the degree of nutrient removal is limited by local soils and the extent of system upkeep and maintenance. Across the U.S., septic systems have been found to be a significant source of phosphorus pollution.

Information on the extent of sewered and non-sewered municipalities in the Rock River/Pierce Lake watershed was obtained from the county health departments. The Boone County Health Department in Illinois was contacted and a response with private septic systems is pending. Additionally, the Winnebago County Health Department in Illinois stated that it does not have a method for geographically searching for septic systems and provided county-wide private septic system installations for 2015-2018. Health department officials in Rock County, Wisconsin stated that other than areas within the City of Beloit, the watershed area in Rock County likely rely on private septic systems with a nearly one-to-one relationship between houses and private septic systems. Rock County, Wisconsin represents a small portion of the watershed area.

5.4.4 Internal Phosphorus Loading in Lakes

An additional potential nonpoint source of pollutants for Pierce Lake is in-lake sediments. Nutrients can be bound to soils and as soils erode throughout the drainage area, they accumulate at the bottom of receiving lakes. Internal phosphorus loading can occur when the water above the sediments becomes 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.

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[7] http://www.epa.state.il.us/water/permits/cafo/

5.5 Watershed Studies and Other Watershed Information

Previous efforts completed within the watershed are listed below. Reports will be reviewed, and data will be incorporated into Stage 3 where appropriate and relevant.

1996 – Illinois State Water Survey (ISWS) Miscellaneous Publication 174, April 1996 – Rock Rover Basin: Historical Background, IEPA Targeted Watersheds, and Resource-Rich Areas – Report notes that in 1971 the Wisconsin Department of Natural Resources – Environmental Protection Division indicated that streams within the Wisconsin portion of the Rock River basin receive organic wastes from treated sewage and industrial wastes. In 1994, the ISWS reported decreasing nitrate-nitrogen levels in the basin, which may be due to improved agricultural practices and reduced septic tank use by lakefront communities.

2006 – Illinois EPA Rock River Basin Assessment, March 2006 – The report identified the phosphorus impairment in Pierce Lake, although none of the other impaired stream segments were identified in the report. The Illinois EPA determined that the Rock River and associated tributaries in Winnebago County do not support designated water uses of swimming and fish consumption. Grant funds were awarded to the City of Rockford to supplement a joint project between Illinois EPA, Rockford, Rock River Water Reclamation District and other Winnebago County communities, which began in 2003.

2019 – Olson Ecological Solutions (OES) South Fork Kent Creek Watershed Resource Inventory, December 2019 – The report identifies the fecal coliform impairment for South Fork Kent Creek. OES performed an evaluation of riparian buffer conditions, erosion rates, and channelization throughout the South Fork Kent Creek sub watershed. Surveys along about 22,000 feet of stream segments for South Fork Kent Creek and tributaries were performed in late October and early November of 2019. About 57% of the surveyed segments were found to have poor riparian conditions, 42% to have good condition, and 3% had fair condition. Streambank erosion was also noted for surveyed stream segments. Mapping and modeling efforts identify low intensity developed areas a significant source for bacteria pollutants in the sub watershed.

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Section 6

Approach to Developing TMDL and Identification of Data Needs

Recommended technical approaches for developing TMDLs are presented in this section. Additional data needs are also discussed.

6.1 Simple and Detailed Approaches for Developing TMDLs

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

6.2 Additional Data Needs for TMDL Development in the Rock River/Pierce Lake watershed

Table 6-1 contains summary information regarding data availability for all impairments to be addressed by TMDLs in the Rock River/Pierce Lake watershed. The available datasets for fecal coliform and/or phosphorus impairments on Keith Creek, North Fork Kent Creek, South Fork Kent Creek, North Kinnikinnick Creek, South Kinnikinnick Creek, Spring Creek – North, and in Pierce Lake are generally sufficient for basic TMDL calculations and model development. Additional data collection is recommended for impairment confirmation for the remaining parameters listed for Keith Creek (PR-99) due to a lack of recent data, limited results showing impairment, and/or data needed to support model development.

Table 6-1 Data Availability and Data Needs for TMDL/LRS Development in the Rock River/Pierce Lake watershed

Impaired Segment	Impairment Parameter	Period of Record	Data Count	Additional Data Needs
Keith Creek (PR-01)	Fecal Coliform	2019	5	none
Keith Creek (PR-99)	Fecal Coliform	2019	5	none
	Arsenic	2008, 2013	6	recommended additional data to confirm impairment
	pH	2013	3	recommended additional data to confirm impairment
	Zinc	2008-2013	3	recommended additional data to confirm impairment
North Fork Kent Creek (PSB-01)	Fecal Coliform	1985, 2019	8	none
South Fork Kent Creek (PSA-01)	Fecal Coliform	2019	5	none
North Kinnikinnick Creek (PU-03)	Fecal Coliform	2019	5	none
South Kinnikinnick Creek (PT-01)	Fecal Coliform	2019	5	none
Spring Creek - North (PZZG-03)	Fecal Coliform	2019	5	none
Pierce Lake (RPC)	Phosphorus (Total)	1998-2004	43	none

6.3 Approaches for Developing TMDLs for Stream Segments in Rock River/Pierce Lake Watershed

6.3.1 Recommended Approach for Arsenic, Fecal Coliform, and Zinc in Impaired Stream Segments

The recommended approach for developing TMDLs for arsenic, fecal coliform, and zinc in streams in the Rock River/Pierce Lake watershed (once impairments have been confirmed or verified) is the load-duration curve method. The load-duration methodology uses the cumulative frequency distribution of stream flow and pollutant concentration data to estimate the allowable loads for a waterbody. As shown in **Table 6-1**, additional data collection is recommended to confirm arsenic and zinc impairments and/or to provide more recent information to show that segment PR-99 of Keith Creek currently supports the aquatic life designated use.

6.3.2 Recommended Approach for pH TMDLs in Keith Creek

Segment PR-99 of Keith Creek is listed for pH impairments. Segment PR-99 had only three samples in 2013 and no exceedances of the pH standard. As shown in **Table 6-1**, additional data collection is recommended to confirm impairment and to provide more recent information for this segment. If continued impairment is confirmed, a TMDL may be developed. TMDL development for pH impairments have historically been performed via

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several different approaches. One procedure used to develop pH TMDLs follows an approach based on an analytical procedure that calculates the allowable hydrogen ion loading in the water column to maintain pH standards. Alternatively, pH can be assessed using alkalinity as a surrogate measure or via a simplistic approach that uses the pH standard range as an “other appropriate measure” to set the LA and WLA. Additional data availability during Stage 3 will be the primary driver of the approach selection.

6.4 Approaches for Developing TMDL for Pierce Lake

6.4.1 Recommended Approach for Total Phosphorus TMDL

Pierce Lake is listed for impairment of the aesthetic quality use, caused by total phosphorus. The BATHTUB model[1] is typically recommended for TMDL development for lake and reservoir impairments such as those in Pierce Lake. The BATHTUB model performs steady-state water and nutrient balance calculations in a spatially segmented hydraulic network that account 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. Oxygen conditions in the model are simulated as meta- and hypolimnetic depletion rates, rather than explicit concentrations. Watershed loadings to the lakes will be estimated using event mean concentration data, precipitation data, and estimated flows within the watershed.

Another option for the total phosphorus TMDL for Pierce Lake is CDM Smith's Simplified Lake Analysis Model (SLAM). SLAM was developed specifically to address an identified need for a practical and low-cost water quality model focused on lake eutrophication that could be easily and simply applied in planning studies by a wide range of end-users. The model was originally developed as an enhanced version of the BATHTUB model and retains many of the core algorithms of that model.

SLAM calculates lake mass and flow balances on a daily time step assuming one or more well-mixed lake zones. Each zone follows the conceptual model often referred to as a "continuously stirred tank reactor" (CSTR), whereby complete and immediate mixing is assumed for each zone in both the vertical and horizontal directions. The model targets the key parameters important for eutrophic lakes: phytoplankton (as chlorophyll-a), phosphorus (P), and nitrogen (N), and can be easily modified to aid in assessment of unrelated conservative parameters such as TSS.

SLAM also includes a state-of-the-art dynamic sediment nutrient flux module. This module calculates internal nutrient loads from the sediments to the water column as a function of shallow sediment nutrient dynamics and diffusive exchanges between sediment pore water and the overlying water column. Internal nutrient loads are a key component of many eutrophic lakes, particularly small and/or shallow lakes with large catchment areas. The inclusion of dynamic and rigorous sediment nutrient calculations within a practical planning level water quality model distinguishes SLAM from the majority of other published lake water quality models and is a particularly appealing feature for this application.

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[1] Walker, William W. 1996. Software for Eutrophication Assessment and Prediction: FLUX, PROFILE, BATHTUB. Retrieved from http://www.wwwalker.net/bathtub/

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Section 7

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