STAGE 1 DRAFT FOR PUBLIC REVIEW

Big Four Ditch Watershed TMDL HUC 0512011901 Stage 1 Report

Prepared for Illinois EPA

February 2021

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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 Big Four Ditch 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. Every two years, Illinois EPA develops a list known as the "303(d) list" of water bodies not meeting water quality standards, 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 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.

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[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

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 the Big Four Ditch 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 Big Four Ditch watershed (HUC 0512011901). 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 Big Four Ditch watershed will include developing TMDLs for all impaired water bodies within the watershed, describing all of the necessary elements of the TMDL, developing watershed-based plan (WBP) for implementing each TMDL, and gaining public acceptance of the process. The following impaired water body segments in the Big Four Ditch watershed are addressed in this report:

- Big Four Ditch (BPKP-01)
- Big Four Ditch (BPKP-02)

These impaired water body segments are shown on **Figure 1-1**. **Table 1-1** lists the water body segment and potential causes and sources of impairment.

Table 1-1 Impaired Water Bodies in the Big Four Ditch Watershed

Segment ID	Segment Name	Potential Causes of Impairment	Designated Use	Potential Sources (as identified by the 2016 303(d) list)
BPKP-01	Big Four Ditch	Dissolved Oxygen	Aquatic Life	Source Unknown*
BPKP-02	Big Four Ditch	Dissolved Oxygen	Aquatic Life	Source Unknown*

*Potential natural sources of low dissolved oxygen may include excessive algae, sediment oxygen demand, and/or lack of reaeration

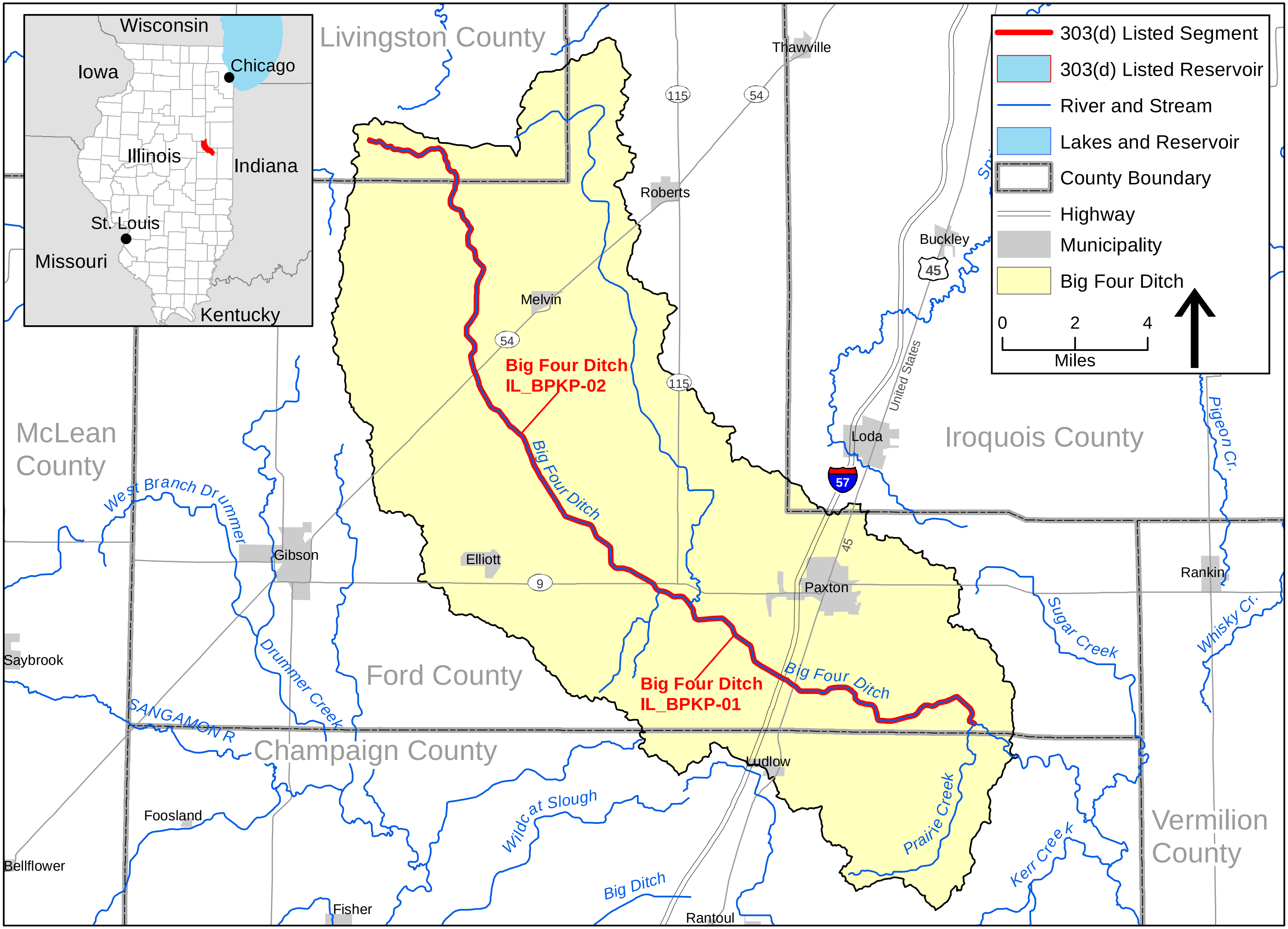

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Figure 1-1: Big Four Ditch Watershed
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The TMDLs for the segments listed above will specify the following elements:

- 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:

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

TMDL development will also take into account the seasonal variability of pollutant loads so that water quality standards are met during all seasons of the year. Also, reasonable assurance that the TMDL will be achieved will be described in the WBP. The WBP for the Big Four Ditch watershed will describe how water quality standards and targets 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 Big Four Ditch 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 Big Four Ditch Watershed Water Quality Standards** defines the water quality standards for the impaired water bodies.
- **Section 5 Big Four Ditch 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 also suggests segments for Stage 2 data collection.
- **Section 7 References**

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Section 2

Big Four Ditch Watershed Description

2.1 Big Four Ditch Watershed Location

The Big Four Ditch watershed (HUC 0512011901 – shown on Figure 1-1) is located in east-central Illinois, flows in a south-easterly direction, and drains approximately 128,000 acres (200 square miles), 106,000 of which are in Ford County (82.8% of the watershed), 15,670 of which are located in Champaign County (12.2% of the watershed), 5,950 of which are in Livingston County (4.7% of the watershed), and approximately 350 of which are in Iroquois County (less than 1% of the watershed).

2.2 Topography

Topography is an important factor in watershed management because stream types, precipitation, and soil types can vary significantly with elevation. National Elevation Dataset[1] (NED) coverages containing 30-meter grid resolution elevation data are available from the U.S. Geological Survey (USGS) for each 1:24,000-topographic quadrangle in the United States. Elevation data for the Big Four Ditch 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 Big Four Ditch watershed ranges from approximately 865 feet above sea level in the northwestern portion of the watershed to approximately 705 feet at the confluence of the Big Four Ditch with the Middle Fork Vermilion River dam at the southeastern extent of the watershed.

2.3 Land Use

Land use data for the Big Four Ditch watershed were extracted from the U.S. Department of Agriculture's (USDA) National Agriculture Statistics Service (NASS) 2018 Cropland Data Layer[2] (CDL) (USDA 2018). 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 27 separate land use classes applicable to the watershed. The available resolution of the land cover dataset is 30 square meters.

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

The land use of the Big Four Ditch watershed was determined by overlaying the Illinois Statewide 2018 CDL onto the GIS-delineated watershed. **Table 2-1** contains the land uses contributing to the Big Four Ditch watershed, based on the 2018 CDL land cover categories, and 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 Cover and Land Use in the Big Four Ditch Watershed

Land Cover Category	Area (Acres)	Percentage
Corn	56,681	44%
Soybeans	56,523	44%
Developed/Low Intensity	4,427	3.5%
Developed/Open Space	3,430	2.7%
Grass/Pasture	2,964	2.3%
Deciduous Forest	1,530	1.2%
Winter Wheat	961	0.8%
Developed/Med Intensity	471	0.4%
Other Hay/Non Alfalfa	343	0.3%
All Others	711	0.6%
Total	**128,041**	**100%**

The land cover data reveal that the vast majority of watershed area is used for crop production (90 percent). Approximately 6.5 percent of the watershed area is developed or urbanized, and 2.3 percent of the watershed area is pasture. Just over one percent of the watershed area is forested while wetlands, marshes, and open water make up the remaining 0.2 percent of the Big Four Ditch watershed.

2.3.1 Subbasin Land Use

The subbasin area draining to each of the two impaired segments were further delineated through GIS (see Figure 2-2). Land cover data were then intersected with the subbasin boundaries to determine the land uses contributing runoff to each impaired waterbody, as shown in **Table 2-2** and **Table 2-3**. The BPKP-01 subbasin area and land use classification areas includes the entire drainage area, including the upstream subbasin area that drains to the other impaired segment in the Big Four Ditch Watershed (BPKP-02).

Table 2-2 Land Cover and Land Use in the Big Four Ditch segment BPKP-01 Subbasin

Land Cover Category	Area (Acres)	Percentage
Corn	53,327	44%
Soybeans	52,962	44%
Developed/Low Intensity	4,337	3.6%
Developed/Open Space	3,280	2.7%
Grass/Pasture	2,644	2.2%
Deciduous Forest	1,235	1.0%
Winter Wheat	945	0.8%
Developed/Med Intensity	465	0.4%
Other Hay/Non Alfalfa	326	0.3%
All Others	585	0.5%
Total	**120,106**	**100%**

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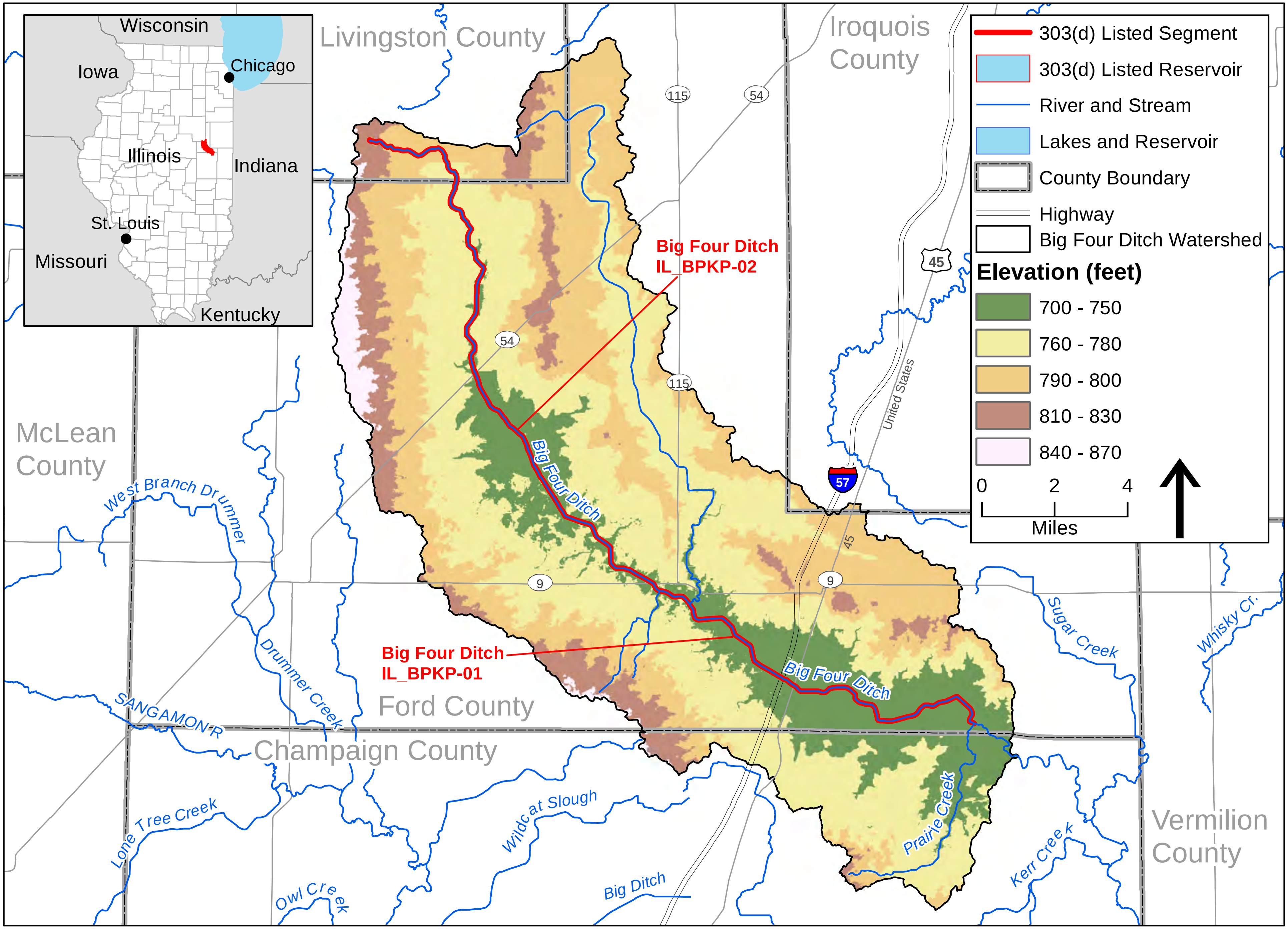

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Figure 2-1: Big Four Ditch Watershed Elevation

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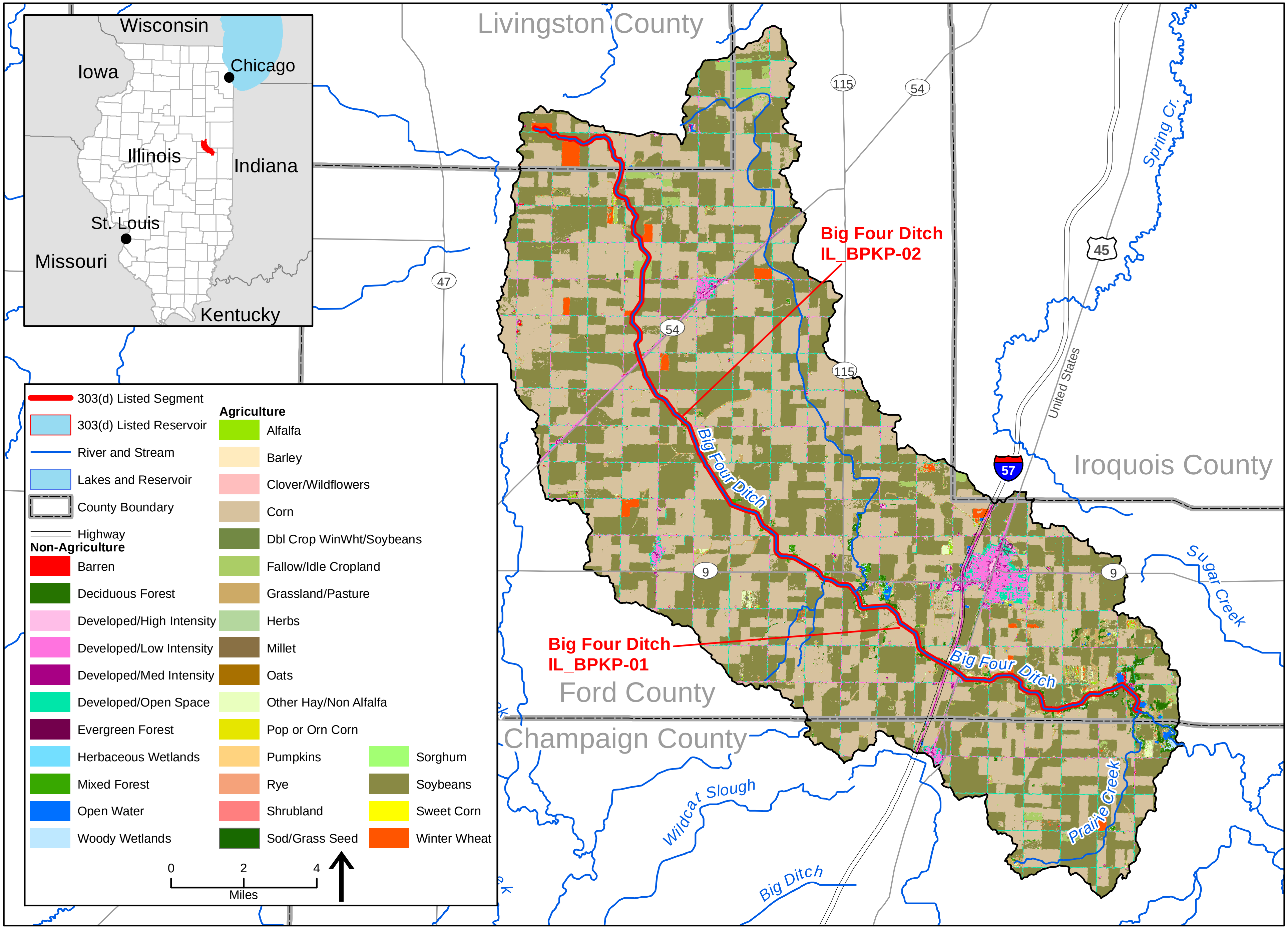

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Figure 2-2: Big Four Ditch Watershed Land Use

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Table 2-3 Land Cover and Land Use in the Big Four Ditch segment BPKP-02 Subbasin

Land Cover Category	Area (Acres)	Percentage
Corn	27,365	48%
Soybeans	25,115	44%
Developed/Low Intensity	1,628	2.9%
Developed/Open Space	1,319	2.3%
Grass/Pasture	804	1.4%
Winter Wheat	303	0.5%
Deciduous Forest	199	0.3%
Other Hay/Non Alfalfa	154	0.3%
All Others	205	0.4%
Total	**57,092**	**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 Big Four Ditch watershed.

2.4.1 Big Four Ditch Watershed Soil Characteristics

Appendix B contains a table of the SSURGO soil series for the Big Four Ditch watershed. A total of 75 soil types exist in the watershed. The three most common types—Ashkum silty clay loam (0-2 percent slopes), Bryce silty clay (0-2 percent slopes), and Elliot silt loam (0-2 percent slopes)—cover almost half of the overall watershed collectively (22.5, 14.3, and 11.8 percent, respectively). All other soil types each represent less than nine 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 Big Four Ditch 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 B, C, D, A/D, B/D, and C/D are all found within the Big Four Ditch watershed, group C/D is by far the most common type and represent 81 percent of the overall watershed. The most common type, Group C/D, is a dual soil group wherein the first letter applies to the drained condition and the second to the undrained condition. Group C is defined as having "moderately high runoff potential when thoroughly wet." These soils are poorly drained. Group D soils are defined as having "high runoff potential when thoroughly wet." These soils have very low drainage. Group C/D, along with the other dual hydrologic soil groups in this area (A/D, B/D) are soils that can be adequately drained. For the purpose of hydrologic soil group, adequately drained means that the seasonal highwater table is kept at 24 inches below the surface (NRCS 2007).

A commonly used soil attribute is the K-factor, which is a measure of soil erodibility and quantifies the relative susceptibility of soil to sheet and rill erosion. Values of K range from 0.02 to 0.64, from least erodible to most erodible, respectively, and are influenced by elements including texture, organic matter content, structure, and saturated hydraulic conductivity (NRCS 2011). The distribution of K-factor values in the Big Creek watershed range from 0.26 to 0.44, as shown in **Figure 2-4**.

2.5 Population

The Census 2015 TIGER/Line data[4] from the U.S. Census Bureau were retrieved. Geographic shapefiles of census block groups[5] were downloaded for the entire state of Illinois. All census block groups 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 6 block group centroids are located within the watershed, it is estimated that approximately 9,000 people reside in the Big Four Ditch watershed. The major municipality in the watershed, which is shown in Figure 1-1, is the city of Paxton, with a population of approximately 4,470.

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[4] https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html
[5] https://www.census.gov/geographies/reference-maps/2010/geo/2010-census-block-maps.html

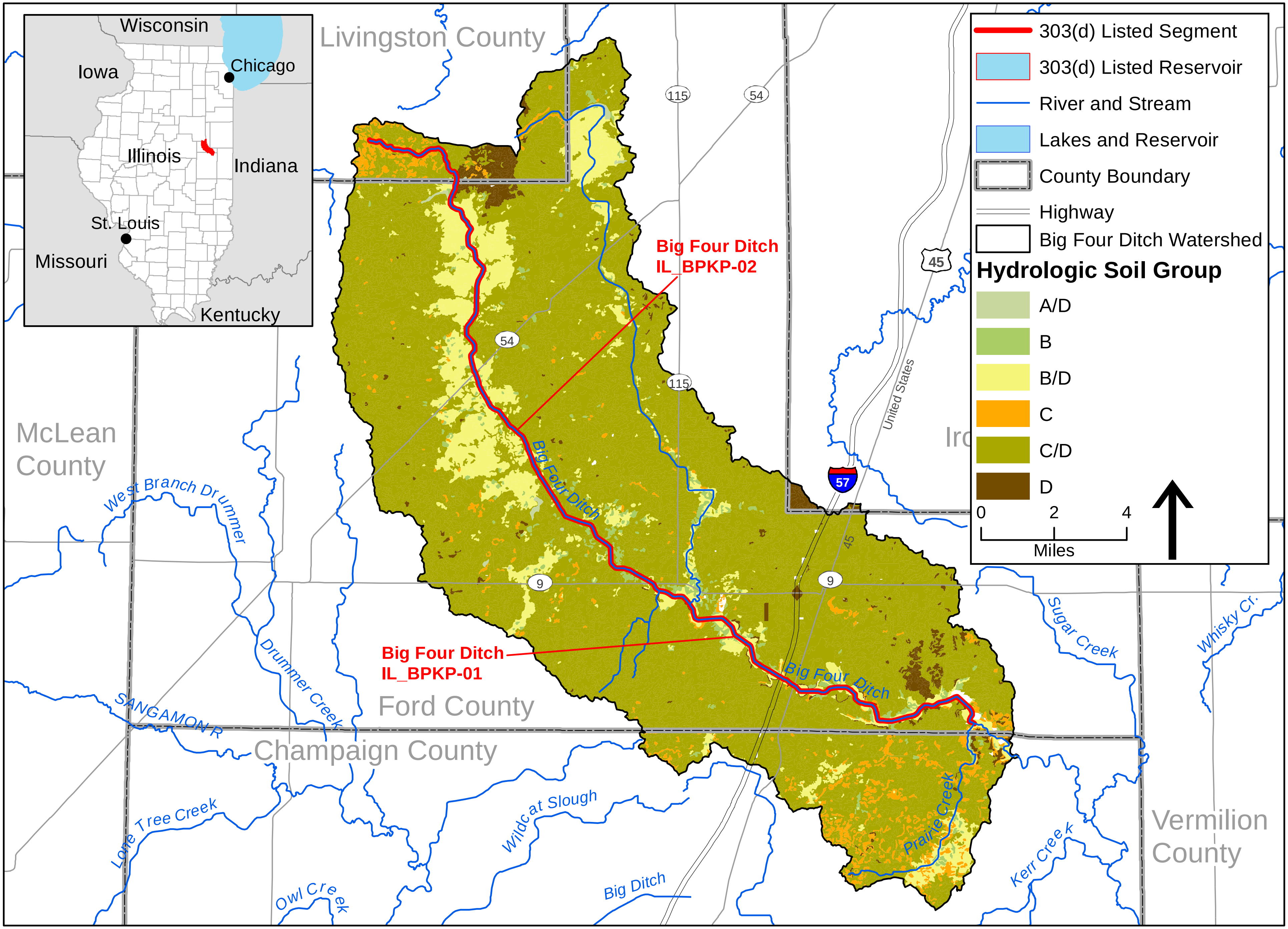

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Figure 2-3: Big Four Ditch Watershed Hydrologic Soil Groups

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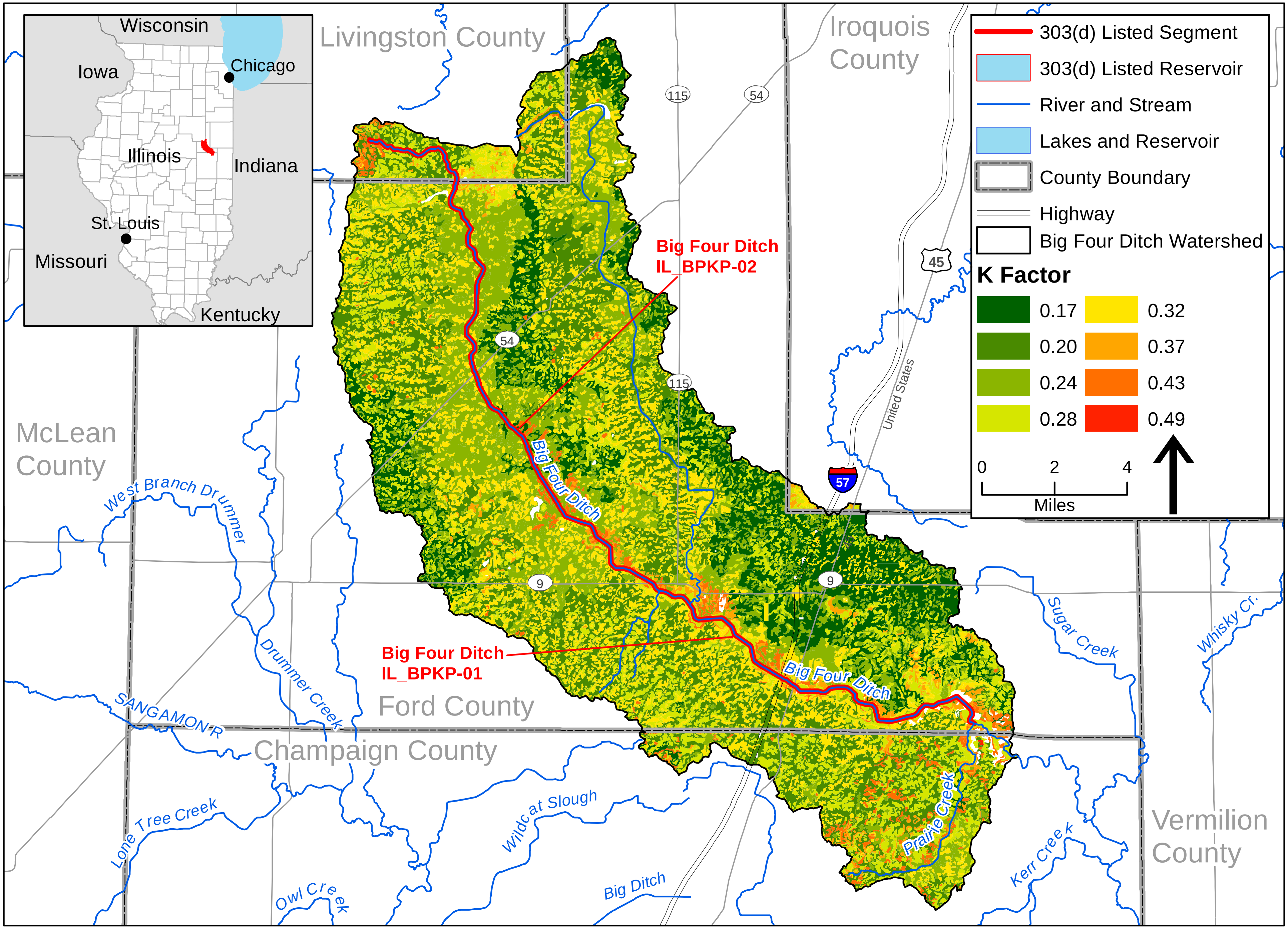

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Figure 2-4: Big Four Ditch Watershed Soil K-Factor Ranges

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2.6 Climate, Pan Evaporation, and Streamflow

2.6.1 Climate

East-central Illinois has a temperate climate with hot summers and cold, moderately snowy winters. Monthly precipitation data from Paxton, Illinois (Station ID USC00116663) in Ford County were extracted from the National Center for Environmental Information (NCEI) [formerly known as the National Climatic Data Center (NCDC)] database[6] for the years of 1987 through 2015. The data station in Paxton, Illinois is near the center of the Big Four Ditch watershed and is expected to be representative of precipitation throughout the watershed.

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 37.6 inches. May and June are historically the wettest months while January and February are the driest. July is historically the warmest month, with an average maximum temperature of 84 °F, while January is typically the coldest month, with an average minimum temperature of 16 °F.

Table 2-4 Average Monthly Climate Data for Paxton, Illinois

Month	Average Total Precipitation (inches)	Average Daily Maximum Temperature (°F)	Average Daily Minimum Temperature (°F)
January	1.9	32.3	16.0
February	1.8	36.1	18.9
March	2.6	48.2	28.8
April	3.7	61.7	39.0
May	4.3	73.0	50.9
June	4.1	81.4	60.1
July	3.9	83.9	63.2
August	3.5	82.8	60.4
September	3.0	78.2	52.6
October	3.3	64.7	41.1
November	2.9	49.7	31.1
December	2.4	36.4	20.9
Annually	**37.6**	**60.7**	**40.3**

2.6.2 Pan Evaporation

Pan evaporation data[7] are available from nine locations across Illinois through data request from the Illinois State Water Survey (ISWS). The Urbana, Illinois station was chosen to be representative of pan evaporation conditions for the Big Four Ditch watershed. The Urbana station is located approximately 26 miles south of Paxton, Illinois. This station was chosen for its proximity to the 303(d)-listed water bodies in east-central Illinois and the completeness of the dataset. The average monthly pan evaporation at the Urbana station for the years 1980 to 2014 yields an average annual pan evaporation of 36.33 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 27.25 inches.

[6] https://www.ncdc.noaa.gov/cdo-web/datatools/findstation
[7] https://www.isws.illinois.edu/warm/reservoirs/contact.asp

2.6.3 Streamflow

Analysis of the Big Four Ditch watershed requires an understanding of flow throughout the drainage area. There are four historical USGS gages within the watershed, shown in **Figure 2-5**; however, none of them are active or have recent data (USGS 2019). There is one USGS gage in an adjacent watershed with similar characteristics to those of the Big Four Ditch Watershed that has available discharge data and may be used to estimate streamflow for the impaired segments of the Big Four Ditch. USGS gage 05570910 (Sangamon River at Fisher, IL) is approximately 9 miles southwest of the Big Four Ditch watershed and has a drainage area of 240 square miles. The average monthly flow at USGS gage 05570910 ranges from 22.0 cubic feet per second (cfs) in August to 1,095 cfs in January, as shown in **Figure 2-6**. **Table 2-5** summarizes the stations along with their respective information.

Table 2-5 Historical Streamflow Gages in and around the Big Four Ditch Watershed[8]

Gage Number	Name	Available Data	POR
03336075	Big Four Ditch near Perdueville, IL	Discharge	1966
03336100	Big Four Ditch Tributary near Paxton, IL	Gage Height, Discharge	1956-1977
03336150	Big Four Ditch above Paxton, IL	Gage Height, Discharge	1966
03336200	Big Four Ditch below Paxton, IL	Discharge	1966
05570910	Sangamon River at Fisher, IL	Gage Height, Discharge	1978-2019

Discharge data from USGS gage 05570910 (Sangamon River at Fisher, IL), which is located in an adjacent and similarly sized watershed to that of the Big Four Ditch, will be used to estimate flow values for the impaired waterbodies in the Big Four Ditch watershed 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. USGS gage 05570910 (Sangamon River at Fisher, IL) is located approximately 9 miles southwest of the Big Four Ditch watershed and has a similar drainage area and will serve as a surrogate gage for the impaired segments of the Big Four Ditch (BPKP-01 and BPKP-02).

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

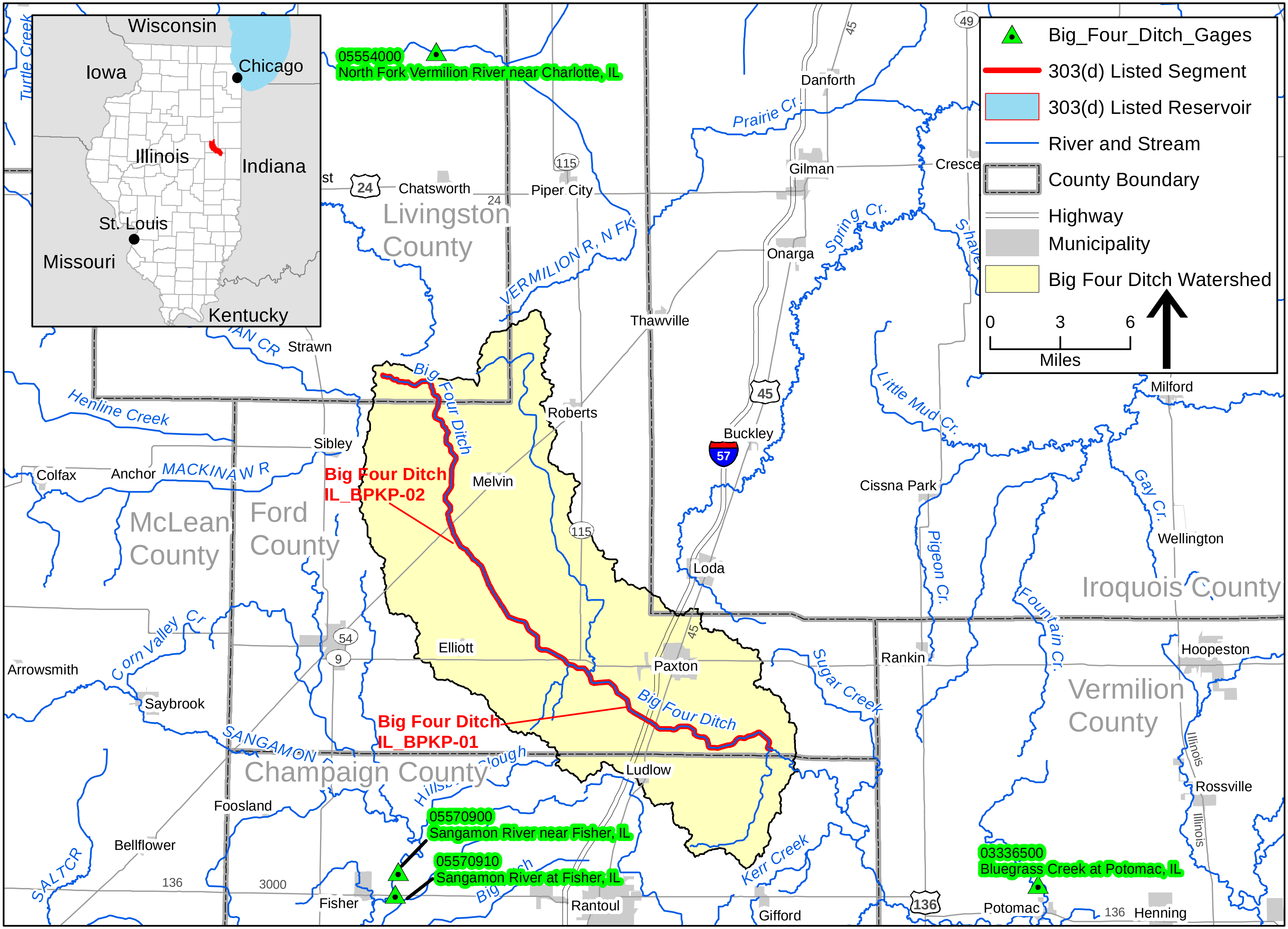

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Figure 2-5: Big Four Ditch Watershed Active USGS Gages

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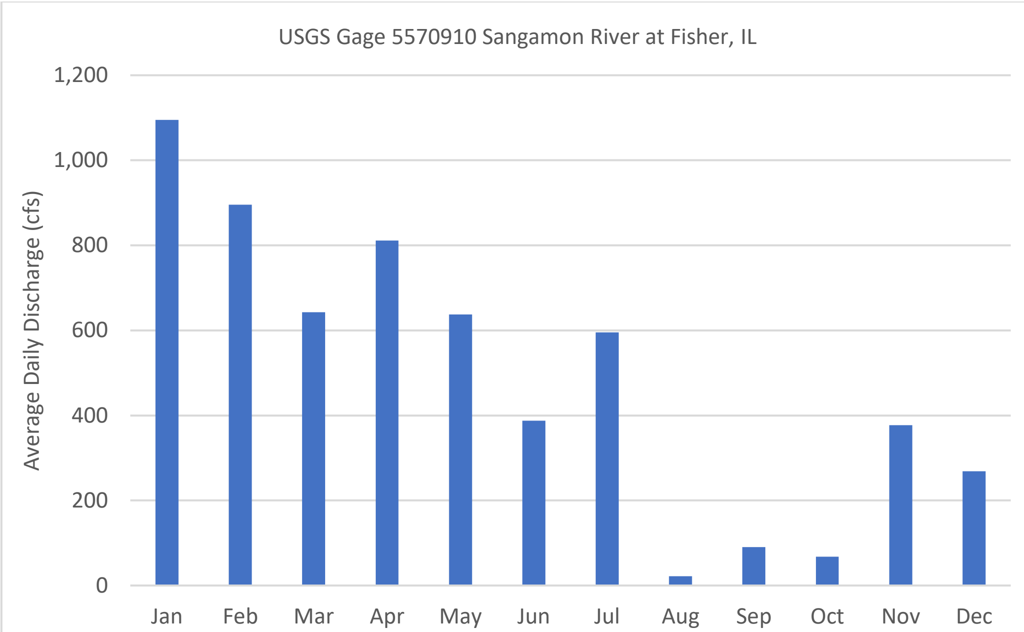

Figure 2-6 Monthly average streamflow for USGS Gage 5570910 Sangamon River at Fisher, IL

Data downloaded through the USGS for the surrogate gage for the available period of record will be adjusted to account for point source influence in the watershed upstream of the gaging station. Average daily flows from all National Pollutant Discharge Elimination System (NPDES) permitted facilities upstream of the surrogate USGS gages are subtracted from the gaged flow prior to flow-per-unit-area calculations. The resulting estimates account for flows associated with precipitation and overland runoff only. Average daily flows from permitted NPDES discharges upstream of the impaired segments in the Big Four Ditch watershed can then be added back into the equation to more accurately reflect estimated daily streamflow conditions in a given segment.

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Section 3

Big Four Ditch Watershed Public Participation

3.1 Big Four Ditch 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 Big Four Ditch watershed at the completion of Stages 1 and 3. Comments received through the public meeting process will be included in an appendix to the final report. This section will be updated following each public meeting.

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Section 4

Big Four Ditch Watershed Water Quality Standards

4.1 Illinois Water Quality Standards

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

Illinois EPA is also responsible for developing scientifically based water quality criteria and proposing them to the IPCB for adoption into state rules and regulations. The Illinois water quality standards are established in the Illinois Administrative Rules Title 35, Environmental Protection; Subtitle C, Water Pollution; Chapter I, Pollution Control Board; Part 302, Water Quality Standards[1].

4.2 Designated Uses

The waters of Illinois are classified into four primary categories of narrative and numeric water quality standards for surface waters, which include: General Use Standards, Public and Food Processing Water Supplies Standards, Secondary Contact and Indigenous Aquatic Life Standards, and Lake Michigan Basin Water Quality Standards[2]. Segments BPKP-01 and BPKP-02 of the Big Four Ditch are impaired by low dissolved oxygen (DO) for the aquatic life use under the General Use standard.

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[2], aquatic life use assessments in streams are typically based on the interpretation of biological information, physiochemical 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 and qualitative

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[1] http://www.ilga.gov/commission/jcar/admincode/035/03500302sections.html
[2] https://www2.illinois.gov/epa/Documents/iepa/water-quality/watershed-management/tmdls/2016/303-d-list/iwq-report-surface-water.pdf

measures of stream bottom composition and qualitative descriptors of channel and riparian conditions. Physiochemical water data used include measures of “conventional” parameters (e.g. DO, pH, and temperature), priority pollutants, non-priority pollutants, and other pollutants.

Tables 4-1 presents the numeric water quality standards of the potential causes of impairment for segmenst BPKP-01 and BPKP-02 of the Big Four Ditch in the Big Four Ditch watershed.

Table 4-1 Summary of Numeric Water Quality Standards for Potential Causes of Stream Impairments in the Big Four Ditch Watershed[3]

Parameter	Units	General Use Water Quality Standard	Regulatory Reference[1]
Dissolved Oxygen	mg/L	*March through July* ≥5.0 minimum & ≥6.0 7-day daily mean averaged over 7 days; *August through February* ≥3.5 minimum, ≥4.0 7-day minimum averaged over 7 days & ≥5.5 30-day daily mean[1]	302.206(b)

mg/L = milligrams per liter
[1]302.206(d) provides further information on detailed calculations for determining the acute and chronic standards for DO

4.4 Potential Pollutant Sources

In order to properly address the conditions within the Big Four Ditch watershed, potential pollutant sources must be investigated for the pollutants where TMDLs will be developed. **Table 4-2** provides a summary of the potential sources associated with the listed potential causes for the 303(d) listed segments in this watershed.

Table 4-2 Impaired Water Bodies in the Big Four Ditch Watershed

Segment ID	Segment Name	Potential Causes of Impairment	Designated Use	Potential Sources (as identified by the 2016 303(d) list)
BPKP-01	Big Four Ditch	Dissolved Oxygen	Aquatic Life	Sources Unknown*
BPKP-02	Big Four Ditch	Dissolved Oxygen	Aquatic Life	Sources Unknown*

*Potential natural sources of low dissolved oxygen may include excessive algae, sediment oxygen demand, and/or lack of reaeration

[3] http://www.ilga.gov/commission/jcar/admincode/035/03500302sections.html

Section 5

Big Four Ditch Watershed Data and Potential Pollution Sources

In order to further characterize the Big Four Ditch watershed, a wide range of pertinent data were collected and reviewed. Water quality data for streams, 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

Illinois EPA monitoring programs that contribute data to the assessment of streams include the Ambient Water Quality Monitoring Network, the Pesticide Monitoring Subnetwork, Facility-Related Stream Surveys, Intensive Basin Surveys, and the Fish Contaminant Monitoring Program[1]. Much of the data used for this report came from the Ambient Water Quality and Lake Monitoring Programs and Intensive Basin Surveys. The Ambient Water Quality Network and Ambient Lake Monitoring Programs include 146 fixed stream stations statewide that are sampled every 6 weeks. Additional data are collected during Intensive Basin Surveys, which are typically conducted on a 5-year cycle and focus on basins where intensive data are currently lacking or where historical data need updating. Additional information on Illinois EPA's monitoring programs can be found in the "Illinois Water Monitoring Strategy[2]."

Data from over 15 historic water quality stations on, or upgradient of, impaired streams within the Big Four Ditch watershed were located and reviewed for this report. These water quality data were primarily provided by the Illinois EPA; however, some additional water quality data provided by the USGS and other sources were pulled from the USEPA's Storage and Retrieval (STORET) database. **Figure 5-1** shows all the water quality data stations on the impaired segments, although not all stations include data relevant to the impairments. **Figure 5-2** and **Figure 5-3** show the subbasins draining to each impaired segment. The figures include land use/land cover data that were presented in Section 2.3.1 and show the locations of permitted discharges (further discussed in Section 5.3).

The impaired water body segments in the Big Four Ditch watershed were presented in Section 1. Refer to Table 1-1 for impairment information specific to each segment. Data are summarized by impairment and discussed in relation to the relevant Illinois numeric water quality standard. Data summaries provided in this section include all available date ranges of collected data. The information presented in this section is a combination of USEPA STORET database and Illinois EPA database data. The following sections will discuss data for the impaired stream segments in the Big Four Ditch watershed.

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[1] https://www2.illinois.gov/epa/topics/water-quality/monitoring/Pages/river-and-stream.aspx
[2] https://www2.illinois.gov/epa/topics/water-quality/monitoring/Pages/strategy.aspx

5.1.1 Stream Water Quality Data

Two impaired stream segments within the Big Four Ditch watershed are addressed in this report (shown on Figures 5-2 and 5-3). There are three active water quality station with applicable data on impaired segment BPKP-01 and two active water quality stations with applicable data on impaired segment BPKP-02 of Big Four Ditch, which is located directly upstream of segment of BPKP-01. The data summarized in this section include water quality data for impaired constituents as well as parameters that may be useful for future modeling and analysis efforts. All available historical water quality data for the impaired segments in the Big Four Ditch watershed are available in Appendix C.

5.1.1.1 Dissolved Oxygen

Big Four Ditch segments BPKP-01 and BPKP-02 are listed for impairment of the aquatic life use by low dissolved oxygen (DO) concentrations. **Table 5-1** summarizes available historical DO data on these segments. The general use water quality standard for DO provides seasonal instantaneous minimum and minimum weekly (7-day) average concentrations for DO in streams. Due to inconsistent and limited datasets, the instantaneous minimum standards of 5.0 mg/L for March through July and 3.5 mg/L for August through February were first used to review data for exceedances of the standard. Given that there were no exceedances according to this standard, the data were also evaluated using the minimum weekly (7-day) average standard of 6.0 mg/L averaged over seven days for March through July and 4.0 mg/L averaged over seven days for August through February. The available dataset exhibited no exceedances under either standard.

Table 5-1 Existing DO Data for Big Four Ditch segments BPKP-01 and BPKP-02

Impaired Segment	Illinois WQ Standard (mg/L)	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Exceedances	Sample Location
BPKP-01	5.0[(1)], 3.5[(2)] 6.0[(3)], 4.0[(4)]	1997; 2 2016; 2	8.66	9.60	8.29	0	BPKP-01, BPKP-PX-A2, BPKP-PX-C2
BPKP-02	5.0[(1)], 3.5[(2)] 6.0[(3)], 4.0[(4)]	2001; 3 2011; 3 2016; 3	8.48	10.90	5.27	0	BPKP-02, BPKP-05

[(1)] Instantaneous Minimum *March-July*
[(2)] Instantaneous Minimum *August-February*
[(3)] Weekly (7-day) Average Minimum *March-July*
[(4)] Weekly (7-day) Average Minimum *August-February*

The summary of data presented in Table 5-1 reflects single samples from each segment compared to the standards during the appropriate months. Only four samples were obtained from the impaired segment of BPKP-01. Nine samples were available for the impaired segment BPKP-02. No sample exceeded the Illinois water quality standard. **Figures 5-4** and **5-5** show the DO measurements collected over time at each impaired segment.

All of the DO measurements in the impaired segments of Big Four Ditch (BPKP-01 and BPKP-02) were collected between May and October. The four samples from impaired segment BPKP-01 were taken in September and October and are subject to the seasonal instantaneous minimum of 3.5 mg/L. Three samples from impaired segment BPKP-02 are subject to the seasonal instantaneous minimum of 5.0 mg/L; the remainder are subject to the seasonal instantaneous minimum of 3.5 mg/L.

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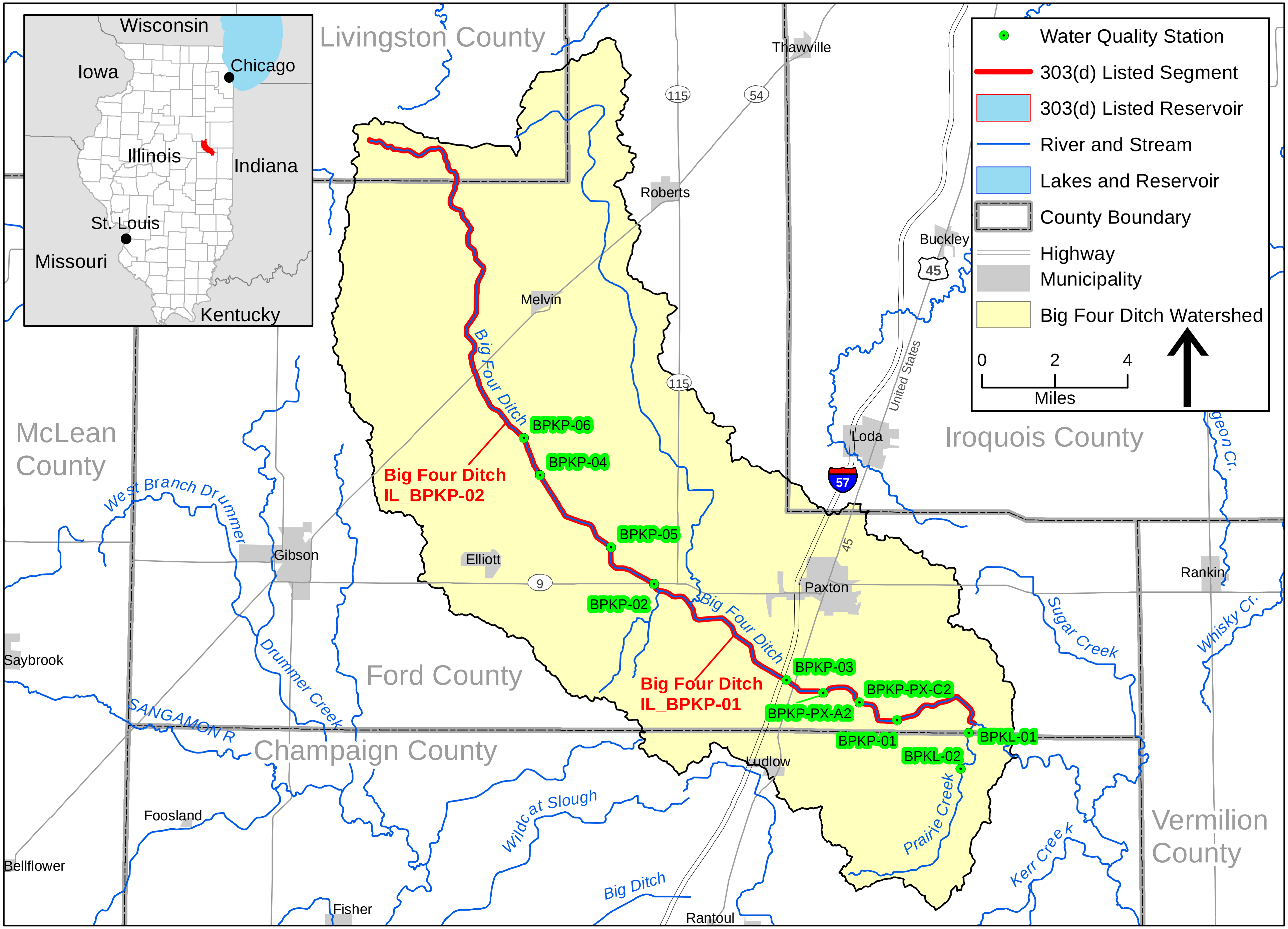

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Figure 5-1: Big Four Ditch Watershed Water Quality Stations

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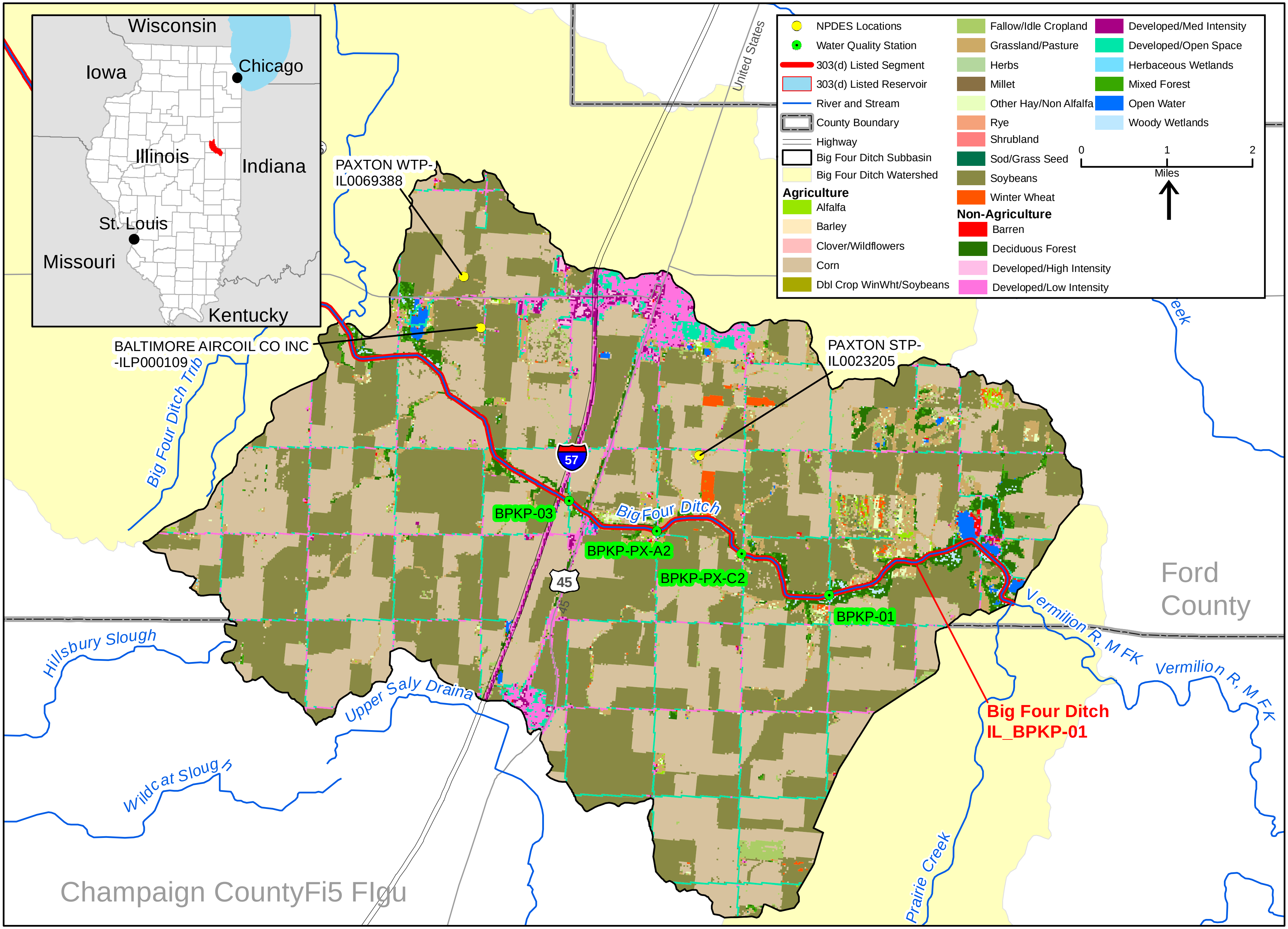

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Figure 5-2: Big Four Ditch Watershed
Big Four Ditch Segment BPKP-01 Subbasin

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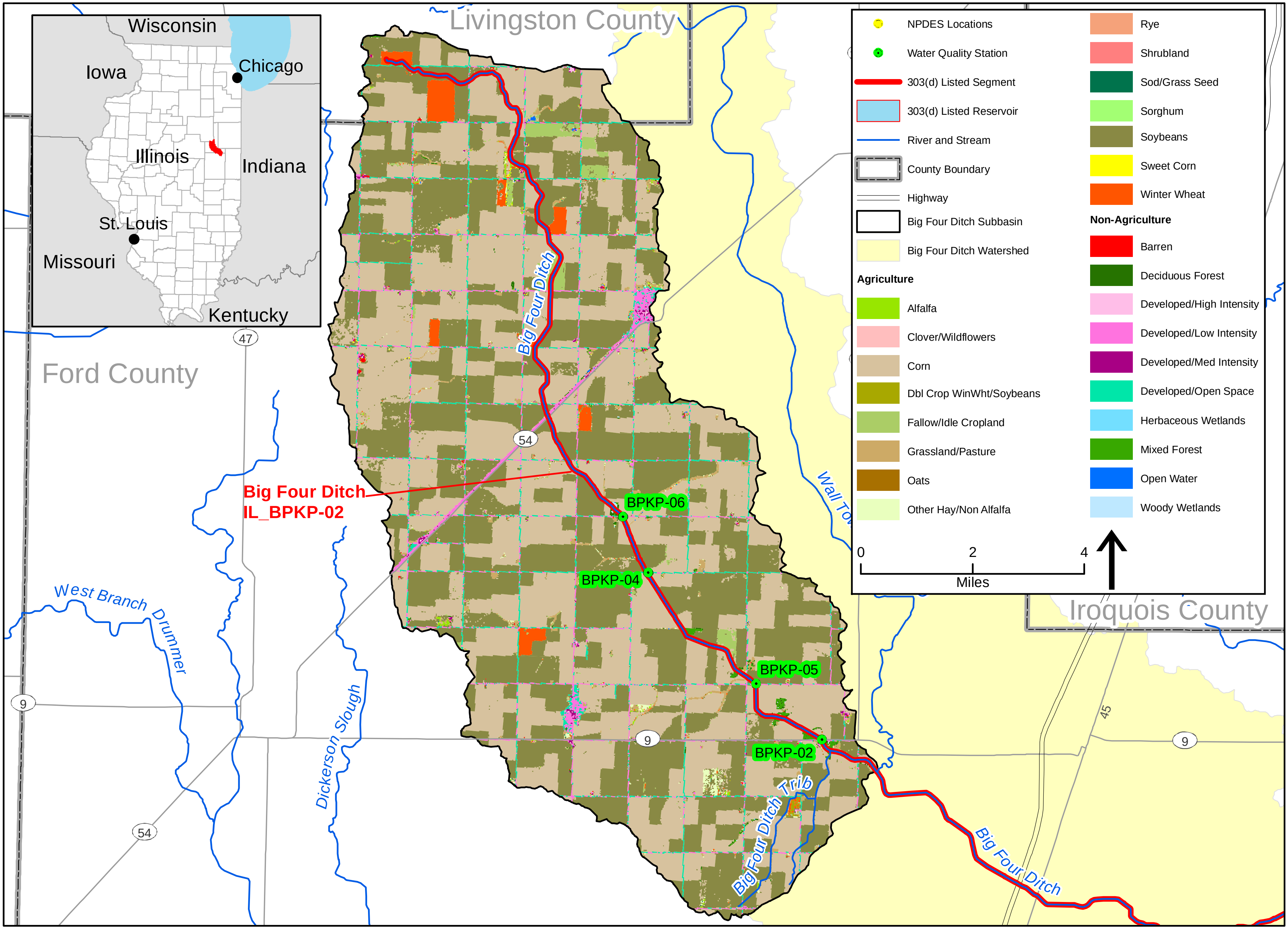

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Figure 5-3: Big Four Ditch Watershed
Big Four Ditch Segment BPKP-02 Subbasin

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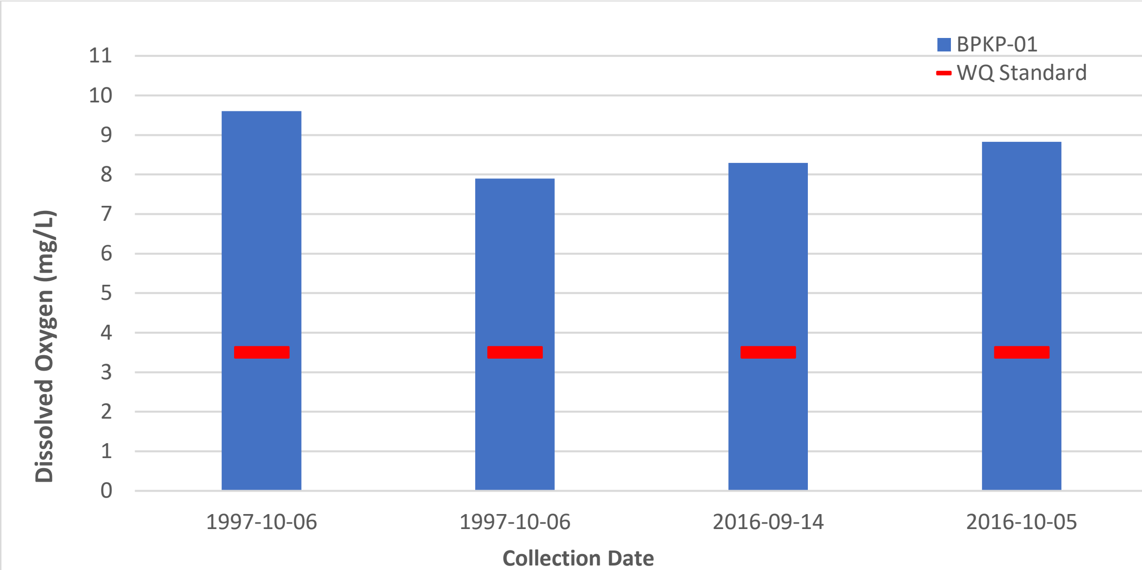

Figure 5-4: Historical Dissolved Oxygen data for Big Four Ditch Segment BPKP-01

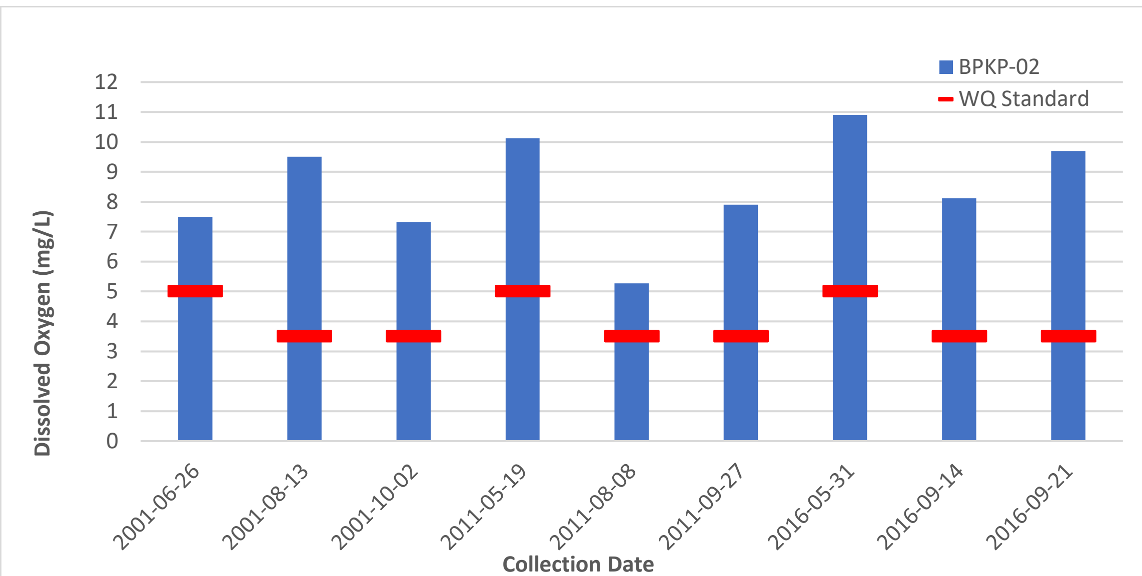

Figure 5-5: Historical Dissolved Oxygen data for Big Four Ditch Segment BPKP-02

5.2 Point Sources

In general, facilities discharging treated domestic wastewater have the potential to affect DO concentrations (through the discharge of nutrients and other oxygen-demanding materials) in their receiving waters. There are two active point sources located within the Big Four Ditch watershed that discharge to or upstream of impaired segment BPK-01 (**Figure 5-6**). The City of Paxton Water Treatment Plant (WTP) is unlikely to discharge effluent that impacts DO levels in its receiving water while treated effluent from the Sanitary Treatment Plant (STP) may contribute oxygen-demanding materials to the impaired segment. **Table 5-2** contains permit information for these point sources.

Permit limits and discharge monitoring reports will be analyzed and further detailed during Stage 3 TMDL development. Two additional non-active NPDES-Permitted facilities exist in the watershed, as shown on Figure 5-6.

Table 5-2 Permitted Facilities Discharging within the Big Four Ditch Watershed

Facility ID	Facility Name	Design Average/Maximum Flow (mgd)	Receiving Water
IL0023205	CITY OF PAXTON STP	0.51/1.42	Unnamed Tributary to Big Four Ditch (BPK-01)

5.3 Nonpoint Sources

There are a number of potential nonpoint sources of pollutant loading to the impaired segments in the Big Four Ditch watershed. The 303(d) list stated "source unknown" for potential sources of impairment within the watershed. This section will discuss site-specific cropping practices, animal operations, and area septic systems as they are historically nonpoint sources of sediment and oxygen-demanding materials within streams. Data were collected through communication with the local NRCS, Soil and Water Conservation Districts (SWCDs), and county health departments.

5.3.1 Crop Information

Approximately 90 percent of the land within the Big Four Ditch watershed is devoted to agriculture. Of the agricultural lands, corn and soybean farming each account for approximately 44 percent of the watershed. Tillage practices can be categorized as conventional till, reduced till, mulch till, and no till. The percentage of each tillage practice for corn, soybeans, and small grains by county are generated by the Illinois Department of Agriculture (IDA) from County Transect Surveys[3]. Data specific to the Big Four Ditch watershed were not available; however, Ford, Iroquois, Livingston, and Champaign County practices were available and are presented as they are reported in the transect surveys in **Tables 5-3** through **5-6**.

Table 5-3 Tillage Practices in Ford County

Tillage System	Corn		Soybean		Small Grain	
	2015	2018	2015	2018	2015	2018
Conventional	66.9%	94.4%	4.3%	28.9%	0.0%	0.0%
Reduced - Till	16.9%	3.1%	18.0%	33.7%	66.7%	0.0%
Mulch - Till	6.8%	0.9%	42.0%	10.7%	33.3%	0.0%
No - Till	9.4%	0.6%	35.7%	26.7%	0.0%	0.0%

Table 5-4 Tillage Practices in Champaign County

Tillage System	Corn		Soybean		Small Grain	
	2015	2018	2015[1]	2018	2015	2018[2]
Conventional	75.0%	93.5%	8.0%	20.4%	100.0%	0.0%
Reduced - Till	13.0%	5.6%	25.0%	41.6%	0.0%	0.0%
Mulch - Till	10.0%	0.6%	41.0%	14.3%	0.0%	0.0%
No - Till	2.0%	0.3%	25.0%	23.7%	0.0%	25.0%

[1] Values presented are as reported, totally slightly below 100%.

[2] Incomplete data available

[3] https://www2.illinois.gov/sites/agr/Resources/LandWater/Pages/Illinois-Soil-Conservation-Transect-Survey-Reports.aspx

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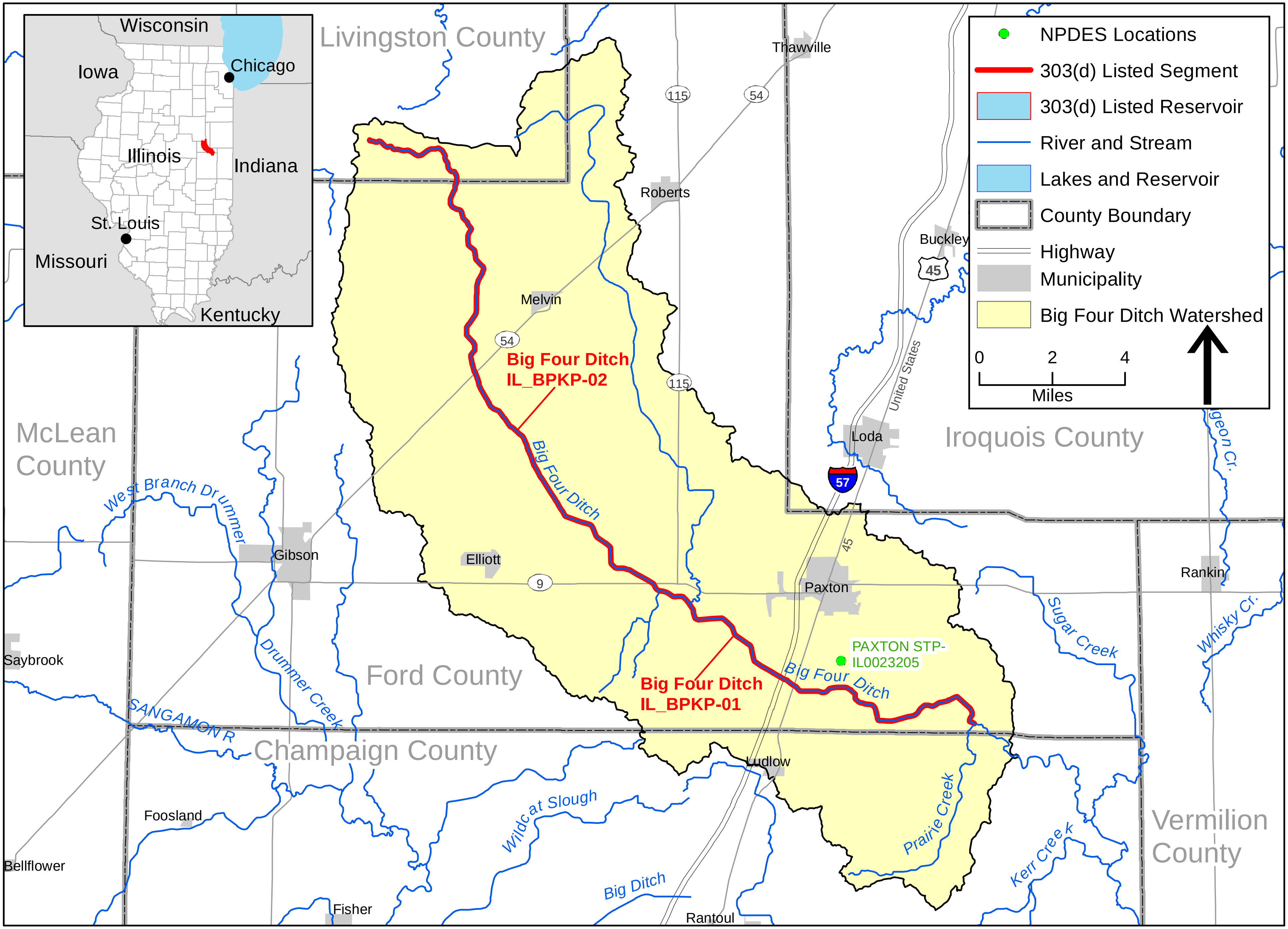

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Figure 5-6: Big Four Ditch Watershed
NPDES Discharge Locations

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Table 5-5 Tillage Practices in Livingston County

Tillage System	Corn		Soybean		Small Grain	
	2015	2018	2015	2018	2015	2018
Conventional	64.3%	65.2%	5.4%	8.3%	0.0%	0.0%
Reduced - Till	16.6%	8.9%	10.3%	13.1%	66.7%	0.0%
Mulch - Till	12.3%	13.3%	40.2%	62.4%	0.0%	0.0%
No - Till	6.8%	12.6%	44.1%	16.2%	33.3%	0.0%

Table 5-6 Tillage Practices in Iroquois County

Tillage System	Corn		Soybean		Small Grain	
	2015	2018	2015	2018	2015	2018
Conventional	31.6%	59.4%	50.0%	4.8%	0.0%	0.0%
Reduced - Till	32.0%	24.9%	6.4%	12.9%	0.0%	25.0%
Mulch - Till	30.2%	9.6%	4.3%	51.9%	0.0%	0.0%
No - Till	6.2%	6.1%	39.3%	30.4%	100.0%	75.0%

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.

Information on field tiling practices was also sought as field drains can influence the timing and amount of water delivered to area streams and reservoirs as well as deliver dissolved nutrients from fields to receiving waters. Local SWCD officials reported that, given the predominant soils in the watershed (very poorly-poorly-somewhat poorly drained or moderately well drained soils on slopes of less than 2%), approximately 88% of the area would be in need of tile drainage[4].

5.3.2 Animal Operations

Information on animal operations within each county in Illinois 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 through manure. Data specific to the Big Four Ditch watershed were not available; however, the Ford, Livingston, Champaign, and Iroquois County animal populations were reviewed and are presented in **Tables 5-7** through **5-10**[5].

[4] Earles, S. 2019, November 15. Soil and Water Conservation District (SWCD) - Ford County, Resource Conservationist. Email correspondence

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

Table 5-7 Ford County Animal Populations

Livestock Type	2012	2017	Percent Change
Cattle and Calves	3,032	2,967	2.1%
Beef	(D)	(D)	--
Dairy	(D)	(D)	--
Hogs and Pigs	128,522	54,271	-57.8%
Poultry	975	1,863	91.1%
Sheep and Lambs	685	736	7.4%
Horses and Ponies	273*	181	-33.7%

(D) - Withheld to avoid disclosing data for individual farms
*USDA 2012

Table 5-8 Champaign County Animal Populations

Livestock Type	2012	2017	Percent Change
Cattle and Calves	12,135	7,300	-39.8%
Beef	(D)	(D)	--
Dairy	(D)	(D)	--
Hogs and Pigs	9,852	10,117	2.7%
Poultry	74	49	-33.8%
Sheep and Lambs	440	460	4.5%
Horses and Ponies	763*	410	-46.3%

(D) - Withheld to avoid disclosing data for individual farms
*USDA 2012

Table 5-9 Livingston County Animal Populations

Livestock Type	2012	2017	Percent Change
Cattle and Calves	10,510	10,893	3.6%
Beef	2,490	2,946	18.3%
Dairy	1,344	1,604	19.3%
Hogs and Pigs	236,426	133,911	-43.4%
Poultry	53	54	1.9%
Sheep and Lambs	359	787	119.2%
Horses and Ponies	357*	201	-43.7%

*USDA 2012

Table 5-10 Iroquois County Animal Populations

Livestock Type	2012	2017	Percent Change
Cattle and Calves	23,621	16,057	-32.0%
Beef	5,536	3,332	-39.8%
Dairy	200	204	2.0%
Hogs and Pigs	57,778	52,640	-8.9%
Poultry	44	47	6.8%
Sheep and Lambs	508	760	49.6%
Horses and Ponies	370*	305	-17.6%

*USDA 2012

Communications with local SWCD and NRCS officials have indicated that there is not a prevalence of animal populations given that the majority of the watershed is lacking in bottomland floodplain[6].

5.3.3 Septic Systems

Many 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 many types of septic systems, but the most common septic system is composed of a septic tank draining to a septic field, where nutrient removal occurs. However, the degree of nutrient removal is limited by soils and system upkeep and maintenance.

Across the U.S., septic systems have been found to be a significant source of phosphorous pollution and failing or leaking septic systems contribute to fecal coliform pollution, both of which can contribute to low DO. Animal waste, urban runoff, and permitted point sources can also contribute. County health departments were contacted for information on the extent of sewered and non-sewered municipalities. Responses from each of the counties were sparse, but in general, there are several unsewered communities throughout the watershed where homes are dependent on private septic systems. It is likely that any homes outside of the sewered areas of Paxton are on septic systems.

5.4 Watershed Studies and Other Watershed Information

The extent of previous planning efforts within the Big Four Ditch watershed is currently unknown. It is assumed that this information will become available through public meetings within the watershed community. In the event that other watershed-specific information becomes available, it will be reviewed, and all applicable data will be incorporated during Stages 2 and 3 of TMDL development.

[6] Earles, S. 2019, November 15. Soil and Water Conservation District (SWCD) - Ford County, Resource Conservationist. Email correspondence

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Section 6

Approach to Developing TMDL and Identification of Data Needs

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. 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 Big Four Ditch watershed.

6.2 Additional Data Needs for TMDL Development in the Big Four Ditch Watershed

Table 6-1 contains summary information regarding data availability for all impairments to be addressed by TMDLs in the Big Four Ditch watershed. The available datasets for impairments on the Big Four Ditch are minimally sufficient for basic TMDL calculations and model development, although the available data do not provide verification that the impairments exist.

The available dataset for addressing DO impairments on Big Four Ditch segment BPKP-01 includes only two data points reported in 2016 and two data points from 1997. There are nine data points for DO in impaired stream segment BPKP-02. No DO levels below the applicable water quality standards were observed in the datasets for either segment. In order to develop a more robust TMDL for these segments, additional data may need to be collected to verify impairment and assess load reduction needs. Sample collection at various times of year and over a range of flow conditions would aid in assessing the entire range of DO conditions that may occur within each segment and would provide for a more accurate depiction of potential factors influencing the DO impairments in this segment. Additional data collection is also recommended to support model development. Specific data requirements include a synoptic (snapshot in time) water quality survey of each reach with careful attention to the location of the point source dischargers. Ideally, the surveys would include measurements of flow, hydraulics, DO, temperature, nutrients, sediment oxygen demand (SOD), and carbonaceous biochemical oxygen demand (CBOD). The collected data would be used to support the model development and parameterization and would lend significant confidence to the TMDL and implementation plan conclusions.

Table 6-1 Data Availability and Data Needs for TMDL Development in the Big Four Ditch Watershed

Impaired Segment	Impairment for Potential TMDL Development	Recommended TMDL/WBP Approach	Data Count	Additional Data Needs
Big Four Ditch (BPKP-01)	Dissolved Oxygen	2016	4	Additional DO data for impairment assessment; Synoptic data for flow, hydraulics, DO, temperature, nutrients, CBOD, and SOD
Big Four Ditch (BPKP-02)	Dissolved Oxygen	2001-2016	9	Additional DO data for impairment assessment; Synoptic data for flow, hydraulics, DO, temperature, nutrients, CBOD, and SOD

6.3 Approaches for Developing TMDLs for Stream Segments in Big Four Ditch Watershed

6.3.1 Recommended Approach for Dissolved Oxygen in Impaired Stream Segments

Assuming additional DO data becomes available to confirm the impairments in these segments, the recommended approach to TMDL development for DO impairments in streams is the development and parameterization of a series of QUAL2K models. QUAL2K is an updated spreadsheet-based version of the well-known and USEPA-supported QUAL2E model[1]. The model simulates DO dynamics as a function of nitrogenous oxygen demand (NOD) and CBOD, atmospheric re-aeration, SOD, and phytoplankton photosynthesis and respiration. The model also simulates the fate and transport of nutrients and BOD and the presence and abundance of phytoplankton (as chlorophyll-a). Stream hydrodynamics and temperature are important controlling parameters in the model. The model is suited to steady-state simulations. It is not anticipated that an additional watershed model will be needed to develop a DO TMDL for this stream. Additional data collection is recommended for Big Four Ditch.

[1] Brown, L.C. and Barnwell, T.O. 1987. The enhanced stream water quality models QUAL2E and QUAL2E-UNCAS: documentation and user manual. EPA-600-3-87-007, US Environmental Protection Agency, Athens, GA

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