Steuben County Strategic Water Quality Monitoring Program

*A **cooperative partnership** between the Steuben County Lakes Council, Steuben County Health Department, Steuben County Soil & Water Conservation District, City of Angola/Trine University MS4 Program, Trine University Biology Department, St. Joseph River Basin Commission, and the Michiana Area Council of Governments AmeriCorps Program*

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2024 Water Quality Results Report

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Project Overview

In 2023, stakeholders from the Steuben County Lakes Council (SCLC), the City of Angola/Trine University MS4 (COA/TU MS4), the Steuben County Soil & Water Conservation District (SWCD), the Steuben County Health Department (HD), the St. Joseph River Basin Commission (SJRBC), the Michiana Area Council of Governments AmeriCorps program (MACOG, the organization that houses the SJRBC), and Trine University developed the Steuben County Strategic Water Quality Monitoring Program (SCSWQMP). The program was structured to build upon the water quality monitoring efforts of the SCLC, which began monitoring various Steuben County waterbodies in the early 2000s. The SCLC's program was started in order to address landowners concerns about unsafe *Escherichia coli (E. coli)* levels in the County's lakes and streams. *E. coli* is a bacterium found in many places, including the environment, foods, water, and the intestines of people and animals. Most *E. coli* strains are harmless and are part of a healthy intestinal tract[1]. *E. coli* help digest food, produce vitamins, and protect us from harmful germs. However, some *E. coli* strains can cause serious illness in people who encounter contaminated water, typically through swimming and other water sports. Nutrient and sediment levels were also of concern as excessive nutrients can lead to harmful algal blooms and beach closures, while high inputs of sediments can adversely affect aquatic life and can lead to increased maintenance costs associated with cleaning out regulated drains.

The SCLC data revealed the extent of *E. coli* in Steuben County, but the data gave a limited insight into the cause of the problem. In response to the need for robust data, the SCSWQMP began to monitor surface water sites on a weekly basis, with samples collected on the same days, during similar times, each week, by trained college interns. The benefit of consistency in the days and times samples are collected each week is that it allows for determination of a more representative sample of water quality trends. The purpose of the program is to establish baseline water quality data and track trends over time. The data can be used to inform local policy decisions which can lead to corrective actions to improve water quality. The program seeks to assist ongoing efforts in the watersheds of Steuben County to reduce nutrient and sediment loadings into surface waters and to eliminate the chronic *E. coli* issues afflicting many of the lakes and streams in Steuben County.

Methods

The second full summer of water quality sampling was completed in 2024, beginning the week of May 21 (Week 1) and ending September 5 (Week 16). The field season involved a team effort that continued from the successful momentum initiated in 2023. Since its inception in 2023, the program has been awarded Steuben County Community Foundation (SCCF) Grants which supported strategic monitoring efforts in 2024. This support, in addition to monetary and in-kind support from the stakeholders, allowed the program to expand the number of sites monitored from 10 to 18, throughout the county. These additional sites added new water quality records which build upon the original 2023 dataset.

The new monitoring sites were selected using an analysis of historical water quality data collected by the SCLC. Monitoring sites consisted of a subset of the most impaired waterways documented by SCLC, sites located upstream of some problematic sites, and the one reference site, Pigeon Creek at 327, which is part of the SCLC monitoring program. Pigeon Creek at 327 was chosen as a reference site because SCLC data show consistently low bacterial, nutrient, and sediment levels, and biological monitoring conducted by the SJRBC demonstrates exceptional stream health[2]. A map of the sampling sites can be accessed on google maps[3].

E. coli, total phosphorus, and total suspended solids were collected via grab samples. Samples were placed on ice immediately after collection for laboratory analysis. Water quality samples need to be kept on ice to slow down microbial activity and chemical reactions that can alter the sample's composition before analysis. Measurements for temperature, Dissolved Oxygen (DO), pH, Total Dissolved Solids (TDS), Conductivity, Chlorophyll-a, and chlorides were taken in the field using a portable water quality meter, a HydroLab HL7 Multiparameter Sonde. Stream discharge was measured using the mechanical current-meter method where water velocity and depth are measured at predetermined points across a stream/river[4]. One change to the strategic sampling program was the discontinuation of analyzing samples for nitrates. The main factor for this decision was cost; price increases in nitrate analysis exceeded the SCSWQMP finance capabilities.

[1]U.S. Centers for Disease Control and Prevention (CDC): https://www.cdc.gov/ecoli/about/index.html
[2]SJRBC Biological Monitoring: https://www.sjrbc.com/docs/resources/monitoring/SJRBC%202021%20Monitoring%20Report.pdf
[3]2024 Sampling Sites Map: https://www.google.com/maps/d/u/0/edit?mid=1xjEy8EYNJ37NEc5sFL0MD9426RnGN4Y&usp=sharing
[4]USGS How Stream Flow Measured; https://www.usgs.gov/special-topics/water-science-school/science/how-streamflow-measured

It is important to note that various sites may not have been sampled every week during the 2024 field season due to limitations of field conditions (e.g., a site may not have been sampled due to "low flow" or "no flow" conditions, etc.) or due to an equipment malfunction. A few times during the sampling season, the field crew were unable to collect in-stream water quality data due to a faulty connection between the sonde and sonde meter cable. The equipment manufacturer was immediately notified of the issue and the problem was resolved with the replacement of the sonde cable.

This report structure follows the 2023 format by providing an initial interpretation of a subset of the water quality data collected by the 2024 SCSWQMP program. This report is organized as follows:

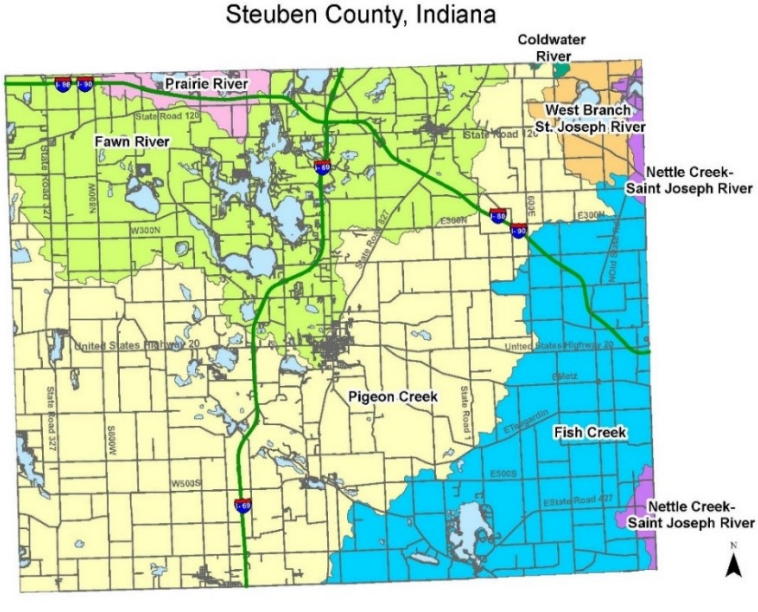
I. Table 1 shows the percentage of sampling events at each site that exceeded water quality standards for *E. coli*, Total Phosphorus (TP), Dissolved Oxygen (DO), and Total Suspended Solids (TSS).

II. Line graphs illustrate weekly *E. coli* and phosphorus levels. The line graphs differ from the 2023 report presentation in that they are grouped by watershed [i.e., Fish Creek, Pigeon Creek, and Fawn River; see Figure 1)], as opposed to being presented in sampling site chronological order. Within each watershed, graphs are presented from an upstream to downstream order, rather than chronologically by site.

III. Summary and Conclusion.

IV. Appendix with details on the water quality parameters measured by the program and bar graphs illustrating daily precipitation from May 20 to September 7, 2024. Precipitation graphs are from the Community Collaborative Rain, Hail & Snow Network or CoCoRaHS. This information is provided for reference purposes to show when precipitation events occurred. Precipitation can significantly impact water quality by increasing surface runoff carrying pollutants, such as nutrients, from urban and agricultural areas into waterways. Understanding these impacts is essential for developing strategies to safeguard water quality. CoCoRaHS is a unique, non-profit, community-based network of volunteers working together to measure and map precipitation (rain, hail, and snow) using low-cost measurement tools. CoCoRaHS stresses training and education, utilizing an interactive website to provide the highest quality data for natural resource, education, and research applications[5].

The Southeastern Lake Michigan (West), including Prairie River, Fawn River, and Pigeon Creek Watersheds, flows through South Bend, IN on its way to drain into Lake Michigan.



The Western Lake Erie Basin, including the West Branch of the St. Joseph River, Nettle Creek, and Fish Creek Watersheds, flows to Fort Wayne, IN on its way to drain into Lake Erie.

Figure 1. Steuben County, Indiana major watersheds. Fawn River is shown in green and Pigeon Creek in yellow, which drain to Lake Michigan. Fish Creek is shown in blue, which drains to Lake Erie.

[5]Community Collaborative Rain, Hail & Snow Network (CoCoRaHS): https://www.cocorahs.org/

I. Percentage of samples that exceeded water quality standards in 2024

A useful metric for understanding water quality is to determine the percentage of water samples from a monitoring location that exceeds existing water quality standards (WQS). The WQS are recommended by the Indiana Department of Environmental Management (IDEM):

a. *E. coli* levels should not exceed 235 colony forming units per 100 milliliter water sample (235 CFU per 100 ml). In this report, *E. coli* measurements are reported in units of Most Probable Number per 100 milliliter sample of water (MPN per 100 ml). Although IDEM does not list the standard in MPN, we use the CFU benchmark as they both quantify bacterial load (see Appendix of Water Quality Definitions on page 17 for additional details).
b. Total Phosphorus (TP) levels should not exceed 0.3 mg/L.
c. Dissolved Oxygen (DO) should be at least 4 mg/L and, at most, 12 mg/L; waterbodies with levels above or below this range indicate impairment.
d. Total Suspended Solids (TSS) levels should not exceed 30 mg/L.

Table 1, below, presents the percentage of water samples from each site that exceeded the water quality standards for *Escherichia coli* (*E. coli*), Phosphorus (P), Dissolved Oxygen (DO), and Total Suspended Solids (TSS).

Table 1. Percent exceedance of the water quality targets for *E. coli*, Total Phosphorus, Dissolved Oxygen, and Total Suspended Solids.

		PERCENT (%) EXCEEDENCE			
SITE ID	SITE NAME	*E. coli*	TOTAL PHOSPHORUS	DISSOLVED OXYGEN	TOTAL SUSPENDED SOLIDS
SITE 1	Fish Creek (Metz Road)	100.0	0	8.0	20.0
SITE 2	Fish Creek (E 40 S)	87.5	0	0	0
SITE 3	Pigeon Creek (Jack Ditch)	93.7	0	7.7	18.2
SITE 4	Fawn River – Center Lake Discharge (N 155 W)	62.5	0	7.7	0
SITE 5	Fawn River – Palfreyman Ditch (Crooked Lake Lane 101b)	93.3	6.7	7.7	18.2
SITE 6	Fawn River – Carpenter Ditch (W 200 N)	31.2	0	0	27.3
SITE 7	Pigeon Creek (Bill Deller Road)	92.8	0	0	20.0
SITE 8	Pigeon Creek (Old US HWY 27)	71.4	7.1	0	10.0
SITE 9	Pigeon – Turkey Creek (S 800 W)	92.3	7.1	18.2	0
SITE 10	Pigeon Creek (SR 327)	15.4	0	0	0
SITE 11	Fawn River – W. Branch Palfreyman Ditch (W Mill Street)	75.0*	0*	25.0*	N/A**
SITE 12	Fawn River – Lower Basin Lake James (W 275 N)	85.7	7.1	0	0
SITE 13	Fawn River – State Fish Hatchery (SR 327)	7.1	0	20.0	0
SITE 14	Pigeon Creek (Lake Arrowhead Lane 100)	92.8	0	0	0
SITE 15	Fawn River – Carpenter Ditch (N 200 W)	100.0	0	8.3	54.5
SITE 16	Fawn River – Center Lake Discharge (W 100 N)	28.6	14.3	0	20.0
SITE 17	Pigeon Creek (20 N)	100.0	0	0	9.1
SITE 18	Black Creek (S 550 E)	73.3	20.0	8.3	45.4

*Small sample sizes due to no or low water levels.
**Insufficient number of samples to accurate reflect Total Suspended Solids percent exceedance.

Notable findings:

- For *E. coli*, fourteen (14) out of the eighteen (18) sites exceeded the water quality standard in more than 50% of samples. Site 13 (Fawn River) and Site 10 (Pigeon Creek) exceeded the water quality standard for *E. coli* only 7.1% and 15.4% of the time, respectively.
- All three sampling sites in the Upper St. Joseph River Watershed (Fish and Black Creek) exceeded the *E. coli* water quality standard nearly ≥90% of the samples. Site 15 (Fawn River) and Site 17 (Pigeon Creek) exceeded the *E. coli* water quality standard in 100% of the samples.
- Six (6) sites exceeded the water quality standard for Total Phosphorus (TP); Site 16 (Fawn River) and Site 18 (Black Creek) exceeded the standard in more than 14.3% of the samples.
- Half of the sites had exceedance rates for Dissolved Oxygen (DO) and Total Suspended Solids (TSS). Site 11 (Fawn River) had the highest exceedance rate for DO and Site 15 (Fawn River) had the highest exceedance rate for TSS. In 2023, Site 3 (Pigeon Creek-Jack Ditch) had the highest exceedance rates for these variables.
- Site 10 (Pigeon Creek at SR 327) again emerged as the highest quality site due to its low overall exceedances for all water quality measurements. These findings again suggest that this site is validated as our reference site because it exhibited the lowest exceedance percentage for most water quality variables.

II. (a) Weekly trends in *E. coli* levels

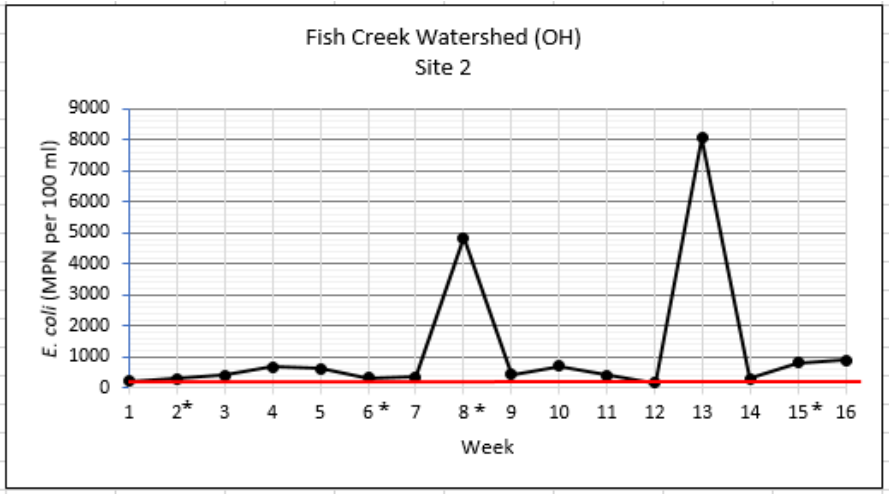
E. coli measurements are reported in units of Most Probable Number per 100 milliliter sample of water (MPN per 100 ml)[6].

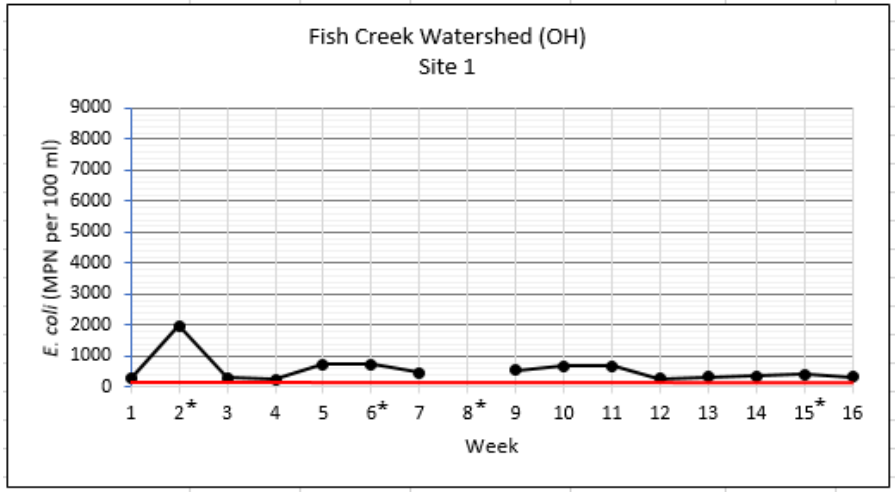
- *E. coli* levels ranged between 6.7 and 8,065.3 and averaged 852.8 MPN per 100 ml, all sites combined.
- By watershed [*see Figures 2 – 4 (pages 5 – 9)*]:
  - *E. coli* levels for Fish Creek ranged between 76 and 8,065.3 MPN per 100 ml and averaged 963.9 MPN per 100 ml;
  - *E. coli* levels for Pigeon Creek ranged between 82 and 8,065.3 MPN per 100 ml and averaged 850.9 MPN per 100 ml; and
  - *E. coli* levels for Fawn River ranged between 6.7 and 5,177 MPN per 100 ml and averaged 807.2 MPN per 100 ml.
- Over the course of the 16-week sampling season, the calculated average *E. coli* concentration at each site exceeded the water quality standard for full-body contact recreation. However, the calculated average *E. coli* concentration at Sites 10 (Pigeon Creek), 13 (Fawn River), and 16 (Fawn River) were below the allowable limit.

(Continued on page 5)

[6]In this report, *E. coli* measurements are reported in units of Most Probable Number per 100 milliliter sample of water (MPN per 100 ml). Although the Indiana Department of Environmental Management (IDEM) does not list the standard in MPN, we use the CFU benchmark of 235 colony forming units per 100 milliliter water sample (235 CFU per 100 ml) as they both quantify bacterial load (see Appendix of Water Quality Definitions on page 17 for additional details).

Fish Creek Watershed *(E. coli)*





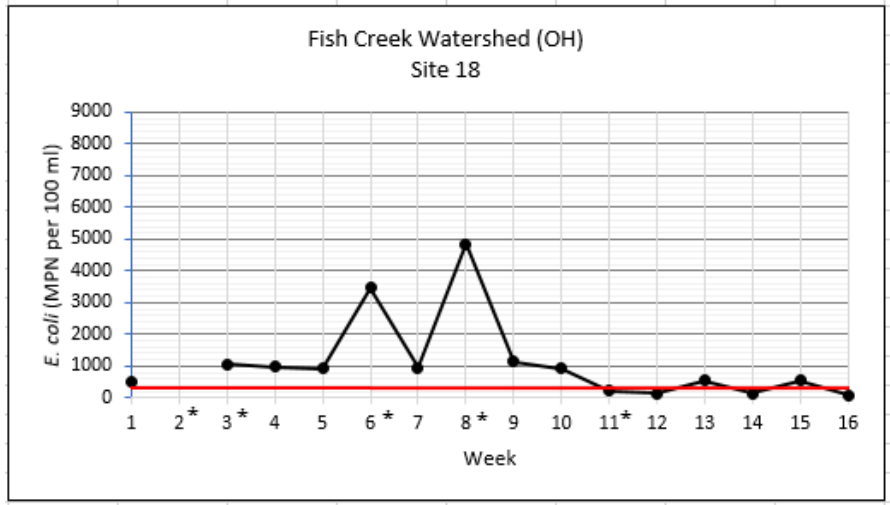


Figure 2. Line graphs of weekly *E. coli* levels (Most Probable Number per 100 ml sample; MPN per 100 ml) at the 3 monitoring sites in the **Fish Creek Watershed [**from the most upstream sampling site (Site 2) to downstream sampling site (Site 18)]. The red horizontal line represents the maximum water quality target value of 235 Colony Forming Units (CFU) per 100 ml for Indiana Waterbodies per the Indiana Department of Environmental Management's (IDEM) water quality standard. **Weeks where there is no marker indicates no data was collected due to limitations of field conditions or equipment**. An **asterisk** indicates the sample collection occurred within 48 hours of a ≥ 0.5-inch rainfall event. Rainfall information provided by the Community Collaborative Rain, Hail, & Snow Network or CoCoRaHS *(rainfall from the nearest gauge station relative to each site; see Appendix, page 19)*.

Pigeon Creek Watershed *(E. coli)*

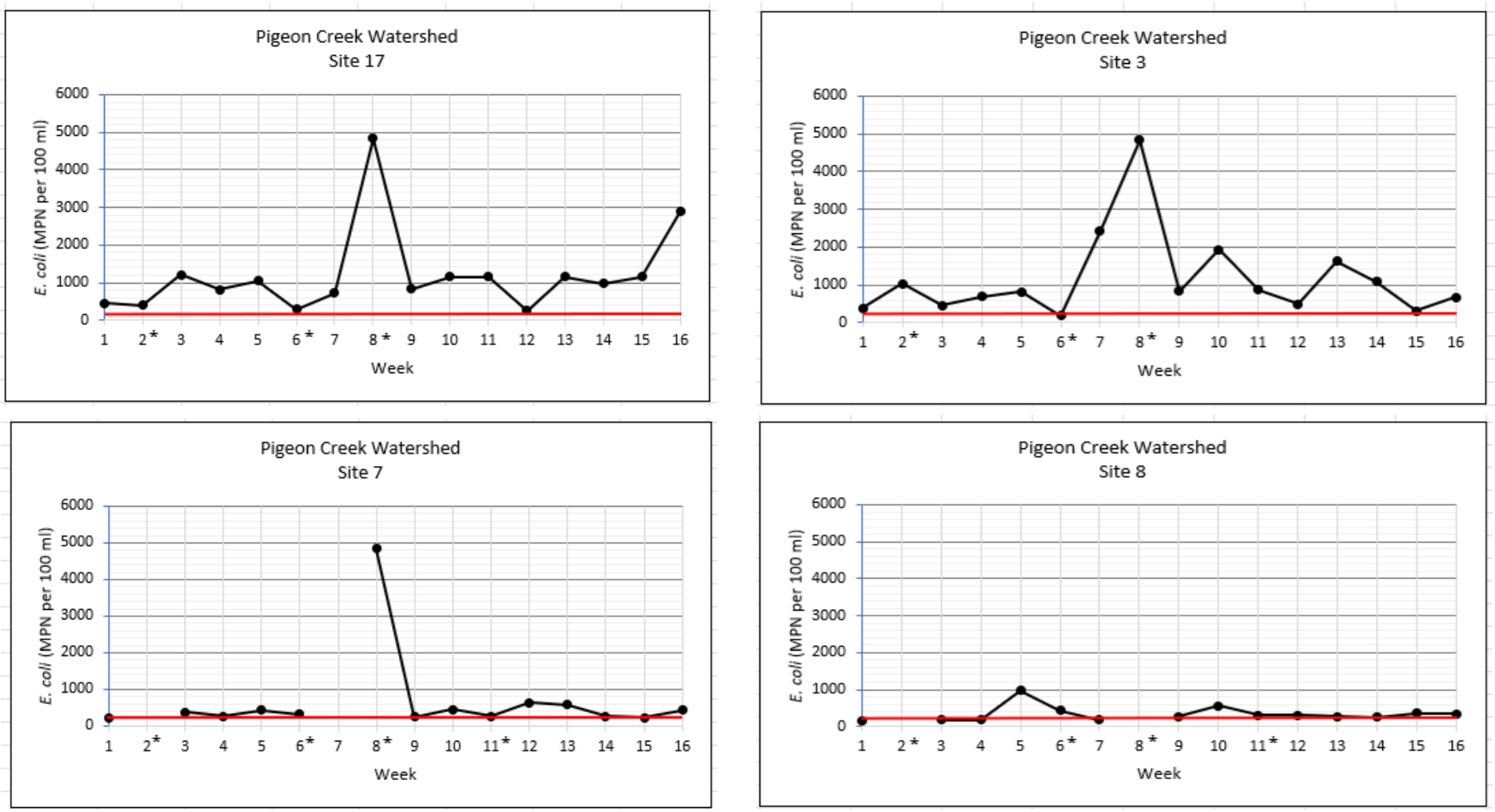
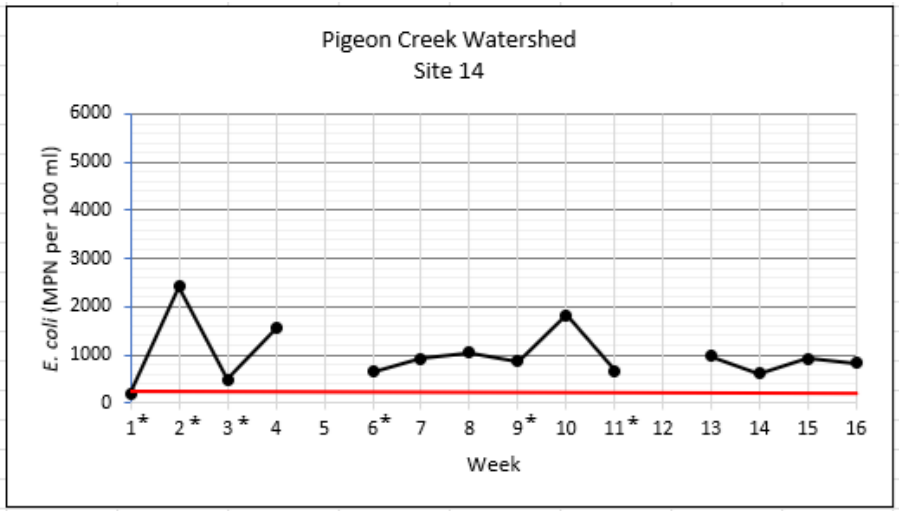
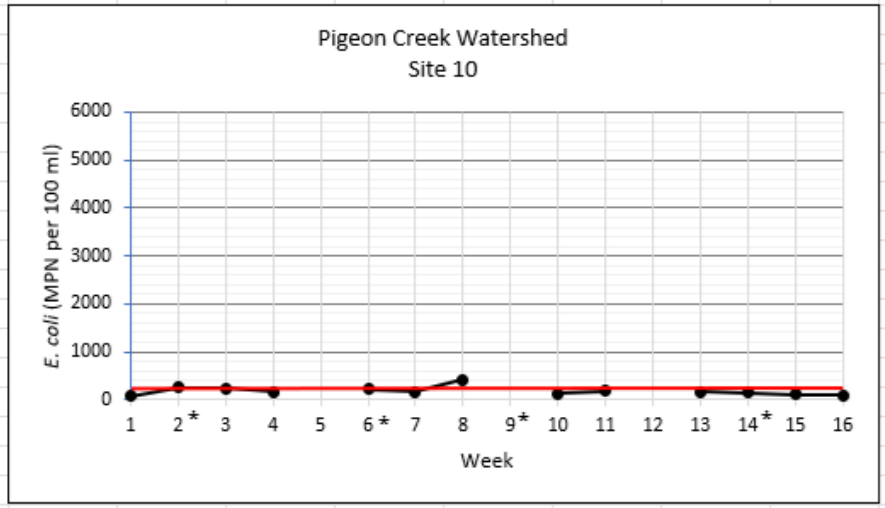


Figure 3. Line graphs of weekly *E. coli* levels (Most Probable Number per 100 ml sample; MPN per 100 ml) at the 7 monitoring sites in the **Pigeon Creek Watershed [**from the most upstream sampling site (Site 17) to downstream sampling site (Site 9)]. The red horizontal line represents the maximum water quality target value of 235 Colony Forming Units (CFU) per 100 ml for Indiana Waterbodies per the Indiana Department of Environmental Management's (IDEM) water quality standard. **Weeks where there is no marker indicates no data was collected due to limitations of field conditions or equipment.** An **asterisk** indicates the sample collection occurred within 48 hours of a ≥ 0.5-inch rainfall event. Rainfall information provided by the Community Collaborative Rain, Hail, & Snow Network or CoCoRaHS *(rainfall from the nearest gauge station relative to each site; see Appendix, page 20)*.

Pigeon Creek Watershed *(E. coli continued)*





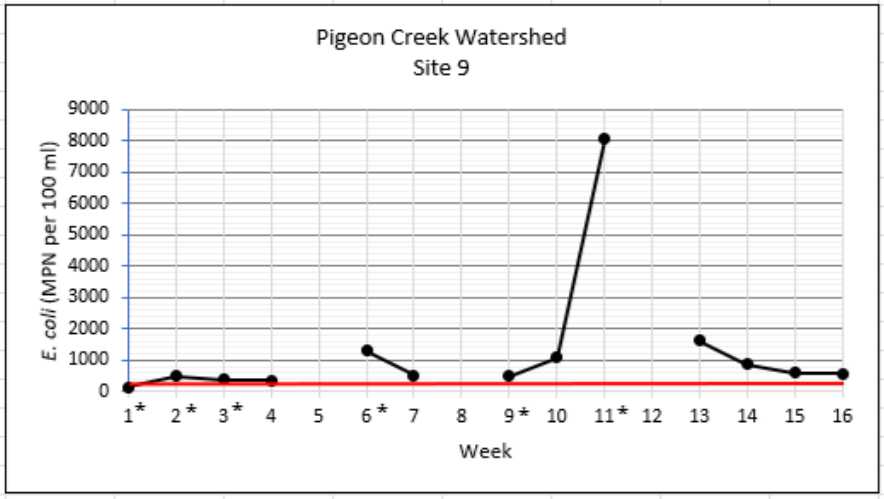


Figure 3 *(continued)*. Line graphs of weekly *E. coli* levels (Most Probable Number per 100 ml sample; MPN per 100 ml) at the 7 monitoring sites in the **Pigeon Creek Watershed** [from the most upstream sampling site (Site 17) to downstream sampling site (Site 9)]. The red horizontal line represents the maximum water quality target value of 235 Colony Forming Units (CFU) per 100 ml for Indiana Waterbodies per the Indiana Department of Environmental Management's (IDEM) water quality standard. **Weeks where there is no marker indicates no data was collected due to limitations of field conditions or equipment**. An **asterisk** indicates the sample collection occurred within 48 hours of a ≥ 0.5-inch rainfall event. Rainfall information provided by the Community Collaborative Rain, Hail & Snow Network or CoCoRaHS *(rainfall from the nearest gauge station relative to each site; see Appendix, page 20)*.

Fawn River Watershed *(E. coli)*

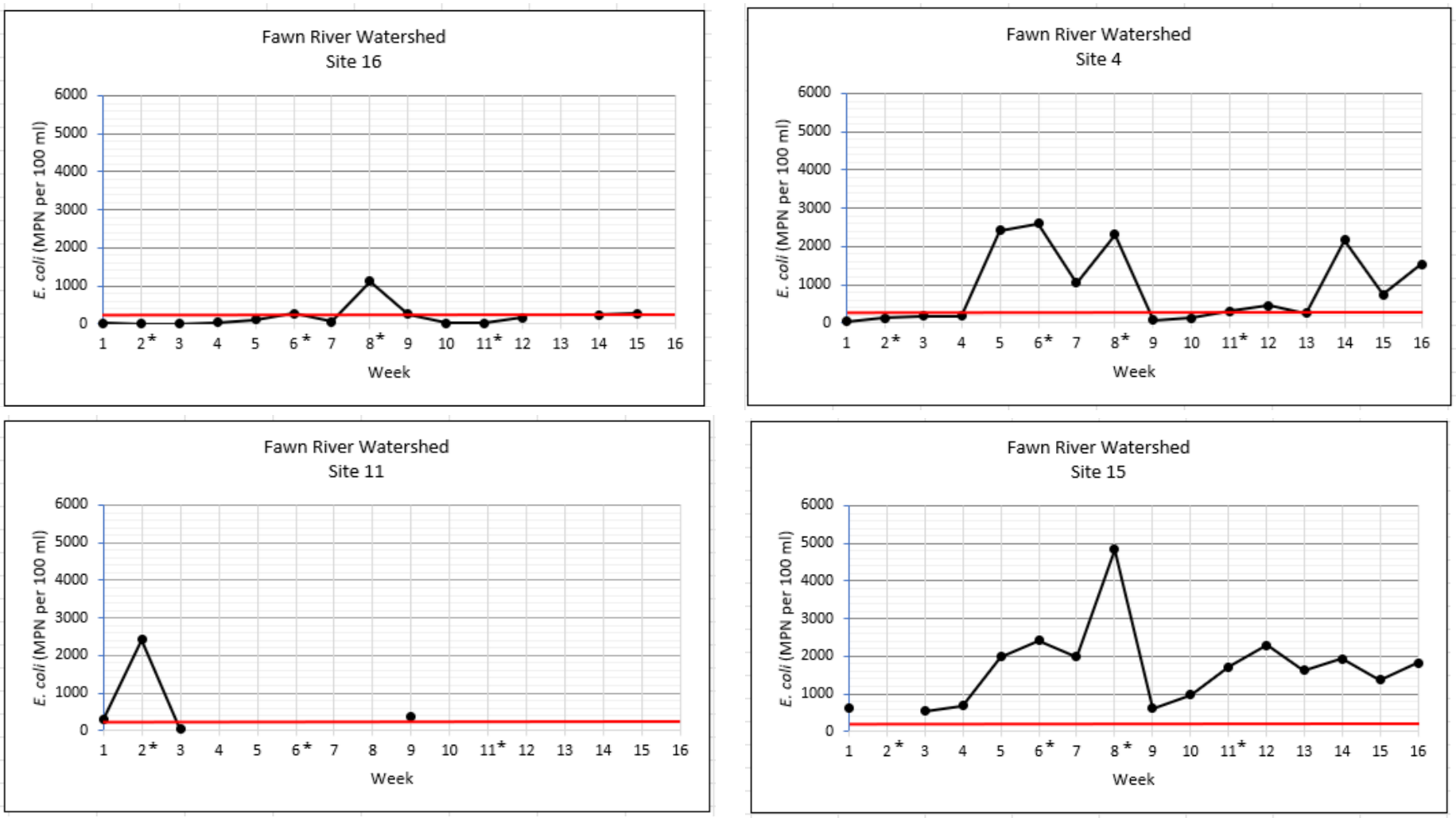


Figure 4. Line graphs of weekly *E. coli* levels (Most Probable Number per 100 ml sample; MPN per 100 ml) at the 8 monitoring sites in the **Fawn River Watershed** [from the most upstream sampling site (Site 16) to downstream sampling site (Site 13)]. The red horizontal line represents the maximum water quality target value of 235 Colony Forming Units (CFU) per 100 ml for Indiana Waterbodies per the Indiana Department of Environmental Management's (IDEM) water quality standard. **Weeks where there is no marker indicates no data was collected due to limitations of field conditions or equipment**. An **asterisk** indicates the sample collection occurred within 48 hours of a ≥ 0.5-inch rainfall event. Rainfall information provided by the Community Collaborative Rain, Hail & Snow Network or CoCoRaHS *(rainfall from the nearest gauge station relative to each site; see Appendix, page 21)*.

Fawn River Watershed *(E. coli continued)*

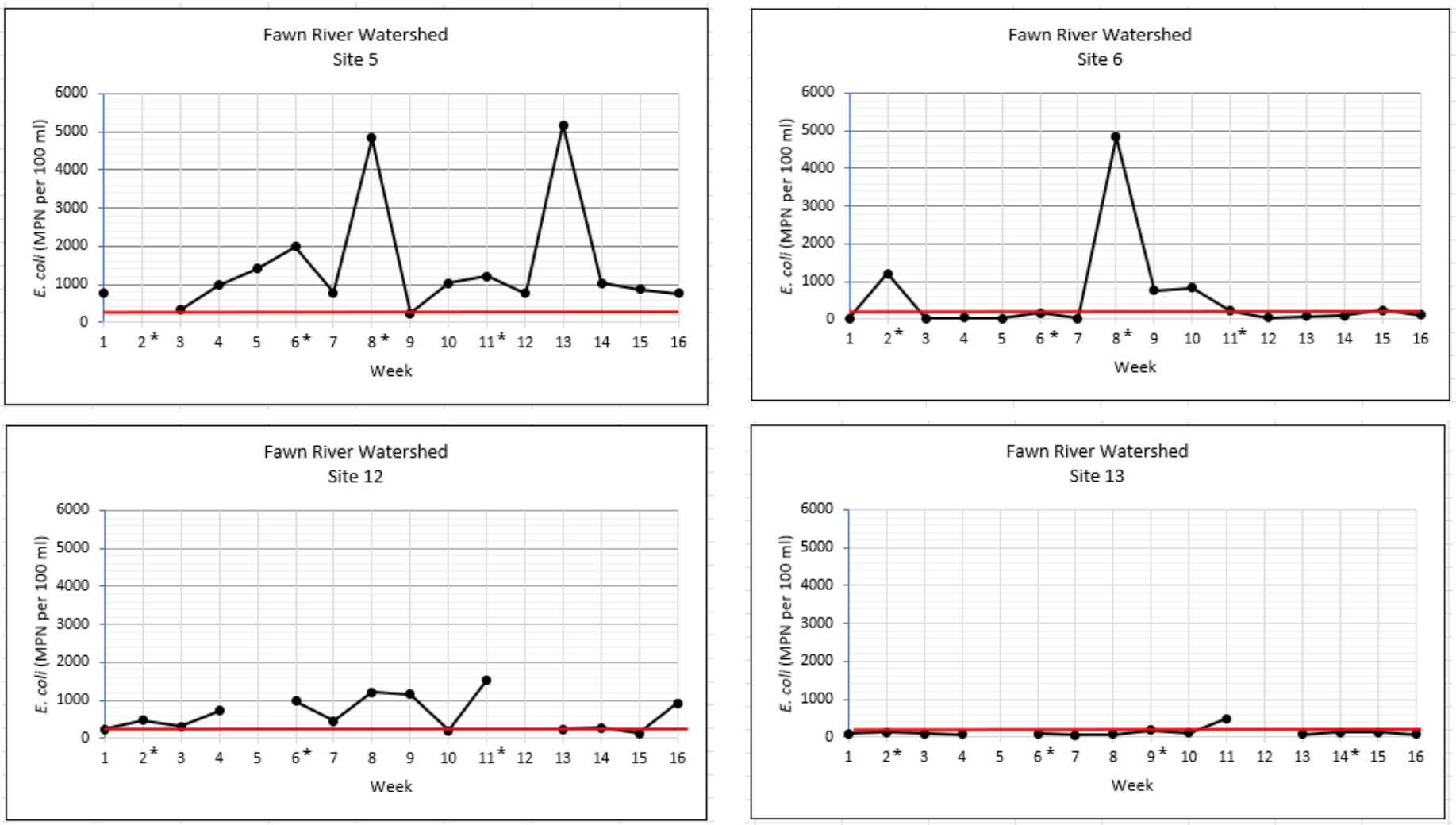


Figure 4 *(continued)*. Line graphs of weekly *E. coli* levels (Most Probable Number per 100 ml sample; MPN per 100 ml) at the 8 monitoring sites in the **Fawn River Watershed** [from the most upstream sampling site (Site 16) to downstream sampling site (Site 13)]. The red horizontal line represents the maximum water quality target value of 235 Colony Forming Units (CFU) per 100 ml for Indiana Waterbodies per the Indiana Department of Environmental Management's (IDEM) water quality standard. **Weeks where there is no marker indicates no data was collected due to limitations of field conditions or equipment**. An **asterisk** indicates the sample collection occurred within 48 hours of a ≥ 0.5-inch rainfall event. Rainfall information provided by the Community Collaborative Rain, Hail & Snow Network or CoCoRaHS *(rainfall from the nearest gauge station relative to each site; see Appendix, page 21)*.

II. (b) Weekly trends in Total Phosphorus levels

Total Phosphorus (TP) measurements are reported in units of milligrams per liter of water (mg/L).

- TP levels ranged between 0.02 and 0.60, and averaged 0.096 mg/L, all sites combined.
- By watershed [*see Figures 5 – 9 (pages 11 – 15)*]:
  - TP levels for Fish Creek ranged between 0.02 and 0.46 and averaged 0.14 mg/L;
  - TP levels for Pigeon Creek ranged between 0.02 and 0.60 and averaged 0.085 mg/L; and
  - TP levels for Fawn River ranged between 0.02 and 0.54 and averaged 0.088 mg/L/.
- Site 18 on Fish Creek, Sites 8 and 9 on Pigeon Creek, and Sites 5, 12, and 16 on Fawn River had instances where the TP concentration surpassed the water quality standard.
- Over the course of the 16-week sampling season, the calculated average TP concentration at each site indicated the water quality standard for total phosphorus was met.

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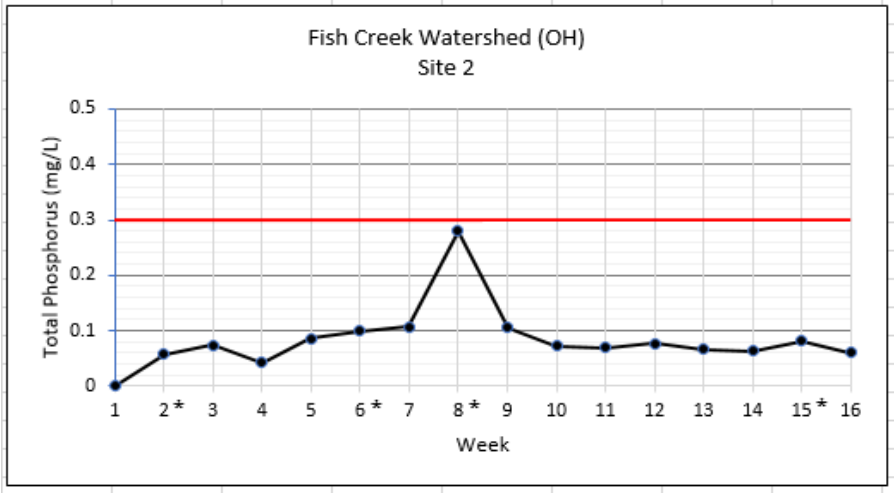
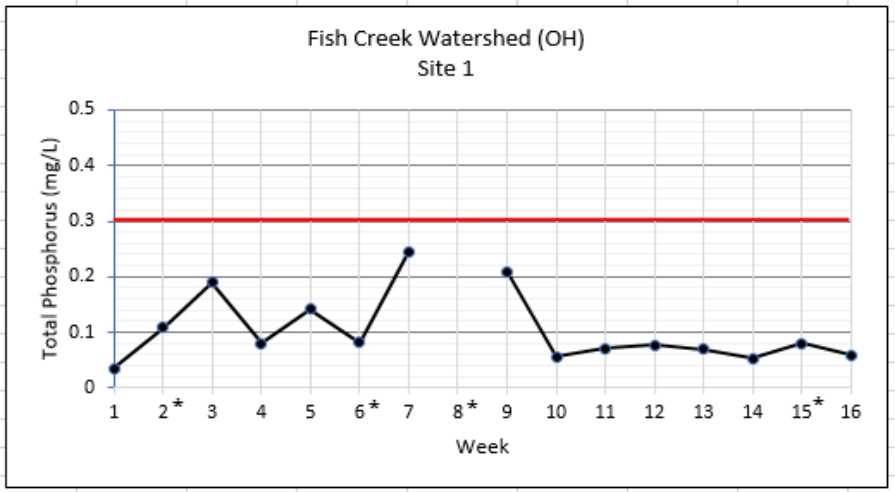
Fish Creek Watershed *(Total Phosphorus)*





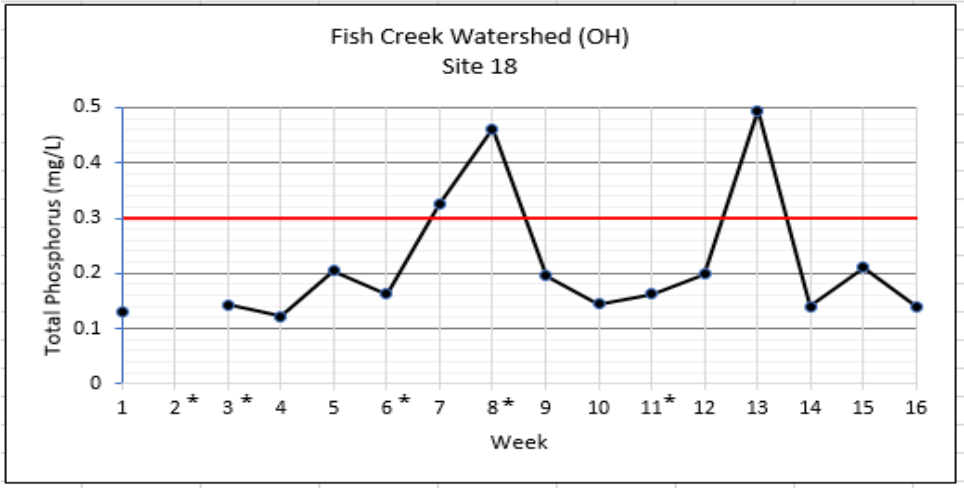


Figure 5. Line graphs showing total phosphorus levels (mg/L) at the 3 monitoring sites in the **Fish Creek Watershed** [from the most upstream sampling site (Site 2) to downstream sampling site (Site 18)]. The red horizontal line represents the maximum water quality target value of 0.3 mg/L phosphorus for Indiana Waterbodies per the Indiana Department of Environmental Management's (IDEM) water quality standard. **Weeks where there is no marker indicates no data was collected due to limitations of field conditions or equipment.** An **asterisk** indicates the sample collection occurred within 48 hours of a ≥ 0.5-inch rainfall event. Rainfall information provided by the Community Collaborative Rain, Hail, & Snow Network or CoCoRaHS *(rainfall from the nearest gauge station relative to each site; see Appendix, page 19)*.

Pigeon Creek Watershed *(Total Phosphorus)*

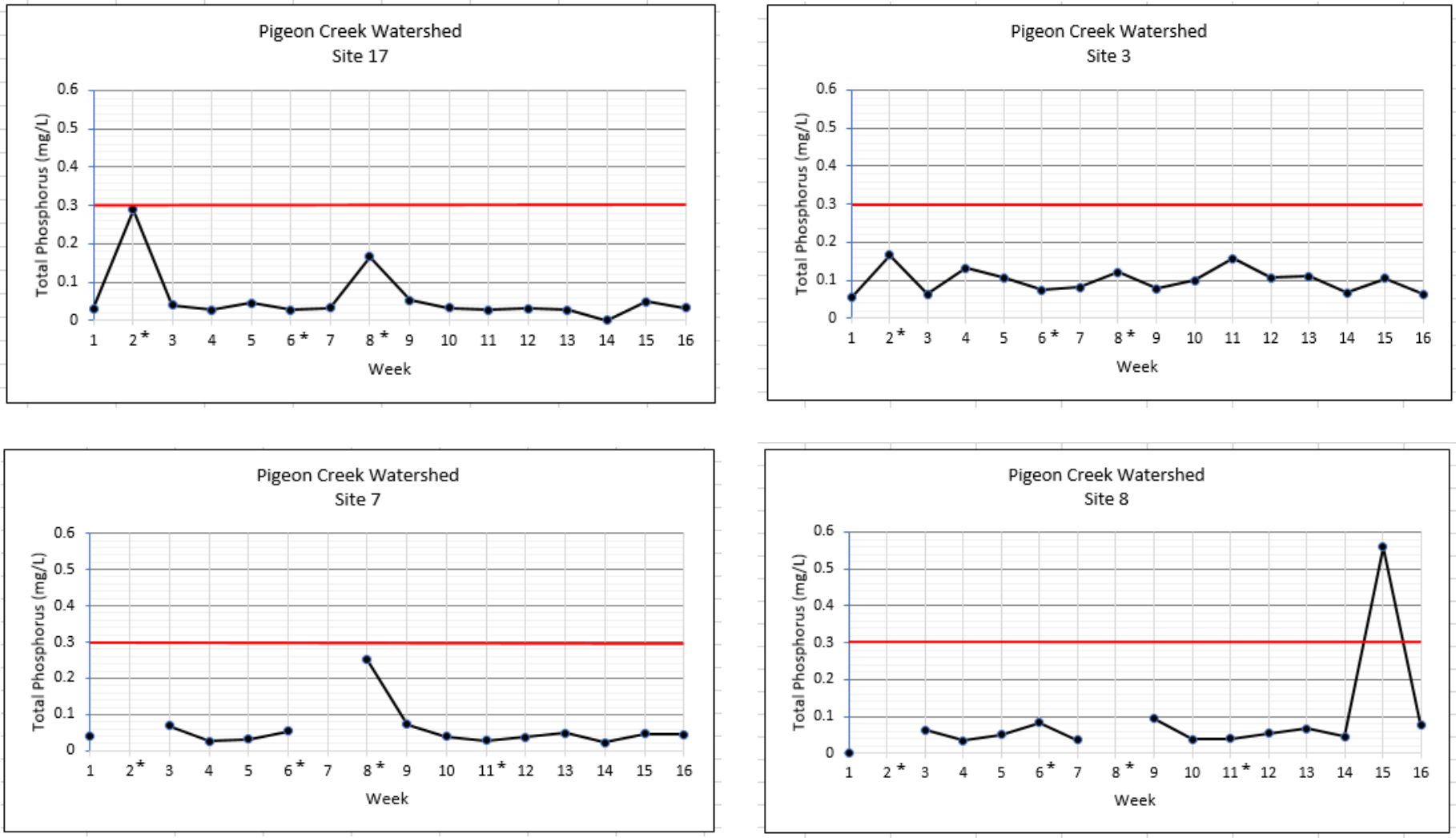
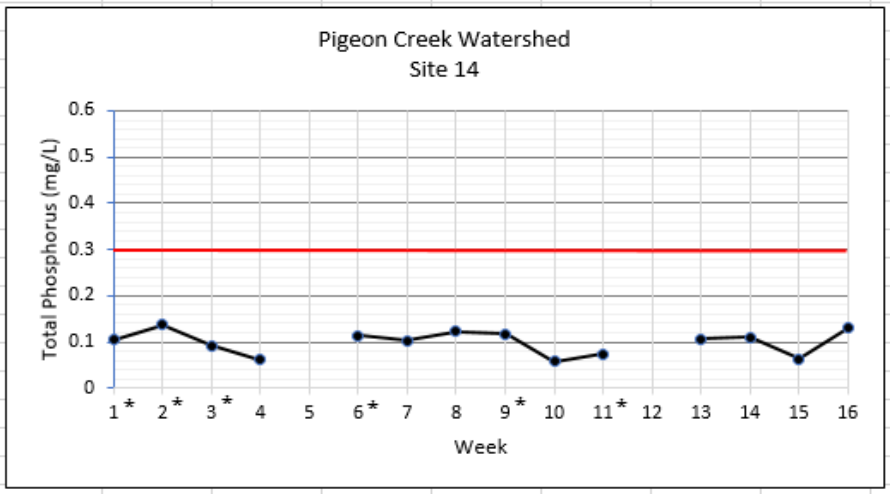
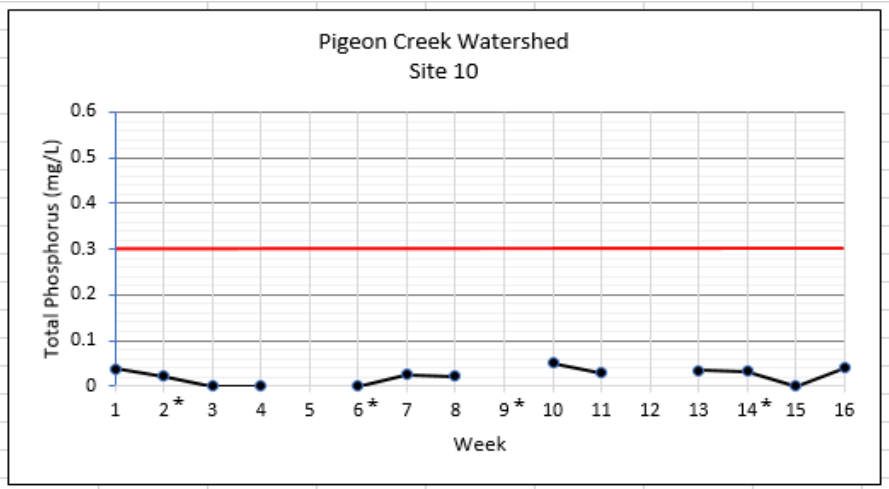


Figure 6. Line graphs showing total phosphorus levels (mg/L) at the 7 monitoring sites in the **Pigeon Creek Watershed** [from the most upstream sampling site (Site 17) to downstream sampling site (Site 9)]. The red horizontal line represents the maximum water quality target value of 0.3 mg/L phosphorus for Indiana Waterbodies per the Indiana Department of Environmental Management's (IDEM) water quality standard. **Weeks where there is no marker indicates no data was collected due to limitations of field conditions or equipment.** An **asterisk** indicates the sample collection occurred within 48 hours of a ≥ 0.5-inch rainfall event. Rainfall information provided by the Community Collaborative Rain, Hail, & Snow Network or CoCoRaHS *(rainfall from the nearest gauge station relative to each site; see Appendix, page 20)*.

Pigeon Creek Watershed *(Total Phosphorus continued)*





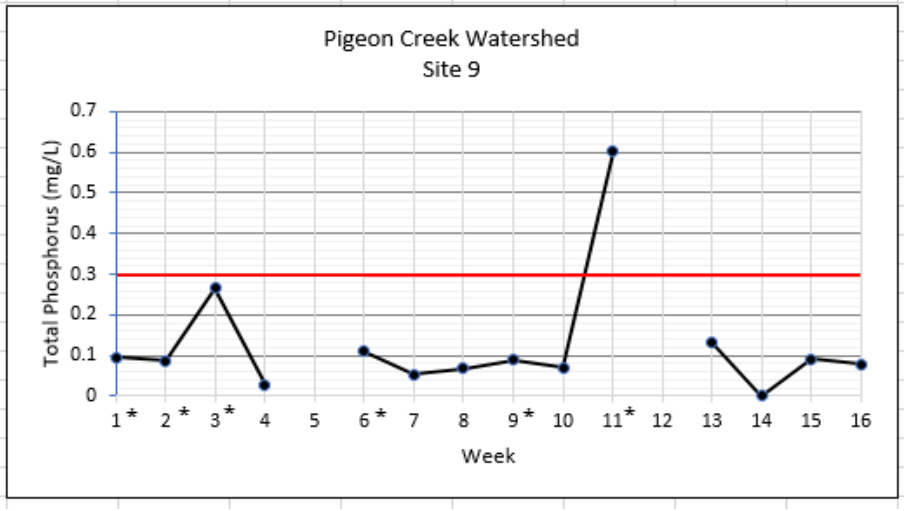


Figure 6 *(continued)*. Line graphs showing weekly total phosphorus levels (mg/L) at the 7 monitoring sites in the **Pigeon Creek Watershed** [from the most upstream sampling site (Site 17) to downstream sampling site (Site 9)]. The red horizontal line represents the maximum water quality target value of 0.3 mg/L for Indiana Waterbodies per the Indiana Department of Environmental Management's (IDEM) water quality standard. **Weeks where there is no marker indicates no data was collected due to limitations of field conditions or equipment.** An **asterisk** indicates the sample collection occurred within 48 hours of a ≥ 0.5-inch rainfall event. Rainfall information provided by the Community Collaborative Rain, Hail & Snow Network or CoCoRaHS *(rainfall from the nearest gauge station relative to each site; see Appendix, page 20)*.

Fawn River Watershed *(Total Phosphorus)*

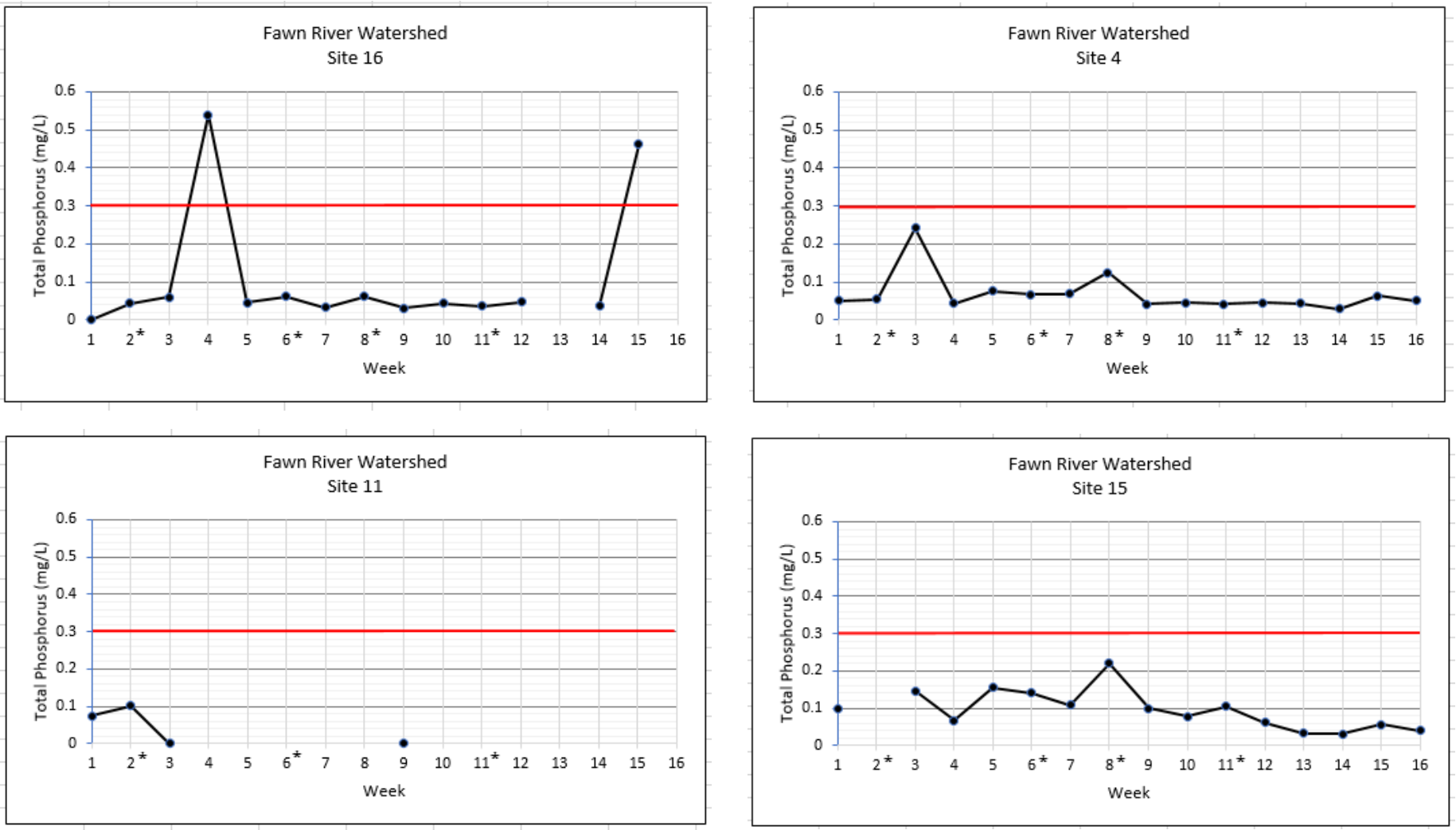


Figure 7. Line graphs showing weekly total phosphorus levels (mg/L) at the 8 monitoring sites in the **Fawn River Watershed** [from the most upstream sampling site (Site 16) to downstream sampling site (Site 13)]. The red horizontal line represents the maximum water quality target value of 0.3 mg/L for Indiana Waterbodies per the Indiana Department of Environmental Management's (IDEM) water quality standard. **Weeks where there is no marker indicates no data was collected due to limitations of field conditions or equipment.** An **asterisk** indicates the sample collection occurred within 48 hours of a ≥ 0.5-inch rainfall event. Rainfall information provided by the Community Collaborative Rain, Hail & Snow Network or CoCoRaHS *(rainfall from the nearest gauge station relative to each site; see Appendix, page 21)*.

Fawn River Watershed *(Total Phosphorus continued)*

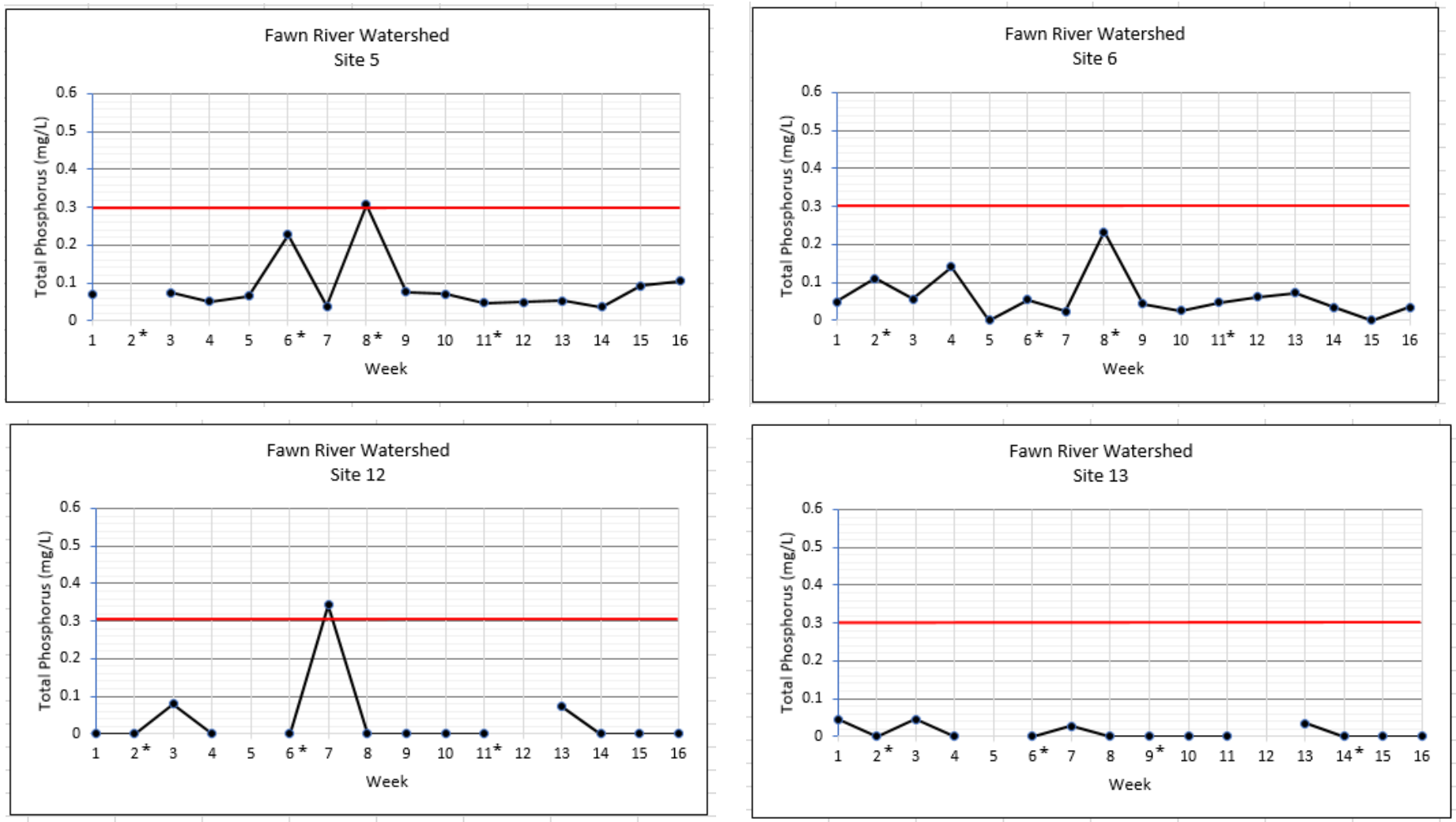


Figure 7 *(continued)*. Line graphs showing weekly total phosphorus levels (mg/L) at the 8 monitoring sites in **Fawn River** [from the most upstream sampling site (Site 16) to downstream sampling site (Site 13)]. The red horizontal line represents the maximum water quality target value of 0.3 mg/L for Indiana Waterbodies per the Indiana Department of Environmental Management's (IDEM) water quality standard. **Weeks where there is no marker indicates no data was collected due to limitations of field conditions or equipment.** An **asterisk** indicates the sample collection occurred within 48 hours of a ≥ 0.5-inch rainfall event. Rainfall information provided by the Community Collaborative Rain, Hail & Snow Network or CoCoRaHS *(rainfall from the nearest gauge station relative to each site; see Appendix, page 21)*.

III. Summary & Conclusion

The 2024 water quality monitoring builds upon the ongoing efforts of the Steuben County Strategic Water Quality Monitoring Program (SWQMP), and the Steuben County Lakes Council (SCLC), to characterize water quality trends across the major waterways of Steuben County. The data show that most sampling sites had average total phosphorus levels that meet the water quality standard for phosphorus; however, one (1) site in the Fish Creek Watershed, two (2) sites in the Pigeon Creek Watershed, and three (3) sites in the Fawn River Watershed had instances in which the water quality standard was surpassed. Some of the exceedances could be the result of the sample being collected within 48 hours after a ≥ 0.5-inch rainfall event; however, this correlation did not hold true for all exceedances. The data also shows consistently elevated *E. coli* levels in several of the monitored streams and ditches.

Protecting our water resources requires the scientific collection of reliable water quality data that can inform our communities about the status and trends in the vitality of our rivers, streams, and lakes. The Steuben County Lakes Council (SCLC), Steuben County Health Department (HD), Steuben County Soil & Water Conservation District (SWCD), Trine University, City of Angola MS4 (COA/TU MS4), and the St. Joseph River Basin Commission (SJRBC) worked together to develop this new water quality monitoring program that has collected hundreds of records on water health from 18 sites across the county. The data collected by this program will serve to better understand and protect the water resources of Steuben County.

Since the strategic monitoring inception in 2023, the program has been awarded a Steuben County Community Foundation Impact Grant to support sampling efforts through 2026. This support from the Community Foundation, and partner organizations, allowed the program to expand the number of sites monitored each year. In addition to adding more sites to the strategic program in 2024, it was also planned to initiate a county-wide biological monitoring of macroinvertebrate communities at all 18 sites. Macroinvertebrates form the cornerstone of aquatic food webs as they provide food sources for fish and other wildlife. Macroinvertebrates also vary in their sensitivity to pollutants and habitat alterations; therefore, macroinvertebrate monitoring can provide a more holistic view of stream health and can complement chemical water quality testing. Unfortunately, the 2024 macroinvertebrate sampling was not completed because of tight time constraints for submitting the water samples to the contracted lab within the necessary time frame for analysis and the additional time commitment. The field crew were already at capacity with the water chemistry testing of the 18 sites throughout the county.

As with any program, the Steuben County SWQMP has run into some challenges. Last fall, Dr. Katherine Barrett, the program manager, left her role with the SJRBC to focus on a full-time teaching career. This departure resulted in a delay in the analysis of the 2024 data. The Steuben County SWQMP Committee partners have reorganized their roles to ensure the program continues moving forward and the work Dr. Barrett led is completed (e.g., data analysis, grant reporting, etc.). Other challenges, including sampling sites not being sampled due to field condition limitations, equipment malfunctions, and time constraints, which prohibited the completion of the macro-invertebrate sampling, were already outlined.

Nutrient and *E. coli* levels in water are highly variable and can fluctuate significantly over short periods of time (day to day, even hour to hour). The results in this summary show what was found during the 16-week sampling period. *E. coli* is often used as an indicator organism to identify potential fecal contamination in freshwater. The presence of *E. coli* suggests that pathogens may also be present. However, for *E. coli*, the results do not necessarily mean that harmful or pathogenic strains of *E. coli* were present. Many environmental and natural factors can influence *E. coli* concentrations besides animal or human waste, including rainfall and stormwater runoff, water temperature, sunlight exposure, sediment disturbance, decaying plant material, soil erosion, and contributions from wildlife, domestic animals, or even natural background sources. Therefore, *E. coli* results should be viewed as one piece of information about water quality, rather than a definitive measure of health risk. The continuation of the SWQMP will allow us to identify trends and patterns in nutrient and bacterial contamination over time. This long-term data will help distinguish between natural fluctuations and significant contamination events, leading to more effective management and remediation strategies.

The completion of the strategic water quality monitoring would not have been possible without the support and guidance of the Steuben County Community Foundation and the cash and in-kind support from the partner agencies, including the City of Angola/Trine University MS4, Steuben County Lakes Council, Steuben County Health Department, Steuben County Soil and Water Conservation District, St. Joseph River Basin Commission, Trine University, the

Michiana Area Council of Governments AmeriCorps Program. Special thanks to the 2024 field interns, Ava McCall and Stephen Noj-Orellana, for their hard work and dedication collecting the data, and Dr. Sam Drerup and Dr. Kate Barrett for their technical assistance. We would also like to acknowledge the Pleasant Township Trustee Office for providing monetary support.

IV. (a) Appendix of Water Quality Definitions

The following definitions outline what water quality parameters are being collected for the Steuben County SWQMP.

Chlorides: Measured in mg/L, this indicates the level of salts in water. Salt can occur as sodium (NaCl), potassium (KCl), and calcium (CaCl2). Chlorides can enter surface waters from a variety of sources. Sodium chloride is widely used in the production of industrial chemicals, and many different salts are used extensively in snow and ice control. Potassium chloride is used in the production of fertilizers. High chloride levels in surface waters can pose risks to aquatic life and humans. According to the U.S. Environmental Protection Agency (EPA), chloride levels that exceed 230 mg/L in freshwater pose significant adverse risks to aquatic life, while chloride levels in excess of 250 mg/L pose health risks to humans.

Chlorophyll-a: This is a photosynthetic pigment present in algae and provides an estimate of algal abundance in a water sample. Elevated levels can indicate eutrophication (high nutrient levels) of surface waters which can potentially lead to fish kills.

Conductivity: This measures how well water can conduct an electrical current. Conductivity increases with increasing amount and mobility of ions such as salts. It is measured and reported as micro-Siemens (µS) per centimeter (µS/cm).

Dissolved oxygen (DO): Measured in milligrams per liter (mg/L), oxygen is another physical characteristic of all aquatic systems, as it is vital to fish, macroinvertebrates, and many smaller microorganisms. Dissolved oxygen measures how much oxygen is available to aquatic life. Indiana Department of Environmental Management (IDEM) has recommended that DO levels in Indiana waterbodies should be at least 4 mg/L and at most 12 mg/L; waterbodies with levels above or below this range indicate impairment.

Escherichia coli (E. coli) is a bacterium that is considered an indicator organism, used to identify fecal contamination from human and non-human sources in freshwater and indicate the possible presence of disease-causing bacteria and viruses (pathogens). Individuals who swim or come into contact with water with elevated levels of *E. coli* and other fecal indicator organisms are at an increased risk of getting sick because of the potential exposure to fecal pathogens. Common symptoms of ingesting a pathogenic strain of *E. coli* include vomiting and diarrhea. High numbers of *E. coli* bacteria may contribute to cloudy water, unpleasant odors, and increased oxygen demand which may reduce levels of dissolved oxygen in the water. *E. coli* is measured and reported in colony forming units per 100 milliliters (CFU per 100 ml) or Most Probable Number (MPN per 100 ml). Both estimate *E. coli* concentrations, but they differ in laboratory methodologies *(CFU involves directly counting bacterial colonies on a solid plate, while MPN uses a statistical estimate based on bacterial growth)*. Both technologies are well-established and are acceptable units for estimates of bacteria numbers. While CFU and MPN are not interchangeable, they are similar enough to quantify bacterial load in a water sample. Indiana observes EPA standards for *E. coli*: waterbodies should not exceed 235 CFU per 100 ml.

Nitrates: Measured and reported in mg/L, nitrates are a common form of nitrogen applied to lawns, gardens, and crop fields as fertilizer, and these can enter waterbodies as runoff. The EPA standard for nitrate in waterbodies is 10 mg/L; excess nitrate loads can contribute to eutrophication of waterbodies and harmful algal blooms.

pH: This is a physical measure of the activity of hydrogen ions in a solution, which determines the acidity or alkalinity of a waterbody. pH ranges between 0 and 14, with 7 being neutral, and below 7 being acidic, and above 7 being basic/alkaline. It is a unitless metric. pH affects many chemical and biological processes. Most aquatic life thrives at a pH range of 6.5 – 8.0, and values outside this range can have negative impacts on aquatic life. Waters that are too acidic or basic can be harmful to aquatic life by altering the availability of dissolved nutrients in water to aquatic life.

Temperature: This is a fundamental physical feature of surface waters that affects how much dissolved oxygen is available to wildlife. Temperature influences aquatic organism survival as all organisms have optimal temperatures. Temperature can be affected by many factors, including stream velocity, sunlight, water depth, turbidity (the cloudiness of the water), and seasonal changes in weather. Measuring temperature over time and at different sites can allow us to look

for fluctuations and identify anomalies (such as during drought and flood years). It is measured in degrees Celsius or Fahrenheit.

Total Dissolved Solids (TDS): This is a measure of the dissolved solids plus suspended and settleable solids in water. In stream water, dissolved solids consist of calcium, chlorides, nitrate, phosphorus, iron, sulfur, and other ions and particles that will pass through a filter with pores of around 2 microns (0.002 cm) in size. Suspended solids include silt and clay particles, plankton, algae, fine organic debris, and other particulate matter. These are particles that will not pass through a 2-micron filter. Higher concentrations of suspended solids can serve as carriers of toxics, which readily cling to suspended particles. TDS can also affect water clarity.

Total Suspended Solids (TSS): Reported in units of mg/L, this is a physical characteristic that measures the levels of particles that are larger than 2 microns that are found in the water column - in other words, sediment loading. Particles of this size include anything drifting or floating in the water, from sediment, silt, sand, to plankton and algae. High TSS levels increase the cloudiness of the water and can limit light availability in the water column, which affects photosynthesis in plant species and reproduction in fish species. These particles can also settle out of the water and ruin habitat suitability for fish and macroinvertebrates. Pollutants and contaminants can attach to particles in the water. Indiana waterbodies should not exceed 30 mg/L TSS as an IDEM Total Maximum Dailey Load (TMDL) target. TMDL is the maximum amount of a specific pollutant that a waterbody can receive in a day and still meet water quality standards.

Various Pharmaceuticals: The source of pharmaceuticals in water can be from pharmaceutical manufacturing plants, humans, and animals. Many of the more than 4,000 prescription medications used for human and animal health ultimately find their way into the environment. Medications that people take internally are not all metabolized in the body, and the excess ends up in our wastewater leaving homes and residential on-site sewage systems or entering the sewage-treatment plants. As these chemicals make their way into terrestrial and aquatic environments, they can affect the health and behavior of wildlife, including insects, fish, birds, and more. The goal of the pharmaceutical testing is to find a pharmaceutical, specific only to humans, that can be used as an effective indicator of human waste in surface waters.

IV. (b) Appendix of Community Collaborative Rain, Hail, & Snow Network (CoCoRaHS) Precipitation Bar Graphs.

The Community Collaborative Rain, Hail & Snow Network, or CoCoRaHS, is a nationwide volunteer network where individuals measure and report precipitation (rain, hail, and snow). This information is provided for reference purposes to show when precipitation events occurred. Precipitation can significantly impact water quality by increasing nutrient and surface runoff carrying pollutants from urban and agricultural areas into waterways. Understanding these impacts is essential to help develop strategies to protect water quality. Figures 8 through 10, below illustrate the daily precipitation from May 20, 2024, through September 7, 2024, by watershed (Fish Creek, Pigeon Creek, and Fawn River). The rainfall information presented on the *E. coli* and total phosphorus (TP) line graphs was provided by the nearest gauge station in relation to each sampling site.

Fish Creek Watershed

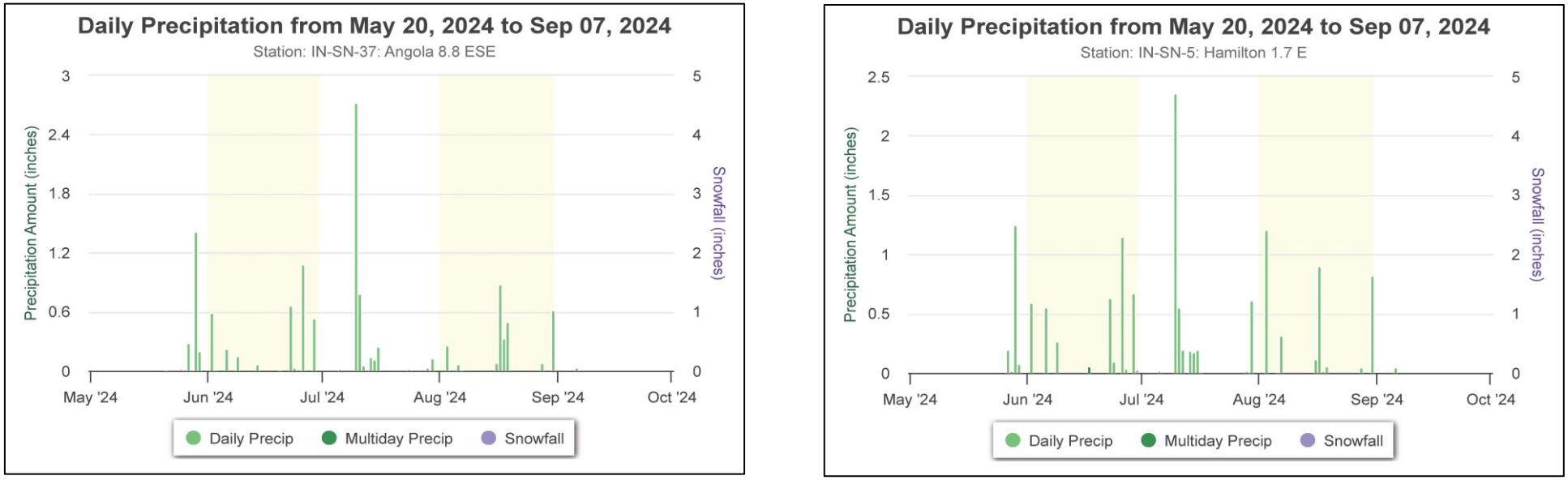
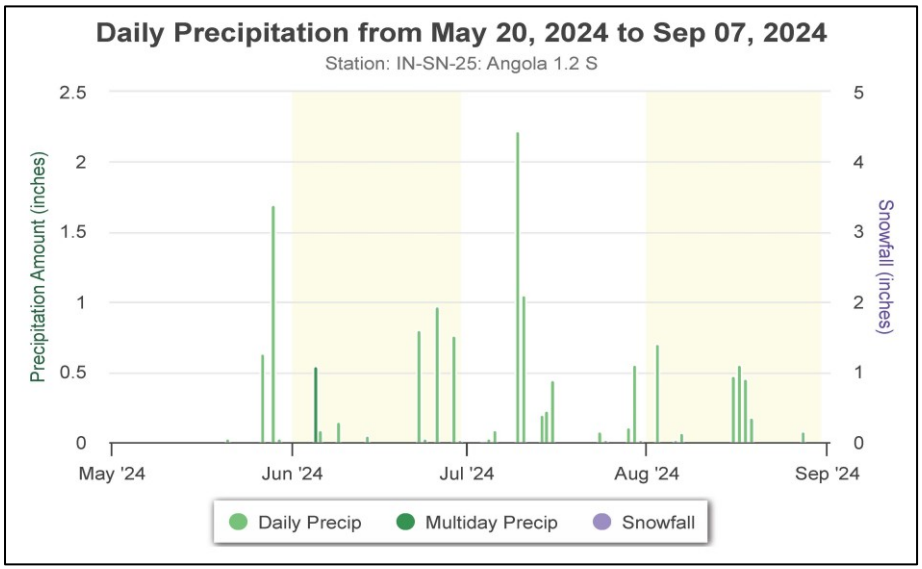
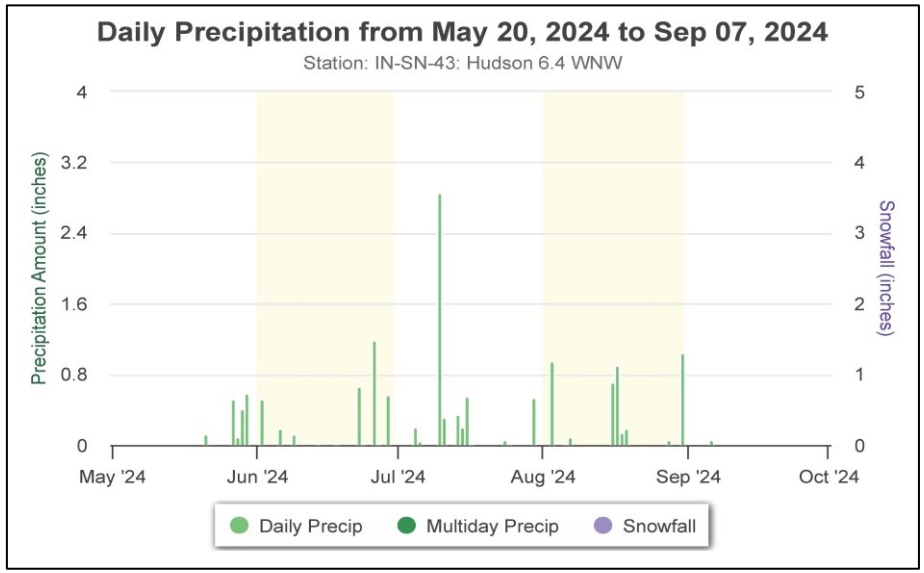


Figure 8. Bar line graphs showing daily precipitation from May 20 to September 7, 2024 for Station IN-SN-37 in Angola (https://dex.cocorahs.org/stations/IN-SN-37) and Station IN-SN-5 in Hamilton (https://dex.cocorahs.org/stations/IN-SN-5).

Pigeon Creek Watershed





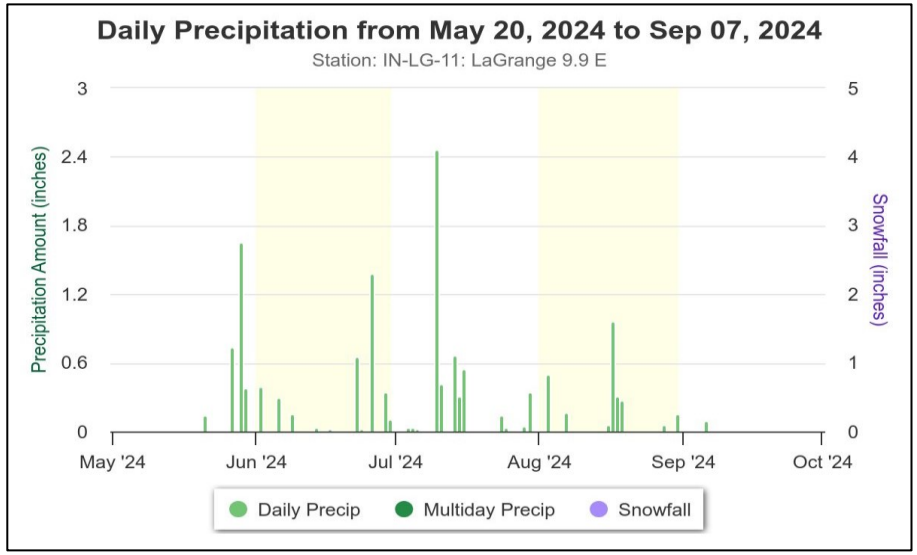


Figure 9. Bar line graphs showing daily precipitation from May 20 to September 7, 2024 for Station IN-SN-25 in Angola (https://dex.cocorahs.org/stations/IN-SN-25), Station IN-SN-43 in Hudson (https://dex.cocorahs.org/stations/IN-SN-43), and Station IN-LG-11 in LaGrange (https://dex.cocorahs.org/stations/IN-LG-11).

Fawn River Watershed

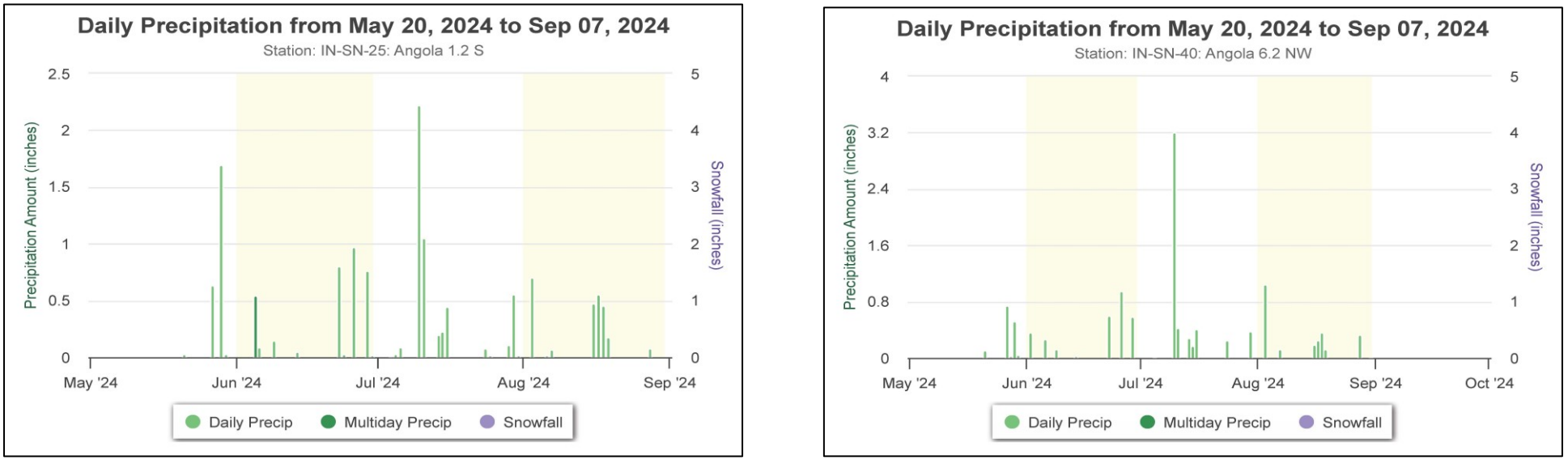


Figure 10. Bar line graphs showing daily precipitation from May 20 to September 7, 2024 for Station IN-SN-25 in Angola (https://dex.cocorahs.org/stations/IN-SN-25) and Station IN-SN-40 in Angola (https://dex.cocorahs.org/stations/IN-SN-40).

For the Fawn River Watershed, Station IN-LG-11 in LaGrange (https://dex.cocorahs.org/stations/IN-LG-11) was also utilized for daily precipitation information (see Figure 9).