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*

*Sincere gratitude is given to the **Steuben County Community Foundation** which provided grant funding to support the launching of this program.*

2023 Water Quality Results Report

By Dr. Katherine L. Barrett, St. Joseph River Basin Commission

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). This program builds upon the water quality monitoring efforts of the SCLC, which monitors several waterways three times each summer. Specifically, our program monitors surface water sites on a weekly basis and all samples are collected on the same days and during similar times by trained college interns. One benefit of consistency in the days and times that samples are collected each week is that it allows for the determination of a more representative sample of water quality trends. The purpose of this new program is to establish baseline water quality and track trends over time to inform local policy decisions that can lead to corrective actions to improve water quality. Our 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.

From the week of June 5 (Week 1) through October 11 (Week 19), 2023, 10 sites were monitored once weekly for 19 consecutive weeks, and several water quality parameters were measured. An analysis of historic water quality data collected by the SCLC guided monitoring site selection. Briefly, our monitoring sites consisted of a subset of the most impaired waterways documented by SCLC, sites located upstream of some problematic sites, and a 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 (click here for more information on SJRBC biological monitoring). A map of the sampling sites can be viewed by clicking here.

This report provides an initial interpretation of a subset of the water quality data collected by the 2023 SCSWQMP program. Details on the water quality parameters measured by our program are included in the Appendix. This report is organized as follows:

1) First, the percentage of sampling events at each site that exceeded water quality standards for *E. coli*, Dissolved Oxygen (DO), Total Suspended Solids (TSS), Phosphorus, and Nitrate in 2023 are displayed in Table 1.
2) Line graphs of weekly *E. coli,* phosphorus, and nitrate levels are presented.

1) **Percentage of samples that exceeded water quality standards in 2023**

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

SITE ID	SITE NAME	*E. COLI*	NITRATE	TOTAL PHOSPHORUS	DISSOLVED OXYGEN	TOTAL SUSPENDED SOLIDS
SITE1	Fish Creek – Metz Rd	94.4	5.6	5.3	10.5	23.5
SITE2	Fish Creek – E 40 S	100.0	5.3	0	5.3	5.9
SITE3	Jack Ditch	52.6	15.8	5.3	47.4	29.4
SITE4	Center Lake Discharge	94.1	27.8	0	27.8	17.6
SITE5	Palfreyman Ditch	64.7	0.0	0	0.0	13.3
SITE6	Carpenter Ditch	38.9	27.8	0	31.6	11.8
SITE7	Pigeon Creek – Bill Deller Rd	94.7	21.1	5.3	5.3	0.0
SITE8	Pigeon Creek – Old US HWY 27	47.4	100.0	0	0.0	0.0
SITE9	Turkey Creek – S 800 W	89.5	15.8	0	5.3	0.0
SITE10	Pigeon Creek – 327	10.5	0.0	0	0.0	0.0

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. The water quality standards are recommended by the Indiana Department of Environmental Management:

a. *E. coli* levels should not exceed 235 colony forming units per 100 ml water sample (235 CFU per 100 ml).
b. DO be at least 4 mg/L and at most 12 mg/L; waterbodies with levels above or below this range indicate impairment.
c. TSS levels should not exceed 30 mg/L.
d. Phosphorus levels should not exceed 0.3 mg/L.
e. Nitrate levels should not exceed 1.5 mg/L.

Table 1, above, presents the percentage of water samples from each site that exceeded the water quality standards for *Escherichia coli* (*E. coli*), Total Suspended Solids (TSS), Dissolved Oxygen (DO), Phosphorus, and Nitrate. Note that for *E. coli*, seven out of the 10 sites exceeded the water quality standard in more than 50% of samples. Pigeon Creek at 327, Site 10, exceeded the water quality standard for *E. coli* only 10% of the time. Other notable findings include that only one site, Site 8, exceeded the water quality standard for Nitrate in 100% of samples, whereas the other sites never exceeded this standard in more than 28% of samples. In contrast, exceedance rates for Total Phosphorus were low, less than 6% for all sites. Additionally, most sites had moderate exceedance rates for Dissolved Oxygen and TSS, while Site 3 had the highest exceedance rates for these variables. Pigeon Creek at 327 emerged as the highest quality site due to its low overall exceedances for all water quality measurements. These findings suggest that Site 10, Pigeon Creek at 327, is validated as our reference site because it exhibited the lowest exceedance percentage for all water quality variables.

2 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). *E. coli* levels ranged between 19.7 and 7,068, and averaged 591.6 MPN per 100 ml (see Figure 1, below). Except for Site 10, all sites had average *E. coli* levels above the water quality standard for full body contact recreation, and Site 4 had the highest average *E. coli* level, 1,691.5 MPN per 100 ml.

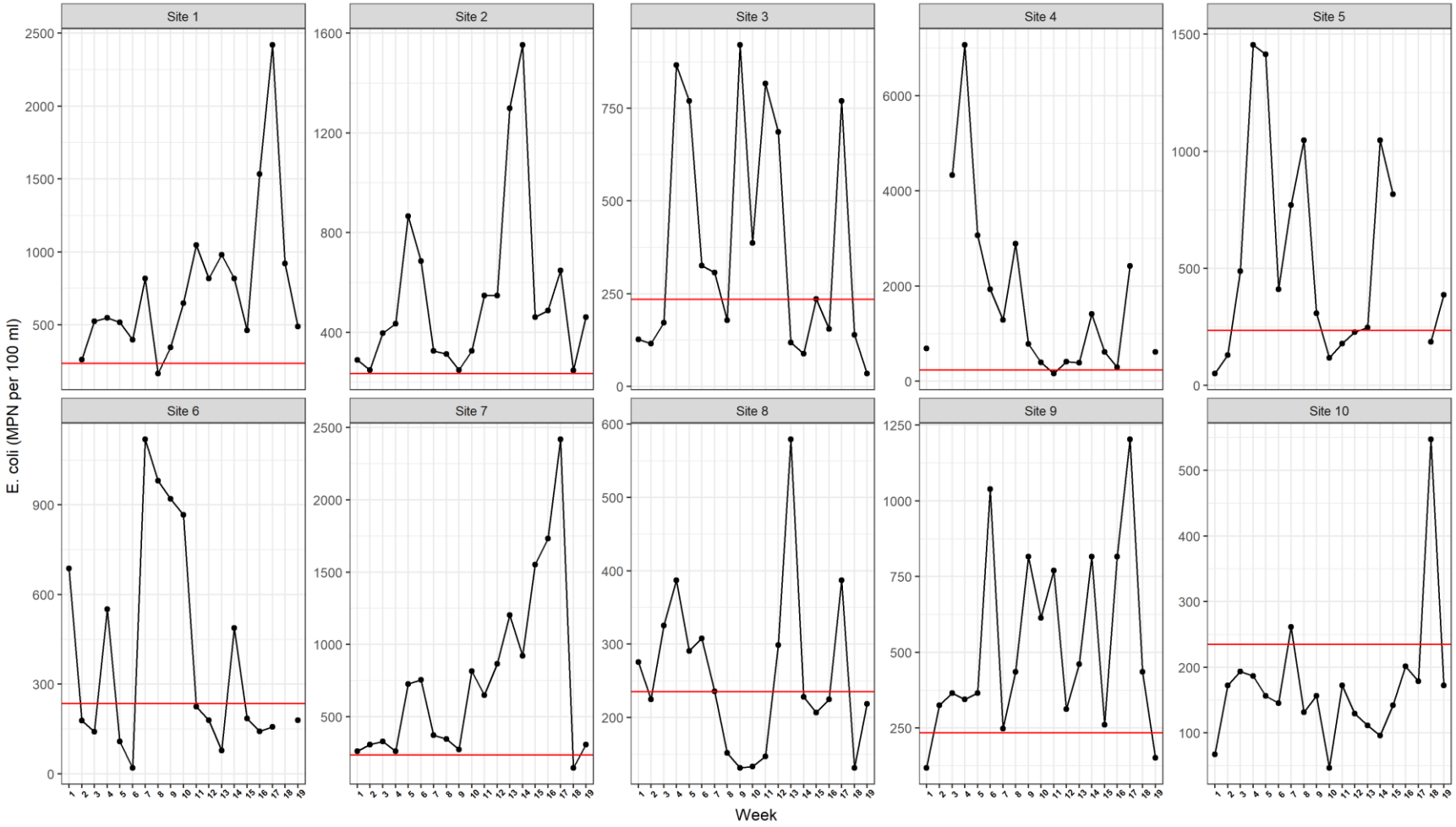

Figure 1. Line graphs of weekly *E. coli* levels (Most Probable Number per 100 ml sample; MPN per 100 ml) at the 10 monitoring sites. The red horizontal line represents the maximum water quality target value of 235 MPN per 100 ml for Indiana waterbodies as an IDEM TMDL target. **Note that the scale for the vertical axis varies for each site to facilitate improved visualization of weekly trends.**

2 b) Weekly trends in Phosphorus levels

Phosphorus measurements are reported in units of milligrams per liter of water (mg/L). Phosphorus levels ranged between 0.02 and 0.61, and averaged 0.09 mg/L (see Figure 2, below). All sites had average phosphorus levels that met the water quality standard for phosphorus, and only two sites, Sites 1, 3, & 7 had instances in which the water quality standard was surpassed.

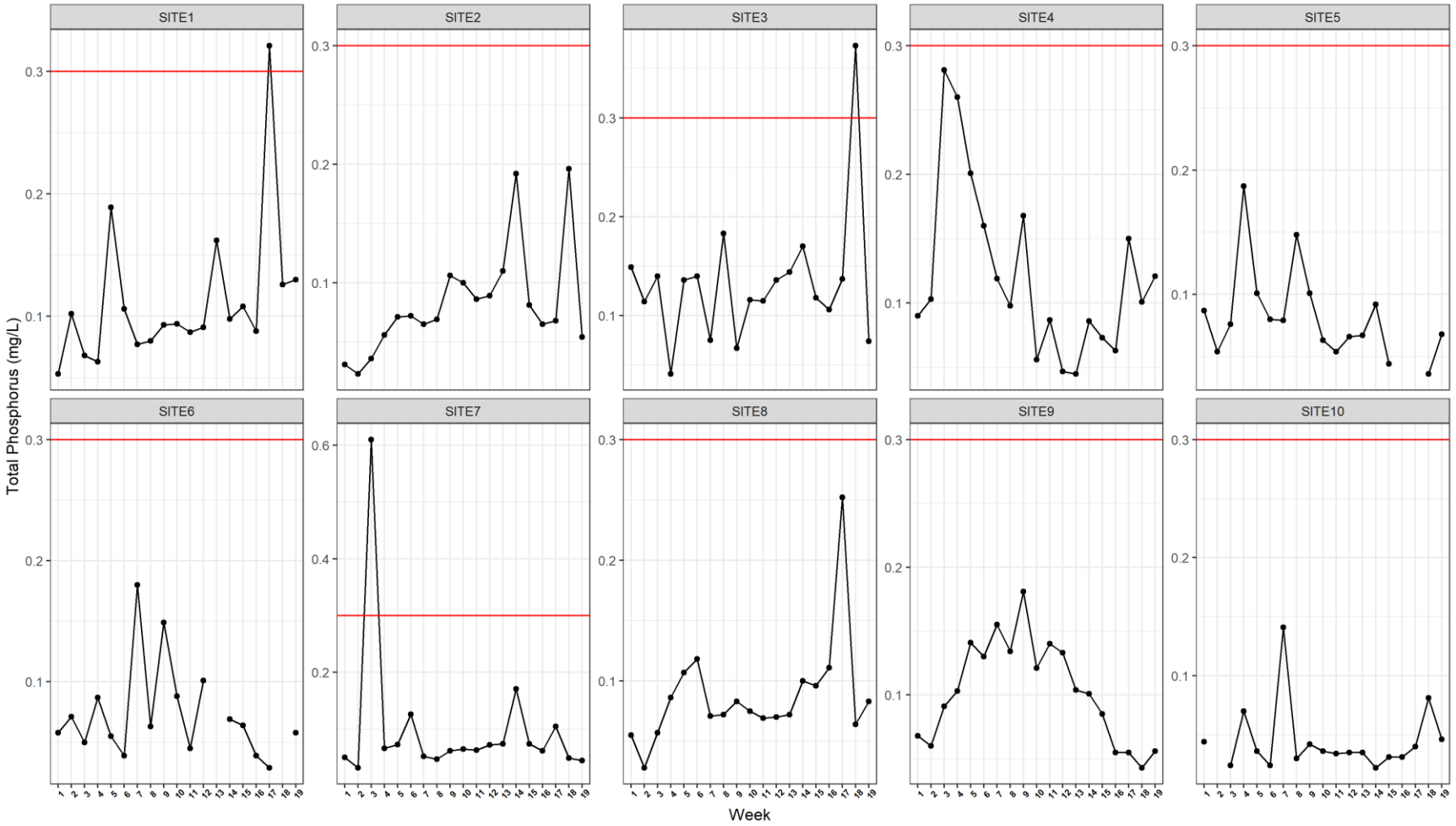

Figure 2. Line graphs showing weekly phosphorus levels (mg/L) at the 10 monitoring sites. The red horizontal line represents the IDEM water quality target of 0.3 mg/L phosphorus. **Note that the scale for the vertical axis varies for each site to facilitate improved visualization of weekly trends.**

2 c) Weekly trends in Nitrate levels

Nitrate measurements are reported in units of milligrams per liter of water (mg/L). The water quality target for nitrate that we benchmark our data against is 1.5 mg/L; at nitrate levels above this level, the ability of streams to support aquatic life can become impaired. Nitrate levels ranged between 0.2 and 7.8 and averaged 1.2 mg/L (see Figure 3, below).

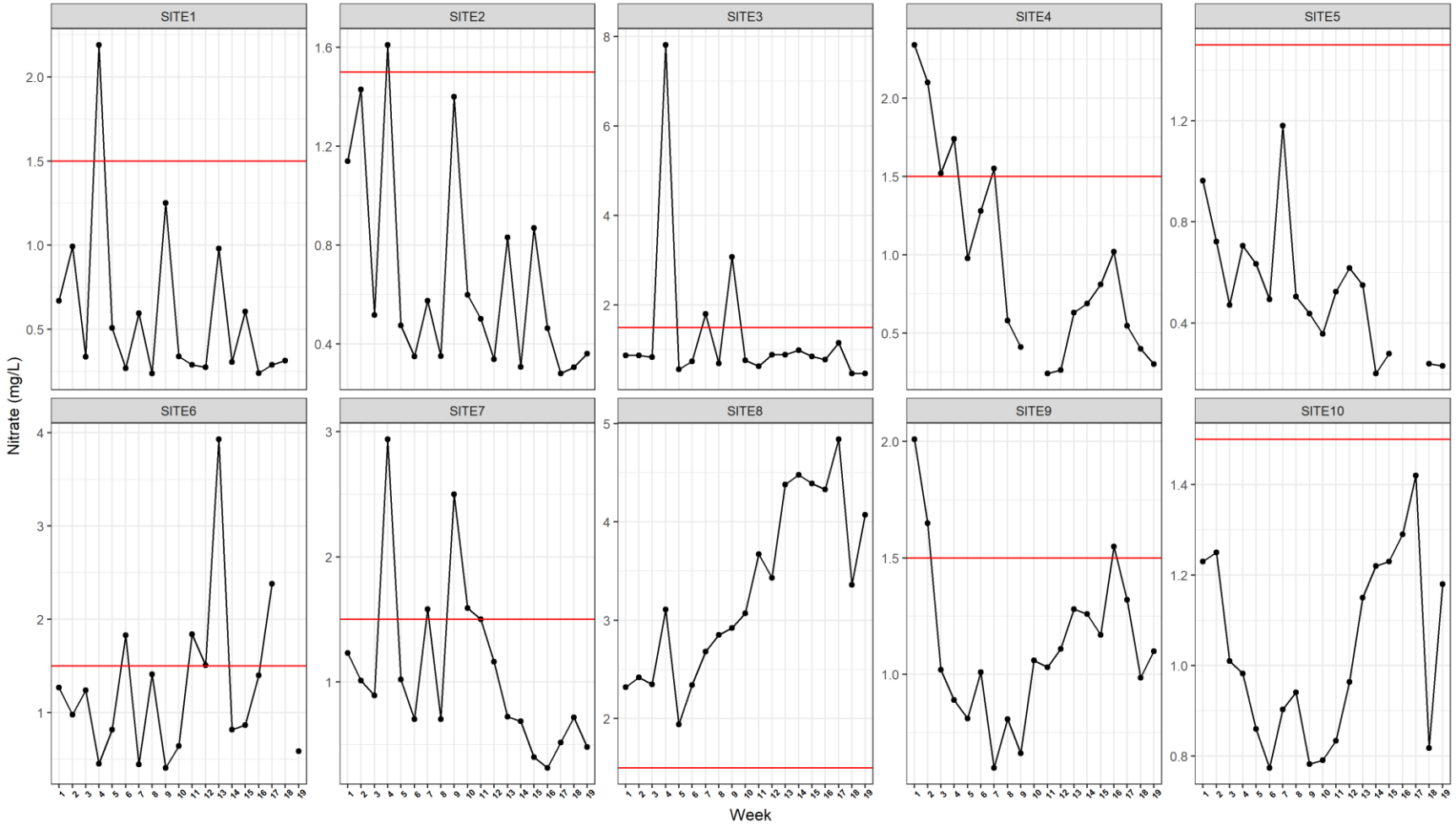

Figure 3. Line graphs showing weekly nitrate levels (mg/L) at the 10 monitoring sites. The red horizontal line represents the water quality target level of 1.5 mg/L nitrate. **Note that the scale for the vertical axis varies for each site to facilitate improved visualization of weekly trends.**

Summary & conclusion

Our program's water quality monitoring results in 2023 build upon the ongoing efforts of the SCLC to characterize water quality trends across the major waterways of Steuben County. Our findings show that excessive nutrients – especially nitrate – are a frequent issue among most of our monitoring sites. Our results also show consistently elevated *E. coli* levels in several of the monitored streams and ditches. We hope that by continuing our strategic monitoring program, we can discern possible sources of excessive nutrients, sediments, and *E. coli* levels in surface waters of Steuben County.

Planning for 2024

Our program's steering committee is currently planning for the 2024 strategic monitoring season. Since its inception in 2023, our program has been awarded a Steuben County Community Foundation Impact Grant that will support strategic monitoring efforts in 2024, 2025, and 2026. The support from the Community Foundation will allow our program to expand the number of sites monitored each year, and in 2024 we will be monitoring 20 sites on a weekly basis during the summer.

In addition to adding more sites to our strategic program, we will initiate county-wide biological monitoring of macroinvertebrate communities at the 20 monitoring sites in 2024. Macroinvertebrates form the cornerstone of aquatic food webs as they provide food sources for fish and other wildlife, and macroinvertebrates vary in their sensitivity to pollutants and habitat alterations. Therefore, macroinvertebrate monitoring can provide a more holistic view of stream health and can complement our chemical water quality testing. Our program will use the Ohio EPA methodology for macroinvertebrates that is currently used by the St. Joseph River Basin Commission (SJRBC) and the Cities of Elkhart-South Bend Aquatic Community Monitoring biological monitoring programs.

Looking ahead to the future, our program is designed to be long-term so that high quality, rigorous, scientific data on water quality can be determined throughout Steuben County. This program, consequently, is part of a broader vision to develop a coordinated, basin-wide water quality monitoring approach.

Appendix of Water Quality Definitions

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/Fahrenheit.

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.

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. Too acidic or basic waters can be harmful to aquatic life by altering the availability of dissolved nutrients in water to aquatic life.

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 (EPA).

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 TMDL target.

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).

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.

Chlorides: Measured in mg/L, this indicates the level of salts in water. Salts can occur as sodium (NaCl), potassium (KCl), and calcium ($CaCl_2$). 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 (World Health Organization). High chloride levels in surface waters can

pose risks to aquatic life and humans. According to the 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.

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.

Escherichia coli (E. coli) is a bacterium that, when present in waterbodies at certain levels, is indicative of fecal contamination from human and non-human sources. It can cause illness, skin infections, and rashes if not controlled. E. coli is measured and reported in Colony Forming Units per 100 milliliters (CFU per 100 ml). Indiana observes EPA standards for *E. coli*: waterbodies should not exceed 235 CFU per 100 ml.

Caffeine: A common chemical compound present in beverages, food items, and pharmaceuticals ingested by humans. Known to be an effective tracer of sanitary water.