2023
WATER SAMPLING REPORT FOR SELECTED MS4 SITES

PREPARED BY ELISE PFAFF, REHS
ENVIRONMENTAL HEALTH SPECIALIST II
ELKHART COUNTY HEALTH DEPARTMENT
ENVIRONMENTAL DIVISION

IN-STREAM SAMPLING PROTOCOLS FOR MS4 SITES

Beginning the fourth week of May and ending the second week of September, the Environmental Health Division conducted surface water testing on a weekly basis throughout the county on ditches, creeks, lakes, and the Elkhart River. The sampling provides data to help prioritize sites with a high illicit discharge potential, characterizes water quality problems, helps determine critical areas for improvement, and documents the long-term success of the illicit discharge and elimination program.

The sites are selected by storm water representatives from the MS4 Partnership which include the cities of Elkhart and Goshen, the town of Bristol, and Elkhart County agencies which meet annually to determine if changes need to be made to the locations. The standard procedure is to obtain a minimum of three years of data per site in order to identify any trends. The following is a list of the sites from the 2023 season:

Baugo Creek: CR 3
Christiana Creek: CR 4
Harverstick-Darkwood Ditch: CR 7
Pine Creek: CR 18 and CR 20
Rock Run Creek: CR 34
Turkey Creek: CR 46
Weaver Ditch: CR 13
Yellow Creek: CR 32 and CR 138
Elkhart River: CR 127 and Indiana Avenue (Goshen)
Little Elkhart River: CR 35
Heaton Lake: Ideal Beach and 22880 Lake Shore Drive
Simonton Lake: 51093 Beach Drive and 51330 SR 19

The sampling form includes whether the sample was considered wet or dry. Our definition of a wet weather event changed this sampling season and is what the Elkhart Public Works and Utilities Laboratory uses. They define a wet event as an accumulation of 0.8 inches or more as well as 72 hours after that limit is established. A dry weather event is defined as a sampling event with no precipitation twenty-four hours prior to collection. Monitoring during both types of events provides representative samples and helps identify how differences in land use impact water quality.

Data gathered for chlorides, dissolved oxygen, pH, temperature, and conductivity are obtained in the field by using a YSI Professional Plus Instrument Probe. Calibration of the instrument probe is done in accordance with the owner's manual. The instrument probe is lowered into the approximate center part of the waterway and placed below the surface of the water to obtain actual real time data. At the sites with piers (Heaton Lake and Simonton Lake) the instrument probe is lowered into the water at the end of the piers. According to the technical experts at YSI, this information is to be used for trending purposes only.

Tests for nitrates, phosphorus, total suspended solids, and E. coli are grab samples in which a single volume of water is obtained at a given point in time, placed in a prepared sample bottle, and then analyzed. Water samples were collected using one of two methods. For low flow sampling and sites with piers, a dipper was used. The dipper is rinsed three times at each site prior to collection to prevent cross contamination between samples sites. For high flow streams, a Van Dorn sampler is used. The device is lowered into the approximate center of the waterway and placed below the water surface for a

minimum of twenty seconds with the ends open to allow rinsing of the unit between sampling sites. A weight is then dropped on a line striking a triggering mechanism which tightly closes each end of the tube at the same time. This captures the free-flowing water to be sampled. All samples are placed in pre-labeled and prepared sample bottles.

Nitrates and phosphorus samples are collected for analysis in the Elkhart County Health Department Laboratory using a Hach portable spectrophotometer. Chain of custody procedures are required and implemented. These include labeling the bottles with the sample site number and all other information as recorded on the water sampling form. Items on the water sampling form include the sampling site identification, sampling date and time, sampling number, dry or wet event, raining at the time of collection, and "ECHD" as the agency that collected the sample.

Total suspended solids collected on Tuesday are analyzed at the Elkhart Public Works and Utilities Laboratory. On Thursday, total suspended solids are collected and submitted for analysis at the Goshen Wastewater Treatment Plant Laboratory. Total suspended solids are not collected at the lake sites. All E. coli samples are submitted to the Elkhart Public Works and Utilities Laboratory which provides the bottles and a pre-printed label. This label is filled out with the site number, location, collection date, who collected the sample, who transported and relinquished the sample. The labels are attached to the sample bottle. Upon arrival at the Elkhart Public Works and Utilities Laboratory, time is also added to the label. The label includes a space to acknowledge who received the sample. The Elkhart County Health Department's water sampling form is also signed by an Elkhart laboratory representative with the time of sample delivery and a copy is made and kept in their laboratory records. This procedure is implemented to verify chain of custody. For the total suspended solids, the samples are collected and placed in pre-labeled containers with the site number, location, date, and who collected the sample. The time is added to the sampling form when the samples are delivered to the City of Goshen Wastewater Treatment Plant Laboratory. Upon delivery, an Elkhart County Health Department representative places the total suspended solids samples into a refrigerated unit to ensure proper temperature requirements before analysis.

All samples collected are immediately placed in a cooler with chill packs as soon as they are obtained in the field in order to maintain proper temperature requirements during transportation per standard methods protocol.

PARAMETER DEFINITIONS AND THEIR IMPORTANCE

CHLORIDES are found in groundwater, streams, and lakes and may be of natural mineral origin or from human or animal sewage, industrial process wastewaters, agricultural fields and roadway deicing salts. It is recommended if very high levels (500 mg/l or more) are found, further investigation should take place to locate the source.

CONDUCTIVITY (SpC) is a measure of how easily electricity flows through water. It is strongly correlated with total dissolved solids. It is useful as a general measure of water quality. Each water body has a fairly constant range of conductivity that can be used for baseline readings. Significant changes in conductivity may be an indicator that a discharge or some other source of pollution has entered the water way. If this occurs, it is recommended that further investigation should take place to locate the source.

DISSOLVED OXYGEN (DO) is considered to be one of the most important parameters of water quality in streams, rivers, and lakes. All aquatic organisms need dissolved oxygen in the water to survive. Stream systems produce and consume oxygen. If more oxygen is consumed than produced, dissolved oxygen levels decline and some organisms move away, weaken, or die. Higher concentrations of dissolved oxygen equate to better water quality. Aquatic life is stressed at levels below 5.0 mg/l and levels below 2 mg/l will not support fish. Dissolved oxygen is very sensitive to temperature. The solubility of oxygen in water decreases as temperature increases. A waste discharge can have a dramatic effect on the oxygen balance of a water body by raising water temperature or introducing pollutants which remove the dissolved oxygen. According to 327 IAC 2-1-6 and the US EPA, the recommended target value is > 6 mg/l and not > 9 mg/l.

E. COLI is a species of fecal coliform bacteria that is specific to fecal matter from humans and other warm-blooded animals. E. coli indicates the possible presence of pathogenic bacteria, viruses, and protozoa that also live in the digestive systems of humans and animals. Their presence in a water body indicate pathogens might be present and that swimming/full body contact recreation can be a health risk. As required by the United States Environmental Protection Agency, total maximum daily load (TMDL) calculations have been established by the Indiana Pollution Control Board (327 IAC 2-1-6 Section 6(d)) for E. coli using membrane filter count and are the following numeric standards:

> "Concentrations shall not exceed 125 cfu/100 ml as a geoemetric mean based on not less than five samples equally spaced over a 30-day period nor exceed 235 cfu/100 ml in any one sample in a 30-day period."

NITRATES (N03) are one of the four forms of nitrogen in the nitrogen cycle. They are essential plant nutrients but in excess amounts they can cause significant water quality problems. Together with phosphorus they can cause increase in plant growth and changes in the types of plants and animals that live in surface water. In turn this affects dissolved oxygen and temperature. Excess nutrients can cause hypoxia which is a condition characterized by low levels of dissolved oxygen when the plants decay. The natural level of nitrates in surface water is typically low, less than 1 mg/l. Sources of nitrates include failing onsite septic systems, runoff from animal manure storage areas, fertilizer runoff from lawns and cropland, wastewater treatment plants and industrial discharges that contain corrosion inhibitors. The US EPA reference level is < 1.5 mg/l.

The **pH** scale measures the logarithmic concentration of hydrogen and hydroxide ions which make up water. Pure water, equal ion concentrations, is neutral with a pH of 7.0. Below 7.0 the water is acidic and above 7.0 the water is alkaline. pH affects many chemical and biological processes in water. The majority of the aquatic organisms survive and thrive at a range of 6.5-8.0. pH outside of this range reduces the diversity of the water way because it stresses the physiological systems of most organisms and can reduce reproduction. Low pH also allows toxic elements and compounds to become soluble and available for uptake by aquatic plants and animals. Some industrial discharges contain very high 12-14 pH or very low 1-3 pH. pH is a good monitoring parameter and significant fluctuations need to be investigated. According to 327 IAC 2-1-6, the target value is > 6 or < 9.

PHOSPHORUS Like nitrogen, phosphorus is an essential nutrient for plants and animals that make up the aquatic food chain. Phosphorus in waterways accelerates plant growth and algae blooms and with their decomposition result in low dissolved oxygen and death of some fish, invertebrates and other aquatic species. There are many natural and human sources of phosphorus. These include soil and rocks, wastewater treatment plants, runoff from fertilized lawns and cropland, failing onsite septic systems, runoff from animal manure storage areas, disturbed land areas and commercial cleaning preparations. Phosphorus is the limiting nutrient in many aquatic environments and very small inputs greatly affect photosynthetic productivity and can initiate a massive bloom of plants and algae in slow moving streams and ponds. These blooms are not desired and have a deleterious effect on the aquatic environments where phosphorus has been enriched. The IDEM 303(d) listing criteria is < 0.3 mg/l.

TEMPERATURE is a very important water quality parameter and influences all biological and chemical reactions. Temperature influences the dissolved oxygen content of the water, the metabolism of all aquatic organisms, the rate of photosynthesis, and the sensitivity of organisms to pollutants such as toxic wastes and parasites. All aquatic organisms have optimal temperatures for their survival. Many factors affect temperature including stream flow, sunlight, shade, water depth, turbidity, bottom color and composition, soil erosion, storm water runoff, and seasonal changes. Temperature is measured in degrees Celsius.

TOTAL SUSPENDED SOLIDS (TSS) are particulates in water and can include many organic and inorganic sources such as silt, decaying plant and animal matter, sewage and industrial wastes. They cause the water to be milky or muddy looking due to the light scattering from very small particles in the water. This is called turbidity. Suspended solids can destroy fish habitat because they can settle to the bottom and smother the eggs of fish and aquatic insects and suffocate newly hatched insect larvae. High levels of suspended solids can clog the gills of fish and reduce their growth rates and reduce dissolved oxygen. Also, pollutants and contaminants adhere to the suspended solids. Total suspended solids are measured in mg/l. There are no numeric standards for total suspended solids however they must meet narrative standards which state in part: "all waters at all times and places, including the mixing zone, shall meet the minimum conditions of being free from substances, materials, floating debris, oil, or scum attributable to municipal, industrial, agricultural, and other land use practices, or other discharges which are in amounts sufficient to injure, be acutely toxic to, or otherwise produce serious adverse physiological responses in humans, animals, aquatic life or plants."

NOTE: The above information was obtained from the United States Environmental Protection Agency (US EPA), the Indiana Department of Environmental Management (IDEM), The Center for Watershed Protection, and Purdue University Department of Agricultural and Biological Engineering.

SAMPLING RESULTS, CHARTS AND MISCELLANEOUS INFORMATION

Appendix 1 contains the water sampling data.

Appendix 2 contains the charts for E. coli and total suspended solids.

Appendix 3 contains the water quality targets.

SUMMARY AND CONCLUSIONS

According to the United States Environmental Protection Agency, "a water body is considered impaired when a water quality standard is violated, whether through exceedance of a numeric or narrative criterion, impairment of a designated use or violation of anti-degradation policy." The results of the 2023 sampling season continue to indicate E. coli levels in excess of the total maximum daily load of 235 cfu/100 ml at many of the sample sites.

The Elkhart County Regional Sewer District has secured contracts for the sewer utility expansion for the unincorporated areas of Tecumseh Acres, Foraker, and Southwest. Tecumseh Acres sewer construction has begun and will be the first area to complete connection to the sanitary sewer. Foraker and Southwest will follow respectively. The treatment services will be provided by the town of Nappanee. Years of sampling data from these areas have proven unacceptable levels of E. coli entering adjacent waterways in these areas. Pharmaceutical and DNA testing has also been conducted in these areas confirming improperly treated wastewater from failing septic systems contributes to the polluted waterways.

Additionally, sediment transport continues in many waterways depositing sediment and contributing to flow restrictions especially after wet weather events. Visible impairments to the structure of the waterways, the stability of the banks and the clarity of the water were also observed.

Water quality is impacted by past and present land use. Various land uses contribute different contaminants to surface waters. As storm water flows across agricultural land, it can pick up pesticides, fertilizers, nutrients, pathogens, sediment, and manure and deposit them into surface waters. Some of these contaminants may infiltrate into the soil surface depending on the vegetation and the rate of transport. In urban areas storm water flows across parking lots and roads transporting motor oil, grease, transmission fluid, sediment and other contaminants which quickly flow to storm water drains discharging to surface waters without treatment. A review of the historic land types could provide further insight into the correlation between land use and surface water degradation.

All water bodies can assimilate a certain amount of pollution without adverse effects because of the dilution and self-purification capabilities of natural processes. The ability of a water body to mitigate for an organic pollutant, such as E. coli is dependent on many factors such as stream flow, depth, dissolved oxygen, temperature, available sunlight, and time. However, the high levels of E. coli indicate these pathogens are being infused at a rate greater than can be mitigated through natural processes resulting in these higher than acceptable numbers. Results such as these are indicators of illicit discharges entering the water bodies requiring investigation to determine their source and enforce compliance with environmental regulations prohibiting these discharges.

ACKNOWLEGEMENTS

I would like to thank the vector technicians who assisted with the sample collection: Evie Long, Kara Stacy, and Regan Landis. Special recognition also goes to Jessica Daub and Ashley Scholl who trained the vector technicians and assisted with the sampling.

Special recognition also goes to the laboratory staff at the Elkhart Public Works and Utilities and the Goshen Wastewater Treatment Plant. Their assistance, expertise and water analysis were instrumental to the sampling program and is very much appreciated.

APPENDIX 1

PINE CREEK CR 18

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/23/2023	8:30	13.8	7.9	714	8.23	145.52	3.65	0.248	10	313	N
6/1/2023	8:25	17.6	6.8	688	8.18	85.33	3.63	0.127	6	404	N
6/6/2023	8:35	15.5	6.8	710	8.23	104.10	4.09	0.256	6	404	N
6/13/2023	8:45	13.2	7.8	715	8.32	112.47	4.38	0.402	5	677	N
6/27/2023	8:25	16.4	7.1	681	8.24	87.22	3.96	0.330	9	1296	Y
7/6/2023	8:25	19.7	5.7	388	8.23	91.82	3.16	0.326	10	865	N
7/11/2023	8:25	16.9	7.3	636	8.37	122.58	3.54	0.225	13	1529	N
7/18/2023	8:20	16.4	7.7	686	8.28	94.70	3.64	0.343	15	1529	N
7/25/2023	8:20	16.9	7.0	690	8.28	110.79	3.49	0.340	15	2481	N
8/1/2023	8:25	17.2	5.6	611	8.07	78.95	2.81	0.389	18	613	Y
8/8/2023	8:25	16.1	0.2	669	8.14	82.26	3.57	0.409	23	1259	Y
8/15/2023	9:00	16.8	6.1	696	8.26	88.64	3.67	0.259	10	1296	Y
8/22/2023	8:30	18.1	5.7	635	8.27	90.30	3.64	0.201	13	1467	N
8/29/2023	8:55	15.1	6.7	705	8.28	101.49	3.84	0.281	43	1259	N
9/12/2023	8:40	15.5	5.1	664	8.28	107.2	4.00	0.282	10	3654	N

PINE CREEK CR 20

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/23/2023	9:05	13.6	6.9	709	8.09	107.10	3.94	0.443	7	743	N
6/1/2023	8:40	17.3	5.2	711	7.99	69.47	3.83	0.215	3	404	N
6/6/2023	8:50	15.5	4.8	704	8.01	81.81	4.42	0.368	2	712	N
6/13/2023	9:00	13.5	5.8	698	8.06	82.02	4.89	0.331	2	703	N
6/23/2023	8:40	16.6	4.8	689	7.98	74.26	3.99	0.397	3	1723	Y
7/6/2023	8:45	20.7	3.8	744	7.86	65.72	2.79	0.404	1	2143	N
7/11/2023	8:55	18.2	5.2	687	7.96	78.5	3.60	0.494	71	1450	N
7/18/2023	8:35	16.9	5.2	686	7.99	73.98	3.51	0.412	2	855	N
7/25/2023	8:35	17.6	3.9	679	7.96	78.51	3.57	0.390	3	1565	N
8/1/2023	8:40	17.1	4.3	629	7.86	63.54	3.21	0.369	5	638	Y
8/8/2023	8:35	15.9	4.6	677	7.96	68.58	3.52	0.782	6	1918	Y
8/15/2023	8:40	16.9	4.7	709	7.97	62.66	3.87	0.269	4	1497	Y
8/22/2023	8:55	18.2	4.4	712	8.00	66.08	3.74	0.271	3	1333	N
8/29/2023	9:15	15.1	4.9	711	8.02	76.74	4.00	0.336	3	480	N
9/12/2023	9:00	15.8	4.8	670	8.07	77.75	4.31	0.481	90	1723	N

ROCK RUN CREEK CR 34

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/23/2023	9:25	13.3	7.0	767	8.01	103.24	5.38	0.221	2	441	N
6/1/2023	9:00	17.2	6.4	771	7.96	65.98	5.75	0.194	3	2098	N
6/6/2023	9:15	15.2	6.5	769	8.08	80.36	6.19	0.207	2	906	N
6/13/2023	9:20	13.1	7.5	770	8.16	84.92	6.55	0.146	2	1039	N
6/23/2023	9:05	16.1	6.7	757	8.10	81.94	5.43	0.257	2	1162	Y
7/6/2023	9:10	19.2	5.7	723	8.00	63.93	5.16	0.164	11	1789	N
7/11/2023	9:20	17.5	5.2	750	8.07	74.59	5.16	0.127	3	1483	N
7/18/2023	9:00	15.7	7.2	768	8.06	71.77	5.11	0.167	6	1162	N
7/25/2023	9:00	16.4	5.8	763	8.02	82.19	4.86	0.184	3	1439	N
8/1/2023	9:20	15.8	6.0	738	7.78	63.05	4.53	0.519	4	1500	Y
8/8/2023	9:00	15.3	6.3	773	7.94	66.63	4.56	0.289	2	820	Y
8/15/2023	9:40	16.6	5.2	766	8.01	67.32	4.71	0.114	3	2187	Y
8/22/2023	9:25	17.9	5.2	772	8.03	63.15	4.55	0.132	15	1500	N
8/29/2023	9:35	14.7	6.2	770	8.07	78.79	5.68	0.105	1	934	N
9/12/2023	9:20	15.6	6.4	744	8.11	81.47	6.67	0.247	3	3255	N

LITTLE ELKHART RIVER CR 35

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/23/2023	9:55	15.4	5.6	741	7.99	155.74	3.11	0.264	5	650	N
6/1/2023	9:35	18.8	7.0	731	8.20	76.43	2.92	0.205	6	395	N
6/6/2023	9:45	11.8	1.2	490	7.69	45.74	2.66	0.243	9	313	N
6/13/2023	9:55	14.0	6.0	677	7.65	85.55	2.97	0.236	12	530	N
6/27/2023	9:35	15.2	0.8	590	7.89	86.45	2.55	0.316	7	934	Y
7/6/2023	9:40	17.3	3.5	547	7.83	88.68	2.58	0.294	11	677	N
7/11/2023	9:55	18.9	6.4	743	8.28	90.10	2.77	0.223	7	450	N
7/18/2023	9:25	17.5	6.9	650	8.26	85.39	2.67	0.232	5	422	N
7/25/2023	9:25	18.2	1.3	687	7.82	133.12	2.98	0.312	5	313	N
8/1/2023	9:50	17.8	5.4	682	8.16	56.75	2.86	0.373	18	743	Y
8/8/2023	9:45	17.0	5.9	685	8.24	75.20	2.91	1.030	12	620	Y
8/15/2023	10:30	17.6	6.2	720	8.29	82.62	3.00	0.313	8	1112	Y
8/22/2023	10:00	19.4	5.9	724	8.29	74.30	2.77	0.221	5	355	N
8/29/2023	10:10	16.8	6.7	749	8.30	94.08	3.22	0.347	6	272	N
9/12/2023	10:00	16.1	5.9	679	8.22	83.88	2.83	0.223	8	1935	N

HEATON LAKE IDEAL BEACH

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/23/2023	10:20	21.2	7.0	370.7	8.62	44.06	0.295	0.077		34	N
6/1/2023	10:05	25.7	7.2	362.1	8.79	27.94	0.348	0.107		63	N
6/6/2023	10:25	24.3	7.4	326.5	8.83	29.28	0.281	0.116		70	N
6/13/2023	10:25	20.4	8.0	332.5	8.93	30.76	0.266	0.060		20	N
6/23/2023	10:05	20.6	6.6	241.1	8.81	26.82	0.321	0.054		461	Y
7/6/2023	10:10	27.3	6.7	244.2	9.11	24.30	0.211	0.065		2240	N
7/11/2023	10:45	26.8	4.8	249.0	8.79	26.76	0.275	0.030		96	N
7/18/2023	9:55	25.2	5.3	258.9	8.80	26.59	0.240	0.079		613	N
7/25/2023	9:55	26.0	5.5	364.1	8.05	40.99	0.278	0.072		28	N
8/1/2023	10:30	25.7	4.7	333.0	7.68	23.07	0.265	0.037		128	Y
8/8/2023	10:10	23.8	2.2	325.3	7.51	23.29	0.293	0.080		17	Y
8/15/2023	10:55	23.8	5.0	263.0	8.53	21.67	0.309	0.054		33	Y
8/22/2023	10:30	25.5	6.6	261.0	8.70	18.10	0.292	0.023		4	N
8/29/2023	10:40	24.5	7.4	244.0	9.13	18.64	0.253	0.054		10	N
9/12/2023	10:30	21.8	4.7	276.0	8.40	24.55	0.259	0.052		8	N

HEATON LAKE 22880 LAKE SHORE DR.

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/23/2023	10:30	20.3	6.9	404.3	8.63	53.03	0.367	0.114		5	N
6/1/2023	10:20	25.0	7.0	281.1	8.71	27.64	0.295	0.032		13	N
6/6/2023	10:35	24.1	6.4	335.4	8.75	30.34	0.268	0.052		3	N
6/13/2023	10:35	19.0	8.0	317.9	8.91	32.20	0.287	0.053		51	N
6/27/2023	10:20	20.5	5.9	200.2	8.72	30.40	0.328	0.057		105	Y
7/6/2023	10:20	27.3	4.9	250.1	9.10	29.93	0.272	0.052		44	N
7/11/2023	11:00	25.6	4.6	274.2	8.70	26.93	0.235	0.050		19	N
7/18/2023	10:10	24.9	5.2	273.3	8.74	26.39	0.264	0.060		1	N
7/25/2023	10:10	25.1	5.6	264.6	8.66	27.81	0.296	0.089		2	N
8/1/2023	10:40	25.6	5.2	256.0	8.76	25.35	0.279	0.060		4	Y
8/8/2023	10:20	24.1	3.3	268.4	8.24	21.45	0.277	0.093		12	Y
8/15/2023	11:05	23.9	4.7	260.0	8.50	22.00	0.224	0.053		5	Y
8/22/2023	10:50	25.4	5.7	278.0	8.15	20.50	0.270	0.048		8	N
8/29/2023	10:55	24.2	8.1	244.0	9.06	20.70	0.253	0.042		1	N
9/12/2023	10:40	21.6	4.2	285.0	8.23	27.68	0.244	0.012		13	N

SIMONTON LAKE 51093 BEACH DR.

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/23/2023	10:50	20.7	7.7	392.9	8.53	64.62	0.376	0.127		4	N
6/1/2023	10:30	25.5	7.1	388.6	8.61	48.31	0.308	0.048		5	N
6/6/2023	10:30	23.8	7.6	358.1	8.88	51.34	0.249	0.106		11	N
6/13/2023	10:45	18.8	7.8	361.4	8.76	57.00	0.149	0.033		53	N
6/23/2023	10:35	20.2	5.7	372.2	8.38	60.48	0.270	0.040		79	Y
7/6/2023	10:30	27.3	5.1	360.1	8.63	51.90	0.203	0.041		166	N
7/11/2023	11:10	26.6	5.9	349.0	8.86	53.55	0.200	0.051		19	N
7/18/2023	10:20	25.3	6.0	348.7	8.67	54.81	0.166	0.053		6	N
7/25/2023	10:20	25.7	5.6	291.5	8.85	57.68	0.172	0.112		15	N
8/1/2023	10:50	25.4	4.9	331.7	8.69	48.21	0.271	0.051		83	Y
8/8/2023	10:40	23.0	4.4	347.7	8.43	46.44	0.242	0.192		225	Y
8/15/2023	11:20	23.2	5.1	357.0	8.53	52.26	0.258	0.071		187	Y
8/22/2023	11:00	25.4	5.6	355.0	8.67	46.70	0.163	0.007		13	N
8/29/2023	11:10	24.1	6.1	369.0	8.55	47.82	0.162	0.048		26	N
9/12/2023	10:50	20.9	5.3	358.0	8.50	55.43	0.167	0.030		26	N

SIMONTON LAKE 51330 SR 19

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/23/2023	11:00	20.8	6.8	418.5	8.39	65.16	0.627	0.132		25	N
6/1/2023	10:45	24.5	5.7	425.8	8.23	48.27	0.672	0.028		20	N
6/6/2023	11:05	24.2	5.9	415.4	8.44	53.71	0.513	0.021		41	N
6/13/2023	11:00	19.8	6.6	414.6	8.33	61.02	0.432	0.028		111	N
6/23/2023	10:50	21.8	5.1	419.3	8.38	61.62	0.367	0.033		172	Y
7/6/2023	10:45	26.1	5.6	410.1	8.22	57.09	0.268	0.029		31	N
7/11/2023	11:25	25.8	6.0	401.5	8.31	56.38	0.264	0.026		51	N
7/18/2023	10:35	24.5	5.4	403.7	8.14	55.07	0.298	0.005		12	N
7/25/2023	10:35	25.0	5.7	388.6	8.39	58.64	0.339	0.030		13	N
8/1/2023	11:10	25.8	3.0	380.0	7.73	53.71	0.298	0.037		9	Y
8/8/2023	10:55	23.8	4.9	363.5	8.40	52.33	0.265	0.059		42	Y
8/15/2023	11:30	23.2	4.9	381.0	8.21	55.95	0.272	0.032		1733	Y
8/22/2023	11:15	25.2	5.8	376.0	8.63	48.50	0.228	0.006		248	N
8/29/2023	11:20	24.3	5.2	373.0	8.64	50.18	0.230	0.023		56	N
9/12/2023	11:00	21.7	5.9	371.1	8.55	58.65	0.235	0.010		51	N

CHRISTIANA CREEK CR 4

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/23/2023	11:10	18.8	8.3	467.0	8.39	40.79	1.58	0.077	3	96	N
6/1/2023	10:55	21.9	6.9	481.0	8.24	31.00	1.67	0.057	6	201	N
6/6/2023	11:15	21.3	6.5	475.9	8.27	35.98	1.72	0.037	3	118	N
6/13/2023	11:10	17.2	7.4	470.0	8.34	39.12	1.73	0.057	3	276	N
6/23/2023	11:00	19.6	6.3	454.0	8.31	37.75	1.56	0.041	5	276	Y
7/6/2023	10:55	24.9	5.7	442.0	8.31	32.14	1.23	0.038	4	387	N
7/11/2023	11:40	23.9	6.6	434.0	8.33	32.80	1.40	0.079	4	131	N
7/18/2023	10:45	21.5	6.4	439.0	8.32	32.25	1.32	0.044	3	308	N
7/25/2023	10:45	22.4	5.8	435.0	8.26	33.59	1.40	0.061	3	147	N
8/1/2023	11:20	24.3	5.4	401.0	8.35	28.90	0.682	0.043	5	86	Y
8/8/2023	11:05	22.0	5.7	415.4	8.27	26.60	0.891	0.068	4	178	Y
8/15/2023	11:40	21.2	5.5	425.0	8.26	29.64	1.14	0.059	3	276	Y
8/22/2023	11:20	23.4	5.7	443.0	8.35	27.60	1.09	0.029	2	192	N
8/29/2023	11:30	21.2	6.5	452.1	8.33	30.77	1.25	0.037	5	238	N
9/12/2023	11:10	19.8	5.9	447.0	8.32	36.43	1.17	0.042	3	236	N

BAUGO CREEK CR 3

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/25/2923	11:10	15.2	6.9	697	8.25	182.72	3.83	0.395	1.50	248	N
6/8/2023	11:04	16.2	7.2	707	8.27	130.93	2.00	0.511	1.67	387	N
6/15/2023	10:50	15.5	7.0	659	8.27	124.3	2.90	0.549	2.25	727	N
6/22/2023	10:40	20.1	5.4	714	8.17	109.05	1.33	0.522	error	299	N
6/29/2023	11:09	18.7	6.4	668	8.21	111.54	1.92	0.750	1.00	461	N
7/13/2023	10:40	19.4	5.4	649	8.19	112.57	1.54	0.805	1.50	517	Y
7/20/2023	10:50	20.1	6.3	704	8.34	116.33	0.762	0.709	1.88	816	N
7/27/2023	10:41	20.3	4.5	610	8.05	107.90	1.46	0.860	16	4611	Y
8/3/2023	10:40	20.0	4.7	637	8.16	103.68	4.06	0.635	1.22	2481	N
8/10/2023	10:45	19.6	4.9	691	8.29	125.45	2.04	0.739	1.13	548	Y
8/17/2023			no sample due to thunderstorms								
8/24/2023	10:50	22.2	4.4	692	8.16	113.84	1.28	0.825	2.38	345	N
8/31/2023	12:00	17.0	6.1	754	8.33	135.87	1.09	0.828	3.75	260	N
9/7/2023	12:10	20.2	5.1	721	8.25	136.54	1.03	0.745	4.13	488	Y
9/14/2023	10:55	14.5	5.7	750	8.31	159.16	1.25	1.17		980	N

YELLOW CREEK CR 32

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/25/2023	10:50	12.8	7.2	864	8.12	215.61	5.37	0.771	2.88	512	N
6/8/2023	10:45	14.0	6.2	918	8.18	192.25	4.53	0.769	1.63	743	N
6/15/2023	10:30	14.6	6.4	828	8.03	142.10	4.14	0.888	3.13	7270	N
6/22/2023	10:20	18.4	5.8	898	8.12	147.63	2.12	1.070	2.50	1153	N
6/29/2023	10:48	17.8	5.4	845	8.13	135.40	2.32	0.994	3.75	1597	N
7/13/2023	10:20	18.5	5.0	825	8.16	143.85	1.68	1.20	2.25	932	Y
7/20/2023	10:30	18.8	3.9	824	8.09	134.48	1.20	1.12	4.00	762	N
7/27/2023	10:21	20.05	4.0	718	7.92	113.09	13.5	2.14	7.50	241960	Y
8/3/2023	10:15	18.2	4.1	876	8.10	155.13	3.08	0.867	6.17	2909	N
8/10/2023	10:25	18.4	4.3	844	8.13	148.39	2.02	1.03	2.00	1400	Y
8/17/2023	10:30	17.1	4.6	838	8.13	158.56	1.92	1.10	5.00	1670	N
8/24/2023	10:30	21.7	3.5	837	8.09	123.85	1.52	1.05	37.1	1670	N
8/31/2023	11:35	14.7	5.9	819	8.18	127.42	1.84	0.815	124.7	5172	N
9/7/2023	11:45	19.3	4.3	825	8.15	127.64	1.37	0.952	3.88	855	Y
9/14/2023	10:30	13.2	5.2	789	8.17	153.97	1.84	0.816	10.5	6488	N

YELLOW CREEK CR 138

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/25/2023	10:40	11.8	10.9	986	8.41	286.78	13.00	0.705	4.50	990	N
6/8/2023	10:30	14.1	6.3	1105	8.19	254.23	16.00	0.992	23.25	1725	N
6/15/2023	10:20	15.0	5.2	1091	8.05	270.55	6.62	1.350	6.33	4611	N
6/22/2023	10:10	18.3	4.2	1118	8.03	226.33	7.86	1.450	7.80	1250	N
6/29/2023	10:34	17.9	4.6	1126	8.04	236.88	6.06	1.540	20.75	2098	N
7/13/2023	10:10	18.6	4.1	1070	8.12	272.88	3.81	2.000	4.88	1211	Y
7/20/2023	10:20	19.2	4.1	1211	8.18	301.53	3.64	2.080	8.80	2359	N
7/27/2023	10:08	19.9	4.1	947	7.69	172.8	12.50	1.43	18.00	68670	Y
8/3/2023	10:05	18.4	4.5	1292	8.05	348.75	7.70	1.13	12.00	1414	N
8/10/2023	10:10	18.9	4.0	1143	8.15	261.06	5.09	1.77	5.83	530	Y
8/17/2023	10:05	17.5	4.1	1111	8.17	278.92	3.85	2.14	9.17	1785	N
8/24/2023	10:15	22.6	2.9	1134	8.09	238.34	3.84	1.70	8.50	1396	N
8/31/2023	11:15	15.6	5.0	1143	8.21	272.00	3.19	1.43	9.50	4106	N
9/7/2023	11:27	19.9	4.2	1132	8.28	235.44	3.74	1.50	23.00	754	Y
9/14/2023	10:20	13.5	5.3	1051	8.24	276.47	3.20	1.54	11.3	9208	N

WEAVER DITCH CR 13

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/25/2023	10:10	12.0	0.3	1934	7.26	1511.26	1.530	7.33	60	241960	N
6/8/2023	10:10	14.0	0.2	1821	7.55	1048.72	0.756	8.40	46	1046200	N
6/15/2023	9:50	14.6	0.7	2265	7.06	1445.15	1.460	12.30	312	816400	N
6/22/2023	9:50	16.8	8.1	992	7.57	1096.44	0.921	11.30	124	648800	N
6/29/2023	10:11	16.1	1.3	1458	7.29	939.81	1.210	13.40	186.7	686700	N
7/13/2023	9:40	17.3	0.2	2323	7.17	1340.10	1.280	13.9	296	980400	Y
7/20/2023	9:55	17.1	0.3	1504	7.29	888.75	1.06	10.6	63.75	120330	N
7/27/2023	9:46	19.2	0.1	2249	7.09	945.88	4.16	9.69	166	2419600	Y
8/3/2023	9:40	18.0	0.8	3912	7.51	NO VALUE	1.25	7.20	33	1046200	N
8/10/2023	9:45	18.4	0.2	1504	7.40	613.53	1.48	7.24	15.33	2419600	Y
8/17/2023	9:50	17.9	0.4	1078	7.05	1067.51	0.898	8.18	32	517200	N
8/24/2023	9:50	18.7	0.1	1031	7.06	1199.85	0.411	6.77	25	241960	N
8/31/2023	10:15	17.1	0.3	1835	7.42	1217	1.12	10.2	2110	410600	N
9/7/2023	10:55	18.6	1.8	1779	7.92	528.98	3.84	6.96	35	727000	Y
9/14/2023	10:00	16.9	0.1	1660	7.14	TNTC	1.08	7.24	19	410600	N

TURKEY CREEK CR 46

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/25/2023	9:20	14.0	5.3	630	8.05	124.22	2.05	0.095	4.38	156	N
6/8/2023	9:20	15.4	5.6	648	8.12	100.92	2.08	0.103	1.11	179	N
6/15/2023	9:10	15.4	6.0	726	8.12	103.66	3.11	0.120	59.25	613	N
6/22/2023	9:00	19.4	5.3	686	7.93	82.94	1.71	0.084	2.13	222	N
6/29/2023	9:32	18.8	5.2	722	8.13	81.65	3.31	0.130	2.63	866	N
7/13/2023	9:05	19.8	5.3	695	8.13	100.45	1.81	0.229	8.63	411	Y
7/20/2023	9:10	20.5	5.3	701	8.17	91.07	1.58	0.143	2.75	152	N
7/27/2023	9:04	20.7	4.0	668	8.06	94.90	1.93	0.149	7.50	816	Y
8/3/2023	9:00	20.3	4.1	638	8.07	80.34	1.54	0.170	3.11	248	N
8/10/2023	9:00	19.9	4.3	464	8.10	84.01	1.56	0.205	4.38	167	Y
8/17/2023	9:05	18.2	5.2	509	8.03	87.00	1.98	0.150	3.25	185	N
8/24/2023	9:10	27.7	0.4	678	7.98	84.34	1.57	0.172	3.75	210	N
8/31/2023	9:50	16.0	4.2	739	7.90	104.84	2.12	0.131	2.50	160	N
9/7/2023	9:50	20.0	4.1	770	8.12	110.99	2.10	0.160	2.53	137	Y
9/14/2023	9:20	14.9	3.7	636	7.89	82.96	2.99	1.280	4.38	291	N

ELKHART RIVER CR 127

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/25/2023	9:00	16.7	6.6	586	8.23	86.08	1.40	0.174	7.30	93	N
6/8/2023	9:00	16.8	6.5	623	8.26	74.26	1.52	0.198	4.50	141	N
6/15/2023	8:55	16.4	6.6	621	8.28	72.08	2.22	0.117	4.75	201	N
6/22/2023	8:45	21.2	5.4	652	8.29	68.73	1.49	1.390	5.70	231	N
6/29/2023	9:14	19.3	5.9	667	8.27	68.70	2.05	0.158	5.14	328	N
7/13/2023	8:50	21.0	5.3	625	8.23	65.09	1.54	0.234	12.2	365	Y
7/20/2023	9:00	21.5	5.4	642	8.26	72.17	1.43	0.272	11.0	276	N
7/27/2023	8:48	21.7	4.9	585	8.16	76.57	2.18	0.321	23.3	1986	Y
8/3/2023	8:45	20.8	5.1	607	8.22	73.19	1.68	0.208	15.5	236	N
8/10/2023	8:45	20.7	5.1	593	8.26	70.75	1.31	0.317	14.25	291	Y
8/17/2023	8:55	19.5	5.4	603	8.27	67.67	1.40	0.256	9.0	276	N
8/24/2023	8:55	24.3	4.4	610	8.25	66.17	1.34	0.268	6.17	328	N
8/31/2023	9:30	17.8	5.4	630	8.35	86.68	1.56	0.248	5.5	196	N
9/7/2023	9:30	21.8	4.6	640	8.29	81.34	1.32	0.179	2.88	411	Y
9/14/2023	9:05	16.1	5.6	665	8.33	85.20	1.53	0.189	2.5	308	N

ELKHART RIVER INDIANA AVE (GOSHEN)

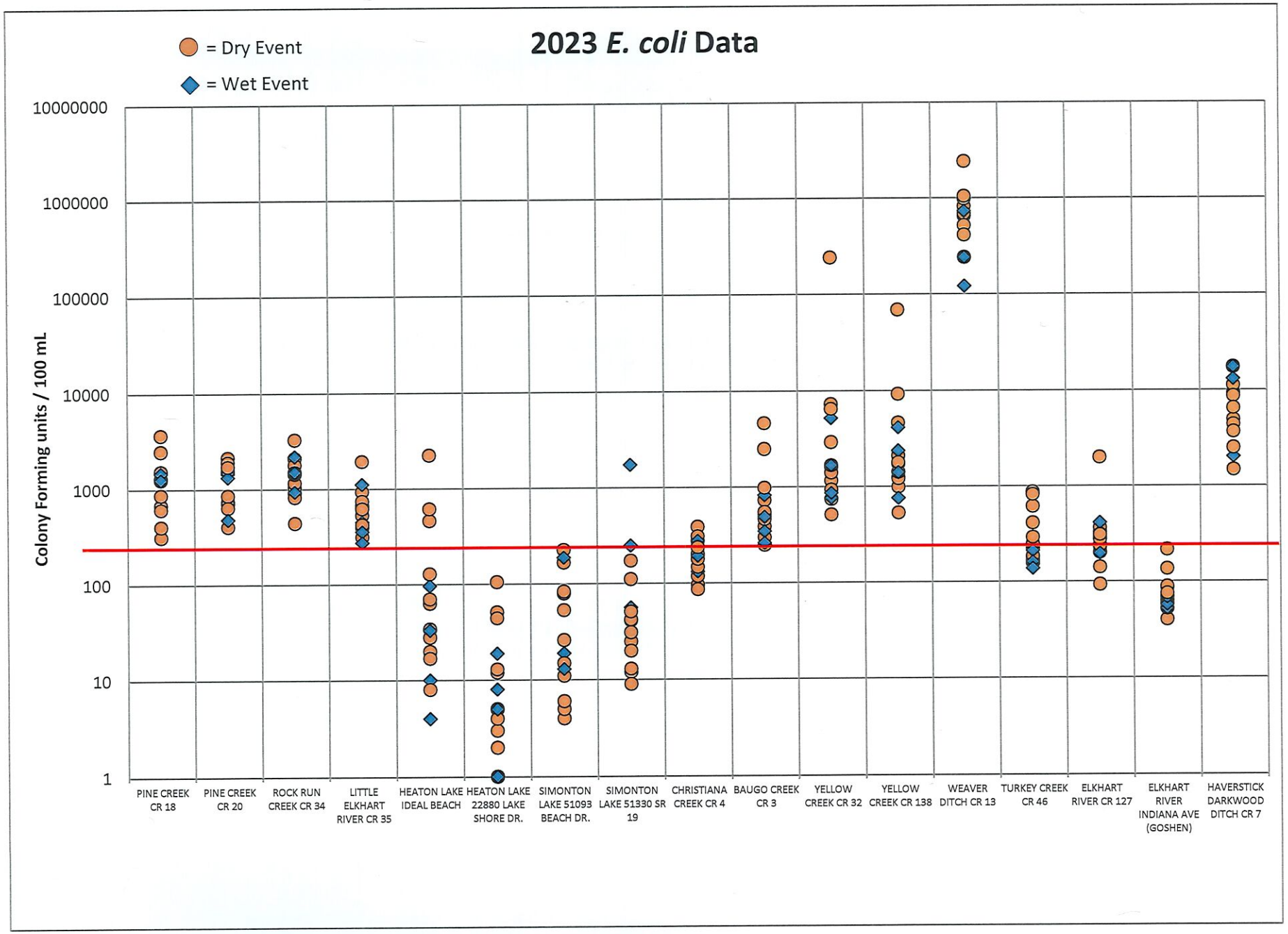
DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E.COLI	WET
5/25/2023	8:30	18.0	7.3	616	8.25	93.53	1.32	0.110	4.5	40	N
6/8/2023	8:30	18.1	6.4	652	8.15	86.07	1.08	0.198	3.5	52	N
6/15/2023	8:25	16.6	7.0	676	8.18	91.50	1.58	0.166	7.3	135	N
6/22/2023	8:15	21.8	5.3	690	8.10	83.99	1.20	0.133	3.0	63	N
6/29/2023	no sample weather conditions										
7/13/2023	8:15	22.1	5.8	654	8.14	74.57	1.31	0.214	3.75	70	Y
7/20/2023	8:30	22.4	5.6	651	8.16	81.86	1.24	0.177	3.5	52	N
7/27/2023	8:20	22.9	4.5	618	8.14	89.35	1.26	0.178	3.0	214	Y
8/3/2023	8:20	22.0	5.1	626	8.17	76.65	1.92	0.219	6.0	86	N
8/10/2023	8:20	21.3	5.2	615	8.14	73.36	1.33	0.242	5.63	88	Y
8/17/2023	8:25	20.0	5.0	630	8.20	79.00	1.29	0.201	4.0	70	N
8/24/2023	8:25	24.4	3.9	640	8.12	78.54	1.13	0.177	2.63	59	N
8/31/2023	9:10	18.8	4.9	658	8.11	88.23	1.27	0.192	2.75	57	N
9/7/2023	8:55	22.6	4.1	675	7.97	82.39	1.20	0.263	1.5	68	Y
9/14/2023	8:35	16.8	5.5	681	8.14	99.02	1.34	0.156	2.6	75	N

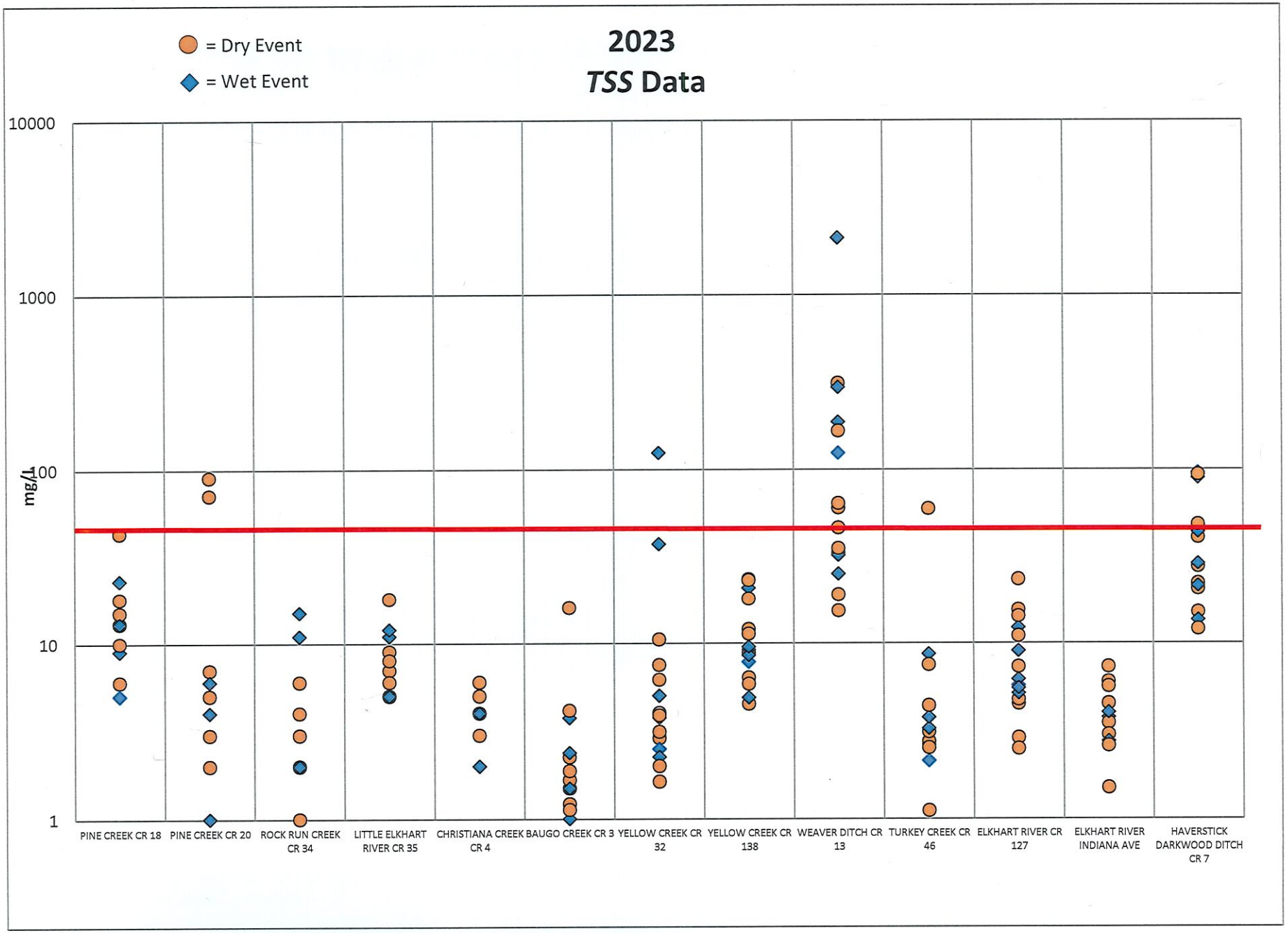
HAVERSTICK DARKWOOD DITCH CR 7

DATE	TIME	TEMP	DO	SPC	PH	CHLORIDES	NITRATES	PHOSPHORUS	TSS	E. COLI	WET
5/25/2023	9:40	11.2	3.2	1033	7.73	585.90	3.310	2.62	40.5	17329	N
6/8/2023	9:45	14.6	1.4	1169	7.70	478.20	0.956	4.13	22.0	9208	N
6/15/2023	9:30	14.8	1.3	1226	7.26	611.87	1.310	2.64	15.0	4884	N
6/22/2023	9:25	18.3	1.6	1198	7.75	406.90	0.798	4.91	95.0	3654	N
6/29/2023	9:53	17.9	2.5	1493	7.61	698.30	0.678	2.73	89.0	1467	N
7/13/2023	9:20	19.0	3.6	1061	7.58	334.20	1.550	2.90	13.5	11199	Y
7/20/2023	9:35	19.5	4.6	1585	7.42	630.31	0.554	5.69	20.5	2014	N
7/27/2023	9:26	20.3	1.0	1052	7.28	569.25	0.806	1.20	27.5	4352	Y
8/3/2023	9:20	18.8	0.1	986	7.26	822.29	0.713	5.79	47.0	8664	N
8/10/2023	9:30	19.0	2.0	889	7.43	626.93	0.766	3.62	12.0	2480	Y
8/17/2023	9:30	18.0	0.4	1674	7.32	852.93	0.648	5.42	28.5	6488	N
8/24/2023	9:30	21.3	0.2	1453	6.96	425.15	0.680	5.62	43.4	12997	N
8/31/2023	10:50	15.6	1.4	2230	7.50	1119.00	0.585	5.82	21.3	17329	N
9/7/2023	10:25	19.7	1.0	2231	7.79	1016.59	0.521	5.38	48.0	12987	N
9/14/2023	9:40	13.8	0.7	1922	7.77	1360.24	0.558	4.87	93.0	3654	N

APPENDIX

2


2023 E. coli Data
= Dry Event
= Wet Event
Colony Forming units / 100 mL
10000000
1000000
100000
10000
1000
100
10
1
PINE CREEK CR 18
PINE CREEK CR 20
ROCK RUN CREEK CR 34
LITTLE ELKHART RIVER CR 35
HEATON LAKE IDEAL BEACH
HEATON LAKE 22880 LAKE SHORE DR.
SIMONTON LAKE 51093 BEACH DR.
SIMONTON LAKE 51330 SR 19
CHRISTIANA CREEK CR 4
BAUGO CREEK CR 3
YELLOW CREEK CR 32
YELLOW CREEK CR 138
WEAVER DITCH CR 13
TURKEY CREEK CR 46
ELKHART RIVER CR 127
ELKHART RIVER INDIANA AVE (GOSHEN)
HAVERSTICK DARKWOOD DITCH CR 7


= Dry Event
= Wet Event
2023
TSS Data
10000
1000
100
10
1
mg/L
PINE CREEK CR 18
PINE CREEK CR 20
ROCK RUN CREEK CR 34
LITTLE ELKHART RIVER CR 35
CHRISTIANA CREEK CR 4
BAUGO CREEK CR 3
YELLOW CREEK CR 32
YELLOW CREEK CR 138
WEAVER DITCH CR 13
TURKEY CREEK CR 46
ELKHART RIVER CR 127
ELKHART RIVER INDIANA AVE
HAVERSTICK DARKWOOD DITCH CR 7

APPENDIX 3

Water Quality Targets

Parameter	Target	Source
Dissolved Oxygen	> 6 mg/L and not > 9 mg/L	327 IAC 2-1-6/US EPA recommendation
Temperature	40-85 degrees F (4.4 – 29.4 C)	MI – R.323.1075
Escherichia coli	< 235 CFU/100 ml per single sample and < 125 CFU/100 ml per the geometric mean of 5 equally spaced samples over a 30 day period	327 IAC 2-1.5-8
Turbidity	< 10.4 NTU	US EPA recommendation (2000)
Total Dissolved Solids	< 750 mg/L	MI – R.323.1051 / 327 IAC 2-1-6
Total Suspended Solids	< 25 mg/L	US EPA recommendation
Total Phosphorus	< 0.3 mg/L	IDEM 303d listing criteria
Nitrate	< 1.5 mg/L	US EPA reference level (2000)
Nitrate-Nitrite	< 1.5 mg/L	Dodds et al. (1998)
TKN	<0.076 mg/L	Dodds et al. (1998)
Biological Oxygen Demand	< 50%	Hoosier Riverwatch Protocol
pH	> 6 or < 9	327 IAC 2-1-6
macroinvertebrate Index of Biotic Integrity (mIBI)	>23 points / >36 points	Hoosier Riverwatch Protocol / IDEM (2008)
Qualitative Habitat Evaluation Index (QHEI)	> 51 pts	IDEM (2008)
Index of Biotic Integrity (IBI) (fish)	≥ 36 points	IDEM (2006)