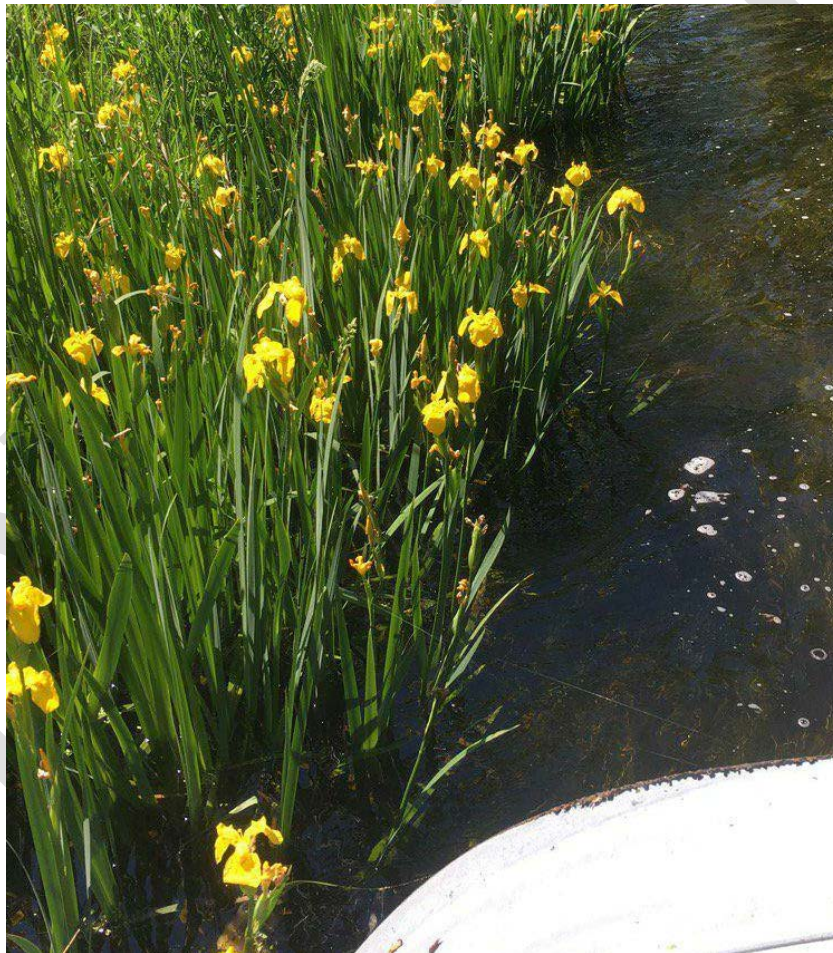




*Aquatic Enhancement
& Survey, Inc.*

**Draft 2018 Water Quality Sampling Report
Steuben County Lakes Council
Steuben County, Indiana**

November 27, 2018



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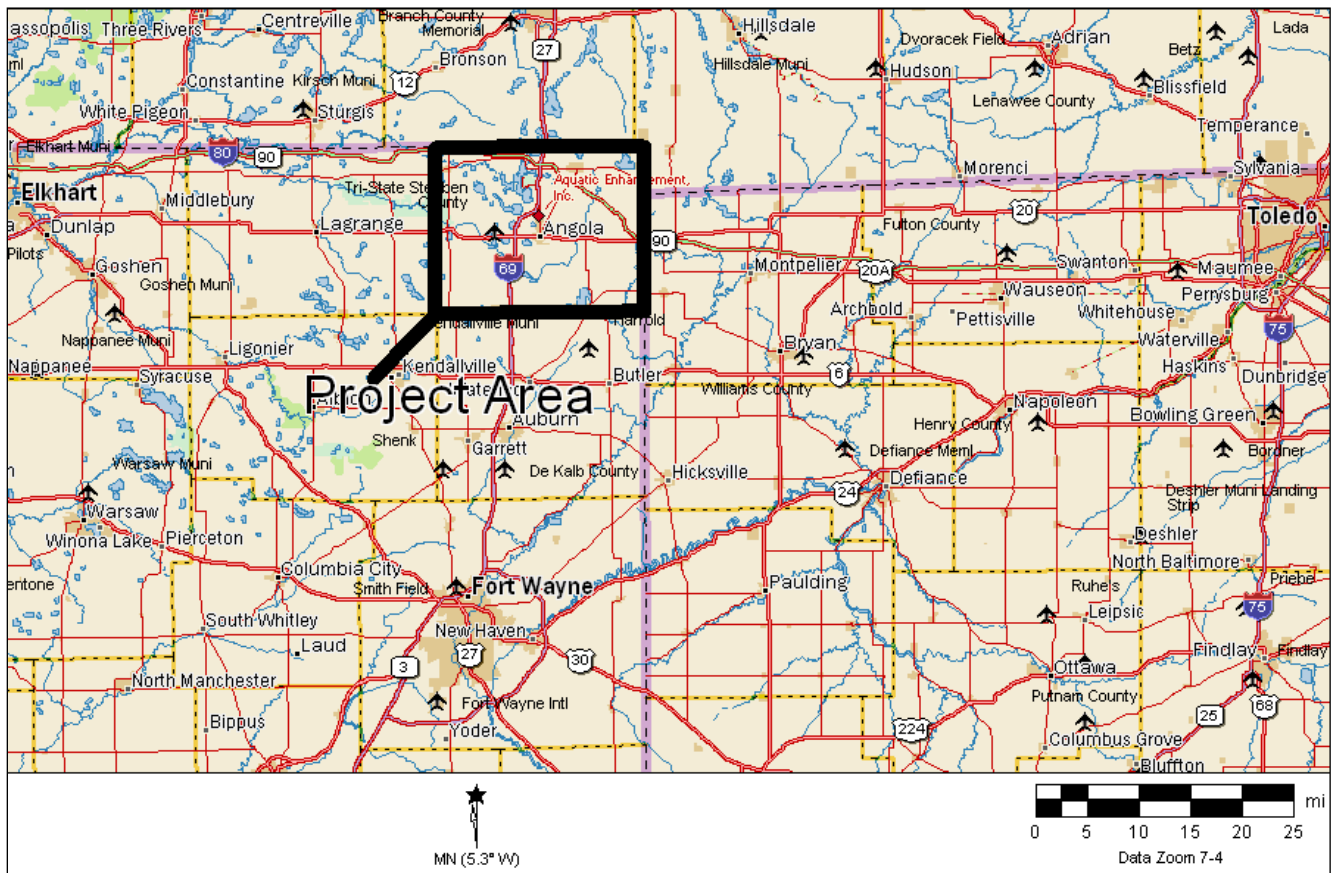


Figure 1 Project location map

1. Project Overview and Purpose:

This project was completed by Aquatic Enhancement & Survey, Inc. under contract with the Steuben County Lakes Council (SCLC) and Angola/Trine MS4. Also partnered with the SCLC in support of this work was the Steuben County Surveyor's Office, and the Clear Lake Township Land Conservancy. Basic water quality data and stream flow (discharge) measurements were collected from a total of 61 sites on several streams and lakes in Steuben County, Indiana, LaGrange County, Indiana, and Branch County, Michigan. The sampling reported in this work was completed in May, July, and August of 2018. Figure 2 (page 6) displays sampling locations and associated surface water features. For most sites, measured parameters included total phosphorus, total suspended solids, pH, dissolved oxygen, temperature, specific conductance, and E-coli. A basic measurement of stream flow-rate (discharge) at each sampling site was taken when conditions permitted.

Total phosphorus and total suspended solids loading figures were calculated for certain sites at which these measurements were detectable and at which a flow measurement was taken. The purpose of the sampling was to gain a basic understanding of the fate and source of contaminants in these systems with a goal of directing future sampling or directing remediation of watershed point and non-point pollution sources. Table 1 provides a site key showing brief written descriptions of each numbered sampling site. Collected data and calculated loading rates are provided in tables 1-6.

2. Methods:

All samples collected were grab samples. Samples were placed on ice immediately after collection. All samples held overnight were refrigerated. Measurements for temperature, dissolved oxygen, and specific conductance were taken in the field using a meter. Measurements of pH were taken in the field using a meter or measured in the laboratory. Meters were calibrated at the beginning of each sampling day. Where possible, stream flows were calculated using measurements of the stream cross-sectional area and stream velocity. Stream flow cross-sectional area was calculated by measuring stream width using a tape measure and calculating average stream depth by measuring depth at multiple equidistant points using a measuring staff or tape measure. Quality Assurance Procedures and EPA method codes for laboratory analysis are available upon request.

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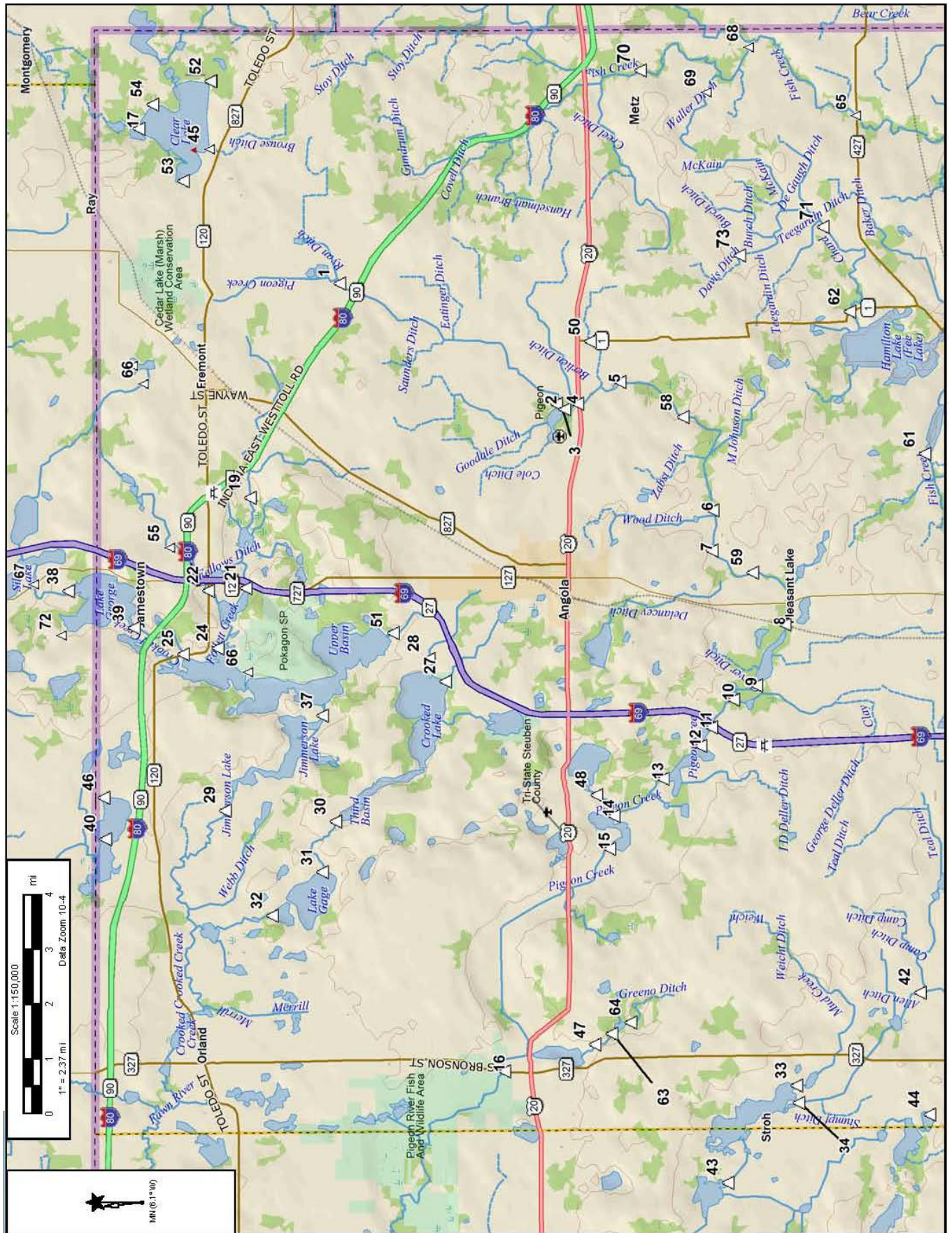


Figure 2 Sampling site map

Samp. Site	SCLC funded	At or near HUC 12 Outlet (10)	At or near HUC14 Outlet Site (13)	Steuben Surveyor Funding (6)	MS4 Funding (4 sites)	Clear Lake funding (2)	Ham. Funding (2)	George Funding (2)	Snow Funding (1)	Location Description
1.	yes		yes							Pigeon, East Ray Clark Road at culvert, below juncture with the Ryan Ditch.
2.	yes									Pigeon Creek, Pigeon Lake Inlet.
3.	yes									Pigeon Creek, Pigeon Lake Outlet.
4.	yes	yes	yes							Pigeon, U.S. 20 Bridge, Below juncture with Berlien Ditch.
5.	yes									Pigeon Creek, Metz Road.
6.		yes	yes		yes					Pigeon Creek, Bill Deller Road.
7.					yes					Pigeon Creek, Meridian Road.
8.	yes									Pigeon Creek, Long Lake Inlet.
9.	yes									Pigeon Creek, Long Lake Outlet.
10.	yes	yes	yes							Pigeon Creek, Mud Lake Outlet just west of Long Lake, Johnson Ditch from Ashley.
11.	yes									Pigeon Creek, Big Bower Lake Inlet.
12.	yes									Pigeon Creek, Big Bower Lake Outlet/Golden Lake Inlet.
13.	yes									Pigeon Creek, Golden Lake Outlet.
14.	yes									Pigeon Creek, Hogback Lake Inlet.
15.	yes	yes	yes							Pigeon Creek, Hogback Lake Outlet.
16.	yes	yes*	yes*							Pigeon Creek at 327.
17.	yes		yes							Clear Lake Outlet.
19.	yes									Crane Marsh Outlet, (tributary to Marsh Lake).
21.	yes									Follet Creek, Little Otter Lake Inlet.
22.	yes									Walter's Lakes Drain (tributary to Big Otter Lake).
24.	yes									Follet Creek, Snow Lake Inlet.
25.	yes									Crooked Creek at 120 (Tributary to Snow Lake).
27.	yes									Carpenter Ditch (Tributary to Crooked Lake).
28.	yes									Palfreyman Ditch (Tributary to Crooked Lake).
29.	yes	yes*	yes*							Crooked Creek (Jimmerson outlet at Nevada Mills).
30.	yes									Concorde Creek (Outlet from Crooked Lake).
31.	yes									Concorde Creek (Inlet to Lake Gage).
32.	yes	yes*	yes*							Concorde Creek (Outlet from Lime Lake).
33.	yes									Dewitt Ditch (Tributary to Big Turkey Lake).
34.	yes									Turkey Creek (Tributary to Big Turkey Lake).
37.	yes									Crooked Creek (James Outlet, Jimmerson Inlet at 4 corners).
38.	yes									Lake George NE tributary (from Silver Lake).
39.	yes		yes							Crooked Creek (Lake George Outlet).
40.	yes									Lake Pleasant.
42.	yes	yes	yes							Turkey Ck at 700S east of 800W, below Little Turkey and Deetz Ditch juncture.
43.	yes	yes*	yes*							Big Turkey Outlet at 350S on curve north of Stroh or west of Turkey Lake Tavern.
44.	yes									Trib. To McClish Lake (east end).
45.	yes									Trib. To Clear Lake (Cyrus Brouse Ditch).
46.	yes									Trib. To Lake Pleasant (East End).
47.	yes									Trib. To West Otter (Between Arrowhead and Otter).
48.	yes									Trib. Between Silver and Hogback.
50.	yes									William Jack Ditch (at State Rd. 1).
51.	yes									Croxton Ditch (at West 275 North).
52.				yes						Clear Lake Trib. (Harry Teeters Ditch).
53.						yes				Clear Lake Trib. (Peter Smith Ditch).
54.						yes				Clear Lake Trib. (Alvin Patterson Ditch).
58.					yes					Pigeon Creek at Hanselman.
59.					yes					Pigeon Creek at 400 South.
61.				yes						Tributary to Ball Lake.
62.				yes						Black Creek, Tributary to Hamilton Lake.
63.	yes									Tributary just downstream of Arrowhead Lake.
64.				yes						Tributary to Arrowhead Lake at south end of Arrowhead Lake
65.	yes									Fish Creek at 427
66.								yes		Pokagon Effluent Outlet
67.								yes		Silver Lake Outlet at S. Angola Rd.
68.										Fish Creek at E 400 S
69.										Fish Creek at S 850 E (5/19/17 upstream of S 850 E)
70.										Fish Creek at E Metz Rd.
71.							yes			Black Creek at S 600 E
72.								yes		Tributary to Lake George at 150 W (Flint Rd. in MI) N. of launch
73.							yes			Davis Ditch, Trib. To Black Creek at S 550 E

Table 1 Descriptions of numbered sampling sites

Site	Date	E-coli	CFM Discharge	Total Phos. (ppm)	Total Phos. Loading (kg/day)	TSS (ppm)	TSS Loading (kg/day)	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *
		(CFU or colonies/100 ml)										
1	5/29/18	1710.0	751.90	0.107	3.28	19.0	582.60	8.39	7.47	19.4	706.0	*
2	5/29/18	350.0	1284.15	0.061	3.19	18.0	942.64	9.33	7.76	21.3	682.0	*
3	5/29/18	31.0	2698.43	0.067	7.37	7.9	869.35	13.19	8.28	25.0	591.0	*
4	5/29/18	132.0	2316.61	0.091	8.60	11.0	1039.21	9.94	7.96	25.0	625.0	*
5	5/29/18	231.0	1937.84	0.079	6.24	7.9	624.31	8.85	7.84	25.0	627.0	*
6	5/29/18	199.0	4385.90	0.111	19.85	20.0	3577.21	7.23	7.77	24.6	635.0	*
7	5/29/18	144.0	3759.29	0.134	20.54	26.0	3985.98	7.29	7.77	24.6	696.0	*
8	5/29/18	345.0	4596.18	0.120	22.49	20.0	3748.72	7.66	7.83	24.3	695.0	*
9	5/29/18	<10.0	nd	0.055	nd	2.9	nd	10.62	8.30	28.2	642.0	*
10	5/29/18	74.0	nd	0.069	nd	7.0	nd	9.63	7.96	26.7	735.0	*
11	5/29/18	41.0	nd	0.077	nd	7.1	nd	7.84	7.91	26.3	681.0	*
12	5/29/18	52.0	6290.70	0.067	17.19	3.3	846.58	9.89	8.18	26.7	665.0	*
13	5/29/18	20.0	nd	0.056	nd	1.6	nd	13.92	8.54	29.0	600.0	*
14	5/29/18	41.0	8243.02	0.068	22.86	8.2	2756.49	9.59	8.13	24.4	633.0	*
15	5/30/18	10.0	8854.35	0.062	22.39	3.0	1083.26	10.65	8.32	25.9	591.0	
16	5/30/18	75.0	8435.75	0.050	17.20	4.8	1651.28	7.88	7.98	24.5	589.0	
17	5/15/18	<10.0	1458.58	0.030	1.78	3.4	202.24	10.46	8.49	17.8	334.6	*
19	5/31/18	243.0	486.91	0.050	0.99	13.0	258.14	8.20	8.17	23.1	812.0	
21	5/30/18	52.0	2530.16	0.034	3.51	<1.0	nd	8.92	8.20	27.1	647.0	
22	5/30/18	262.0	116.19	0.143	0.68	2.4	11.37	6.27	7.69	26.1	671.0	
24	5/31/18	121.0	nd	0.026	nd	<1.0	nd	9.18	8.21	26.2	588.0	*
25	5/30/18	75.0	1566.03	0.022	1.41	<1.0	nd	6.64	7.90	27.2	440.0	
27	5/30/18	86.0	254.29	0.060	0.62	4.3	44.59	8.09	8.28	24.7	566.0	
28	5/30/18	231.0	62.49	0.106	0.27	12.0	30.58	8.78	8.13	28.7	732.0	
29	5/31/18	193.0	6140.54	0.019	4.76	1.4	350.58	7.30	8.01	26.4	531.0	*
30	5/31/18	62.0	1298.20	0.031	1.64	<1.0	nd	6.38	7.85	25.3	477.5	*

Table 2 May data for sites 1 through 30. The notation “nd” denotes that no data was collected or calculated due to a result below lab detection limits or the constraints of field conditions. Data shaded exceeds certain water quality standards selected from those provided by IDEM (see corresponding shaded standards in table 8). An asterisk (*) in the post rain event column indicated sample collection occurred within 48 hours of .5 inches of rainfall or more.

Site	Date	E-coli	CFM Discharge	Total Phos.	Total Phos. Loading	TSS	TSS Loading	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *
		(CFU or colonies/100 ml)		(ppm)	(kg/day)	(ppm)	(kg/day)					
31	5/31/18	223.0	1029.80	0.045	1.89	4.4	184.78	6.72	7.82	24.8	483.0	*
32	5/31/18	52.0	962.00	0.016	0.63	4.2	164.77	7.22	8.21	26.2	471.0	*
33	5/31/18	86.0	1128.30	0.035	1.61	<1.0	nd	7.99	8.09	22.6	637.0	*
34	5/31/18	185.5	2899.85	0.067	7.92	1.1	130.08	5.29	7.86	22.3	650.0	*
37	5/31/18	63.0	nd	0.014	nd	1.4	nd	8.70	8.36	25.8	542.0	*
38	5/30/18	86.0	1010.26	0.033	1.36	2.5	103.00	6.15	7.69	27.8	426.0	
39	5/30/18	52.0	1520.24	0.016	0.99	<1.0	nd	7.89	8.33	27.5	420.0	
40	5/30/18	<10	lake site	0.013	nd	<1.0	nd	8.46	8.32	27.7	425.3	
42	5/31/18	17329.0	1537.15	0.264	16.55	9.8	614.32	5.37	7.67	21.2	637.0	*
43	5/31/18	187.0	4009.14	0.041	6.70	4.0	653.98	6.71	7.91	24.7	551.0	*
44	5/31/18	836.0	65.60	0.049	0.13	3.6	9.63	6.33	7.46	14.3	729.0	*
45	5/15/18	15531.0	1371.65	0.371	20.75	86.0	4810.58	7.49	7.27	16.1	301.2	
46	5/30/18	41.0	83.21	0.062	0.21	6.8	23.07	6.55	7.26	21.5	604.0	
47	5/31/18	256.0	262.75	0.081	0.87	1.9	20.36	5.36	7.93	23.8	556.0	*
48	5/31/18	121.0	418.86	0.028	0.48	<1.0	nd	6.39	7.98	25.2	469.0	*
50	5/15/18	2046.0	927.60	0.494	18.69	53.0	2004.90	6.61	7.16	15.6	346.3	*
51	5/30/18	591.0	88.54	0.020	0.07	2.6	9.39	9.78	8.06	23.5	913.0	
52	5/15/18	2755.0	741.63	0.201	6.08	90.0	2721.98	6.13	7.41	17.1	305.0	*
53	5/15/18	1723.0	138.09	0.399	2.25	84.0	473.04	6.20	8.79	16.8	216.2	*
54	5/15/18	2481.0	nd	0.179	nd	3.2	nd	3.71	7.06	17.2	223.0	*
58	5/29/18	269.0	2829.13	0.092	10.61	8.2	946.07	8.19	7.85	24.4	630.0	*
59	5/29/18	249.0	5025.66	0.119	24.39	20.0	4099.01	7.76	7.81	23.7	686.0	*
61	5/15/18	5172.0	2453.82	0.612	61.24	97.0	9706.67	9.01	7.52	17.6	226.6	*
62	5/15/18	19863.0	6289.18	0.805	206.46	210.0	nd	9.19	7.43	16.9	264.2	*
63	5/31/18	85.0	nd	0.065	nd	<1.0	nd	5.31	7.85	23.8	557.0	*
64	5/31/18	1162.0	511.84	0.120	2.50	8.5	177.42	5.80	7.77	20.2	582.0	*
65	5/15/18	48392.0	nd	0.540	nd	64.0	nd	7.54	7.54	16.9	339.5	*
66	5/31/18	<10.0	1.44	0.236	0.01	2.2	0.13	8.86	7.73	20.6	4206.0	*
67	5/30/18	249.0	922.69	0.021	0.79	<1.0	nd	7.55	8.13	28.1	422.0	
68	5/15/18	3654.0	nd	0.300	nd	31.0	nd	7.90	7.54	17.2	350.9	*
69	5/15/18	39726.0	nd	0.374	nd	17.0	nd	7.56	7.59	16.8	359.5	*
70	5/15/18	12033.0	nd	0.615	nd	120.0	nd	7.82	7.48	16.2	316.4	*
71	5/15/18	10462.0	nd	0.573	nd	71.0	nd	7.44	7.35	17.2	232.0	*
72	5/30/18	63.0	25.50	0.076	0.08	8.4	8.74	7.43	7.29	22.2	550.0	
73	5/31/18	2014.0	56.26	0.204	0.47	25.0	57.36	6.41	7.68	24.6	397.0	*

Table 3 May data for sites 31 through 73. The notation “nd” denotes that no data was collected or calculated due to a result below lab detection limits or the constraints of field conditions. Data shaded exceeds certain water quality standards selected from those provided by IDEM (see corresponding shaded standards in table 8). An asterisk (*) in the post rain event column indicated sample collection occurred within 48 hours of .5 inches of rainfall or more.

Site	Date	E-coli	CFM Discharge	Total Phos.	Total Phos. Loading	TSS	TSS Loading	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *
		(CFU or colonies/100 ml)										
1	7/30/18	648.8	275.77	0.037	0.42	2.0	22.49	6.38	7.12	16.0	799	
2	7/30/18	727.0	325.63	0.028	0.37	3.2	42.49	7.48	7.88	17.3	792	
3	7/30/18	9.8	692.40	0.034	0.96	2.4	67.77	8.59	8.29	22.6	673	
4	7/30/18	131.7	706.41	0.050	1.44	9.0	259.27	6.26	7.98	21.4	718	
5	7/30/18	52.0	693.93	0.070	1.98	6.4	181.11	5.66	7.87	21.4	733	
6	7/30/18	727.0	1054.76	0.040	1.72	2.0	86.03	7.05	8.08	20.3	724	
7	7/30/18	686.7	1604.16	0.065	4.25	12.0	785.03	7.18	8.01	20.2	896	
8	7/30/18	307.6	1393.52	0.045	2.56	3.6	204.58	7.60	8.02	19.9	850	
9	7/30/18	20.3	1536.69	0.030	1.88	4.2	263.20	10.25	8.49	23.1	771	
10	7/30/18	29.5	2413.92	0.046	4.53	7.8	767.84	9.14	8.23	23.0	860	
11	7/30/18	73.7	nd	0.071	nd	9.2	nd	7.38	8.19	22.9	797	
12	7/30/18	12.1	2494.29	0.047	4.78	3.8	386.53	8.30	8.14	23.6	791	
13	7/30/18	1.0	nd	0.104	nd	16.0	nd	17.85	8.69	25.0	655	
14	7/30/18	26.2	2680.53	0.053	5.79	4.6	502.85	10.35	8.33	24.2	663	
15	7/30/18	<1.0	2796.08	0.078	8.89	8.7	992.03	14.86	8.79	25.2	577	
16	7/30/18	137.4	3734.98	0.042	6.40	<2.0	nd	8.15	8.01	21.4	627	
17	7/25/18	17.1	nd	0.013	nd	<2.0	nd	7.47	8.15	23.9	245	
19	7/26/18	517.2	532.31	0.040	0.87	5.2	112.88	7.33	7.95	18.9	829	
21	7/26/18	41.4	1269.49	0.018	0.93	<2.0	nd	5.07	7.97	22.6	725	
22	7/26/18	325.5	55.74	0.089	0.20	<2.0	nd	2.95	7.60	19.3	770	
24	7/26/18	52.1	nd	0.020	nd	<2.0	nd	6.15	8.08	24.0	631	
25	7/26/18	40.8	758.61	0.015	0.46	<2.0	nd	5.10	7.80	24.1	409	
27	7/26/18	980.4	24.37	0.038	0.04	<2.0	nd	7.75	8.21	21.4	665	
28	7/26/18	1119.9	138.21	0.042	0.24	<2.0	nd	9.18	8.16	23.5	729	
29	7/26/18	117.8	2720.03	0.017	1.89	<2.0	nd	7.37	8.12	26.6	510	
30	7/26/18	35.9	323.14	0.019	0.25	<2.0	nd	6.74	7.81	26.1	440	

Table 4 July data for sites 1 through 30. The notation “nd” denotes that no data was collected or calculated due to a result below lab detection limits or the constraints of field conditions. Data shaded exceeds certain water quality standards selected from those provided by IDEM (see corresponding shaded standards in table 8). An asterisk (*) in the post rain event column indicated sample collection occurred within 48 hours of .5 inches of rainfall or more.

Site	Date	E-coli	CFM Discharge	Total Phos.	Total Phos. Loading	TSS	TSS Loading	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *
		(CFU or colonies/100 ml)		(ppm)	(kg/day)	(ppm)	(kg/day)					
31	7/26/18	325.5	330.82	0.031	0.42	5.0	67.46	7.05	8.01	24.3	476	
32	7/26/18	10.9	357.19	0.015	0.22	4.2	61.18	7.12	8.34	26.3	463	
33	7/27/18	135.4	nd	0.025	nd	2.6	nd	8.49	8.08	23.3	599	
34	7/27/18	307.6	1457.75	0.092	5.47	<2.0	nd	4.50	7.66	20.7	578	
37	7/26/18	28.5	nd	0.009	nd	<2.0	nd	8.39	8.36	25.8	529	
38	7/26/18	1119.9	396.94	0.025	0.40	0.0	0.40	4.42	7.59	24.3	395	
39	7/26/18	6.3	783.75	0.017	0.54	<2.0	nd	7.55	8.36	24.8	353	
40	7/27/18	1.0	lake site	0.009	nd	2.2	nd	7.54	7.93	24.5	415	
42	7/27/18	517.2	283.48	0.081	0.94	2.6	30.06	7.18	7.90	20.7	638	
43	7/27/18	78.0	809.36	0.036	1.19	<2.0	nd	7.27	8.17	24.9	518	
44	7/27/18	547.5	30.37	0.023	0.03	2.8	3.47	6.57	7.61	16.0	757	
45	7/25/18	1670.0	70.24	0.197	0.56	70.0	200.51	7.16	7.81	17.4	741	
46	7/26/18	344.8	24.80	0.022	0.02	3.0	3.03	7.29	7.65	19.2	636	
47	7/27/18	980.4	21.27	0.121	0.10	2.6	2.26	6.78	8.02	21.2	488	
48	7/27/18	98.7	145.21	0.021	0.12	<2.0	nd	6.55	8.06	25.6	451	
50	7/25/18	497.8	nd	0.175	nd	13.0	nd	6.07	7.88	23.2	745	
51	7/26/18	387.3	103.75	0.043	0.18	<2.0	nd	8.35	8.05	21.0	891	
52	7/25/18	3106.2	20.89	0.353	0.30	10.0	8.52	4.59	7.63	19.9	647	
53	7/25/18	<2.0	8.43	0.020	0.01	<2.0	nd	5.45	7.12	15.3	616	
54	7/25/18	105.8	nd	0.082	nd	<2.0	nd	2.60	7.39	19.6	435	
58	7/30/18	290.9	795.41	0.041	1.33	3.8	123.26	7.42	8.06	20.8	732	
59	7/30/18	307.6	1488.52	0.066	4.01	6.0	364.22	7.03	7.99	22.0	7.03	
61	7/25/18	870.4	82.12	0.090	0.30	2.8	9.38	7.79	8.10	21.0	667	
62	7/25/18	548.0	833.55	0.119	4.05	2.0	67.99	7.39	8.14	20.9	638	
63	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	
64	7/27/18	461.1	47.79	0.089	0.17	<2.0	nd	6.37	7.92	20.3	637	
65	7/25/18	1820.0	1146.04	0.115	5.37	8.8	411.28	6.89	8.17	21.4	677	
66	7/26/18	1.0	1.72	0.458	0.03	<2.0	nd	7.78	7.77	21.1	4627	
67	7/26/18	119.8	372.41	0.016	0.24	8.2	124.53	5.86	7.88	25.0	385	
68	7/25/18	774.6	nd	0.077	nd	5.2	nd	7.87	8.15	23.3	680	
69	7/25/18	1024.0	1264.38	0.094	4.85	4.2	216.56	7.24	8.20	21.1	699	
70	7/25/18	830.0	550.51	0.073	1.64	3.4	76.33	7.11	7.84	21.1	719	
71	7/25/18	2613.0	34.81	0.158	0.22	6.6	9.37	7.58	7.91	24.2	624	
72	7/26/18	488.4	1.29	0.070	0.00	2.4	0.13	4.16	7.35	20.9	663	
73	7/25/18	2827.2	0.63	0.250	0.01	70.0	1.80	5.68	7.81	21.3	647	

Table 5 July data for sites 31 through 73. The notation “nd” denotes that no data was collected or calculated due to a result below lab detection limits or the constraints of field conditions. Data shaded exceeds certain water quality standards selected from those provided by IDEM (see corresponding shaded standards in table 8). An asterisk (*) in the post rain event column indicated sample collection occurred within 48 hours of .5 inches of rainfall or more.

Site	Date	E-coli (CFU or colonies/100 ml)	CFM Discharge	Total Phos. (ppm)	Total Phos. Loading (kg/day)	TSS (ppm)	TSS Loading (kg/day)	D.O.	pH	Temp (C)	Specific Conductance	Rain event
1	8/29/18	410.6	485.42	0.071	1.41	11.0	217.75	5.73	7.68	20.2	727	
2	8/29/18	727.0	595.69	0.061	1.48	9.2	223.49	7.50	7.94	21.6	762	
3	8/29/18	28.5	1226.82	0.037	1.85	6.4	320.20	11.04	8.50	24.8	640	
4	8/29/18	84.2	1021.55	0.058	2.42	12.0	499.92	5.83	8.06	24.8	673	
5	8/29/18	71.2	969.20	0.074	2.92	7.6	300.39	6.85	8.07	24.3	683	
6	8/29/18	613.1	2112.83	0.077	6.63	15.0	1292.44	6.02	7.98	23.4	699	
7	8/29/18	686.7	2371.02	0.103	9.96	19.0	1837.15	6.29	7.95	23.1	844	
8	8/29/18	866.4	2013.72	0.074	6.08	8.2	673.39	6.57	7.97	22.9	823	
9	8/29/18	6.3	2745.25	0.055	6.16	9.8	1097.14	11.38	8.49	24.9	695	
10	8/29/18	27.5	nd	0.047	nd	7.4	nd	10.05	8.37	25.4	750	
11	8/30/18	63.8	nd	0.047	nd	6.3	nd	7.73	8.12	22.4	735	
12	8/30/18	98.5	3908.40	0.062	9.88	7.6	1211.35	9.56	8.26	23.6	696	
13	8/30/18	2.0	nd	0.052	nd	8.8	nd	9.56	8.30	23.4	679	
14	8/30/18	13.1	4672.10	0.063	12.00	8.0	1524.26	6.28	8.03	22.1	679	
15	8/30/18	66.3	4780.44	0.053	10.33	8.7	1696.07	7.70	8.26	23.7	648	
16	8/30/18	62.0	4718.54	0.031	5.97	3.1	596.52	5.85	7.78	20.7	658	
17	8/20/18	37.5	578.01	0.026	0.61	<2.0	nd	7.39	8.40	23.1	341	
19	8/24/18	129.5	854.51	0.091	3.17	5.1	177.72	7.42	8.32	16.7	853	
21	8/21/18	45.0	2614.99	0.013	1.39	1.1	117.31	7.20	8.07	24.8	720	*
22	8/21/18	188.3	513.40	0.060	1.26	1.7	35.59	4.35	7.49	22.0	797	*
24	8/21/18	77.0	nd	0.007	nd	<1.0	nd	8.65	8.26	25.7	656	*
25	8/21/18	311.0	1448.06	0.022	1.30	<1.0	nd	4.20	7.49	24.9	365	*
27	8/20/18	404.5	38.05	0.060	0.09	4.0	6.21	7.47	8.09	21.0	547	
28	8/20/18	120.5	115.82	0.058	0.27	2.4	11.34	6.18	7.74	24.2	457	
29	8/21/18	24.3	3394.45	0.013	1.80	1.0	138.43	6.93	7.96	25.5	516	*
30	8/21/18	49.3	269.66	0.017	0.19	1.9	20.89	5.66	7.51	24.3	429	*

Table 6 August data for sites 1 through 30. The notation “nd” denotes that no data was collected or calculated due to a result below lab detection limits or the constraints of field conditions. Data shaded exceeds certain water quality standards selected from those provided by IDEM (see corresponding shaded standards in table 8). An asterisk (*) in the post rain event column indicated sample collection occurred within 48 hours of .5 inches of rainfall or more.

Site	Date	E-coli	CFM Discharge	Total Phos. (ppm)	Total Phos. Loading (kg/day)	TSS (ppm)	TSS Loading (kg/day)	D.O.	pH	Temp (C)	Specific Conductance	Rain event
		(CFU or colonies/100 ml)										
31	8/21/18	311.0	309.19	0.036	0.45	8.4	105.92	7.11	7.84	22.7	471	*
32	8/21/18	52.7	1154.42	<0.007	nd	2.6	122.40	7.17	8.26	24.9	450	*
33	8/21/18	57.7	319.50	0.043	0.56	6.9	89.90	9.98	8.28	23.2	561	*
34	8/21/18	294.7	2343.74	0.116	11.09	2.4	229.39	3.15	7.54	21.8	579	*
37	8/21/18	20.7	nd	<0.007	nd	1.1	nd	7.77	8.33	25.8	525	*
38	8/24/18	308.5	436.15	0.031	0.55	2.2	39.13	4.85	7.45	20.1	372	
39	8/24/18	10.0	1131.79	0.022	1.02	<2.0	nd	7.88	8.22	22.0	358	
40	8/30/18	2.0	lake site	0.088	nd	2.3	nd	7.78	8.56	24.4	413	
42	8/21/18	8704.0	936.00	0.145	5.53	5.0	190.85	4.85	7.45	21.2	606	*
43	8/21/18	66.3	2153.25	0.310	27.22	7.7	676.15	5.99	7.96	24.2	448	*
44	8/21/18	271.0	31.45	0.025	0.03	2.6	3.33	5.64	7.40	16.3	774	*
45	8/20/18	1724.0	15.66	0.144	0.09	26.0	16.60	7.03	7.82	18.1	740	
46	8/24/18	247.5	52.58	0.050	0.11	<2.0	nd	5.55	7.32	15.1	621	
47	8/21/18	432.0	78.94	0.073	0.24	3.0	9.66	5.69	7.90	22.7	509	*
48	8/24/18	15.5	140.82	0.027	0.16	<2.0	nd	5.86	7.81	23.9	444	
50	8/20/18	572.5	28.74	0.101	0.12	4.4	5.16	6.32	7.64	19.7	702	
51	8/21/18	471.3	286.84	0.018	0.21	1.3	15.21	7.80	7.90	22.4	620	*
52	8/20/18	7068.0	42.91	0.418	0.73	30.0	52.50	5.09	7.63	19.7	588	
53	8/20/18	15.0	3.07	0.020	0.00	<2.0	nd	5.59	7.24	14.5	630	
54	8/20/18	220.5	nd	0.102	nd	2.2	nd	2.56	7.30	18.8	438	
58	8/24/18	288.0	1452.99	0.057	3.38	7.0	414.78	7.57	7.98	21.5	647	
59	8/24/18	568.5	3143.47	0.114	14.61	20.0	2563.86	7.56	7.88	19.4	752	
61	8/20/18	466.5	77.37	0.064	0.20	2.0	6.31	7.96	8.08	20.8	665	
62	8/20/18	538.0	85.30	0.147	0.51	2.8	9.74	7.56	8.15	21.0	577	
63	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	
64	8/21/18	273.3	125.48	0.121	0.62	3.2	16.37	5.39	7.74	20.6	619	*
65	8/20/18	1936.5	1329.75	0.157	8.51	14.0	759.20	7.03	8.07	21.4	591	
66	8/24/18	5.0	0.74	0.184	0.01	<2.0	nd	7.78	7.60	19.4	588	
67	8/24/18	150.5	525.97	0.025	0.54	2.1	45.04	6.85	7.91	20.6	376	
68	8/20/18	892.5	nd	0.119	nd	12.0	nd	7.42	8.01	22.3	612	
69	8/20/18	891.0	2043.80	0.141	11.75	8.1	675.12	7.35	8.06	22.4	603	
70	8/20/18	959.0	1382.14	0.098	5.52	6.4	360.73	7.09	7.75	20.7	639	
71	8/20/18	2737.5	70.85	0.209	0.60	10.0	28.89	7.65	8.00	21.8	615	
72	8/24/18	147.0	4.76	0.042	0.01	3.5	0.68	3.26	7.13	18.4	617	
73	8/20/18	2270.5	11.19	0.164	0.07	5.2	2.37	5.71	7.76	20.5	522	

Table 7 August data for sites 31 through 73. The notation “nd” denotes that no data was collected or calculated due to a result below lab detection limits or the constraints of field conditions. Data shaded exceeds certain water quality standards selected from those provided by IDEM (see corresponding shaded standards in table 8). An asterisk (*) in the post rain event column indicated sample collection occurred within 48 hours of .5 inches of rainfall or more.

Parameter	Target	Reference/other information
Temperature	Dependent on time of year and whether stream is designated as a cold water fishery	Indiana Administrative Code (IAC)
Dissolved Oxygen (DO)	Min: 4.0 mg/L Max: 12.0 mg/L	Indiana Administrative Code (IAC)
	Min: 6.0 mg/L in cold water fishery streams	Indiana Administrative Code (IAC)
	Min: 7.0 mg/L in spawning areas of cold water fishery streams	Indiana Administrative Code (IAC)
E. coli	Max: 235 CFU/ 100mL in a single sample,	Indiana Administrative Code (IAC)
	Max: <u>Geometric Mean</u> of 125 CFU/ 100mL from 5 equally spaced samples over a 30-day period	
Total Phosphorus	Max: 0.076 mg/L	U.S. EPA recommendation
	0.07 mg/L	Dividing line between mesotrophic and eutrophic streams (Dodd et al. 1998)
	Max: 0.08 mg/L	Ohio EPA recommendation to protect aquatic biotic integrity in WWH
	Max: 0.3 mg/L	IDEM draft TMDL target
Total Suspended Solids (TSS)	Max: 80.0 mg/L	Wawasee Area Conservancy Foundation recommendation to protect aquatic life in lake systems
	Max: 30.0 mg/L	IDEM draft TMDL target
	Range: 25.0-80.0 mg/L	Concentrations within this range reduce fish concentrations (Waters, 1995)
	Max: 40.0 mg/L	New Jersey criteria for warm water streams
	Max: 46.0 mg/L	Minnesota TMDL criteria for protection of fish/macroinvertebrate health
Turbidity	Max: 10.4 NTU	U.S. EPA recommendation

Table 8 Indiana Department of Environmental Quality Table of Water Quality Targets. Standards shaded on results tables correspond to standards shaded in this table.

3. Results: May Sampling

May sampling occurred at all 61 sites. May sampling results are listed in tables 2 and 3. Samples collected represented rainfall-runoff conditions at 45 of the 61 sites sampled in May. Table 8 contains a variety of stream water quality targets provided by the Indiana Department of Environmental Management (IDEM) for comparison with the 2018 season data. Also provided for comparison is table 9 containing averages of stream data from the IDEM probabilistic data set. The data used to calculate these averages was collected from Indiana Streams within the St. Joseph River watershed from year 2000 to 2005. Most of the collection sites included in the 2018 data are also within the St. Joseph River watershed and therefore represent somewhat similar soil types, topography, and land uses. This allows some amount of judgment to be made as to whether the 2018 samples were “below average”, “average” or “above average” in terms of Northern Indiana stream water quality. In May several sites did not conform to the standards listed in table 8. Twenty-six sites exceeded the E-coli standard of 235 and 28 sites exceeded the total phosphorus standard of .076.

Parameter	IDEM Mean Stream Data St. Joseph Wtrshd 2000-2005
pH	n/d
D.O. (ppm)	7.14
Temp. (deg C)	19.91
Specific conductance umho/cm	764.19
Total Suspended Solids (ppm)	36
Total Phosphorus (ppm)	0.382
E-coli (CFU/100ml)/(MPN)	1895.58

Table 9 Average of IDEM-collected probabilistic Indiana stream data for the St Joseph River Watershed 2000-2005

4. Results: July Sampling

July sampling occurred at 60 sites. One site was not sampled due to a lack of legal access. July sampling results are listed in tables 4 and 5. All samples collected represented baseline flow conditions. E-coli standards were exceeded at 32 of the 60 sites sampled. Total phosphorus standards were exceeded at 18 sites.

5. Results: August Sampling

August sampling occurred at 60 sites. One site was not sampled due to a lack of legal access. Sampling results are listed in tables 6 and 7. Samples collected represented baseline flow conditions at 43 sites and rain-event sampling at 17 sites. E-coli standards were exceeded at 29 of the 60 sites sampled. Total phosphorus standards were exceeded at 21 sites.

6. Conclusions

A number of notable observations were made during the 2018 season sampling. The standard typically used for maximum E-coli 235 CFU. Ideally waters are not to exceed this count. A

notable number of sites returned E-coli measurements of over 10,000 CFU in May of 2018. Five of these were from various Fish Creek and Black Creek sites in the Fish Creek watershed in southeastern Steuben County. The highest measurement recorded was 48,392 in a sample from Fish Creek at 427. Members of the SCLC water quality committee have been taking steps toward ongoing watershed improvements in this region, working with landowners and regulators.

E-coli measurements above the 235 CFU standard on Pigeon Creek were somewhat less common in 2018 than in 2017. Of 54 samplings 19 E-coli measurements (35%) were above 235. In 2017 a total of 30 of 54 sampling events (56%) returned results above 235.

Out of 33 sampling events on the upper Pigeon (sites 1-11 above Big Bower Lake) 13 exceeded the E-coli standard (39%) compared to 22 (67%) in 2017. This included a rain-event sampling in May. Looking back in 2016, 30% were above 235, 48% in 2015, 34% in 2014 and 41% in 2013. These numbers vary according to rainfall conditions, but the average for the last six years is 43% of sites being over the standard. This places 2018 a bit under the average. The highest E-coli count recorded on the upper Pigeon reach was 1710 recorded in a sample from site 1, East Ray Clark Road on May 29. In 2017 the highest measurement was 2909 recorded in a sample from site 2, the inlet to Pigeon Lake. Looking back, the highest count in 2016 was 862 from site 7 (Meridian Rd.), in 2015 it was 4950 from site 11 (Big Bower Lake inlet) in 2014 it was 1435 from site 7 (Meridian Road) and in 2013 the highest was 9300 colonies at site 1 (Ray Clark Rd.).

With regard to total phosphorus on the upper Pigeon, 9 samplings (27%) exceeded a standard of .076 ppm. Looking back, 14 samplings (42%) exceeded the standard in 2017, only 1 sampling (3%) exceeded it in 2016, and 3 samplings (9%) in 2015. The higher phosphorus levels are to be expected with the rain event flow rates of 2018 and 2017, while the 2016 and 2015 sampling represented baseline flow conditions. In 2014 sampling, which included rain events, 13 of 44 upper Pigeon samplings (30%) exceeded the standard. This was similar to the 2013 season when 27 of 88 sites (31%) exceeded that standard.

In 2018 sites 1, 2, and 8, on the Pigeon Creek exceeded the E-coli standard on all three samplings. In 2017 sites 1, 2, 6, 7, 58, and 59 on the Pigeon Creek exceeded the E-coli standard on all three samplings. In 2016 no sites exceeded the standard all three times.

The tributary to Ball Lake was above the standard for E-coli during all three samplings as it was in 2017 and 2016, although levels were not near the count of 19,862.9 recorded in August of 2015. Supplemental sampling efforts by the Ball Lake residents to track potential pollution sources in that watershed are ongoing.

Over several years the SCLC has built an extensive body of local water quality data. There are many ways to examine the statistical content of the data and glean information to assist in meeting the needs of local lake residents, government agencies, and land users. The SCLC is encouraged to continue to convey the water quality information through its website, meetings, and other outlets, fostering cooperative community water-quality improvement efforts and encouraging new input and ideas to direct future sampling.