



Aquatic Enhancement
& Survey, Inc.

**2011 Water Quality Sampling Report
Steuben County Lakes Council
Steuben County, Indiana**

November 28, 2011



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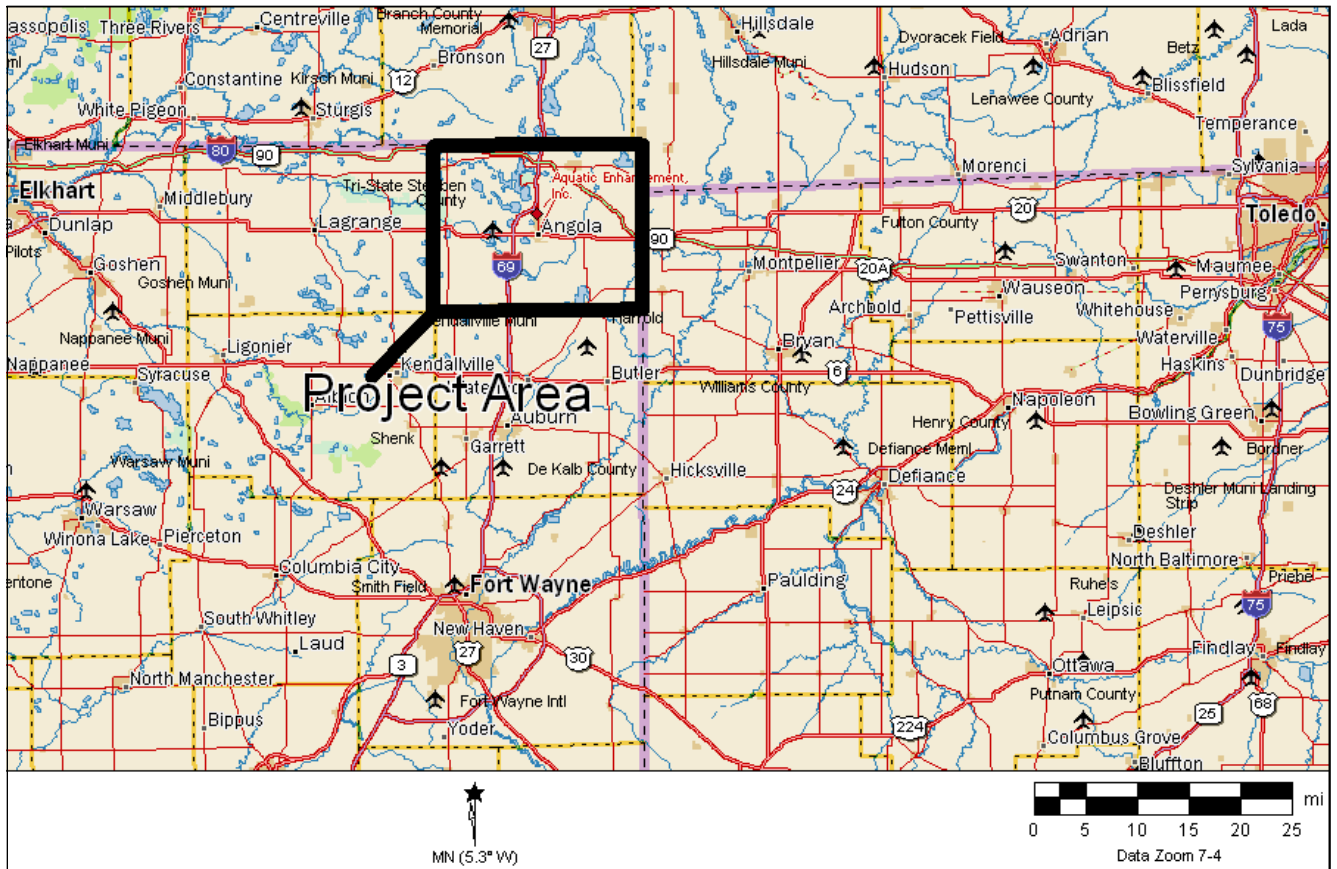


Figure 1 Project location map

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 Soil and Water Conservation District (SWCD) (working with the assistance of EPA 319 grant funding administered through the Indiana Department of Environmental Management), and the Steuben County Surveyor's Office. Basic water quality data and stream flow (discharge) measurements were collected from several streams and lakes in Steuben County, Indiana. One sampling site was located in LaGrange County Indiana and one was located in Branch County Michigan (See figure 1 above for general project area location). Sampling was completed in May, July, and August of 2011. Figure 2 (page 6) displays sampling locations and associated surface water features. Measured parameters included total phosphorus, total suspended solids, pH, dissolved oxygen, temperature, specific conductance, E-coli, and a basic measurement of stream flow-rate (discharge) at each sampling site having measurable flow. Total phosphorus and total suspended solids loading figures were calculated for each site 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 and directing remediation of watershed point and non-point pollution sources. Table one on page 8 provides a site key showing brief written descriptions of each numbered sampling site. Collected data and calculated loading rates are provided in tables 2-4 on pages 9 through 14.

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 and dissolved oxygen were taken in the field using a YSI 85 dissolved oxygen, temperature, conductivity, and salinity meter. Measurements of pH were taken in the field using an Oakton pH 6 Acorn series meter. Both 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 marked section of rope, tape measure, or laser rangefinder and calculating average stream depth by measuring depth at multiple equidistant points using a measuring staff, or tape measure. Laboratory analysis for all samples was completed by A & L Great Lakes Laboratories, Inc., 3505 Conestoga Dr., Fort Wayne, Indiana 46808. Quality Assurance Procedures and EPA method codes are available upon request.

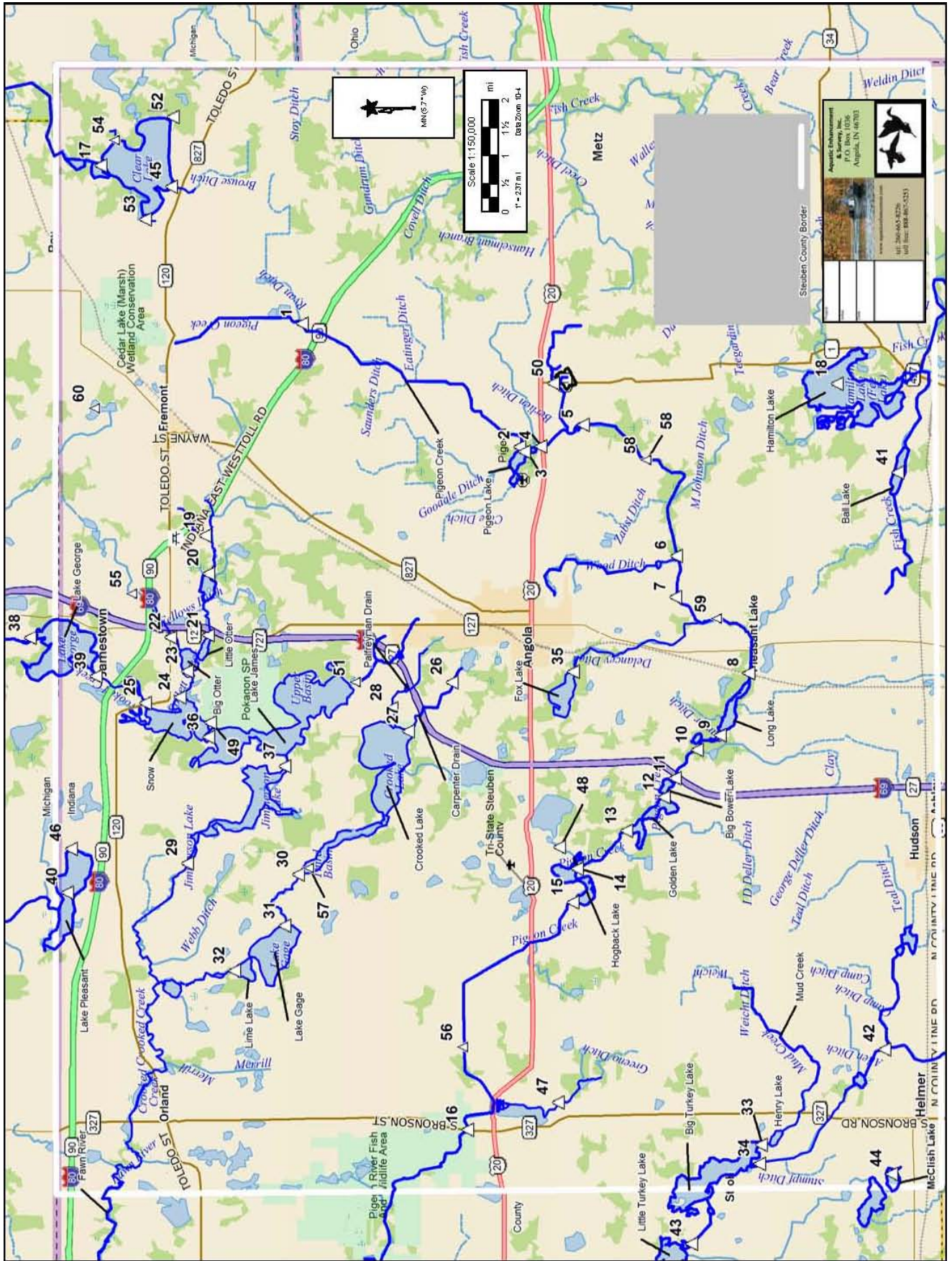


Figure 2 Sampling site map.

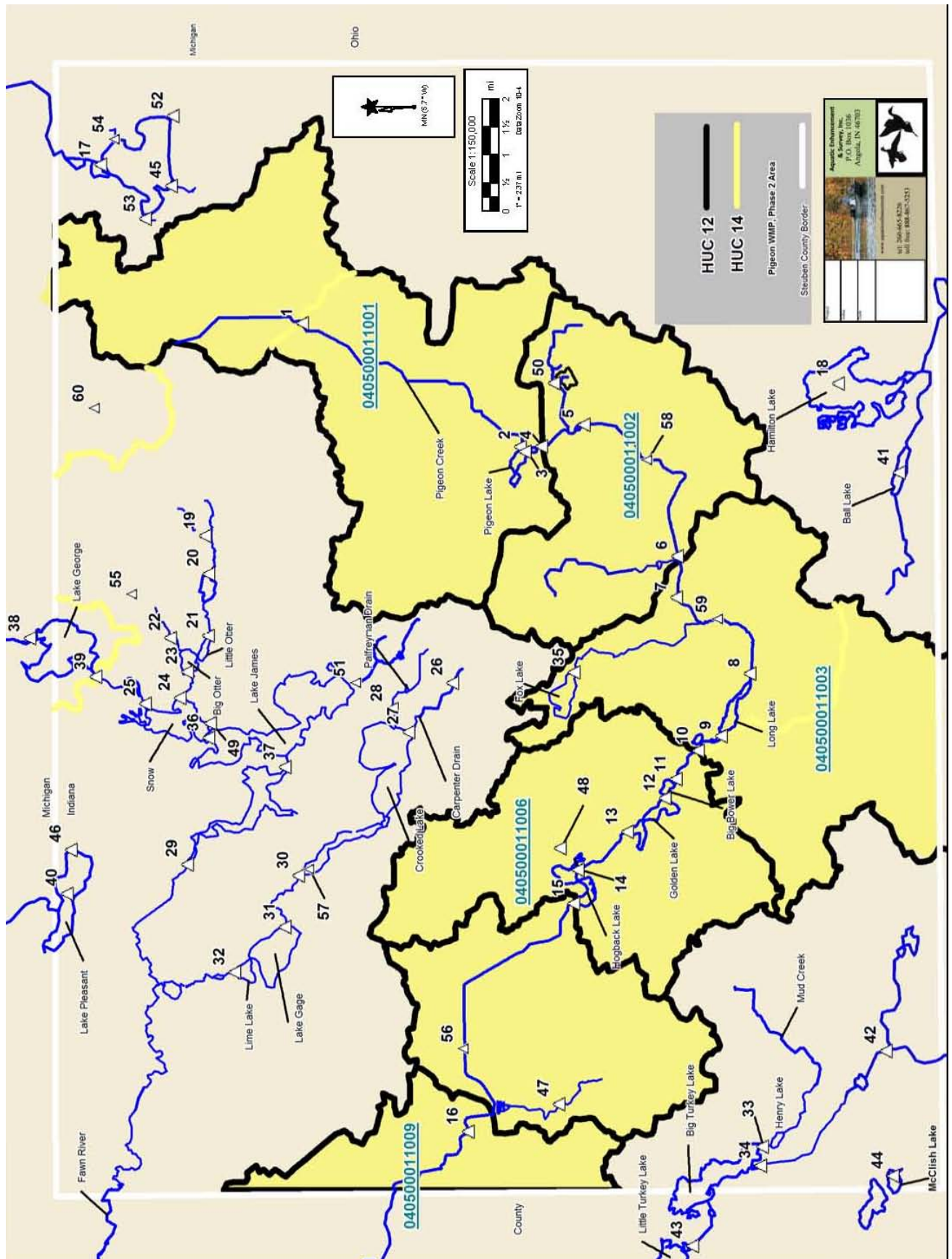


Figure 3. Sampling site map showing Pigeon HUC 12 and 14 subwatershed units.

Sampling Site	At or near HUC 12 Outlet (11)	At or near HUC14 Outlet Site (14)	Steuben County Surveyor Funding (13)	MS4 Funding (7 sites)	Pigeon 319 funded site (14)	Included in 319 QAPP	Location Description
1.		yes			yes	yes	Pigeon, East Ray Clark Road at culvert, below juncture with the Ryan Ditch
2.					yes	yes	Pigeon Creek, Pigeon Lake Inlet
3.					yes	yes	Pigeon Creek, Pigeon Lake Outlet
4.	yes	yes			yes	yes	Pigeon, U.S. 20 Bridge, Below juncture with Berlien Ditch
5.					yes	yes	Pigeon Creek, Metz Road
6.	yes	yes		yes		yes	Pigeon Creek, Bill Deller Road
7.				yes		yes	Pigeon Creek, Meridian Road
8.					yes	yes	Pigeon Creek, Long Lake Inlet
9.					yes	yes	Pigeon Creek, Long Lake Outlet
10.	yes	yes			yes	yes	Pigeon Creek, Mud Lake Outlet just west of Long Lake, Johnson Ditch from Ashley
11.					yes	yes	Pigeon Creek, Big Bower Lake Inlet
12.					yes	yes	Pigeon Creek, Big Bower Lake Outlet/Golden Lake Inlet
13.					yes	yes	Pigeon Creek, Golden Lake Outlet
14.					yes	yes	Pigeon Creek, Hogback Lake Inlet
15.	yes	yes			yes	yes	Pigeon Creek, Hogback Lake Outlet
16.	yes*	yes*			yes	yes	Pigeon Creek at 327
17.		yes					Clear Lake Outlet
18.	yes*	yes*	yes				Hamilton Lake
19.							Crane Marsh Outlet, (tributary to Marsh Lake)
20.			yes				Deller Ditch (Tributary to Marsh Lake)
21.							Follet Creek, Little Otter Lake Inlet
22.			yes				Walter's Lakes Drain (tributary to Big Otter Lake)
23.							Follet Creek, Big Otter Lake Outlet
24.							Follet Creek, Snow Lake Inlet
25.			yes				Crooked Creek at 120 (Tributary to Snow Lake)
26.				yes			Carpenter Ditch (outlet from Center Lake)
27.				yes			Carpenter Ditch (Tributary to Crooked Lake)
28.				yes			Palfreyman Ditch (Tributary to Crooked Lake)
29.	yes*	yes*					Crooked Creek (Jimmerson outlet at Nevada Mills)
30.							Concorde Creek (Outlet from Crooked Lake)
31.							Concorde Creek (Inlet to Lake Gage)
32.	yes*	yes*					Concorde Creek (Outlet from Lime Lake)
33.			yes				Dewitt Ditch (Tributary to Big Turkey Lake)
34.							Turkey Creek (Tributary to Big Turkey Lake)
35.							Discontinued for 2011 Fox Lake Outlet
36.	yes	yes					Crooked Creek (Snow Lake outlet, Inlet to James)
37.							Crooked Creek (James Outlet, Jimmerson Inlet at 4 corners)
38.							Lake George NE tributary (from Silver Lake)
39.		yes					Crooked Creek (Lake George Outlet)
40.							Lake Pleasant
41.			yes				Ball Lake
42.	yes	yes					Turkey Ck at 700S east of 800W, below Little Turkey and Deetz Ditch juncture
43.	yes*	yes*					Big Turkey Outlet at 350S on curve north of Stroh or west of Turkey Lake Tavern
44.							Trib. To McClish Lake (east end)
45.							Trib. To Clear Lake (Cyrus Brouse Ditch)
46.							Trib. To Lake Pleasant (East End)
47.							Trib. To West Otter (Between Arrowhead and Otter)
48.							Trib. Between Silver and Hogback
49.							Trib. To Snow Lake (Pokagon State Park)
50.							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)
55.			yes				Walter's Lake Drain at 660 North
56.			yes				Steuben Regional Waste District Effluent (Trib. to Pigeon)
57.			yes				Crooked Lake Third Basin
58.				yes			Pigeon Creek at Hanselman
59.				yes			Pigeon Creek at 400 South
60.							Fish Lake (Fremont)

Table 1 Description of numbered sampling sites.

May Site	Sampling Date	E-coli (CFU or colonies/100 ml)	Total Phos. (ppm)	Total Suspended Solids (ppm)	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *	CFM discharge estimate	T.S.S. Loading estimate Kg/day	Phos. Loading estimate Kg/day
1.	5/26/11	27,500	.60	158	6.26	7.12	14.5	410.7	*	flooded	flooded	flooded
2.	5/26/11	18,100	.60	195	6.64	7.14	15.2	384.0	*	9933.30	78936.36	242.88
3.	5/26/11	12,000	.20	74	7.70	7.45	15.3	478.5	*	flooded	flooded	flooded
4.	5/26/11	6,700	.18	53	6.73	7.29	15.5	478.6	*	flooded	flooded	flooded
5.	5/26/11	10,600	.40	88	7.22	7.43	16.2	464.8	*	flooded	flooded	flooded
6.	5/26/11	7,300	.19	39	5.39	7.46	17.1	467.1	*	flooded	flooded	flooded
7.	5/26/11	10,400	.40	64	6.38	7.52	16.8	462.6	*	flooded	flooded	flooded
8.	5/26/11	10,900	.40	80	7.13	7.39	17.1	459.1	*	flooded	flooded	flooded
9.	5/26/11	6,700	.09	9	6.31	7.59	18.7	544	*	flooded	flooded	flooded
10.	5/26/11	9,000	.50	80	6.93	7.54	17.2	593	*	flooded	flooded	flooded
11.	5/26/11	6,200	.18	47	6.69	7.66	17.6	572	*	flooded	flooded	flooded
12.	5/26/11	1,800	.10	13	6.84	7.76	18.8	603	*	flooded	flooded	flooded
13.	5/26/11	80	.05	<1	7.45	7.87	19.9	551	*	flooded	flooded	flooded
14.	5/27/11	260	.07	6	6.17	7.75	16.2	549	*	flooded	flooded	flooded
15.	5/27/11	84	.05	6	6.53	7.77	16.9	533	*	flooded	flooded	flooded
16.	5/31/11	110	.06	7	9.75	7.88	21.1	528	*	flooded	flooded	flooded
17.	5/25/11	1	<.01	<1	8.82	8.34	18.7	345.3	*	1673.99	BDL	BDL
18.	5/24/11	22	.05	9	10.4	8.73	20	358.9		lake site	lake site	lake site
19.	5/25/11	12.2	.07	4	8.36	7.77	16.7	1334	*	94.5	15.40	.27
20.	5/24/11	128	.04	9	8.35	7.83	20.4	749		848.72	311.28	.48
21.	5/25/11	42.2	.02	<1	5.37	7.65	19.5	651		1097.52	BDL	.89
22.	5/23/11	164	.07	3	6.41	7.56	21.9	505		203.96	24.94	.58
23.	5/25/11	14.6	.01	3	7.86	8.14	21.4	626		NFM	NFM	NFM
24.	5/25/11	61.3	.01	<1	6.22	7.97	21.2	628		NFM	NFM	NFM
25.	5/23/11	30	.01	9	7.05	7.79	20.6	34.6		1495.6	548.54	0.61
26.	5/25/11	60.9	.09	15	7.31	8	21	429.6		177.01	108.20	.65
27.	5/23/11	144	.10	12	7.95	7.74	22	466.6		328.99	160.88	1.34
28.	5/25/11	58.3	.04	3	7.41	7.87	19.1	631		115.37	14.10	.19
29.	5/23/11	32	.01	<1	7.65	7.91	22.4	519		4856.6	BDL	1.98
30.	5/23/11	210	.02	2	7.01	7.77	22.9	454.1		781.21	63.67	0.64
31.	5/23/11	238	.08	3	7.50	7.71	22.2	421.1		1224.88	149.75	3.99
32.	5/23/11	22	<.01	3	8.22	8.11	22.3	443.5		1445.65	176.74	BDL
33.	5/31/11	186	.07	7	11.49	7.83	21.6	522	*	flooded	flooded	flooded
34.	5/31/11	137.4	.10	12	9.28	7.66	23.8	539		2372.36	1160.14	9.67
35.	Discontinued Site.											
36.	5/25/11	5.2	.01	6	8.39	8.4	21.8	557		NFM	NFM	NFM
37.	5/25/11	9.6	.01	<1	8.12	8.35	20	526	*	5320.14	BDL	2.17
38.	5/23/11	204	<.01	<1	5.69	7.46	20	444.5		618.55	BDL	BDL
39.	5/23/11	100	<.01	<1	8.46	8	18.9	410.2		1552.36	BDL	BDL
40.	5/24/11	6	.01	7	8.36	8.12	21.2	464.3	*	lake site	lake site	lake site
41.	5/24/11	20	.06	<1	8.23	7.87	20.4	436.3	*	lake site	lake site	lake site
42.	5/31/11	165.8	.13	15	9.18	7.66	24	540	*	6654.96	4068.04	35.26
43.	5/31/11	78	.03	4	11.15	8.28	22.7	556	*	flooded	flooded	flooded
44.	5/31/11	26.5	.10	2	5.88	7.44	19.8	526	*	47.6	3.88	0.19
45.	5/25/11	>2419.6	.18	64	8.16	7.67	14.7	514	*	176.99	461.61	1.30

May Sample Site	Sampling Date	E-coli (CFU or colonies/100 ml)	Total Phos. (ppm)	Total Suspended Solids (ppm)	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *	CFM discharge estimate	T.S.S. Loading Kg/day	Phos. Loading Kg/day
46.	5/24/11	168	.02	<1	8.83	7.32	18.5	611		39.74	BDL	0.03
47.	5/31/11	160.7	.07	10	7.15	7.81	21	427.4	*	730.21	297.58	2.08
48.	5/25/11	1203.3	.03	<1	7.23	7.92	19.4	441	*	815.46	BDL	1.00
49.	5/24/11	2	1.20	2	8.78	7.8	17.7	2172		1.34	0.11	0.07
50.	5/26/11	11100	.40	71	6.35	7.02	15.3	358	*	398.06	1151.74	6.49
51.	5/25/11	172	.01	1	8.82	7.88	16.6	802	*	119.13	4.85	0.05
52.	5/25/11	579.4	.40	19	5.90	7.45	16.7	450.1	*	568.62	440.28	136.72
53.	5/25/11	22.8	.04	1	7.71	7.17	13.1	624	*	flooded	flooded	flooded
54.	5/25/11	461.1	.06	3	5.17	7.12	16.1	330.4	*	1782	217.86	4.36
55.	5/23/11	320	.07	3	6.41	7.56	21.9	505		203.96	24.94	0.58
56.	5/31/11	29.5	.19	2	11.34	8.14	20.7	2810		53.29	4.34	0.41
57.	5/31/11	8.6	.02	2	7.70	8.13	22	425.7		lake site	lake site	lake site
58.	5/26/11	14100	.40	84	6.83	7.39	16.8	451.3	*	flooded	flooded	flooded
59.	5/26/11	9600	.40	72	6.10	7.5	17.2	449.1	*	flooded	flooded	flooded

Table 2 Summary table of May sampling results. NFM denotes no flow measurement taken. BDL = below detection limit. Data shaded exceeds water quality standards selected from those provided by IDEM. (see corresponding shaded standards on table 8 page 15)

July Site	Sampling Date	E-coli (CFU or colonies/100 ml)	Total Phos. (ppm)	Total Suspended Solids (ppm)	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *	CFM discharge estimate	T.S.S. Loading estimate Kg/day	Phos. Loading estimate Kg/day
1.	7/26/11	720	.02	7	8.77	8.15	20.1	794		156.43	44.62	.13
2.	7/27/11	800	.02	12	7.25	7.97	18.1	753		368.55	180.23	.3
3.	7/27/11	74	.01	12	7.65	8.09	26	664		612.36	299.46	.25
4.	7/27/11	128	.03	17	6.59	7.86	23.7	702		360.86	250	.44
5.	7/27/11	76	.03	17	6.10	7.69	24.1	727		552.48	382.75	.68
6.	7/27/11	840	.06	19	5.92	7.93	21.2	728		1442.87	1117.2	3.53
7.	7/27/11	360	.08	24	5.64	7.91	21.30	829.0		1879.20	1837.95	6.13
8.	7/27/11	880	.07	13	6.56	7.87	22.1	794.0		1112.75	589.51	3.17
9.	7/27/11	46	.02	9	7.85	8.13	27.20	731.00		1493.60	547.81	1.22
10.	7/28/11	46	.03	8	6.52	8.77	26	787		3105.91	1012.58	3.8
11.	7/28/11	62	.04	14	6.13	8.75	26.5	746		NFM	NFM	NFM
12.	7/28/11	32	.04	11	6.08	8.84	27	748		2200.13	986.26	3.59
13.	7/28/11	10	.05	12	9.99	8.66	28.2	669		NFM	NFM	NFM
14.	7/28/11	32	.04	15	6.75	8.74	27.6	678		1913.33	1169.58	3.12
15.	7/28/11	32	.04	15	8.30	8.69	28.6	620		2529.66	1546.33	4.12
16.	7/28/11	360	.03	10	6.12	8.08	25.6	648		2804.58	1142.92	3.43
17.	7/18/11	14	.02	2	6.12	7.88	28.40	366.8		NFM	NFM	NFM
18.	7/19/11	30	.03	4	7.29	8.4	29.4	368.2		lake site	lake site	lake site
19.	7/22/11	8	.17	8	6.20	7.14	25.8	1708		55.08	17.96	.38
20.	7/22/11	1080	.04	11	6.50	7.47	24	889		239.75	107.47	.39
21.	7/22/11	108	.02	5	3.88	7.22	27.3	728		268.08	54.62	0.22
22.	7/22/11	1780	.02	7	7.09	7.36	18.2	766		1.37	0.39	0
23.	7/26/11	46	.01	2	7.64	8.02	28.3	555		NFM	NFM	NFM
24.	7/27/11	2	.02	5	6.07	7.52	27.8	631		NFM	NFM	NFM
25.	7/22/11	354	.02	<1	3.97	7.04	23.6	597		40.99	BDL	0.03
26.	7/19/11	2080	.04	4	5.25	7.39	25.2	614		7.66	1.25	0.01
27.	7/19/11	2040	.05	2	7.80	8.37	25	698		15.42	1.26	0.03
28.	7/19/11	1180	.04	8	7.03	7.41	27.9	784		0.2	0.07	0
29.	7/26/11	14	.02	6	5.69	7.94	28.7	562		899.91	220.04	0.73
30.	7/19/11	3300	.03	8	4.45	7.16	29.1	521		76.98	25.1	0.09
31.	7/19/11	580	.04	15	6.56	7.94	27	548		143.74	87.87	0.23
32.	7/19/11	460	.05	9	6.21	7.93	29.8	459		120.22	44.09	0.25
33.	7/21/11	600	.02	5	5.82	7.65	28	670		NFM	NFM	NFM
34.	7/21/11	1400	.07	5	4.29	7.1	24.7	637		524.01	106.80	1.49
35.	Discontinued Site.											
36.	7/26/10	14	.01	5	8.11	8.20	28.3	516		NFM	NFM	NFM
37.	7/26/11	66	.03	29	6.10	7.87	27.6	545		NFM	NFM	NFM
38.	7/18/11	320	.04	7	2.94	6.83	28.2	464		40.34	11.51	0.07
39.	7/21/11	20	.03	4	5.55	7.55	31.2	340.3		64.26	10.47	0.08
40.	7/19/11	4	.01	5	7.68	8.53	29.1	460.7		lake site	lake site	lake site
41.	7/19/11	0	.02	4	8.92	8.72	28.8	439.9		lake site	lake site	lake site
42.	7/21/11	1256	.05	4	2.94	6.83	28.2	464		372.74	60.75	0.76
43.	7/21/11	780	.02	12	6.55	7.68	29.1	566		876.29	428.53	0.71
44.	7/21/11	1700	.04	18	6.89	7.06	16.6	745		21.3	15.43	0.03
45.	7/18/11	2560	.05	20	7.75	7.29	20.3	891		255.66	208.37	0.52
46.	7/19/11	4	.03	9	7.61	7.64	19.1	659		18.63	6.83	0.02

July Site	Sampling Date	E-coli (CFU or colonies/100 ml)	Total Phos. (ppm)	Total Suspended Solids (ppm)	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *	CFM discharge estimate	T.S.S. Loading Kg/day	Phos. Loading Kg/day
47.	7/21/11	2100	.07	<1	5.83	7.61	27.1	551		18.99	BDL	0.05
48.	7/21/11	360	.02	5	5.67	7.63	30.30	439.3		49.57	10.10	0.10
49.	7/21/11	22	.06	4	7.28	7.08	25.9	2184		3.81	0,62	0.01
50.	7/26/11	820	.13	12	5.38	7.61	22.7	796		4.42	0.02	2.16
51.	7/21/11	1480	.01	1	8.11	7.67	25.7	844		59.33	2.42	0.02
52.	7/18/11	3980	.40	16	4.75	7.27	24.10	628		2.29	1.49	0.04
53.	7/18/11	1280	.09	3	6.95	7.2	16.7	650		0.95	0.12	0
54.	7/18/11	1280	.09	3	2.36	6.9	25.1	415.5		12.79	1.56	0.05
55.	7/22/11	5500	.15	4	6.46	7.53	24.40	455.5		35.87	5.85	0.22
56.	7/21/11	30	.80	3	5.42	7.34	24.3	3181		35.19	4.30	1.15
57.	7/19/11	26	.03	15	6.54	7.97	30.50	517.00		lake site	lake site	lake site
58.	7/27/11	200	.04	14	6.26	7.95	23.4	724		4269.28	2435.74	6.96
59.	7/27/11	440	.08	19	5.46	7.83	22	821		1671.28	1294.05	5.45

Table 3 Summary table of July sampling results.

Aug. Site	Sampling Date	E-coli (CFU or colonies/100 ml)	Total Phos. (ppm)	Total Suspended Solids (ppm)	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *	CFM discharge estimate	T.S.S. Loading estimate Kg/day	Phos. Loading estimate Kg/day
1.	8/23/11	720	.04	29	7.31	7.24	14.9	746		221.32	261.56	.36
2.	8/23/11	13680	.03	19	7.3	7.35	16	748		314.50	243.51	.38
3.	8/23/11	22	.03	15	8.5	7.75	22.8	636		486.24	297.23	.59
4.	8/23/11	170	.04	18	7.24	7.37	21.2	664		446.81	327.75	.73
5.	8/23/11	20	.07	20	4.94	7.12	21.5	692		463.52	377.79	1.32
6.	8/23/11	320	.04	12	7.21	7.46	21	706		472.19	230.91	.77
7.	8/23/11	378	.06	20	7.3	7.51	20.6	881		1149.66	937.02	2.81
8.	8/25/11	1180	.12	34	6.58	7.50	22.5	782		2300.14	3187.00	11.25
9.	8/25/11	1180	.12	34	10.22	8.04	25.6	697		1289.13	1786.18	6.30
10.	8/31/11	50	.04	7	8.85	7.61	22.3	798		1764.45	503.33	2.88
11.	8/30/11	110	.04	14	8.75	7.63	22.4	717		NFM	NFM	NFM
12.	8/30/11	34	.05	10	8.11	7.70	23.6	730		1633.63	665.74	3.33
13.	8/30/11	380	.04	4	9.26	8.02	25	667		NFM	NFM	NFM
14.	8/31/11	32	.04	10	6.03	7.52	23.2	667		2939.28	1197.82	4.79
15.	8/31/11	108	.04	8	6.58	7.84	24	618		1605.50	532.42	2.62
16.	8/31/11	156	.02	10	6.79	7.49	20.5	654		2826.75	1151.96	2.30
17.	8/15/11	4	<.01	11	6.82	8.39	23.6	358.2		NFM	NFM	NFM
18.	8/11/11	18	.02	2	7.41	8.02	26.1	258		lake site	lake site	lake site
19.	8/18/11	12	.15	23	7.18	7.2	24.6	1654		51.84	48.59	.32
20.	8/22/11	320	.04	11	7.67	7.59	17.4	913		252.45	113.17	.41
21.	8/22/11	18	<.01	13	5.46	7.04	20.7	719		328.64	174.11	BDL
22.	8/15/11	520	0.03	9	7.85	7.06	20.8	741		49.7	18.23	0.06
23.	8/19/10	2	0.01	9	7.68	8.26	26.3	617		NFM	NFM	NFM
24.	8/19/10	30	0.01	8	5.03	7.92	25.5	619		NFM	NFM	NFM
25.	8/15/11	340	0.02	9	5.86	7.67	25	477		242.39	88.90	0.20
26.	8/26/11	620	0.04	8	6.89	7.15	19.7	667		NFM	NFM	NFM
27.	8/12/11	2040	0.04	9	8.20	7.8	18.4	716		9.08	3.33	0.01
28.	8/12/11	380	0.03	11	6.32	7.15	20.7	597		8.1	3.63	0.01
29.	8/22/11	28	<.01	12	5.89	7.15	24.2	530		164.11	80.25	BDL
30.	8/12/11	540	0.02	6	4.66	6.85	18.7	521		0.76	0.19	0.00
31.	8/12/11	540	0.6	10	8.76	7.72	17.4	627		31.18	12.71	0.76
32.	8/12/11	80	<.01	9	6.23	7.57	23.6	438.5		50.76	18.62	BDL
33.	8/17/11	18	0.03	6	7.78	8.08	22.7	568		3.22	0.79	0.00
34.	8/17/11	320	0.04	3	4.56	7.83	21.4	613		349.27	42.70	0.57
35.	Discontinued Site.											
36.	8/22/11	60	0.01	14	7.05	7.92	25.1	554		NFM	NFM	NFM
37.	8/22/11	28	<.01	8	7.04	7.90	24.1	537		NFM	NFM	NFM
38.	8/15/11	10	0.03	9	5.07	7.88	22.1	387.7		102.38	37.55	0.13
39.	8/15/11	8	0.02	8	5.99	7.13	24.4	398.7		455.09	148.09	0.37
40.	8/11/11	6	0.01	7	7.6	8.14	26	440.9		lake site	lake site	lake site
41.	8/11/11	18	0.02	2	7.43	8.01	25.9	417		lake site	lake site	lake site
42.	8/17/11	340	0.03	6	7.15	7.10	18.9	644		230.81	56.44	0.28
43.	8/17/11	20	0.01	6	8.59	7.81	26.2	505		379.36	92.76	0.15
44.	8/17/11	520	0.01	6	7.36	7.79	17.4	736		5.88	1.44	0.00
45.	8/15/11	880	0.03	9	7.26	7.99	15.8	895		11.18	4.10	0.01

Aug. Site	Sampling Date	E-coli (CFU or colonies/100 ml)	Total Phos. (ppm)	Total Suspended Solids (ppm)	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *	CFM discharge estimate	T.S.S. Loading Kg/day	Phos. Loading Kg/day
46	8/11/11	500 (8/12/11)	0.02	23	9.06	7.32	21.1	638		27.6	25.87	0.02
47	8/18/11	8700	0.07	6	7.92	7.50	20.8	510		10.69	2.61	0.03
48	8/18/11	152	<.01	8	7.31	7.50	25.9	445.9		55.08	17.96	BDL
49	8/18/11	104	0.05	9	8.11	7.00	22.7	2608		2.69	0.99	0.05
50	8/23/11	500	0.07	6	6.67	7.07	16.1	830		1.34	0.33	0.00
51	8/18/11	920	<.01	7	9.52	7.45	19.4	831		51.41	14.67	BDL
52	8/15/11	1020	0.7	34	4.15	7.67	18	700		2.42	3.35	0.07
53	8/15/11	10	0.03	9	6.01	7.61	15.2	677		2.14	0.78	0.00
54	8/15/11	310	0.14	9	2.08	7.65	18.1	421.1		31.75	11.64	0.18
55	8/15/11	420	0.08	14	6.54	7.2	22.8	458.8		9.68	5.52	0.03
56	8/17/11	12	0.4	7	6.01	7.32	22.8	3240		30.08	8.58	0.49
57	8/12/11	38	0.02	19	7.06	7.86	25.2	499		lake site	lake site	lake site
58	8/23/11	360	0.03	6	6.68	7.51	21	695		369.46	90.34	0.45
59	8/25/11	1380	0.13	35	5.83	7.46	21.7	787		2786.49	3974.43	14.76
60	8/11/11	0	0.03	10	6.57	7.54	25.1	442		lake site	lake site	lake site

Table 4. Summary table of August sampling results, sites 1-46. NFM denotes no flow measurement taken. BDL = below detection limit.

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 coldwater fishery streams	Indiana Administrative Code (IAC)
	Min: 7.0 mg/L in spawning areas of coldwater fishery streams	Indiana Administrative Code (IAC)
E. coli	Max: 235 CFU/ 100mL in a single sample,	Indiana Administrative Code (IAC)
	Max: Geometric Mean 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

Table 5 Indiana Department of Environmental Quality Table of Water Quality Targets. Data exceeding standards shaded in this table is shaded in the preceding 2011 SCLC data tables.

3. Results: May Sampling

Stream and lake sampling was performed at 59 sites between May 23 and May 31. Sampling results are listed in table 2 on pages 9 and 10. Samples collected in May represented mostly high-flow conditions following significant rainfall. Flow measurements could not be taken at most Pigeon Creek sites due to dangerously fast flow rates and high water levels. Table 5, page 15 contains a variety of stream water quality targets provided by the Indiana Department of Environmental Management (IDEM) for comparison with the 2011 season data. Also provided for comparison is table 6 page 17 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 (draining to Lake Michigan HUC 8 04050001) from year 2000 to 2005. Most of the collection sites included in the 2011 SCLC data are also within this same watershed and therefore represent somewhat similar soil types, topography, and land uses. This allows an evaluation to be made as to whether the 2011 SCLC samples were “below average”, “average” or “above average” in terms of Indiana stream water quality.

In May measurements of pH ranged from 7.22 at William Jack Ditch to 8.73 at Hamilton Lake. All were considered to be normal. No pH data is available from the IDEM probabilistic dataset for comparison. Dissolved oxygen levels ranged from 5.17 parts per million (ppm) at Alvin Patterson Ditch (Clear Lake) to 11.49 at Dewitt Ditch (Big Turkey Lake). Levels at all sites were adequate to sustain fish and other gill-breathing aquatic organisms and were above relevant target minimums listed with IDEM. Measured temperatures ranged from 13.1 C at Peter Smith Ditch (Clear Lake) to 23.8 C measured at Turkey Creek (Big Turkey Lake). All measured temperatures were considered to be normal for the prevailing climatic conditions. Specific conductance ranged from 330.4 umho/cm at Alvin Patterson Ditch (Clear Lake), to 2810 umho/cm at the Steuben Lakes Regional Waste District outflow to Pigeon Creek. No targets for specific conductance were listed in the IDEM table. E-coli bacteria measurements ranged from one colony per 100 milliliters (col/100 ml) at the Clear Lake outlet, to over 27,500 occurring at Pigeon Creek at East Ray Clark Road. A total of 20 samples exceeded a target maximum of 235 CFU/100 ml listed in the IDEM standards. The twelve sites in the Upper Pigeon watershed located upstream of Golden Lake returned counts of 1800 or higher following a significant rain even in late May. (see sites 1 through 12 fig. 3 page 7 and table 1 page 8) The highest measurement for total phosphorus in May (1.2 ppm) occurred in a sample collected from the Pokagon treatment plant effluent outlet (Snow Lake). Four sites were below a lab detection limit of .01 ppm. A total of 17 samples exceeded a target maximum of .076 ppm listed in the IDEM standards. All 12 sites in the Upper Pigeon watershed located upstream of Golden Lake were in excess of that number due to the heavy rainfall that preceded sampling. (see sites 1 through 12 fig. 3 page 7 and table 1 page 8) The highest measurement for total suspended solids (TSS) in May (195 ppm) occurred at the inlet of Pigeon Creek to Pigeon Lake. Eleven sites were below a lab detection limit of 1 ppm TSS. A total of 11 samples exceeded a target maximum of 30 ppm listed in the IDEM standards. All 8 sampling sites in the Upper Pigeon watershed located upstream of Long Lake were in excess of that number due to the heavy rainfall that preceded sampling. (see sites 1 through 12 fig. 3 page 7 and table 1 page 8) Where possible a rough estimate of stream flow (discharge) was calculated with total suspended solids and total phosphorus loading figures calculated using May data. Of the sites where flow rates were taken, the highest estimated discharge occurred on Pigeon Creek at the inlet to Pigeon Lake (site 2) with an estimated discharge of 9933.30 cubic feet per minute (CFM). The highest estimated total suspended solids loading also occurred at site 2 (78,936.36 Kilograms per day). The highest estimated total phosphorus loading occurred there as well (242.88 kg/day). Discharge

and loading estimates for other Pigeon River sites could not be performed due to fast water and flooded conditions.

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
Tss Loading Kg/day	n/d
Total Phos. Loading Kg/day	n/d

Table 6 Average of IDEM-collected probabilistic Indiana stream data for the St Joseph River Watershed 2000-2005

4. Results: July Sampling

Stream and lake sampling was performed at 59 sites between July 18 and July 28th. Sampling results are listed in table 3 on pages 11 and 12. Samples collected in July represented baseline flow conditions. July measurements of pH ranged from 7.06 at the tributary to McClish Lake to 8.84 at the Big Bower Lake outlet. All were considered to be normal. Dissolved oxygen levels ranged from 2.36 parts per million (ppm) at Alvin Patterson Ditch (Clear Lake) to 9.99 at the outlet of Golden Lake. Oxygen levels below 4 ppm (normally required to sustain most fish and other gill-breathing aquatic organisms) were recorded at four sites. Temperature measurements ranged from 16.6 C at the tributary to McClish Lake to 30.50 measured in the third basin of Crooked Lake. All measured temperatures were considered to be normal for the prevailing climatic conditions. Specific conductance ranged from 366.8 umho/cm at the Clear Lake outlet, to 3181 umho/cm at the Steuben Lakes Regional Waste District outflow to Pigeon Creek. No targets for specific conductance were listed in the IDEM table. E-coli bacteria measurements ranged from zero colonies per 100 milliliters (col/100 ml) at Ball Lake, to 5500 at Walter's Lakes Drain at 660 North. A total of 30 samples exceeded a target maximum of 235 CFU/100 ml listed in the IDEM standards. The highest measurement for total phosphorus in July (.8 ppm) occurred in the sample collected from the SLRWD treatment plant effluent outlet (Pigeon Creek). No sites were below a lab detection limit of .01 ppm. A total of 9 samples exceeded a target maximum of .076 ppm listed in the IDEM standards. The highest measurement for total suspended solids (TSS) in July (29 ppm) occurred at the outlet of Lake James/Inlet to Jimmerson (four corners). Two sites were below a lab detection limit of 1 ppm TSS. No samples exceeded a target maximum of 30 ppm listed in the IDEM standards. Where possible a measurement of stream flow (discharge) was taken and suspended solids and phosphorus loading figures were calculated. The highest estimated discharge occurred on Pigeon Creek at Hanselman Road (site 58). The discharge was estimated to be 4269.28 cubic

feet per minute (CFM) . The highest estimated total suspended solids loading also occurred at site 58 (2435.74 Kilograms per day) as well as the highest estimated total phosphorus loading (6.96 kg/day).

5. Results: August Sampling

August sampling was performed at 60 sites between 8/11/11 and 8/31/11. Sampling results are listed in table 4 on pages 13 and 14. Samples collected in August represented baseline flow conditions. August measurements of pH ranged from 6.85 at Concorde Creek (outlet from Crooked Lake) to 8.39 at the Clear Lake outlet. All were considered to be within normal ranges. Dissolved oxygen levels ranged from 2.08 parts per million (ppm) at Alvin Patterson Ditch (Clear Lake) to 10.22 at the outlet of Long Lake. Only Alvin Patterson Ditch was below the oxygen level required to sustain most fish and other gill-breathing aquatic organisms in August. Temperatures ranged from 14.9 C at Pigeon Creek at East Ray Clark Road to 26.2 in Turkey Creek (Big Turkey Outlet). All temperatures measured were considered to be normal for the prevailing climatic conditions. Specific conductance ranged from 258 umho/cm at Hamilton Lake, to 3240 umho/cm at the Steuben Lakes Regional Waste District outflow to Pigeon Creek. No targets for specific conductance were listed in the IDEM table.

E-coli bacteria measurements ranged from zero col/100 ml at Fish Lake (Fremont), to 13680 at Pigeon Creek (Inlet to Pigeon Lake). A total of 27 samples exceeded a target maximum of 235 CFU/100 ml listed in the IDEM standards. The highest measurement for total phosphorus in August (.7 ppm) occurred in a sample collected from Harry Teeters Ditch (Clear Lake). Seven sites were below a lab detection limit of .01 ppm phosphorus in August. A total of 9 samples exceeded a target maximum of .076 ppm listed in the IDEM standards. The highest measurement for total suspended solids (TSS) in August (35 ppm) occurred on Pigeon Creek at 400 South. No sites were below a lab detection limit of 1 ppm TSS. Four sites exceeded a target maximum of 30 ppm listed in the IDEM standards. Where possible a measurement of stream flow (discharge) was taken and suspended solids and phosphorus loading figures were calculated using the August data. The highest estimated discharge occurred on Pigeon Creek at the Inlet to Hogback Lake (2939.28 CFM) . The highest estimated total suspended solids loading occurred at Pigeon Creek at 400 South (3974.43 Kilograms per day) along with the highest estimated total phosphorus loading (14.76 kg/day).

7. Conclusions

A number of water quality concerns were noted during the 2011 season sampling. The July and August samples collected from Alvin Patterson ditch showed oxygen levels below the 4 ppm target listed in the IAC. Turkey Creek at 700 South, Crooked Creek (Trib.to Snow), and Follet Creek (upstream of Big Otter) also had low oxygen measurements in August. With the possible exception of Turkey Creek this was probably due to decomposition taking place in marshy areas just upstream of the sampling sites during the hottest part of the season. Additionally, significant amounts of emergent or floating vegetation growing in these marshes may have the effect of shading out submersed vegetation that releases oxygen into the water. While these oxygen levels have implications for organisms living in the streams, the low oxygen condition of these streams probably does not persist very far out into the lake before diffusion and mixing with oxygenated lake water eliminates it.

The May rain event produced extremely high flows in Pigeon Creek which appear to have boosted E-coli, phosphorus, and total suspended solids levels significantly over baseline flow conditions. A similar event in 2010 did not appear to increase E-coli levels in Pigeon Creek, but rather appeared to reduced them significantly in comparison to previous data. This demonstrates

a considerable variability in E-coli measurements in this watershed that may be related to the duration and intensity of rainfall events or other specific climatic factors.

Repeated high e-coli counts in streams can be the result of wildlife sources such as geese and raccoons, or waste from humans or livestock. Because elevated E-coli levels can indicate a potential source of human illness, persistent problems with E-coli should be further investigated, especially if they occur in the vicinity of waters used for human and animal contact. An examination of stream corridors, watershed land-use, and wastewater disposal practices combined with additional sampling may be able to better identify potential sources of the bacteria in these problem areas. Lake associations may be able to investigate these problem areas further with the goal of eventually eliminating certain bacterial sources. In some cases funding and technical assistance may be available through the Steuben County Lakes Council, Steuben County Soil and Water Conservation District, USDA Natural Resources Conservation Service, or USEPA. In response to this work investigations of E-coli levels above those indicated in IDEM water quality standards are ongoing on the upper Pigeon Creek watershed through the joint efforts of the SCLC, Steuben SWCD, and Steuben County Surveyors Office. The sampling results in 2011 showed that this work and the ongoing IDEM 319 grant funded work being performed in the Pigeon Creek watershed through the Steuben County Soil and Water Conservation District are properly focused, as several lakes are significantly impacted by water quality on Pigeon Creek.

Findings of the sampling efforts organized by the SCLC since 2007 are available online at www.lakescouncil.org in pdf and excel spreadsheet formats. The Steuben County SWCD and Steuben County GIS department have also assembled a water quality database to provide for further data query and analysis. Private Lake associations with persistent water quality data occurring outside recommended standards should contact the Lakes Council to investigate the possibility of initiating specific follow-up work. In some cases this can help pinpoint sources of contaminants and connect lake associations with local landowners to work toward common water quality and land management goals.