

Watershed Performance Benchmarks

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Current Water Quality Data

Stakeholders have long raised concerns regarding the water quality within the Pigeon Creek Watershed. Human activities allow many elements to enter and affect the quality of adjacent lakes and rivers. These elements include fertilizer from lawns, phosphorus, nitrogen, sediment from developing areas, hydrocarbons from automobiles, and both treated and untreated sewage (sanitary and/or storm).

The Indiana Department of Environmental Management (IDEM) tracks water quality in streams and lakes throughout the state. Table 12 presents a list of 303(d) impaired aquatic resources and the listed parameters of concern for year 2004. Table 13 presents a list of 303(d) fish consumption advisories.

303(d) #	Waterbody Name	Parameters of Concern
33	Pigeon Creek	<i>E. Coli</i>
33	Pigeon Creek	Impaired Biotic Communities, <i>E. Coli</i>
33	Mud Creek	Total Dissolved Solids, Chlorides
420	Meserve Lake	Impaired Biotic Communities

Table 12: 303(d) Impaired Aquatic Resources – Year 2004.

303(d) #	Waterbody Name	Concerns
25	Long Lake	Hg
33	Pigeon Creek	PCBs and Hg
419	Pleasant Lake	PCBs and Hg

Table 13: 303(d) Fish Consumption Advisories – Year 2004.

IDEM also tracks lake trophic status, which is a measure of biologic activity. Indiana uses a “trophic state index” (TSI) to help identify the status of lakes. Indiana’s TSI uses a set of parameters to which an index, or eutrophy number, is assigned. The TSI results in the sum of the individual eutrophy points and varies from 0 to 75. TSI ranges from oligotrophic (low nutrients – low plants and fish) to hypereutrophic (high in nutrients – support large amounts of plants and fish). Eutrophy points are evaluated for the following parameters: Total Phosphorus, Soluble Phosphorus, Organic Nitrogen, Nitrate, Ammonia, Dissolved Oxygen (both % saturation at 5 feet and % water column >1.0 mg/L), Light Penetration, Light Transmission and Total Plankton.

High levels of Phosphorus and Nitrogen contribute to the eutrophic and hypereutrophic conditions within Big Bower Lake, Golden Lake, Hogback Lake, Little Bower Lake, Long Lake and Pigeon Lake. Table 14 presents a list of 305(b) reports on lake trophic status and trends for years 2002 and 2004.

Waterbody Name	2002 Trophic Trend	2002 Trophic Status	2004 Trophic Trend	2004 Trophic Status
Bass Lake	Improving	Oligotrophic	N/A	N/A
Beaver Dam Lake	Improving	Oligotrophic	Stable	Oligotrophic
Big Bower Lake	Fluctuating	Eutrophic	Fluctuating	Eutrophic
Booth Lake	Improving	Mesotrophic	Stable	Mesotrophic
Fox Lake	Fluctuating	Mesotrophic	Fluctuating	Mesotrophic
Golden Lake	Stable	Eutrophic	Fluctuating	Hypereutrophic
Green Lake	Improving	Mesotrophic	Stable	Oligotrophic
Hogback Lake	Fluctuating	Hypereutrophic	Fluctuating	Hypereutrophic
Little Bower Lake	Stable	Eutrophic	N/A	N/A
Long Lake	Stable	Eutrophic	Stable	Hypereutrophic
Mud Lake	Improving	Mesotrophic	N/A	N/A
Pigeon Lake	Fluctuating	Eutrophic	Fluctuating	Mesotrophic
Silver Lake	Fluctuating	Oligotrophic	Fluctuating	Mesotrophic
Stayner Lake	Improving	Oligotrophic	Stable	Oligotrophic
West Otter Lake	Fluctuating	Mesotrophic	Fluctuating	Mesotrophic

Table 14: 305(b) Lake Trophic Status – Years 2002 and 2004.

The Environmental Protection Agency (EPA), through the National Pollutant Discharge Elimination System (NPDES), regulates most industrial, municipal, and construction activities for point discharges. Table 15 presents a list of registered NPDES permits in the Pigeon Creek Watershed according to the EPA registry as of May 17, 2004. Although the treatment plants are registered point discharges, it should be noted that they will have a limited impact on water quality in the watershed as a whole, as the volume of effluent released from the plants is negligible when compared to the total volume of flow conveyed by Pigeon Creek under normal conditions. As previously noted, two additional treatment plants are planned near Flint (near 150N 800W) and Pleasant Lake.

Facility Name	NPDES ID Number	Permit Activity
Ashley Municipal STP	IN0022292	Active
Ashley Water Works	IN0057371	Active
Angola WWTP	IN0021296	Active
Silver Lake Mobile Homes	IN0039543	Active
Walnut Grove Dairy	INA000011	Active
Pigeon Creek Rest Area I-69 SB	IN0052043	Active
Steuben Lakes RWD WWTP	IN0061557	Active

Table 15: Pigeon Creek Watershed NPDES Permit Listing.

Stakeholders have raised many concerns involving the Angola WWTP effluent, which reaches Pigeon Creek upstream of the chain of lakes via Wood Ditch. Lake residents have been concerned that the effluent, and especially the release of untreated sewage, is releasing untreated bacterium into the waterway that will degrade the lake ecosystems.

Over recent years, the City of Angola has implemented several measures to reduce sewer overflows and improve the water quality downstream of the WWTP. The most important measures have consisted of improvements to the plant and the separation of the city's storm and sanitary sewer system. Under the previous configuration, untreated storm and sanitary flow would be directly discharged into Wood Ditch under extreme rainfall events when flows exceed the plant capacity. Due to the modifications, annual sewer overflow events have decreased from 152 to 10 in the period from 1999 to 2002. During this time, the annual volume of untreated flow released to Wood Ditch has also decreased from 193 MG to approximately 4 MG. In addition to the completed modifications, two 1.25 MG storage tanks are proposed to retain untreated sewage during extreme rainfall events to further reduce the potential for a sewage overflow. (The WWTP will submit a long term control plan to mitigate remaining combined sewer overflow events by November 2006 as part of the National Pollutant Discharge Elimination System permit requirements.)

To further study the water quality downstream of the treatment plant, city personnel have measured levels of *E. Coli* in Mud Creek downstream of the WWTP, as well as in Pigeon Creek. The recordings, shown below in Table 16, indicate that bacterium contained in the WWTP effluent is substantially diluted during conveyance through Wood Ditch.

Location	E.Coli Concentration (# Colonies/100 mL)
Angola WWTP Outlet	4,500
Wood Ditch at Bill Deller Rd	600
Wood Ditch at 275 S	250
Wood Ditch at Pigeon Creek	475
Inlet to Long Lake	715

Table 16: Sample Results March 10, 2004.

Table 16 also indicates that the concentration of *E. Coli* at the confluence of Wood Ditch with Pigeon Creek is greater than upstream in Wood Ditch, which would indicate that the treatment plant effluent is not the primary cause of *E. Coli* in the watercourse. This fact is further evident when the loading of *E. Coli* colonies is compared at the treatment plant outlet and at Pigeon Creek. Table 17 shows that the number of *E. Coli* colonies at Pigeon Creek is 3-4 times larger than at the Angola treatment plant outlet under average daily flow conditions.

Location	E.Coli Concentration (# Colonies/100 mL)	* Average Daily Flow (MGD)	= <i>E. Coli</i> (# Colonies / sec)
Angola WWTP Outlet	4500	1.0	2M
Wood Ditch at Pigeon Creek	475	~ 30 - 40	6.2M – 8.3M

Table 17: Sample Results March 10, 2004.

A second, independent test was performed in September 2004 by a biologist at Indiana University-Purdue University Fort Wayne that showed similar results. Other possible sources of *E. Coli* include animal waste from direct land application and natural droppings, septic field leaching, and illicit connections of house sanitary lines to drain tiles. During the site inspection in October 2004, foam from laundry detergent was observed in the creek near a drain tile outlet. The observation was reported to the county health department, who is resolving the problem by requiring the source house to be replumbed.

Current Flooding Data

Although flooding occurs frequently within the watershed, minimal detailed data is currently available regarding exact flood levels for various rainfall events. As previously noted, a detailed flood study has not been performed for the Pigeon Creek Watershed, and Flood Insurance Rate Maps are based on approximate inundation areas. However, the 1967 Preliminary Investigation Report claims that the flood stage for the lake chain is as high as six feet for the two-year rainfall event and seven feet for the ten-year rainfall event. The 1983 SCS Report further states that the 100-year event in 1982 had a flood stage of approximately 8.5 feet, with the majority of flooding occurring around the lake chain. Minimal out-of-bank channel flooding was reported.

Sedimentation

Sedimentation is a natural stream process that occurs when water velocity decreases to the point that suspended particles drop out of the flow regime and are deposited on the lake/channel bottom. In the Pigeon Creek Watershed, sedimentation problems occur at the inlet to the lake chain (Long Lake), as well at points where tributaries connect to the main channel of Pigeon Creek. In some locations, accumulated sediment has formed sandbars (Long Lake Inlet, Hogback Lake Outlet) that provide habitat for animals and are subject to close regulation by state and federal agencies.

Erosion

A precursor to sedimentation, erosion is a natural or man-made process where the earth is pulled into the flow regime and transported to a point downstream. This generally occurs when the stream flow is unstable, or the flow is confined in a restrictive channel. In this case, the water will erode the channel banks to widen the channel and provide additional conveyance capacity at a stable condition. For the Pigeon Creek Watershed, this occurs in both the Upper Watershed and channelized sections downstream of Hogback Lake (See Figures 19 and 20). In addition to natural erosion, erosion can also be manmade when associated with construction activities.

Steering Committee members Beth Williams (Steuben County SWCD), Chad Hoover (Steuben County GIS Coordinator), Greg Wolterstorff and Ed Belmonte (both of V3) toured the Pigeon Creek watershed by canoe on October 1, 2004. This vantage point allowed for the observation of the prevalence of instream erosion. The stream bank source of erosion along with agricultural land use runoff provide the two most significant contributors to the watershed's erosion problems.

Nitrates, Nitrites, and Phosphates

Water quality samples throughout the watershed have shown elevated levels of nitrates, nitrites, and phosphates. Results from samples collected by the Soil Conservation Services upstream of Long Lake in 1982, as well as recent samples taken by the Hoosier Riverwatch are presented in Table 18.

Compound	SCS 1982	Hoosier Riverwatch 1996-2004	Indiana Drinking Water Standards
NO ₃	1.0 - 1.7 mg/L	0 - 39 mg/L	10.0 mg/L
NO ₂	0.01 - 0.07 mg/L	N/A	1.0 mg/L
PO ₄	0.2- > 2.0 mg/L	0 - 3.33 mg/L	n/a

Table 18: Nitrate, Nitrite, and Phosphate Samples in the Watershed.

In general, the Hoosier Riverwatch has taken numerous water quality samples throughout the Pigeon Creek Watershed. Tables 19 and 20 summarize the water quality concerns identified by the sampling data.

Sample Location	Testing Dates	Water Quality Score	Parameters of Concern
Golden Lake	1996-2003	69-88	Phosphate > 0.025 mg/L
West Otter Lake	1996-1998	76-79	Phosphate > 0.025 mg/L
Long Lake	2003-2004	47-63	<i>E. Coli</i> Phosphate > 0.025 mg/L Nitrate > 10 mg/L
Hammond Ditch	1996	74	Phosphate > 0.025 mg/L
Pigeon Ck at County Line	1999-2000	67-82	Nitrate > 10 mg/L

Table 19: Summary of Hoosier Riverwatch Sampling Data.

The Hoosier Riverwatch Score is calculated through the use of statistically representative values found on roughly 2/3rds of Indiana streams and rivers tested from 1991 to 2002 for eight water quality parameters. These parameters include: dissolved oxygen, *E. coli*, pH, biochemical oxygen demand, water temperature, total phosphate, nitrate and turbidity. Water quality scores for each parameter are then multiplied by a weighting factor and the resulting value ranges between 0 and 100, with higher numbers being of higher quality.

Golden Lake, West Otter Lake, and Long Lake are all developed with residential lots surrounding the water bodies with maintained lawns extending up to the shoreline. Phosphate loading is potentially caused by lawn fertilizer washing into the lakes. As the first lake in the lake chain, Long Lake is the first level of treatment for nutrients and bacteria carried from upstream fields. Elevated concentrations of nitrates and *E. Coli* may be from upstream agricultural sources (see Stressor Source Identification section).

Hammond Ditch connects Lake Arrowhead (residentially developed) to West Otter Lake. As in the other lakes, the phosphate loading in Hammond Ditch may be caused by lawn fertilizer applied upstream at Lake Arrowhead.

Pigeon Creek samples taken at the Lagrange / Steuben County line are downstream of a long agricultural stream reach. Elevated nitrate loadings may be caused by adjacent agricultural sources.

Sampling Location	# Samples	Water Quality Score	DO (ppm)	DO (% Sat.)	<i>E. Coli</i> (col/100 mL)	pH	BOD5 (mg/L)	Total Phosphate (mg/L)	Nitrate (mg/L)	Turbidity (NTU)
Golden Lake Inlet	11	82.3	9.2	92	24.8	7.7	3.5	0.1	1.3	9
W. Otter Lake Outlet	2	77.5	12	138	83	8	4	0.1	1.0	8
Pigeon Ck. @ Cty Line	5	76.4	9.2	91	88	7.8	1.5	0.3	7.6	4
Long Lake Inlet	8	62.4	9.6	96	4469	8.4	4.8	0.8	10	19
Hammond Ditch	1	74.4	9	110	333	7.5	4	0.3	4	5

Table 20: Summary of Average Baseline Measurements from Hoosier Riverwatch Sampling Data.

Relevant Standards:

E. Coli: 235 CFU / 100 mL (IDEM Dry Weather – excludes 48-72 hrs after rain)

pH: 6.5-8.5 (IDEM Drinking Water Standard)

Nitrate: <10 mg/L (IDEM Drinking Water Standard)



Figure 19: Eroded Channel Bank in Upper Watershed.



Figure 20: Eroded Channel Bank in Upper Watershed.