IV. Identified Problems

A. Water Quality Assessment

The water quality within the Puterbaugh Creek – Heaton Lake Watershed was evaluated using a variety of sources, water quality sampling results, historical water quality sampling results and previous studies.

2004 ECC 205(j) Grant Project Water Quality Sampling

The watershed was sampled at 6 locations during the project. The sampling locations are described in Table 5 The sampling locations as well as drainage area boundaries are shown in Figure 7.

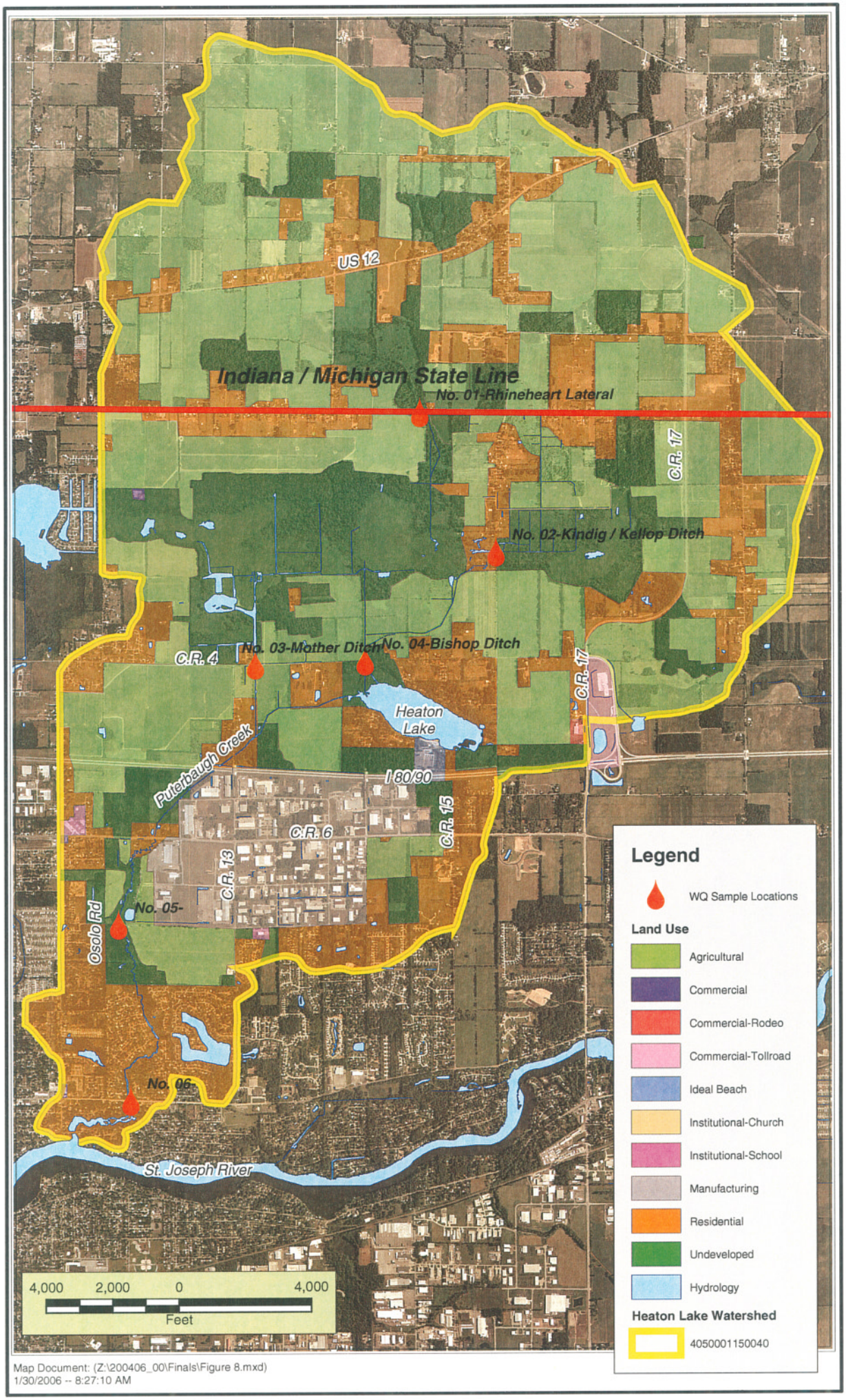
Table 5
Puterbaugh Creek – Heaton Lake Water Quality Sampling Locations

Site #	Location	Stream Name	Approximate Drainage Area (Acres)
1	State Line Road	Rhineheart Lateral	956
2	County Road 15	Kindig/Kellog	2,913
3	County Road 4	Mather Ditch	2,291
4	County Road 4	Bishop Ditch	4,693
5	County Road 106	Puterbaugh Creek	7,897
6	Bristol Street	Puterbaugh Creek	10,909

Samples were collected for two dry weather events and two wet weather events. The sampling procedures are described in detail in the Quality Assurance Project Plan (QAPP) for Puterbaugh Creek – Heaton Lake Watershed Management Plan, Elkhart County, Indiana ARN 03-671 (May 2004).

Samples were analyzed for the following parameters:

Dissolved Oxygen (DO)
Temperature
pH
Conductivity
Total Dissolved Solids (TDS)
Total Suspended Solids (TSS)
Ammonia-Nitrogen (NH_3-N)
Nitrate-Nitrogen (NO_3-N)
Total Kjeldahl Nitrogen (TKN)
Orthophosphate
Total Phosphorus
Surfactants (MBAS)
E. Coli



Map Document: (Z:\200406_00\Finals\Figure 8.mxd)
1/30/2006 -- 8:27:10 AM

Elkhart County 205(j) Grant
Puterbaugh Creek - Heaton Lake
Watershed Management Plan

Water Quality Sampling Locations

N
W E
S

LAWSON-FISHER ASSOCIATES P.C.
CONSULTING ENGINEERS
525 W. WASHINGTON AVENUE
SOUTH BEND, INDIANA 46601
PH. (574) 234-3167

Figure 7

200406.00

Jan. 2006

The sampling events during the water sampling collection are summarized below in Table 6.

Table 6
Sampling Event Summary

Date	Rainfall (inches)*	Type
6/10/04	0.98	Wet
9/13/04	-	Dry
9/16/04	0.64	Wet
9/21/04	-	Dry

*48 hour total.

The results of the sampling are summarized in Table 7 Water quality data is included in Appendix C.

Heaton Lake Data

Secchi disk data has been gathered at Heaton Lake by volunteers since 1994. The Secchi disk is a round disk that is lowered into the lake until the observer loses site of the disk. The disk is then raised until it reappears. The depth at which the disk disappears and reappears to the observer is the Secchi disk depth. The Secchi disk measurement of water clarity allows for a simplistic approach to evaluating the transparency of water. The following Table 8 outlines the averages of the Secchi disk readings for the period of record:

Table 8
Heaton Lake Secchi Disk Data

Annual Summaries										
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Average (feet)	11.9		10.0	5.5	7.6	10.7	7.6			7.1

Elkhart – South Bend Fish Community Monitoring – 2000 and 2003 Annual Report

Elkhart Public Works and Utilities conducted a series of studies monitoring the fish communities of St. Joseph River, Elkhart River and their tributaries in St. Joseph and Elkhart Counties. Puterbaugh Creek was one of the tributaries sampled. The Index of Biotic Integrity or IBI was determined at various locations and is a tool that is used to assess water quality using fish community information. The IBI is useful in translating complex fish community information into a more understandable format for non-biologists. In addition, the Qualitative Habitat Evaluation Index (QHEI) was used to assess the available habitat at all the sampling locations. The QHEI assists in determining the extent to which the IBI scores are being affected by habitat.

Table 7
Elkhart County 205(j) Grant Project
Water Quality Monitoring Results

	Water Quality Guidelines					6 - 9	Varies by month		750 mg/L		5 mg/L		235 CFU/100 mL		Varies with pH and Temperature				
	No.	Sampling Location	Date	Time	Ambient Temp. (°C)	Weather Condition	pH	Water Temp. (°C)	Cond. (µS/cm)	TDS	Color	DO (mg/L)	DO (%)	E. Coli	TKN (mg/L)	Ammonia (mg/L)	Nitrate (mg/L)	Orthophosphorus (mg/L)	Total Phosphorus (mg/L)	TSS (mg/L)	MBAS (Surfactants) (mg/L)
Wet Weather Sample	1	Rhineheart Lateral	6/10/2004				7.72	19.2	373	190	Light Brown	6.97	75.1	11000	1.8	0.3	2.5	<0.05	0.37	35	<0.1
	2	Kindig/Kellog	6/10/2004	2:45 PM	21.7	Light Rain	7.22	21.3	210	107	Rust/Brown	1.35	15.1	1360	1.6	0.2	<0.1	<0.05	0.27	6	0.21
	3	Mather Ditch	6/10/2004	3:00 PM	21.7	Overcast	8.07	23.2	388	197	Clear	6.85	74.6	280	0.49	<0.05	<0.1	<0.05	<0.05	18	20
	4	Bishop Ditch	6/10/2004		21.7	Light Rain	7.57	20.5	361	184	Light Brown	3.88	43.8	1640	1.3	0.3	<0.1	<0.05	0.41	5	0.14
	5	Puterbaugh Creek	6/10/2004		21.7	Overcast	7.97	21.5	385	196	Clear	7.01	79.6	360	0.99	<0.05	<0.1	<0.05	0.24	8	<0.1
0.98 inches	6	Puterbaugh Creek	6/10/2004	3:00 PM	21.7	Overcast	8.08	21.2	396	201	Clear	7.95	89.2	900	1.1	0.4	0.12	<0.05	0.34	2	0.12
	Duplicate	Rhineheart Lateral	6/10/2004	2:25 PM		Light Rain	7.72	19.2	373	190	Light Brown	6.97	75.1	11000	1.8	0.4	2.5	<0.05	0.26	32	0.12
	Trip Blank		6/10/2004											<1	0.72	0.2	0.23	<0.05	<0.1	<1	<0.1
	No.	Sampling Location	Date	Time	Ambient Temp. (°C)	Weather Condition	pH	Water Temp. (°C)	Cond. (µS/cm)	TDS	Color	DO (mg/L)	DO (%)	E. Coli	TKN (mg/L)	Ammonia (mg/L)	Nitrate (mg/L)	Orthophosphorus (mg/L)	Total Phosphorus (mg/L)	TSS (mg/L)	MBAS (Surfactants) (mg/L)
Wet Weather Sample	1	Rhineheart Lateral	9/16/2004	7:30 AM	21.1	Sunny	8.4	18.6	430	300	Light Brown	4.7	50.6	21400	2.4	<0.05	0.39	0.12	0.46	24	0.13
	2	Kindig/Kellog	9/16/2004	8:00 AM	21.1	Sunny	7.6	19.2	420	320	Light Brown	0.26	2.8	1540	4.4	<0.05	<0.1	0.067	0.45	29	0.27
	3	Mather Ditch	9/16/2004	8:35 AM	21.1	Sunny	8.4	23.4	420	280	Clear	8.3	97.2	68	0.34	<0.05	<0.1	0.054	0.16	1	<0.1
	4	Bishop Ditch	9/16/2004	8:15 AM	21.1	Sunny	7.8	18.1	500	330	Light Green	1.92	16.6	450	0.71	<0.05	<0.1	0.13	0.24	4	<0.1
0.64 inches	5	Puterbaugh Creek	9/16/2004	8:55 AM	21.1	Sunny	8	17.6	500	310	Clear - Light Green	6.48	67.5	1100	<0.1	<0.05	0.13	0.055	0.2	<1	<0.1
	6	Puterbaugh Creek	9/16/2004	9:10 AM	21.1	Sunny	8.1	17.1	510	300	Clear - Light Green	6.98	72.8	3600	0.52	<0.05	0.18	0.054	0.22	3	<0.1
	Duplicate	Bishop Ditch	9/16/2004	8:15 AM	21.1	Sunny	7.8	18.1	480	300	Light Green	1.92	16.6	500	0.76	<0.05	<0.1	0.13	0.23	2	<0.1
	Trip Blank		9/16/2004						7.9	<2				<1	<0.1	<0.05	<0.1	<0.05	<0.05	<1	<0.1
	No.	Sampling Location	Date	Time	Ambient Temp. (°C)	Weather Condition	pH	Water Temp. (°C)	Cond. (µS/cm)	TDS	Color	DO (mg/L)	DO (%)	E. Coli	TKN (mg/L)	Ammonia (mg/L)	Nitrate (mg/L)	Orthophosphorus (mg/L)	Total Phosphorus (mg/L)	TSS (mg/L)	MBAS (Surfactants) (mg/L)
	1	Rhineheart Lateral	9/13/2004	9:00 AM	24.5	Sunny	8.1	14.9	580	370	Light Brown	7.27	72	700	3.2	<0.05	0.68	0.09	0.29	140	0.27
	2	Kindig/Kellog	9/13/2004	9:10 AM	24.5	Sunny	7.4	16.3	410	330	Light Brown	0.26	2.6	84	1.8	<0.05	<0.1	<0.05	0.24	8	0.27
	3	Mather Ditch	9/13/2004	9:40 AM	24.5	Sunny	8.2	22.1	410	280	Clear	9.9	113.5	11	0.23	<0.05	<0.1	<0.05	0.23	<1	0.2
	4	Bishop Ditch	9/13/2004	9:30 AM	24.5	Sunny	7.7	14.8	520	340	Yellowish - Green	1.12	10.9	230	0.62	<0.05	<0.1	0.15	0.23	2	0.1
Dry Weather Sample	5	Puterbaugh Creek	9/13/2004	9:55 AM	24.5	Sunny	8	18.3	490	310	Clear	7.04	74.8	110	0.64	<0.05	<0.1	0.07	0.28	2	<0.1
	6	Puterbaugh Creek	9/13/2004	10:10 AM	24.5	Sunny	8	16.9	500	300	Clear	7.59	78.3	280	0.43	<0.05	0.15	0.074	0.21	12	<0.1
	Duplicate	Kindig/Kellog	9/13/2004	9:10 AM	24.5	Sunny	7.4	16.3	410	330	Light Brown	0.26	2.6	56	2.8	<0.05	<0.1	<0.05	0.24	5	0.2
	Trip Blank		9/13/2004						<1	10				<1	<0.1	<0.05	<0.1	<0.05	0.13	<1	<0.1
	No.	Sampling Location	Date	Time	Ambient Temp. (°C)	Weather Condition	pH	Water Temp. (°C)	Cond. (µS/cm)	TDS	Color	DO (mg/L)	DO (%)	E. Coli	TKN (mg/L)	Ammonia (mg/L)	Nitrate (mg/L)	Orthophosphorus (mg/L)	Total Phosphorus (mg/L)	TSS (mg/L)	MBAS (Surfactants) (mg/L)
	1	Rhineheart Lateral	9/21/2004	7:00 AM	15.6	Sunny	8.2	10.6	590	390	Light Brown	6.86	66.5	3400	0.86	<0.05	0.46	0.07	0.16	27	0.13
	2	Kindig/Kellog	9/21/2004	7:10 AM	15.6	Sunny	8.1	12.6	430	340	Brown	1.01	9.6	126	1.7	<0.05	<0.1	0.073	0.4	12	0.38
Dry Weather Sample	3	Mather Ditch	9/21/2004	7:40 AM	15.6	Sunny	8.4	18.5	420	300	Clear	8.98	95.6	32	<0.1	<0.05	<0.1	0.077	0.12	<1	0.21
	4	Bishop Ditch	9/21/2004	7:30 AM	15.6	Sunny	8	12.4	450	330	Light Brown	2.46	21.5	118	1.1	<0.05	<0.1	0.1	0.19	2	0.21
	5	Puterbaugh Creek	9/21/2004	8:00 AM	15.6	Sunny	8.2	12.3	520	330	Light Green	7.84	73.2	580	0.22	<0.05	<0.1	0.087	0.24	1	0.16
	6	Puterbaugh Creek	9/21/2004	8:15 AM	15.6	Sunny	8.2	12.7	490	360	Clear - Light Green	8.47	79.7	420	0.34	<0.05	0.22	0.092	0.21	5	<0.1
	Duplicate	Rhineheart Lateral	9/21/2004	7:00 AM	15.6	Sunny	8.2	10.6	590	400	Light Brown	6.86	66.5	3800	0.78	<0.05	0.43	0.12	0.32	23	0.14
	Trip Blank		9/21/2004						13.7	12				<1	<0.1	<0.05	<0.1	<0.07	<0.05	<1	<0.1

Puterbaugh Creek was evaluated for its IBI at Reedy Drive in 2003 and at County Road 8 in 2000. The creek was evaluated for its QHEI at Reedy Drive and County Road 4 in the 2003 Report. IBI scores can range from 12 (very poor) to 60 (very good). QHEI scores can range from 0 (very poor) to 100 (excellent). The IBI and QHEI scores for Puterbaugh Creek are shown in Table 9.

Table 9
Fish Community Monitoring Index of Biotic Integrity (IBI) and Qualitative Habitat Evaluation Index (QHEI) for Puterbaugh Creek Locations

Site	*1998 IBI*	*1999 IBI*	*2000 IBI*	*Average IBI*
County Road 8	38	41	37	39

Site	*2001 IBI*	*2002 IBI*	*2003 IBI*	*Average IBI*	*2003 QHEI Score*
County Road 4					27
Reedy Drive	33	41	36	37	63

The fish community condition in this stream is fair and basically stable from site to site (Foy 2003). The 2000 and 2003 Elkhart – South Bend Fish Community Monitoring Annual Reports are included in Appendix D.

Water Quality Discussion

There are various standards and guidelines for some of the parameters monitored for the watershed management plan. The water quality standards for the parameters tested are shown in Table 10 Some of these standards are not appropriate for the regulation of Puterbaugh Creek (such as drinking water standards, since the Creek is not used as a source of drinking water); however, they provide a standard by which to evaluate the water quality.

Table 10
Water Quality Standards/Guidelines

Water Quality Parameter	*Standard*	*Source/Standard*
Dissolved Oxygen	5 mg/L daily average 4 mg/L minimum	327 IAC 2
Temperature	Varies by month	327 IAC 2
Total Dissolved Solids	750 mg/L	327 IAC 2
Chlorides	860 mg/L Maximum	327 IAC 2
pH	6-9	327 IAC 2
E. Coli	235 CFU/100 mls Primary Contact Max Daily Conc.	327 IAC 2
	125 CFU/100 mls Primary Contact 30 Day Geometric Mean	327 IAC 2
Nitrate	10 mg/L	Drinking Water Standards
Ammonia	Varies with pH and Temperature	327 IAC 2
Total Phosphorus	0.04 mg/L Daily Maximum	327 IAC 2 – evaluated during IDEM triennial review at Great Lakes drinking water intakes (not a WQ Standard)

E. Coli

E. Coli measured during the Elkhart County 205(j) Grant Project sampling exceeded the standard of 235 CFU/100 mls maximum daily concentration in all but one sample during wet weather events. The standard was exceeded at Site No. 1 (State Line Road) and Site No. 6 (Puterbaugh Creek) during both dry weather events. The standard was exceeded at Site No. 5 (Puterbaugh Creek) during the September 21, 2004 dry weather event. *E. Coli* is an indicator organism which may indicate the presence of human or animal wastes. The USEPA uses *E. Coli* measurements to determine whether fresh water is safe for recreation. The presence of *E. Coli* within the Puterbaugh Creek – Heaton Lake Watershed is most likely due to a number of sources, including failed septic systems, livestock and or wildlife. However, the *E. Coli* contribution from the lower portion of the watershed is most likely from domestic sources, not agricultural. The lower portion of the watershed has a significant number of residences on septic systems, and a relatively small amount of livestock within the watershed. The *E. Coli* contribution from the upper portion of the watershed is mainly due to agricultural sources. In almost every case, the wet weather *E. Coli* concentrations were significantly higher than the dry weather concentrations, indicating a significant contribution of *E. Coli* from surface runoff.

Total Dissolved Solids

In all cases, the measurements for the Puterbaugh Creek/Heaton Lake Watershed were less than the standard of 750 mg/L for total dissolved solids. High total dissolved solids can be an indication of domestic wastewater pollution or pollution associated with livestock or wildlife.

Nutrients

In general, the nitrogen and phosphorus levels within the Puterbaugh Creek – Heaton Lake Watershed are moderate to high. This is not unexpected due to the level of agricultural land use within the watershed.

- ### Nitrogen

  Nitrogen is a nutrient that is necessary for the growth of all living organisms. The water quality sampling results for nitrates were all less than 10 mg/L, the drinking water standard. There are several potential sources of nitrates in surface water including industrial pollutants and nonpoint – source runoff from heavily fertilized cropland lawns.

  Nitrates are a primary component of most fertilizers. Additionally, nitrates are formed by the oxidation of ammonia (NH_3-N) a component of human and animal wastes.

The ammonia results in the water quality samples taken during the two (2) September 2004 dry weather events and the one (1) September 2004 wet weather event were less than the detection limit of 0.05 mg/L. However, some of the results of the samples gathered during the first wet weather event taken during June 2004 were above the water quality standards for unionized ammonia, which ranges from 0.0075 mg/L at a pH of 6.5 and temperature of 0 C, to 0.2137 mg/L at a pH of 9 and a temperature of 30 C. While these values do not meet the standard, the concentrations, in general, do not increase throughout the Puterbaugh Creek – Heaton Lake Watershed. A primary source of ammonia nitrogen is the urea component of human and animal wastes.

Total Kjehldahl Nitrogen (TKN) is a measure of NH_3-N and organic nitrogen. While there is no standard on TKN, a comparison of the TKN and NH_3-N results provides an insight on the amount of organic nitrogen.

- *Phosphorus*

  There is no Indiana State Standard for phosphorus within Puterbaugh Creek and its tributaries. However, phosphorus is monitored during IDEM's triannual review process at drinking water intakes in Lake Michigan. The daily maximum for this review is 0.04 mg/L. The total phosphorus results exceeded the 0.04 mg/L standard in all samples. High levels of phosphorus can contribute to algal blooms in lakes. However, similar to ammonia-nitrogen, the levels of phosphorus did not increase throughout the Puterbaugh Creek – Heaton Lake Watershed. Sources of phosphorus include human and animal wastes, fertilizers and decaying organic matter (i.e. leaves and foliage).

Temperature

All temperature measurements were within the monthly temperature standards set forth in the IAC.

Dissolved Oxygen

Dissolved oxygen did not meet the state standards during all four (4) sampling events at the County Road 15 (Site No. 2) sampling site and the County Road 4 (Site No. 4) sampling site. Dissolved oxygen at the State Line Road (Site No. 1) sampling site was below the dissolved oxygen standard only during the September 16, 2004 wet weather event. Dissolved oxygen is critical to the health of aquatic species in a water body. Low dissolved oxygen can be an indication of a pollutant source, especially human and animal wastes.

MBAS

MBAS is a measure of surfactants, primarily occurring from sources of commercial or domestic laundry operations or other cleansing operations. For the purposes of this study, it is being used as an indicator of domestic wastewater. Raw wastewater has a typical range of 1 – 20 mg/L MBAS. Natural waters typically have less than 0.1 mg/L MBAS. Many of the sampling locations exhibited MBAS levels greater than 0.1 mg/L indicating a potential for domestic wastewater contribution.

Estimated Annual Pollutant Loading

Based on the water quality analyses performed at the 6 sampling locations, annual pollutant loading was estimated for the following parameters:

Puterbaugh Creek and its tributaries are not gauged, therefore, estimated annual runoff was used to estimate the volume of flow at each of the sampling locations. Average annual runoff from USGS Gauging Station 04101000 (St. Joseph River at Elkhart, Indiana) of 13.69 inches (1948-2004 period of record) was utilized to estimate the flow volume. The results of the water quality analyses were averaged and applied to the runoff to estimate the annual pollutant loading. The results of this analysis are included as Table 11 and are presented as lb. per year for the watershed and normalized to lb. per acre.

Table 11
Estimated Pollutant Loadings

Sampling Location	*1 Rhineheart Lateral*	*2 Kindig/ Kellog*	*3 Mather Ditch*	*4 Bishop Ditch*	*5 Puterbaugh Creek*	*6 Puterbaugh Creek*
Approximate Drainage Area (Acres)	956	2,913	2,291	4,693	7,897	10,909
Estimated Annual Flow Volume (MG/yr)	341	1,039	817	1,675	2,818	3,893
Average TDS (mg/L)	307	285	264	297	287	290
TDS Loading (lb/yr)	873,000	2,476,000	1,803,000	4,148,000	6,737,000	9,429,000
TDS Loading (lb/acre/yr)	913	850	787	884	853	864
Average *E. Coli* (cfu/100 ml)	8,550	633	98	588	538	1,300
E. Coli Loading (cfu/yr)	1.1xE14	2.5xE13	3.0xE12	3.7xE13	5.7xE13	1.9xE14

Table 11
Estimated Pollutant Loadings (Continued)

Sampling Location	1 Rhineheart Lateral	2 Kindig/ Kellog	3 Mather Ditch	4 Bishop Ditch	5 Puterbaugh Creek	6 Puterbaugh Creek
E. Coli Loading (cfu/acre/yr)	1.2xE11	8.6xE9	1.3xE9	7.9xE9	7.3xE9	1.8xE10
Nitrate (mg/L	1.16	<0.1	<0.1	<0.1	<0.11	0.17
Nitrate Loading (lb/yr)	3,300	*	*	*	*	5,400
Nitrate Loading (lb/acre/yr)	3.5	*	*	*	*	0.5
Average Total P (mg/L)	0.31	0.32	<0.14	0.26	0.24	0.25
Total P Loading (lb/yr)	880	2,780	*	3,630	5,640	7,960
Total P Loading (lb/acre/yr)	0.92	0.95	*	0.77	0.71	0.73
Average TSS (mg/L)	47	12	<5.3	3	<3	6
TSS Loading (lb/yr)	133,000	104,000	*	42,000	*	179,000
TSS Loading (lb/acre/yr)	139	36	*	9	*	16
Average MBAS (mg/L)	0.15	0.27	5.2	*	*	*
MBAS Loading (lb/yr)	427	2,307	35,474	*	*	*
MBAS Loading (lb/acre/yr)	0.45	2.4	37.1	*	*	*

*Loadings not estimated where analysis results were below detection limits for 1 or more samples.

B. Pollutant Sources and Stressors

- *Failing On-Site Septic Systems*

The water quality sampling indicates fairly high levels of *E. Coli*, an indicator of human or animal wastes. Additionally, in some areas, the high *E. Coli* levels are combined with elevated MBAS (surfactants) indicating the presence of domestic wastes (soaps and detergents). The high levels of E. coli combined with the surfactants greater than 0.1 indicate a domestic source of contamination. The predominant land uses within the sub-basins monitored are agricultural and rural/suburban residential. There is currently no publicly owned treatment facility serving most of the watershed, with exception of the very southern portion which is served by the City of Elkhart. The location of the septic permit applications (1990-2004) shown in Figure 5, further suggest the dominance of on-site septic systems in the watershed. A geographic database of septic permits did not exist for the portion of the watershed in the State of Michigan, however, this area is also not served by a public sewer system, and therefore all facilities are served by on-site systems. The limited capacity of the existing soils for septic systems also leads to the conclusion that there may be failing septic systems within the area. With a limited depth to water table, septic tank effluent may intercept groundwater or surface water sources, without receiving adequate treatment, resulting in contaminated ground or surface waters.

As development increases and on-site systems are used, the potential for failing systems increases. While this management plan has focused on the impairments to the surface water within the Puterbaugh Creek – Heaton Lake Watershed, the groundwater quality is also at risk due to failing on-site septic systems. Most of the homes within the watershed have individual wells as their water supply.

- *Direct Discharge of Septic Tank Effluent*

Because of the poor soils, older residences may have direct discharges of their septic tank effluent to either creeks or ditches. Septic systems or connection to a public sewer are of course required for newer construction and have been required since 1967. Although no direct discharges were identified during the Watershed Management Plan water quality monitoring, a sanitary survey was not conducted in the entire creek system of the watershed.

- *Increased Development*

Increased development has the potential to adversely affect the surface water quality and quantity. The increased residential development requiring on-site wastewater disposal systems has a significant potential to affect water quality, due to the limited capacity for septic treatment of the existing soils. Additionally, water quality can be affected by construction practices. Higher density development also contributes to water pollution due to many factors, including increased traffic, increased surface water runoff that may cause erosion and higher peak flows.

Agricultural Practices

A significant portion of the watershed is agricultural, primarily cropland. There is a moderate potential for erosion, due to the nature of the soils within the area, which can impair water quality. Erosion increases the sediment load to surface waters as well as transporting nutrients (phosphorus and nitrogen) from fertilizers. Land use north of the I-80/90 (Indiana Toll Road) is primarily agricultural or undeveloped with some rural-residential development along roadways (see Figure 5).

C. *Identification of Critical Areas*

- *Rhineheart Lateral*

  Water quality sampling results at the Rhineheart Lateral near State Line Road consistently displayed the highest level of *E. Coli* of any of the sampling locations during the four (4) sampling events. The samples at this site also exhibited higher levels of nitrates, phosphorus and TSS than the other five (5) sampling locations. The contributing watershed to the Rhineheart Lateral is located primarily in Michigan.

- *Kindig/Kellog Ditch and Bishop Ditch*

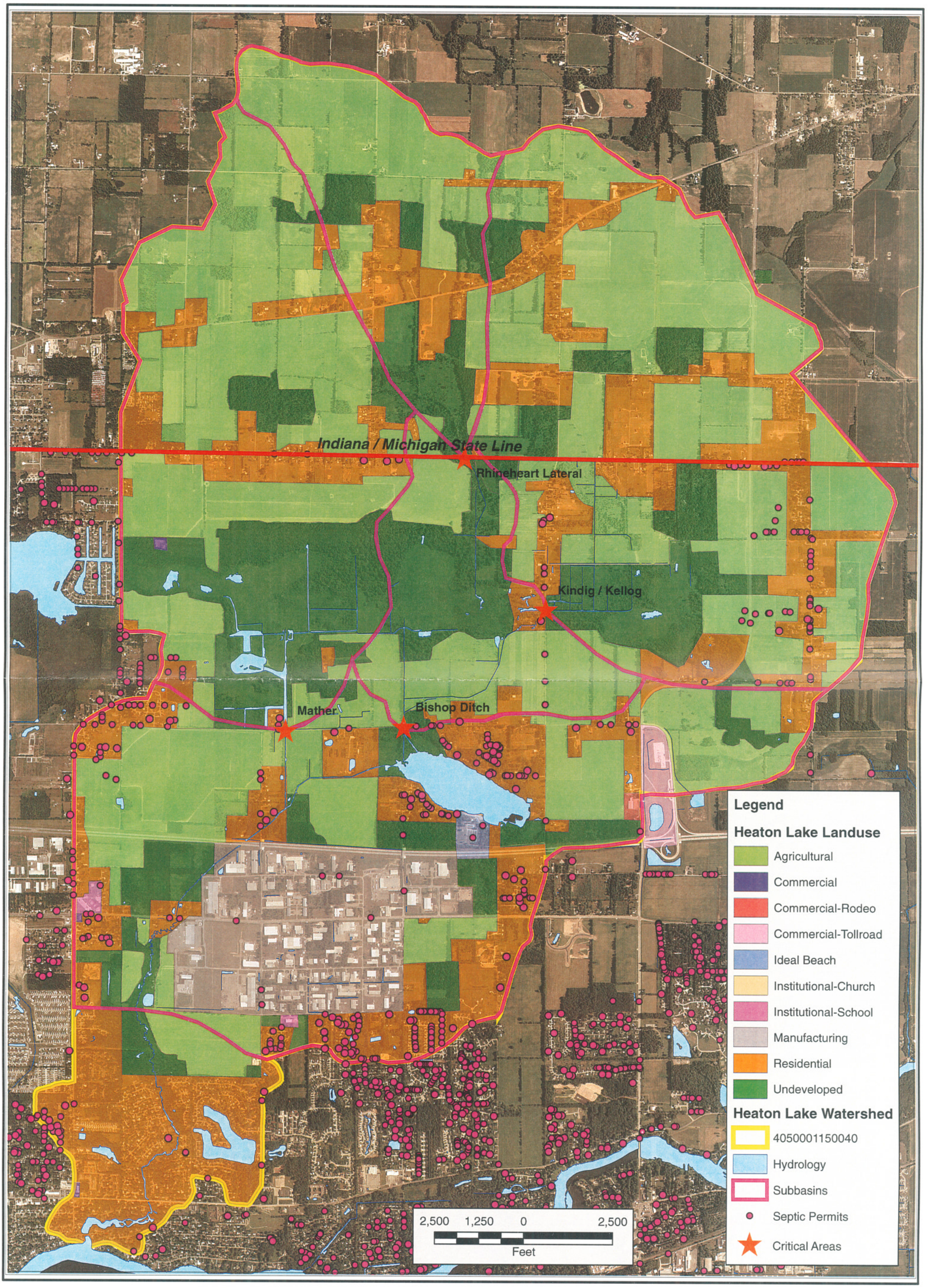
  Low dissolved oxygen levels were noted in both of these ditches during the water quality sampling. Kindig/Kellog Ditch drains directly to Bishop Ditch and the low DO may be an indication of a pollutant source. On a lb. per acre basis, Kindig/Kellog Ditch had the highest and second highest phosphorus and TSS Loadings. The Kindig/Kellog Ditch and Bishop Ditch water samples exceeded State standards for *E. Coli* during wet weather event sampling.

- *Mather Ditch*

  High surfactant levels were noted in Mather Ditch during the water quality sampling on June 10, 2004. A number of residences are located upstream of County Road 4 along Mather Ditch. The high surfactant levels are indicative of domestic waste (soaps and detergents). On the June 10, 2004 wet weather sampling event, the MBAS was measured to be 20 mg/L, a typical concentration found in raw wastewater. However, *E. Coli* level at this site exceeded the water quality standard on only one (1) sampling event at a level of 280 cfu/100 ml.

The sampling points identified as critical areas as well as their contributing watershed boundaries and land uses are shown on Figure 8. These contributing watersheds are primarily the northern half of the study area, and all but the Mather Ditch sub-watershed contribute directly to Heaton Lake. The characteristics of each of these sub-watersheds is primarily agricultural with some rural residential development (with on-site septic systems) along main roadways. Water quality monitoring results indicate the presence of both agricultural and domestic pollutants impacting water quality.

Map Document: (Z:\200406_00\Finals\Figure 8-critical areas.mxd)
1/30/2006 -- 8:35:23 AM



January 2006	200406	Figure 8	LAWSON-FISHER ASSOCIATES P.C. CONSULTING ENGINEERS 525 W. WASHINGTON AVENUE SOUTH BEND, INDIANA 46601 PH. (574) 234-3167	N W E S			Elkhart County 205(j) Grant Puterbaugh Creek - Heaton Lake Watershed Management Plan Critical Areas Map