Lower Little Wolf River Priority Watershed

Surface Water Resources

Appraisal Report

Prepared By

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I. Introduction

The function of this surface water resources appraisal is to summarize the existing condition of the surface water resources of the Lower Little Wolf River Watershed in order to develop surface water resource goals and objectives for each subwatershed.

The surface water resources appraisal workgroup was formed to identify water quality problems associated with nonpoint source pollution, determine the potential use of the water resources, ascertain the potential for the water resources to recover, and develop preliminary surface water resources goals and objectives. These preliminary surface water resources goals and objectives will be combined with land use inventories data (such as critical sites, barnyards, land uses and streambank cover) to produce the final water resources goals and objectives, including pollution reduction goals for the project.

The surface water resources appraisal report is designed to assist the planner and county staff in writing the watershed management plan and is not meant to be a comprehensive document of water quality. To characterize water quality with the data gathered in one monitoring season can not be conscientiously done. The Lower Little Wolf River Watershed ranked "medium priority" for surface water and "high priority" for groundwater under the Nonpoint Source (NPS) Priority Watershed selection process. Lakes in this watershed were not included in the ranking due to the lack of sufficient data available. However, Bear Lake was ranked "high priority" under the NPS Priority Lakes selection process (Wolf River Basin Water Quality Management Plan, 1996).

II. Summary of Watershed Conditions

The Lower Little Wolf River Watershed is approximately 152 square miles in size and lies entirely in Waupaca County. The "lower" portion of the Little Wolf River begins at the hydroelectric dam at Big Falls and continues for about 27 miles to the confluence of the South Branch Little Wolf River. There are a total of 149.6 miles of named and unnamed streams in the watershed. Land use in the watershed is primarily agriculture though a significant portion is wooded.

Cold water trout streams in the watershed include the North Fork Blake Creek, the South Fork Blake Creek, Spaulding Creek, the South Fork Whitcomb Creek and Whitcomb Creek and Blake Creek. These streams are located in the mostly wooded, northwestern region of the watershed. The Little Wolf River and the near mouth area of Blake Creek are considered to be warm water sport fish communities. All others in the watershed are considered to be either forage fish communities or have insufficient data to characterize them.

Meters to continuously monitor diel and rain event induced fluctuations in temperature and dissolved oxygen were placed in streams of the watershed for approximately one week at a time. Dissolved oxygen was normally quite good and only one violation of the state dissolved oxygen standard occurred.

Water chemistry runoff samples were collected on June 17th at several places in the watershed. This monitoring coincided with a 1 in 50 year rain event that deposited over 6.8 inches of rain in a 72 hour period (State Climatologist, pers. comm. 1996). Results from the sampling show elevated levels of total P, ortho P, bacteria and in some cases, nitrates and suspended solids. Most other water chemistry monitoring conducted before and after this storm indicate good water quality with results that show low levels of the above parameters. Events like the pre-June 17th rainstorm are rare enough that the results will not be used to establish nutrient reduction goals.

Many of the streams in the watershed showed evidence of extreme flashiness. In some cases, debris was found 4 feet above normal water levels. Increasing water infiltration or retaining runoff by changing landuse patterns will hopefully reduce the severity and duration of runoff events and increase baseflow to provide more consistent water levels.

There are 21 lakes in the watershed. Most are seepage with small basins. Five waterbodies, representing a cross section of the different lake types in the watershed were monitored. The results indicate the lakes of the watershed are generally in good condition with few problems noted. Exceptions include Manawa Millpond, Bear Lake and School Section Lake which have higher than average nutrient levels.

III. Methods

Monitoring activities for the water resources appraisal were conducted from September 1995 through September 1996. The following is a summary of the methods employed to collect information for the appraisal report.

A. Macroinvertebrates

Aquatic macroinvertebrates were collected at 8 sites in the fall of 1995 and again in the spring of 1996. They were sampled using a D-frame net as outlined by Hilsenhoff (1982). The samples were preserved in 70% isopropyl alcohol and sent to the University of Wisconsin-Stevens Point Entomology Lab to be sorted and identified. Sample results were evaluated using the Hilsenhoff Biotic Index (HBI), which is a measure of organic loading to streams in the stream segment directly above the sample site (Table 3). The percent Ephemeroptera, Plecoptera and Tricoptera (EPT) genera out of all the genera in each sample will be calculated. These insect orders are considered to be intolerant of organic pollution and therefore, the higher the EPT percentage the lower the organic pollution.

B. Stream Habitat Evaluations

Stream habitat evaluations were conducted at 23 locations in the watershed using the stream habitat evaluation guidelines developed by Ball (1982). Habitat evaluations assess physical stream conditions like streamflow, width, depth, substrate composition and streambank characteristics. These evaluations rate the stream segment from "excellent" to "poor" depending on the habitat that is present.

C. Runoff Sampling

Runoff samples were collected at 7 sites. The parameters monitored include: total and dissolved phosphorous, suspended solids, biochemical oxygen demand (BOD), ammonia, and nitrite/nitrate nitrogen.

Fecal coliform bacteria and fecal streptococcus bacteria were monitored to determine if any State Standards violations occurred. Wisconsin Administrative code stipulates that Membrane Filter Fecal Coliform Count may not exceed 400/100 mg/l in more that 10% of all samples collected during any month (Chapter NR 102.04 (5) (a) 1993). Based upon this standard, bacteria counts 400/100 mg/l and greater are considered high.

D. Continuous Dissolved Oxygen (D.O.) and Temperature Monitoring

Temperature and dissolved oxygen were continuously monitored in roughly one week intervals during the summer of 1996. This was done at 10 sites in the watershed using the Hydrolab Recorder-Water Quality Multiprobe Logger. The minimum dissolved oxygen level established by Wisconsin Administrative Code NR 102, in order to maintain favorable aquatic life, is 5 mg/l for warmwater and 6 mg/l for coldwater. Excess nutrients affect water quality by promoting the growth of both algae and macrophytes. Plants actively photosynthesize during the day and produce abundant oxygen. At night plants use up oxygen during respiration. Dramatic dissolved oxygen fluctuations can stress or kill fish and other aquatic life.

E. Low Flow Monitoring for Nitrates and Triazine

Nitrate samples were collected in mid-February during a period of extreme cold when the possibility of surface runoff was very low. This was done to locate areas of surface water that had high levels of nitrates. Normal background levels of nitrates in surface water are between 1-2 mg/l, values in excess indicate contamination (Dr. Byron Shaw, UW Stevens Point, pers.comm.).

Surface water triazine samples were taken at 5 sites during mid-summer low flow conditions. Only two samples had any detections with 0.3 ppb being the highest.

F. Lake Monitoring

Five lakes were monitored in 1996 to determine their Trophic Status Index (TSI). TSI is defined as the extent to which lakes have become enriched with nutrients, thereby increasing the production of rooted aquatic plants and algae. Lake trophic classifications range from oligotrophic (nutrient poor), to eutrophic (productive and fertile). TSI can be determined for a lake using chlorophyll-a, surface total phosphorus, or secchi disk depth data (Table 4).

G. Fishery Surveys

Twenty five stations were sampled in the watershed during August and September. Fish were sampled using a standard WDNR-type DC stream electroshocker equipped with three electrodes and powered by a 2500 watt AC generator. At each station all fish were captured, identified, counted and released; however, fish species that could not be identified were preserved in formalin for later identification by Professor Phil Cochran, St Norberts College. All trout were measured and weighed. In the Wisconsin version of the warmwater (Lyons, 1992) and coldwater Index of Biotic Integrity (IBI) (Lyons, 1996), fish assemblages were used to assess environmental degradation. Fish habitat and fish population assessments were also conducted (Niebur and Hitchcock-Esch, 1996).

IV. Results and Discussion

Current biological use, limiting factors, observed or potential sources of pollutants, and surface water resource goals and objectives for each subwatershed are listed in Table 1. Monitoring results are presented in Table 2.

Following the tables is a discussion of the appraisal monitoring results for each subwatershed in the Lower Little Wolf River Watershed (Figure 1). The subwatershed descriptions provide a summary of the available information on each stream evaluated, a discussion of the present surface water resource conditions, the factors affecting the resource and the potential for the resource to improve should the factors be controlled.

Table 1

Name of Stream: All named and some unnamed streams are listed. Stream names are those found on U.S. Geological Survey (USGS) quadrangle maps unless the Wisconsin Geographic Names Council established a different name. Unnamed streams are identified by township, range and section.

Length: Stream length is either the total length of the stream or the starting and ending mile of the portion of the stream described based on data from the Fish Distribution Study conducted by the Bureau of Research (1984). The stream mile at the mouth is zero ("0") and increases as one moves upstream.

Biological Use Classification: This column indicates a particular stream's current biological use listed in the Wolf River Basin Water Quality Management Plan (DNR, 1996). The following abbreviations for streams are used in the table:

COLD -cold water community; includes surface waters capable of supporting a community of cold water fish and other aquatic life or serving as a spawning area for cold water fish species.
Class I - Trout populations that are sustained entirely by natural reproduction.
Class II - Some natural reproduction of trout, but stocking is needed to maintain a desirable fishery.
Class III - No natural reproduction of trout, stocking is required for desirable fishery.

WWSF -warm water sport fish community; includes surface waters capable of supporting a community of warm water sport fish or serving as a spawning area for warm water sport fish.

WWFF -warm water forage fish community; includes surface waters capable of supporting an abundant diverse community of forage fish and aquatic organisms.

LFF -limited forage fishery; includes surface waters of limited capacity because of low flow, naturally poor water quality or poor habitat. These surface waters are capable of supporting only a limited community of forage fish and aquatic life.

LAF -limited aquatic life; includes surface waters severely limited because of very low or intermittent flow and naturally poor water quality or poor habitat. These surface waters are capable of supporting only a limited community of aquatic life.

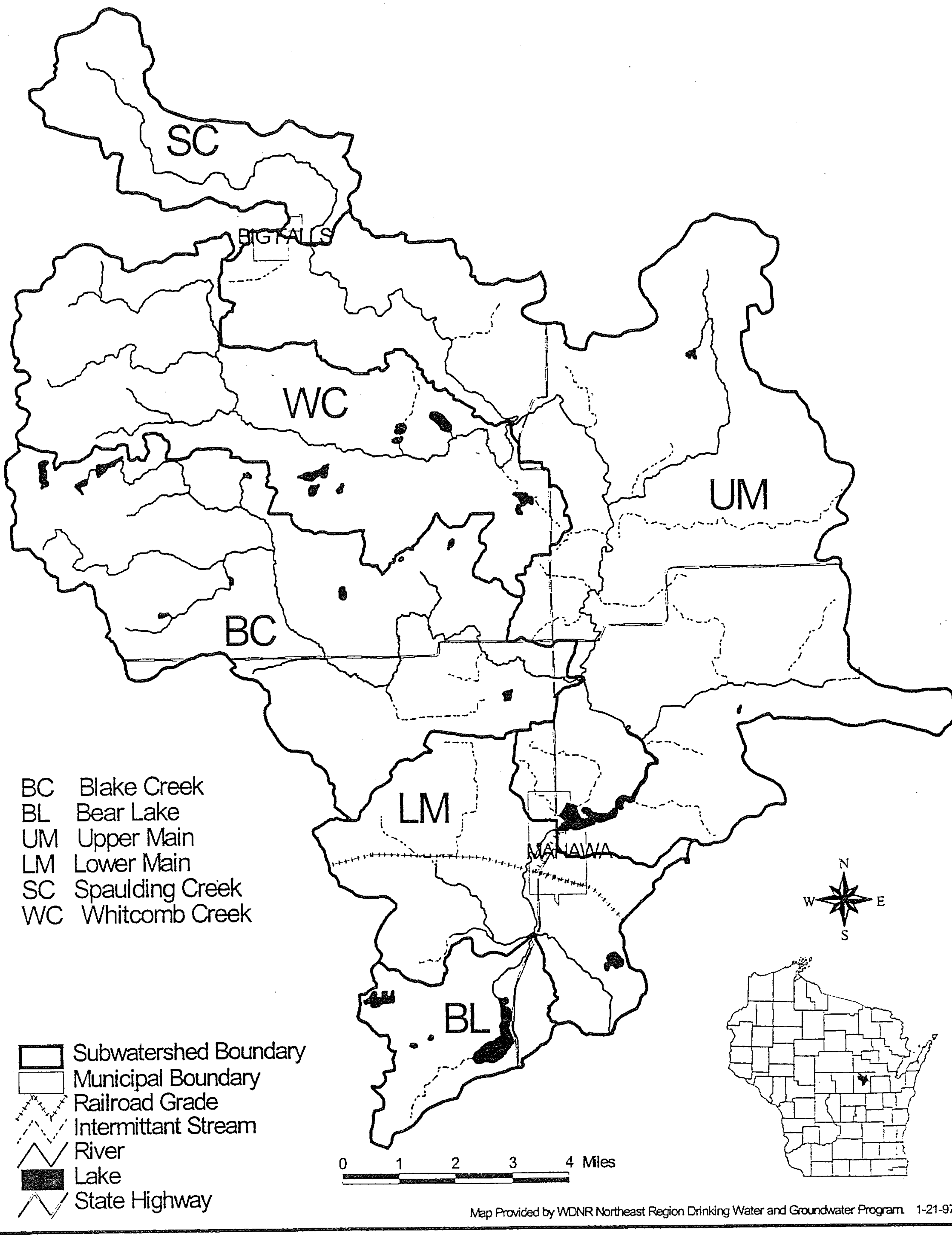
UNK -unknown; insufficient data on the surface water.

Use Problems, Limiting Factors/Sources: This column indicates the probable sources of pollution in the stream and the types of water quality problems present.

Sources	NPS - Unspecified nonpoint sources	PSB - Streambank pasturing
	CON - Construction site runoff	URB - Urban runoff
	BY - Barnyard or exercise yard runoff	CL - Cropland erosion
	DCH - Ditching	DRDG - Dredging

Factors	SED - Sedimentation	HAB - Habitat (lack of cover, sedimentation, scouring, etc.)
	TURB - Turbidity	NH3 - Ammonia toxicity
	DO - Dissolved oxygen	FLOW - Unnatural stream flow fluctuation conditions
	NUT - Nutrients	TEMP - Temperature (fluctuations or extreme high or low)

LOWER LITTLE WOLF WATERSHED



Map Provided by WDNR Northeast Region Drinking Water and Groundwater Program. 1-21-97.

Table 1: Surface Water Resources Conditions, Goals, and Objectives for the Lower Little Wolf River Watershed

SUBWATERSHED	STREAM NAME	LENGTH (MILES)	BIOLOGICAL USE (MILES)	LIMITING FACTORS	OBSERVED OR POTENTIAL SOURCES	SURFACE WATER RESOURCE GOALS	SURFACE WATER RESOURCE OBJECTIVES
Spaulding Creek	Spaulding Creek	0-2 2-10	Cold II (2) Cold I (8)	HAB	BDAM, CON	-Protect and enhance aquatic life habitat	-Reduce sediment delivered to the stream -Promote the use of forestry BMP's -Conduct habitat improvement projects -Control construction site erosion -Protect and enhance stream buffers
Whitcomb Creek	Whitcomb Creek	0-18	Cold I (18)	HAB, SED, TEMP	NPS, CL, PSB, SB	-Reduce duration and intensity of high flow events -Maintain and improve aquatic life habitat -Maintain and improve water quality	-Promote agricultural BMP's -Reduce sediment delivered by 18% -Create, enhance and preserve stream buffers -Create, enhance and preserve wetlands -Promote adoption of forestry BMP's -Discourage drainage ditching and field tiling -Install habitat improvement structures -Reduce nutrients delivered to surface water -Expand fee acquisition project and include portions for stewardship easements -Control construction (road and home) site erosion
	S. Fork Whitcomb Creek	5	Cold I (5)				
	Unn. Trib. to Whitcomb Creek (T24N-R13E-S16)	2	Cold I (2)				
	Unn. Trib. to Whitcomb Creek (T24N-R12E-S12)	<1	WWSF <1				
Blake Creek	Blake Creek	0-5 5-14	WWSF (5) Cold II (9)	HAB, SED, TEMP	NPS, CL, PSB, SB	-Reduce duration and intensity of high flow events -Maintain and improve aquatic life habitat -Maintain and improve water quality	-Promote agricultural BMP's -Reduce sediment delivered by 25% -Create, enhance and preserve stream buffers -Create, enhance and preserve wetlands -Discourage drainage ditching and field tiling -Expand fee acquisition project area -Purchase streambank easements -Install habitat improvement structures -Control construction (road and home) site erosion
	North Fork Blake Creek	6	Cold II (6)				
	South Fork Blake Creek	0-1 1-8	Cold II (1) Cold I (7)				
Upper Main	Little Wolf River	26.6	WWSF (26.6)	BAC, HAB, SED, TEMP	DRDG, NPS, PSB, SB, UR	-Reduce duration and intensity of high flow events -Maintain and improve aquatic life habitat -Maintain and improve water quality	-Promote agricultural BMP's -Reduce sediment delivered by 27% -Create, enhance and preserve stream buffers -Discourage drainage ditching and field tiling -Install habitat improvement structures -purchase stewardship easements on the Little Wolf River -Reduce nutrients delivered to surface water -Create, enhance and preserve wetlands -Control construction (road and home) site erosion
	Little Creek	7	WWFF (7)				
	Shaw Creek	9	WWSF (9)				
	Beaver Creek	4	Unknown				
	Fountain Creek	2	Unknown				
Lower Main	Thiel Creek	4	WWFF (4)	BAC, HAB, SED, TEMP, FLOW	DRDG, NPS, CL, PSB, SB, PSM, UR	-Reduce duration and intensity of high flow events -Maintain and improve aquatic life habitat -Maintain and improve water quality	-Promote agricultural BMP's -Reduce sediment delivered by 23% -Create, enhance and preserve stream buffers -Discourage drainage ditching and field tiling -Install rip-rap for erosion control and sturgeon spawning habitat -Create, enhance and preserve wetlands -Control construction (road and home) site erosion -Reduce nutrients delivered to surface water
Bear Lake	Spiegelberg Creek	5	WWFF	BAC, HAB, SED	SL, PSB, NPS, CL	-Maintain and improve aquatic life habitat -Maintain and improve water quality	-Promote agricultural BMP's -Reduce sediment delivered by 16% -Create, enhance and preserve stream buffers -Ensure septic systems are functioning correctly -Reduce nutrients delivered to surface water -Create, enhance and preserve wetlands -Control construction (road and home) site erosion

Table 2: Monitoring Summary for the Lower Little Wolf Watershed

SUBWATERSHED	STREAM NAME	WATER CHEMISTRY STREAM SITES	HABITAT RATING (LOCATION)	EPT (PERCENT)	HBI RATING (DATE)	CONTINUOUS D.O. AND TEMPERATURE, LOCATION AND DATES MONITORED
Spaulding Creek	Spaulding Creek	CTH G	106-Good			
			(Blw. CTH G)			
			108-Good			
			(Abv. Spaulding Rd.)			
			117-Good			
			(Blw. CTH E)			
Whitcomb Creek	Whitcomb Creek	CTH E	185-Fair			CTH OO, 8/15-822
			(Abv. CTH OO)			CTH E, 8/15-8/22
			89-Good	42.1	3.26-Excellent (10/95)	
			(Abv. CTH E)	29.7	3.47-Excellent (5/96)	
			104-Good			
			(Abv. Carper Rd.)			
			117-Good			
			(Abv. CTH G)			
Blake Creek	Blake Creek	STH 22	115-Good			STH 22, 8/08-8/15
			(Blw. HWY 161)			STH 161, 8/08-8/15
			195-Fair			
			(Abv. STH 22)			
			201-Poor	53.8	4.08-Very Good (10/95)	
			(Abv. CTH K)	60.0	4.80-Good (5/96)	
	N. Fork Blake Creek		171-Fair			
			(Blw. CTH E)			
	S. Fork Blake Creek		108-Good	52.3	3.36-Excellent (10/95)	
			(Abv. CTH E)	71.5	3.31-Excellent (5/96)	
Upper Main	Little Wolf River	Bridge Road	190-Fair			Bridge Road, 9/10-9/19
		CTH C (Bacteria Only)	(Blw. Bridge Rd.)			Little Falls, 9/10-9/18
			95-Good			
			(Blw. Little Falls)			
			107-Good	41.5	3.02-Excellent (10/95)	
			(Blw. STH 161)	58.3	3.13-Excellent (5/96)	
			166-Fair	54.7	3.23-Excellent (10/95)	
			(Abv. Kretchner Rd.)	59.9	2.96-Excellent (5/96)	
	Little River	CTH O (Bacteria Only)	208-Poor			Cleveland Lane, 8/22-
			(Blw. CTH O)			9/02
	Shaw Creek	CTH O	231-Poor			
			(Abv. CTH O)			CTH O, 8/22-9/10

Table 2: Continued

SUBWATERSHED	STREAM NAME	WATER CHEMISTRY STREAM SITES	HABITAT RATING (LOCATION)	EPT (PERCENT)	HBI RATING (DATE)	CONTINUOUS D.O. AND TEMPERATURE, LOCATION AND DATES MONITORED
Lower Main	Thiel Creek	Little Wolf Cemetery Road	209-Poor (Blw. Swan Rd.)	7.6 0.8	4.36-Very Good (10/95) 5.17-Good (5/96)	Little Wolf Cemetery Road, 8/01-8/08
	Little Wolf River		150-Fair (Blw. CTH BB) 178-Fair (Abv. Little Wolf Cemetery Road)	62.7 70.5	3.21-Excellent (10/95) 3.01-Excellent (5/96)	
Bear Lake	Spiegelberg Creek	Little Wolf Cemetery Road	124-Good (Blw. Bear Lake Rd.) 193-Fair (Abv. Hwy 110 Wayside)	37.2 37.9	5.29-Good (10/95) 5.95-Fair (5/96)	Little Wolf Cemetery Road, 8/01-8/08

Table 3: HBI Rating Values

Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very Good	Possible slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly Poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.0	Very Poor	Severe organic pollution

Table 4: Lake TSI Values and Classification

>50	Eutrophic
40 - 50	Mesotrophic
<40	Oligotrophic

Overall Watershed Goal for the Lower Little Wolf River Watershed

Enhance and protect the water quality of the surface water of the subwatersheds in order to improve the water quality of all subwatersheds and ultimately the receiving water, the Wolf River.

Encourage good land use planning for water quality.

Spaulding Creek Subwatershed

The Spaulding Creek Subwatershed (Table 1) consists of the 10 miles of Spaulding Creek from its headwaters near the Shawano County line to its mouth just below Big Falls. Spaulding Creek is a perennial stream that drains approximately 9.8 square miles of land. The first two miles (measured from the mouth upstream) are considered Cold Class II trout water. The upper eight miles are considered Cold Class I trout water. The entire stream is considered an Outstanding Resource Water (ORW) (NR 102) (Wolf River Basin Water Quality Management Plan, 1996).

Spaulding Creek is the least impacted subwatershed in the entire project. It is mostly forested with a fair number of rural-residences. Small areas of agriculture exist north of the stream on CTH E and east of the stream off of CTH G. Land use in the subwatershed is comprised of 18% agriculture, 51% woodland, 29% wetland, and 2 % urban or developed.

Surface Water Resource Conditions

Spaulding Creek has very good to excellent water quality. The stream is well buffered and no livestock have access to the stream. Streamflow is not a problem and does not seem to limit aquatic organisms. Wetland drainage and groundwater recharge comprise most of the annual flow. Habitat availability is less than desired due to shifting sands and some shallow stream depths. Runoff events and extreme water fluctuations are rare.

Habitat evaluations conducted in the subwatershed to assess the suitability of the habitat to aquatic life were taken at three sites. All the habitat evaluations ranked the stream reaches as "good". Any habitat limitations observed were due to shallow stream depths and some soft sediments. Macroinvertebrate sampling was not conducted in this subwatershed.

Coldwater Index of Biotic Integrity (IBI) (Lyons, 1996) scores for Spaulding Creek ranged from 40 to 70 indicating "fair" to "good" fish community integrity (Niebur and Hitchcock-Esch, 1997). The most common fish species present include brook trout, creek chub, mottled sculpin, pearl dace and blacknose dace. Beaver dams on Spaulding Creek may restrict fish movement and warm water temperatures.

Water chemistry samples were taken at Spaulding Creek at CTH G approximately 2 miles up from the mouth (Table 5). Samples were collected after four runoff events of differing severity. The values of the parameters monitored are indicative of a relatively unimpacted stream. Mid-winter nitrate samples from Spaulding Creek ranged from .26 mg/l to .50 mg/l indicating no contamination.

Table 5: Spaulding Creek Water Chemistry Results

Date	BOD 5 day	Ammonia-N	Nitrate/Nitrite	Total Phosphorus	Ortho-Phosphorus	Suspended Solids	MFFCC-Bacteria	Fecal Strep.
8/18/95	1.9 mg/l	ND	0.082 mg/l	0.044 mg/l	0.012 mg/l	ND		
4/11/96	1.7 mg/l	ND	0.129 mg/l	0.027 mg/l	0.005 mg/l	5.0 mg.l	<10/100 ml	30/100 ml
6/17/96	<3 mg/l	ND	ND	0.065 mg/l	0.013 mg/l	8.5 mg/l	5200/100 ml	3700/100 ml
9/24/96	1.1 mg/l	ND	0.386 mg/l	0.011 mg/l	0.007 mg/l	ND	70/100 ml	120/100 ml

Dissolved oxygen and temperature were not monitored continuously due to time and meter usage conflicts. The parameters were monitored during each grab water chemistry sample and habitat evaluation. Each reading was well above the state standard for cold water streams (NR 102).

Streambanks are generally well buffered with few agricultural activities directly impacting the stream. Substrate is primarily composed of shifting sand, causing the bottom to be in a constant state of change. Habitat is limited to undercut banks, a few riffles, and a lot of woody debris. Trout habitat improvements have been conducted and several fishing easements purchased on this stream. Flora present include *Sparganium sp., Potamogeton sp.,* and aquatic moss.

The water quality of Spaulding Creek is excellent. Aquatic life habitat is good but could be enhanced with habitat improvement structures. Forestry best management practices and construction site erosion control practices would protect this excellent resource.

Goals and Objectives for the Spaulding Creek Subwatershed

1. Maintain and improve aquatic life habitat by:
   - A. reducing the amount of sediment reaching the stream.
   - B. maintaining buffers that filter sediments and pollutants, provide shading and stabilize streambanks.
   - C. controlling construction site erosion by using best management practices.
   - D. promoting the use of forestry best management practices.
   - E. supporting habitat improvement projects.

Whitcomb Creek Subwatershed

The Whitcomb Creek subwatershed consists of the North Branch, South Branch and mainstem Whitcomb Creek, two unnamed tributaries to Whitcomb Creek, Blue Mountain Lake, Campbell Lake, Cedar Lake, Price Lake, School Section Lake, and North and South Twin Lakes. In total there are 23 miles of named streams and 3 miles of unnamed streams. The streams are all perennial and drain a total of 27.6 square miles of land. The five miles of the South Fork Whitcomb Creek is considered Cold Class I trout water and an Exceptional Resource Water (ERW). All 18 miles of Whitcomb Creek are considered to be Cold Class I trout water and an ORW (Wolf River Basin Water Quality Management Plan, 1996). In general, the stream reaches west of CTH E are trout waters, and the reaches east of CTH E support forage minnows.

The western part of this subwatershed is mostly forested with little agricultural land use activities occurring. In the eastern part, land use is dominated by agricultural activities. Large wetlands exist and presumably provide some baseflow. Land use in the subwatershed is comprised of 43% agriculture, 32% woodland, 20% wetland, and 5% urban or developed.

Surface Water Resource Conditions

The surface water resources of the Whitcomb Creek subwatershed are in good condition. Water quality is significantly better in the western half of the subwatershed where woodlands and wetlands dominate land use, than in the eastern half of the subwatershed where agricultural land use predominates. The streams are well buffered in the headwaters and mid-reaches and become more poorly buffered closer to the mouth. Numerous wetlands cause the stream to become shallower and wider than desired, limiting habitat to woody debris and a few riffles.

The lakes in this subwatershed are fairly small and relatively deep with small (generally less than one square mile) basins. Number of lake lots vary from 0 at North Twin Lake to 28 at Blue Mountain Lake. Marl deposits predominate the sediments of these hardwater lakes. The marl precipitates phosphorus out of the water column resulting in lower algae production and better water clarity. TSI values for the lakes monitored indicate they are moderately fertile to fertile with School Section Lake having the highest values (Table 6).

Table 6: Lakes of the Whitcomb Creek Subwatershed

Lake Name	Lake Type	Surface Area (Acres)	Maximum Depth (Feet)	Number of Lots	Chlorophyll-a TSI	Surface Total Phosphorus TSI	Secchi Disk Depth TSI
Blue Mountain	Seepage	7	8	28			
Campbell	Seepage	38	28	12	45	49	50
Cedar*	Drainage	45	50	25	48	49	55
Price	Seepage	15	26	2			
School Section	Spring	39	38	12	59	59	53
Twin (North)	Seepage	27	26	0			
Twin (South)	Seepage	11	25	1			

* TSI Values Derived From Self Help Data Collected By John Blohm

Habitat evaluations conducted to assess the suitability of the habitat to aquatic life were taken at numerous sites in the subwatershed. The stream segments ranked out from "good" to "fair". Most of the habitat limitations stem from shallow stream depths and abundant soft sediments. Rock, cobble, and gravel habitat is very limited, woody debris is abundant. Hilsenhoff Biotic Indices (HBI) (1982) samples collected downstream of the CTH OO bridge in October, 1995 and again in May, 1996 indicate "excellent" water quality (Table 2). This rating indicates that there is little organic loading to this stream segment.

The headwaters of Whitcomb Creek had coldwater IBI (Lyons, 1996) scores of 90-100 indicating "excellent" fish community structure. Lower reaches had IBI scores from 50-60 indicating "fair" to "good" fish community integrity. The upper reaches were dominated by intolerant brook trout and northern brook lampreys. Fish species in the lower reaches were dominated by brook trout and the more tolerant creek chubs, common shiners, and white suckers (Niebur and Hitchcock-Esch, 1997).

Water chemistry data was collected three times at Whitcomb Creek at CTH E. Most of the data indicates very good to excellent water quality (Table 7). Mid-winter nitrate

Table 7: Whitcomb Creek Water Chemistry Samples

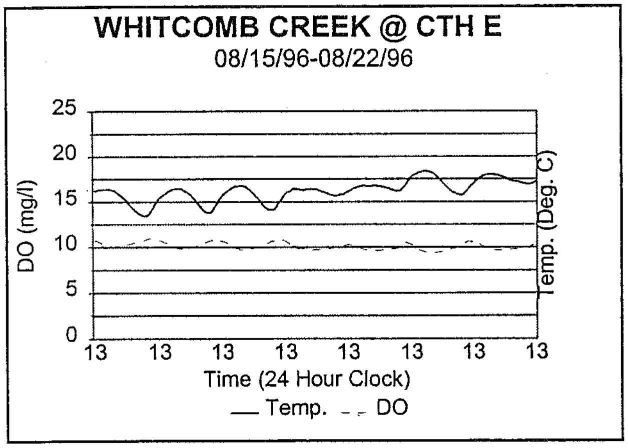
Date	BOD 5 day	Ammonia-N	Nitrate/Nitrite	Total Phosphorus	Ortho-Phosphorus	Suspended Solids	MFFCC-Bacteria	Fecal Strep.
08/18/95	2.2 mg/l	ND	0.391 mg/l	0.038 mg/l	0.010 mg/l	ND		
06/17/96	<3 mg/l	ND	0.193 mg/l	0.076 mg/l	0.007 mg/l	24.5 mg/l	6300/100 ml	3000/100 ml
09/24/96							100/100 ml	120/100 ml

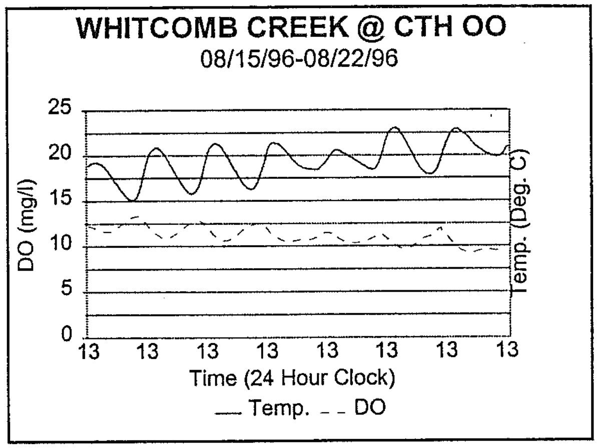
Continuous dissolved oxygen and temperature monitoring was conducted at Whitcomb Creek at both CTH OO and at CTH E from August 15 - August 22, 1996. In that time, dissolved oxygen never fell below 9 mg/l. It is unlikely that this stream has a problem with low dissolved oxygen levels (Figure 2).

The substrate of the streams of this subwatershed are composed primarily of sand. Wetland drainage and groundwater recharge provide the primary stream baseflow. Due to the sandy soil conditions, runoff occurs only during the most severe precipitation events. Macrophytes, including *Potamogeton spp., Ranunculus sp.,* and

Sparganium sp., were scarce to abundant. An antiquated dam structure is located above CTH E. It does not back up any water or negatively impact the stream.

Figure 2:





The surface waters of the Whitcomb Creek Subwatershed will benefit from the adoption of forestry (west) and agricultural (east) best management practices (BMP's). BMP's will decrease sediment delivery to the streams and increase aquatic life habitat. Habitat would improve if stream widths decreased and stream depths increased. The installation of habitat improvement structures and the purchase of conservation easements along the margins of the streams and lakes will benefit fish as well as other aquatic life.

Goals and Objectives for the Whitcomb Creek Subwatershed

1. Maintain and improve aquatic life habitat by:
   - A. reducing sediment delivered by 18%
   - B. installing habitat improvement structures.
   - C. creating, preserving, and enhancing stream buffers that filter sediments, provide shading, and stabilize streambanks.
   - D. expanding the Whitcomb Creek Fee Acquisition Project and including portions for stewardship easements.
   - E. controlling construction site erosion.
2. Maintain and improve water quality by:
   - A. controlling nutrients by a low level.
   - B. promoting agricultural best management practices.
   - C. promoting the adoption of forestry best management practices.
3. Reduce duration and intensity of high flow events by:
   - A. promoting agricultural practices that foster the infiltration of runoff.
   - B. discouraging the use of drainage ditching and field tiling.
   - C. create, enhance, and maintain wetlands for runoff attenuation.

Blake Creek Subwatershed

The surface water in the Blake Creek subwatershed consists of the North Fork, South Fork, and mainstem Blake Creek, Chapin Lake, Goodhal Lake, Gregerson Lake, Lutz Lake, Roland Lake and Storm Lake. There are 28 miles of named streams in the subwatershed that drain 33.2 square miles of land. One mile of stream has an existing use as Cold Class I, 22 miles are considered Cold Class II, and five miles of stream are considered Warm Water Sport Fish. All Cold Class I and Cold Class II portions of the streams are ERW streams as designated in NR 102 (Wolf River Basin Water Quality Management Plan, 1996).

The western half of the subwatershed is mostly forested with a few agriculture operations and rural residences. The east part of the subwatershed is mostly agricultural with little forested acreage. Large wetland complexes exist in the watershed and provide some baseflow. Land use in the subwatershed is 43% agriculture, 29% woodland, 24% wetland, and 4% urban or developed.

Surface Water Resource Conditions

The surface water resources of the Blake Creek subwatershed are generally in good condition. The streams are well buffered west of CTH E and more poorly buffered east of CTH E. A significant portion of stream flows through wetlands, causing the streams to be wider and shallower than desired. Habitat is often limited to woody debris and small pools and riffles. The streams have good water clarity but are often stained tannin-brown due to wetland drainage.

The lakes of this subwatershed are small, mostly seepage with little development. They are mostly private with no public access except by town roads. None of the lakes in this subwatershed were monitored in 1997 (Table 8).

Table 8: Lakes of the Blake Creek Subwatershed

Lake Name	Lake Type	Surface Area (Acres)	Maximum Depth (Feet)	Number of Lots
Chapin	Seepage	9	25	0
Goodhal	Seepage	32	10	30
Gregerson	Seepage	35	5	8
Lutz	Spring	14	21	3
Roland	Seepage	13	19	2
Storm	Seepage	16	17	6

Habitat evaluations conducted in the subwatershed ranked the streams from "good" to "poor". Due to the large amounts of soft sediments, these habitats ranked less than anticipated. In general, reaches farther upstream had better habitat rankings. HBI macroinvertebrate samples from Blake Creek at CTH K rated this stream segment as "very good" in October of 1995 and "good" in April of 1996 (Table 2). These results indicate that some organic pollution is impacting this stream segment (Table 3). The HBI sampling from the South Branch Blake Creek at CTH E rated the water quality as "excellent" in October of 1995 and again in April 1996 (Table 2). A rating of excellent indicates that organic pollution, if present, is not impacting this stream segment (Table 3) (Hilsenhoff, 1982).

The headwaters of Blake Creek had coldwater IBI (Lyons,1996) scores of between 60-80 indicating "good" fish community structure. Lower reaches had IBI scores from 40-50 indicating "fair" fish community integrity. The upper reaches were dominated by intolerant brook trout while fish species in the lower reaches were dominated by the more tolerant creek chubs, common shiners, and burbot. Fisheries data suggests that water quality degrades rapidly below the first crossing of State Highway 161 (Niebur and Hitchcock-Esch, 1997).

Water chemistry samples were collected four times after runoff events at Blake Creek at STH 22/110 (Table 9). The results indicate Blake Creek is in fair condition. A triazine sample taken at Blake Creek at STH 22/110 on

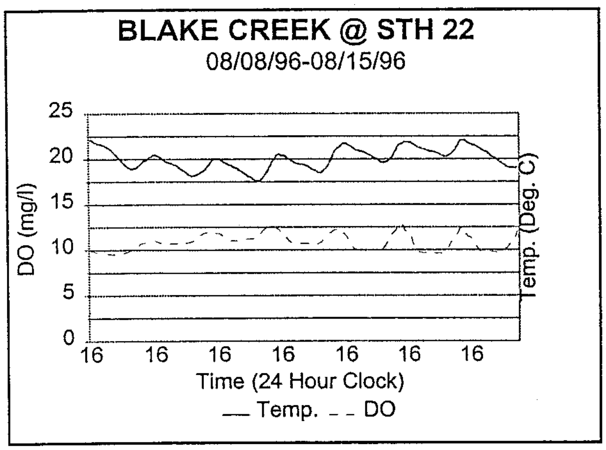
September 9, 1996 was returned as having no detections. Mid-winter nitrate samples collected in the subwatershed ranged from .21 mg/l to 2.0 mg/l indicating possible slight organic pollution.

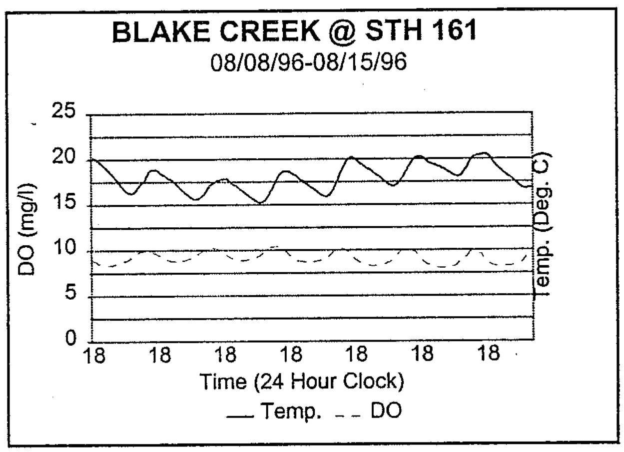
Table 9: Blake Creek Water Chemistry Samples

Date	BOD 5 day	Ammonia-N	Nitrate/Nitrite	Total Phosphorus	Ortho-Phosphorus	Suspended Solids	MFFCC-Bacteria	Fecal Strep.
8/17/95	2.3 mg/l	0.030 mg/l	0.043 mg/l	0.162 mg/l	0.076 mg/l	ND		
4/11/96	1.9 mg/l	0.036 mg/l	0.170 mg/l	0.063 mg/l	0.016 mg/l	ND	30/100 ml	80/100 ml
6/17/96	3.8 mg/l	0.120 mg/l	2.23 mg/l	0.425 mg/l	0.187 mg/l	49 mg/l	37000/100 ml	88000/100 ml
9/24/96	1.0 mg/l	ND	0.933 mg/l	0.022 mg/l	0.009 mg/l	ND	600/100 ml	180/100 ml

Dissolved oxygen and temperature were monitored near the mouth of Blake Creek at STH 22/110 and upstream at STH 161 (crossing nearest to CTH E) from August 8 - August 15. Both monitoring runs showed classic diel dissolved oxygen and temperature swings indicating that some primary production was taking place. The lowest D.O. level recorded was about 8.0 mg/l, well above the state standard (Figure 3).

Figure 3:





The aquatic life habitat and water quality of the Blake Creek Subwatershed is impacted by eroded soil. This soil causes increased sedimentation of riffles and pools. Water quality remains good and dissolved oxygen does not limit the aquatic fauna present. Macrophytes present include *Sparganium sp., Sagittaria sp., Potamogeton richardsonii, and Potamogeton zosteriformes.*

The streams of the Blake Creek Subwatershed would benefit from reduced sediment delivery. Streambank stabilization in wetland areas would decrease stream width and increase stream depth. With appropriate agricultural BMP's aquatic life habitat could improve enough to support more diverse communities of flora and fauna.

Goals and Objectives for the Blake Creek Subwatershed

1. Maintain and improve aquatic life habitat by:
   - A. reducing sediment delivered by 25%.
   - B. creating, preserving, and enhancing stream buffers that filter sediments, provideshading, and stabilize streambanks.
   - C. controlling construction (home and road) site erosion.
   - D. installing habitat improvement structures.
   - E. expanding Blake Creek Fee Acquisition Project.

F. including lower watershed in stewardship program for streambank easements.

2. Maintain and improve water quality by:
   A. controlling nutrients delivered to the surface water.
   B. promoting agricultural best management practices.
   C. encouraging good land use planning.
3. Reduce duration and intensity of high flow events by:
   A. promoting agricultural practices that foster the infiltration of runoff.
   B. discouraging the use of drainage ditching and field tiling.
   C. create, enhance, and preserve wetlands for runoff attenuation.

Upper Main Subwatershed

The surface water resources in the Upper Main Subwatershed consist of the Little Wolf River from the dam at Big Falls to the dam at Manawa, Beaver Creek, Shaw Creek, Little Creek, Driscol Lake, Mud Lake and the Manawa Millpond. There are 37.6 miles of named streams in this subwatershed that drain 58.3 square miles of land. Shaw Creek and Little Creek are considered Warm Water Forage Fish communities. The Little Wolf River is classified as a Warm Water Sport Fish community (DNR, Wolf River Basin Water Quality Management Plan, 1996).

The land use in this subwatershed is primarily agriculture with a few large wetlands. Most of the northern and western portions of the Village of Manawa are in this subwatershed. Land use in the subwatershed is 61% agriculture, 29% woodland, 6% wetland, and 4 % urban or developed.

Surface Water Resource Conditions

The surface waters of the Upper Main Subwatershed can be broken down in to two segments, the Little Wolf River proper and the tributaries that feed it. The Little Wolf River has excellent water quality and good habitat. The streambanks are well buffered though limited areas of livestock access do exist. Shaw Creek and Little Creek have poor water quality and are significantly degraded by sediment. The streams are poorly buffered and the streambeds are mostly comprised of soft sediments. Little Creek suffers increased water temperatures and sedimentation rates due to intensive agricultural ditching that has occurred in the upper reaches. Shaw Creek has poor aquatic life habitat due to high amounts of shifting sand substrate. Beaver Creek is an extensively ditched intermittent stream that has little flow most of the year.

Manawa Millpond is an impoundment that drains 131 square miles. The millpond traditionally supports dense summer growths of aquatic plants as well as nuisance levels of algae. Poor TSI values support the assertion that the millpond is very fertile and eutrophic. The property owners around the Millpond have begun to organize into a lake district. The other lakes in the watershed are undeveloped and only slightly impacted by the land use around them (Table 10).

Table 10: Lakes of the Upper Main Subwatershed

Lake Name	Lake Type	Surface Area (Acres)	Maximum Depth (Feet)	Number of Lots	Chlorophyll-a TSI	Surface Total Phosphorus TSI	Secchi Disk Depth TSI
Driscol	Seepage	6	10	0			
Manawa	Drainage	192	12	41	47	57	54
Mud	Seepage	13	5	2			

Habitat evaluations conducted on the Little Wolf River ranked the stream from "good" to "fair". Habitats from Little Creek and Shaw Creek both ranked out as "poor". Silt and shifting sand substrate combined to bring these rankings down. Little Creek and Shaw Creek have very little stable habitat aside from woody debris. The Little Wolf River has some excellent habitat and riffle areas separated by stretches of sand and slack water. HBI insect data was collected on the Little Wolf River at Kretchner Road and at CTH B. The samples were taken in October, 1995 and again in May, 1996. Sample results indicate "excellent" water quality and limited organic pollution (Table 4) (Hilsenhoff, 1982).

The warmwater IBI (Lyons, 1992) scores from the Little Wolf River ranged from 77-90 indicating "excellent" water quality. Shaw Creek had warmwater IBI scores of 47 (fair) and 0 (very poor). Little Creek had a warmwater IBI score of 0 (very poor). The "very poor" IBI ratings occurred because not enough fish species were collected to calculate a score. The most common fish species present in the Little Wolf River include Blackside darters, white suckers, northern hog suckers, burbot, and common shiners. Common fish species at the IBI site at Shaw Creek included johnny darters and burbot (Niebur and Hitchcock-Esch, 1997).

Water chemistry samples were collected three times at Bridge Road on the Little Wolf River (Table 11). Most of the water chemistry results indicate good water quality. One additional bacteria sample was collected from the Little Wolf River at CTH C and indicated no problems. Mid-winter nitrate samples collected from the Little Wolf River ranged from 2.4 mg/l to 2.6 mg/l indicating some slight organic pollution.

Table 11: Little Wolf River Water Chemistry Samples

Date	BOD 5 day	Ammonia-N	Nitrate/Nitrite	Total Phosphorus	Ortho-Phosphorus	Suspended Solids	MFFCC-Bacteria	Fecal Strep.
4/11/96	1.7 mg/l	ND	0.689 mg/l	0.056 mg/l	0.019 mg/l	5.0 mg/l	10/100 ml	100/100 ml
6/17/96	<3 mg/l	0.072 mg/l	1.39 mg/l	0.216 mg/l	0.094 mg/l	40.7 mg/l	27000/100 ml	42000/100 ml
9/24/96	1.3 mg/l	ND	1.89 mg/l	0.010 mg/l	0.004 mg/l	5.0 mg/l	70/100 ml	70/100 ml

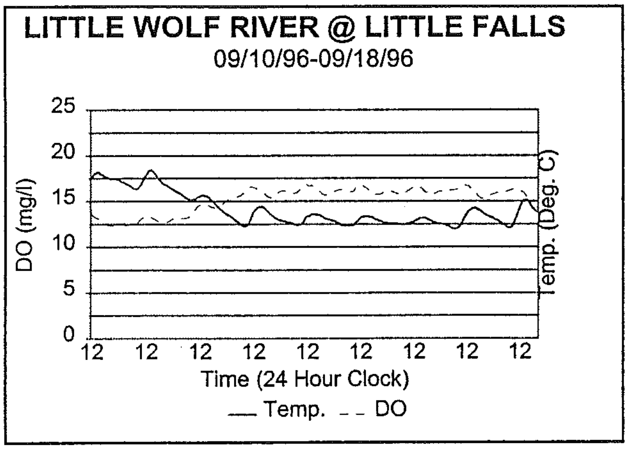
One water chemistry sample and one bacteria sample were taken at Shaw Creek at CTH O (Table 12). The high total and ortho phosphorus results indicate some organic loading to the stream. The ortho or soluble phosphorus value is quite high. A bacteria sample taken from Little Creek at CTH O did not indicate any problems with bacteria contamination. Triazine samples were collected from Shaw Creek at CTH O and from Little Creek at CTH O. Triazines were not detected in the Shaw Creek sample, but were detected at 0.3 parts per billion at Little Creek. This level is one tenth of the preventative action limit for triazine. Mid-winter nitrate samples collected from Shaw Creek and Little Creek ranged from .15 mg/l to .99 mg/l indicating little if any organic pollution present.

Table 12: Shaw Creek Water Chemistry Samples

Date	BOD 5 day	Ammonia-N	Nitrate/Nitrite	Total Phosphorus	Ortho-Phosphorus	Suspended Solids	MFFCC-Bacteria	Fecal Strep.
8/17/95	2.6 mg/l	0.061 mg/l	0.145 mg/l	0.230 mg/l	0.158 mg/l	ND		
9/24/96							300/100 ml	400/100 ml

Dissolved oxygen and temperature were continuously monitored in one week intervals at two sites at the Little Wolf River, one at Shaw Creek and one at Little Creek. The Little Wolf River was monitored at Bridge Road and at Peterson Road, near Little Falls, from September 10th - September 18th (Figure 4). Shaw Creek was monitored at CTH O from September 22nd - September 2nd (Figure 5). Little Creek was monitored at CTH O from August 22nd - September 10th (Figure 6). All streams had classic diel dissolved oxygen swings, yet no dissolved oxygen standards violations occurred.

Figure 4:



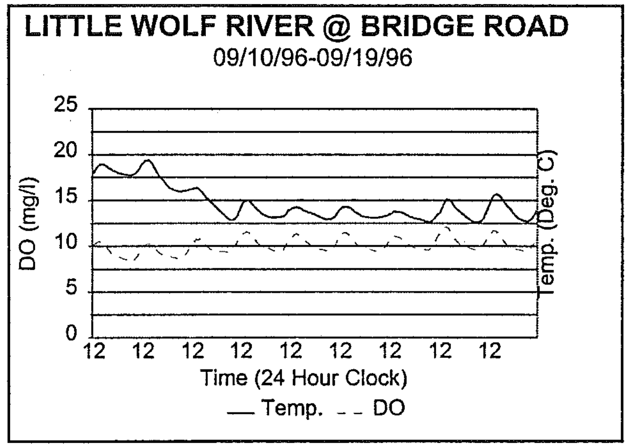


Figure 5:

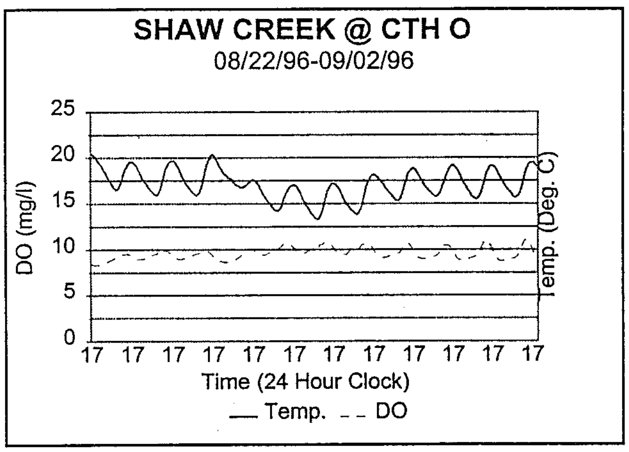
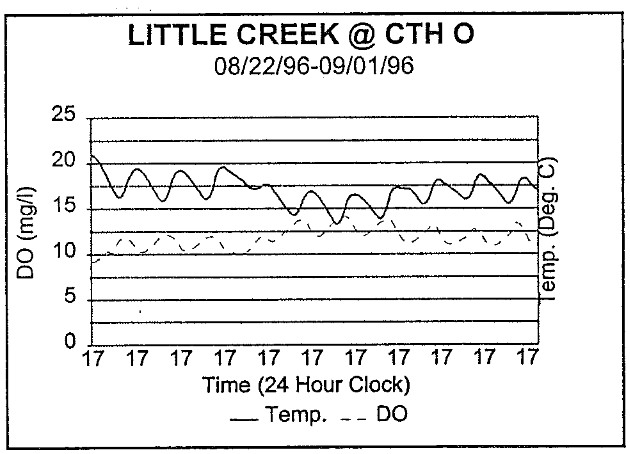
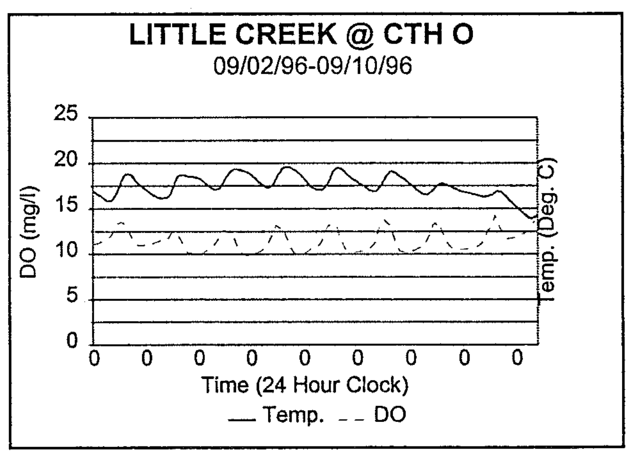


Figure 6:





The aquatic life habitat and water quality of the streams of the Upper Main Subwatershed are severely impacted by the large amounts of sediment being delivered to the streams. Sedimentation of pools and riffles limits aquatic life habitat to aquatic vegetation and woody debris. Shaw Creek and Little Creek are particularly degraded, while the Little Wolf River is in fairly good condition. Macrophytes present include *Sparganium sp., Ranunculus sp., Potamogeton spp., and Sagittaria sp.*

With a high level of sediment control, Little Creek and Shaw Creek could support more diverse populations of invertebrates, fish and other aquatic fauna. Reductions of phosphorus and sediment in the above tributary streams should also translate into reductions for the receiving water, the Little Wolf River. Habitat needs and wetland restoration are critical needs in this subwatershed.

Goals and Objectives for the Upper Main Subwatershed

1. Maintain and improve aquatic life habitat by:
   A. reducing sediment delivered by 27%.
   B. creating, preserving, and enhancing stream buffers that filter sediments, provide shading, and stabilize streambanks.
   C. installing habitat improvement structures.
   D. controlling construction site erosion through the use of best management practices.
   E. purchasing stewardship easements for the Lower Little Wolf River.
2. Maintain and improve water quality by:
   A. controlling nutrients by a medium level.
3. Reduce duration and intensity of high flow events by:
   A. promoting agricultural practices that foster the infiltration of runoff.
   B. discouraging the use of drainage ditching and field tiling.
   C. create, enhance, and maintain wetlands for runoff attenuation.

Lower Main Subwatershed

The surface water resources of the Lower Main Subwatershed consist of the Little Wolf River from the dam in Manawa to the confluents with the South Branch Little Wolf River, Thiel Creek, and Mountain Lake. There are nine miles of stream in this subwatershed that drain 16 square miles of land. The Little Wolf River is classified as a Warm Water Sport Fish community from its mouth to the dam at Manawa and is designated as an ERW in NR 102. Thiel Creek is considered a Warm Water Forage Fish community for its entire length (Wolf River Basin Water Quality Management Plan, 1996).

The Manawa wastewater treatment plant discharges to the Little Wolf River. Most of the Village of Manawa lies within this subwatershed. Land use in the subwatershed is 65% agriculture, 12% woodland, 14% wetland, and 9% urban or developed.

Surface Water Quality Conditions

The surface waters of Thiel Creek are significantly degraded by heavy sedimentation and the lack of aquatic life habitat. Buffering is limited to riparian wetland areas that are unsuitable for agriculture. Substrate is almost entirely comprised of soft sediments and sand. Mud and sludge-like deposits are also in evidence. The Little Wolf River has much better water quality and habitat than Thiel Creek, though habitat is still less than desirable.

Mountain Lake is only lake in the Lower Main Subwatershed. It is relatively shallow and is unimpacted by lake development (Table 13).

Table 13: Lakes of the Lower Main Subwatershed

Lake Name	Lake Type	Surface Area (Acres)	Maximum Depth (Feet)	Number of Lots
Mountain	Seepage	43	7	0

Habitat evaluations (Ball, 1982) ranked Thiel Creek from "poor" to "fair", and Little Wolf River as "good". Soft sediments combine to severely limit the habitat available for aquatic fauna. HBI (Hilsenhoff, 1982) macroinvertebrate data collected at Thiel Creek at Swan Road ranked the stream as "very good" in October, 1995 and "good" in April, 1996. The results from the Little Wolf River, sampled in October, 1995 and May, 1996, came back "excellent".

A warmwater IBI (Lyons, 1992) was conducted on Thiel Creek upstream of Swan Road. The score of 60 indicates "good" water quality. The most common fish species present include common shiners, creek chubs, johnny darters and central mudminnows (Niebur and Hitchcock-Esch, 1997).

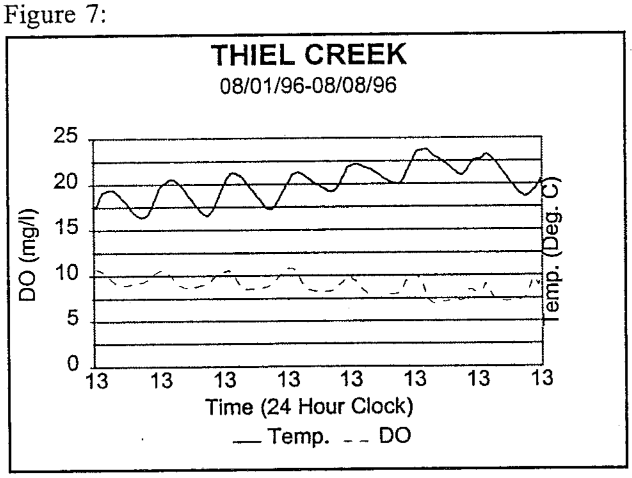
Water Chemistry samples were taken at Thiel Creek at Little Wolf Cemetery Road after 2 rain events (Table 14). Triazines were monitored at Thiel Creek at Little Wolf Cemetery Road and at Little Wolf River at CTH BB. There were no detects from Thiel Creek, but triazines were found at 0.1 parts per billion at the Little Wolf River.

Table 14: Thiel Creek Water Chemistry Samples

Date	BOD 5 day	Ammonia-N	Nitrate/Nitrite	Total Phosphorus	Ortho-Phosphorus	Suspended Solids	MFFCC-Bacteria	Fecal Strep.
6/17/96	4.2 mg/l	0.281 mg/l	1.50 mg/l	0.328 mg/l	0.180 mg/l	45.5 mg/l	19000/100 ml	23000/100 ml
9/24/96	1.1 mg/l	ND	0.633 mg/l	0.078 mg/l	0.050 mg/l	9.0 mg/l	100/100 ml	310/100 ml

Dissolved oxygen and temperature were monitored continuously from August 1st - August 8th at Thiel Creek at Little Wolf Cemetery Road. Results indicate few dissolved oxygen problems (Figure 7). Even the lowest dissolved oxygen (7 mg/l) was still well above the state standard for warm water streams (5 mg/l). The Little Wolf River was not monitored due to meter use conflicts. Mid-winter surface water nitrate samples ranged from

Figure 7:



.07 mg/l at Thiel Creek to 2.1 at the Little Wolf River.

Thiel Creek carries a significant sediment load. Habitat is severely degraded by soft sediments and deposited organic matter. There are few riffle areas and habitat is mostly comprised of woody debris. Streambanks are generally low and overbank flows are common. Major agricultural drainage ditching in the upper reaches of the subwatershed (north of CTH B) combine to increase water temperatures and stream flashiness. Evidence of this flashiness was found over five feet above natural or average flow. Macrophytes present include *Sagittaria sp., Lemna sp., Callitriche sp.,* and purple loosestrife.

The Manawa wastewater treatment plant discharges to the Little Wolf River. A facility upgrade was completed in Fall, 1996 (DNR Wastewater Files, 1996). Streamflows of the Little Wolf River vary with the discharge from the Manawa Millpond. During periods of low flow, many riffle areas become too shallow for adequate fish habitat. *Vallisneria americana* is abundant.

The streams of the Lower Main Subwatershed would benefit from the reduction of sediment and to a limited extent, nutrients. With a decrease in sedimentation, habitat for aquatic fauna would increase thereby increasing the diversity of the aquatic life present. Alternatives to ditching and tiling and the creation of wetlands would attenuate high flows and reduce the flashiness of the streams. Thiel Creek may have the potential to be a good northern pike spawning and nursery area.

Goals and Objectives for the Lower Main Subwatershed

1. Reduce the occurrence and severity of high flow conditions by:
   A. promoting agricultural practices that allow for increased infiltration of precipitation and runoff.
   B. encouraging alternatives to ditching and drain tile.
   C. maintaining, enhancing, and creating wetlands to slow the release of water to prevent flooding.
2. Protect and enhance aquatic life habitat by:
   A. reducing sediment delivery to the surface water by 23%.
   B. creating, improving, and maintaining buffers to slow runoff and filter sediment.
   C. controlling construction site erosion through the use of best management practices.
   D. encourage the placement of rip-rap along areas of eroded streambank to provide erosion control and spawning habitat for lake sturgeon and smallmouth bass.
3. Protect and enhance water quality by:
   A. controlling nutrients by a high level.
   B. promoting agricultural best management practices.

Bear Lake Subwatershed

The surface water resources of the Bear Lake subwatershed consist of Spiegelberg Creek, Bear Lake, Fox Lake, Vesey Lake and Woodnorth Lake. There are five miles of stream in this subwatershed that drain 7.2 square mile of land. Spiegelberg Creek flows north out of Bear Lake to the Little Wolf River. The stream is considered a Warm Water Forage Fish community (Wolf River Basin Water Quality Management Plan, 1996).

Land use in this subwatershed is primarily agriculture though significant areas of woodland and wetland exist. The riparian area around Bear Lake is moderately developed with year round and seasonal residences. No point sources of pollution exist in the subwatershed. Land use in the subwatershed is 66% agriculture, 14% woodland, 13% wetland, and 7% urban or developed.

Surface Water Resource Conditions

The surface water resources of the Bear Lake Subwatershed are slightly degraded. Spiegelberg Creek has some sedimentation problems as well as some higher than normal bacteria levels. Habitat is good coming out of Bear Lake, but diminishes in quality nearer to the Little Wolf River.

There are four lakes in the subwatershed, with Bear Lake the largest and most heavily developed. Bear Lake has had historical phosphorus problems. TSI data collected at Bear Lake in 1996 indicate that it is mesotrophic to eutrophic. The other lakes are undeveloped and there is not enough data to characterize them (Table 15). The Waupaca County LWCD and University of Wisconsin-Extension have encouraged the Bear Lake riparian owners to form a Lake Management Organization and have met with little success.

Table 15: Lakes of the Bear Lake Subwatershed

Lake Name	Lake Type	Surface Area (Acres)	Maximum Depth (Feet)	Number of Lots	Chlorophyll-a TSI	Surface Total Phosphorus TSI	Secchi Disk Depth TSI
Bear	Drainage	194	62	103	51	52	51
Fox	Spring	3	14	0			
Vesey	Seepage	54	8	0			
Woodnorth	Spring	5	27	0			

Ball (1982) habitat evaluations conducted on Spiegelberg Creek ranked the stream from "good" to "fair". Hilsenhoff (1982) macroinvertebrate samples collected near the Highway 22 wayside, ranked the stream "good" in October, 1995 and "fair" in April, 1996. These HBI results were the lowest recorded in the entire watershed and indicate the presence of some organic pollution (Table 3).

Water chemistry samples were collected after three rain events at the mouth of Spiegelberg Creek near the Highway 22 wayside (Table 16). The ammonia, total P and ortho P levels were high in the sample from April 11, 1996. A bacteria violation occurred in the stream on September 9, 1996. Mid-winter nitrate samples were not collected in this subwatershed.

Table 16: Spiegelberg Creek Water Chemistry Samples

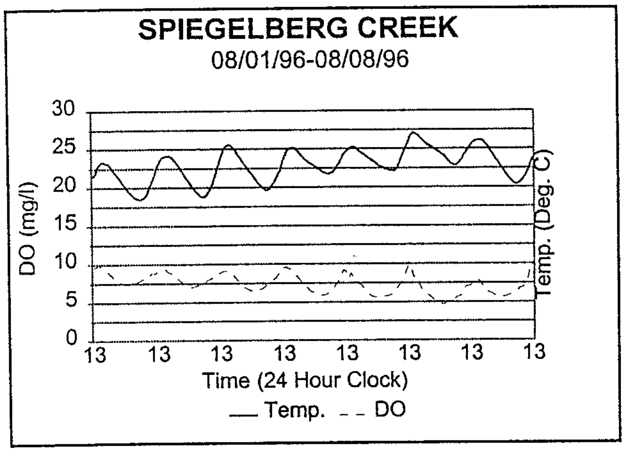
Date	BOD 5 day	Ammonia-N	Nitrate/Nitrite	Total Phosphorus	Ortho-Phosphorus	Suspended Solids	MFFCC-Bacteria	Fecal Strep.
4/11/96	2.6 mg/l	0.452 mg/l	0.227 mg/l	0.195 mg/l	0.100 mg/l	ND	<10/100 ml	20/100 ml
6/17/96	3.8 mg/l	0.142 mg/l	0.595 mg/l	0.164 mg/l	0.074 mg/l	21 mg/l	4300/100 ml	20000/100 ml
9/24/96	0.8 mg/l	0.039 mg/l	0.636 mg/l	0.025 mg/l	0.016 mg/l	7.0 mg/l	930/100 ml	160/100 ml

Dissolved oxygen and temperature were monitored at Spiegelberg Creek near the Highway 22 wayside from August 1st to August 8th (Figure 8). One dissolved oxygen violation occurred for four hours on August 7th. The dissolved oxygen went down to a low of 4.69 mg/l, barely below the state standard of 5 mg/l. It is unlikely that 4.69 mg/l of dissolved oxygen would stress any aquatic life present.

The aquatic life habitat and water quality of Spiegelberg Creek is degraded. In-stream habitat starts off in good condition at the outlet of Bear Lake but muck and marl soon predominate the substrate. The stream channel becomes braided and velocity decreases. Good, hard bottom does exist under the soft sediments. The macrophytes *Sparganium sp., Ranunculus sp.,* and *Phalaris arundinacea* are abundant. *Vallisneria americana, Sagittaria sp., Elodea sp. and Heteranthera dubia* are present. *Lythrum salicaria* or purple loosestrife is common along the stream margins.

The flow of Spiegelberg Creek is dependant on the water levels of Bear Lake. The water quality of the stream is more influenced by the land use practices around it than by the water quality of Bear Lake. Spiegelberg Creek is a conduit for fish species to travel between the Little Wolf River and Bear Lake. The stream would benefit from the reduction of nutrients and to greater extent the reduction of sediments reaching the stream. Sediment reductions would provide greater in-stream habitat for aquatic fauna while reducing their dependance on the larger bodies of water.

Figure 8:



Goals and Objectives for the Bear Lake Subwatershed

1. Enhance and protect aquatic life habitat by:
   - A. reducing sediment delivery to surface water by 16%.
   - B. using construction site best management practices.
   - C. creating, improving, and protecting buffers around lakes and streams.
2. Enhance and protect water quality by:
   - A. ensuring septic systems are functioning correctly and up to code.
   - B. encouraging good land use planning.
   - C. reducing nutrients by a medium level.
   - D. maintaining, enhancing, and creating wetlands to slow the release of water to prevent event related flooding.

Conclusion

Surface water in the Lower Little Wolf River Watershed is being adversely affected by land use activities taking place. Sediment is degrading stream habitat by silting in riffles, pools and spawning areas. Lack of habitat and habitat degradation have played a major role in limiting the aquatic life in the streams. Lakes are being impacted by nutrients and sediments from shoreline developments and agricultural practices. These inputs increase macrophyte and algae production and reduce water quality.

The water quality and the aquatic life of the Lower Little Wolf River Watershed would benefit most from the reduction of sediment to the surface waters. Land use planning with regards to controlling erosion is critical in improving the water quality and aquatic life habitat of the surface water. Nutrients do not seem to be a problem in watershed streams, but are a concern in some of the lakes (School Section, Manawa, Bear), as well as the receiving water (Wolf River) and downstream Pool Lakes. Local planning is the key to ensuring the watershed will continue to be an outstanding resource.

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