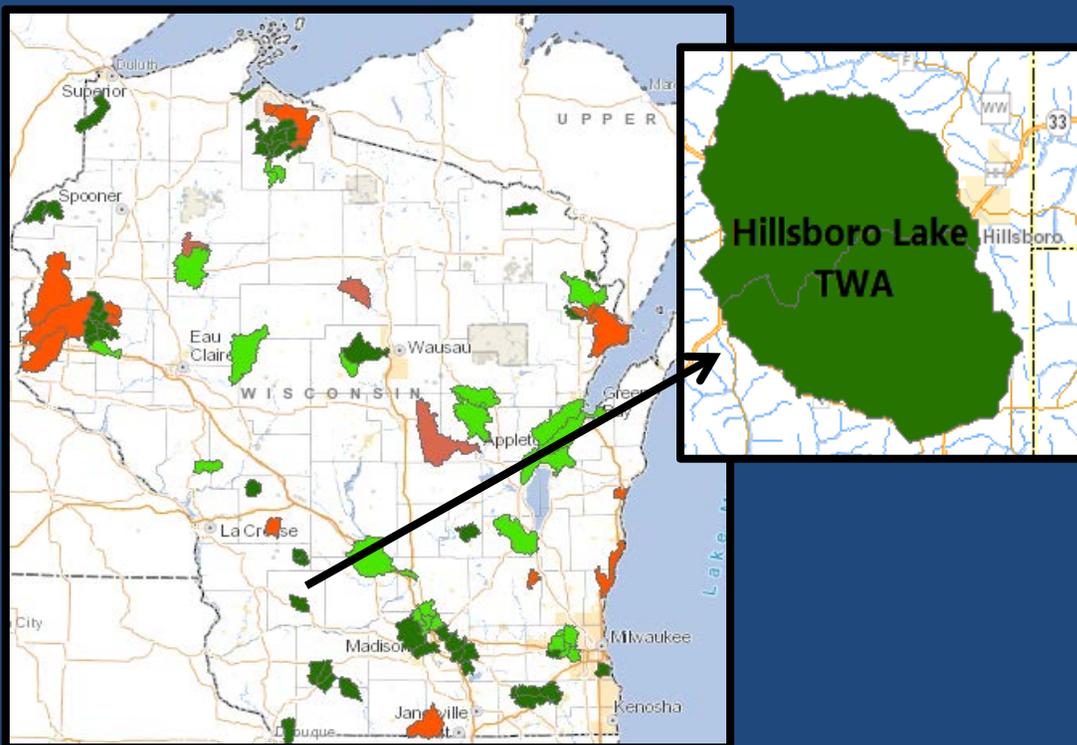


West Branch of Baraboo River downstream of Grimm Road Bridge

Photo by Jean Unmuth, DNR

HILLSBORO LAKE TWA WQM PLAN 2017

*Seymour Creek and Upper Baraboo River (LW24)
HUC: 070700040105 and 070700040104
Monitored in 2015*



EGAD # 3200-2017-03
Water Quality Bureau,
Wisconsin DNR

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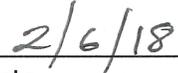
Wisconsin Water Quality Monitoring and Planning

This Water Quality Management Plan was created under the state's Water Quality Management Planning and Water Resources Monitoring Programs. The plan reflects Water Quality Bureau and Water Resources Monitoring Strategy 2015-2020 goals and priorities and fulfills Areawide Water Quality Management Planning milestones under the Clean Water Act, Section 208. Condition information and resource management recommendations support and guide program priorities for the plan area.

This plan is hereby approved by the Wisconsin DNR Water Quality Program and is a formal update to the Lower Wisconsin Areawide Water Quality Management Plan and Wisconsin's Statewide Areawide Water Quality Management Plan. This plan will be forwarded to USEPA for certification as a formal plan update.



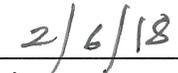
 Water Quality Field Supervisor



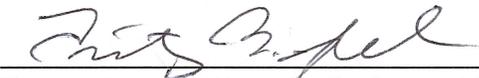
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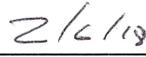
 Greg Searle, Water Quality Bureau Field Operations Director



 Date



 Timothy Asplund, Water Quality Bureau Monitoring Section Chief



 Date

Basin/Watershed Partners

- Trout Unlimited Southern Wisconsin Chapter
- Trout Unlimited Coulee Chapter
- Driftless Area Land Conservancy
- Vernon County Land Conservation Department
- Natural Resources Conservation Service (NRCS)

Report Acknowledgements

- Jean Unmuth, Primary Author and Investigator, Southern District, Wisconsin DNR
- Victoria Ziegler, Program Support, Water Quality Bureau, Wisconsin DNR
- Lisa Helmuth, Program Coordinator, Water Quality Bureau, Wisconsin DNR

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List of Abbreviations

BMP: Best Management Practice. A practice that is determined effective and practicable (including technological, economic, and institutional considerations) in preventing or reducing pollution generated from nonpoint sources to a level compatible with water quality goals.

DNR: Department of Natural Resources. Wisconsin Department of Natural Resources is an agency of the State of Wisconsin created to preserve, protect, manage, and maintain natural resources.

FIBI: Fish Index of biological integrity (Fish IBI). An Index of Biological Integrity (IBI) is a scientific tool used to identify and classify water pollution problems. An IBI associates anthropogenic influences on a water body with biological activity in the water and is formulated using data developed from biosurveys. In Wisconsin, Fish IBIs are created for each type of natural community in the state's stream system.

HUC: Hydrologic Unit Code. A code or sequence of numbers that identify one of a number of nested and interlocked hydrologic catchments delineated by a consortium of agencies including USGS, USFS, and Wisconsin DNR.

MIBI: Macroinvertebrate Index of biological integrity. In Wisconsin, the MIBI, or macroinvertebrate Index of biological integrity, was developed specifically to assess Wisconsin's macroinvertebrate community (see also Fish IBI).

Natural Community. A system of categorizing waterbodies based on their inherent physical, hydrologic, and biological assemblages. Both Streams and Lakes are categorized using an array of "natural community" types.

Monitoring Seq. No. Monitoring Sequence Number, refers to a unique identification code generated by the Surface Water Integrated Monitoring System (SWIMS), which holds much of the state's water quality monitoring data.

SWIMS ID. Surface Water Integrated Monitoring System (SWIMS) Identification Code is the unique monitoring station identification number for the location where monitoring data was gathered.

TWA: Targeted Watershed Assessment. A statewide study design a rotating watershed approach to gathering of baseline monitoring data with specialized targeted assessments for unique and site specific concerns, such as effectiveness monitoring of management actions.

WATERS ID: The Waterbody Assessment, Tracking and Electronic Reporting System Identification Code (WATERS ID) is a unique numerical sequence number assigned by the WATERS system, also known as "Assessment Unit ID code".

WBIC: Water Body Identification Code. WDNR's unique identification codes assigned to water features in the state. The lines and information allow the user to execute spatial and tabular queries about the data, make maps, and perform flow analysis and network traces.

Watershed Goals & Management Recommendations

Watershed Goals

The overall goal of this plan is to improve and protect water quality in the Lower Wisconsin Basin. This Targeted Watershed Assessment monitoring project provided substantial data to analyze current conditions and to make recommendations for future management actions in the area. This plan is designed to present monitoring study results, identify issues or concerns in the area found during the project and to make recommendations to improve or protect water quality consistent with Clean Water Act guidelines and state water quality standards.

Watershed Overview

The Seymour Creek and Upper Baraboo River Watershed, located in Juneau, Monroe, Sauk and Vernon Counties, contains all of the streams that drain to the uppermost 30 miles of the Baraboo River which eventually reaches the Wisconsin River 120 miles downstream near Portage. Hillsboro Lake TWA focuses on the southwestern part of the larger watershed (Figure 1). The land in this watershed is characteristic of the driftless area with steep hills, however many stream valleys are fairly wide. Agricultural activities are found both on the wider ridgetops and in most valleys.

Population, Land Use, Site Characteristics

Population in the Seymour Creek and Upper Baraboo River watershed in 2000 was estimated at 6,790. Municipalities in the watershed include Elroy, Hillsboro, Kendall and Union Center. Overall population growth in the communities is below the state average. The Seymour Creek and Upper Baraboo River watershed is 171.73 mi². Land use in the watershed is primarily agricultural (62%), forest (30%), and a mix of suburban (5%) and other uses (2%). This watershed has 414.62 stream miles, 124.03 lake acres, and 4,637.96 wetland acres.

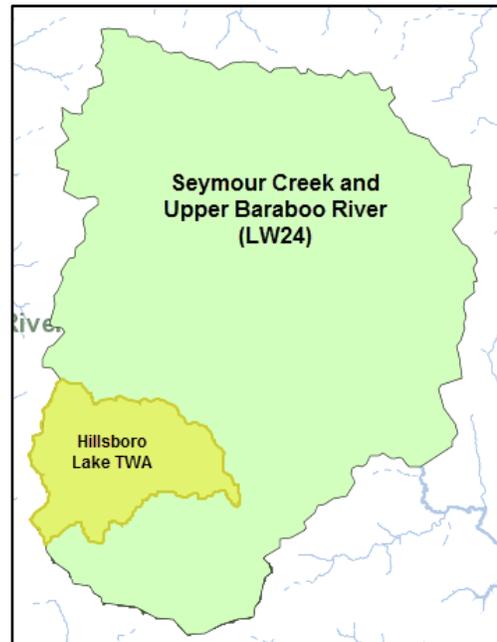


Figure 1: Seymour Creek and Upper Baraboo River Watershed with Hillsboro Lake TWA highlighted.

Hillsboro Lake TWA Overview

The Hillsboro Lake targeted watershed contains two major streams, West Branch of the Baraboo River (WBIC: 1288400), and South Branch Creek (WBIC: 1289800). The South Branch Creek subwatershed is approximately 11,428 acres in size, and land use in the subwatershed is dominantly agriculture (48%), followed by forest (31%), grassland/pasture (16%), residential (5%), and water (0.12%) (Figure 2). The major tributary of South Branch Creek is Beaver Creek (WBIC: 1290100). Both the West Branch and South Branch flow into Hillsboro Lake at the west end. West Branch Creek subwatershed is approximately 11,635 acres, and land use in the subwatershed is primarily agricultural (43%), followed by forest (36%), grassland/pasture (16%), residential (5%), and water (0.02%) (Figure 3). The major tributary of The West Branch is an unnamed tributary (WBIC: 1290900), also known locally as Dilly Creek.

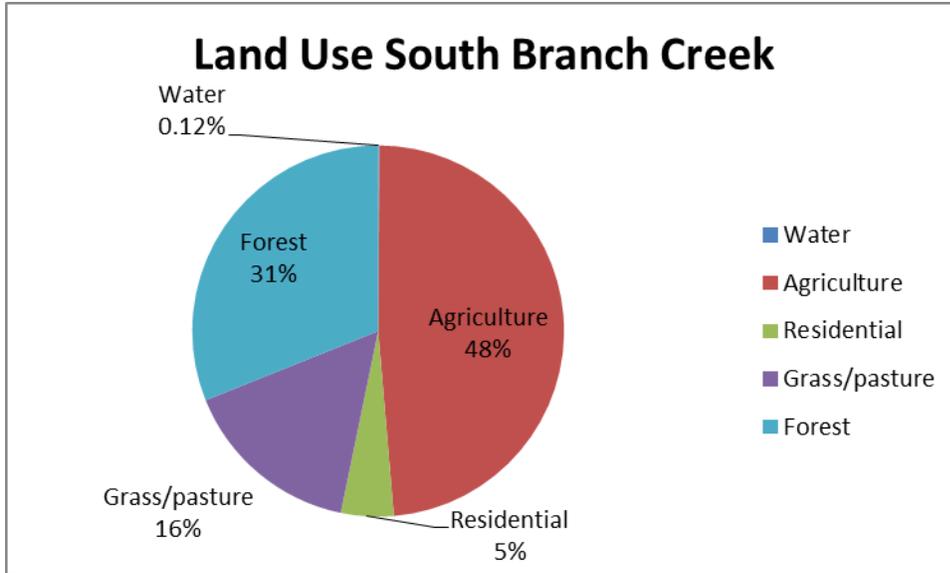


Figure 2: South Branch Watershed Land Use (Wisconsin Land Cover Dataset 2011).

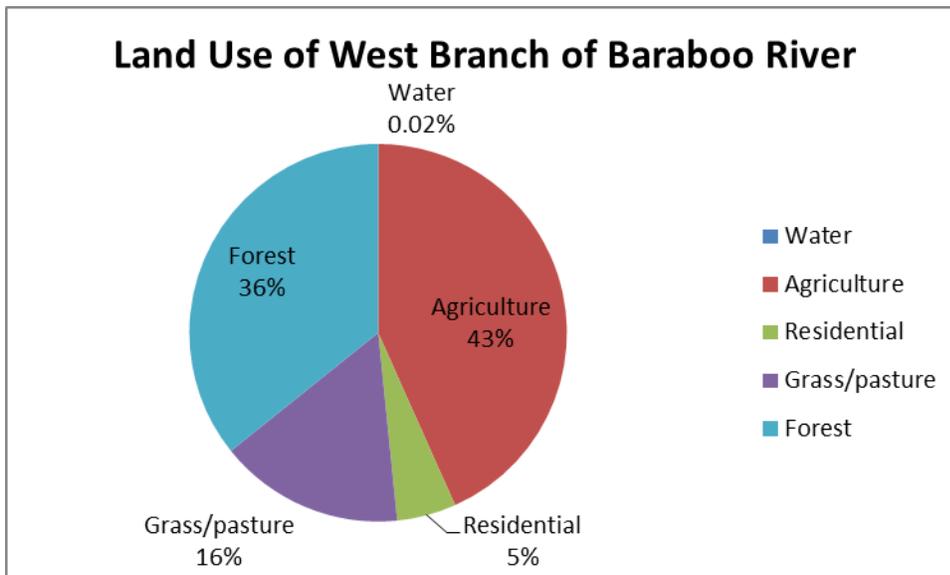


Figure 3: West Branch Watershed Land Use (Wisconsin Land Cover Dataset 2011).

Ecological Landscapes

The Western Coulee and Ridges Ecological Landscape in southwestern and west central Wisconsin is characterized by its highly eroded, driftless topography and relatively extensive forested landscape. Historical vegetation consisted of southern hardwood forests, oak savanna, scattered prairies, and floodplain forests and marshes along the major rivers. With Euro-American settlement, most of the land on ridgetops and valley bottoms was cleared of oak savanna, prairie, and leveled forest for agriculture. The steep slopes between valley bottom and ridgetop, unsuitable for raising crops, grew into oak-dominated forests after the ubiquitous presettlement wildfires were suppressed.

The primary forest cover is oak-hickory (51%) dominated by oak species and shagbark hickory. Maple-basswood forests (28%), dominated by sugar maple, basswood and red maple, are common in areas that were not subjected to repeated presettlement wildfires. Bottomland hardwoods (10%) are common in the valley bottoms of major rivers and are dominated by silver maple, ashes, elms, cottonwood, and red maple. Relict conifer forests including white pine, hemlock and yellow birch are a rarer natural community in the cooler, steep, north slope microclimates. The Seymour Creek and Upper Baraboo River Watershed has a variety of quality habitats and rare plant communities that are listed on the state's Natural Heritage Inventory, (NHI), kept by the Bureau of Endangered Resources. These communities include: dry-mesic prairie, hemlock relict, moist cliff, pine relict, southern dry-mesic forest, and southern mesic forest.

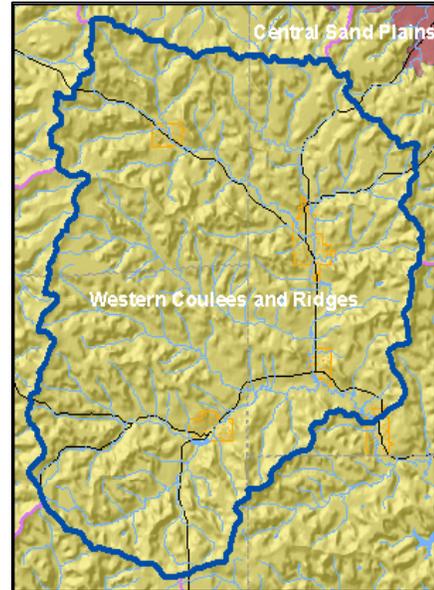


Figure 4: Ecological Landscape Map.

Hydrology

The Hillsboro Lake watershed has no natural lakes as Hillsboro Lake itself is an impoundment of the West and South Branches of the Baraboo River. Wetland complexes are rare in the watershed and mainly limited to the margins of streams, near stream mouths, and around the shoreline of Hillsboro Lake. Lake water quality is marginal due to heavy siltation from upland runoff to streams entering the lake. Water clarity is low and the lake is classified as eutrophic.

Ecological, Aquatic Resources

Outstanding and Exceptional Resource Waters

Wisconsin has designated many of the state's highest quality waters as Outstanding Resource Waters (ORWs) or Exceptional Resource Waters (ERWs). Waters designated as ORW or ERW are surface waters which provide outstanding recreational opportunities, support valuable fisheries and wildlife habitat, have good water quality, and are not significantly impacted by human activities. ORW and ERW status identifies waters that the State of Wisconsin has determined warrant additional protection from the effects of pollution.

Within the Seymour Creek and Upper Baraboo River watershed almost three miles of Spring Valley Creek (WBIC 1294000) has been classified as an ERW (Table 1). There are no ORW or ERW waters within the sub-watershed of Hillsboro Lake.

Table 1: List of ERWs in Seymour Creek and Upper Baraboo River watershed (LW24).

Waterbody Name	WBIC	Start Mile	End Mile
Spring Valley Creek	1294000	2.49	5.93

Impaired Waters

Every two years, Section 303(d) of the Clean Water Act requires states to publish a list of all waters that do not meet water quality standards. The list, also known as the Impaired Waters List, is updated to reflect waters that are newly added or removed based on new information. Impaired waters in this watershed are impaired for historical discharges, mine tailings, and runoff issues. Within the Seymour Creek and Baraboo River watershed there are many waters currently impaired, and under total maximum daily load (TMDL) development (Table 2). A segment of the West Branch Baraboo River downstream of Hillsboro Lake and South Branch Creek in the Hillsboro watershed are impaired and under TMDL development.

Table 2: Seymour Creek and Baraboo River watershed Impaired waters.

Waterbody Name	WBIC	Start Mile	End Mile	Pollutant	Impairment	Sources	303(d) Status
Baraboo River	1271100	86.79	101.29	Total Phosphorus	Impairment Unknown	Non-point source (rural or urban)	TMDL Development
Baraboo River	1271100	101.35	106.16	Total Phosphorus	Impairment Unknown	Non-point source (rural or urban)	TMDL Development
Baraboo River	1271100	108.6	118.93	Total Phosphorus	Impairment Unknown	Non-point source (rural or urban)	TMDL Development
Cleaver Creek	1292500	0	5	Total Phosphorus	Water Quality Use Restrictions	Non-point source (rural or urban)	TMDL Development
Hills Creek	1288800	0	10	Total Phosphorus	Degraded Biological Community	Non-point source (rural or urban)	TMDL Development
Seymour Creek	1291400	0	2.63	Total Phosphorus	Impairment Unknown	Non-point source (rural or urban)	TMDL Development
Seymour Creek	1291400	2.63	6.48	Total Phosphorus	Impairment Unknown	Non-point source (rural or urban)	TMDL Development
Seymour Creek	1291400	6.48	11.49	Total Phosphorus	Impairment Unknown	Non-point source (rural or urban)	TMDL Development
South Br Creek (S Branch Baraboo)	1289800	0	1.25	Total Phosphorus	Impairment Unknown	Non-point source (rural or urban)	TMDL Development
West Br Baraboo River DS Hillsboro Lake	1288400	0	7.24	Total Phosphorus	Low DO	NA	TMDL Development
West Br Baraboo River DS Hillsboro Lake	1288400	0	7.24	Sediment/Total Suspended Solids	Low DO	NA	TMDL Development
West Br Baraboo River DS Hillsboro Lake	1288400	0	7.24	BOD	Low DO	NA	303d Listed

Trout Waters

DNR uses three categories to classify the different types of trout streams throughout Wisconsin. These are evident in Wisconsin Trout Stream Maps, which provides a comprehensive list of trout streams and a set of trout stream maps covering the majority of the state. Efforts have been made to list all trout streams in the State of Wisconsin, but it is recognized that this listing is not exhaustive. Trout waters in this watershed are listed in Table 3.

High quality trout waters (Class I) that have sufficient natural reproduction to sustain populations of wild trout, at or near carry capacity. Consequently, streams in this category require no stocking of hatchery trout. These streams or stream sections are often small and may contain small or slow-growing trout, especially in the headwaters. Class II streams may have some natural reproduction, but not enough to utilize available food and space. Therefore, stocking is required to maintain a desirable sport fishery. These streams have good survival and carryover of adult trout, often producing some fish larger than average size. Class III are marginal trout habitat with no natural reproduction occurring. They require annual stocking of trout to provide trout fishing. Generally, there is no carryover of trout from one year to the next.

There are seven trout water streams in the Seymour Creek, Baraboo River Watershed. Within the Hillsboro Lake watershed, both the South Branch Creek and West Branch of Baraboo River have segments of trout water (Table 3).

Table 3: Trout waters within the Seymour Creek, Baraboo River Watershed.

Waterbody Name	WBIC	Start Mile	End Mile	Trout Class
Baraboo River	1271100	108.6	118.93	CLASS II
Baraboo River	1271100	101.35	106.16	CLASS III
West Branch Baraboo River	1288400	9.3	15.89	CLASS III
South Branch Creek (South Branch Baraboo)	1289800	1.25	9.44	CLASS III
Seymour Creek	1291400	6.48	11.49	CLASS III
Fox River Valley Creek	1294300	0	4.87	CLASS III
Spring Valley Creek	1294000	2.23	2.49	CLASS I
Spring Valley Creek	1294000	0	2.23	CLASS II
Spring Valley Creek	1294000	2.49	5.93	CLASS I
Seymour Creek	1291400	0	2.63	CLASS III

Monitoring Project Discussion

Purpose of Project

The purpose of this study was to monitor the effectiveness of implementing agricultural best management practices (BMP's) in the Hillsboro Lake watershed since the installation of practices between 1995 and 2005. Wisconsin Department of Natural Resources (DNR) conducted a Clean Water Act Section 319 project to evaluate monitoring in the Hillsboro Lake watershed in eastern Vernon

County, Wisconsin. The thirty-five square mile Hillsboro Lake watershed was designated a priority watershed under the Wisconsin Nonpoint Source Pollution Abatement Program in 1993. A Hillsboro Priority Watershed Surface Water Resource Appraisal was completed in December of 1994 as part of this project. The watershed appraisal included monitoring during 1993-1994 for fish and habitat surveys at 11 sites, temperature monitoring at two sites, and macroinvertebrate sampling at six sites. The data, used in conjunction with observations about watershed health, are also used to guide planning for improvements where needed. Results from the 1993-1994 monitoring indicated that the West Branch of Baraboo River water quality was very good to excellent with minimal organic loading, while water quality in South Branch Creek was poor in the lower stream reaches but good in the upper stream reach, with some organic loading. The DNR worked with watershed and county staff to determine the location, number and type of BMP's to be installed in the watershed. The BMP locations helped DNR staff prioritize where follow-up monitoring would be conducted during 2015.

The 2015 study provides data to identify the contemporary status of two HUC 12s which comprises the Hillsboro Lake watershed. DNR collected fish, habitat, macroinvertebrate, and water chemistry data for streams in the watershed. The data helps determine whether these streams are achieving their attainable uses and supports listing waters not meeting designated and attainable use, and assess the overall health of the watersheds as required by Section 305(b) of the Clean Water Act. Follow-up monitoring targeted areas containing the greatest number and largest scale of BMP's installed. Individual streams or reaches of streams were also targeted with specific goal oriented follow-up monitoring.

Site Selection and Study Design

Two streams and their major tributaries in the watershed were monitored. The West Branch (WBIC: 1288400) is 9.29 miles long, and is classified as a Class II trout water from the headwaters down to Sebranek Road. Its major unnamed tributary stream (WBIC: 1290900), also locally known as Dilly Creek, is 4.05 miles long. The South Branch Creek (WBIC: 1289800) is 9.44 miles long, and is classified as a Class II trout water from the headwaters down to STH-80. Its major tributary is Beaver Creek (WBIC: 1290100) which is 4.78 miles long.

The streams are cool-cold natural communities, and standard DNR protocols and methods were used to assess qualitative habitat, fish and water quality at 10 sites in the watershed during 2015. Fish index of biotic integrity (FIBI) results were summarized over the past 10 years (2005-2015) at 16 stations (Figure 5) and macroinvertebrate index of biotic integrity (MIBI) results were summarized over the past 10 years (2005-2015) at 7 stations to assess watershed health (Table 4).



Table 4: Stream site monitoring locations from upstream to downstream.

Stream Name	SWIMS Station	WBIC	SWIMS Station Location	Earliest Fieldwork Year	Latest Fieldwork Year	Fish Station (Fish ID)	Monitoring Seq. No	MIBI Station	Habitat Station
West Branch Baraboo River	10011292	1288400	100 meters DS from upper culvert driveway	2012	2015	129140	103421	No	No
West Branch Baraboo River	10011291	1288400	100 meters US Grimm Rd.	2012	2015	129139	103420	Yes	Yes
West Branch Baraboo River	10032062	1288400	300 meters south of Grimm Rd.	2009	2009	None	None	Yes	No
West Branch Baraboo River	10017181	1288400	US of Sebranek Rd.	2012	2015	15776029	15776029	No	Yes
West Branch Baraboo River	10039097	1288400	50 yards US of STH-33	2012	2015	72765060	72765060	Yes	Yes
Unnamed Tributary of W. Branch WBIC: 1291100 (Dilly Creek)	10043634	1290900	US of STH-33	2015	2015	118251567	118251567	Yes	Yes
South Branch Creek	10032372	1289800	Verbsky Ln.	2010	2010	40869055	40869055	No	No
South Branch Creek	10043625	1289800	McKenzie Rd.	2015	2015	117705640	117705640	No	Yes
South Branch Creek	10011295	1289800	St. 3, Saint Patrick Rd.	2010	2010	129143	103424	No	No
South Branch Creek	10015731	1289800	DS Kouba Valley Rd.	2010	2010	50014	50014	Yes	Yes
South Branch Creek	10011294	1289800	St. 2, Farmers Bridge	2010	2010	129142	103423	No	No
South Branch Creek	10011293	1289800	St. 1, South Br.US Beaver Cr. mouth	2010	2010	129141	103422	No	No
South Branch Creek	10015761	1289800	Upstream STH-80	2015	2015	50044	50044	No	Yes
South Branch Creek	10017179	1289800	Upstream CTH-Q	2015	2015	15776009	15776009	Yes	Yes
Beaver Creek	10016405	1290100	US Beaver Creek Rd.	2015	2015	50688	50688	Yes	Yes
Beaver Creek	633182	1290100	US Kouba Valley Rd.	2015	2015	11572	11572	No	Yes

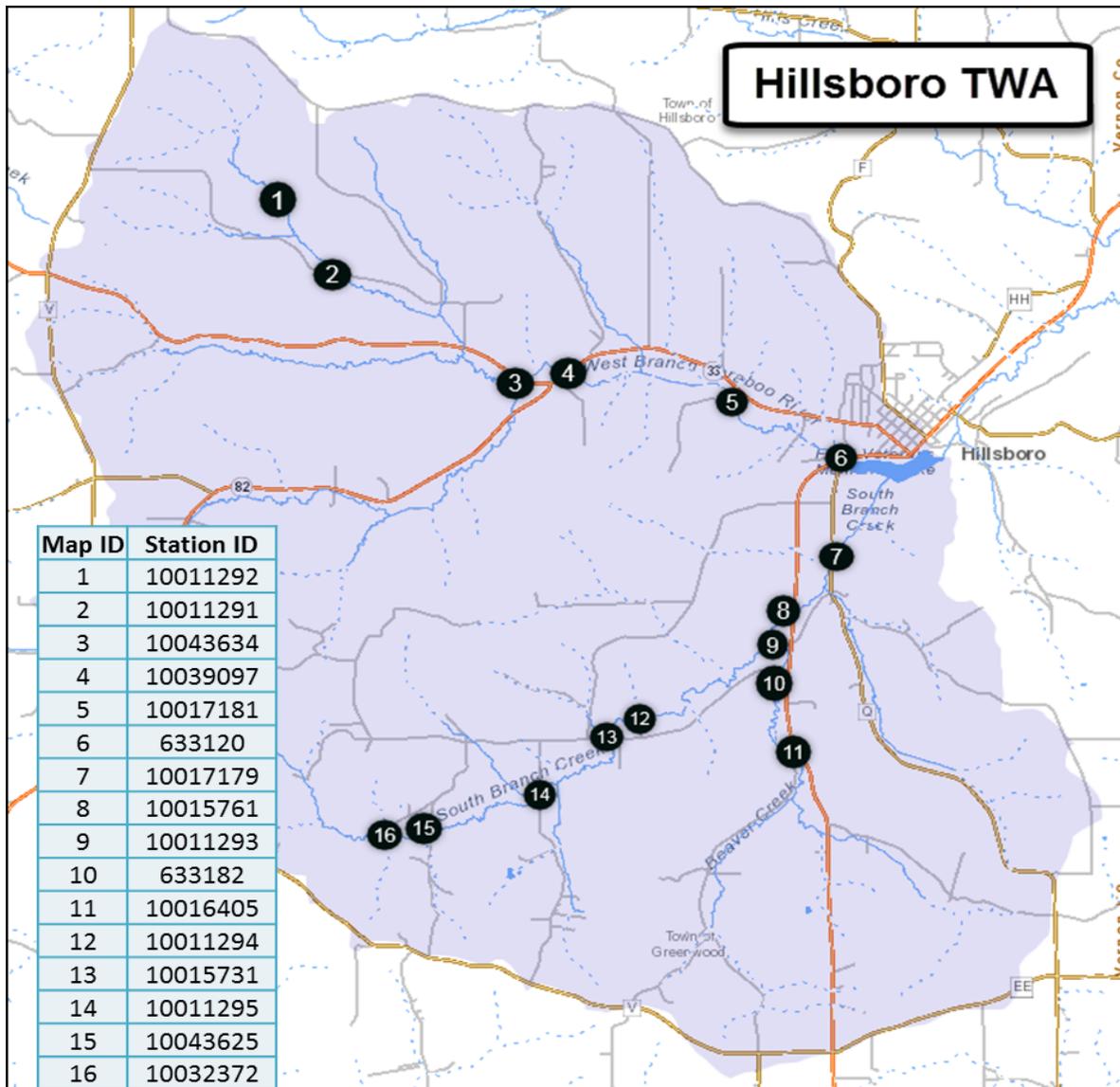


Figure 5: Monitoring Stations in the Hillsboro TWA.

Methods, Equipment and Quality Assurance

The fisheries assemblage was determined by electroshocking a section of stream with a minimum station length of 35 times the mean stream width (Lyons, 1992). A stream tow barge with a generator and two probes was used at most sites. A backpack shocker with a single probe was used at sites generally less than two meters wide. All fish were collected, identified, and counted. All gamefish were measured for length. At each site qualitative notes were collected for average stream width and depth, riparian buffers and land use, evidence of sedimentation, fish cover and potential management options. A qualitative habitat survey (Simonson, et. al., 1994) was also performed at each site. Macroinvertebrate samples were obtained by kick sampling and collecting using a D-frame net at two sites each in The West Branch and South Branch Creek, and one site in Beaver Creek and the unnamed tributary (Dilly Creek), and sent to the UW-Stevens Point lab for analysis. Continuous temperature monitoring was collected at two sites each in the West Branch and South Branch Creek, and one site near the mouths of Beaver Creek and the unnamed tributary (Dilly Creek) using Pro V-2 temperature meters. Meters were

programmed to collect water temperatures in 15 minute increments from the end of May through the end of August. Monthly phosphorus samples were collected from May through October by Water Action Volunteer citizen monitors trained in using DNR methods, near the mouths of West Branch and South Branch Creeks. Diatom sampling was performed by DNR central office staff in South Branch Creek, West Branch Baraboo River, and Beaver Creek.

Data Tables

Table 5: Watershed Total Phosphorus Results and Biological Exceedances

Waterbody – SWIMS ID (Years of data)	Total Phosphorus (mg/l)		Biological Impairment?
	Median	Single Sample	
West Branch Baraboo River 10017181 ⁽¹²⁾	0.077		None
West Branch Baraboo River – 633120 ⁽⁶⁾	0.110		None
South Branch Creek – 10017179 ⁽⁶⁾	0.108		None
Unnamed Trib of West Branch (Dilly Cr.)- 10043634 ⁽¹⁾		0.089	MIBI – Poor but needs a second sample
Beaver Creek	No data	No data	None

Table 6: Total Phosphorus Criteria.

	Biological Response Indicators	Overall Assessment Result & EPA Listing Category	Pollutant
Meets TP Criteria	None indicate impairment	Not Impaired (Fully Supporting) Category 2	NA
	One or more indicate impairment	Impaired—Biology Only (Not Supporting) Category 5A	Unknown
Exceeds TP Criteria (not an overwhelming exceedance)	One or more indicate impairment	Impaired—TP & Bioconfirmation (Not Supporting) Category 5A	TP
	None indicate impairment	Impaired—Exceeds TP but has insufficient or conflicting biological data (Not Supporting) Category 5P	TP
Exceeds TP Criteria by an Overwhelming Amount	None needed	Impaired—TP Only (i.e. Overwhelming exceedance (Not Supporting) Category 5A	TP

Table 7: Fish taxonomy for streams in Hillsboro watershed during 2015 monitoring, from upstream to downstream.

Fish Species	West Branch Of Baraboo R.			Unnamed Tributary of West Branch (Dilly Cr.)	South Branch Creek				Beaver Creek	
	US. Grimm Rd.	US Sebranek Rd.	US STH-33		US STH-33	US McKenzie Rd.	DS Kouba Valley Rd.	US STH-80	US CTH-Q	US Beaver Cr. Rd
<i>Bluegill</i>						1	2	2		
<i>Bluntnose Minnow</i>		2				2	100	4	13	11
Brook Trout	11	2	7			1			2	
Brook Stickleback		11		4		1	1		21	
Brown Trout			5	3						
<i>Common Shiner</i>		14	6		1	71	110	2	5	17
Creek Chub		9	36	32	166	119	75	2	262	69
<i>Fantail Darter</i>		47	267	160	130	293	255	86	383	58
<i>Fathead Minnow</i>									2	
<i>Golden Shiner</i>				2		24	42		1	10
<i>Green Sunfish</i>						1		1		
<i>Hornyhead Chub</i>			15	1		18	30	3		
Johnny darter		14	10	40	143	16	42	16	40	20
Slimy Sculpin	92	10	169	140						
<i>Smallmouth Bass</i>							7	3		
<i>Southern Redbelly dace</i>				2	13	2	7		80	4
<i>Spotfin Shiner</i>						2				10
Western Blacknose Dace		3	36	65	23	5	33		57	44

Fish Species	West Branch Of Baraboo R.			Unnamed Tributary of West Branch (Dilly Cr.)	South Branch Creek				Beaver Creek	
	US. Grimm Rd.	US Sebranek Rd.	US STH-33		US STH-33	US McKenzie Rd.	DS Kouba Valley Rd.	US STH-80	US CTH-Q	US Beaver Cr. Rd
White Sucker		50	149	107	117	107	145	10	257	103
<i>Yellow Bullhead</i>								1		
Modeled Natural Community ¹	CCH	CCM	CCM	CCH	CCH	CCH	CCM	CCM	CCH	CCH
Verified	Yes	Yes	Yes	Yes	No	No	No	Yes	No	No
Verified Natural Community ²	CCH	CCM	CCM	CCH	CWH	CWH	CWM	CWH	CWH	CWH
Cool-Cold/Cool-Warm IBI ³	80	100	90	100	60/60	90	80/70	90/80		
Other IBI ⁴									90	100
%Tolerant	0	40	32	38	45	44	47	14	54	69
Stenothermal Coldwater Species	103	23	181	143	0	1	0	0	2	0
Tolerant Species	0	64	221	210	306	304	396	18	592	242
Intolerant Species	103	12	176	140	1	1	7	3	2	0

****Species names in italics indicate warmwater species**

Table 7 continued

¹ Lyons, John 2013. Draft Methodology for Using Field Data to Identify and Correct Wisconsin Stream "Natural Community" Misclassifications Version 4, May 16, 2013.

² Natural Community suggested by the methodology cited above.

³ Coolwater IBI: Poor <20; Fair 21-40; Good 41-60; Excellent 61-100.

⁴ Small and Intermittent Streams IBI (Lyons 2006)

Table 8: Habitat Value Scores for project stations

Station Name	Year	Flow CMS	Riparian Buffer Score	Bank Erosion Score	Pool Area Score	Width Depth Score	Riffle Riffle Score	Fine Sediments Score	Fish Cover Score	Total Habitat Score	Habitat Rating
West Branch Baraboo River Grimm Rd.	2015	0.06	15	15	0	10	15	5	15	75	Excellent
West Branch Baraboo River Sebranek Rd.	2015	0.83	10	10	7	10	15	5	15	72	Good
West Branch Baraboo River STH-33	2015	0.16	10	10	3	10	15	10	15	73	Good
Unnamed Trib. Of West Branch Baraboo River STH-33	2015	0.04	0	5	0	10	15	5	5	40	Fair
South Branch Creek McKenzie Rd.	2015	0.05	0	5	10	10	15	5	15	60	Good
South Branch Creek Kouba Valley Rd.	2015	0.05	10	15	3	10	15	10	5	68	Good
South Branch Creek STH-80	2015	0.07	5	10	3	10	15	5	0	48	Fair
South Branch Creek CTH-Q	2015	0.13	15	15	0	10	0	5	15	60	Good
Beaver Creek Beaver Creek Rd.	2015	0.03	15	15	3	10	10	5	5	68	Good
Beaver Creek Kouba Valley Rd.	2015	0.04	15	15	3	10	15	5	15	78	Excellent



DNR monitoring South Branch Creek at Kouba Road

Results and Discussion

West Branch Baraboo River

The West Branch of Baraboo River is a cool-cold headwater and mainstem natural community. It is classified as a Class III trout stream from Sebranek Road to the headwaters. Continuous temperature monitoring was conducted between June 1 and August 24, 2015 at two sites in the West Branch Baraboo River; Grimm Road and Sebranek Road. Maximum daily mean temperatures at both sites were below 22.0 degrees C, indicating stream temperatures can support cold water fishes (Appendix A). Fish IBI's at all four sites indicated the cool-cold ratings were mainly excellent, with most scores in the range of 80-100 (Table 9). Thirteen different species of fish were caught, with sculpin, white sucker and fantail darter dominating the catch. Brook trout ranged from 2.6" to 10.7" in length, and brown trout ranged from 3.2" to 17.5" in length, indicating there is some fish natural reproduction. The stream has not been stocked with trout since 2006, according to the fish stocking database. The natural community validation indicated the stream is correctly classified as cool-cold.

Table 9: West Branch Baraboo River fish IBI cool-cold ratings and scores from upstream to downstream.

SWIMS Station ID	Years	FIBI Ratings	FIBI Scores
10011292	2012	Excellent	80
10011291	2012/2015	Excellent/Excellent	80/80
10017181	2012/2015	Good/Excellent	50/100
10039097	2012/2015	Excellent/Excellent	90/90

Quantitative habitat ratings ranged from excellent in the upper stream segment to good in the middle to lower stream segments (Tables 8, 10). Stream banks were relatively stable, except for some stream segments that had vertical eroding banks, although banks did not appear to be excessively grazed (Table 11). Percent fines were also high in some stream segments, indicating erosion is occurring. While fish cover was good throughout the stream, most fish lunger structures in the segment above STH-33 have collapsed, and no longer provide good cover for adult fish.

Table 10: West Branch Baraboo River quantitative habitat ratings upstream to downstream.

SWIMS Station ID	Years	Habitat Ratings	Habitat Scores
10011291	2015	Excellent	75
10017181	2015	Good	73
10039097	2015	Good	72

Table 11: West Branch Baraboo River quantitative habitat summary.

SWIMS Station ID	Stream Mean Width	Main Habitat	Erosion	Vegetative Buffer	Amount/Type Fish Cover	Riparian Habitat Type
10011291	1.4	Riffle/Run	Low	Excellent	High Undercut Overhanging	Meadow Wetland Woodland
10017181	3.5	Pool/Run/Riffle	Moderate	Good	Moderate Overhanging Woody	Meadow Pasture Wetland
10039097	4.1	Riffle/Run	Moderate	Good	Moderate Overhanging Boulder	Meadow Shrubs

Macroinvertebrates indices of biotic integrity (MIBI) ratings collected from the West Branch of Baraboo River over the past 10 years indicate scores ranged from 3.19 to 9.15 with ratings from fair to excellent, however the rating of excellent was back in 2009, hence ratings have since declined (Table 12).

Table 12: W.Br. Baraboo R. Macroinvertebrate Ratings and Scores from upstream to downstream.

SWIMS Station ID	Year	MIBI Score	MIBI Rating
10011291	2015	4.92	Fair
10032062	2009	9.15	Excellent
10039097	2015	3.19	Fair

Six monthly phosphorus samples were collected from the mouth of the West Branch Baraboo River where it enters Field Veterans Memorial Lake at SWIMS station 633120, located below STH-80. Median phosphorus was 0.110 mg/l, exceeding the phosphorus criteria of 0.075 mg/l (Table 5), however the location where samples were collected is where the stream meets the lake, and essentially functions more as a lake site than stream site, as it is influenced by lake water backing up into the stream. The next site upstream where 12 phosphorus samples were collected is located at Sebranek Road, and the median value was 0.077 (Table 5), which is a slight exceedance of the phosphorus criteria, however is not considered as impaired for phosphorus as the lower confidence limit of the sample dataset does not exceed the criteria.

Unnamed Tributary (WBIC: 1290900) of West Branch Baraboo River

This tributary, also known locally as Dilly Creek, is a cool-cold headwater natural community. Continuous temperature monitoring was conducted between June 1 and August 24, 2015 upstream of STH-33, near the stream mouth. Maximum daily mean temperatures were below 22.0 degrees C, but nearly half of the days during deployment, the temperature readings were in the cool range, indicating the stream temperature can support a cool-cold water fish community (Appendix A). Fish were sampled upstream of STH-33, and the fish IBI rating was excellent with a score of 100. Eleven different species of fish were caught, and similar to the West Branch of Baraboo River, sculpin, white sucker and fantail darters dominated the catch (Table 7). No brook trout were collected, and just three brown trout were collected, ranging from 8.2" to 9.4" in length. The stream has not been stocked according to the fish stocking database. The natural community validation indicated that the stream is correctly classified as cool-cold.

Quantitative habitat was also collected in the unnamed tributary (Dilly Creek) upstream of STH-33, and habitat rated fair with a score of 40. Stream banks were highly eroded, there was little to no vegetated buffer, banks were heavily grazed and livestock present in the stream (Tables 8 and 13). The amount of fine sediments was fairly high, stream width was wide, and the stream lacked pools but had a good amount of riffles and bends. Fish cover was lacking in this stretch of stream. Non-point runoff may be reaching the stream via barnyard spring ponds. MIBI results for the unnamed tributary (Dilly Creek) scored 2.31, with a rating of poor.

Table 13: Unnamed tributary (Dilly Creek) (WBIC: 1290900) quantitative habitat summary

SWIMS Station	Stream Mean Width	Main Habitat Type	Erosion	Vegetative Buffer	Amount/Type Fish Cover	Riparian Habitat Type
10043634	3.0	Run/Riffle	High	None	Low Woody Boulder Overhanging	Meadow Wetland Woodland

South Branch Creek

South Branch Creek is a cool-cold headwater and main stem natural community stream except downstream of CTH-Q, where it is listed as a cold water. It is classified as Class III trout water upstream of STH-80. Continuous temperature monitoring was conducted between June 1 and August 24, 2015 at two sites in South Branch Creek. The maximum daily mean temperature at McKenzie Valley Road was 22.8 degrees C, and at Kouba Valley Road was 23.8 degrees C, indicating the stream temperature may be able to support cool-cold water fish, however for at least 10 days during the summer, both sites had temperatures above 25 degrees Celsius, exceeding the cool temperature range (Appendix A). Summer temperatures were more within the range for cool-warm transitional systems (Lyons et. al., 2009). Fish IBI's at all eight sites indicated both the cool-cold ratings and cool-warm ratings were good to excellent, from upstream to downstream, respectively, and scores ranged from 60-90 (Table 14). Seventeen different species of fish were caught, with fantail darter, white sucker, creek chub, Johnny darter and common shiner dominating the catch (Table 7).

Only one brook trout was found in South Branch Creek, at the Kouba Valley Road site. No brown trout were collected, and the stream has not been stocked since 2006. Environmental degradation can sometimes explain the discrepancy between the modelled and actual community where there is a lack of intolerant species and a dominance of tolerant ones. The percentage of tolerant fish in the South Branch fall within the expected ranges for cool-cold transitional systems, and therefore a degraded community is not the principle reason for the discrepancy. The discrepancy between temperature data and the fish community can happen for several reasons: either the year of the thermal measurement was not representative of the long-term average, the modeled thermal values were inaccurate, or both. In this case, air temperatures during the 2015 summer season over which the thermistors were deployed were not considered abnormal, so weather likely did not affect the fish assemblage. The fish assemblage encountered in 2015 was similar to that found in other years going back as far as 2004. More cool transitional to warm water fish dominated this stream as compared to other streams we monitored in the watersheds, and the natural community validation indicated that the stream is incorrectly classified as cool-cold, and should be classified as a cool-warm fish natural community.

Table 14: South Branch Creek fish IBI cool-cold/cool-warm ratings and scores upstream to downstream

SWIMS Station	Years	Cool-Cold FIBI Ratings	Cool-Cold FIBI Scores	Cool-Warm FIBI Ratings	Cool-Warm FIBI Scores
10032372	2010	Good	60	Excellent	90
10043625	2015	Good	60	Good	60
10011295	2010	Excellent	80	Excellent	70
10015731	2015	Excellent	90	Missing Data	Missing Data
10011294	2010	Good	60	Good	60
10011293	2010	Good	60	Excellent	70
10015761	2015	Excellent	80	Excellent	70
10017179	2015	Excellent	90	Excellent	80

Quantitative habitat rated good at all sites except at STH-80 where the habitat rated fair (Table 15). The riparian area in some stream stretches appeared to be excessively grazed and lacked bank vegetation. Some areas had livestock trampling directly in the stream further exacerbating stream sedimentation (Table 16). In some stream segments where banks had shrubs and trees, banks were heavily trampled by livestock. Closer to the headwaters of South Branch Creek, there was a good mix of riffle, pool complexes, but the amount of fine sediments was high, indicating excessive stream bank erosion. Excessive nutrients and silt were observed coming from small spring tributaries, where livestock roamed freely in springheads. Filamentous algae was common in springs in the headwaters of South Branch Creek. The Kouba Valley Road site had a good amount of riffles and runs, but was relatively lacking in pool habitat, with the exception of one large pool where a spring tributary outlets to the pool. Excessive algae at both the tributary mouth and in the pool below the tributary was observed. The STH-80 site has adequate riffles, a fair amount of bends, and few pools. The CTH-Q site was mostly run, lacking in riffles and pools. Fish cover was good downstream of McKenzie Road and CTH-Q, but lacking at Kouba Valley Road, and STH-80. DNR had hoped to deploy a continuous temperature meter at CTH-Q, but the stream was too deep to allow for safe access during the spring. DNR suspects water temperatures may be higher from CTH-Q downstream to the mouth, and that the stream may not be able to support a cold water fishery, even though the natural community indicates it is cold water. DNR observed that the stream easily backs up with water from Hillsboro Lake all the way up to CTH-Q during even minor rain events, which may also influence stream temperature.

Table 15: South Branch Baraboo River quantitative habitat ratings upstream to downstream.

SWIMS Stations	Years	Habitat Ratings	Habitat Scores
10043625	2015	Good	60
10015731	2015	Good	68
10015761	2015	Fair	48
10017179	2015	Good	60

Table 16: South Branch Baraboo River quantitative habitat summary

SWIMS Station	Stream Mean Width	Main Habitat Type	Erosion	Vegetative Buffer	Amount/Type Fish Cover	Riparian Habitat Type
10043625	3.3	Run/Pool	High	None	Low Undercut Woody	Woodland
10015731	2.6	Run/Riffle Pool	Low	Excellent	Moderate Overhanging Woody	Meadow Woodland
10015761	6.0	Run/Pool	High	Poor	Low Overhanging	Pasture Meadow
10017179	5.8	Run/Pool	Low	Excellent	High Overhanging Boulder	Meadow Shrubs

MIBI results indicate that that South Branch rated from fair to good (Table 17).

Table 17: South Branch Creek macroinvertebrate ratings and scores upstream to downstream.

SWIMS Stations	Years	MIBI Ratings	MIBI Scores
10015731	2015	Fair	2.78
10017179	2015	Good	6.09

Six monthly phosphorus samples were collected from the mouth of the South Branch Creek at CTH-Q, SWIMS station 10017179. Median phosphorus was 0.108 mg/l, or well above the criteria, and the median value exceeded the lower confidence limit for the samples, indicating the stream should remain on the impaired for phosphorus list (Table 5).

Beaver Creek

This tributary of South Branch Creek is a cool-cold headwater fish natural community. Continuous temperature monitoring was conducted between June 1 and August 24, 2015 at Kouba Valley Road, near the stream mouth. Maximum daily mean temperatures were 22.9 degrees C, indicating the stream has the ability to support cold water fish; however for at least 8 days during the summer of 2015 the stream reaches temperatures slightly higher than 25 degrees C, or in the warm transition zone (Appendix A). Fish were sampled upstream of Beaver Creek Road, and upstream of Kouba Valley Road, and because the stream averages less than 3.5 meters in width and flows ranged from 0.029-0.037 cm/s it is considered a small stream, though it is a perennial headwater system. Therefore, the small stream IBI was used to calculate the FIBI. Fourteen different species of fish were caught with fantail darter, white sucker and creek chub dominating the catch (Table 7). Two brook trout were collected, both were 4.5" in length, and no brown trout were caught. The stream has not been stocked according to the fish stocking database. The small stream FIBI scores were excellent (Table 18). The natural community validation indicated that the stream is incorrectly classified as cool-cold, and should be classified as a cool-warm fish natural community. Environmental degradation can sometimes explain the discrepancy between the modelled and actual community where there is a lack of intolerant species and a dominance of tolerant ones. The percentage of tolerant fish in the South Branch fall within the expected ranges for cool-cold transitional systems, and therefore a degraded community is not the principle reason for the discrepancy. The discrepancy between temperature data and the fish community can happen for several reasons: either the year of the thermal measurement was not representative of the long-term average, the modeled thermal values were inaccurate, or both. In this case, air temperatures during the 2015 summer season over which the thermistors were deployed were not considered abnormal, so weather likely did not affect the fish assemblage. The fish assemblage encountered in 2015 showed similar attributes to that found in 2004, except in 2004 there were no trout found in that survey. The fish found in 2015 favored transitional cool-warm systems, thus the designation of Beaver Creek as cool-cold water headwater fish community should be changed to a cool-warm transitional fish community.

Table 18: Beaver Creek small stream fish IBI scores upstream to downstream

SWIMS Stations	Years	Small Stream FIBI Score
10016405	2015	90
633182	2015	100

Quantitative habitat was also collected in Beaver Creek at the same sites where fish were collected, with habitat rating good at the Beaver Creek Road site and excellent at the Kouba Valley Road site, with scores of 68 and 78, respectively. Riparian habitat was well vegetated, and bank erosion was minimal

(Tables 8, 19). It appeared that the banks were lightly grazed in the corridor upstream of Beaver Creek Road, while no evidence of livestock grazing was noted at the Kouba Valley Road site. There was a good mix of riffle, runs, pools and bends. Fine sediments were fairly high, and instream fish cover was adequate, mainly overhanging vegetated cover, and undercut banks, but also some woody debris downstream of Beaver Creek Road. The MIBI score for Beaver Creek was 5.19, with a rating of good.

Table 19: Beaver Creek quantitative habitat summary

SWIMS Station	Stream Mean Width	Main Habitat Type	Erosion	Vegetative Buffer	Amount/Type Fish Cover	Riparian Habitat Type
10016405	3.4	Run/Riffle	Low	Excellent	Moderate Overhanging Undercut	Meadow Shrub Woodland
633182	2.6	Run/Riffle Pool	Low	Excellent	Moderate Undercut	Meadow Shrub Woodland

River/Stream Health Overview

A watershed's fishery is a long-term gauge of conditions in the stream and is therefore most important for bioassessment. That's not to say measured water temperatures aren't useful, but for natural community determination and IBI purposes, and in the absence of moderate to severe environmental perturbation, the fishery assemblage trumps water temperature.

Natural Community Analysis versus Stream Temperatures

Most of the streams in the two HUC 12's are modelled to be cool-cold transitional headwaters or mainstems, with the exception of very short segments in both the West Branch of the Baraboo and South Branch Creeks very near where they flow into Hillsboro Lake, where the natural community is modelled as cold water (Lyons, 2008). The department has recently developed a draft method to determine whether or not the modeled natural community is accurate based on the fishery assemblage and climate conditions (Lyons, 2013). In the case of the West Branch of Baraboo River and the unnamed tributary (Dilly Creek), the thermal composition of species (cold, warm, or transitional) and percentage of intolerant fish verifies the modelled cool-cold natural communities. Both brook and brown trout were found in the West Branch of the Baraboo, while in the unnamed tributary (Dilly Creek) only a few brown trout were found in the survey. Continuous summer stream temperature monitoring at two sites in the West Branch of the Baraboo River, and in the unnamed tributary (Dilly Creek) indicate both streams have temperatures in the cool-cold range, and cool-cold transitional fish were dominant.

In South Branch Creek and Beaver Creek the thermal composition of species indicated the stream resembles a cool-warm system, rather than a cool-cold system. There is a fair amount of diversity of non-game cool-warm transitional fish species, and only a single cold water fish, a brook trout was found in South Branch surveys, while only two cold water brook trout were found in Beaver Creek surveys. Environmental degradation can sometimes explain the discrepancy between the modelled and actual community where there is a lack of intolerant species and a dominance of tolerant ones. For South Branch Creek and Beaver Creek, the percentage of tolerant fish fell within the expected ranges for cool-cold transitional systems, and therefore a degraded community is not the principle reason for the discrepancy in actual versus modelled natural community.

The discrepancy between the temperature data and the fish community can also happen if the year of the thermal measurement wasn't representative of the long-term average. In this case air temperatures

were not considered abnormal during summer when we had the thermistors deployed. Continuous stream temperature monitoring at two sites in South Branch Creek indicated that for about 10 days the summer temperatures were above 25 degrees Celsius, exceeding the cool temperature range for cool-cold fish assemblages, and supports that the stream natural community should be changed from the modelled cool-cold to cool-warm. Similarly, stream temperatures monitored upstream of the mouth of Beaver creek indicated temperatures exceeded the cool-cold range, and were in the cool-warm range for at least 8 days, and supports that the natural community should be changed from the modelled cool-cold to cool-warm. In addition, the cool-warm dominant fish assemblages encountered in 2015 for South Branch Creek and Beaver Creek were similar to assemblages found in historical surveys as far back as 2004, further supporting the change in natural community to cool-warm.

Fish Species Found

The West Branch and unnamed tributary had a far greater abundance of cold water fish and a smaller percentage of tolerant fish species as compared to the South Branch and its tributary, Beaver Creek (Table 7). Additionally, there were many more intolerant species in the West Branch and unnamed tributary compared to the South Branch and Beaver Creek. Only two fish species were collected from the West Branch near the headwaters; brook trout and slimy sculpin. Slimy sculpin dominated the cold water fish caught in the West Branch and unnamed tributary, while in the South Branch Creek and Beaver Creek, sculpin were virtually absent. In Beaver Creek only two brook trout were caught, while in the South Branch only one brook trout was caught, and the fish communities of those streams were dominated by more cool-warm fish species. There were up to 15 different species in the South Branch as compared to up to 10 different species found in the West Branch, which is expected as the South Branch fish community mimics a cool-warm fish community, which normally has greater fish diversity than a cold water system.

Transitional fish species (brook stickleback, creek chub, western blacknose dace, and white sucker) tolerant to low dissolved oxygen, and/or disturbed habitat were found in much higher numbers in South Branch Creek as compared to the West Branch. The two fish most commonly found throughout all of the streams were creek chub and fantail darter. Fantail darters are usually in abundance when there is hard bottom substrate such as bedrock, rubble, cobble and gravel (Becker 1983), which gives evidence that good substrate is common in these streams. Conversely, fantail darters are less sensitive to moderate turbidity and siltation than for example, rainbow darters (Scott and Crossman 1973), which we did not see in any streams, and that may indicate that even though substrate is adequate, turbidity and siltation is a common occurrence.

The fishery is only one environmental indicator and for this reason, the quality of the resources should be looked at in the context of overall conditions including habitat and macroinvertebrates.

Macroinvertebrate Data

Macroinvertebrate results were variable in the two subwatersheds and ratings ranged from poor to good during the 2015 monitoring season. Localized stressors likely explain a significant portion of variance among sites. Weigel (2003) found that while watershed and local variables explain a significant portion of variance in macroinvertebrate IBI (MIBI) among sites within the driftless region, localized stressors were of greater importance to explain the MIBI than in other parts of the state. A single excellent rating was collected during 2009 in the West Branch of the Baraboo River, while during 2015 both MIBI's from the upper and lower stream segments rated only fair where we collected samples from rock riffles that were not heavily embedded in silt, and where the vegetative buffer was good. The

unnamed tributary (Dilly Creek) rated poor, even though there was adequate rock-riffle habitat to sample, that habitat was moderately embedded in silt, filamentous algae was present, bank erosion was high, and both the stream bottom and the riparian area was trampled by livestock. South Branch MIBI ratings were good in the upper stream segment where rock riffles were sampled, and the riparian habitat had a good vegetated buffer, but the downstream MIBI collected near CTH-Q rated only fair where rock riffle habitat was heavily embedded with silt, filamentous algae was excessive, erosion was high, and the banks were heavily trampled by livestock. Beaver Creek MIBI rated good where rock riffles were clear of silt, algae was rare, and there was a good vegetated buffer.

Phosphorus Concentrations

Growing season phosphorus concentrations were fairly similar at the mouths of both the West Branch of the Baraboo and South Branch Creek (Table 5). Data shows both streams exceed the phosphorus concentration of 0.75 mg/l. The department's listing methodology for impaired waters (WDNR, 2013) recommends listing sites where the median phosphorus concentration exceeds 0.075 mg/l on wadable streams and 0.1 mg/l on rivers. The impairment listing protocol uses a 95% confidence interval around the median for listing streams and rivers.

Management Actions

Management Priorities

It is imperative to work with the landowners and Vernon County staff to install agricultural BMPs that will help protect the water quality coming from spring heads. It is imperative to continue to work with landowners in the watersheds in locations where woody vegetation has overgrown the stream banks. The goal would be to encourage prevention of woody overgrowth along banks so that streams can continue to flow in a meandering pattern and to narrow streams for better fish habitat. Bank shaping and sloping at a 3:1 ratio in areas with eroding banks will help stabilize stream banks and reduce soil erosion. Encouraging stabilization of banks with vegetated buffers planted in grasses and forbs will help prevent erosion, act as natural cover for fish, and reduce sediment and nutrients flowing to the streams.

Monitoring and Assessment Recommendations

- The West Branch of Baraboo River at Sebranek Road had a median value for phosphorus of 0.077 mg/l, but did not exceed the lower confidence limit for the 12 samples, thus is not considered as impaired for phosphorus. This water should not be listed as impaired.
- The West Branch should be removed from the impaired waters list for Low DO, phosphorus, sediment, total suspended solids and BOD. Biological information rated from fair to excellent and does not support listing the stream for biological impairment.
- The West Branch of Baraboo River phosphorus monitoring site located at STH-33, should not be used as a stream site for calculation of phosphorus values, due to the site being located within Hillsboro Lake. Instead use the phosphorus values from the Sebranek Road site.
- The West Branch of Baraboo River fish natural community designations of cool-cold were verified, and the fish and aquatic life should be changed to good or supporting.
- DNR should monitor monthly phosphorus at the mouth of the unnamed tributary (WBIC: 1290900 Dilly Creek) to determine if it is impaired for phosphorus.
- DNR should conduct follow up monitoring in the unnamed tributary (WBIC: 1290900 Dilly Creek) at another location upstream in segment one for a second biological indicator for impairment decisions.
- DNR should monitor Hillsboro Lake to determine lake health and condition.

Natural Community Changes

- The unnamed tributary (WBIC: 1290900 Dilly Creek) fish natural community designations of cool-cold were verified, thus no changes are recommended.
- DNR should monitor South Branch Creek downstream of CTH Q to determine if the natural community designation of cold water is correct. Currently, the stream is designated as cold-water in the lower stretch near the stream mouth and at the stream outlets to Hillsboro Lake, which is a shallow warm-water lake; this water backs up into South Branch Creek downstream of CTH Q even during small rain events.
- South Branch Creek was previously listed on the 303(d) list in 2014 as impaired for phosphorus from STH-80 Bridge to the mouth. However, biological information rated good to excellent and does not support a 303(d) listing for biological impairment.
- DNR should change the natural community designation of South Branch Creek from cool-cold to cool-warm.
- DNR should change the natural community designation of Beaver Creek from cool-cold to cool-warm.

Management Recommendations for External Partners

- South Branch Creek has some stream segments and springheads that are highly eroded from livestock grazing, therefore, DNR and partners should implement agricultural BMPs to reduce soil erosion.
- The Unnamed Tributary (WBIC: 1290500) of South Branch Creek flowing from a spring pond, appears to be contributing a high amount of nutrients to South Branch Creek, and DNR along with partners should implement BMPs to reduce soil erosion and nutrient inputs.
- The West Branch of Baraboo River has some stream segments that, while not excessively grazed, have steep or vertical banks. DNR and Partners should implement stream bank erosion controls on bends to reduce erosion and stream siltation.
- The West Branch of Baraboo River fish lunger structures in the segment upstream of STH-33 have either collapsed or silted in. DNR should work with Trout Unlimited to restore structures and improve cover for fish.

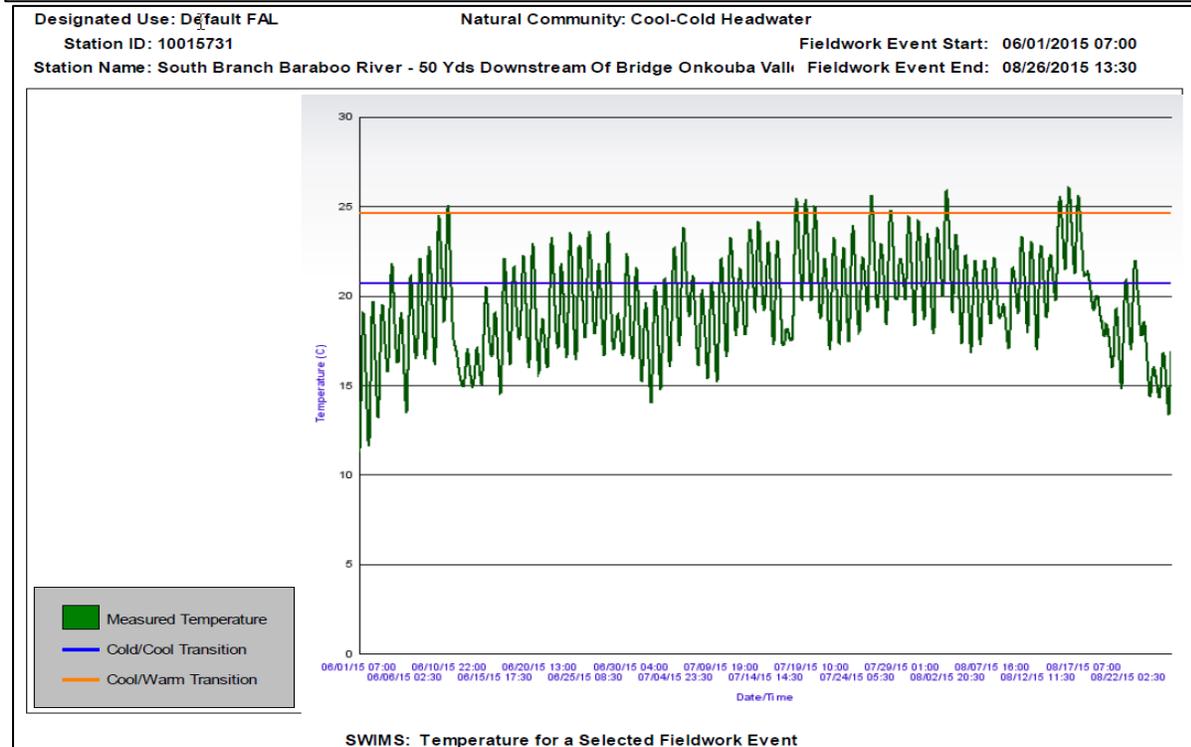
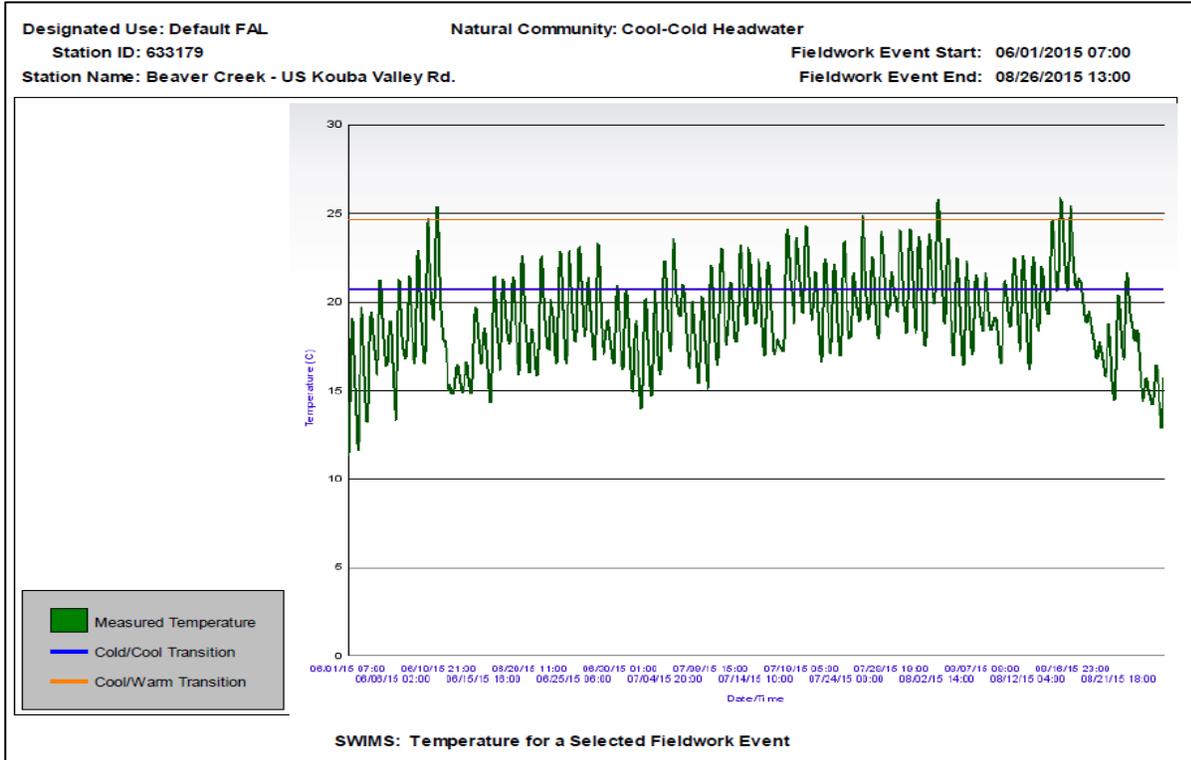
Management Recommendations for DNR

- DNR should investigate management actions that may help increase base flow and dissolved oxygen to the West Branch of the Baraboo River, downstream of the lake.
- DNR should work on outreach efforts with landowners in the watershed, and research opportunities for harvestable buffers to provide economic incentives for maintaining buffers along streams.
- DNR should work with the Hillsboro School District to encourage environmental programs and citizen monitoring of streams and Hillsboro Lake through the Citizen Lake Management Network and the Water Action Volunteer Programs.

Appendix A: References

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Appendix B: Temperature Graphs



Designated Use: Default FAL

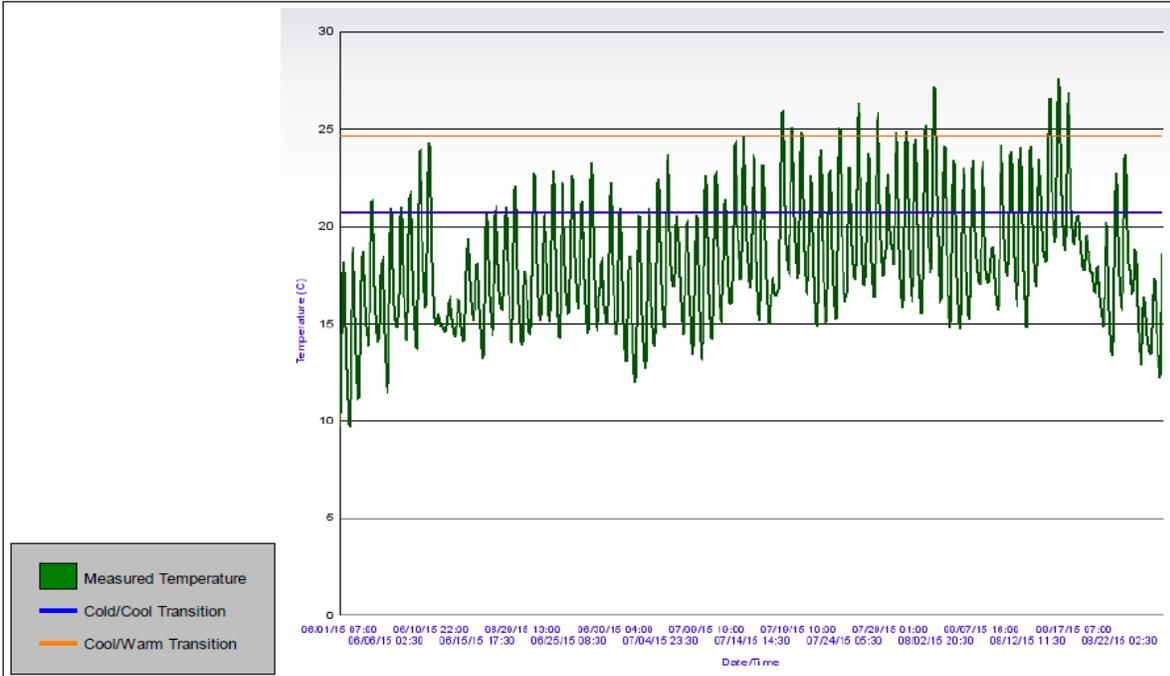
Natural Community: Cool-Cold Headwater

Station ID: 10043625

Fieldwork Event Start: 06/01/2015 07:00

Station Name: South Br. Cr. US McKenzie Rd.

Fieldwork Event End: 08/26/2015 13:00



SWIMS: Temperature for a Selected Fieldwork Event



Appendix C: Waterbody Narratives

West Branch Baraboo River

WBIC: 1288400

(Overview) The West Branch of the Baraboo River, located in northeastern Vernon County and western Juneau County, flows in a northeasterly direction for 16 miles before reaching the Baraboo River at Union Center. One dam at the Village of Hillsboro impounds the West Branch of the Baraboo River at its midpoint. Some people and references in documents erroneously identify the portion of river downstream of Hillsboro Lake as South Branch of the Baraboo River when in fact it is the West Branch of the Baraboo River. The South Branch of the Baraboo River, also known as South Branch Creek, is a tributary to the West Branch at Hillsboro Lake. The West Branch of the Baraboo River has a gradient of 69 feet per mile upstream of Hillsboro Lake and drains hilly agricultural and forested land. The West Branch of the Baraboo River upstream of Hillsboro Lake is in the Hillsboro Lake Priority Watershed. The West Branch of the Baraboo River is a Class III trout stream for 4.6 miles upstream of Sebranek Road just west of Hillsboro. The remainder of the river contains forage fish species and possibly some game fish species.

The most recent biological survey, conducted in 1988, documented a marginal trout fishery upstream of Sebranek Road just west of Hillsboro. The stretch of river from this bridge downstream to Hillsboro Lake was inhabited by white suckers and largemouth bass. The West Branch of the Baraboo River upstream of Hillsboro Lake suffers from flooding, sedimentation of pools and riffles, manure runoff, and lack of instream habitat for adult trout. The water quality standard for dissolved oxygen has been violated under low-flow conditions downstream of Hillsboro Lake in 1983; consequently a 1.75 mile section of this river below the lake is classified as an impaired water (303d list). Several factors may contribute to the lack of dissolved oxygen including: discharges from the Hillsboro wastewater treatment plant and from Foremost Farms USA, low stream velocity, an upstream impoundment with algae problems, and stream channelization. To increase dissolved oxygen levels in the river, the Village of Hillsboro may want to review and possibly change dam operation procedures during summer months when algae blooms occur. Since this stretch of river has a very low gradient which is not conducive to aeration, an alteration of the river to induce more aeration may also prove beneficial. If dissolved oxygen levels in the West Branch of the Baraboo River consistently stay above the state standard, removal from the impaired waters list would result. DNR records indicate that the West Branch of the Baraboo River has been stocked with brown trout consistently since 1960. Access to the West Branch of the Baraboo River is from seven road crossings.

South Branch Creek (S Br Baraboo)

WBIC: 1289800

(Overview) South Branch Creek, also known as the South Branch of the Baraboo River, flows in a northeasterly direction for 6.5 miles before reaching the West Branch of the Baraboo River at Hillsboro Lake in Hillsboro. Some people and references in older documents erroneously identify the South Branch of the Baraboo River as extending below Hillsboro Lake to its confluence with the Baraboo River near Union Center. The river below Hillsboro Lake, however, is in fact the West Branch of the Baraboo River. South Branch Creek, located in northeastern Vernon County, has a gradient of approximately 23 feet per mile and drains hilly agricultural and forested lands. The creek is a Class III trout stream for its entire length upstream of HWY 80 just south of Hillsboro. The lower half mile of the stream contains warm water fish species also found in Hillsboro Lake. The South Branch Creek suffers from flooding,

sedimentation of pools and riffles, manure runoff, and lack of in-stream habitat for adult trout. The most recent biological survey, conducted in 1968, documented very few brown trout and numerous forage fish species. A habitat survey, conducted in 1994, documented a stream bottom consisting of equal amounts of gravel, cobble, sand and silt; however, in-stream cover for adult trout was lacking. There is a USGS gauging station at Hillsboro. DNR records indicate that the South Branch Creek has been stocked with brown trout consistently since 1960. Access to this stream is from five road crossings.

Field Veterans Memorial Lake

WBIC: 1289700

Field-Veterans Memorial Lake (Hillsboro Lake) is a hard water; drainage impoundment is located on the South Branch of the Baraboo River in the City of Hillsboro. The West Branch of the Baraboo River joins the South Branch at the impoundment. The water level is controlled by a tainter gate and the dam is owned by the city. The light brown water is alkaline and at the time of survey, had low transparency. Following the rebuilding of the dam, in 1967, a chemical fish eradication program was carried out in the impounded area and the two inlet streams prior to closing the gate. Trout were stocked to provide immediate fishing, and the basic fishery management is for rainbow trout, largemouth bass and bluegill. There is a public picnic site, access from State Highway 80, and navigable water access. Wood ducks and teal nest at this lake, while puddle ducks, diving ducks, and Canada and Blue geese use it while migrating. No hunting is allowed within the city limits.

Beaver Creek

WBIC: 1290100

Beaver Creek is a small size spring-fed tributary of the South Branch Creek located near Hillsboro. Beaver Creek flows in a southeasterly direction for 4.78 miles. It has a steep gradient of 56 feet per mile and drains forested hills and agricultural land. The most recent survey, completed in 2004, documented clear cool water. Undercut banks and overhanging vegetation provided the majority of in-stream cover. In a 2004 survey fish catch was dominated by creek chub, white sucker, Johnny darter, bluntnose minnow, and fantail darter, among other forage species. This stream was not stocked with brown or brook trout, and the stream was documented as entrenched. Access is possible from two road crossings.

West Branch Baraboo River

WBIC: 1288400

The West Branch of the Baraboo River, located in northeastern Vernon County and western Juneau County, flows in a northeasterly direction for 16 miles before reaching the Baraboo River at Union Center. One dam at the Village of Hillsboro impounds the West Branch of the Baraboo River at its midpoint. Some people and references in documents erroneously identify the portion of river downstream of Hillsboro Lake as South Branch of the Baraboo River when in fact it is the West Branch of the Baraboo River. The South Branch of the Baraboo River, also known as South Branch Creek, is a tributary to the West Branch at Hillsboro Lake. The West Branch of the Baraboo River has a gradient of 69 feet per mile upstream of Hillsboro Lake and drains hilly agricultural and forested land. The West Branch of the Baraboo River upstream of Hillsboro Lake is in the Hillsboro Lake Priority Watershed. The West Branch of the Baraboo River is a Class III trout stream for 4.6 miles upstream of Sebranek Road just west of Hillsboro. The remainder of the river contains forage fish species and possibly some game fish species. The most recent biological survey, conducted in 1988, documented a marginal trout fishery upstream of Sebranek Road just west of Hillsboro. The stretch of river from this bridge downstream to

Hillsboro Lake was inhabited by white suckers and largemouth bass. The West Branch of the Baraboo River upstream of Hillsboro Lake suffers from flooding, sedimentation of pools and riffles, manure runoff, and lack of instream habitat for adult trout. The water quality standard for dissolved oxygen has been violated under low-flow conditions downstream of Hillsboro Lake in 1983; consequently a 1.75 mile section of this river below the lake is classified as an impaired water (303d list). Several factors may contribute to the lack of dissolved oxygen including: discharges from the Hillsboro wastewater treatment plant and from Foremost Farms USA, low stream velocity, an upstream impoundment with algae problems, and stream channelization. To increase dissolved oxygen levels in the river, the Village of Hillsboro may want to review and possibly change dam operation procedures during summer months when algae blooms occur. Since this stretch of river has a very low gradient which is not conducive to aeration, an alteration of the river to induce more aeration may also prove beneficial. If dissolved oxygen levels in the West Branch of the Baraboo River consistently stay above the state standard, removal from the impaired waters list would result. DNR records indicate that the West Branch of the Baraboo River has been stocked with brown trout consistently since 1960. Access to the West Branch of the Baraboo River is from seven road crossings.

Appendix D: Monitoring Station Report

WBIC	WATERBODY NAME	STATION ID	STATION NAME	EARLIEST FIELDWORK DATE	LATEST FIELDWORK DATE
1288400	West Branch Baraboo River	633120	Baraboo River W. Branch Of - W. Branch Of Baraboo River	07/13/1973	10/28/2015
1289800	South Branch Creek	10017179	South Branch Baraboo at Cth Q	11/05/1973	10/28/2015
1288800	Hills Creek	10030192	Hills Creek at Hwy 33	06/11/2009	10/06/2015
1288400	West Branch Baraboo River	10011291	West Branch Baraboo River - West Branch Baraboo River Station #3 100m Upstream Bridge On Grimm Rd.	06/01/2015	09/22/2015
1290900	Unnamed	10043634	Unnamed (Dilly Creek) US STH. 33	06/01/2015	09/22/2015
1288400	West Branch Baraboo River	10039097	West Branch Baraboo River 50 yds above HWY 33 bridge crossing	08/24/2015	09/22/2015
1290100	Beaver Creek	10016405	Beaver Creek - 50 Yds Downstream Of Bridge On Sth80	07/20/1998	09/22/2015
1289800	South Branch Creek	10015731	South Branch Baraboo River - 50 Yds Downstream Of Bridge Onkouba Valley Rd.	03/17/1994	09/22/2015
1288400	West Branch Baraboo River	10017181	West Branch Baraboo at Sebranek Road	01/31/2007	08/24/2015

WBIC	WATERBODY NAME	STATION ID	STATION NAME	EARLIEST_FIELDWORK DATE	LATEST FIELDWORK DATE
1289800	South Branch Creek	10043625	South Br. Cr. US Mckenzie Rd.	06/01/2015	08/13/2015
1290100	Beaver Creek	633179	Beaver Creek - US Kouba Valley Rd.	08/23/2001	08/13/2015
1289700	Field Veterans Memorial Lake	10005953	Field Veterans Memorial Lake	07/27/1999	07/30/2015
1271100	Baraboo River	10013899	Baraboo River Station 1-1962-Ne1/4 Ne1/4 Sec 32-Starts At Town Bridge In Village Of Elroy	05/08/2012	01/01/2015
1292500	Cleaver Creek	10012756	Cleaver Creek -Above Hwy. 82	10/13/2004	01/01/2015
1271100	Baraboo River	10013905	Baraboo River at Hwy. 71 bridge Kendall (Station 7)	08/02/1989	01/01/2015
1288400	West Branch Baraboo River	10017367	West Branch Baraboo River At E. Madison. St. Bridge	03/16/2007	01/01/2015
1291400	Seymour Creek	10012187	Seymour Creek - Upstream Raese Road	10/13/2004	01/01/2015
1288800	Hills Creek	10043661	Hills Creek HwyF & Young Rd	09/08/2014	09/08/2014
1291400	Seymour Creek	10033911	Seymour Creek at CTH WW	07/07/2011	09/08/2014
1288800	Hills Creek	10043660	Hills Creek HwyF & Hickory Rd	09/08/2014	09/08/2014
1271100	Baraboo River	10043605	Baraboo River at STH 33	09/03/2014	09/03/2014
1271100	Baraboo River	10012192	Baraboo River - Schaller Rd (Hann St)	07/03/2014	07/03/2014
5028515	Unnamed	10037666	Unnamed Tributary (5028515) to Hills Creek at CTH F	07/30/2013	11/14/2013
1271100	Baraboo River	293065	Baraboo River - Sth 80 - 82 Sec. 4	05/08/1979	10/02/2013
1271100	Baraboo River	10011191	Baraboo River - Baraboo River St. 3 - Bridge W In Kendall	08/02/1989	10/22/2012
1290200	Unnamed	10011201	Stream 10-16 St. 1 Bridge Off Hwy 80	07/05/2012	10/22/2012
1293000	Unnamed	10003069	Unnamed Lake (T15 R2E S5)	07/27/1999	10/03/2012
1289700	Field Veterans Memorial Lake	10017494	Field Veterans Memorial Lake -- Access	03/19/2012	03/19/2012
1294300	Unnamed	10031064	Lydon Valley creek down stream of NOD barnyard	03/23/2010	04/18/2011
5564024	Unnamed	10036229	Unnamed Lake	07/17/2010	07/17/2010

WBIC	WATERBODY NAME	STATION ID	STATION NAME	EARLIEST_FIELDWORK DATE	LATEST_FIELDWORK DATE
1294300	Unnamed	10031065	Lydon Valley Creek upstream of NOD barnyard	03/23/2010	03/23/2010
1291200, 1288400	Unnamed, West Branch Baraboo River	10032062	W. Branch of Baraboo River 300 meters south of Grimm Rd. near Amberg Rd.	11/12/2009	11/12/2009
1292600	Unnamed	10030193	Unnamed trib to Baraboo River - HWY 80	06/11/2009	09/24/2009
1289700	Field Veterans Memorial Lake	634001	Hillsboro Pond - Hillsboro Pond	08/28/1979	08/27/2009
1290900	Unnamed	10029984	Unnamed WBIC: 1290900 (Dilly Creek)	05/05/2009	05/05/2009
1291400	Seymour Creek	10011225	Seymour Creek - Seymour Creek Station #3 (Bridge On Ottoman Ave.)	08/18/2008	10/13/2008
1288400	West Branch Baraboo River	10021116	West Branch Baraboo River Downstream Of Cth Ff	08/07/1989	10/30/2007
1271100	Baraboo River	10021930	Baraboo River 100 M Downstream From Hwy 71 Crossing	10/10/2007	10/10/2007
1288400	West Branch Baraboo River	633190	Baraboo River West Branch Of - Hwy 33 Downstream From Hillsboro Stp	08/23/2005	08/30/2005
1288400	West Branch Baraboo River	633189	Baraboo River West Branch Of - Upstream Of Hwy Ff Bridge	08/23/2005	08/30/2005
1291400	Seymour Creek	10011224	Seymour Creek - Seymour Creek Station #2 (140m Downstream Of Bridge On Shaker Rd.)	10/15/2004	10/15/2004
1289800	South Branch Creek	10011295	South Branch Creek - South Branch Baraboo River Station #3 Bridge On St. Patrick Rd.	10/15/2004	10/15/2004
1271100	Baraboo River	10013903	Baraboo River Station 5-1962-Ne 1/4 Nw 1/4 Sec. 14- Starts At Monitor Road Bridge Crossing.	10/14/2004	10/14/2004
1271100	Baraboo River	293011	Baraboo River - Union Center Stp	11/14/1977	10/13/2004
1288400	West Branch Baraboo River	10011185	West Branch Baraboo River - W. Br. Baraboo St. 1 - Bridge On Smith Rd	10/13/2004	10/13/2004
1288800	Hills Creek	633156	Hills Creek - Hills Creek	06/23/2003	10/23/2003

WBIC	WATERBODY NAME	STATION ID	STATION NAME	EARLIEST_FIELDWORK DATE	LATEST FIELDWORK DATE
1288400	West Branch Baraboo River	10011186	West Branch Baraboo River - W. Br. Baraboo St. 2 - 245m Ds Of Snowmobile Bridge	10/08/2003	10/08/2003
1288800	Hills Creek	633157	Hills Creek - (Bridge)	06/23/2003	08/20/2003
NA	NULL	633033	Baraboo River West Branch - Hillsboro Stp	01/24/1977	10/20/2002
1288400	West Branch Baraboo River	633183	West Branch Baraboo River at Sth 33 Near Hillsboro WI	03/17/1994	10/18/2001
1290900	Unnamed	633178	Dilly Creek - Near Hillsboro WI	03/17/1994	10/18/2001
1288400	West Branch Baraboo River	10011290	West Branch Baraboo River - West Branch Baraboo River Station #2 Fenceline 20m Upstream Of Hwy 33	10/16/2001	10/16/2001
1290100	Beaver Creek	633182	Beaver Creek - Near Hillsboro WI	05/24/2001	07/20/2001
1289800	South Branch Creek	10015761	South Branch Baraboo River - 70 Yds Above Bridge On Sth 80	03/17/1994	03/17/1994
1289700	Field Veterans Memorial Lake	633122	Field Veterans Memorial Lake - Deep Hole	07/13/1973	06/04/1990
NA	NULL	293010	Baraboo River - Elroy Stp	09/15/1977	01/24/1985
1271100	Baraboo River	293009	Baraboo River - Elroy Community Dairy Inc Elroy	02/14/1980	08/03/1982
NA	NULL	423018	Baraboo River - Kendall Stp	09/27/1976	07/14/1982
NA	NULL	293012	Baraboo River - Wis Dairies Coop Union Center	04/08/1976	04/08/1976

Appendix E: Waterbody Assessment Reportⁱ

WBIC	Local Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Assessment	Impaired Water Status
1029400	Un Lake	0	0.41	Small	FAL	Not Assessed	Default FAL	NA	No Assessment on File	NA
1271100	Baraboo River	86.79	101.29	WWSF	FAL	Not Supporting	Default FAL	Impairment Unknown	Monitored	TMDL Development
1271100	Baraboo River	101.35	106.16	Class III Trout	FAL	Not Supporting	Default FAL	Impairment Unknown	Monitored	TMDL Development
1271100	Baraboo River	108.6	118.93	Cold (Class II Trout)	Cold (Class II Trout)	Not Supporting	Cold	Impairment Unknown	Monitored	TMDL Development
1288400	West Br Baraboo River	0	7.24	WWSF	FAL	Not Supporting	Default FAL	Low DO	Monitored	303d Listed, TMDL Development
1288400	West Br Baraboo River	7.95	9.3	WWSF	FAL	Supporting	Default FAL	NA	Monitored	NA
1288400	West Br Baraboo River	9.3	15.79	Class III Trout	FAL	Fully Supporting	Default FAL	NA	Monitored	NA
1288800	Hills Creek	0	10	FAL	WWSF	Not Supporting	Default FAL	Degraded Biological Community	Monitored	TMDL Development

WBIC	Local Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Assessment	Impaired Water Status
1289500	Unnamed Creek	0	2	FAL	FAL	Not Assessed	Default FAL	NA	No Assessment on File	NA
1289700	Field Veterans Memorial Lake	0	56	Impounded Flowing Water	FAL	Supporting	Default FAL	NA	Monitored	NA
1289800	South Br Creek (S Br Baraboo)	0	1.25	FAL	FAL	Not Supporting	Default FAL	Impairment Unknown	Monitored	TMDL Development
1289800	South Br Creek (S Br Baraboo)	1.25	9.44	Class III Trout	FAL	Fully Supporting	Default FAL	NA	Monitored	NA
1290100	Beaver Creek	0	4.78	FAL	FAL	Not Assessed	Default FAL	NA	No Assessment on File	NA
1290900	Dilly Creek	0	4	FAL	FAL	Not Assessed	Default FAL	NA	No Assessment on File	NA
1291400	Seymour Creek	0	2.63	Class III Trout	FAL	Not Supporting	Default FAL	Impairment Unknown	Monitored	TMDL Development
1291400	Seymour Creek	2.63	6.48	FAL	FAL	Not Supporting	Default FAL	Impairment Unknown	Monitored	TMDL Development
1291400	Seymour Creek	6.48	11.49	Class III Trout	FAL	Not Supporting	Default FAL	Impairment Unknown	Monitored	TMDL Development

WBIC	Local Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Assessment	Impaired Water Status
1292500	Cleaver Creek	0	5	FAL	WWSF	Not Supporting	Default FAL	Water Quality Use Restrictions	Monitored	TMDL Development
1292600	Sherman Valley	0	7.96	FAL	FAL	Supporting	Default FAL	NA	Monitored	NA
1293000	Unnamed Lake	0	10.67	FAL	FAL	Supporting	Default FAL	NA	Evaluated: Modeled Data	NA
1293700	Un Spring	0	1.07	Small	FAL	Not Assessed	Default FAL	NA	No Assessment on File	NA
1294000	Spring Valley Creek	0	2.23	Cold (Class II Trout)	Cold (Class II Trout)	Not Assessed	Cold	NA	No Assessment on File	NA
1294000	Spring Valley Creek	2.23	2.49	Cold (Class I Trout)	Cold (Class I Trout)	Not Assessed	Cold	NA	No Assessment on File	NA
1294000	Spring Valley Creek	2.49	5.93	Cold (Class I Trout)	Cold (Class I Trout)	Not Assessed	Cold	NA	No Assessment on File	NA
1294300	Fox River Valley Creek	0	4.87	Class III Trout	FAL	Fully Supporting	Default FAL	NA	Monitored	NA

ⁱ The watershed assessment table reflects the condition of waters in the study area watershed. This table data is stored in the Water Assessment Tracking and Electronic Reporting System (WATERS) and is updated on an ongoing basis via monitoring data and assessment calculations. The following definitions apply:

- Current Use – current condition of water based on monitoring data.
- Attainable Use – “ecological potential” of water based on water type, natural community, lack of human-induced disturbances.
- Supporting Attainable Use – decision on whether the water’s current condition is supporting its designated use under “water quality standards”.
- Designated Use – the water’s classified use under NR102, Wisconsin Water Quality Standards, for Fish and Aquatic Life.
- Impairments – documented impacts on water condition due to pollution sources or changes in hydro-geomorphological changes.
- Assessment – field indicates what type of data or information supports the decisions in the table (current, attainable, and supporting attainable).
- Impaired Water Status – This column indicates the status of the impaired water for TMDL development. `