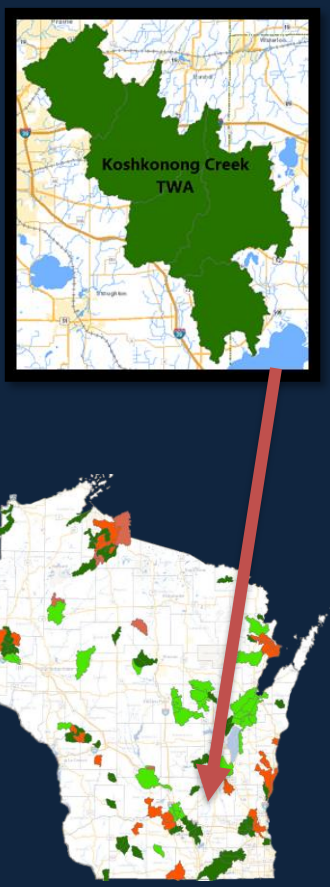
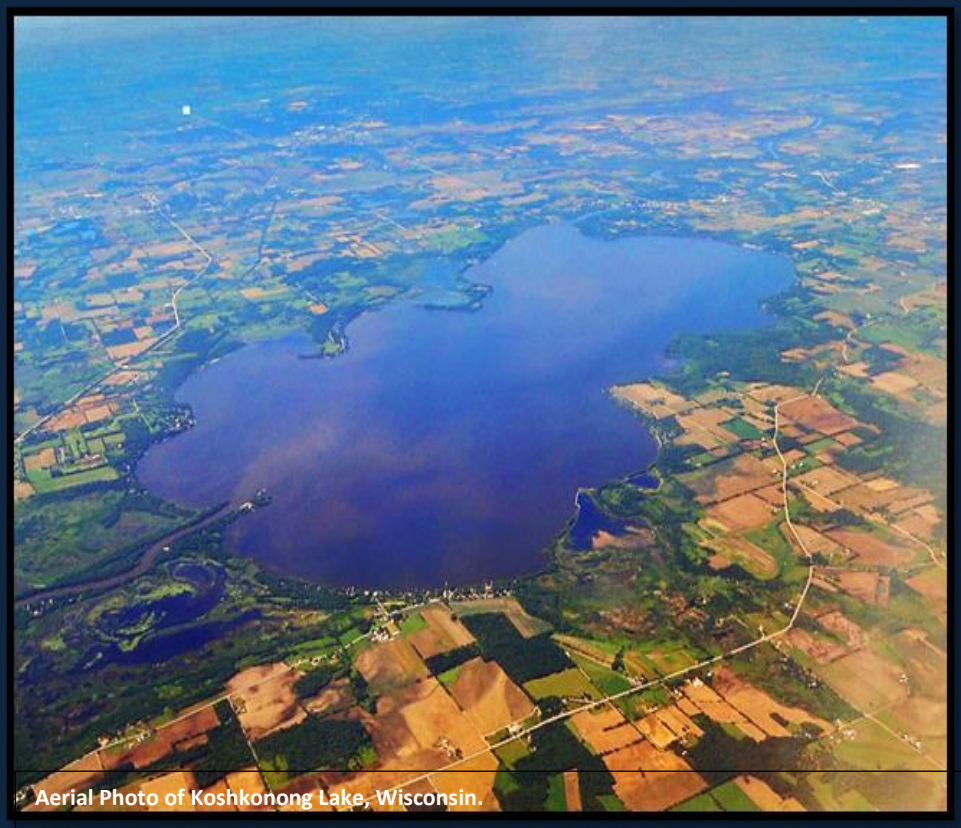
Koshkonong Creek Targeted Watershed Assessment: A Water Quality Plan to Protect Wisconsin Watersheds, 2020

Watershed Report by the Bureau of Water Quality in support of the Clean Water Act.

Lower and Upper Koshkonong Creek (LR11 and LR12)
HUC 10: 0709000204
Monitored In 2016





Aerial Photo of Koshkonong Lake, Wisconsin.

WISCONSIN
DEPT. OF NATURAL RESOURCES

To learn more about this area, see **Wisconsin TWA Projects Online!**

Search for more information on **Explore Your Waters!**

EGAD # 3200-2020-05
Water Quality Bureau
Wisconsin DNR

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Targeted Watershed Assessment Study Summary

Purpose

This Targeted Watershed Evaluation Assessment (TWA) of Koshkonong Creek HUC10 involves monitoring biological data, habitat condition, flow, and aquatic invasive species at all stations in five separate HUC12s. This project generated data to analyze current conditions in the Koshkonong Creek watershed and to make recommendations for future management actions in the area.

Evaluation surveys were conducted at 23 sites in the watershed in 2016 to allow biologists to evaluate fish assemblage, macroinvertebrate assemblage, habitat quality, stream flow, and diatom samples. This water quality plan presents study results, identifies issues or concerns found during the project, and advances recommendations to improve or protect water quality under the federal Clean Water Act and state water quality standards. This data is presented for both the Rock River Recovery / TMDL project for follow up through project sector teams and cooperative partnership planning and implementation discussions.

Biological Community and Water Quality

Despite Koshkonong Creek being impaired by phosphorus and impacted by major hydrologic modification and sedimentation, the creek and tributaries have an impressive array of fish species. While tolerant species tend to make up the bulk of the assemblages, there are sites that have several intolerant species – some of which make up a significant part of the total fish numbers.

Many of the most dominant species of the watershed were those tolerant to disturbed habitat and low dissolved oxygen. It was not surprising to find central mudminnows throughout the watershed; this species is known for inhabiting low gradient wetland streams. It is associated with clearer waters with moderate to dense vegetation and prefers water lacking flow and can survive where dissolved oxygen levels are very low. White suckers, creek chubs, and green sunfish are highly adaptable species that can thrive in the channelized, featureless types of systems that have little fish cover and are high in sediment. They tend to predominate in hydrologically modified areas; there doesn't appear to be any strong correlation between the fish IBI and the overall habitat score or any particular habitat metric. The sites generally with the best overall scores tended to have higher IBIs, and the converse was generally true. In other words, sites with poor habitat did not have good fish assemblages. Overall 13 out of 24 sites had fair or lower IBI's. Eight sites had "excellent" IBIs and 3 sites were "good" in the IBI rating. For the sites with excellent IBI's, overall habitat scores ranged from 25 (fair) to 68 (good), with most between 30 and 50, or fair.

Recommendations

Natural resources codes should be updated to reflect current conditions. Re-creating natural meanders may not be possible and creating gradient, or bottom substrate of wetland systems, is not possible. Therefore, reflecting the true potential of the stream systems in the establishment of "attainable use" through updated water quality standards and assessment processes would provide a more realistic gauge of condition and system potential.

Controlling nutrient input from waste treatment systems and sediment/nutrient from agricultural fields are priorities.
Soil health and cover crop practices can be employed to minimize soil and nutrient loss from crop fields.
The county should continue to work with individual farms to adopt whole farm planning.

The county should work with the drainage district to allow improvements in water flow while protecting habitat in the stream and the riparian area from erosion and wetland degradation.

Koshkonong Creek: Newly formed stream channel in what was once an impoundment

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 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 approved by the Wisconsin DNR Water Quality Program and is a formal update to the Lower Rock 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.

_____	_____
James Amrhein, Water Quality Biologist, South District	Date
_____	_____
Michael Sorge, Water Resources Field Supervisor, South District	Date
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Greg Searle, Water Quality Bureau Field Operations Director	Date
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Timothy Asplund, Water Quality Bureau Monitoring Section Chief	Date

Basin/Watershed Partners

Dane County Land and Water Conservation Department
Rock County Land and Water Conservation Department
Dodge County Land and Water Conservation Department
Columbia County Land and Water Conservation Department

Report Acknowledgements

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EGAD # 3200-2020-05

Abbreviations

Aquatic Macroinvertebrates – aquatic insects (monitored when in early stages of live) that are large enough to be seen without magnification.

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.

ERW: Exceptional Resource Waters. Designation under water quality standards that identify high quality waters that have a higher level of protection through various programs and processes.

FMDB: Statewide Fisheries Management Database. A centralized database for all statewide fish surveys, wadable stream habitat surveys, fish propagation information, fishing tournament permits, and fish kill investigations. Formally the Statewide Fish and Habitat Biology Database (FHBD)

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 sequence of numbers that identify nested 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).

NC: 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.

NRCS: USDA Natural Resources Conservation Service. The federal agency providing local support and land management outreach work with landowners and partners such as state agencies.

ORW: Outstanding Resource Waters. Wisconsin's designation under state water quality standards to waters with outstanding quality and which may be provided a higher level of protection through various programs and processes.

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

TP: Total Phosphorus. An analyzed chemical parameter collected in aquatic systems frequently positively correlated with excess productivity and eutrophication in many of Wisconsin's waters.

TWA: Targeted Watershed Assessment. A statewide study design that includes 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.

WBIC: Water Body Identification Code. WDNR's identification codes for water features.

Water Quality Plan Goals

The goal of this plan is to improve and protect water quality in the Lower Rock River Basin. This Targeted Watershed Assessment (TWA) 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.

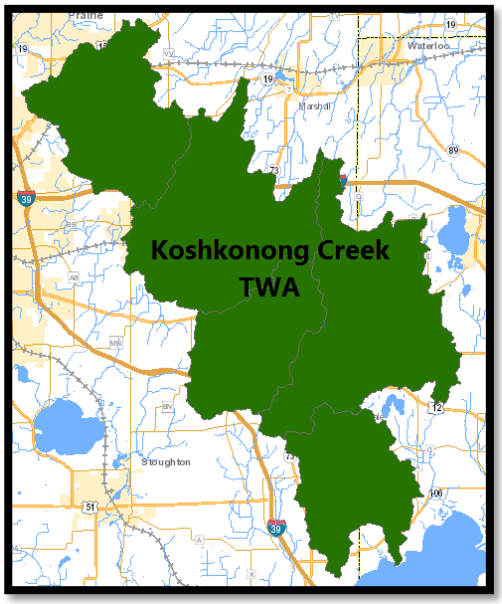


Figure 1: Koshkonong Creek Watershed Targeted Watershed Assessment (TWA) Project

Resources

Location and Size

The Koshkonong Creek HUC 10 studied in this TWA is part of two larger watersheds, Lower Koshkonong Creek (LR11) and Upper Koshkonong Creek (LR12). Koshkonong Creek itself is a 54-mile-long stream that begins in the City of Sun Prairie and flows southeast until it meets Lake Koshkonong in the southwestern corner of Jefferson County. The upper 6 miles from the headwaters down to CTH T is classified as Limited Aquatic Life (LAL). Downstream from there to the mouth it is classified as a warm water sport fishery. Much of the upper half of the stream has been ditched for agriculture. The lower third, downstream of Cambridge, still flows in its natural channel. The only impoundment on the creek at Rockdale was removed in 2001.

Historical accounts describe a stream that was plagued by hydrologic modification, clogged with "debris", and having overall poor water quality in the form of high levels of phosphorus, chlorides, bacteria, ammonia and nitrogen. This was the result of runoff from agricultural fields as well as "sludge" from the wastewater treatment facility in Sun Prairie (WDNR, 1985). While improvements were made to the wastewater discharge, effects from historical point and nonpoint sources still affected the stream. It was not until in 2016, however, that the stream was put on the state's 303(d) list of impaired waters due to phosphorus levels exceeding the state's criteria (WDNR, 2017). It is also proposed to be listed for temperatures exceeding the state's criteria in 2018.

Many other tributaries drain into Koshkonong Creek and very few have remained without hydrological modifications (channelization) made to enhance field drainage. While the majority of wetlands in the watershed have been drained for agricultural purposes, some significant wetlands remain. The City of Sun Prairie, as well as the villages of Deerfield, Cambridge, and Rockdale have wastewater discharges in the watershed.

Land Use and Population

The project area covers 169 mi2 of the Lower (LR11) and Upper (LR12) Koshkonong Creek Watersheds. Land use in the Lower Koshkonong (LR11) watershed is primarily agricultural (54.20%), wetland (11.60%) and a mix of grassland (10.50%) and other uses (23.70%) (Figure 2). Land use in the Upper Koshkonong (LR12) watershed is primarily agricultural (58.60%), grassland (11.80%) and a mix of wetland (9.90%) and other uses (19.60%) (Figure 3).

The TWA study area straddles the boarder of Dane and Jefferson Counties in Southeastern Wisconsin. A total of 18 communities have municipal boundaries that overlap with the TWA study area (Figure 4). Of those communities, the villages of Deerfield, Rockford, and Cambridge fall entirely within the study area's boundaries (Table 1).

Wastewater Service Planning

The Village of Cambridge has a population of over 1,100. Its population grows to roughly six times that number of people during the summer season. The village's facilities plan should be reviewed to ensure that the city's wastewater treatment plant could accommodate these seasonal fluctuations. Sewerage capacity and land use issues have been a top concern in this area, as the Oakland Sanitary District, which sends its effluent to the Cambridge wastewater treatment plant, has developed a moratorium on multi-scale development, allowing only single-family development. The town of Oakland developed a draft land use plan that will limit unsewered development and build in a developer payback to cover infrastructure costs. This plan does not address the existing approved plans that continue to be developed and may yet add another 100 homes. The single-family development moratorium may encourage urban/suburban sprawl, precipitating the loss of prime agricultural land and leading to low density growth that drives up the cost of wastewater treatment. While sewer service area planning is conducted in the Dane County portion of Cambridge, the Jefferson County portion, which is growing more rapidly than the west side, has no sewer service area planning in place. Cambridge should work with Dane County, Jefferson County and surrounding urbanizing areas to develop a comprehensive long-term sewer service area plan that addresses the entire urban area, and which reflects the facilities plan for the Cambridge wastewater treatment plant.

Figure 2: Land Use Upper and Lower Koshkonong Watersheds.

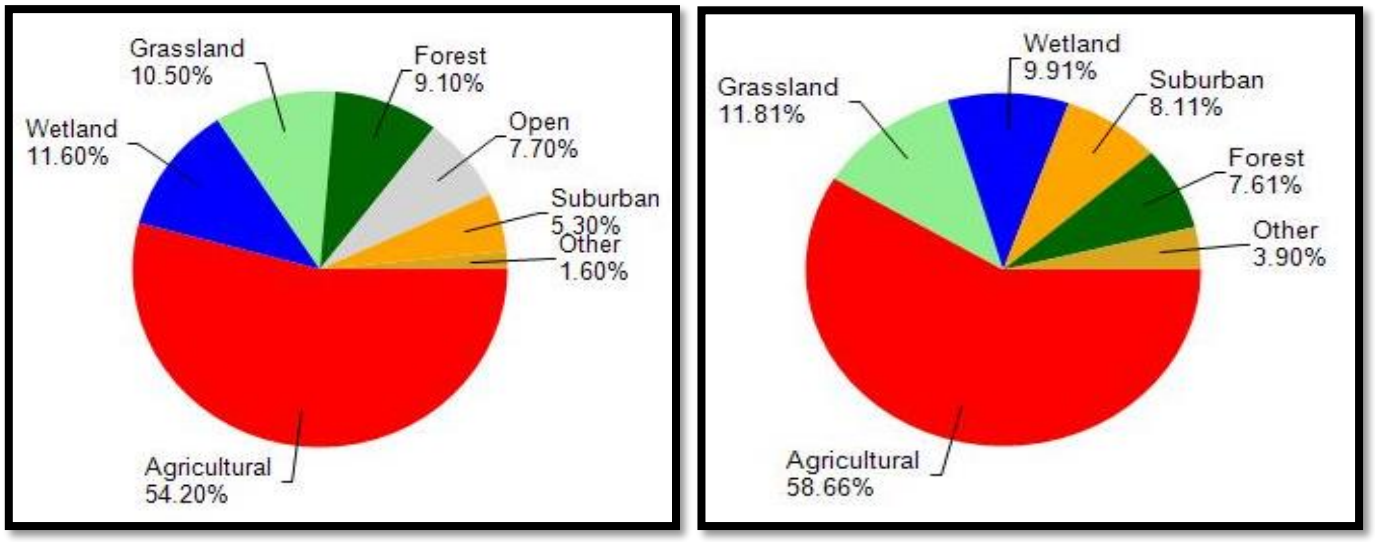


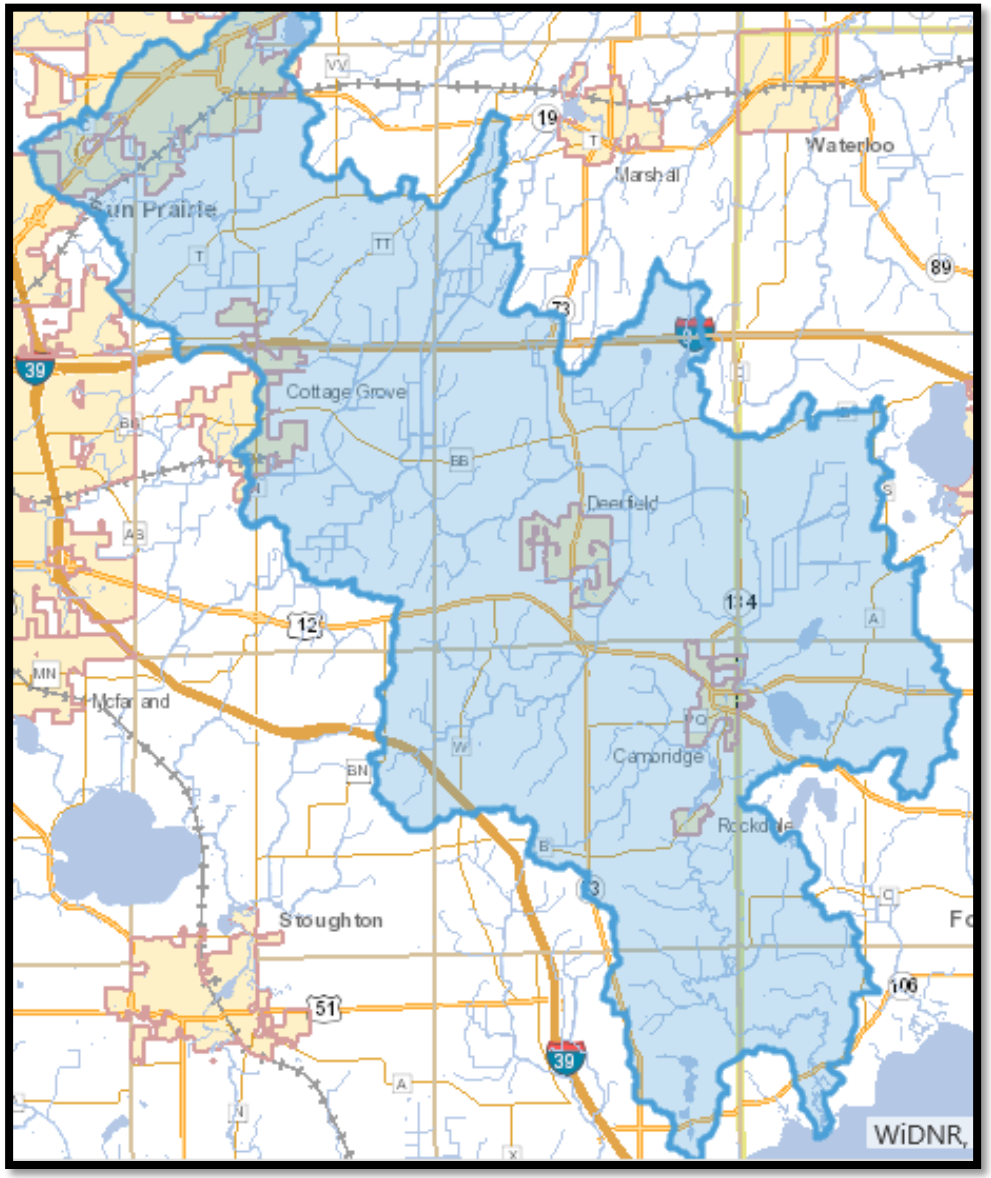
Figure 3: Land Use in the Koshkonong Creek Watershed(s) WiscLand2

Table 1: Municipalities within the Koshkonong Creek TWA study area and their populations as of the 2010 United States Census.

Municipalities	Type	Population	County
Cottage Grove*	Town	3875	Dane
Albion*	Town	1823	Dane
Deerfield	Village	2319	Dane
Sun Prairie*	Town	2326	Dane
Sumner*	Town	832	Jefferson
Cottage Grove*	Village	6248	Dane
Sun Prairie*	City	29441	Dane
Bristol*	Town	3765	Dane
Medina*	Town	1235**	Dane
Lake Mills*	Town	2070	Jefferson
Burke*	Town	3284	Dane
Pleasant Springs*	Town	3154	Dane
Christiana*	Town	1235	Dane
Deerfield*	Town	1470**	Dane
Oakland*	Town	3100	Jefferson
Madison*	City	233209	Dane
Rockdale	Village	214	Dane
Cambridge	Village	1457	Dane, Jefferson

*Portions of municipality lies outside of the TWA study area.
**Population count taken from 2000 United States Census.

Figure 4: Municipalities within the Koshkonong Creek TWA Study area.



Ecological Landscapes

The Southeast Glacial Plains Ecological Landscape makes up the bulk of the non-coastal land area in southeast Wisconsin. This Ecological Landscape is made up of glacial till plains and moraines. Most of this Ecological Landscape is composed of glacial materials deposited during the Wisconsin Ice Age, but the southwest portion consists of older, pre-Wisconsin till with a more dissected topography. Soils are lime-rich tills overlain in most areas by a silt-loam loess cap. Agricultural and residential interests throughout the landscape have significantly altered the historical vegetation. Most of the rare natural communities that remain are associated with large moraines or in areas where the Niagara Escarpment occurs close to the surface. Historically, vegetation in the Southeast Glacial Plains consisted of a mix of prairie, oak forests and savanna, and maple-basswood forests. Wet-mesic prairies, southern sedge meadows, emergent marshes, and calcareous fens were found in lower portions of the Landscape. End moraines and drumlins supported savannas and forests. Agricultural and urban land use practices have drastically changed the land cover of the Southeast Glacial Plains since Euro-American settlement. The current vegetation is primarily agricultural cropland. Remaining forests occupy only about 10% of the land area and consist of maple-basswood, lowland hardwoods, and oak. No large mesic forests exist today except on the Kettle Interlobate Moraine which has topography too rugged for agriculture. Some existing forest patches that were formerly savannas have succeeded to hardwood forest due to fire suppression.

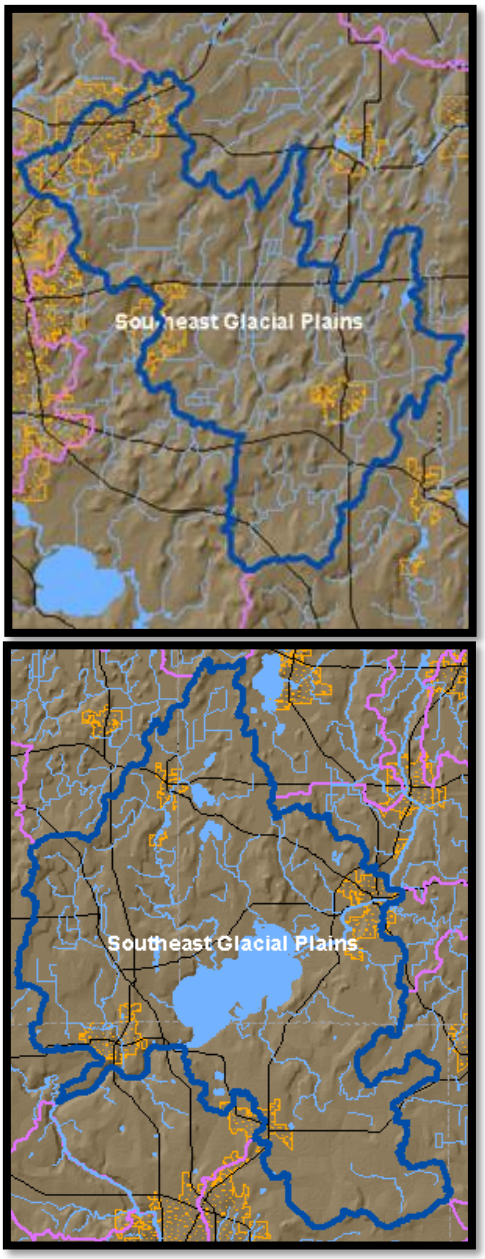


Figure 5: Koshkonong Creek Ecological Landscape.

Hydrology

Lower Koshkonong Creek watershed, which is 265.61 mi², has 283.47 stream miles, 1,735.65 lake acres and 18,171.94 wetland acres. Upper Koshkonong Creek watershed, which is 104.25 mi², has 176.17 stream miles, 157.76 lake acres and 6,145.17 wetland acres. The smaller HUC 10 used in this study drains 108,230 acres (169 square miles) including a substantial portion of eastern Dane County with the communities of Sun Prairie, Cottage Grove, and Deerfield, many small subdivisions, and a glacial drumlin-marsh area. Portions of the stream are part of a drainage district. Land use is primarily agricultural, and a sizable percentage of original wetlands have been drained for this purpose. This wetland loss, coupled with stream ditching and widespread use of field tiles, allows significant nutrient and sediment loads to reach surface waters in this and downstream watersheds (WDNR, 2002). A detailed study of the water quality in the Upper Koshkonong was conducted in 1981 by the University of Wisconsin Institute for Environmental Studies, which enumerated sources and causes of pollution affecting the creek. This watershed is experiencing rapid population growth in the City and Town of Sun Prairie and the Village and Town of Deerfield. The Towns of Deerfield and Sun Prairie have soil erosion rates of 8.9 and 7.0 tons/acre/year, respectively.

Trout Waters

DNR classifies and lists all trout streams online. New waters are monitored and identified or evaluated every year. There are no trout waters in the Upper and Lower Koshkonong Creek (LR11 & LR12) Watersheds as of the time of this report.

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.

Table 2: Outstanding and Exceptional Resources in the Koshkonong Creek Watersheds (LR11 & LR12).

Local Waterbody Name	WBIC	ORW/ERW	Start Mile	End Mile
Allen Creek	813300	/ERW	0	7.52

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 additional information.

Table 3: Impaired waters in Upper and Lower Koshkonong Creek Watersheds (LR11 & LR12).

Waterbody Name	WBIC	Start Mile	End Mile (acres)	Pollutant	Impairment	Sources	303 Status
Clear Lake	775000	0	77.41	Mercury	Contaminated Fish Tissue	Atmospheric Deposition	303d Listed
Clear Lake	775000	0	77.41	Total Phosphorus	Excess Algal Growth		303d Listed
Lower Koshkonong	808800	0	27.27	Total Phosphorus	Water Quality Use Restrictions	Non-Point Source	303d Listed
Upper Koshkonong	808800	27.27	48.42	Total Phosphorus	Degraded Biological Community, Water Quality Use Restrictions	Non-Point Source	303d Listed
Upper Koshkonong	808800	27.27	48.42	Unknown Pollutant	Elevated Water Temperature		303d Listed
Lake Koshkonong	808700	0	10596	Sediment/ Total Suspended Solids	Degraded Habitat, Turbidity	Non-Point Source Discharges from MS4s, Non-irrigated crop production	TMDL Approved
Lake Koshkonong	808700	0	10596	Total Phosphorus	Low DO, Eutrophication		TMDL Approved
Lake Ripley Beach	809600	0	418	E. coli	Recreational Restrictions -Pathogens	NA	Water Delisted
Red Cedar Lake	813100	0	359	Unknown Pollutant	Excess Algal Growth	NA	303d Listed
Rock River	788800	193.11	201.29	Total Phosphorus	Low DO	Livestock (grazing or feeding operations), contaminated sediments, non-point source	TMDL Approved
Rock River	788800	193.11	201.29	PCBs	Contaminated Fish Tissue		Pollutant Removed
Rock River	788800	193.11	201.29	Sediment/ Total Suspended Solids	Degraded Habitat		TMDL Approved
Rock River	788800	201.29	207.03	Mercury	Contaminated Fish Tissue	Livestock (grazing or feeding operations), contaminated sediments, non-point source	Pollutant Removed
Rock River	788800	201.29	207.03	Total Phosphorus	Low DO		TMDL Approved
Rock River	788800	201.29	207.03	Sediment/Total Suspended Solids	Degraded Habitat		TMDL Approved
Rock River	788800	213.62	249.13	Total Phosphorus	Low DO, Eutrophication, Degraded Biological Community	NA	TMDL Approved
Inlet of Lake Ripley	809700	0	3.62	Total Phosphorus	Impairment Unknown	Non-point source (rural or urban)	303d Listed

Monitoring Project

Purpose

The primary objective of this Targeted Watershed Assessment was to analyze conditions in the Koshkonong Creek watershed to make recommendations for future management actions. Monitoring consisted of fish surveys, macroinvertebrate sampling, quantitative habitat assessment, and flow measurements.

Recommendations

- Update natural resources codes to reflect current conditions
- Control nutrient input from waste treatment systems and sediment/nutrient inputs from agricultural fields. Soil health and cover crop practices can be employed to minimize soil and nutrient loss from crop fields.
- The county should continue to work with individual farms to adopt whole farm planning.
- The county should also work with the drainage district to allow improvements in water flow while protecting habitat in the stream and the riparian area from erosion and wetland degradation.

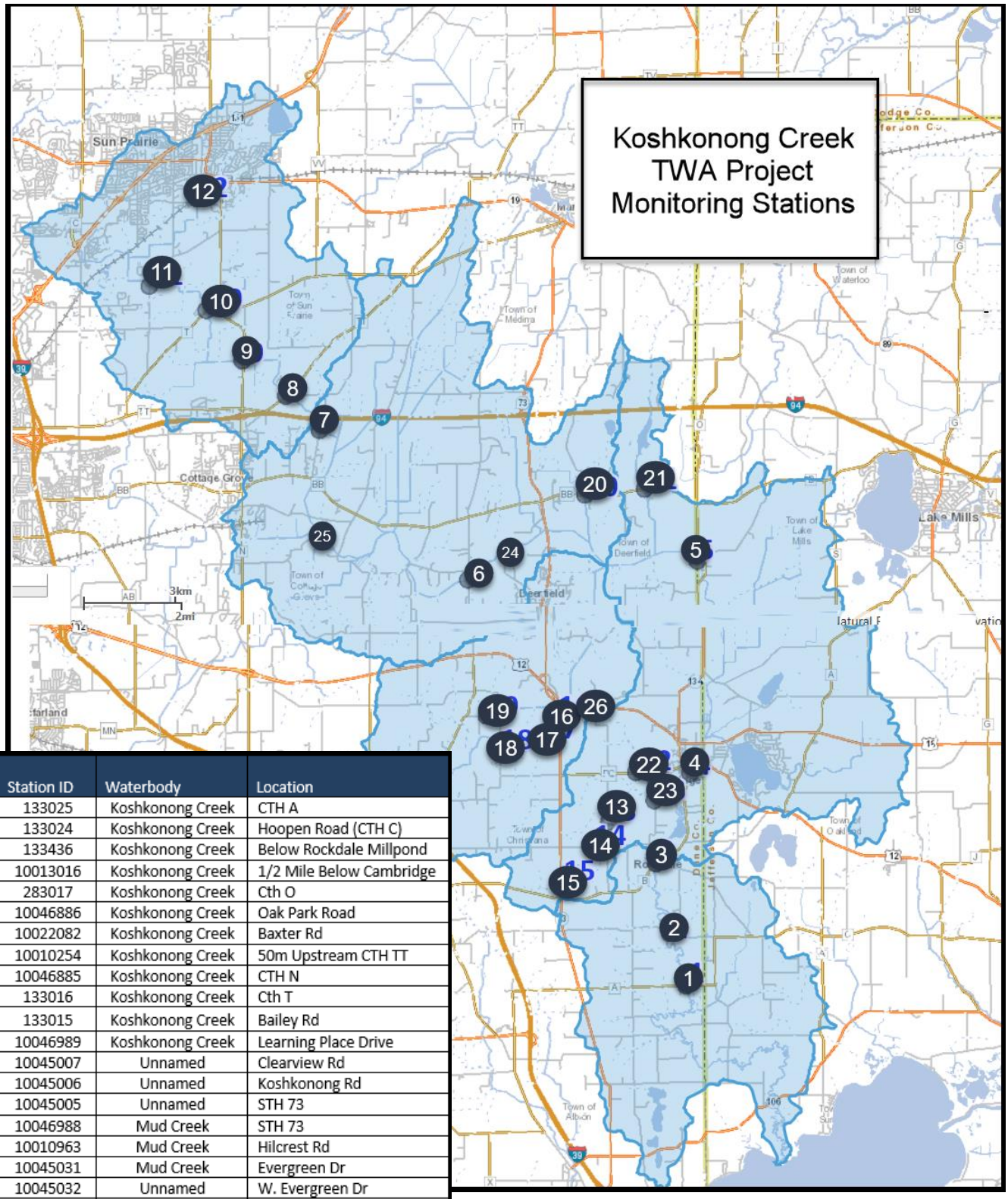
Site Selection and Study Design

Evaluation surveys were conducted at 23 sites in the watershed in 2016 to evaluate fish assemblage, macroinvertebrate assemblage, habitat quality and stream flow (Table 4, Figure 7). Data from five additional surveys taken prior to 2016 was also analyzed during this study.

Table 4. Monitoring Stations in the Koshkonong Creek TWA Study.

Map Site	Station ID	Waterbody	Location	WBIC	Invertebrate	Habitat	Fish	Flow
1	133025	Koshkonong Creek	CTH A	808800	x	x	x	
2	133024	Koshkonong Creek	Hoopen Road (CTH C)	808800	x	x	x	x
3	133436	Koshkonong Creek	Below Rockdale Millpond	808800	x			
4	10013016	Koshkonong Creek	1/2 Mile Below Cambridge	808800	x	x	x	x
5	283017	Koshkonong Creek	Cth O	808800		x	x	x
6	10046886	Koshkonong Creek	Oak Park Road	808800	x	x	x	x
7	10022082	Koshkonong Creek	Baxter Rd	808800	x	x	x	x
8	10010254	Koshkonong Creek	50m Upstream CTH TT	808800	x			
9	10046885	Koshkonong Creek	CTH N	808800	x	x	x	
10	133016	Koshkonong Creek	Cth T	808799	x	x	x	x
11	133015	Koshkonong Creek	Bailey Rd	808800	x			
12	10046989	Koshkonong Creek	Learning Place Drive	808800	x	x	x	
13	10045007	Unnamed	Clearview Rd	5036882	x	x	x	
14	10045006	Unnamed	Koshkonong Rd	5036882	x	x	x	
15	10045005	Unnamed	STH 73	5036882	x	x	X	
16	10046988	Mud Creek	STH 73	810300	x	x	x	
17	10010963	Mud Creek	Hilcrest Rd	810300		x	x	
18	10045031	Mud Creek	Evergreen Dr	810300		x	x	
19	10045032	Unnamed	W. Evergreen Dr	810400		x	x	
20	10045009	Unnamed	CTH BB	810500		x	x	
21	10010983	Unnamed	Hwy BB	810100		x	x	
22	10045008	Unnamed	CTH PQ	5036215	x	x	x	
23	10033604	Unnamed	Highland Dr.	5036882				
24	133020	Upper Koshkonong	STH 73-mile N of Deerfield	808800	x	x	x	
25	10033797	Upper Koshkonong	Uphoff Rd	808800	x	x	x	
26	10031596	Mud Creek	STH 12	810300	x	x	x	

Figure 6. Monitoring Stations in the Koshkonong Creek TWA Study Sites.



Map Site	Station ID	Waterbody	Location
1	133025	Koshkonong Creek	CTH A
2	133024	Koshkonong Creek	Hoopen Road (CTH C)
3	133436	Koshkonong Creek	Below Rockdale Millpond
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6	10046886	Koshkonong Creek	Oak Park Road
7	10022082	Koshkonong Creek	Baxter Rd
8	10010254	Koshkonong Creek	50m Upstream CTH TT
9	10046885	Koshkonong Creek	CTH N
10	133016	Koshkonong Creek	Cth T
11	133015	Koshkonong Creek	Bailey Rd
12	10046989	Koshkonong Creek	Learning Place Drive
13	10045007	Unnamed	Clearview Rd
14	10045006	Unnamed	Koshkonong Rd
15	10045005	Unnamed	STH 73
16	10046988	Mud Creek	STH 73
17	10010963	Mud Creek	Hilcrest Rd
18	10045031	Mud Creek	Evergreen Dr
19	10045032	Unnamed	W. Evergreen Dr
20	10045009	Unnamed	CTH BB
21	10010983	Unnamed	Hwy BB
22	10045008	Unnamed	CTH PQ
23	10033604	Unnamed	Highland Dr.
24	133020	Upper Koshkonong	STH 73-mile N of Deerfield
25	10033797	Upper Koshkonong	Uphoff Rd
26	10031596	Mud Creek	STH 12

Methods, Equipment, and Quality Assurance

Fish Assemblage

The fisheries assemblage was determined by electrofishing 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 2 meters wide. All fish were collected, identified, and counted. All gamefish were measured for length. Guidelines for Assessing Fish Communities of Wadeable Streams in Wisconsin

Habitat Evaluation

At each site, qualitative notes on average stream width and depth, riparian buffers and land use, evidence of sedimentation, fish cover and potential management options were also recorded. A qualitative habitat survey (Simonson, et. al., 1994) was also performed at each site. Some sites, particularly on Koshkonong Creek between Baxter Road and Oak Park Road, as well as downstream of CTH A, were not able to be sampled because they were too deep and/or mucky for wading. The same can be said for sites on Mud Creek downstream of STH 12. Procedures documents include Guidelines for Qualitative Physical Habitat Evaluation of Wadeable Streams Guidelines for Evaluating Habitat of Wadeable Streams Revised June 2002 (Quantitative Habitat).

Macroinvertebrate Evaluation

Macroinvertebrate samples were obtained by kick sampling and collecting using a D-frame. Samples were preserved and sent to the University of Wisconsin-Stevens Point for analyses. Guidelines for Collecting Macroinvertebrate Samples in Wadeable Streams

Water Sampling

Water samples were and analyzed for total phosphorus, total nitrogen, and total suspended solids at the State Laboratory of Hygiene. Guidelines and Procedures for Surface Water Grab Sampling (Dec. 2005 Version 3).

Flow

Flow measurements were collected at six sites on Koshkonong Creek in July and August 2016 using a [insert flow meter used here] handheld flow meter mounted to a top setting wading rod.

Results

The Following tables and figures display fish, habitat, macroinvertebrate, and flow data collected as part of the Koshkonong Creek TWA study (Tables 6-8). This data was used to assess waterbody condition and develop management recommendations within the targeted watershed. Additional data is presented in Appendices B, C, & D.

Fish Assemblage & Condition

The following table shows the natural community modeled, verified, the selected natural community, and the fish IBI used to derive the fish IBI score and condition value.

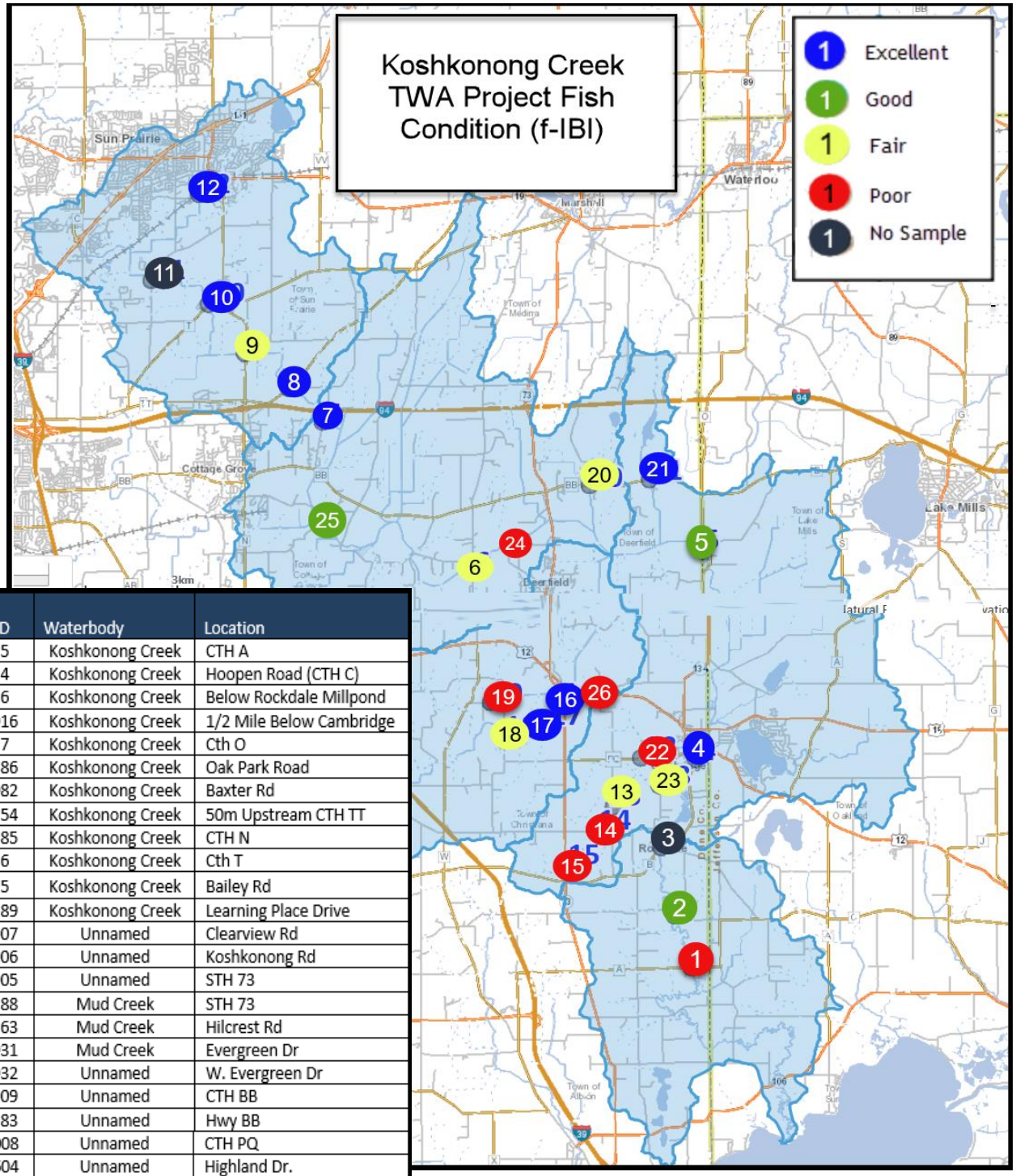
Table 5: Fish Index of Biotic Integrity and Conditions in the Koshkonong Creek TWA Study Area.

Map Site	Station ID	Waterbody	WBIC	Location	Modeled Natural Community	Selected Natural Community	Index of Biological Integrity	Fish IBI	Condition Category
1	133025	Lower Koshkonong	808801	CTH A	Warm Mainstem	Warm Mainstem	Warmwater IBI Cs Near	25	Poor
2	133024	Lower Koshkonong	808800	Hoopen Road (CTH C)	Warm Mainstem	Warm Mainstem	Warmwater IBI Cs Near	62	Good
4	10013016	Lower Koshkonong	808800	1/2 Mile Below Cambridge	Warm Mainstem	Warm Mainstem	Warmwater IBI Cs Near	72	Excellent
5	283017	Upper Koshkonong	808800	Cth O	Warm Mainstem	Warm Mainstem	Warmwater IBI Cs Near	50	Good
6	10046886	Upper Koshkonong	808800	Oak Park Road	Warm Mainstem	Warm Mainstem	Warmwater IBI Cs Near	40	Fair
7	10022082	Upper Koshkonong	808800	Baxter Rd	Warm Mainstem	Cool-Warm Mainstem	Cool-Warm IBI	70	Excellent
8	10010254	Upper Koshkonong	808800	50m US Cty Tt	Warm Mainstem	Cool-Warm Mainstem	Cool-Warm IBI	80*	Excellent
9	10046885	Upper Koshkonong	808800	CTH N	Warm Headwater	Cool-Warm Mainstem	Cool-Warm IBI	40	Fair
10	133016	Upper Koshkonong	808800	Cth T	Warm Headwater	Cool-Warm Headwater	Intermittent IBI	70	Excellent
12	10046989	Upper Koshkonong	808800	Learning Place Drive	Warm Headwater	Cool-Warm Headwater	Intermittent IBI	80	Excellent
13	10045007	Trib to Koshkonong	5036882	Clearview Rd	Cool-Cold Headwater	Cool-Warm Headwater	Intermittent IBI	40	Fair
14	10045006	Trib to Koshkonong	5036882	Koshkonong Rd	Cool-Cold Headwater	N/A**			Poor
15	10045005	Trib to Koshkonong	5036882	STH 73	Cool-Cold Headwater	N/A**			Poor
16	10046988	Mud Creek	810300	STH 73	Cool-Cold Headwater	Cool-Warm Headwater	Intermittent IBI	80	Excellent
17	10010963	Mud Creek	810300	Hilcrest Rd	Cool-Cold Headwater	Cool-Warm Headwater	Intermittent IBI	80	Excellent
18	10045031	Mud Creek	810300	Evergreen Drive	Cool-Cold Headwater	Cool-Warm Headwater	Intermittent IBI	40	Fair
19	10045032	Trib to Mud Cr	810400	W. Evergreen Dr	Cool-Warm Headwater	Warm Headwater	Intermittent IBI	0	Poor
20	10045009	Trib to Koshkonong	810500	CTH BB	Warm Headwater	Cool-Warm Headwater	Intermittent IBI	30	Fair
21	10010983	Trib to Goose Lake	810100	CTH BB	Warm Headwater	Cool-Warm Headwater	Intermittent IBI	70	Excellent
22	10045008	Unnamed Trib	5036215	CTH PQ	Cool-Warm Headwater	N/A**			Poor
23	10033604	Local Water	5036882	Highland Dr.	Cool-Warm Headwater	Cool-Warm Headwater	Intermittent IBI	40	Fair
24	133020	Upper Koshkonong	808800	STH 73-mile N of Deerfield	Warm Mainstem	Warm Mainstem	Warmwater IBI Cs Near	15*	Poor
25	10033797	Upper Koshkonong	808800	Uphoff Rd	Cool-Warm Mainstem	Cool-Warm Mainstem	Cool-Warm IBI	60*	Good
26	10031596	Mud Creek	810300	STH 12	Cool-Cold Headwater	Cool-Cold Headwater	Intermittent IBI	10*	Poor

**Data taken from surveys conducted prior to this TWA study.*

***Not enough fish collected to determine Natural Community or IBI. Defaults to "poor" IBI.*

Figure 7. Fish Condition on Koshkonong Creek TWA Study Sites.



Map Site	Station ID	Waterbody	Location
1	133025	Koshkonong Creek	CTH A
2	133024	Koshkonong Creek	Hoopen Road (CTH C)
3	133436	Koshkonong Creek	Below Rockdale Millpond
4	10013016	Koshkonong Creek	1/2 Mile Below Cambridge
5	283017	Koshkonong Creek	Cth O
6	10046886	Koshkonong Creek	Oak Park Road
7	10022082	Koshkonong Creek	Baxter Rd
8	10010254	Koshkonong Creek	50m Upstream CTH TT
9	10046885	Koshkonong Creek	CTH N
10	133016	Koshkonong Creek	Cth T
11	133015	Koshkonong Creek	Bailey Rd
12	10046989	Koshkonong Creek	Learning Place Drive
13	10045007	Unnamed	Clearview Rd
14	10045006	Unnamed	Koshkonong Rd
15	10045005	Unnamed	STH 73
16	10046988	Mud Creek	STH 73
17	10010963	Mud Creek	Hilcrest Rd
18	10045031	Mud Creek	Evergreen Dr
19	10045032	Unnamed	W. Evergreen Dr
20	10045009	Unnamed	CTH BB
21	10010983	Unnamed	Hwy BB
22	10045008	Unnamed	CTH PQ
23	10033604	Unnamed	Highland Dr.
24	133020	Upper Koshkonong	STH 73-mile N of Deerfield
25	10033797	Upper Koshkonong	Uphoff Rd
26	10031596	Mud Creek	STH 12

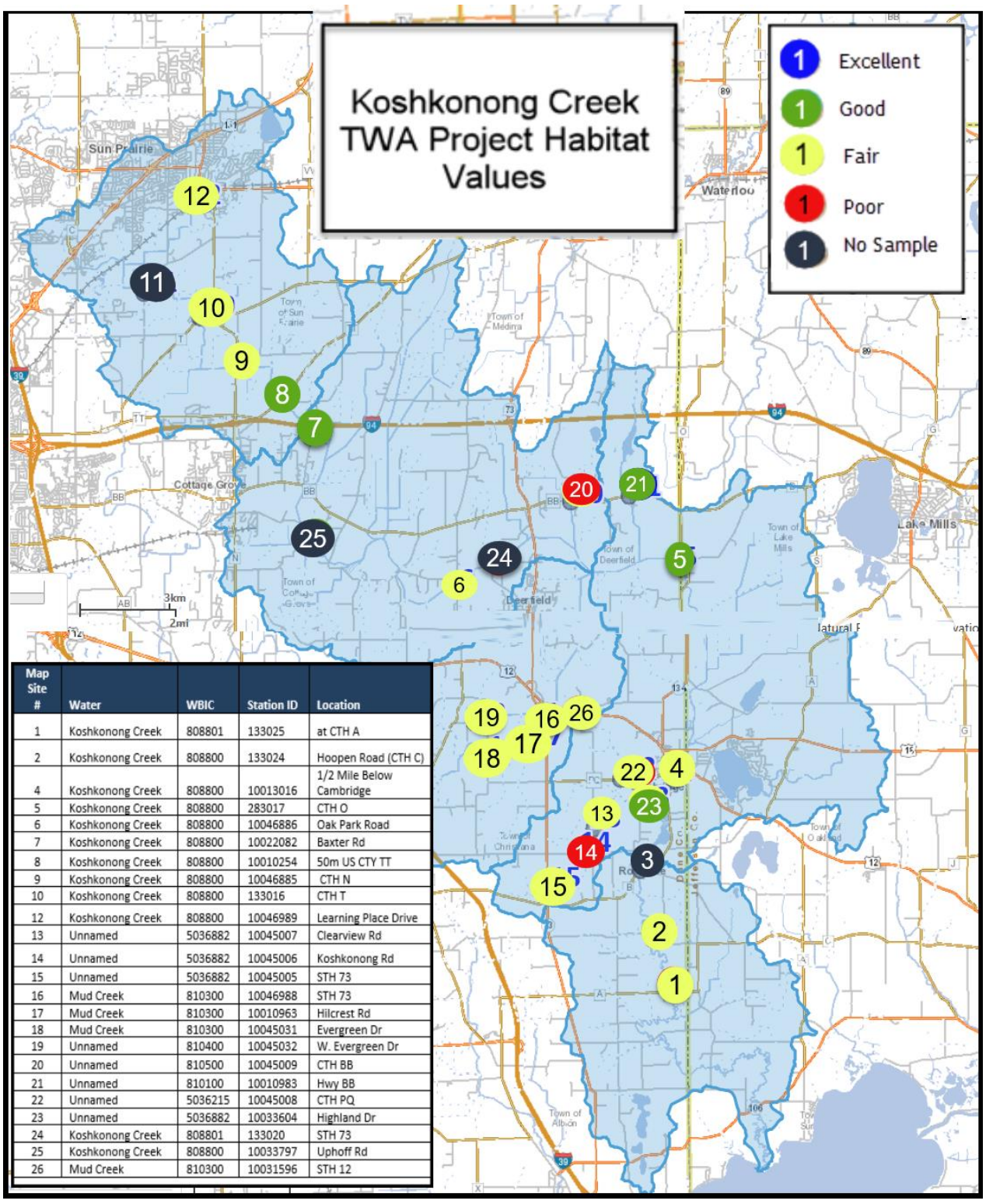
Habitat

The following table displays results of twenty-six (26) quantitative habitat samples, collected at the time of the fish surveys.

Table 6: Quantitative Habitat Koshkonong Creek TWA Study Area.

Map Site #	Water	WBIC	Station ID	Location	Quantita-tive Habitat	Habitat Condition	Fish IBI Score	fIBI	mIBI Score	mIBI Condition
1	Koshkonong Creek	808801	133025	at CTH A	37	Fair	25	Poor	Na	na
2	Koshkonong Creek	808800	133024	Hoopen Road (CTH C)	37	Fair	62	Good	3.9	Fair
4	Koshkonong Creek	808800	10013016	1/2 mi DS Cambridge	40	Fair	72	Excellent	3.8	Fair
5	Koshkonong Creek	808800	283017	CTH O	58	Good	50	Good	6.7	Good
6	Koshkonong Creek	808800	10046886	Oak Park Road	35	Fair	40	Fair		
7	Koshkonong Creek	808800	10022082	Baxter Rd	68	Good	70	Excellent	4.1	Fair
8	Koshkonong Creek	808800	10010254	50m US CTY TT	60*	Good	80*	Excellent	4.2	Fair
9	Koshkonong Creek	808800	10046885	CTH N	35	Fair	40	Fair		
10	Koshkonong Creek	808800	133016	CTH T	25	Fair	70	Excellent	3.4	Fair
12	Koshkonong Creek	808800	10046989	Learning Place Drive	48	Fair	80	Excellent	6.1	Good
13	Unnamed	5036882	10045007	Clearview Rd	40	Fair	40	Fair	4.1	Fair
14	Unnamed	5036882	10045006	Koshkonong Rd	20	Poor		Poor	4.2	Fair
15	Unnamed	5036882	10045005	STH 73	35	Fair		Poor	4.7	Fair
16	Mud Creek	810300	10046988	STH 73	30	Fair	80	Excellent	4.7	Fair
17	Mud Creek	810300	10010963	Hilcrest Rd	45	Fair	80	Excellent	5.2	Good
18	Mud Creek	810300	10045031	Evergreen Dr	35	Fair	40	Fair		
19	Unnamed	810400	10045032	W. Evergreen Dr	35	Fair	0	Poor	3.5	Fair
20	Unnamed	810500	10045009	CTH BB	20	Poor	30	Fair		
21	Unnamed	810100	10010983	Hwy BB	50	Good	70	Excellent		
22	Unnamed	5036215	10045008	CTH PQ	30	Fair		Poor	6.1	Good
23	Unnamed	5036882	10033604	Highland Dr	67	Good	40	Fair	5.2	Good
24	Koshkonong Creek	808801	133020	STH 73	20*	Poor	15*	Poor	3.4*	Fair
25	Koshkonong Creek	808800	10033797	Uphoff Rd			60*	Good	3.8*	Fair
26	Mud Creek	810300	10031596	STH 12	35*	Fair	10*	Poor	5.3*	Good

Figure 8. Habitat Condition on Koshkonong Creek TWA Study



Map Site #	Water	WBIC	Station ID	Location
1	Koshkonong Creek	808801	133025	at CTH A
2	Koshkonong Creek	808800	133024	Hoopen Road (CTH C)
4	Koshkonong Creek	808800	10013016	1/2 Mile Below Cambridge
5	Koshkonong Creek	808800	283017	CTH O
6	Koshkonong Creek	808800	10046886	Oak Park Road
7	Koshkonong Creek	808800	10022082	Baxter Rd
8	Koshkonong Creek	808800	10010254	50m US CTY TT
9	Koshkonong Creek	808800	10046885	CTH N
10	Koshkonong Creek	808800	133016	CTH T
12	Koshkonong Creek	808800	10046989	Learning Place Drive
13	Unnamed	5036882	10045007	Clearview Rd
14	Unnamed	5036882	10045006	Koshkonong Rd
15	Unnamed	5036882	10045005	STH 73
16	Mud Creek	810300	10046988	STH 73
17	Mud Creek	810300	10010963	Hilcrest Rd
18	Mud Creek	810300	10045031	Evergreen Dr
19	Unnamed	810400	10045032	W. Evergreen Dr
20	Unnamed	810500	10045009	CTH BB
21	Unnamed	810100	10010983	Hwy BB
22	Unnamed	5036215	10045008	CTH PQ
23	Unnamed	5036882	10033604	Highland Dr
24	Koshkonong Creek	808801	133020	STH 73
25	Koshkonong Creek	808800	10033797	Uphoff Rd
26	Mud Creek	810300	10031596	STH 12

Macroinvertebrates

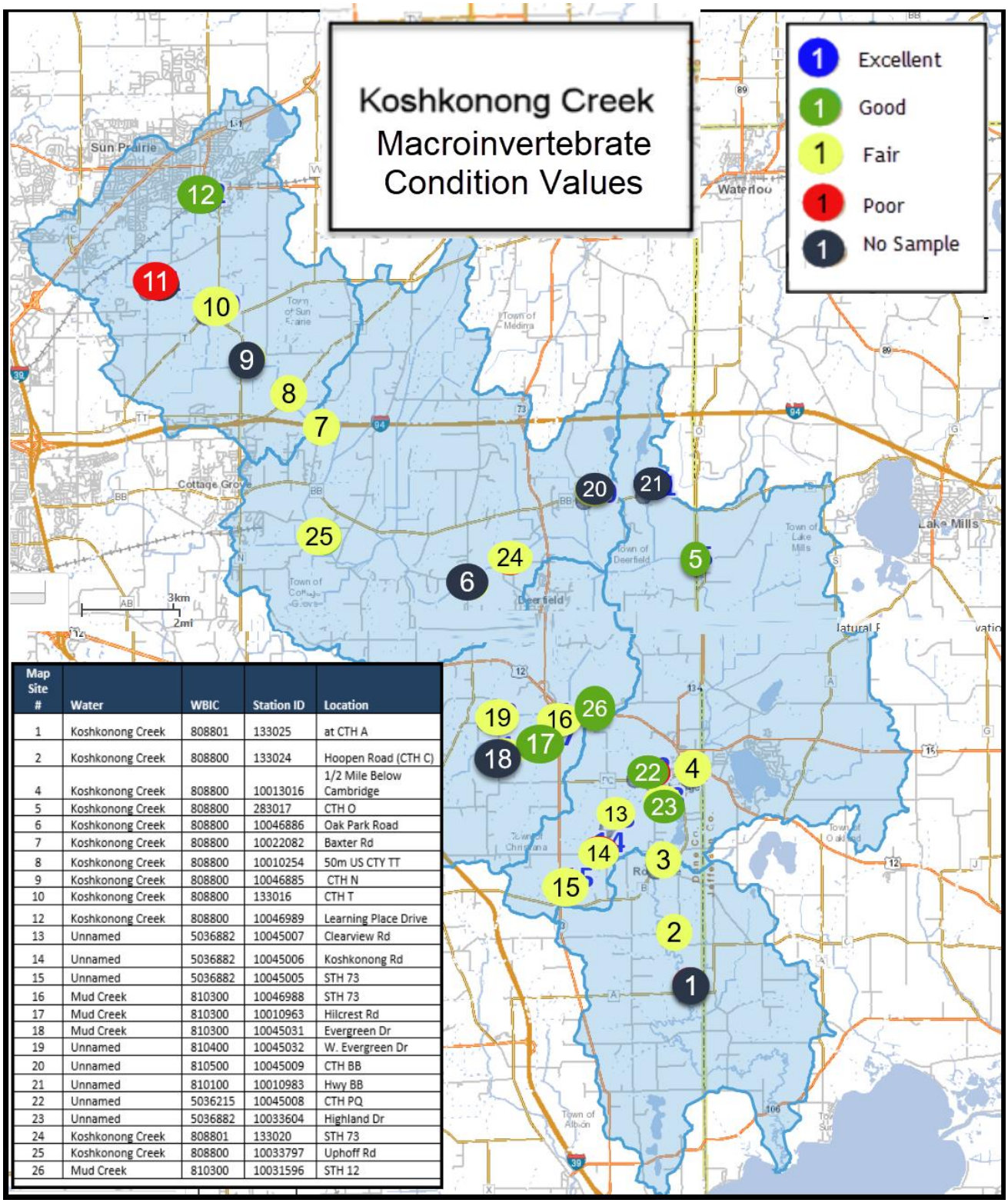
Table 7: Macroinvertebrate Index of Biotic Integrity Condition

Map Site #	SWIMS ID	Water	Location	WBIC	M IBI Score	Condition
2	133024	Koshkonong Creek	Hoopen Road (CTH C)	808800	3.9	Fair
3	133436	Koshkonong Creek	Below Rockdale Millpond	808800	4.7	Fair
4	10013016	Koshkonong Creek	1/2 Mile Below Cambridge	808800	3.8	Fair
5	283017	Koshkonong Creek	CTH O	808800	6.7	Good
7	10022082	Koshkonong Creek	Baxter Rd	808800	4.1	Fair
8	10010254	Koshkonong Creek	50m Upstream CTY TT	808800	4.2	Fair
10	133016	Koshkonong Creek	CTH T	808800	3.4	Fair
11	133015	Koshkonong Creek	Bailey Rd	808800	2.1	Poor
12	10046989	Koshkonong Creek	Learning Place Drive	808800	6.1	Good
13	10045007	Unnamed	Clearview Rd	5036882	4.1	Fair
14	10045006	Unnamed	Koshkonong Rd	5036882	4.2	Fair
15	10045005	Unnamed	STH 73	5036882	4.7	Fair
16	10046988	Mud Creek	STH 73	810300	4.7	Fair
17	10010963	Mud Creek	Hilcrest Rd	810300	5.2	Good
19	10045032	Unnamed	W. Evergreen Dr	810400	3.5	Fair
22	10045008	Unnamed	CTH PQ	5036215	6.1	Good
23	10033604	Unnamed	Highland Dr.	5036882	5.2	Good
24	133020	Koshkonong Creek	STH 73	808800	3.4*	Fair
25	10033797	Koshkonong Creek	Uphoff RD	808800	3.8*	Fair
26	10031596	Mud Creek	Mud Creek at STH 12	810300	5.3*	Good

*Scores based on data collected prior to the Koshkonong Creek TWA projected (Appendix B)

Koshkonong Creek. Photo by https://www.wisconsinrivertrips.com/segments/koshkonong-creek

Figure 9. Macroinvertebrate Condition Koshkonong TWA Study



Map Site #	Water	WBIC	Station ID	Location
1	Koshkonong Creek	808801	133025	at CTH A
2	Koshkonong Creek	808800	133024	Hoopen Road (CTH C)
4	Koshkonong Creek	808800	10013016	1/2 Mile Below Cambridge
5	Koshkonong Creek	808800	283017	CTH O
6	Koshkonong Creek	808800	10046886	Oak Park Road
7	Koshkonong Creek	808800	10022082	Baxter Rd
8	Koshkonong Creek	808800	10010254	50m US CTY TT
9	Koshkonong Creek	808800	10046885	CTH N
10	Koshkonong Creek	808800	133016	CTH T
12	Koshkonong Creek	808800	10046989	Learning Place Drive
13	Unnamed	5036882	10045007	Clearview Rd
14	Unnamed	5036882	10045006	Koshkonong Rd
15	Unnamed	5036882	10045005	STH 73
16	Mud Creek	810300	10046988	STH 73
17	Mud Creek	810300	10010963	Hilcrest Rd
18	Mud Creek	810300	10045031	Evergreen Dr
19	Unnamed	810400	10045032	W. Evergreen Dr
20	Unnamed	810500	10045009	CTH BB
21	Unnamed	810100	10010983	Hwy BB
22	Unnamed	5036215	10045008	CTH PQ
23	Unnamed	5036882	10033604	Highland Dr
24	Koshkonong Creek	808801	133020	STH 73
25	Koshkonong Creek	808800	10033797	Uphoff Rd
26	Mud Creek	810300	10031596	STH 12

Flow

Table 8: Stream Flow Rates in the Koshkonong Creek TWA Study Area.

Waterbody	WBIC	Station ID	Location	Flow (cms)
Koshkonong Creek	808800	10013016	1/2 Mile Below Cambridge	1.2
Koshkonong Creek	808800	10022082	Baxter Rd	0.434
Koshkonong Creek	808800	283017	CTH O	0.981
Koshkonong Creek	808800	133016	CTH T	0.101
Koshkonong Creek	808800	133024	Hoopen Road (CTH C)	1.28
Koshkonong Creek	808800	10046886	Oak Park Road	0.594

Discussion

Fish Assemblage

The results of the fisheries surveys are summarized in Table 6. The Wisconsin Stream model (Lyons, 2008) predicted most of the waters in the watershed to be cool transitional waters or warm waters. The natural community verification process developed by Lyons (2015) showed the fishery assemblage to indicate a warm transitional (cool-warm) community a most sites except for the lower half of Koshkonong Creek, which had a warmwater assemblage. Therefore, the coolwater index of biotic integrity (IBI) developed by Lyons (2012) or the warmwater IBI (Lyons, 1992) was applied to the sites based on the community verification.

A total of 42 fish species were collected in the 2016 surveys. Brook stickleback, central mudminnow, creek chubs, fathead minnow, green sunfish, johnny darter and white sucker were the most widely distributed species. The great majority of species found in the watershed represent the warm thermal regime, with 10 species representing cool transitional temperatures. Several game species, including northern pike and largemouth bass were found in Koshkonong Creek. Most bass were young-of-the-year (YOY) at less than 3 inches in length and most northern pike were smaller specimens (less than 12 inches). The rock bass was the most prevalent panfish species found, especially in the lower sections of Koshkonong Creek. Black crappie, bluegill and yellow perch were also found in the creek. While the most common species in the watershed were those which are tolerant to low dissolved oxygen and environmental disturbance, there were several intolerant species found in Koshkonong Creek (and 1 tributary) that were quite common at certain sites. The tributaries generally contained a subset of the species found in the main creek.

Despite being impaired by phosphorus and impacted by major hydrologic modification and sedimentation, Koshkonong Creek and tributaries actually has an impressive array of fish species. While tolerant species tend to make up the bulk of the assemblages, there are sites that have several intolerant species – some of which make up a significant part of the total fish numbers

Fish species found in the Koshkonong Creek watershed.

The blacknose shiner is a species not often encountered in southern central Wisconsin and the Koshkonong Creek watershed appears to be one of only several areas of southern Wisconsin where it is still regularly reported. It has apparently disappeared from a number of locations where it was originally reported back in 1935 (Becker, 1983). It requires clear and vegetated waters and prefers slower moving waters. Likewise, banded darters prefer clear streams with moderate to high gradient, preferring riffles or pools adjacent to riffles (Ibid). Despite these preferences, it was found quite commonly in the lower gradient waters of middle and lower Koshkonong Creek. Another darter species, the blackside darter, is common in medium to large size streams in southern Wisconsin but is seldom seen in large numbers. However, in the middle to lower section of Koshkonong Creek, it was one of the more common species.

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While it was interesting to find these more sensitive species in these hydrologically modified creeks, many of the most dominant species of the watershed were those tolerant to disturbed habitat and low dissolved oxygen. It was not surprising to find central mudminnows throughout the watershed. This species is known for inhabiting low gradient wetland streams. It is associated with clearer waters with moderate to dense vegetation and prefers water lacking flow. It can survive where dissolved oxygen levels are very low (Ibid). White suckers, creek chubs, and green sunfish are highly adaptable species that can thrive in the channelized, featureless types of systems that have little fish cover and are high in sediment. They tend to predominate in hydrologically modified areas.

Fish Condition

The IBI tends to reflect the varied nature of the community that inhabits the streams of this watershed. On one hand, there are sites where the IBI is good to even excellent – owing to the variety of native species present. On the other hand, the predominance of tolerant species in certain sites tends to depress the scores in those sections. Interestingly, there doesn't appear to be any strong correlation between the IBI, and the overall habitat score or any particular habitat metric. Certainly, the sites generally with the best overall scores tended to have higher IBIs, and the converse was generally true. In other words, sites with poor habitat did not have good fish assemblages. Overall 13 out of 24 sites had fair or lower IBI's. Eight sites had "excellent" IBIs and 3 sites were "good" in the IBI rating. For the sites with excellent IBI's, overall habitat scores ranged from 25 (fair) to 68 (good), with most between 30 and 50, or fair.

Five sites had poor or very poor IBI ratings. These sites either had very few fish present or the assemblage was dominated by tolerant species, and fathead minnow. At 3 sites, fewer than 25 fish were collected, for which the default IBI is poor (Lyons, 2012). An exception to this is the site on Koshkonong Creek at CTH A. The low fish count may have been an artifact of the difficulty in sampling. The water was waist to chest deep in most areas with many obstacles (coarse woody debris) which dramatically reduced the effectiveness of the shocking crew. The fish assemblage on Unnamed Tributary (5036882) upstream of Koshkonong Road may be impacted by the perched culvert that exists at Koshkonong Road and may impact fish movement upstream of that point. Biologists did note that the species assemblage and fish numbers (and associated IBI) were lower than expected at Highland Drive on this same tributary. This assessment comes after biologists noted that this site "was probably one of the nicest looking sections of stream in eastern Dane County" from a habitat standpoint

Habitat

Overall habitat scores tended to be buoyed by the riparian buffer and width-to-depth metrics. Indeed, these 2 metrics tended to make up about 40 -75% of the overall score for all sites that scored lower than good. This is one reason the overall habitat score should be scrutinized. For instance, a dredged, channelized system with a good buffer may also have a good width-to-depth ratio. However, if it is a monotypic run which is high in fine sediment with little fish cover, the overall habitat score is not consistently going to be reflected by a higher fish IBI. This may explain the variability in the fish IBI vs. habitat score. Certain sites that had higher fish IBIs tended to have one or more areas of hard substrate (gravel, rubble/cobble, or boulders) and/or some coarse woody debris, even if these features did not make up most of the site.

Mud Creek

Tributary to Koshkonong Creek

Mud Creek (WBIC = 810300) is a major tributary to Koshkonong Creek. Historically, the creek wove through interconnected wetlands. In the early 1900's, farmers organized to straighten the stream and drain the wetlands. The watershed is now primarily agricultural. Ground water recruitment is low, causing fluctuations in flow and water levels, especially after major storms. The Village of Deerfield discharges treated wastewater and storm sewer effluent to Mud Creek through a small tributary.

Agricultural polluted runoff is the primary threat to existing water quality. Surveys in 1984 and 1988 showed the stream received an abundant silt load from agricultural fields, reducing aquatic and fish habitat. The stream was classified as an intermediate surface water, supporting a limited forage fishery, but was reclassified as a warm water forage fishery in 1988, indicating water quality improvement (WDNR, 1985).

In the past, northern pike were observed moving up Mud Creek to spawn in the wetlands adjoining the stream, but it is not known if this still occurs. The primary species found in 2016 included a variety of non-game species including tolerant and intermediate tolerance species. The upper middle sections of the creek contained some of the best species, including banded darters and northern pearl dace. The lower half of the creek, downstream of STH 12, could not be sampled due to the fact it is too deep and/or contained too much soft sediment for wading.

Macroinvertebrates

The macroinvertebrate data indicate there is a significant amount of organic loading that occurs at the headwaters, likely from the Sun Prairie wastewater plant as well as from urban runoff. This effect appears to be diluted further downstream where HBI values improve, indicating less organic pollution. The tributaries to Koshkonong Creek indicate very little organic loading. The MIBI scores are consistent in the "fair" category. In general, the macroinvertebrate IBI has shown the combination of watershed land cover and local riparian and instream conditions strongly influence one another (Weigel, 2003). The similarity between IBIs indicates similar land use and stressors throughout the watershed, with certain local stressors affecting a few specific sites. For instance, the IBI for Learning Place Drive was relatively high, despite its proximity to an urban area and its rocky bottom was the result of flashiness and scour during storm events. However, the next site down at Bailey Road showed a "poor" IBI, presumably because it is less than 400 meters downstream of a WWTP

discharge (a source of high nutrients) and habitat was less desirable. For the most part, however, those sites and tributaries without influence of point sources of pollution were similar in both IBI and HBI, indicating consistent watershed influences.

Flow

All flow measurements were taken on the mainstem of Koshkonong Creek. The highest flow rate of 1.28 cubic meters per second (cms) occurred south of Rockdale at Hoopen Road (CTH C) where stream width was 12 meters and stream depth 1 meter. This segment of Koshkonong Creek runs through a forested flood plain surrounded by agriculture. Bank stability was found to be fair, with moderate erosion. The habitat was monotonous with minimal rocky substrate and only occasional coverage. Overall habitat scored as fair at this site. On the opposite end of the spectrum, the lowest flow rate of 0.101 cms occurred at CTH T in a channelized, tiled segment of the stream south of Sun Prairie. This stream segment has a moderately disturbed, narrow buffer zone and exists in a segment of the watershed dominated by agriculture. The stream has moderate bank erosion with no pools, monotonous habitat, fine sediments, and occasional fish cover. Overall habitat scored as fair for this site as well.

Recommendations

Potential management actions for streams dramatically altered are listed below. Some improvements have been noted in the current conditions compared to historical accounts. The removal of the Rockdale Dam was studied by the University of Wisconsin-Madison to look at changes in sediment movement and biotic response. The upper sections which are currently classified as Limited Aquatic Life are now full fish and aquatic life.

- The natural resources codes need to be updated to reflect current conditions. It is difficult to imagine an era in which one would put these streams back to their original meander pattern. Likewise, one cannot change gradient, or bottom substrate of these wetland systems.
- We can control nutrient input from waste treatment systems and sediment/nutrient inputs from agricultural fields. Soil health and cover crop practices can be employed to minimize soil and nutrient loss from crop fields.
- The county should continue to work with individual farms to adopt whole farm planning.
- The county should also work with the drainage district to allow improvements in water flow while protecting habitat in the stream and the riparian area from erosion and wetland degradation.

Resource managers and the public must be realistic in understanding legacy sediment will continue to be to be an issue in this system because of the lack of scour due to low gradient. Given the extent and volume of sediment, it is unlikely a sediment removal project could be undertaken that would be financially feasible. Therefore, the stream and its associated biology will remain tied to its history. The fishery is good in some stretches that have high enough gradient or habitat to support a diversity of species. However, to think that major changes to the fishery will occur because of changes to on-land practice is probably unrealistic. It is a highly impacted resource that has certain nice sections which contain some quality species. It will likely remain that way for the near future.

Recommendations for DNR

- Revisit (resample) fish survey sites that lacked sufficient fish during this study to determine Natural Community and condition.
- Encourage partnerships with local communities to work on collaborative efforts.
- Seek engagement with farmer-led coalitions as opportunities arise to adequately address land use related water quality concerns from the land owner's perspective.
- Integrate findings and recommendations of the Rock River Recovery Project into ongoing work by DNR staff, including targeted monitoring, site specific criteria analyses, and partnership outreach efforts.

Recommendations for External Partners

The Village of Cambridge has a population of over 1,100. Its population grows to roughly six times that number of people during the summer season. Cambridge's' facilities plan should be reviewed to ensure that the city's wastewater treatment plant could accommodate these seasonal fluctuations.

- As small communities grow, a comprehensive stormwater management plan should be in place. The plan should reflect local master and land use plans and state and regional planning goals (Kroner 1996).

Sewerage capacity and land use issues have been a top concern in this area, as the Oakland Sanitary District, which sends its effluent to the Cambridge wastewater treatment plant, has developed a moratorium on multi-scale development, allowing only single-family development. The Town of Oakland developed a draft land use plan that limits unsewered development and builds in a developer payback to cover infrastructure costs. Yet this plan does not address the existing approved plans that continue to be developed and may yet add another 100 homes. Theoretically, the single-family development moratorium may encourage urban/suburban sprawl, precipitating the loss of prime agricultural land and leading to low density growth that drives up the cost of wastewater treatment.

While sewer service area planning is conducted in the Dane County portion of Cambridge, the Jefferson County portion, which is growing more rapidly than the west side, has no sewer service area planning in place.

- Cambridge should work with Dane County, Jefferson County and surrounding urbanizing areas to develop a comprehensive long-term sewer service area plan that addresses the entire urban area and which reflects the facilities plan for the Cambridge wastewater treatment plant.

Koshkonong River Runs Free

Removal of the Rockdale Dam on Koshkonong Creek

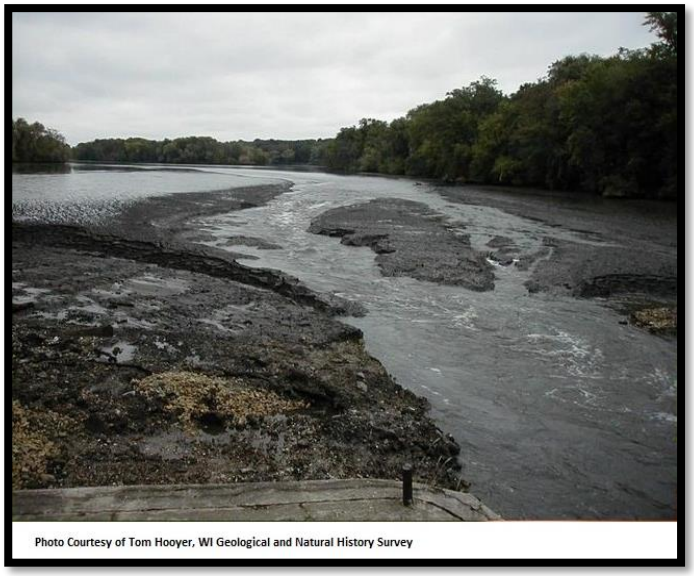
Photo Courtesy of Tom Hooyer, WI Geological and Natural History Survey

On September 12, 2000, the Rockdale Dam on Koshkonong Creek was breached to grade (see above photo). The remainder of the structure (i.e., the lateral portion) was removed during late June 2001. A team of researchers subsequently studied the effects of dam removal on sediment and nutrient transport as well as biota.

Doyle et. al. (2003) found prior to dam removal, the reservoir was a sediment sink that had accumulated 287,000 m^3 of sediment. Sediment within the reservoir varied from 1 to 2 m thick. There was a distinct difference between the fine sediment at the surface and the underlying coarser sediment. Fine sediments also covered the channel upstream of the reservoir to a depth of 10-20 cm. Once the dam was removed, researchers noted a net export of fine sediment from the old reservoir. Initial fine sediment export was substantial but had little effect on channel formation. Channel development was instead in the form of head cutting, which was significant within the 1st day, but decreased dramatically during the ensuing week. The sediment surface upstream of the head-cut remained undisturbed after the initial flush, while the channel downstream of the head cut changed substantially. There was very little in-channel deposition downstream of the former dam; however, vegetation colonized some of the soft sediment deposits up to 2600 m downstream and were not eroded by subsequent flows. In some cases, this sediment deposition coupled with rapid vegetation establishment narrowed the channel, which caused deepening of the thalweg. There was little downstream sedimentation through time due to limited reservoir sediment erosion.

Because there were few fishery surveys of the stream and impoundment prior to removal, it is unknown what effect dam removal had on the fish community itself. The 2016 surveys conducted upstream at Cambridge and downstream at Hoopen Road showed a diverse fishery at both sites with a health biotic index, but of course this survey occurred 15 years post-removal.

The macroinvertebrate community showed similar characteristics at the removal site as well as throughout the watershed. Again, very little monitoring of macroinvertebrates was done prior to dam removal. However, based on studies of macroinvertebrate communities in response to dam removals on other streams (Stanley, et. al., 2002), one can assume the results were similar. In those cases, changes in macroinvertebrate assemblages over the course of dam removals were rapid in reaches upstream of the dams and limited in reaches immediately below the dams. Lentic assemblages in the upstream impoundments such as tubificid worms and chironomid were replaced by more lotic assemblages (caddis and mayflies) within a year of removal, indicating rapid colonization and establishment of lotic fauna in these newly created habitats.

The biota most impacted by dam removal appeared to be in the mussel communities. Sethi et. al. (2004) conducted post-removal survey of mussels with the impoundment and downstream following removal of the dam. Within the reservoir, mortality rates were extremely high following removal due to desiccation and exposure. Mussel densities downstream from the dam declined immediately after dam removal. Mortality of mussels buried in deposited silt were observed up to 1.7 km below the dam. In the case of the mussel Q pustulosa, their populations vanished downstream of the dam after removal. Absence of mussels in the newly formed channel upstream of the old dam emphasizes the slow recovery of this group of organisms compared to fish and macroinvertebrates.

A study of nutrient dynamics (Stanley and Doyle, 2002) showed the backwater conditions created by the dam greatly enhanced nutrient retention and thus as the free-flowing water progressed through the reservoir, there was a downstream reduction in nutrient concentration. Removal of the dam and formation of a narrow channel in the lower impoundment worked greatly to increase flow velocity, reducing the potential for nutrient retention. However, upstream of the head cut, the reservoir remained mostly unaffected by

the dam removal, so the nutrient retention trends are similar to when the dam was still in place. Final equilibrium conditions showed decreased, but still persistent nutrient retention. So, while dams are detrimental to many facets of a stream ecosystem, they can create conditions conducive to sediment and nutrient retention.

One final conclusion of study by Doyle, et. al, (2005) was that it is unlikely ecosystems will fully recover to pre-dam conditions or be so slow to recover that it is imperceptible. This should not be perceived as a reason to forego dam removal, but merely a point that expectations should be measured.

Figure 10. Rockdale Dam on the Koshkonong River.
(a) Rockdale reservoir pre-removal; view is facing upstream from dam, September 2000. (b) Rockdale reservoir, 24 hours post-removal. (c) Rockdale reservoir, November 2000. (d) Rockdale reservoir, May 2001. From: Doyle, et. al., 2003.

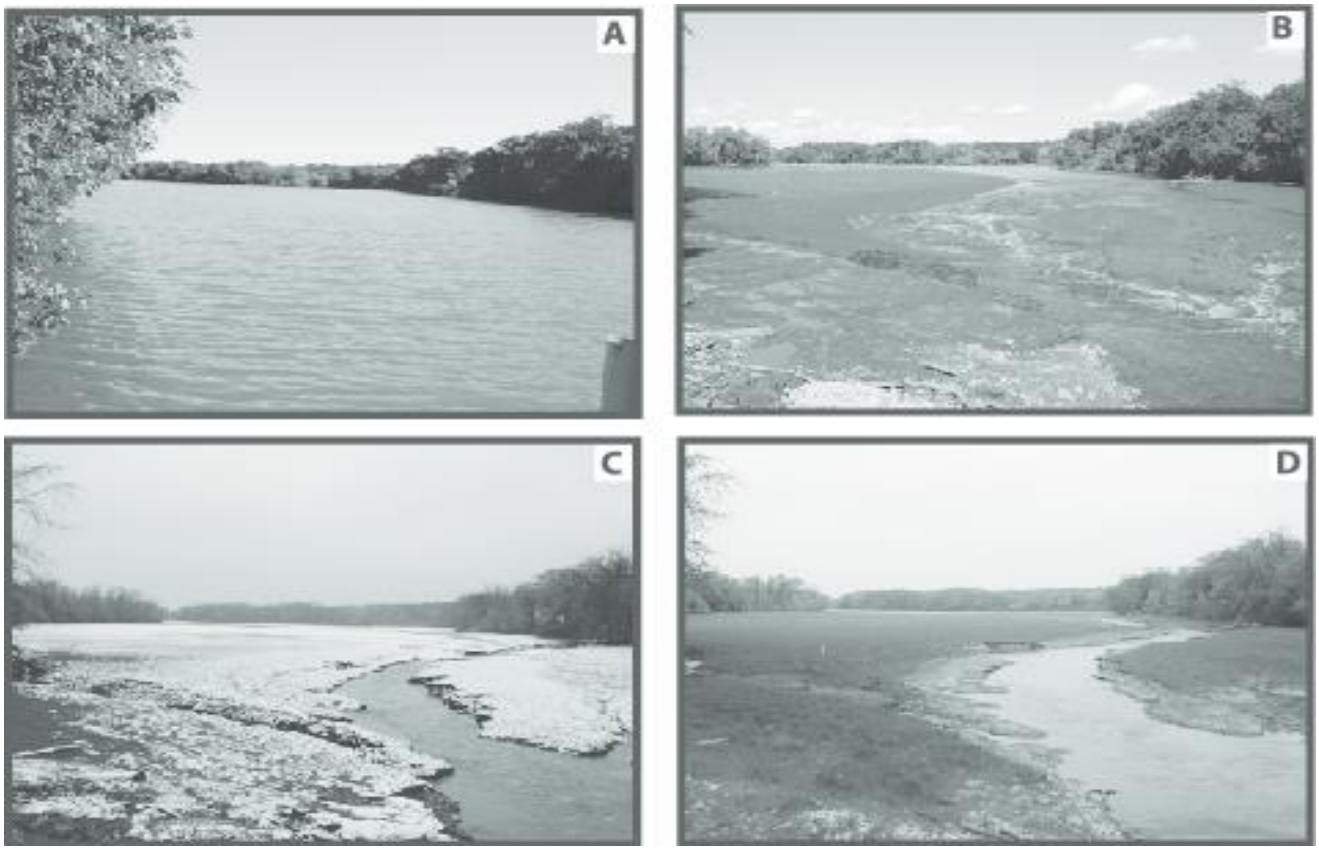

Photo Courtesy of Friends of Dane County Parks

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Appendix B: Fish Assemblage, Natural Community and Fish Condition of Koshkonong Creek Watershed Streams

Table 9. Fisheries Assemblage, Community, and Condition Koshkonong TWA

Stream	Koshkonong Creek												Unnamed Trib (810500) to Koshkonong Crk	Unnamed Trib (810100) to Koshkonong Crk	Unnamed Trib (5036882) to Koshkonong Crk					Unnamed Trib (5036215) to Unnamed Trib (5036882)	Mud Creek				Unnamed Trib (810400) to Mud Crk
Site (Year if not 2016)	Learning Place Drive	CTH T	CTH N	CTH TT (2015)	Baxter Rd	Uphoff Rd (2011)	Oak Park Rd	STH 73 (2012)	CTH O	Water St (Cambridge)	Hoopen Rd (CTH C)	CTH A	CTH BB	CTH BB	STH 73	Koshkonong Rd	Clearview Rd	Highland Dr (2011)	Highland Dr	CTH PQ	Evergreen Dr	Hilcrest Rd	STH 73	STH 12 (2010)	W. Evergreen Dr.
SWIMS Station ID	10046989	133016	10046885		10022082	10033797	10046886	133020	283017	10013016	133024	133025	10045009	10010983	10045005	10045006	10045007	10033604	10033604	10045008	10045031	10010963	10046988	10031596	10045032
BANDED DARTER		2	3	29	48		11	48	53	140	43							4	3			1	3		
BANDED KILLIFISH													1	1											
BLACK BULLHEAD	1					5																			
BLACK CRAPPIE									1	2															
BLACKNOSE SHINER	61				3									30											
BLACKSIDE DARTER				34	35		34	3	16	38	15							3	3		3	1	7		
BLACKSTRIPE TOPMINNOW			6			5	12	26	60	2	64	10													
BLUEGILL	83		1			3				4	2	1					1	2							
BLUNTNOSE MINNOW		88	1	2	2	6	18	48	6	8	43							2						1	
BRASSY MINNOW	18																							1	
BROOK STICKLEBACK	50	19	5	8	2	4					2		25	9			11	5	7	2	1	15		14	1
CENTRAL MUDMINNOW	19	16	168	43	55	62		13	17	7	7		39	23				9	1		1	7		1	
CENTRAL STONEROLLER	10	77		28	1									1				17	1						
COMMON CARP						2												1							
COMMON SHINER										5															
CREEK CHUB	200	164	45	59	16		2	10		7			29	51		1	8	27	71	2	21	1	33	1	6
EMERALD SHINER						25						2						44							
FANTAIL DARTER																		15	20		20	13			
FATHEAD MINNOW	21	2		7		15		278	8	3			27	109			28	257	25		12	11	1	165	24
FRESHWATER DRUM									10	6	2														
GOLDEN REDHORSE										1															
GOLDEN SHINER		1						3										8							
GRASS PICKEREL										9	1														
GREEN SUNFISH	43	1		12	4	3	2	2	6	30	3					5	1	86	16			2	1		
HORNYHEAD CHUB										37	8														
IOWA DARTER	5		1		1									6											
JOHNNY DARTER	48	49	15	102	31		23	20	15	15	23		2					1	7		5	29	30	12	
LARGEMOUTH BASS	12	2								1															
LOGPERCH										3	11														
NORTHERN PIKE		1	22	2	15	1	1				2														
NORTHERN PEARL DACE	56							1					14	82								16	40		
PUMPKINSEED	2				2						10														
ROCK BASS							5	9	27	39	27	2													
SAND SHINER		2		1						5	1														
SHORTHEAD REDHORSE										2	1														
SOUTHERN REDBELLY DACE	10												6	26											
SPOTFIN SHINER				5	2	6	17	15	4	21	15	2						1							
STONECAT										3															
TADPOLE MADTOM		3	17			1	1	46	2																
WHITE SUCKER	145	17	555	76	143	10	13		22	31	15	5		2			1	89	75	1	15	10	26	17	
YELLOW BULLHEAD	1					2					3														
YELLOW PERCH						1																		1	
Modeled Nat. Community	WHW	WHW	WHW	WMS	WMS	CWMS	WMS	WMS	WMS	WMS	WMS	WMS	WHW	WHW	CCHW	CCHW	CCHW	CWHW	CWHW	CWHW	CCHW	CCHW	CCHW	CCHW	CWHW
Verified Nat. Commuity	CWHW	CWHW	CWMS	CWMS	CWMS	CWMS	WMS	WMS	WMS	WMS	WMS	WMS	CWHW	CWHW	N/A[2]	N/A[2]	CWHW	CWHW	CWHW	N/A[2]	CWHW	CWHW	CWHW	CWHW	CWHW
IBI[1]	80 (Excellent)	70 (Excellent)	40 (Fair)	80 (Excellent)	70 (Excellent)	60 (Good)	40 (Fair)	15 (V. Poor)	50 (Good)	72 (Excellent)	62 (Good)	25 (Poor)	30 (Fair)	70 (Excellent)	(Poor)	(Poor)	0 (Poor)	50 (Good)	40 (Fair)	(Poor)	40 (Fair)	80 (Excellent)	80 (Excellent)	10 (Poor)	0 (Poor)

1) IBI based on Natural Community, using either Lyons, 2012 for warm transitional sites, or Lyons, 1992 for warm sites

2) Not enough fish collected to determine Natural Community or IBI. Defaults to "poor" IBI.

Tolerant Species

Intolerant Species

Species names in italic indicates thermally transitional species

Appendix C: Qualitative Habitat Assessment of Koshkonong Creek Watershed Streams.

Table 10. Habitat Assessment Values Koshkonong TWA

	Station Name	Swims Station Id	Date	Flow (cms)	Stream Width (m)	Ave Stream Depth (m)	Riparian Buffer Score	Bank Erosion Score	Pool Area Score	Width Depth Score	Riffle Riffle Ratio Score	Fine Sediments Score	Fish Cover Score	Habitat Score (Rating)	Comments
Small Stream QHI (< 10 m)	Koshkonong Creek at Learning Place Drive	10046989	08-Aug-16	-	5	0.3	10	5	3	5	10	10	5	48 (Fair)	
	Koshkonong Creek at Cth T	133016	20-Jul-16	0.101	6	0.5	5	5	0	10	0	0	5	25 (Fair)	CHANNELIZED, TILED. REPRESENTATIVE OF THE CHANNELIZED SECTIONS OF THE STREAM. AREAS DOWNSTREAM ARE MUCH DIFFERENT.
	Koshkonong Creek at CTH N	10046885	20-Jul-16	-	6	0.6	10	10	0	10	0	0	5	35 (Fair)	DITCHED (IN DRAINAGE DISTRICT).SILT/SAND BOTTOM. LOTS OF MACROPHYTES.
	Koshkonong Creek - at CTH TT	10010254	25-Aug-15	0.149	6	-	15	10	0	5	10	15	5	60 (Good)	
	Koshkonong Creek At Baxter Rd	10022082	18-Jul-16	0.434	7	0.5	10	15	3	10	10	10	10	68 (Good)	SOME RIP-RAP DONE.NICE LOOKING SITE. FLOW MAY BE IMPACTED BY MACROPHYTES.
	Koshkonong Creek at Oak Park Road	10046886	18-Jul-16	0.594	7	0.5	15	0	0	10	0	0	10	35 (Fair)	
	Koshkonong Creek at STH 73	133020	12-Jul-12	-	9	0.35	5	10	0	0	0	0	5	20 (Poor)	BOTTOM SAND, SOME GRAVEL/SILT; BANK 5-8FT FAIRLY STABLE; WET MEADOW ON RIGHT, ROW CROPS ON LEFT 2-3M BUFFER; SED HIGH;
	Koshkonong Creek at Cth O	283017	18-Jul-16	0.981	9.9	1	15	10	3	10	0	10	10	58 (Good)	MACROPHYTES MAY AFFECT FLOW
	Koshkonong Creek - Dwnstrm Water St. in Cambridge	10013016	24-Aug-16	1.2	9.5	0.6	10	5	0	10	0	5	10	40 (Fair)	SAND BOTTOM; VARIETY OF HABITATS; COARSE WOODY DEBRIS
	Unnamed Trib (5036882) to Koshkonong Cr at STH 73	10045005	09-Jun-16	-	2	0.1	15	5	0	5	5	5	0	35 (Fair)	HUGE DROP CULVERT AT KOSHKONOG RD.
	Unnamed Trib (5036882) to Koshkonong Cr at Koshkonong Rd	10045006	09-Jun-16	-	3	0.1	15	0	0	0	0	0	5	20 (Poor)	PERCHED CULVERT. VERY SHALLOW
	Unnamed Trib (5036882) to Koshkonong Cr at Clearview Rd	10045007	09-Jun-16	-	2	0.3	5	10	0	15	0	5	5	40 (Fair)	
	Unnamed Trib (5036882) to Koshkonong Cr at Highland Drive	10033604	21-Jun-16	-	5	0.3	15	5	7	5	15	10	10	67 (Good)	HIGH GRADIENT. GOOD BUFFER. ROCK, RUBBLE, GRAVEL BOTTOM. PROBABLY ONE OF THE NICEST SECTIONS OF STREAM IN EASTERN DANE CO.
	Unnamed Trib (5036215) to Unnamed Trib (5036882) at CTH PQ	10045008	09-Jun-16	-	1.5	0.15	5	10	0	10	0	0	5	30 (Fair)	STRAIGHT (CHANNELIZED), DEEPLY ENTRENCHED.
	Unnamed Trib (810100) to Koshkonong Crk at CTH BB	10010983	09-Jun-16	-	2	0.3	15	10	0	10	0	10	5	50 (Good)	
	Unnamed Trib (810500) to Koshkonong Crk at CTH BB	10045009	09-Jun-16	-	1.5	0.075	10	5	0	5	0	0	0	20 (Poor)	CHANNELIZED. HEAVY SEDIMENT.
	Mud Creek at Evergreen Drive	10045031	21-Jun-16	-	4	0.2	10	5	0	5	5	5	5	35 (Fair)	
	Mud Creek at Hillcrest Road	10010963	21-Jun-16	-	5	0.3	15	10	0	5	5	5	5	45 (Fair)	SAND/GRAVEL BOTTOM; DOWNED TREES AND WOODY COVER.
	Mud Creek at STH 73	10046988	08-Aug-16	-	5	0.2	15	0	0	5	5	0	5	30 (Fair)	WIDE AND SHALLOW
	Mud Creek at STH 12	10031596	06-Aug-10	-	5	0.4	15	10	0	5	0	0	5	35 (Fair)	
	Unnamed Trib (810400) to Mud Crk at W. Evergreen Dr	10045032	21-Jun-16	-	2.5	0.1	15	5	0	5	0	5	5	35 (Fair)	CHANNELIZED. WOODED CORRIDOR WITH RAW BANKS.
Large Stream QHI (>10 m)	**Station Name**	**Swims Station Id**	**Date Time**	**Flow (cms)**	**Stream Width (m)**	**Ave Stream Depth (m)**	**Bank Stability Score**	**Maximum Thalweg Depth Score**	**Riffle Riffle Ratio Score**	**Rocky Substrate Score**	**Fish Cover Score**			**Habitat Score (Rating)**	**Comments**
	Koshkonong Creek at Hoopen Road (CTH C)	133024	19-Jul-16	1.28	12	1	4	25	0	0	8			37 (Fair)	FLOWS THROUGH FORESTED FLOODPLAIN.
	Koshkonong Creek at Cth A Brg	133025	20-Jul-16	-	15	1	0	25	0	0	8			37 (Fair)	SITE WAS TOO DEEP TO SAMPLE PROPERLY.

Appendix D: Macroinvertebrate Data (2010-2016) Koshkonong Creek Watershed.

Table 11. Macroinvertebrate Data 2010-2016 Koshkonong Creek Watershed

Station Name	Date	**MIBI** Score (Rating)	**HBI** Score (Rating)
Koshkonong Creek at Learning Place Drive	10/13/16	6.1 (Good)	7.4 (Fairly Poor)
Koshkonong Creek at Bailey Rd	10/13/16	2.1 (Poor)	7.7 (Poor)
Koshkonong Creek at CTH T	10/13/16	3.4 (Fair)	7.4 (Fairly Poor)
Koshkonong Creek at CTH TT	10/13/16	4.2 (Fair)	6.0 (Fair)
Koshkonong Creek at Baxter Rd	10/13/16	4.1 (Fair)	5.0 (Good)
Koshkonong Creek at Uphoff Rd	10/14/11	3.8 (Fair)	7.4 (Fairly Poor)
Koshkonong Creek at STH 73	9/24/12	3.4 (Fair)	5.7 (Fair)
Koshkonong Creek at Cth O	10/13/16	6.7 (Good)	4.8 (Good)
Koshkonong Creek at Water Street (Cambridge)	10/13/16	3.8 (Fair)	4.9 (Good)
Koshkonong Creek - Below (former) Rockdale Millpond	10/13/16	4.7 (Fair)	4.8 (Good)
Koshkonong Creek at Hoopen Road (CTH C)	10/13/16	3.9 (Fair)	5.3 (Good)
Unnamed Trib (5036882) to Koshkonong Cr at STH 73	10/24/16	4.7 (Fair)	3.8 (Very Good)
Unnamed Trib (5036882) to Koshkonong Cr at Koshkonong Rd	10/24/16	4.2 (Fair)	4.3 (Very Good)
Unnamed Trib (5036882) to Koshkonong Cr at Clearview Rd	10/24/16	4.1 (Fair)	5.2 (Good)
Unnamed Trib (5036882) to Koshkonong Crk at Highland Dr.	9/26/11	4.9 (Fair)	4.4 (Very Good)
Unnamed Trib (5036882) to Koshkonong Crk at Highland Dr.	10/24/16	5.2 (Good)	4.6 (Good)
Unnamed Trib (5036215) to Unnamed Trib (5036882) at CTH PQ	10/24/16	6.1 (Good)	4.5 (Very Good)
Mud Creek - Mud Creek At Hilcrest Rd	10/24/16	5.2 (Good)	5.0 (Good)
Mud Creek at STH 73	10/24/16	4.7 (Fair)	4.7 (Good)
Mud Creek at STH 12	10/25/10	5.3 (Good)	4.6 (Good)
Unnamed Trib (810400) to Mud Crk at W. Evergreen Dr	10/24/16	3.5 (Fair)	4.4 (Very Good)

Perched Culvert

Appendix E: Water Narratives

Lake Koshkonong WBIC: 808700

A large shallow impoundment of the Rock River, Lake Koshkonong exhibits the same water quality problems as other impoundments in southern Wisconsin but on a much larger scale. The lake was originally a shallow and deep-water marsh; a dam constructed in 1850 created a shallow lake. The dam was rebuilt in 1917, raising the lake level an additional two feet. The lake is a major stop-over for migratory waterfowl and was renowned for waterfowl hunting. The drainage area above the lake encompasses 2,640 square miles.

Tremendous sediment and nutrient loads from the Rock River, Koshkonong Creek and other tributaries enter the lake annually. These loads are primarily from agricultural and some urban sources. In addition, shoreline erosion is severe on the lake. Failing septic systems were a problem in the past but the creation of a sanitary district around a portion of the lake has reduced the impact of this source on water quality. Carp are a widespread problem despite a large commercial carp fishery; the carp destroy habitat and increase the lake's existing level of turbidity. As a result, severe nuisance growth of algae and algae blooms are common, often resulting in fish kills.

The lake's shallow depth combined with its long fetch--the distance the wind blows across it uninterrupted-- causes serious shoreline erosion during major storms. All these conditions combined adversely affect water quality and the lake's fisheries. The Indianford Dam, which controls the water level of the lake, is in need of repair. The allocation of repair costs among the counties and towns that border the lake has become a local political issue. One group of property owners wants a higher water level to improve boating while another group wants lower levels to protect and improve wetland habitat.

The lake is included on the DNR's 303(d) Impaired Waters list. Impairments include low dissolved oxygen, degraded habitat, and turbidity from total phosphorus and sediment/total suspended solids. The lake is included in the Rock River Recovery plan for phosphorus and sediment reductions. Failing septic systems were a problem in the past but the creation of the sanitary district around a portion of the lake has reduced the impact of this source on water quality.

Lower Koshkonong Creek WBIC: 808800

This large stream drains lands of the drumlin-marsh area in Dane and Jefferson counties and is a tributary to the Rock River system entering at Lake Koshkonong. Small plots of wetlands, totaling several thousand acres, adjoin the stream. Mud Creek is a major tributary and Rockdale Millpond is a major impoundment. Ditching has occurred over most of its length, and many portions are now clogged with debris. The substrate consists of silt over gravel, except in areas of faster water. Water quality is poor throughout the Dane County sections, but especially near the headwaters. The City of Sun Prairie is a major contributor of treated sewage effluent and storm sewer runoff. Although the Sun Prairie treatment plant has been recently upgraded, very few species of aquatic life are found directly below this discharge. Further downstream the Villages of Deerfield, Cambridge, and Rockdale contribute wastewater as do several industries. Increased flow in the lower reaches of the stream dilutes pollutants, improving water quality and diversity. Carp have become a nuisance in the system and an eradication program is being considered. Northern pike provide a fair fishery in the lower part of the stream. Cam-Rock County Park on Rockdale Millpond provides camping and picnicking. Numerous road crossings also provide access.

Above County Trunk Highway T the creek supports a few tolerant forage species. From its headwaters to Hwy T, the river is classified as supporting limited aquatic life, or marginal surface waters. Although the stream is marginal, Hilsenhoff Biotic Index data from 1989 indicated water quality in the stream improved from very poor to poor. Base flow monitoring in 1990 showed high levels of phosphorus, chloride, fecal coliform bacteria, ammonia-nitrogen, and nitrate-nitrogen at the Baily Road monitoring site.

Below Highway T, Koshkonong Creek is classified as a warm water sport fishery, though it is severely affected by polluted runoff and past point source discharges. Research into water quality improvements from the upgrade of the Sun Prairie wastewater treatment plant examined aquatic insects via the Hilsenhoff Biotic Index and the stream's chemical water quality. These studies showed improvement in water quality based on chemical parameters only. The biotic index indicated less improvement than anticipated, possibly due to the persistent effects of sludge deposits on the stream bottom coupled with ongoing polluted runoff."

Koshkonong Creek is an effluent dominated system beginning at the Sun Prairie wastewater treatment plant on the southern border of the city. Upstream of this point streamflow is very low (currently 0.2 cfs or less). Groundwater modeling, using the regional groundwater model developed by the Wisconsin Geological and Natural History Survey, shows that baseflow in Koshkonong Creek has increased 800 percent due to municipal wastewater treatment plant discharges, compared to pre-development conditions (from 0.6 cfs to 5.0 cfs).

The 2018 assessments of Koshkonong Creek (miles 27.27-48.42) showed continued impairment by temperature; new temperature sample data exceeded 2018 WisCALM listing criteria for the Fish and Aquatic Life use. Based on the most updated information, no change in existing impaired waters listing is needed.

Rock River WBIC: 788800

A large seepage and drainage fed stream originating in Fond du Lac, Dodge and Washington Counties. The Rock River enters Rock County at the foot of Lake Koshkonong, flows south through the center of the county, and into Illinois at Beloit. Four dams are located on the river in Rock County; Indianford Dam (6-foot head) located 6 miles below Lake Koshkonong, Janesville Central Dam (9 foot head) and Monterey Dam (9 foot head) located in Janesville, and Beloit Dam (10 foot head) located in Beloit. The 4 dams were originally constructed for hydroelectric power, but only the Janesville Central and Beloit Dams are still used for this purpose. The Indianford and Monterey Dams are maintained for recreation and flood control.

Flooding is a potential hazard along the Rock River. The river commonly rises 3-5 feet each spring but has risen much higher and caused a great deal of damage. The greatest flood on record occurred in 1929 when a flood stage of 11.81 feet was reached at the U.S. Geological Survey stream gaging station at Afton. It is possible for floods of even greater magnitude to occur in any given year.

Pollution of the Rock River is not a new problem, but only in recent years have people become alarmed about the condition of this important water resource. At the present time an intensive pollution survey of the entire Rock River watershed is being jointly undertaken by State and Federal agencies. As sources of pollution are located, corrective steps will be taken.

The Rock River fishery is composed of a wide variety of species and is best described as multiple. The major sport fishery is made up of white bass crappies catfish northern pike, walleye and largemouth bass. Northern pike and walleye fishing is usually good below the dams in early spring. A large carp and sucker population is also present. Other species which appear in varying numbers include yellow perch smallmouth bass bluegill buffalo redhorse longnose gart sheepshead bowfin and forage species. Most of the wetland along the river is associated with tributary streams and the description of these areas is included with the tributary description. There are about 100 additional acres of shallow marsh wet- land bordering the river. Waterfowl, predominantly wood ducks bluewing teal and American coott are commonly observed along the river during migratory periods.

Access to the Rock River is available from 14 bridge crossings and several roads which parallel and end at the river. In addition, there are eight boat launching ramps available for public use (indicated on Figure 9). There are also three marinas which rent boats and have launching facilities. There are 6 county parks which have a total river frontage of 2 miles.

There are many lakes, rivers or streams in the Rock River Basin that are included on the 303(d) List. This effort is focused on those waters that are impaired by either excessive sediment, high phosphorus concentrations, or both sediment and phosphorus. These pollutants cause impacts to waterways which include low dissolved oxygen concentrations, degraded habitat, and excessive turbidity. All of these problems result in harm to fish and aquatic life, water quality, recreation and even navigation. Everyone who lives or recreates in the Rock River basin will benefit from the improved water quality that will result from reduced sediment and phosphorus.

Watertown (population 21,420) is the largest city in the Upper Rock River Basin. The Rock River, which winds through Watertown, is the community's major water resource, providing numerous recreational opportunities. There are two small Federal Energy Regulatory Commission (FERC) licensed hydropower dams at Watertown. A 1994 water quality study conducted as part of the FERC relicensing process indicated that the upper dam had little impact on water quality (Hansis, 1995). However, flow reductions in the river resulting from hydropower operations at the Upper Watertown Dam may seriously threaten aquatic habitat. The slender madtom, a state endangered catfish species, is susceptible to flow reductions; its prime habitat is fast moving riffle areas.

Watertown has land use and facilities plans for the city's wastewater treatment plant service area. In 2001, the city began the process to develop a sewer service area plan pursuant to Chapter NR 121, Wisconsin Administrative Code. Such a plan would guide growth within Watertown's anticipated 20-year service area. The plan would identify areas for development and guide how that development will be staged over time to allow the most cost-effective expansion of sewer services. The plan would also identify environmentally sensitive areas such as wetlands, floodplains, stormwater conveyance and treatment areas, and other areas unsuitable for development or otherwise not to be developed (e.g., parks).

Watertown is experiencing development pressure largely due to its location approximately halfway between Madison and Milwaukee. No evaluation of construction site erosion problems or stormwater management has been conducted. Watertown should develop a comprehensive stormwater management plan in conjunction with current land use or long-range development plans.

The City of Jefferson is at the juncture of the Crawfish and Rock rivers, which are regionally important recreational and aesthetic natural resources. The Jefferson wastewater treatment plant is addressing phosphorus reduction in its permit compliance schedule.

A dam on the Rock River at Jefferson is obstructing fish migration. Studies have been conducted through the DNR and the US Corps of Engineers to assess installation of a fish passage at the dam.

The City of Fort Atkinson needs a sewer service plan to guide growth within its anticipated 20-year service area. Such a plan would identify areas for development and guide how that development will be staged over time. The plan would also identify environmentally sensitive areas such as wetlands, floodplains, stormwater conveyance and treatment areas, and other areas unsuitable for development or otherwise not to be developed (e.g., parks).

Upper Koshkonong Creek WBIC: 808800

This large stream drains lands of the drumlin-marsh area in Dane and Jefferson counties and is a tributary to the Rock River system entering at Lake Koshkonong. Small plots of wetlands, totaling several thousand acres, adjoin the stream. Mud Creek is a major tributary and Rockdale Millpond is a major impoundment. Ditching has occurred over most of its length, and many portions are now clogged with debris. The substrate consists of thick silt over gravel, except in areas of faster water. Water quality is poor throughout the Dane County sections, but especially near the headwaters. The City of Sun Prairie is a major contributor of treated sewage effluent and storm sewer runoff. Although the Sun Prairie treatment plant has been recently upgraded, very few species of aquatic life are found directly below this discharge. Further downstream the Villages of Deerfield, Cambridge, and Rockdale contribute wastewater as do several industries. Increased flow in the lower reaches of the stream dilutes pollutants, improving water quality and diversity. Carp have become a nuisance in the system and an eradication program is being considered. Northern pike provide a fair fishery in the lower part of the stream. Cam-Rock County Park on Rockdale Millpond provides camping and picnicking. Numerous road crossings also provide access.

Bullhead and rough fish dominate the fishery although northern pike provide a fair fishery in the lower reaches. Wetlands near the creek mouth provide spawning areas for northern pike."

(Overview) Koshkonong Creek (Upper) Rising on the east edge of the city of Sun Prairie, much of the creek's headwaters are ditched and straightened. This river exhibits natural limiting conditions as well, such as a flat gradient, low base flow, warm temperatures, and high inputs of sediment and nutrients from the fertile watershed. Agricultural land use, urban development and hydrologic modifications result in sluggish flows, river stretches clogged with debris, and overall poor water quality. Most of its tributary streams have also been ditched and are also clogged with debris. The creek's substrate consists of thick silt, probably washed from nearby farm fields, and sludge from the Sun Prairie wastewater treatment plant lying over gravel.

Appendix F: Water Quality Standards, Koshkonong Watershed LR11[1]

Stream Name	WBIC	Local Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Designation Source	Assessment
Allen Creek	813300	Allen Creek	0	7.52	WWSF	WWSF	Fully Supporting	Default FAL	NR102 Classification	Monitored
Clear Lake	775000	Blackhawk Pier Beach	0	0.03	Shallow Headwater	FAL	Not Assessed	Default FAL	NR102 Classification	Monitored
Bowers Lake	774500	Bowers Lake	0	34.42	Small	FAL	Supporting	Default FAL	NR102 Classification	Monitored
Clear Lake[1]	775000	Clear Lake	0	77.41	Shallow Headwater	FAL	Not Supporting	Default FAL	NR102 Classification	Monitored
Edgerton Pond	808300	Edgerton Pond	0	1.43	Small	FAL	Not Assessed	Default FAL	NR102 Classification	Not assessed
Galloway Creek	814000	Galloway Creek	0	9.36	WWFF	WWFF	Supporting	WWSF	NR102 Classification	Monitored
Grass Lake	776200	Grass Lake	0	73.69	Shallow Seepage	FAL	Supporting	Default FAL	NR102 Classification	Monitored
Hope Lake	809800	Hope Lake	0	107.74	Deep Seepage	FAL	Supporting	Default FAL	NR102 Classification	Monitored
Unnamed Inlet of Lake Ripley[2]	809700	Inlet of Lake Ripley	0	3.62	FAL	FAL	Not Supporting	Default FAL	NR102 Classification	Monitored
Lake Koshkonong[3]	808700	Lake Koshkonong	0	10595.67	Shallow Lowland	WWSF	Not Supporting	Default FAL	NR102 Classification	Monitored
Lake Koshkonong	808700	Lakeview Campground Beach	0	0.06	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Monitored
Lake Ripley	809600	Lake Ripley	0	419.51	Deep Lowland	FAL	Fully Supporting	Default FAL	NR102 Classification	Monitored
Lake Ripley	809600	Lake Ripley Beach	0	0.09	Deep Lowland	FAL	Not Assessed	Default FAL	NR102 Classification	Monitored
Lake Koshkonong	808700	Lakeland Campground Beach	0	0.02	Shallow Lowland	FAL	Not Assessed	Default FAL	NR102 Classification	Monitored
Unnamed	813400	Local Water	0	7.68	FAL	FAL	Fully Supporting	Default FAL	NR102 Classification	Monitored
Unnamed	5036882	Local Water	0	5.39	FAL	FAL	Fully Supporting	Default FAL	NR102 Classification	Monitored
Koshkonong Creek[4]	808800	Lower Koshkonong	0	27.27	WWSF	WWSF	Not Supporting	WWSF	NR102 Classification	Monitored
Mud Lake	778500	Mud Lake	0	185.14	FAL	FAL	Supporting	Default FAL	NR102 Classification	Evaluated
Otter Creek	812600	Otter Creek	0	15.25	WWSF	WWSF	Fully Supporting	WWSF	NR102 Classification	Monitored
Unnamed	809500	Outlet of Lake Ripley	0	0.58	FAL	FAL	Fully Supporting	Default FAL	NR102 Classification	Monitored
Red Cedar Lake	813100	Red Cedar Lake	0	343.7	Shallow Seepage	FAL	Fully Supporting	Default FAL	NR102 Classification	Monitored
Rice Lake	779500	Rice Lake	0	117.35	Shallow Headwater	FAL	Supporting	Default FAL	NR102 Classification	Monitored

[1] Clear Lake is listed for eutrophication from nonpoint sources.
[2] This portion of the lake is listed as impaired for issues related to nonpoint sources.
[3] Lake Koshkonong is listed as impaired for Low DO, Eutrophication, Degraded Habitat, Turbidity from nonpoint sources, discharges from Municipal Separate Storm Sewer Systems (MS4), Non-irrigated Crop Production
[4] This portion of Koshkonong Creek is listed as impaired for High Phosphorus Levels from Non-Point Source (Rural or Urban)

Stream Name	WBIC	Local Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Designation Source	Assessment
Rock River[5]	788800	Rock River	193.11	207.03	FAL	FAL	Not Supporting	Default FAL	NR102 Classification	Monitored
Rock River[6]	788800	Rock River	207.32	242.84	WWSF	WWSF	Not Supporting	Default FAL	NR102 Classification	Monitored
Rose Lake	779600	Rose Lake	0	49.38	Shallow Seepage	FAL	Supporting	Default FAL	NR102 Classification	Monitored
Saunders Creek	808000	Saunders Creek	0	5	WWSF	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Saunders Creek	808000	Saunders Creek	5	16.76	WWFF	WWFF	Supporting	WWSF	NR102 Classification	Monitored
Unnamed	808450	Sheepskin Lake	0	44.17	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not assessed
Storrs Lake	780300	Storrs Lake	0	20.25	Deep Headwater	FAL	Fully Supporting	Default FAL	NR102 Classification	Monitored
Sweet Lake	780400	Sweet Lake	0	24.36	Shallow Headwater	FAL	Supporting	Default FAL	NR102 Classification	Monitored
Unnamed	808200	Un Lake	0	0.09	Small	FAL	Not Assessed	Default FAL	NR102 Classification	Not assessed
Unnamed	809100	Un Lake	0	12.11	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not assessed
Unnamed	5036215	Unnamed	0	1.2	FAL	FAL	Fully Supporting	Default FAL	NR102 Classification	Monitored
Unnamed	813000	Unnamed Stream	0	2.46	FAL	FAL	Supporting	Default FAL	NR102 Classification	Monitored
Koshkonong Creek[7]	808800	Upper Koshkonong	27.27	48.42	WWSF	WWSF	Not Supporting	LAL	Classification Survey Pending	Monitored
Unnamed	5035616	Zeloski Marsh Ditch	0	1.63	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Unnamed	809900	Zeloski Marsh Main Ditch	2.18	3.71	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Unnamed	809900	Zeloski Marsh Main Ditch to Koshkonong Creek	0	2.17	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed

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.

[5] This portion of the Rock River is listed as impaired for Low DO, Degraded Habitat from Livestock (Grazing or Feeding Operations), Non-Point Source (Rural or Urban), Impacts from Hydrostructure Flow Regulation/modification, Loss of Riparian Habitat.
[6] portion of the Rock River is listed as impaired for This Low DO, Eutrophication, Degraded Biological Community from Non-Point Source (Rural or Urban), Discharges from Municipal Separate Storm Sewer Systems (MS4)
[7] This portion of Koshkonong Creek is listed as impaired for Degraded Biological Community, Elevated Water Temperature, High Phosphorus Levels from nonpoint sources.

Appendix G: Water Quality Standards, Koshkonong Watershed, LR12

Official Name	WBIC	Water Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Designation Source	Assessment
Brazee Lake	774800	Brazee Lake	0	148.06	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Goose Lake	810200	Goose Lake	0	63.33	Shallow	FAL	Not Assessed	Default FAL	NR102 Classification	Not assessed
Unnamed	5574704	Local Water	0	2.29	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not assessed
Mud Creek	810300	Mud Creek	0	10.05	WWFF	WWFF	Supporting	WWFF	NR104 Classification Survey	Monitored
Mud Lake	810700	Mud Lake	0	33.26	Shallow	FAL	Supporting	Default FAL	NR102 Classification	Monitored
Unnamed	5573407	Patrick Lake/Marsh	0	0.83	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Evaluated
Unnamed	810340	Trib to Mud Creek	0	0.94	FAL	FAL	Not Assessed	LAL	NR104 Classification Survey	Not assessed
Unnamed	5574156	Unnamed Lake	0	4.18	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Unnamed	5574088	Unnamed Lake	0	10.5	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Evaluated
Unnamed	5034918	Unnamed Stream	0	0.29	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Unnamed	5035510	Unnamed Stream	0	0.4	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Unnamed	5035900	Unnamed Stream	0	1.72	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Unnamed	5035296	Unnamed Stream	0	1.18	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Unnamed	811500	Unnamed Stream	0	1.7	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Unnamed	810600	Unnamed Stream	0	1.48	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Unnamed	5036313	Unnamed Stream	0	0.96	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Unnamed	811600	Unnamed Stream	0	4.77	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Unnamed	5035247	Unnamed Stream	0	1.7	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Unnamed	5035666	Unnamed Stream	0	0.21	FAL	FAL	Not Assessed	Default FAL	NR102 Classification	Not Assessed
Unnamed	810500	Unnamed Trib to Koshkonong Creek	0	1.02	FAL	FAL	Supporting	Default FAL	NR102 Classification	Monitored
Unnamed	810400	Un. Trib to Mud Cr	0	3.26	FAL	FAL	Supporting	Default FAL	NR102 Classification	Monitored
Koshkonong Creek	808800	Upper Koshkonong [1]	27.27	48.42	WWSF	WWSF	Not Supporting	LAL	Classification Survey Pending	Monitored
Koshkonong Creek	808800	Upper Koshkonong	48.42	54.42	LAL	LAL	Supporting	LAL	Classification Survey Pending	Monitored

[1] Koshkonong Creek in this stretch is listed as impaired for Degraded Biological Community, Elevated Water Temperature, High Phosphorus Levels from Non-Point Source (Rural or Urban)

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