milwaukee
RIVERKEEPER®

2015 Milwaukee River Basin Report Card

Introduction

Dear Friend of the River,

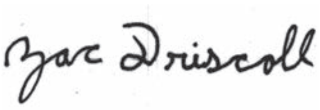
Welcome to our sixth annual Milwaukee River Basin Report Card. This year's Report Card summarizes the 2015 water quality of the Milwaukee River Basin, which includes the Kinnickinnic and Menomonee River Watersheds, in addition to the entire Milwaukee River Watershed (consisting of the Cedar Creek, East & West Branch, North Branch, and South Branch Subwatersheds).

In 2015, the Milwaukee River Basin received an overall C- grade, which is consistent with the 2014 grade and slightly worse than the C grade received in 2013. The grade for the Kinnickinnic River Watershed diminished slightly from 2014 while grades for the Milwaukee and Menomonee River Watersheds remained the same. Interestingly, the Kinnickinnic River Watershed received a better grade than the Menomonee River Watershed for the fourth year in a row, receiving a C- . While some good progress towards improved water quality continues to be made, we are still failing to meet our targets for many water quality indicators, most notably bacteria, chloride, conductivity, and phosphorus. We also continue to see poor grades for turbidity in the lower half of the Basin.

Our water quality grades are based on compiling and averaging available data from our dedicated Milwaukee Riverkeeper stream monitoring volunteers, as well as data from the Milwaukee Metropolitan Sewerage District (MMSD) and the Wisconsin Department of Natural Resources (WDNR). Our Report Card provides a snapshot of the health of the river at subwatershed, watershed, and basin levels. We measured basic water quality parameters such as dissolved oxygen, temperature, turbidity, pH, and macroinvertebrates (aquatic organisms), as well as several other pollutants of concern.

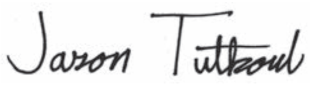
Production of this year's report card was led by Jason Tutkowski, our intern from the University of Wisconsin-Milwaukee School of Freshwater Sciences. Jason perfected his skills in analyzing data, creating tables and graphs, and communicating monitoring results in a way that we hope you find useful, interesting, and easy to understand. As always, let us know what you think! Milwaukee Riverkeeper would also like to welcome Zac Driscoll, our new Water Quality Specialist to our team. Zac has been with Milwaukee Riverkeeper since March 2016 and is excited to work with volunteers and to continue to improve our monitoring programs so that we have the best possible data to better prioritize our work to achieve clean, fishable, swimmable waters throughout the Milwaukee River Basin.

Sincerely,



Zac Driscoll,
Water Quality Specialist

Cheryl Nenn,
Riverkeeper



Jason Tutkowski,
Water Quality Intern

If you are interested in getting involved as a citizen stream monitoring volunteer, please contact us!

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Water Quality Monitoring Program At A Glance

WHO is monitoring?

76 volunteer stream monitors, Milwaukee Riverkeeper staff, as well as various MMSD and WDNR staff.

WHAT do we monitor?

We monitor water temperature, dissolved oxygen, pH, turbidity, phosphorus, conductivity, chloride, streamflow, bacteria, and macroinvertebrates.

WHEN do we monitor?

Volunteers collect baseline water quality data monthly from May through October. We install thermistors at most sites which measure temperature hourly. Staff monitor stormwater for bacteria from April through November. Staff and volunteers monitor conductivity and chloride during the winter "road salt" season. MMSD collects and analyzes water quality samples year round and WDNR monitors sporadically.

WHERE do we monitor?

We monitor throughout the Milwaukee River Basin (see watershed and subwatershed maps for locations).

WHY do we monitor?

We monitor for three primary reasons: 1) to help identify sources of pollution, 2) to help inform permitting and management decisions, and 3) to measure the effectiveness of recently implemented policies and projects. Ultimately, monitoring measures our progress toward attaining the Clean Water Act goals of clean, fishable, swimmable waters.

HOW do we monitor?

Volunteers monitor the same location monthly using protocols developed by WDNR and UW-Extension. Some parameter results are instant, while phosphorus, chloride, and bacteria samples are sent to a certified lab for analysis. We primarily monitor stormwater for bacteria where the storm sewer flows into the river. We also monitor whether best management practices are effective in removing pollutants from stormwater runoff.

What Our Grades Mean

Water quality data analyzed for this report card is a combination of volunteer, WDNR and MMSD data. Parameter grades are based on the percentage of data points that met our targets relating to aquatic ecosystem health. Grades are assigned on a typical percentage scale (A = 90 – 100%, B = 80 – 89%, C = 70 – 79%, D = 60 – 69%, and F = below 60%). Overall watershed and subwatershed grades are computed by averaging their respective individual parameter grades. The overall Milwaukee River Basin grade is determined by averaging overall grades for the three major watersheds (Milwaukee, Menomonee, and Kinnickinnic). For more information on how we determine water quality grades and set targets for watershed health, see pages 28 – 29 or visit our website at www.milwaukeeriverkeeper.org.

It is important to note that issues such as legacy contaminants, emerging pollutants, and stream conditions are not factored into our grading system. These factors may pose challenges to meeting our goals. For example, legacy pollutants such as polychlorinated biphenyls (PCBs), heavy metals, and petroleum products can impair stream health, but monitoring for these contaminants is extremely expensive. The effect of many "emerging" pollutants, such as pharmaceuticals and even nanomaterials, are just beginning to be understood. Likewise, many of our streams are channelized with concrete or have other impairments such as seawalls along the shoreline or dams that prevent fish from traveling upstream to spawn. These features make meeting fish and habitat goals difficult despite how good the water quality data may be for a particular site or stream.

A — All water quality indicators meet desired targets 90 - 100% of the time. Streams or river segments have "good" water quality, which are capable of supporting fish and other aquatic life.

B — Most water quality indicators meet desired targets roughly 80 - 89% of the time. Quality of these streams and river segments tend to be good. Most areas are capable of supporting fish and other aquatic life.

C — There is a mix of healthy and unhealthy water quality indicators or indicators are only meeting water quality targets 70 - 79% of the time. Water quality of these waters tends to be fair, as well as have fair conditions for fish and most aquatic life.

D — Few water quality indicators meet desired targets or only meet water quality targets 60 - 69% of the time. Water quality and wildlife habitat of these waters tend to be poor.

F — Very few water quality indicators meet desired targets or meet water quality targets below 60% of the time. Quality of these streams and river segments are very poor and most often lead to poor conditions for fish and aquatic life.

Milwaukee River Basin

The Milwaukee River Basin contains three major watersheds, the Milwaukee, Menomonee, and Kinnickinnic, encompassing 882.3 square miles of land and is home to 1.3 million people in southeast Wisconsin. The Basin discharges into Lake Michigan, the source of drinking water to over 900,000 people (WDNR, 2013). About 20% of the Basin is urban or suburban and about 80% is dominated by agricultural or rural uses.

The Milwaukee River Watershed is the largest of the three watersheds in the Basin and contains four individual subwatersheds: 1) the East & West Branch, 2) the North Branch, 3) the South Branch, and 4) Cedar Creek. The Menomonee and Kinnickinnic Rivers are smaller urban watersheds, and are considered major tributaries to the Milwaukee River.

Collectively, the Basin contains approximately 68,000 acres of wetlands, 600 miles of perennial streams, 450 miles of intermittent or ephemeral streams, and 57 named lakes and ponds (WDNR, 2013). Of all the streams in the Basin, about 303 miles are designated as impaired (WDNR, 2016b).

The Basin received an overall C- grade for 2015, which is unchanged from 2014. Grades for dissolved oxygen, pH, and water temperature were extremely good and all in the A's, whereas phosphorus, conductivity, and bacteria were quite poor and all received F's. Rounding out the middle was chloride with a B and turbidity with a C-. As in 2014, there was geographical variability within grades, with the more rural and suburban northern half (East & West Branch Milwaukee, North Branch Milwaukee, and Cedar Creek) faring better in water quality, than the more urbanized southern half (South Branch Milwaukee, Menomonee, and Kinnickinnic). Table 1 below highlights the overall grade of the Milwaukee River Basin from 2013 to 2015. A map of the Basin can be seen in Figure 1 on the following pages.

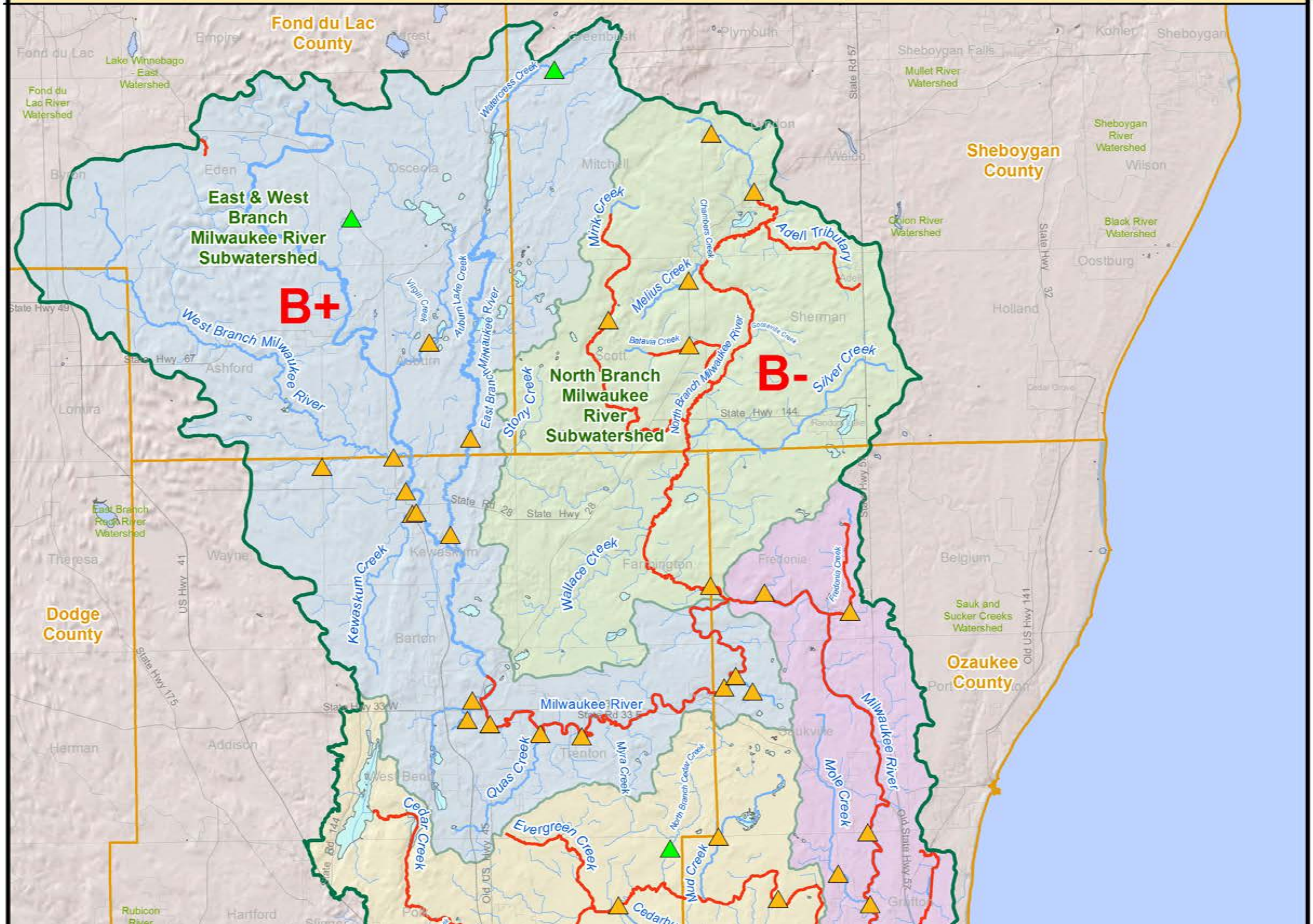
Generally, Milwaukee Riverkeeper and MMSD water quality data results were similar with a few exceptions. MMSD data showed higher rates of turbidity in the South Branch Milwaukee River and Menomonee River Watersheds as well as lower concentrations of phosphorus in the Kinnickinnic River Watershed.

Table 1

		Overall Grade
2015	**Grade**	**C-**
	% meet target	72.6
	# samples	10898
2014	**Grade**	**C-**
	% meet target	71.8
	# samples	7257*
2013	**Grade**	**C**
	% meet target	74.2
	# samples	10509

* In 2014, MMSD's water quality data collected at estuary sites at three different depths and ultimately averaged, reducing sample number.

Milwaukee River Basin



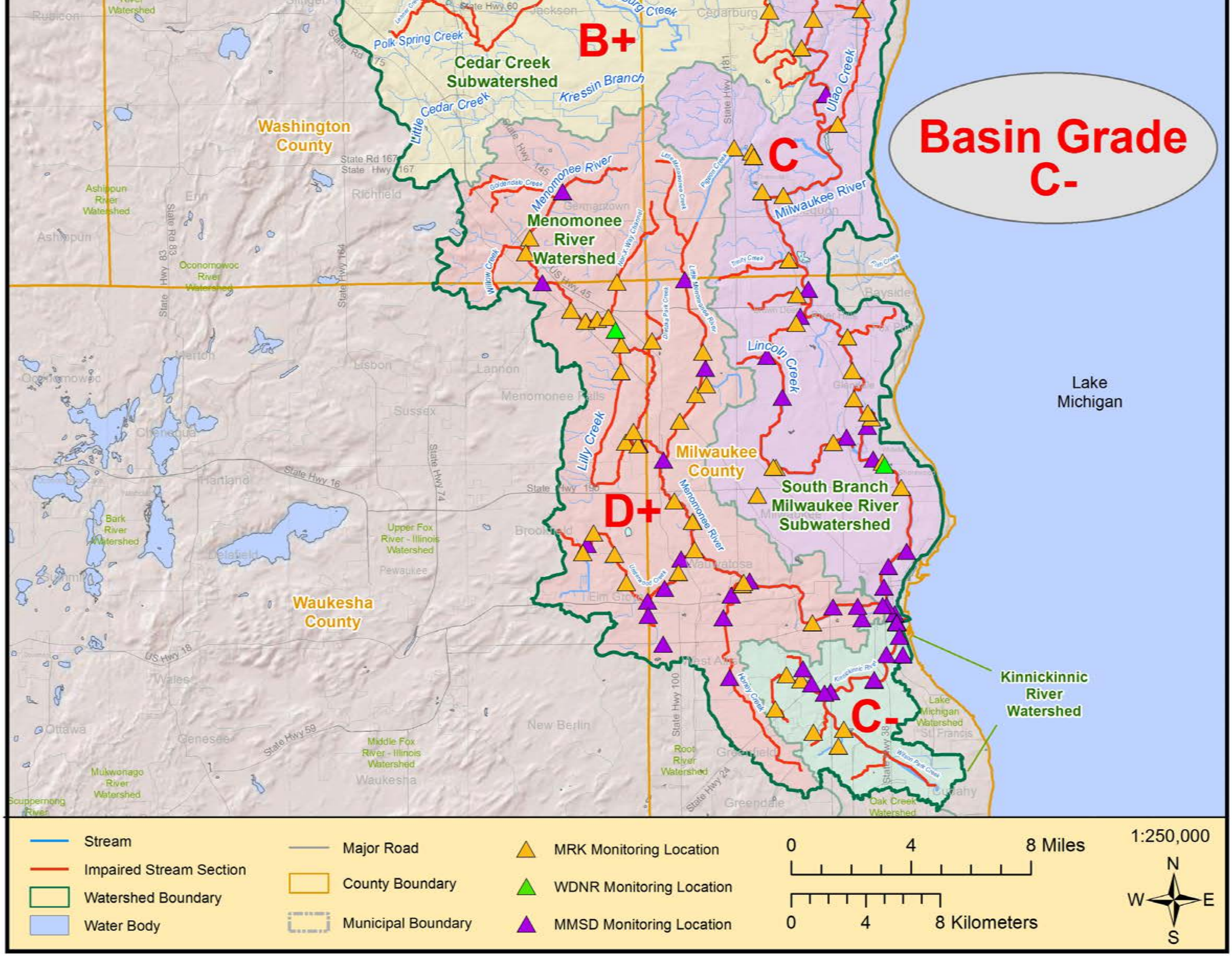

Basin Grade C-
Lake Michigan
B+
C
D+
C-
Cedar Creek Subwatershed
Menomonee River Watershed
South Branch Milwaukee River Subwatershed
Kinnickinnic River Watershed
Washington County
Milwaukee County
Waukesha County
Polk Spring Creek
Kressin Branch
Little Cedar Creek
Ulao Creek
Milwaukee River
Menomonee River
Lincoln Creek
Lilly Creek
Honey Creek
Oconomowoc River Watershed
Ashippun River Watershed
Bark River Watershed
Upper Fox River - Illinois Watershed
Middle Fox River - Illinois Watershed
Mukwonago River Watershed
Root River Watershed
Lake Michigan Watershed
Oak Creek Watershed
Stream
Impaired Stream Section
Watershed Boundary
Water Body
Major Road
County Boundary
Municipal Boundary
MRK Monitoring Location
WDNR Monitoring Location
MMSD Monitoring Location
0 4 8 Miles
0 4 8 Kilometers
1:250,000
N
W
E
S

Figure 1

Milwaukee River Watershed

The Milwaukee River Watershed received an overall water quality grade of a C in 2015, which is the same as the previous year. Temperature, pH, dissolved oxygen, and chloride received A grades, of which the latter two parameters both saw a slight improvement from A- grades in 2014 (Table 2). The average chloride grade for the entire watershed over the whole year was good, but many of the smaller creeks in the watershed (e.g., Lincoln, Southbranch) have chloride levels exceeding what is considered safe for fish during winter and early spring months. This is a concern because too much chloride can be toxic to fish and other aquatic life.

Turbidity, which looks at the amount of suspended sediment or "cloudiness" of the water, received a D+ grade in 2015. While the North Branch and East & West Branch both received good scores for turbidity, the South Branch dragged down the overall turbidity score. The primary reason is that there are over five times as many samples collected in the South Branch than the northern subwatersheds, and since the South Branch generally has lower water quality, its data weighs down the turbidity score for the watershed.

Phosphorus, conductivity, and bacteria all received F grades in 2015, which is consistent with previous years, although data was only available for conductivity and bacteria from the South Branch. Agricultural and urban runoff coupled with likely leakages from sewer infrastructure and septic tanks could contribute to these poor scores. Phosphorus in particular scored D's or F's in all subwatersheds of the Milwaukee River. This is consistent with data from previous years and confirms there is a widespread problem with phosphorus pollution. This is also particularly disconcerting because phosphorus is the limiting nutrient in most freshwater ecosystems and excessive levels can cause growth of nuisance algae as well as other water quality problems (see pages 22-23 for more information on phosphorus and its impact on river health).

Poor water quality contributes to the degradation of beneficial uses in the Milwaukee Estuary, which largely spans the area where the Milwaukee, Menomonee, and Kinnickinnic Rivers come together and discharge into the Milwaukee Harbor. In 1987, the International Joint Commission, an organization created by the United States and Canada to help regulate shared water uses and investigate transboundary issues (IJC, 2016), designated the Milwaukee Estuary as an Area of Concern (AOC) due to historic waterway modifications and legacy contamination. Boundaries for the AOC include the inner and outer Milwaukee Harbors, nearshore Lake Michigan, the Kinnickinnic River upstream

Counties

- Dodge
- Fond du Lac
- Milwaukee
- Ozaukee
- Sheboygan
- Washington

Communities

- Adell
- Bayside
- Brown Deer
- Campbellsport
- Cascade
- Cedarburg
- Fox Point
- Fredonia
- Germantown
- Glendale
- Grafton
- Fredonia
- Jackson
- Kewaskum
- Lyndon
- Mequon
- Milwaukee
- Newburg
- Random Lake
- Richfield
- River HIlls
- Saukville
- Shorewood
- Slinger
- Thiensville
- West Bend
- Whitefish Bay

to Chase Avenue, the Milwaukee River upstream to its confluence with Cedar Creek, the lower five miles of Cedar Creek downstream from Bridge Road, the Menomonee River upstream to its confluence with the Little Menomonee River, and the Little Menomonee River upstream to Brown Deer Road (WDNR, 2016a). The Milwaukee Estuary can only be taken off of the AOC list by restoring its beneficial uses, which can be partially accomplished through cleanup and other restoration activities (US EPA, 2015). An AOC designation gives the Milwaukee Estuary priority for funding under several Federal programs that help clean up hot spots of contamination in the Great Lakes.

The following sections go into more detail about the water quality and physical characteristics of each of the Milwaukee River's four subwatersheds.

Macroinvertebrate Monitoring

In 2015, volunteers monitored 13 sites for macroinvertebrates in the Milwaukee River Watershed, including 1 site in Cedar Creek, 5 sites in the East & West Branch, and 7 sites in the South Branch. Volunteers completed 30 total surveys in the Milwaukee River Watershed with an average ranking on the low end of "Fair." When breaking down the ranking for each subwatershed, the Cedar Creek site ranked on the low end of "Good," the East & West Branch sites received an average ranking on the low end of "Fair," and the South Branch sites received an average ranking on the high end of "Fair." Hence, only Cedar Creek received what we consider a passing grade for macroinvertebrates.

Table 2

	Overall Grade	Dissolved Oxygen	pH	Turbidity	Water Temp	Phosphorus	Conductivity	Chloride	Bacteria
Milwaukee River Watershed									
2015 Grade	**C**	**A**	**A**	**D+**	**A**	**F**	**F**	**A**	**F**
% meet target	77.0	95.2	99.7	68.3	100	51.3	8.8	95.0	42.9
# samples	4309	622	600	571	609	552	340	696	319
2014 Grade	**C**	**A-**	**A**	**D+**	**A**	**F**	**F**	**A-**	**F**
% meet target	74.7	93.2	99.8	67.6	100	43.1	5.1	92.1	50.8
# samples	3176	458	454	435	462	450	235	444	238
2013 Grade	**C+**	**A**	**A**	**C**	**A**	**F**	**F**	**A**	**F**
% meet target	77.3	93.9	99.0	74.7	100.0	53.1	7.9	96.6	45.5
# samples	4326	609	597	601	611	548	368	684	308

South Branch and Cedar Creek Subwatersheds

The South Branch Milwaukee River Subwatershed is located in two counties (Milwaukee and Ozaukee) and covers an area of 167.9 square miles. Approximately 33% of the land is urban, 25% is agriculture, and 39% is grassland, forest, and wetlands (WDNR, 2013). Most of the urban area is concentrated in the southern part of the subwatershed in metropolitan Milwaukee. The rural area is mostly north of Saukville and west of Port Washington in Ozaukee County.

In 2015, 23 Milwaukee Riverkeeper volunteers monitored 18 sites, while staff from the WDNR and MMSD monitored 1 and 14 sites, respectively (Figure 2). In total, 3,712 water quality data points were collected for the South Branch Milwaukee River Subwatershed. The 2015 grade was a C, which was a slight improvement from 2014 (Table 3). Overall, the grades have not changed much since 2010. Grades were also fairly consistent when comparing data collected by volunteer monitors and MMSD. Dissolved oxygen, pH, and water temperature all received A's, turbidity received a D, and phosphorus and conductivity received F's. The majority of data for chloride and all the data for bacteria came from MMSD, which scored an A and an F, respectively. Such a high chloride grade was greatly influenced from year-round sampling conducted by MMSD (see page 20 for information about seasonal variations in chloride).

The Cedar Creek Subwatershed is centrally located within the Milwaukee River Basin in Ozaukee and Washington counties and covers an area of 128 square miles (WDNR, 2013). It is primarily a rural watershed with agriculture accounting for 49% of the land use and urban uses comprising only 3.5%. The Cedarburg Bog State Natural Area and the Jackson Marsh State Wildlife Area are important wetland complexes that provide important habitat for fish species and other wildlife (WDNR, 2013).

The lower 5 miles of Cedar Creek (Figure 3), before it discharges into the Milwaukee River, contains two Superfund project sites with PCBs from former industrial activities of Mercury Marine and Amcast. Mercury Marine is planning cleanup activities starting in fall of 2016 for the first phase of cleanup. The second phase of cleanup is still in the planning process and an initial cleanup proposal should be available for public comment in 2017 (US EPA, 2016).

In 2015, five Milwaukee Riverkeeper volunteers monitored four sites, while staff from the WDNR monitored one site (Figure 2). In total, 94 water quality data points were produced for Cedar Creek. No data was provided from MMSD because Cedar Creek is outside of their service area. The 2015 grade was a B+, which was consistent with 2014. The score was tied with the East & West Branch, which had the highest overall grade of any watershed in the Milwaukee River Basin. These higher grades could be partially attributed to a lack of urban development. Dissolved oxygen, pH, turbidity, and water temperature parameters all scored A's. Phosphorus was the lone standout, which scored an F and was down from a D+ a year earlier. High phosphorus could be partially due to agricultural runoff.

Figure 3. Cedar Creek in Cedarburg, WI.

Table 3	Overall Grade	Dissolved Oxygen	pH	Turbidity	Water Temp	Phosphorus	Conductivity	Chloride	Bacteria
South Branch									
2015 Grade	**C**	**A**	**A**	**D**	**A**	**F**	**F**	**A**	**F**
% meet target	74.9	96.3	99.8	64.5	100	48.7	8.8	95.0	42.9
# samples	3712	492	479	473	490	423	340	696	319
Cedar Creek									
2015 Grade	**B+**	**A**	**A**	**A**	**A**	**F**	**N/A**	**N/A**	**N/A**
% meet target	89.4	95.5	100	100	100	52.6	N/A	N/A	N/A
# samples	94	22	20	12	21	19	N/A	N/A	N/A

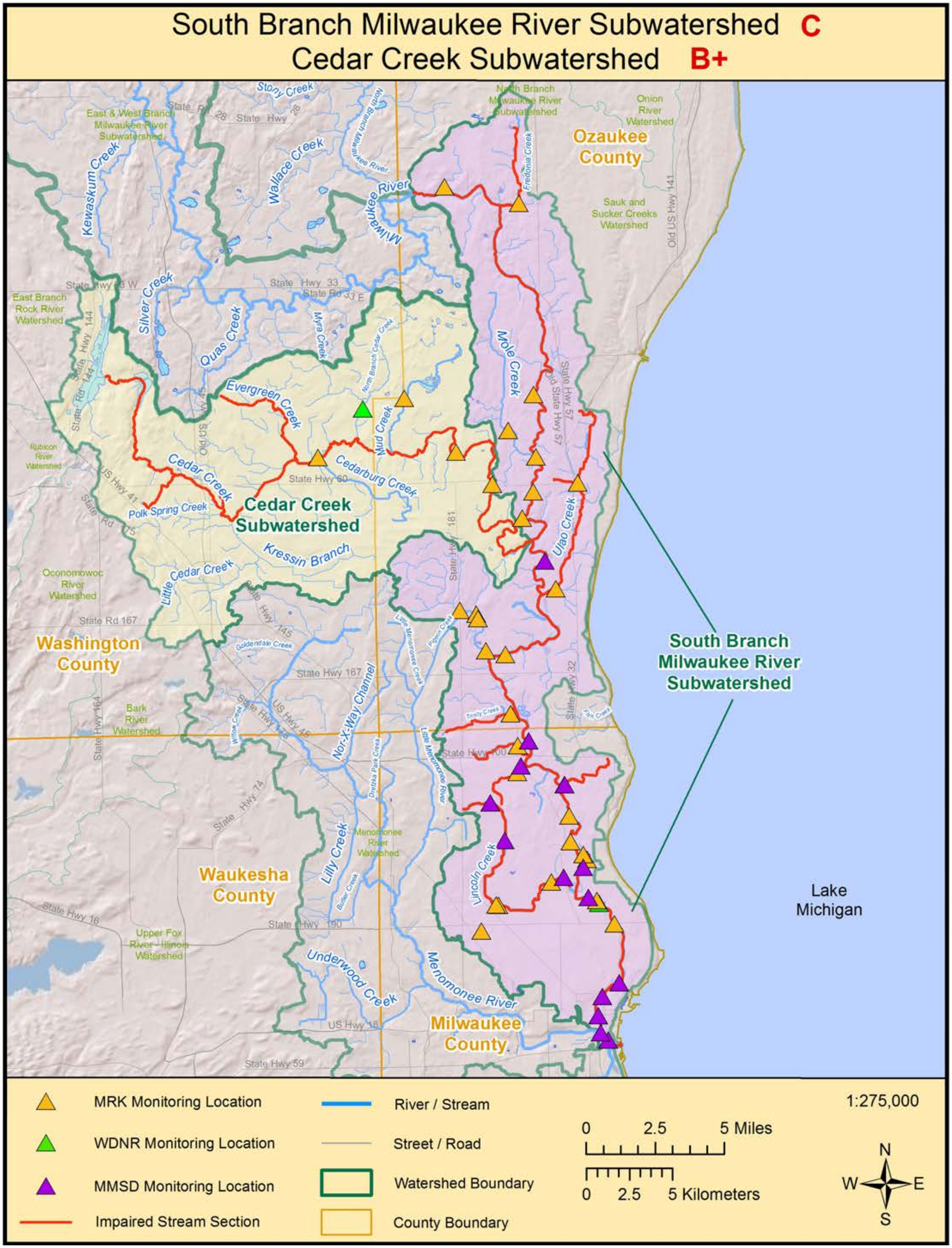

South Branch Milwaukee River Subwatershed C
Cedar Creek Subwatershed B+
Cedar Creek Subwatershed
South Branch Milwaukee River Subwatershed
Ozaukee County
Washington County
Waukesha County
Milwaukee County
Lake Michigan
North Branch Milwaukee River Subwatershed
Onion River Watershed
East & West Branch Milwaukee River Subwatershed
Sauk and Sucker Creeks Watershed
East Branch Rock River Watershed
Rubicon River Watershed
Oconomowoc River Watershed
Bark River Watershed
Menomonee River Watershed
Upper Fox River - Illinois Watershed
Stony Creek
Kewaskum Creek
Wallace Creek
Milwaukee River
Silver Creek
Quas Creek
Myra Creek
Evergreen Creek
Mud Creek
Cedar Creek
Cedarburg Creek
Polk Spring Creek
Kressin Branch
Little Cedar Creek
Mole Creek
Fredonia Creek
Ulao Creek
Pigeon Creek
Little Menomonee Creek
Little Menomonee River
Goldendale Creek
Nor-X-Way Channel
Willow Creek
Trinity Creek
Fish Creek
Lincoln Creek
Lilly Creek
Butler Creek
Underwood Creek
Menomonee River
Dretzka Park Creek
State Hwy 28
State Hwy 33
State Rd 33 E
State Hwy 57
Old State Hwy 57
Old US Hwy 141
State Hwy 60
US Hwy 41
State Rd 175
State Hwy 181
State Rd 167
State Hwy 167
State Hwy 145
US Hwy 45
State Hwy 32
State Hwy 100
State Hwy 164
State Hwy 74
State Hwy 16
State Hwy 190
US Hwy 18
State Hwy 59
State Hwy 144
MRK Monitoring Location
WDNR Monitoring Location
MMSD Monitoring Location
Impaired Stream Section
River / Stream
Street / Road
Watershed Boundary
County Boundary
1:275,000
0 2.5 5 Miles
0 2.5 5 Kilometers
N
S
W
E

Figure 2

North Branch and East & West Branch Subwatersheds

The North Branch Milwaukee River Subwatershed is located in four counties (Fond du Lac, Ozaukee, Sheboygan, and Washington) and covers an area of 149.7 square miles (WDNR, 2013). Approximately 57% of the land is agriculture, while 14% is wetland, 12% is grassland, 11% is forest, and less than 0.5% is urban. The aptly named Nichols Creek Wildlife Area covers 612 acres and includes seeps and springs that form Nichols Creek and eventually the North Branch Milwaukee River (WDNR, 2015).

In 2015, six Milwaukee Riverkeeper volunteers monitored seven sites (Figure 4). In total, 155 water quality data points were collected for the North Branch Milwaukee River Subwatershed. The 2015 grade was a B-, which remained consistent from the previous year (Table 4). Water temperature and pH both scored an A, while turbidity went from an A in the previous year down to a B-. Dissolved oxygen scored a C and phosphorus scored a D-. Grades in the North Branch tend to be very dynamic, which could be caused by several factors. A low number of data points for the North Branch region could cause the grades to be more sensitive to change. Agricultural runoff, for example, is likely to affect phosphorus levels, but runoff is also highly dependent on weather. Also, several small streams tend to decrease in volume and flow during late summer, which dramatically affects dissolved oxygen levels and other parameters. Low flow may be one of the reasons why dissolved oxygen levels were so low and variable in Batavia, Mink, and Melius Creeks in 2015 (Figure 5). This is concerning because dissolved oxygen should not fall below 5 mg/L as that can stress and kill aquatic life.

The East & West Branch Milwaukee River Subwatershed is located in five counties (Dodge, Fond du Lac, Ozaukee, Sheboygan, and Washington) and covers 266 square miles, the largest land area in the Milwaukee River Watershed. Like the North Branch, land use is mostly rural with agriculture comprising 47%. Only 3% is urban, but encompasses large and growing population centers such as West Bend, Newburg, Kewaskum, and Campbellsport (WDNR, 2013).

In 2015, seven Milwaukee Riverkeeper volunteers monitored 16 sites, while staff from the WDNR monitored two sites (Figure 4). In total, 348 water quality data points were collected for the East & West Branch Milwaukee River Subwatershed. The 2015 grade was a B+, which was a slight improvement from the previous year's B-. Dissolved oxygen, pH, and water temperature all received A grades with turbidity following close behind with a B+. However, phosphorus received a D- and has scored consistently low grades since 2010. A likely reason for this consistently low grade is agricultural runoff. The North Branch and East & West Branch were not monitored by MMSD because they are outside of their service area.

2015 Melius, Mink, and Batavia Creek Dissolved Oxygen Comparison (May - October)

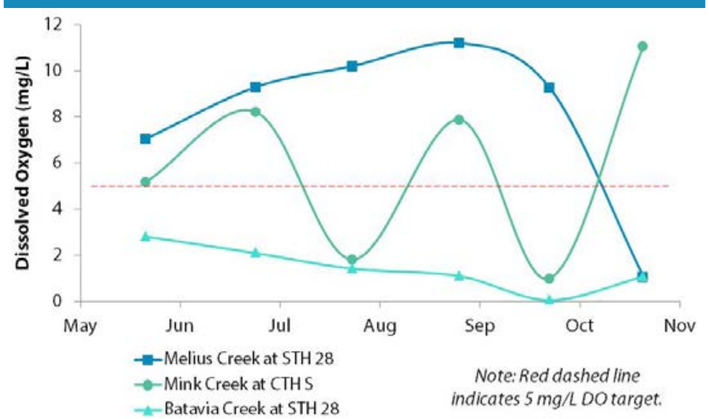
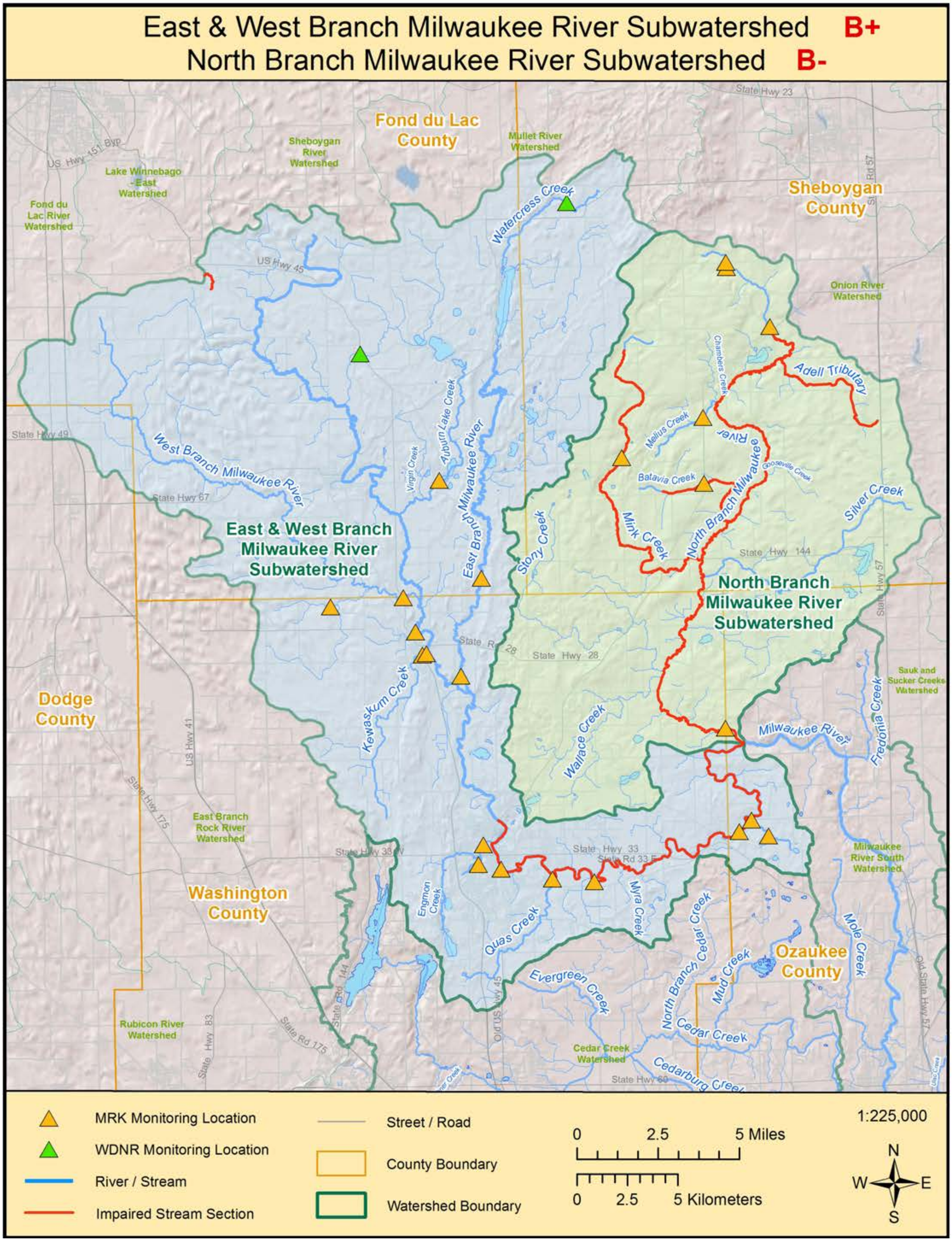


Figure 5

Table 4		Overall Grade	Dissolved Oxygen	pH	Turbidity	Water Temp	Phosphorus	Conductivity	Chloride
North Branch									
2015	**Grade**	**B-**	**C**	**A**	**B-**	**A**	**D-**	**N/A**	**N/A**
% meet target		83.2	75.7	100	80.0	100	62.5	N/A	N/A
# samples		155	37	36	25	25	32	N/A	N/A
East & West Branch									
2015	**Grade**	**B+**	**A**	**A**	**B+**	**A**	**D-**	**N/A**	**N/A**
% meet target		87.9	97.2	98.5	86.9	100	60.3	N/A	N/A
# samples		348	71	65	61	73	78	N/A	N/A



East & West Branch Milwaukee River Subwatershed B+
North Branch Milwaukee River Subwatershed B-
Fond du Lac County
Sheboygan County
Dodge County
Washington County
Ozaukee County
East & West Branch Milwaukee River Subwatershed
North Branch Milwaukee River Subwatershed
West Branch Milwaukee River
East Branch Milwaukee River
North Branch Milwaukee River
Milwaukee River
Watercress Creek
Auburn Lake Creek
Virgin Creek
Kewaskum Creek
Stony Creek
Wallace Creek
Mink Creek
Melius Creek
Batavia Creek
Chambers Creek
Adell Tributary
Silver Creek
Fredonia Creek
Quas Creek
Engmon Creek
Myra Creek
Evergreen Creek
North Branch Cedar Creek
Mud Creek
Cedar Creek
Cedarburg Creek
Mole Creek
MRK Monitoring Location
WDNR Monitoring Location
River / Stream
Impaired Stream Section
Street / Road
County Boundary
Watershed Boundary
1:225,000
0 2.5 5 Miles
0 2.5 5 Kilometers

Figure 4

Menomonee River Watershed

The Menomonee River Watershed is located in four counties (Milwaukee, Ozaukee, Washington, and Waukesha) and covers an area of 136.12 square miles. The watershed contains a wide variety of land uses including 42% urban, 22% grasslands, 17% agriculture, 8% forests, and 7% wetlands. Most of this land is within the boundaries of incorporated municipalities (WDNR, 2013). In 2015, 35 Milwaukee Riverkeeper volunteers monitored 29 sites, while staff from the WDNR and MMSD monitored 1 and 21 sites, respectively (Figure 6). In total, 4,178 water quality data points were produced. So how healthy is the Menomonee River Watershed and its tributaries? In 2015, the watershed earned an overall grade of a D+, the lowest overall grade in the Milwaukee River Basin (Table 5). Year to year overall scores for the Menomonee are consistently amongst the lowest in the Basin.

The Menomonee received A grades for temperature and pH as well as an A- for dissolved oxygen, which are consistent with 2014. Chloride took a small jump and increased from a C- in 2014 to a B- in 2015. While this improvement is welcome, it should be noted that out of the three watersheds where data was collected, which also included the Kinnickinnic and South Branch Milwaukee River, the Menomonee River Watershed had the most data points that did not meet the chronic chloride standard (230 mg/L). Only 65.5% of the samples collected in the Menomonee River Watershed met the chronic target for chloride toxicity. The majority of exceedances occurred during winter and early spring when road salt runoff is high.

The worst grades in the watershed came from turbidity, which scored a D+, as well as phosphorus, conductivity, and bacteria, which all scored F's. Figure 7 shows a graph of total phosphorus collected on Dretzka Park Creek. The July water sample measured 1.91 mg/L, the highest phosphorus score in the Milwaukee River Basin, which is more than 25 times higher than our target of 0.075 mg/L for a small stream. Fertilizer runoff from urban and agricultural sources to the north is a suspected source of phosphorus. Conductivity in the Menomonee scored the worst grade out of any water quality parameter in our analysis with 21 out of 387 data points (only 5%) meeting its target. However, this was an improvement from the 2.4% of data points that met the target in 2014. Agricultural and urban runoff coupled with likely leakages from sewer infrastructure and septic tanks could contribute to these poor scores.

Figure 8 shows the percentage of different streambank types within the Menomonee River Watershed. Portions of Honey Creek, Underwood Creek, and Nor-X-Way Channel have concrete reinforced streambanks; portions of Dretzka Creek, Honey Creek, and Underwood Creek are enclosed; and portions of Honey Creek and the lower Menomonee River are walled (Figure 9). Concrete lining can cause a variety of problems in a stream, first and foremost is the near to complete destruction of available in-stream habitat. Also during wet conditions, channelized streams can transport water much quicker, which can increase erosion downstream and result in sedimentation and tree falls. Whereas during dry summer conditions, the concrete channel can warm the stream water beyond healthy levels and the concrete also prohibits additions of spring or groundwater that often can ameliorate warmer water temperatures.

Counties

- Milwaukee
- Ozaukee
- Washington
- Waukesha

Communities

- Brookfield
- Butler
- Elm Grove
- Germantown
- Greendale
- Greenfield
- Menomonee Falls
- Mequon
- Milwaukee
- New Berlin
- Richfield
- Wauwatosa
- West Allis
- West Milwaukee

2015 Phosphorus in Dretzka Park Creek at W. Bradley Road

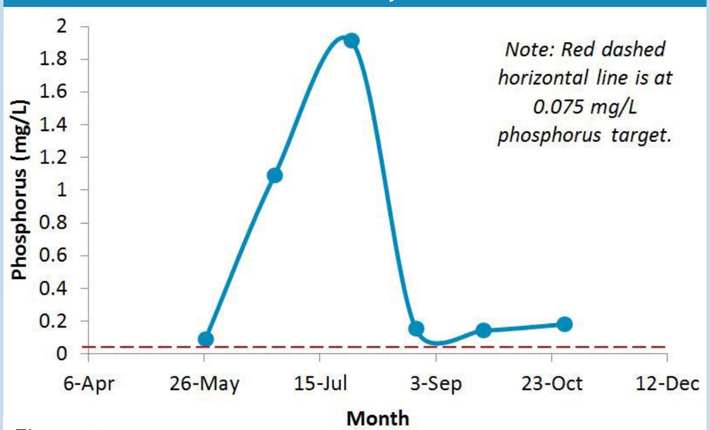


Figure 7

Menomonee River Watershed Streambank Type

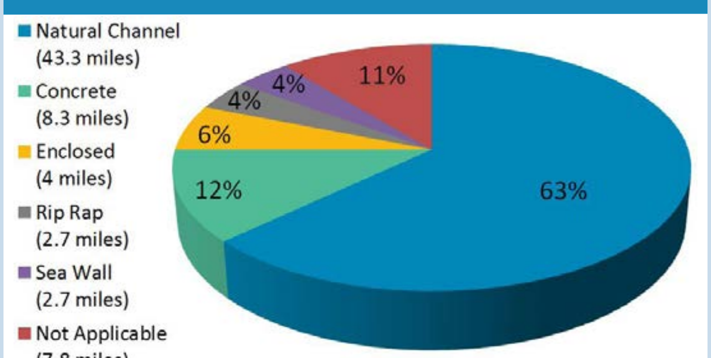


Figure 8

Source: Inter-Fluve Milwaukee County Stream Study, 2004

Figure 9. Deteriorating wall of the Menomonee River (Milwaukee, WI).

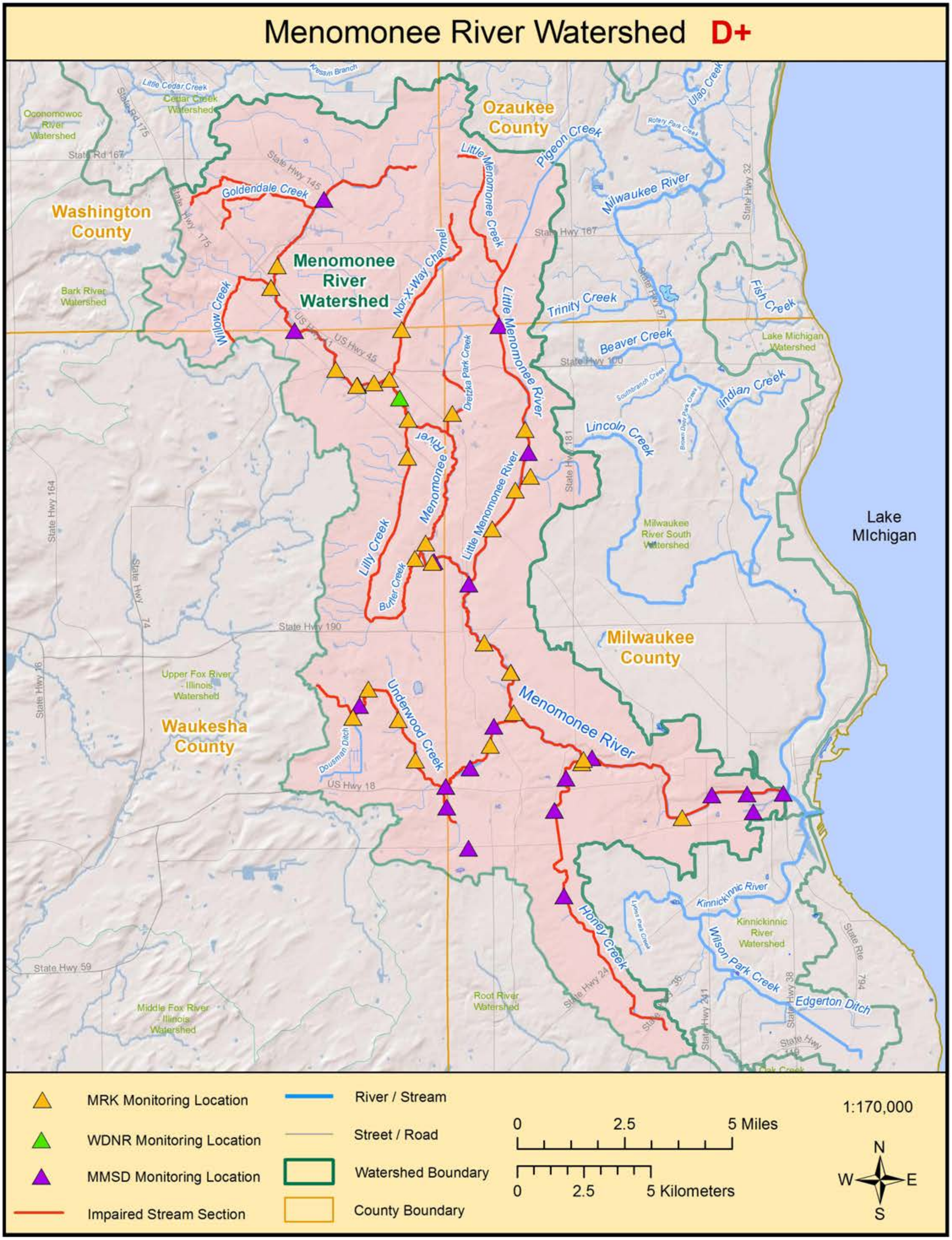

Menomonee River Watershed D+
Menomonee River Watershed
Washington County
Ozaukee County
Milwaukee County
Waukesha County
Lake Michigan
Goldendale Creek
Willow Creek
Nor-X-Way Channel
Little Menomonee Creek
Little Menomonee River
Menomonee River
Dretzka Park Creek
Lilly Creek
Butler Creek
Underwood Creek
Dousman Ditch
Honey Creek
Pigeon Creek
Milwaukee River
Trinity Creek
Beaver Creek
Lincoln Creek
Indian Creek
Fish Creek
Ulao Creek
Kinnickinnic River
Wilson Park Creek
Edgerton Ditch
Oconomowoc River Watershed
Cedar Creek Watershed
Bark River Watershed
Upper Fox River - Illinois Watershed
Middle Fox River - Illinois Watershed
Root River Watershed
Milwaukee River South Watershed
Lake Michigan Watershed
Kinnickinnic River Watershed
MRK Monitoring Location
WDNR Monitoring Location
MMSD Monitoring Location
Impaired Stream Section
River / Stream
Street / Road
Watershed Boundary
County Boundary
1:170,000
0 2.5 5 Miles
0 2.5 5 Kilometers
N
W
E
S

Figure 6

Menomonee River Watershed Monitoring Results

In 2015, significant work was done by MMSD to improve fish passage along the Menomonee River near Hoyt Park between Swan Boulevard and 83rd Street (Figures 10 and 11). At an estimated cost of $1.5 million, the project planned to remove five low barriers including three sewer crossings, one old road crossing, and one dam. While only ranging from one to three feet above the river, weak swimming fish such as northern pike and smallmouth bass cannot make it over these obstacles. The project was a great success, although only four of the five barriers were able to be removed as one sewer pipe crossing that serves the Hoyt Park pool had to be left in because there was not adequate funding for placement of a deeper sewer. Instead of removing this barrier, a limestone rock ramp was designed and installed to facilitate fish passage over the sewer crossing. The project opened miles of stream for fish to migrate upstream from Hoyt Park to better spawning areas. Milwaukee Riverkeeper worked with youth from the Great Lakes Conservation Corps to remove more than 26 massive debris jams that were blocking stream flow and impeding fish passage upstream in the Menomonee and Little Menomonee River systems. Work with the Village of Menomonee Falls to address several bad culverts upstream, which are fish passage obstacles, is also in progress.

Macroinvertebrate Monitoring

In 2015, Milwaukee Riverkeeper volunteers monitored 11 sites for macroinvertebrates in the Menomonee. Volunteers completed 27 macroinvertebrate surveys for an average ranking on the low end of "Fair." A "Fair" grade is considered failing. The Menomonee scored slightly higher than the Kinnickinnic, but lower than the Milwaukee River Watershed.

Table 5

	Overall Grade	Dissolved Oxygen	pH	Turbidity	Water Temp	Phosphorus	Conductivity	Chloride	Bacteria
Menomonee River Watershed									
2015 Grade	D+	A-	A	D+	A	F	F	B-	F
% meet target	68.3	91.7	99.8	68.9	100	44.9	5.4	82.0	29.4
# samples	4178	519	489	508	516	494	387	782	487
2014 Grade	D+	A-	A	D+	A	F	F	C-	F
% meet target	68.0	91.9	99.2	67.9	100	59.4	2.4	72.6	35.9
# samples	3101	371	367	365	378	357	296	580	387
2013 Grade	C-	B+	A	D+	A	C	F	B-	F
% meet target	70.4	87.1	100	66.7	100	74.3	2.5	82.1	28.2
# samples	4184	511	496	508	520	471	400	792	486

Figure 10. Menomonee River near Hoyt Park before barrier removal.

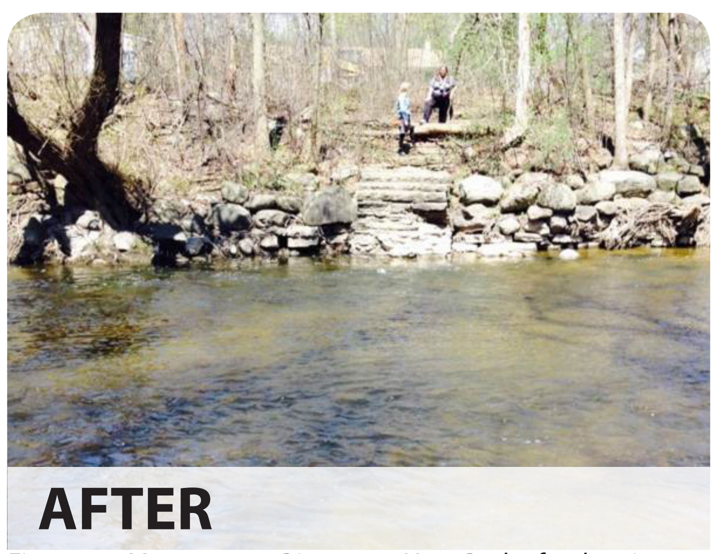


Figure 11. Menomonee River near Hoyt Park after barrier removal.

Kinnickinnic River Watershed

The Kinnickinnic River Watershed is located completely within Milwaukee County and covers an area of 33.4 square miles (Figure 12). The Kinnickinnic is the smallest watershed in the Milwaukee River Basin, but is also the most developed with 90% of its land designated as urban. Other land uses include 5.3% for parks and recreation, 1.5% as forest, and 0.36% as wetland (WDNR, 2013).

The Kinnickinnic River was greatly modified during the 20th century. Many of its streams are lined with concrete or enclosed, and most of the remaining open channel is unstable and highly erodible (Figure 13). Impervious surfaces, such as concrete, prevent water from infiltrating into the ground, and instead cause overland flow, flashy water levels in streams, higher velocity stream flows, and higher incidence of flooding. Urbanization and development have also contributed to more than 70% of river corridors within the watershed having unhealthy riparian buffers less than 75 feet wide. Healthy riparian buffers are critical in protecting water quality, providing habitat for fish and other wildlife, and providing ecological resilience to climate change impacts, flooding, and invasive species (WDNR, 2013).

Presently the Kinnickinnic River is undergoing a dramatic restoration led by MMSD. Past work has already removed 1,000 feet of concrete channel just downstream of 6th Street and replaced it with a more natural stream (Figures 14 and 15). Eventually concrete will be removed from 6th Street upstream to 43rd Street on the main stem, as well as from several creeks. The goals of the project are to improve safety, recreation, aesthetics, flood management, and habitat for fish and other aquatic wildlife. Milwaukee Riverkeeper is an active member of the Kinnickinnic River Watershed Advisory Committee and has taken the lead to monitor effects of several green infrastructure pilot projects in the watershed as well as to coordinate citizen monitoring efforts.

In 2015, Milwaukee Riverkeeper also conducted testing of stormwater outfalls for human bacteria throughout the Kinnickinnic River Watershed as part of our partnership with Dr. Sandra McLellan at University of Wisconsin-Milwaukee's School of Freshwater Sciences. Results are provided on page 25. Figure 16 summarizes the results as the percent of bacteria samples that fall into each range.

Note that Figure 16 has human *Bacteroides* counts in "Copy Number" (CN) counts rather than "colony forming units" (cfu). Since stormwater should have no human sewage indicators, any positive sample is a concern.

2015 Human Bacteria Counts (CN/100 mL)

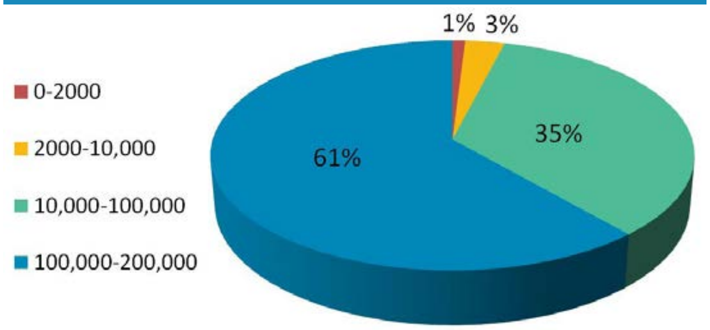


Figure 16

Counties
Milwaukee

Communities
Cudahy
Greenfield
Milwaukee
St Francis
West Allis
West Milwaukee

Notable Streams
Kinnickinnic River
Wilson Park Creek
Holmes Avenue Creek
Cherokee Creek
Edgerton Ditch
43rd Street Ditch

Kinnickinnic River Watershed Streambank Type

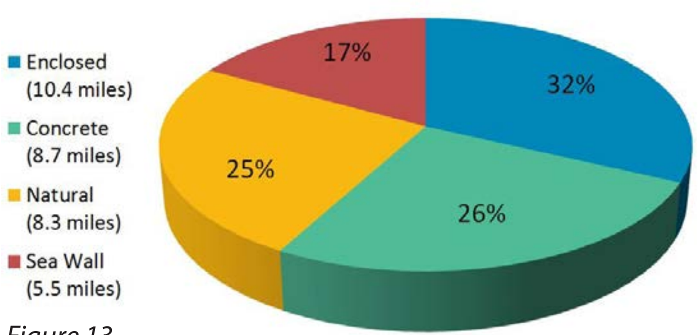


Figure 13
Source: SEWRPC GIS Land Use Layer, 2010

Figure 14. Kinnickinnic River at 6th Street before restoration. Source: SSCHC

Figure 15. Kinnickinnic River at 6th Street after restoration. Source: SSCHC

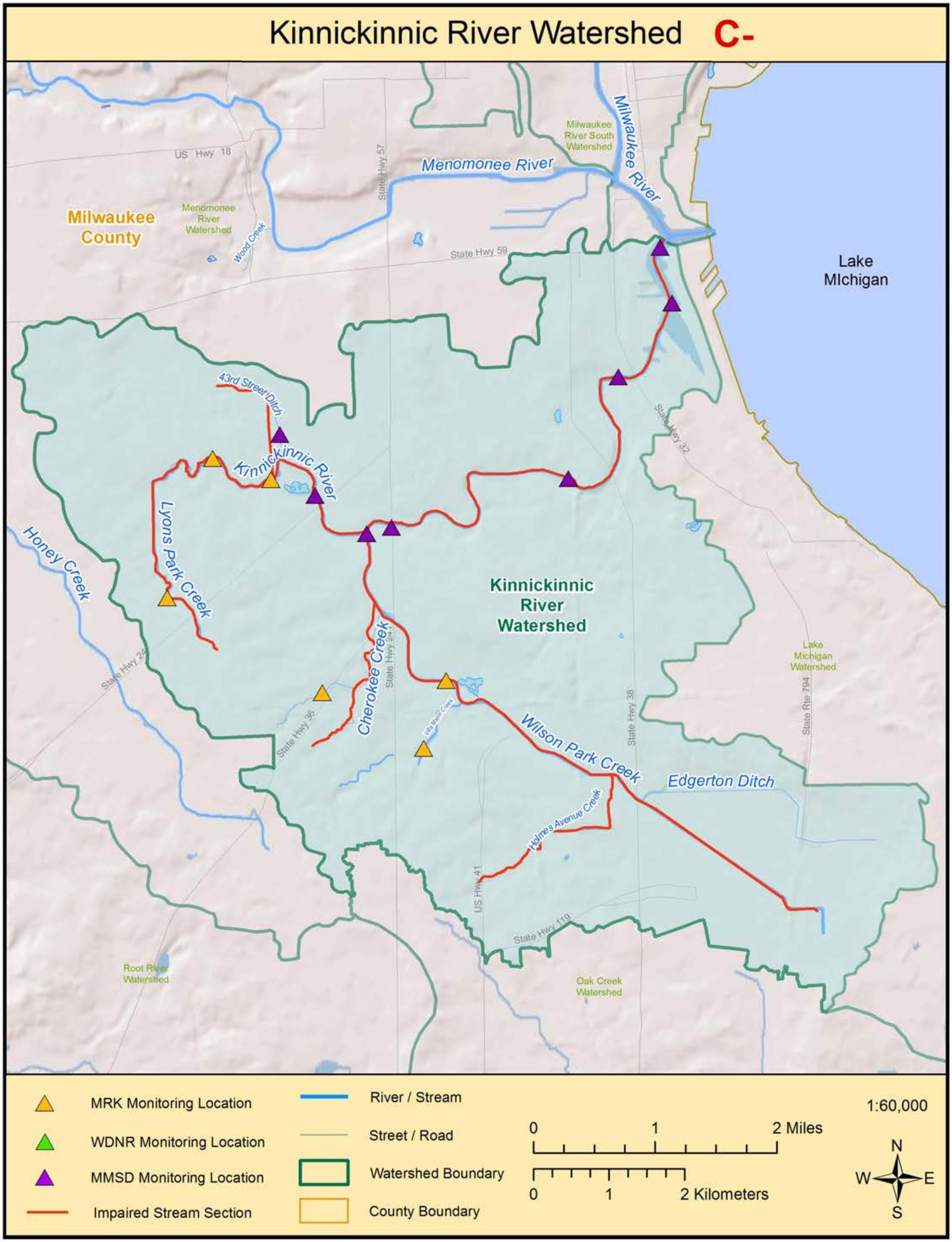

Kinnickinnic River Watershed C-
Milwaukee County
Menomonee River Watershed
Wood Creek
US Hwy 18
State Hwy 57
Menomonee River
Milwaukee River South Watershed
Milwaukee River
State Hwy 59
Lake Michigan
43rd Street Ditch
Kinnickinnic River
Lyons Park Creek
Honey Creek
State Hwy 32
Kinnickinnic River Watershed
State Hwy 24
Cherokee Creek
State Hwy 36
Wilson Park Creek
State Hwy 38
Lake Michigan Watershed
State Rte 794
Edgerton Ditch
Holmes Avenue Creek
US Hwy 41
State Hwy 119
Root River Watershed
Oak Creek Watershed
MRK Monitoring Location
WDNR Monitoring Location
MMSD Monitoring Location
Impaired Stream Section
River / Stream
Street / Road
Watershed Boundary
County Boundary
0 1 2 Miles
0 1 2 Kilometers
1:60,000
N
W E
S

Figure 12

Kinnickinnic River Watershed Monitoring Results

In 2015, 13 Milwaukee Riverkeeper volunteers monitored six sites, while staff from MMSD monitored eight sites (Figure 12). In total, 2,411 water quality data points were collected. So how healthy is the Kinnickinnic River Watershed and its tributaries? In 2015, the watershed earned an overall grade of a C-, which was a slight decline from 2014 (Table 6). Overall grades for the watershed are consistently in the C to D range, which could be due to the highly urbanized nature of the area.

The Kinnickinnic received A grades for pH and temperature as well as a B+ and a B- for dissolved oxygen and chloride, respectively. Those parameters are generally consistent year to year, although the chloride grade dropped from a B+ in 2013 to a C in 2014. One possible reason for this variability could be due to an above average snowfall and subsequent increase in road salt applications during the winter of 2014.

Turbidity received a C+ in 2015 and phosphorus received a D. While a D for phosphorus might not seem very good, it is actually the best phosphorus grade out of any watershed in the entire Milwaukee River Basin. A possible reason for this could be due to the lack of sources of phosphorus from industrial discharges and runoff from agriculture, golf courses, etc. Conductivity and bacteria have continued to score poorly in the watershed with both parameters receiving F grades.

Figure 18. Kinnickinnic River concrete bed lining.

Table 6

	Overall Grade	Dissolved Oxygen	pH	Turbidity	Water Temp	Phosphorus	Conductivity	Chloride	Bacteria
Kinnickinnic River Watershed									
2015 Grade	**C-**	**B+**	**A**	**C+**	**A**	**D**	**F**	**B-**	**F**
% meet target	73.0	89.8	99.6	75.5	100.0	65.5	21.0	81.7	28.8
# samples	2411	283	282	282	281	287	257	524	219
2014 Grade	**C**	**A-**	**A**	**C**	**A**	**C+**	**F**	**C**	**F**
% meet target	74.3	92.8	99.2	74.0	100	78.2	14.7	75.5	9.8
# samples	980	125	129	127	131	124	95	188	61
2013 Grade	**C**	**B**	**A**	**D-**	**A**	**C-**	**F**	**B+**	**F**
% meet target	75.4	85.7	99.2	62.7	100	71.1	22.3	89.4	40.4
# samples	1999	244	242	244	248	246	215	424	136

Figure 17. Scud (left), crayfish (middle), non-red midge larvae (right) can all be found in the Kinnickinnic River.

Macroinvertebrate Monitoring

In 2015, volunteers monitored four sites for macroinvertebrates (Figure 17) in the Kinnickinnic River Watershed. Volunteers completed 16 macroinvertebrate surveys for an average ranking on the high end of "Poor." This is the lowest macroinvertebrate score out of any of the watersheds in the Milwaukee River Basin likely due to the concrete bed lining and poor habitat (Figure 18). Hopefully as concrete removal and habitat restoration work continues on streams throughout the watershed, the macroinvertebrate score will improve.

Conductivity and Chloride

For the sixth winter in a row, Milwaukee Riverkeeper has monitored the effects of road salt in the Milwaukee River Basin by measuring levels of conductivity and chloride at different stream sites. Conductivity can be thought of as the degree to which water can conduct an electric current and is measured in-stream by a handheld sensor (Figure 19). The more charged ions in the water, such as chloride from road salt, the greater the conductivity. Studies by the USGS have shown strong correlations between conductivity and chloride within our urban streams (Corsi et al. 2010; Corsi et al. 2014). In addition to road salt, conductivity can be driven by the surrounding geology, stormwater and agricultural runoff, and industrial discharges.

Milwaukee Riverkeeper's target for conductivity, which according to EPA guidance should provide a healthy mix of aquatic life in our streams, is 150 to 500 microSiemens per centimeter (µS/cm) (US EPA, 1997). Units for conductivity may also be written as micromhos per centimeter (µmhos/cm), which are equivalent to µS/cm. EPA has also developed chloride criteria to determine when water becomes unsafe for fish and aquatic life. The chronic (long term) level in freshwater is set at 230 mg/L and the acute (instantaneous) level is set at 860 mg/L. Exceeding these targets either at a high or acutely toxic level, or at a lower or chronic level over a longer period of time, creates harmful water conditions for aquatic organisms. In 2015, the majority of the data we used for calculating the conductivity and chloride grades came from MMSD and its service area, which includes the South Branch Milwaukee River, Kinnickinnic River, and Menomonee River Watersheds. Milwaukee Riverkeeper volunteers and staff also monitor during winter months. If conductivity exceeds certain threshold values, then a water sample is taken and sent off to the State Lab for chloride analysis.

Figure 19. Oakton ECTestr11 Conductivity Meter.

2015 Milwaukee River Basin Conductivity/Chloride Analysis Results

	Salt Season Dec. 2014–May 2015	Off Season June 2015–Nov. 2015	One Year Total Dec. 2014–Nov. 2015
Conductivity			
Grade	**F**	**F**	**F**
# Meet Stnd (150 - 500 µS/cm)	11	90	101
# Samples	387	589	976
% Meet Stnd	2.8%	15.3%	10.3%
Average (µS/cm)	1369.5	877.8	1072.8
Acute Chloride			
Grade	**A**	**A**	**A**
# Meet Stnd (860 mg/L)	385	590	975
# Samples	410	590	1000
% Meet Stnd	93.9%	100.0%	97.5%
Average (mg/L)	301.4	143.1	208.0
Chronic Chloride			
Grade	**F**	**B**	**C-**
# Meet Stnd (230 mg/L)	226	499	725
# Samples	410	590	1000
% Meet Stnd	55.1%	84.6%	72.5%
Average (mg/L)	301.4	143.1	208.0

Table 7

Table 7 shows conductivity as well as acute and chronic chloride grades based on data compiled from December 2014 through November 2015 in the Milwaukee River Basin. Conductivity fairs poorly throughout the year particularly during the salt season (December 2014–May 2015), and has a yearlong average value that is more than double the high end of the target range (150-500 µS/cm).

Almost all the samples met the acute chloride standard throughout the year, however the Kinnickinnic, Milwaukee, and Menomonee Rivers each had samples reaching 1,000 mg/L chloride and some reached as high as 1,500 mg/L, which is well over the acute standard. Another warning sign was that only a little over 50% of samples met the chronic chloride standard during the salt season, although that jumped to 84.6% during the off season. Even at lower levels, exceeding the chronic standard for chloride could be stressful or lethal to many fish or aquatic life. Yearlong chloride exceedances could be due to chloride sticking around in the stream or accumulating in groundwater (Kaushal et al. 2005) and then being released throughout the year into the surrounding environment (Rosenberry et al. 1999; Corsi et al. 2014). Thanks to the generous support of the Fund for Lake Michigan, Milwaukee Riverkeeper will be able to increase its monitoring efforts for conductivity and chloride in 2016, and will also train private road salt applicators and residential homeowners to reduce winter deicing and chloride inputs to streams.

Dissolved Oxygen

Dissolved oxygen (DO) is a strong indicator of environmental health and water quality. Like the name implies, dissolved oxygen is the amount of oxygen dissolved in the water. It can be measured with a sensor such as a YSI 550A meter (Figure 20) and is most commonly recorded in units of milligrams DO per liter of water (mg/L). Milwaukee Riverkeeper's target for dissolved oxygen is based on the WDNR's designation for a warm water stream, which should have a minimum DO of no less than 5 mg/L. Milwaukee Riverkeeper believes all streams in the Milwaukee River Basin are capable of reaching the 5 mg/L target. Just like humans, most aquatic organisms need oxygen to breathe and when deprived of oxygen they suffocate and die. Oxygen incorporates into streams from the atmosphere, turbulence caused by fast moving water, and photosynthesis caused by aquatic plants. Generally, stagnant and slow moving water will have less oxygen than fast moving water.

Two common reasons for low oxygen levels include nutrient pollution and high water temperatures. Plants and algae need nutrients like phosphorus and nitrogen to grow, but too many nutrients can cause growth at a nuisance level. Eventually when the plants and algae die, bacteria involved in decomposition can use up all the oxygen creating hypoxic (oxygen deficient) or anoxic (no oxygen) conditions. Agricultural runoff in the Milwaukee and Menomonee Rivers is a common source of nutrients to our waterways. High water temperatures also affect the amount of oxygen in our streams. Dissolved oxygen concentration is inversely proportional to water temperature because gas solubility decreases as temperature increases. Cold water holds more oxygen than warm water. You can see this trend in the data for the Milwaukee River Basin (Figure 21). Urban runoff, industrial pollution, organic matter, and diurnal (or daily recurring) cycles all contribute to variations in dissolved oxygen levels. Milwaukee Riverkeeper monitoring volunteers measure DO at the same time each visit because DO follows a diurnal cycle or changes throughout the day, so monitoring at consistent times makes it easier to make data comparisons. DO is generally at its lowest around dawn, peaks in early afternoon with high plant photosynthesis, and decreases through the late afternoon and evening as photosynthesis stops. The process then starts all over again the following dawn.

Figure 20. YSI 550A Dissolved Oxygen Meter.

2015 Mean Dissolved Oxygen and Temperature at Monitoring Sites in the Milwaukee River Basin

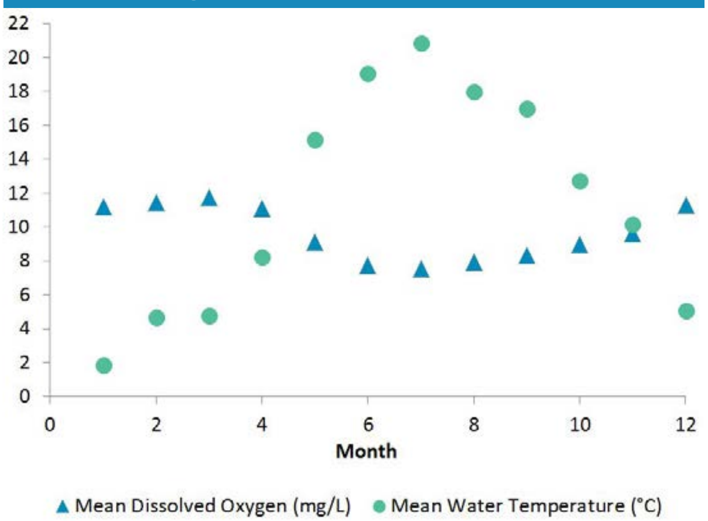


Figure 21

Milwaukee Riverkeeper volunteers also monitor for macroinvertebrates and develop a biotic index from what they find. The biotic index is directly related to the DO levels at each stream site. Macroinvertebrates that are sensitive to low oxygen such as stonefly or dobsonfly larva are good indicators of a healthy stream, whereas low oxygen tolerant organisms such as leeches and isopods are found in most any stream in the Milwaukee River Basin.

Since DO is so important in the aquatic environment, looking at the minimum DO values from each monitoring site can sometimes be helpful to find trouble areas. Many of the sites adjacent to the confluence of the Milwaukee, Menomonee, and Kinnickinnic Rivers have had minimum DO values below 5 mg/L, likely due to urban runoff and pollutants that are generally increasing from upstream to downstream. Generally, the overall watershed grades for DO are pretty good. The Menomonee River Watershed actually has the most sites with minimum values above the WDNR coldwater spawning season standard of 7 mg/L, which is excellent. This is a major contributor to why overall dissolved oxygen received an A- in the Milwaukee River Basin. The North Branch Milwaukee River Subwatershed received the lowest grade of a C with scores from Batavia, Mink, and Melius Creeks bringing down the grade (Figure 5, Pg. 10).

TMDLs and Phosphorus

Impaired waters do not meet water quality standards set forth by the Clean Water Act and as you can see from Figure 1 on Pg. 4, there are many impaired waters in the Milwaukee River Basin. As a way to meet those standards, EPA requires states to create and update a list of impaired waters every two years and to develop total maximum daily loads (TMDLs) for impaired waters, which are plans designed to reduce pollutant loads from key sources and get waters back to meeting standards for aquatic health and safety. A TMDL is the amount of a pollutant that can enter a waterbody and still allow the waterbody to meet its water quality standards. This provides an estimate of how much of a pollutant needs to be reduced. Once a pollutant target is determined for a waterbody, a TMDL is calculated by adding together the allowable point source pollution (called a wasteload allocation), nonpoint source pollution (called a load allocation), and a margin of safety (that recognizes our models are not perfect). While this may seem simple, in reality, this calculation is very complicated and is done by creating complex computer models that mimic real world conditions and are validated with real water quality data. Modeling challenges have led the Milwaukee River Basin TMDL (just released in July 2016) to be delayed by over four years. TMDLs have now been developed for total suspended solids, bacteria, and phosphorus.

Phosphorus is an essential nutrient in aquatic ecosystems and is used by all life forms, but too much phosphorus can cause aquatic plants and algae to grow to nuisance levels. Large algae blooms can cause the water to turn a green, brown, or red hue. When algae die, bacteria involved in decomposition can use up a lot of dissolved oxygen and create low oxygen environments or even dead zones with no oxygen. Cyanobacteria blooms (often called blue-green algae) can also produce toxins that are harmful to both aquatic organisms and humans. Most famously, toxins from cyanobacteria shut down the drinking water supply in Toledo, Ohio just a few years ago. Phosphorus is also a limiting nutrient in freshwater systems, meaning that no matter how much of the other nutrients are available, plants will cease to grow once the limiting nutrient has run out. It is for these reasons that Milwaukee Riverkeeper volunteers collect water samples for total phosphorus, which are analyzed by the Wisconsin State Lab of Hygiene. MMSD also monitors year round.

Grades for phosphorus have consistently been among the worst for the entire Milwaukee River Basin, scoring an F for phosphorus in 2015, as well as in four out of the last five years. Both the Milwaukee and Menomonee River Watersheds scored F's for phosphorus, while the Kinnickinnic River Watershed scored a D. Figure 22 shows average phosphorus values at sites in the Milwaukee River Basin. Many high phosphorus values can be seen in the Menomonee and South Branch Milwaukee River Watersheds. Figure 23 shows the percentage of samples that met their phosphorus target in each watershed. As you can see, late fall and winter samples had the best compliance with state phosphorus standards, which plummeted in summer during times of peak fertilizer use. The influx of phosphorus into our waterways is really a combination of multiple sources including fertilizers from urban and agricultural runoff, effluent from sewer treatment plants and sewer overflows, industrial discharges, and even from the orthophosphate that many municipalities use to prevent leaching of lead from old lead drinking water pipes. One of the best things you can do to reduce phosphorus is to eliminate fertilizer use and plant native vegetation that does not need much maintenance, especially along riparian buffers.

2015 Phosphorus Compliance Chart

Watershed	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Milwaukee	100%	100%	65%	32%	48%	26%	38%	40%	56%	70%	70%	0%
Menomonee	100%	100%	93%	37%	60%	25%	31%	20%	36%	51%	35%	19%
Kinnickinnic	20%	0%	79%	50%	70%	59%	65%	67%	58%	69%	57%	86%

Percent Compliance: 0%, 20%, 40%, 60%, 80%, 100%

Percent Compliance: 0% – 100%

Figure 23

Mean Total Phosphorus at Milwaukee River Basin Monitoring Sites

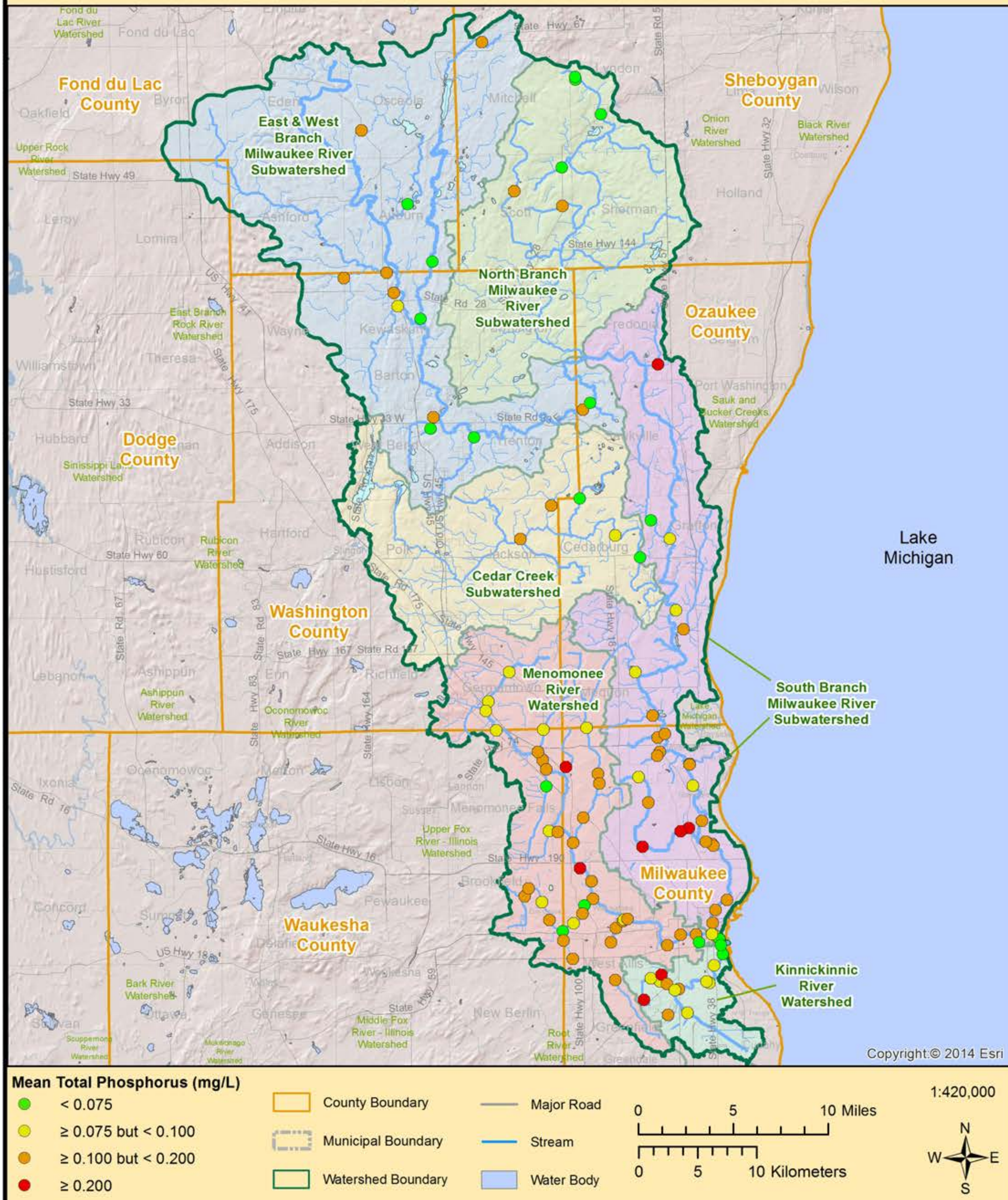


Figure 22

Menomonee Valley Stormwater

Nonpoint source pollution or stormwater runoff is one of the most significant threats to the waterways of the Milwaukee River Basin. Stormwater runoff is caused by rainfall and snow melt that sweeps contaminants from many different sources on the land into our local streams either directly or through stormwater systems or groundwater. One way to help deal with stormwater pollution is to construct wet detention ponds with native vegetation, which maximize collection of stormwater, uptake of nutrients by plants, and infiltration of stormwater before it runs off into waterways. Stormwater Park (Figure 24) and Three Bridges Park (Figure 25) in the Menomonee Valley both have a series of wet detention basins to collect stormwater from the surrounding transportation, industrial, and commercial land uses, which contribute the heaviest loading of pollutants of concern to the Menomonee River.

In 2014 and 2015, Milwaukee Riverkeeper partnered with Menomonee Valley Partners (MVP) and the Milwaukee Metropolitan Sewerage District (MMSD) to test the effectiveness of the chain of stormwater ponds constructed in each park by quantifying the level of five different water quality parameters in stormwater runoff entering the Menomonee River, including total suspended solids, biological oxygen demand, fecal coliform bacteria, *E. coli* bacteria, and total phosphorus. The hypothesis was that water quality would improve as stormwater moved from the top ("upstream") of the chain of ponds to the bottom ("downstream"). Water sampling occurred at each park on five separate dates: once during Fall 2014, twice during Spring 2015, and twice during Fall 2015. Two samples were collected on each date: one from the top of the chain of ponds and one from the bottom or downstream end. Efforts were made to go out during rain events; however, the heaviest event sampled only produced 0.8 inches of rain. During most sample events, no runoff was

Figure 25. Three Bridges Park and the Menomonee River.

Figure 24. Stormwater Park.

flowing into the river, so samples were taken at the most downstream extent of water. Riverkeeper staff collected water samples, which were put on ice and delivered to the lab at MMSD to be analyzed.

Results were somewhat of a mixed bag, and it should be noted that five sets of data collected on five different wet weather days is a fairly limited amount of data. With that in mind, some trends begin to pop up in the data. At Stormwater Park, which was constructed a decade ago and where vegetation is well established, water quality generally improved from the top of the pond chain to the bottom. We never witnessed any flow to the Menomonee River, which is likely due to the minor rain events sampled, but also due to the good design of the ponds that ensures flow is only entering the river during heavy storms. At Three Bridges Park, pond construction occurred in summer 2014 and there was little vegetation when sampling occurred in late 2014 and early 2015. Water quality generally got worse from the top of the treatment train to the bottom due to lack of vegetation and areas of exposed soil. However, there is some evidence that water quality began to improve in late 2015 as vegetation became better established. We are interested to see if the water quality from the ponds in Three Bridges Park improves as vegetation becomes even better established over time. In all but one of the rain events sampled, no runoff was seen traveling from Three Bridges directly to the Menomonee River, indicating the ponds seemed to do a good job of minimizing stormwater runoff to the Menomonee River during smaller storms sampled.

While this study was a good initial look at the effectiveness of stormwater ponds at Stormwater Park and Three Bridges Park, future monitoring should be completed with more samples collected over a longer period of time, during more intensive rain events, and when there is more established vegetation at the Three Bridges Park study site.

Human *Bacteroides*

Milwaukee Riverkeeper has continued to monitor stormwater outfalls in partnership with Dr. Sandra McClellan's lab at the UWM School of Freshwater Sciences. Sampling occurred during rain events on two days in June 2015 and one day in October 2015 at eight different sites between the Menomonee and Kinnickinnic River Watersheds. High amounts of human *Bacteroides* (over 1,000 CN/100mL), which is a bacteria specific to the human gut, were found in 14 out of 18 samples. The sample with the highest amount of *Bacteroides* was taken on the Kinnickinnic River and returned a count of 181,351 CN/100mL (Figure 26).

The presence of these bacteria signifies that somehow human fecal matter has made its way into our streams. Aging sanitary and storm sewer infrastructure can lead to broken pipes and cross contamination, but sources of the *Bacteroides* are still unknown. Milwaukee Riverkeeper is working with partners at MMSD and municipalities to help find sources of bacteria up the pipe and has helped with sample collection to inform USGS's development of a new sensor to predict sewage contamination. In order to ensure clean, swimmable waters, bacteria contamination needs to be addressed.

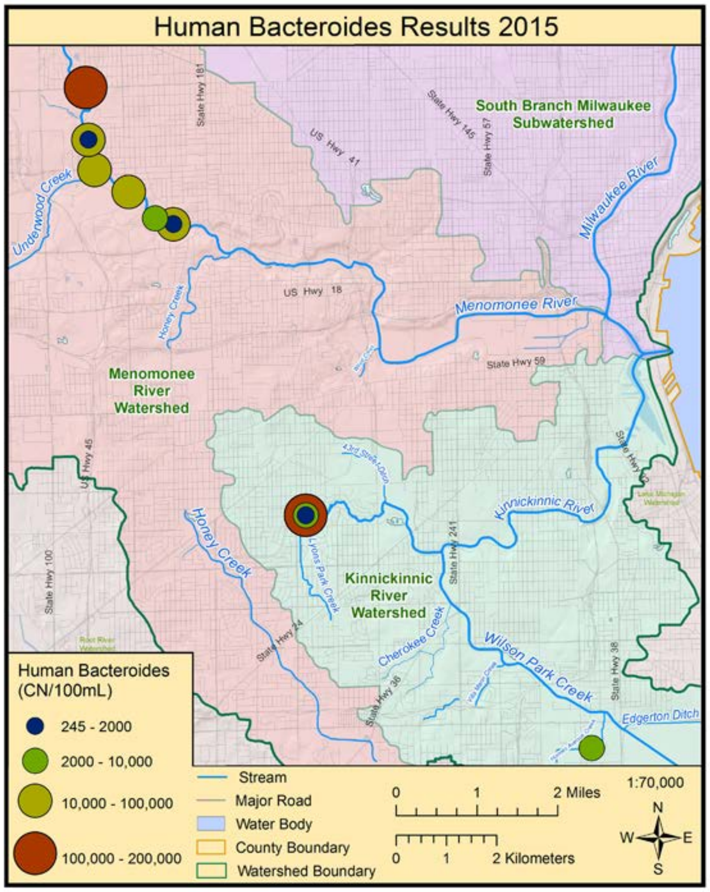


Figure 26

Sewage contamination in Great Lakes waterways: Can we find more efficient ways to locate and repair the sources?

Steve Corsi, Research Hydrologist, USGS

There are more than 1400 wastewater treatment facilities in the United States and Canada that discharge 4.8 billion gallons of treated effluent to the Great Lakes each day (Arvai et al. 2014). However, a large volume of sewage never makes it to wastewater treatment plants due to illicit discharges and leaking sewer infrastructure. Contaminants such as nutrients, pharmaceuticals, endocrine disruptors, toxic compounds, and pathogens that are found in sewage can have a substantial adverse effect on the aquatic ecosystem. These sources of untreated sewage are dispersed throughout urban areas and are very difficult to locate in an efficient manner with available methods. Currently, the most effective methods require sample collection and laboratory analysis that can be expensive and time consuming. As part of a Great Lakes Protection Fund project, a team of researchers with the U.S. Geological Survey and University of Wisconsin-Milwaukee are collaborating with sensor manufacturers in an effort to develop field sensors that can predict when contamination is present in water. To date, more than 400 samples have been collected from storm sewers, ditches, outfalls and streams and analyzed for bacteria that are specific to human waste as an indication of sewage contamination. These same samples have also been analyzed for optical properties of water (fluorescence and absorbance). Data analysis is currently ongoing to identify the optical properties that are predictive of sewage contamination (those samples that have high human-specific bacteria). The researchers will then work with sensor manufacturers to optimize field sensors for measurement of these optical signals. These types of sensors could then be used by watershed management practitioners such as the project participants at Milwaukee Metropolitan Sewerage District, the City of Milwaukee, and the Macomb County Michigan and Monroe County New York Health Departments to help in their water quality programs. If this sensor development effort is successful, it will provide these types of stakeholders an efficient means to trace sewage contamination signals to the source, allowing for rapid remediation to meet the ultimate objective: improved water quality in Great Lakes watersheds.

Volunteer Monitor Spotlight!

Jim Gennrich and Jim Engstrom

Jim and Jim are both exceptional volunteers who have been stream monitoring since 2007. While they initially began with three monitoring sites, they were interested enough that they added three more for a total of six sites on the Milwaukee River, Cedar Creek, and Mole Creek. Jim E. notes that stream monitoring is a great way to make a difference in your community and get away from the daily stresses of life. We heartily concur!

A love of fisheries led Jim G. to want to learn more about water quality in his local streams. Macroinvertebrate monitoring is a particular joy for him and he has fueled his passion by learning as much as he can and passing on that knowledge to kids through local environmental programs. Jim E. became interested in our program due to its scientific nature and connection with state-wide WDNR aquatic monitoring efforts. While neither of the Jims knew each other before participating in our program, they have proven to be an extremely effective team. A personal goal for them is to find the optimum strategy for deploying a thermistor. A thermistor is a small device which has to be left in-stream so it can continuously measure water temperature and is thus, at the mercy of the elements. Every year they evaluate the success of their current technique and make changes to ensure one is never lost, which we truly appreciate.

And what is the perfect way to top off a day of stream monitoring? According to Jim G., the best way is to celebrate and relax with either beer or custard! Thank you, Jim and Jim, for all your hard work!

Nancy Greifenhagen and Jeff Nettesheim

Nancy and Jeff have been faithful volunteer stream monitors since 2009. When they began, Milwaukee Riverkeeper did not have any volunteers sampling in the Village of Menomonee Falls. Since Nancy is an Environmental Coordinator for the Village and Jeff is the Director of Utilities, both are keenly interested in the water quality of their local streams. So they decided to take on the responsibility of monitoring two sites along the Menomonee River. Since 2011, they have also added phosphorus monitoring to their duties.

Nancy and Jeff both note that water quality monitoring helps the Village fulfill its Municipal Separate Storm Sewer System (MS4) permit for stormwater. Jeff also feels that personally verifying water quality results for the Menomonee River greatly aids in discussions with Village residents. In addition to being part of their work-related duties, stream monitoring provides them with a welcome chance to get out of the office. Jeff especially enjoys seeing the changing landscape and local wildlife. Nancy's interest in streams is one of the reasons why she chose natural resources as her profession. Getting out and experiencing nature firsthand also provides them with added motivation to work towards improving the quality of stormwater discharges, which make their way into local streams.

We are honored to recognize their dedication and service as volunteer stream monitors. Thank you Nancy and Jeff!

Quote to Ponder!

"Never doubt that a small group of committed people can change the world. Indeed, it is the only thing that ever has."

— Margaret Mead

Top 10 Ways You Can Help Protect and Improve Our Waters!

1. **Conserve water** both inside and outside your home. Reduce the use of water during heavy rain storms to lessen the stress on local sewers and protect our rivers and Lake Michigan from sewage overflows.
2. **Clean up after your pets.** Pet waste is a major source of bacteria in our rivers and streams.
3. **Reduce, minimize, or eliminate use of pesticides and road salt** on your lawn and paved surfaces.
4. **Do NOT flush unused pharmaceuticals, paint, or household chemicals down the drain.** Take them to a proper disposal center. Most wastewater treatment plants are not designed to remove drugs and other emerging contaminants from wastewater. These chemicals can end up in rivers where they can harm fish and other aquatic life.
5. **Vote GREEN** and advocate for fishable, swimmable, drinkable rivers and lakes. Contact elected officials and let them know that the health of the rivers and Lake Michigan is important to you. Join Our Network of Advocates!
6. **Stay up-to-date** on current issues affecting water quality and wildlife habitat. Sign up for Riverkeeper News at www.milwaukeeriverkeeper.org to get updates or connect with on social media!
7. **Get involved.** Join us for river cleanups and other community events to clean up and protect our rivers and the land that drains to them. Find these events at www.milwaukeeriverkeeper.org!
8. **Reduce runoff.** Install rain gardens, rain barrels, cisterns, and plant native vegetation to cutback the effect of the paved surfaces around your home. This will reduce stormwater runoff by catching and encouraging slow infiltration of rain and snow melt. Attend our rain barrel workshop in the spring!
9. **Become a monitor.** We train a new group of volunteers every spring. This is a great way to get involved and learn more about water quality and river health.
10. **Report Pollution.** Keep an eye on a section of river near you and report potential sources of pollution from construction sites or stormwater outfalls, eroding areas, and other problems to Milwaukee Riverkeeper at 414-287-0207 or to the WDNR at 1-800-TIP-WDNR.

LEARN MORE about the health of the Milwaukee River Basin and **DONATE** to support Milwaukee Riverkeeper in our work of restoring streams, identifying pollution, and fighting for strong policies and enforcement of laws to keep our water clean at **www.milwaukeeriverkeeper.org**.

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How We Grade Our Water Quality Parameters

Below are descriptions of water quality parameters used for the Report Card. Water quality data was assessed against targets and goals as described below to determine the health and condition of our waterways. Where there is a regulatory standard or Federal guidance for a parameter, that is generally listed as the goal. In some cases, we have created our own targets based on what we feel is the reasonable potential of our streams to support fish and recreational activities.

DISSOLVED OXYGEN

Dissolved oxygen (DO) is crucial for aquatic life. Many streams and stream segments in the urban portion of the Milwaukee River Basin have regulatory variances (per State of Wisconsin Administrative Code) allowing DO concentrations as low as 2 mg/L. This is suitable only for the most pollution tolerant fish species. These classifications have not been updated for decades. We believe all streams and stream segments in the Milwaukee River Basin are capable of at least reaching the **Warm Water Sport Fisheries (WWSF) DO standard of 5 mg/L** (most streams in the watershed are designated WWSF). This was the target we used to determine if waterways were meeting our DO goal, and could support a diverse ecosystem of fish and aquatic life. We did not assess variance streams to variance standards. While many streams in the Basin already meet or are capable of meeting cool or cold water standards for fish and aquatic life, we did not use cold water sport fishery standards.

WATER TEMPERATURE

Water temperature also greatly affects fish and aquatic life. Since the majority of streams and stream segments in the Milwaukee River Basin are classified as existing or attainable WWSF streams, water temperature should remain below the WWSF continuous water temperature **maximum standard of 31.7°C**. Both instantaneous water temperatures (measured monthly using meters) and continuous water temperatures (measured hourly by thermistors) were analyzed against this standard.

pH LEVEL

pH is a measure of acidity, or the amount of hydrogen (H^+) ions in water. pH ranges from 0 to 14 (0 being the most acidic, 14 being the most basic) with a value of 7 representing a “neutral” solution. Milwaukee River Basin streams generally run on the basic side of neutral, with values typically between 7 or 8 on the pH scale. It is generally accepted that a **pH range of 6-9** can support a healthy aquatic ecosystem.

TURBIDITY

Turbidity, or water clarity, affects both the light and energy inputs available to aquatic ecosystems. Our volunteers measure turbidity using transparency tubes. These are clear, plastic tubes that are filled and/or emptied of stream water until they reveal a black and white pattern on the bottom of the tube (similar to a lake secchi disc). A height of at least 54.7 cm of stream water in a 120 cm transparency tube indicates healthy water. A turbidity level of **<10 NTU** is ideal for aquatic life, and was used as the target for stream health. MMSD does not use transparency tubes but instead uses sensors to directly test the turbidity values of water in units of FNU (a similar turbidity unit to NTU). A turbidity level of **<10 FNU** was used as a target for MMSD data.

PHOSPHORUS

Phosphorus (measured as Total P) is an essential nutrient for plants, animals, and aquatic life. Phosphorus is typically low to absent in natural freshwater systems. Human activities have led to large inputs of phosphorus into our rivers and lakes. These activities include fertilization of lawns and fields, sewage treatment discharge, and the addition of phosphorus into our water supply as an anti-corrosion inhibitor for old, lead pipes. Excess phosphorus entering our waterways causes growth of nuisance algae as well as a cascade of water quality problems. A subset of Milwaukee Riverkeeper volunteers take monthly water samples that are shipped to the State Lab of Hygiene for total phosphorus analysis. These sample results are assessed against Wisconsin phosphorus standards, which are **0.075 mg/L for smaller streams and 0.1 mg/L for larger rivers and the Milwaukee Estuary.**

MACROINVERTEBRATES

To assess aquatic macroinvertebrates, Milwaukee Riverkeeper volunteers use a simple biotic index, developed by a group of Wisconsin scientists, that is specifically designed for streams in Wisconsin. Index score classifications range from Good-Fair-Poor. Our target for sites in the Milwaukee River Basin is a **“good” classification**. Because macroinvertebrates cannot readily migrate like fish, they provide a good overall indicator of the health of a certain stream segment and tend to be classified per tolerance to a range of oxygen conditions.

CHLORIDE

High chloride concentrations in rivers and streams are toxic to aquatic organisms. Road salt runoff constitutes a large source of chloride. Elevated levels of chloride can disrupt an organism's ability to maintain a natural internal water balance, which leads to impaired survival, growth, and/or reproduction. The Environmental Protection Agency (EPA) has set an **acute chloride standard at 860 mg/L and a chronic chloride standard of 230 mg/L** as targets for healthy streams. These levels recognize that high levels of chloride can be acutely or instantly toxic to fish, but that lower levels of chloride over a longer period of time or chronic exposure can be just as toxic. Chloride data was assessed against these targets to determine grades. Grades for acute and chronic criteria were averaged to determine an overall grade.

CONDUCTIVITY

Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by charged particles (ions), which can be both positive (cation) and negative (anion). Anions include chloride, nitrate, sulfate, and phosphate. Positive ions include sodium, magnesium, calcium, iron, and aluminum. Conductivity in streams is naturally affected by geology. Bedrock streams tend to have lower conductivity whereas streams passing through clay soils tend to have higher conductivity. Anthropogenic discharges to streams -- such as discharge of industrial waste (e.g., heavy metals), sewage, or other "charged" contaminants such as chloride, phosphate, and nitrate -- can raise conductivity. **A conductivity reading of 150 - 500 µS/cm** provides for a healthy aquatic ecosystem with mixed fisheries according to Federal guidance, and this threshold was used as the target for determining water quality grades for this parameter.

BACTERIA

High bacteria concentrations impact not only stream health, but also human health. Regulatory agencies such as MMSD and WDNR regularly test for fecal coliform and *E. coli* bacteria in surface waters. According to State of Wisconsin Recreational Use Standards, **fecal coliform levels should never exceed 200 CFU/100 mL (colony forming units/100 milliliter sample) in waterways, and the EPA established an *E. coli* standard of 235 CFU/100 mL for beaches**. The percentage of samples meeting these recreational health targets was used to determine water quality grades for bacteria. Waters were not assessed to variance standards.

HUMAN BACTEROIDES

Historically high levels of bacteria along stretches of the Menomonee and Kinnickinnic Rivers in Milwaukee and Wauwatosa led Milwaukee Riverkeeper (along with the University of Wisconsin - Milwaukee School of Freshwater Sciences) to investigate the possibility that failing sewer infrastructure was the culprit. Dr. Sandra McLellan's Lab at UWM has developed techniques to identify and quantify the presence and concentration of human bacteria in stormwater using a genetic test called qPCR, which can count DNA sequences in a sample that are associated with human sewage. We looked at the **percentage of samples that tested negative** for human strains of Bacteroides to determine our grade. For example, at least 90% of samples testing negative would be an A grade.

***NOTE:** It should be noted that DNR and Milwaukee Riverkeeper volunteer baseline data was only analyzed from May – November. Bacteria data, such as human Bacteroides, was collected from June through October, and chloride and conductivity data was collected during the winter "road salt season" or roughly December through March.*

MMSD, on the other hand, collects data year round. This heavily impacted our final chloride and conductivity grades. Also, MMSD confines their monitoring to sites in the Menomonee and Kinnickinnic River Watersheds, and the southern portion of the South Branch Milwaukee River Subwatershed. Hence, the grades in the southern half of the Basin were heavily skewed towards MMSD data and grades for the upper half of our Basin had comparatively fewer data points.

Targets And Goals

Dissolved Oxygen	≥ 5.0 mg/L
Water Temperature	< 31.7°C
Total Phosphorus	
Large Stream	< 0.1 mg/L
Small Stream	< 0.075 mg/L
pH	6 - 9
Turbidity	< 10 NTU < 10 FNU
Conductivity	150-500 µS/cm
Chloride	
Chloride (Acute)	< 860 mg/L
Chloride (Chronic)	< 230 mg/L
Bacteria	
Fecal coliform	< 200 CFU/100 mL
E. coli	< 235 CFU/100 mL
Macroinvertebrates	"Good"

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Our Mission

Our mission is to protect, improve and advocate for water quality, riparian wildlife habitat, and sound land management in the Milwaukee, Menomonee, and Kinnickinnic River Watersheds. We envision a future in which people from all walks of life can enjoy the healthy waterways of the Milwaukee River Basin.

Milwaukee Riverkeeper serves as a voice for the Milwaukee, Menomonee, and Kinnickinnic Rivers and works tirelessly for swimmable, fishable waters. Our core programming involves water quality monitoring and advocating on behalf of the rivers. We also coordinate hands-on river restoration projects and organize thousands of volunteers each year in river cleanups. We connect people to water through river-focused events and educate our community about water quality and river health.

Milwaukee Riverkeeper is a licensed member of the Waterkeeper Alliance, an international coalition dedicated to clean water and healthy communities.

Help us achieve swimmable, fishable rivers.
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