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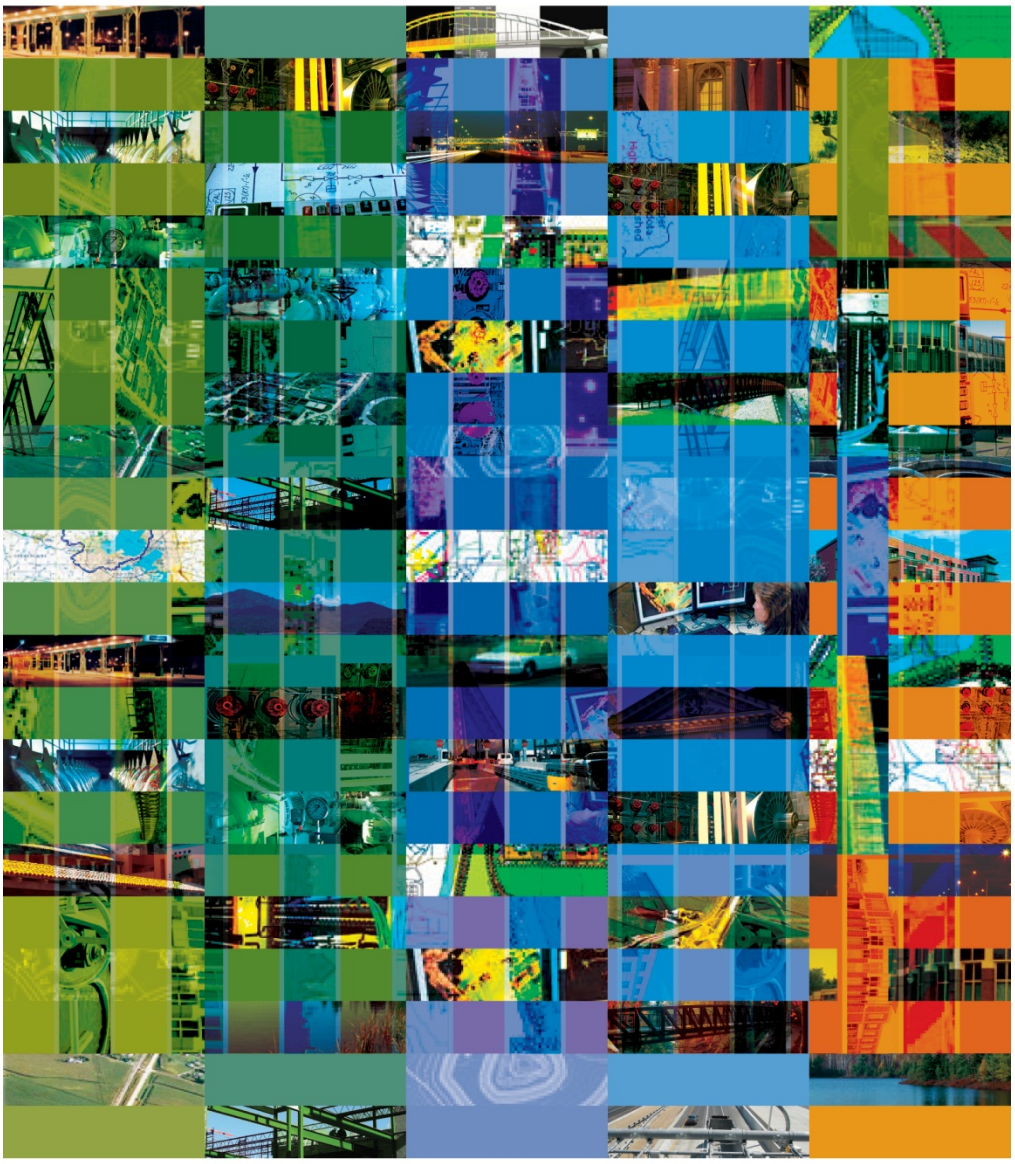
Kankakee River Nutrient Assessment Reduction Plan



Report

Kankakee River

Metropolitan Agency, IL

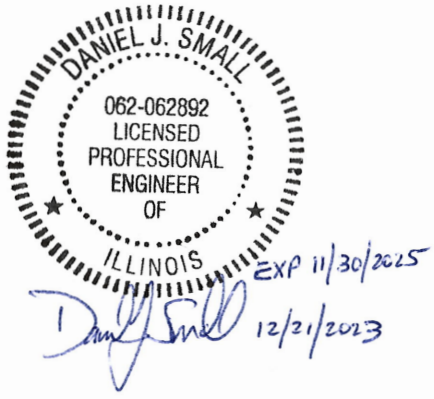
December 2023

STRAND ASSOCIATES®

Report for

Kankakee River Metropolitan Agency, Illinois

Kankakee River Nutrient Assessment Reduction Plan



Prepared by:

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December 2023

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APPENDICES

SECTION 1
INTRODUCTION

1.01 BACKGROUND

Kankakee River Metropolitan Agency (KRMA) owns and operates a 25-million-gallon-per-day (MGD) activated sludge wastewater treatment plant (WWTP) along the banks of the Kankakee River. The Kankakee River is listed as a General Use waterbody, according to the 2022 Integrated Report and Section 303d list (303d list). The WWTP serves the City of Kankakee and Villages of Aroma Park, Bourbonnais, and Bradley. This includes approximately 65,000 people, 30 significant industrial users, and approximately 700 commercial users. KRMA received its current National Pollutant Discharge Elimination System (NPDES) permit (Permit No. IL0021784) on February 19, 2020, with an effective date of March 1, 2020, excerpts of which can be found in Appendix A.

Special Condition 20 of the NPDES permit requires that KRMA develop a Nutrient Assessment Reduction Plan (NARP) to be submitted to the Illinois Environmental Protection Agency (IEPA) by December 31, 2023. The NARP requirement was developed as part of three-party negotiations between the IEPA, Environmental Advocacy Groups, and the Illinois Association of Wastewater Agencies in response to the Illinois Nutrient Loss Reduction Strategy.

Two scenarios could trigger the need to include the NARP language into an NPDES permit, as summarized in the following:

1. The facility discharges either into or upstream of a waterbody segment, which is listed in the 303d list as impaired for either dissolved oxygen (DO) or total phosphorus (TP).

2. The facility discharges either into or upstream of a waterbody segment that has been determined to be at a risk of eutrophication due to phosphorus levels in the waterbody.

IEPA does not currently have a numeric water quality standard for TP Instead, IEPA uses the “offensive Conditions” paragraph in Illinois Administrative Code (IL Admin Code) Title 35 Section 302.203 to identify 303d list impairments associated with TP.

KRMA’s effluent discharges to Segment F-12 of the Kankakee River. The segments of the Kankakee River downstream of F-12 include F-04, F-16, and F-01. None of these river segments are listed on the 2022 303d list as impaired because of DO or TP.

Therefore, it is the second scenario that triggered the NARP requirement in KRMA’s NPDES permit. A waterbody is considered at risk of eutrophication if it meets at least one of the three following criteria:

1. One water quality sample measuring a pH greater than 9.0 standard units (su) at a given sample site.

2. One water quality sample measuring a median sestonic chlorophyll-a value greater than 26 micrograms per liter (μg/L) at a given sample site.

3. Two consecutive days of sampling where the daily maximum pH is greater than 8.35 su and the daily maximum DO saturation is greater than 110 percent.

IEPA's risk of eutrophication assessment is meant to be a theoretical prediction of offensive conditions potentially developing in the future. The Kankakee River is not impaired for TP, though IEPA indicates there is a risk of eutrophication. Because there is no data before 2010, it is possible the Kankakee River has always had these water quality characteristics without any offensive conditions occuring.

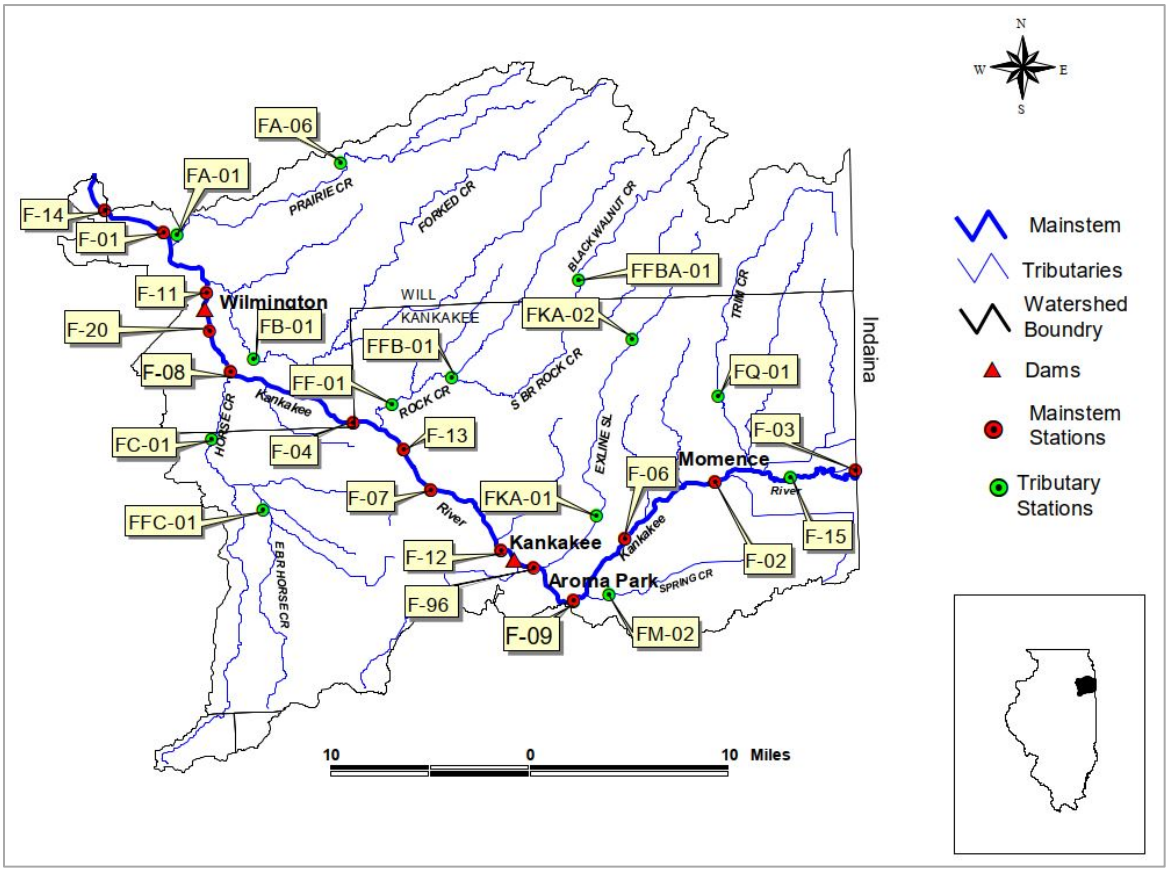
The IEPA collected water quality data between 2010 and 2020 at several sites along the Kankakee River, three of which were located downstream of KRMA's discharge. All three sites had water quality sampling data that met the third criteria, which triggered including the NARP language in KRMA's NPDES permit. A summary of the sampling data along the Kankakee River is enclosed (Appendix A).

The Illinois Department of Natural Resources (IDNR) document titled *Integrating Multiple Taxa in a Biological Stream Rating System* identifies the Kankakee River is given an integrity rating of "A" approximately 2.2 miles downstream of KRMA's discharge to the Kankakee River.

In addition, IDNR's *2015 Evaluation of Stream Quality and Sport Fisheries in the Kankakee River Basin* that was published in September 2017 and included in Appendix A stated the following:

> "The 2015 Kankakee River Basin survey is the fifth IDNR evaluation of fish communities in the watershed since 1994. Additional IDNR surveys on the Kankakee River mainstem date back to 1975, representing a 40-year record of fish collections. *Overall, the Kankakee River remains a high-quality system with relatively stable conditions over the sampling period. Although yearly variations have been noted, no major trends have been observed for species composition, or stream quality… Index of Biotic Integrity (IBI) scores ranged from 36 to 57 (60 maximum), with nine of the 13 historic mainstem stations scoring 50 points or more.*"

Appendix A contains additional information regarding KRMA's NARP requirements for the entire Kankakee River watershed. A detailed description of the Kankakee River watershed is included in Appendix B. Figure 1.01-1 shows a map of the NARP boundary along with the IDNR sampling locations. This NARP boundary covers the mainstem Kankakee River watershed within Illinois. The NARP boundary excludes the Iroquois River watershed, which contributes a significant amount of TP into the mainstem Kankakee River. This is discussed in more detail in Section 3.



Source: Evaluation of Stream Quality and Sport Fisheries in the Kankakee River Basin

Figure 1.01-1 NARP Boundary with IDNR Sampling Locations

1.02 NARP MINIMUM REQUIREMENTS

The intent of the NARP is to mitigate the risk of eutrophication, as assessed by the IEPA, in the Kankakee River. The NARP evaluates TP reduction in consideration of IEPA's recommended TP water quality objectives summarized in Table 1.02-1. Because TP is a limiting nutrient and focus for IEPA's risk of eutrophication, total nitrogen water quality objectives are not relevant at this time.

The Nutrient Science Advisory Committee (NSAC) was formed to assist with development of the Illinois Nutrient Loss Reduction Strategy. NSAC developed a TP water quality objective for the overall northern Illinois ecoregion using available surface water quality data provided by IEPA from 1999 through 2014. The ecoregions accounted for variability in geology, topography, soils, vegetation, and climate. The NSAC guidance does not account for the specific geology, topography, soils, vegetation, and climate that are variable and unique across the Kankakee River watershed. It is important to note the numeric criteria developed by NSAC are for guidance only and are not currently codified by IEPA in the IL Admin Code.

KRMA can choose to use to develop its own target or choose to use the NSAC guidance. Because there are segments of the Kankakee River that do not meet IEPA's criteria for risk of eutrophication, there are no segments of the Kankakee River that have offensive conditions, and the Kankakee River has good IBI scores, higher TP water quality objectives are likely justified for the Kankakee River and its' tributaries.

Compliance Point	Water Quality Objective	Statistic Code or Statute
Rivers and streams	Free from sludge or bottom deposits, floating debris, visible oil, odor, plant or algal growth, color, or turbidity of other than natural origin	35 IL Admin Code 302.203
Rivers and streams	0.1 ppm target level geometric mean during growing season (May 1 to October 31)	IEPA guidance based on recommended criteria (NSAC, 2018)

ppm=parts per million

Table 1.02-1 TP Water Quality Objectives in Illinois Surface Waters

The recommended content for the NARP follows IEPA's requirements included in KRMA's NPDES permit, as summarized in Table 1.02-2. Table 1.02-2 lists the sections of this report that each NARP element is discussed.

NARP Section	Elements	Methods	End Products
2	Stakeholder engagement.	Public informational meeting(s).	List of stakeholders
3	Identify causes and sources of pollution.	Water quality objectives.	Mass balance inputs
4	Estimate load reductions expected.	Existing data and alternatives evaluation based on load reduction and ease of implementation of identified alternatives. Include review of potential projects.	Potential project list
4	Describe management measures and targeted areas.	Identify critical areas and plan for each area or overall plan.	Capital improvement plan and associated Best Management Practices
4	Develop a project schedule.	Projects are scheduled based on impact, ease of implementation, and funding opportunities.	Implementation schedule

Table 1.02-2 NARP Elements

1.03 REFERENCES

Illinois Nutrient Loss Reduction Strategy Implementation: https://www2.illinois.gov/epa/topics/water-quality/watershed-management/excess-nutrients/Pages/nutrient-loss-reduction-strategy.aspx

1.04 ABBREVIATIONS AND DEFINITIONS

303d list	2018 Integrated Report and Section 303d list
BNR	biological nutrient removal
DO	dissolved oxygen
IBI	Index of Biotic Integrity
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
IL Admin Code	Illinois Administrative Code
lb/yr	pounds per year
KRMA	Kankakee River Metropolitan Agency
MGD	million gallons per day
mg/L	milligrams per liter
mi^2	square miles
NARP	Nutrient Assessment Reduction Plan
NPDES	National Pollutant Discharge Elimination System
NSAC	Nutrient Science Advisory Committee
ppm	parts per million
su	standard unit
SWCD	Soil and Water Conservation District
TP	total phosphorus
μg/L	micrograms per liter
USGS	United States Geological Survey
WWTP	wastewater treatment plant

SECTION 2
STAKEHOLDERS AND PUBLIC ENGAGEMENT

2.01 STAKEHOLDER IDENTIFICATION AND PUBLIC OUTREACH

No watershed group currently exists for the Kankakee River watershed in the State of Illinois. All sources of TP contributing to the Kankakee River must be considered to increase the chances of success for this NARP, including other WWTPs and runoff from agricultural, urban, and natural sources. These multiple jurisdictions are a key consideration to identify stakeholders in the watershed.

KRMA prepared an informational NARP flyer (Appendix B) for a public meeting on May 5, 2022, that was issued for public notice in the local newspaper (Appendix C) and sent directly to the following entities:

1. KRMA Board of Directors, which includes the Mayors of the Villages of Aroma Park, Bourbonnais, and Bradley; and the City of Kankakee.
2. WWTPs
    a. Aqua Illinois
    b. Village of Grant Park
    c. Village of Manteno
    d. City of Momence
    e. Village of Peotone
    f. Village of Beecher
    g. City of Wilmington
    h. Village of Essex
    i. Village of Herscher
    j. Village of Sun River Terrace
3. Will County Soil and Water Conservation District (SWCD)
4. Kankakee County SWCD
5. Illinois Farm Bureau–Kankakee and Will Counties
6. Kankakee River State Park
7. Friends of the Kankakee–Member of National Wildlife Refuge Association
8. Kankakee County
9. Kankakee River Basin Commission
10. Kankakee Riverfront Society
11. IEPA
12. Sierra Club
13. Prairie Rivers Network

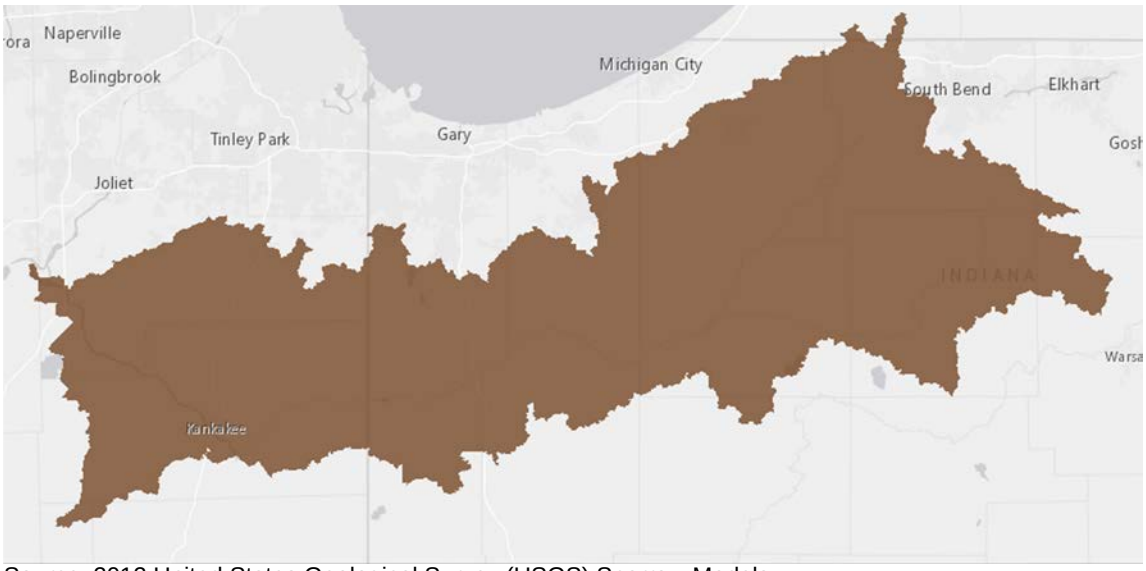
The presentation for the May 5, 2022, informational meeting is included in Appendix D. The informational meeting register is included in Appendix E. KRMA has no intention of leading the development of a new watershed group for the purposes of this NARP but is willing to be an ombudsman and active participant should a watershed group be formed by others.

During NARP development, KRMA conducted periodic informational meetings to support, coordinate, and assist in prioritizing watershed-wide TP reduction projects identified by other stakeholders. The meeting registers for the October 28, 2022, and June 14, 2023, meetings are included in Appendix E. KRMA also participated and gave a presentation on NARP development at the Kankakee River Watershed Conference at Kankakee Community College on March 10, 2023, which included more than 100 attendees from a wide variety of backgrounds.

SECTION 3
SOURCE IDENTIFICATION

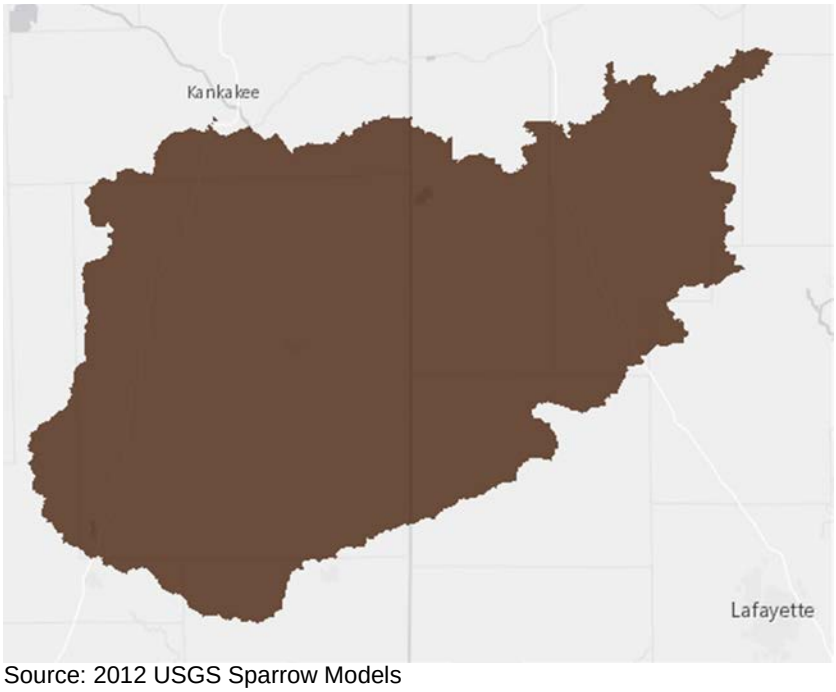
3.01 SOURCE IDENTIFICATION

The Kankakee River watershed includes the mainstem Kankakee River (see Figure 3.01-1) and the Iroquois River watershed (see Figure 3.01-2) that discharges to the Kankakee River near the Village of Aroma Park, Illinois.



Source: 2012 United States Geological Survey (USGS) Sparrow Models

Figure 3.01-1 Mainstem Kankakee River Watershed



Source: 2012 USGS Sparrow Models

Figure 3.01-2 Iroquois River Watershed

The 2012 USGS Sparrow Models for the Midwest contains the most recent known identification of TP loads throughout the Kankakee River watershed. Data was provided for individual catchment areas within each subwatershed and divided into five major categories that are summarized in Table 3.01-1.

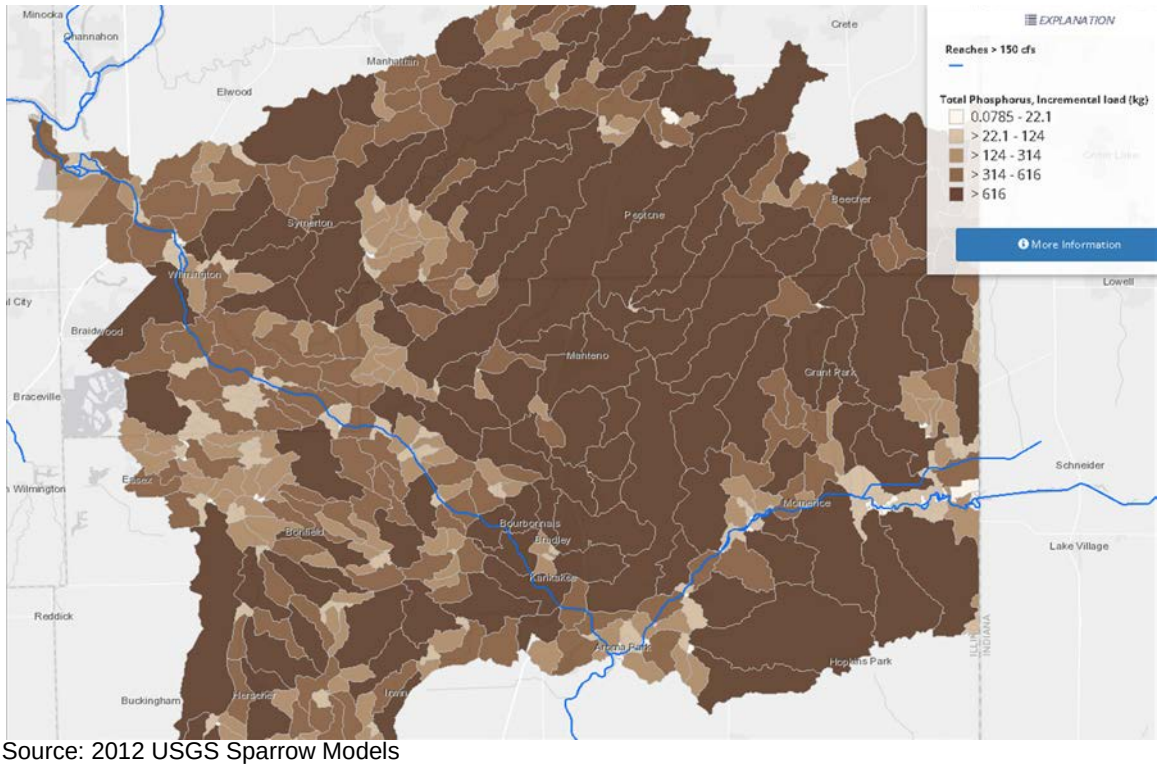
		Annual TP Load (lb/yr)						
Subwatershed	**Area (mi^2)**	**WWTPs**	**Farm**	**Manure**	**Natural Sources**	**Urban**	**Total**	**% of Total**
Mainstem in the State of Illinois (KRMA NARP Area)	872	135,296	343,385	10,246	151,473	46,951	687,351	19
Mainstem in the State of Indiana	2,138	58,310	645,422	95,093	230,008	67,963	1,096,795	31
Iroquois in the State of Illinois	1,294	34,661	769,535	58,965	174,347	42,380	1,079,887	30
Iroquois in the State of Indiana	849	1,416	527,486	63,284	107,447	24,493	724,127	20
Total	**5,154**	**229,683**	**2,285,828**	**227,588**	**663,275**	**181,787**	**3,588,160**	
% of Total		**6**	**64**	**6**	**19**	**5**		

lb/yr=pounds per year
mi^2=square miles

Table 3.01-1 Summary of TP Loads in Kankakee River Watershed

As identified in Figures 3.01-1 and 3.01-2, and Table 3.01-1, over one-half of the watershed area and annual TP load originates in Indiana. Without action in Indiana, very little change in conditions can be expected in Illinois. In addition, approximately 94 percent of the total annual TP loads to the Kankakee River comes from nonpoint sources that are not regulated or enforced by IEPA. Accordingly, reducing loads from KRMA and other WWTPs is not expected to have a significant impact on the risk of eutrophication.

Figure 3.01-3 shows the incremental TP loads from each catchment within the NARP area.



Source: 2012 USGS Sparrow Models

Figure 3.01-3 Incremental TP Loads Within the NARP Area

3.02 SAMPLING PLAN

KRMA prepared a sampling plan (Appendix F) to:

1. Supplement the limited existing data to better understand how often the conditions that suggest a risk of eutrophication are present.

2. Assess the impact of KRMA's discharge to Kankakee River water quality.

KRMA's sampling plan was submitted to IEPA and the Sierra Club for review on January 10, 2022, and presented at the May 5, 2022, informational meeting. There were no comments. KRMA has encouraged other stakeholders to conduct similar grab and continuous sampling throughout the watershed.

The City of Wilmington (which is downstream of KRMA's sampling location at Warner Road bridge) has performed additional sampling that will be submitted to IEPA as part of the City of Wilmington's NARP (see Appendix K). Like KRMA's data summarized in the following, the City of Wilmington's data also shows TP concentrations are already at or below NSAC's recommended target water quality objective of 0.1 milligrams per liter (mg/L). The City of Wilmington's data did not identify a risk of eutrophication downstream of the Warner Road bridge.

A. KRMA Grab Sampling Results

Data from the grab sampling is shown in Appendix G and summarized in Table 3.02-1. There were no consistent trends that indicate KRMA has a significant impact on the TP concentration in the Kankakee River. The average TP concentration at all locations were already at or below NSAC's recommended target water quality objective of 0.1 mg/L. The highest TP concentrations were observed at the Station Street bridge upstream of KRMA.

	TP at Station Street Bridge (mg/L)	TP–KRMA Upstream (mg/L)	TP–KRMA Downstream (mg/L)	TP at Warner Bridge (mg/L)
Minimum	0.039	0.008	0.041	0.019
Geometric Mean	0.088	0.077	0.094	0.078
Maximum	0.701	0.466	0.453	0.619

Table 3.02-1 KRMA Grab Sampling Summary

B. KRMA Continuous Monitoring Results

Data from the continuous monitoring is shown in Appendices H and I. Summary charts for the 2022 data are provided in Appendix J. Both sondes were damaged on June 9, 2023. The sonde at the Station Street bridge was not able to be reinstalled, and the sonde at Warner Road bridge was reinstalled September 19, 2023.

The data for the Station Street bridge upstream of KRMA identified a risk of eutrophication on August 11, 2022, based on sestonic chlorophyll-a concentration greater than 26 μg/L and also on August 18 to 19, 2022, based on two consecutive days with pH greater than 8.35 and DO saturation greater than 110 percent.

The data for the Warner Road bridge downstream of KRMA identified a risk of eutrophication on 43 days based on sestonic chlorophyll-a concentration greater than 26 μg/L and also on 53 events based on two consecutive days with pH greater than 8.35 and DO saturation greater than 110 percent.

The summary charts in Appendix J indicate different physical characteristics of the Kankakee River at both monitoring locations. This is evident from the significantly larger daily variations in temperature at Warner Road bridge, possibly because of shallower depth. The risk of eutrophication upstream of KRMA at the Station Street bridge could be exacerbated by potential different physical characteristics of the Kankakee River downstream of KRMA independent of the TP concentration in the Kankakee River. Additional research is needed to better understand this phenomenon.

SECTION 4
PROJECTS

4.01 PROJECTS COMPLETED

KRMA's NPDES permit does not include TP effluent limitations, though KRMA has voluntarily implemented biological nutrient removal (BNR) as part of a $65 million upgrade to its facility completed in 2017. Because the BNR process became operational in 2017, KRMA's effluent TP has consistently been less than 0.5 mg/L, which is a technology-based limit that is expected to be in KRMA's NPDES permit by 2035. From July 2017 through November 2023, KRMA's annual average effluent TP concentration was 0.44 mg/L, and TP loading was 18,000 lb/yr. The BNR process became operational after the 2012 USGS Sparrow Model information (summarized in Section 3) estimated KRMA's annual effluent TP load to be 86,800 lb/year. This represents a 79 percent reduction (68,800 lb/year reduction) in KRMA's annual effluent TP load at a cost of approximately $923 per pound of TP removed per year. An additional TP load reduction of approximately 30,500 lb TP per year could be possible if KRMA were to reduce its effluent TP concentration from 0.5 to 0.1 mg/L. However, this would require effluent pumping, filtration, and additional chemical dosage, which would not be cost-effective or affordable at more than $1,600 per pound TP removed per year and would provide little benefit to the overall TP load reduction to the Kankakee River. In addition, KRMA's sampling data presented in Section 3 identifies that, even if KRMA were to eliminate all TP in its discharge, there would be no significant change in Kankakee River TP concentration and no significant impact on the risk of eutrophication. Upstream TP loads must be addressed first to have an impact.

The Kankakee County SWCD is very active and effective. SWCD conducted several outreach and education programs over the last 2 years (Appendix L), which focus on farming practices that reduce sediment and nutrient loads to the Kankakee River. SWCD plans to continue these important efforts, which are possible from funding from the State of Illinois, the Partners for Conservation program (More 4 Ag), and the National Wildlife Federation.

Kankakee County has created a Waterways Division and has successfully used state and federal funding to implement watershed projects that reduce sediment and nutrient loads to the Kankakee River. Projects includes sediment removal from boat launches, bank stabilization, log jam removal, and strategic maintenance as part of a long-term 40-year work plan. Kankakee County is also collaborating with the Kankakee River Basin and Yellow River Basin Development Commission in Indiana to share information and potential funding opportunities.

4.02 PROJECT IDENTIFICATION AND ASSESSMENT

Potential stakeholders in the NARP area were encouraged to prepare an inventory of possible projects to achieve additional TP source reductions. Proposed projects are listed in order of priority based on relevance to identified significant sources, ability to receive funding, best cost-benefit ratio (cost per pound of TP removed per year), annual TP load reduction, ease of implementation, and other metrics deemed relevant by stakeholders. Projects that are easily implemented may provide early progress and momentum for continued progress.

SWCD estimates that 20 out of approximately 500 farm fields in Kankakee County are performing conservation practices (such as cover crops, strip till, or not till). SCWD's goal is for the ongoing outreach programs to increase the number of fields performing conservation practices. SWCD estimates that till, strip till, and cover crop practices can result in annual phosphorus load reductions

of 57, 43, and 15 pounds, respectively, for every 18 acres. With more than 300,000 acres of farms in Kankakee County, this could reduce TP loads to the Kankakee River by 240,000 pounds per year or more. The cost to implement is unique to each farm property but is expected to be more cost-effective for significant TP load reductions than additional TP removal at KRMA's WWTP.

Kankakee County's Waterways Division plans to continue implementing projects for sediment removal from boat launches, bank stabilization, log jam removal, and other strategic maintenance, based depending on funding levels.

Table 3.01-1 identifies that other WWTPs in Illinois contribute approximately 83,200 pounds TP per year to the Kankakee River. If TP removal was implemented with similar performance as KRMA's TP removal project, TP loads from other WWTPs in Kankakee and Iroquois Counties could be reduced by approximately 79 percent, or 65,700 pounds TP per year.

The City of Wilmington is completing planning efforts and intends to implement TP removal to meet an effluent TP limit of 0.5 mg/L by 2035.

4.03 CONTINUOUS MONITORING

KRMA will continue to offer guidance and resources to encourage other stakeholders to conduct sampling and monitoring at other locations. Ongoing sampling will identify progress made with future projects by other potential stakeholders to help address IEPA's determination that the Kankakee River is at risk of eutrophication.

4.04 IMPLEMENTATION SCHEDULE

KRMA will continue to be a resource for information for other watershed stakeholders and will perform continuous monitoring for the life of the current sonde sampling equipment, which are expected to last approximately 2 more years.

SWCD's outreach efforts and Kankakee County's implementation projects are ongoing with no specific implementation schedule.

Other WWTPs should implement TP removal by 2030 or 2035, though this depends on IEPA including NPDES permit special conditions and effluent limits in future NPDES permits.

Additional research is merited to identify the cause for risk of eutrophication near Warner Road bridge that could be related to unique physical characteristics of the Kankakee River in this area. This research would require funding from outside sources, otherwise the costs would need to be equitably shared by all entities contributing TP loads to the Kankakee River.

SECTION 5
CONCLUSIONS

5.01 CONCLUSIONS

Conclusions from KRMA's NARP plan are summarized as follows:

1. KRMA has informed and engaged potential stakeholders in the Kankakee River watershed. However, KRMA does not have the staff or financial resources to start a Kankakee River Watershed group. If a group were to be formed, KRMA will be an active participant to further explore opportunities to improve water quality in the Kankakee River.

2. KRMA will continue collecting water quality data for the useful life of its continuous monitoring sondes. The data will be made available to interested stakeholders. If a watershed group is formed by others, the data will be made available for the group's use.

3. If the NSAC recommendations were to be implemented for the Kankakee River watershed, KRMA's sampling data suggests the Kankakee River would already be in compliance. Additional watershed research and data needs to be collected to identify a watershed specific TP water quality objective for the Kankakee River.

4. KRMA's sampling data confirms there is a risk of eutrophication in the Kankakee River upstream and downstream of KRMA. However, the geometric mean of TP data downstream of KRMA is less than the NSAC recommendations. This, combined with the results of the IDNR fish surveys, suggests that the risk of eutrophication could be a result of something other than TP, including physical characteristics of the river. Either way, TP does not appear to be negatively impacting the aquatic life or overall biointegrity in the Kankakee River. Additional research and data collection is required to better understand what is causing the risk of eutrophication.

5. KRMA has voluntarily reduced its TP load to the river by 79 percent, from 86,800 pounds TP per year to 18,000 pounds TP per year at a cost of $923 per pound. The cost to further reduce KRMA's TP load would be more than $100,000 per pound TP per year and would have a negligible impact to the overall TP load to the Kankakee River. KRMA has identified several more cost-effective opportunities to generate larger TP load reductions to the Kankakee River, which should be implemented before KRMA invests additional capital to further reduce its TP loading to the Kankakee River.

6. A 0.5 mg/L annual average TP limit by 2030 or 2035 for all major WWTP dischargers to the Kankakee and Iroquois Rivers should be considered by IEPA to continue maintaining in stream TP concentrations at or below current levels. This could result in a further reduction of 65,700 pounds TP per year.

APPENDIX A
KRMA IEPA LETTER

Strand Associates, Inc.®
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October 1, 2021

Mr. Brant Fleming, P.E.
Permit Section Manager
Division of Water Pollution Control
Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, IL 62974-9276

Re: Request to Remove the Requirement for the Nutrient Assessment Reduction Plan (NARP)
Kankakee River Metropolitan Agency, Illinois (KRMA)

Dear Mr. Fleming:

KRMA owns and operates a 25 million gallon per day activated sludge wastewater treatment plant (WWTP) along the banks of the Kankakee River. The Kankakee River is listed as a General Use waterbody according to the 2018 Integrated Report and Section 303d list (303d list). The WWTP serves the City of Kankakee and Villages of Aroma Park, Bourbonnais, and Bradley. This includes approximately 65,000 people, 30 significant industrial users, and approximately 700 commercial users. KRMA received its updated National Pollutant Discharge Elimination System (NPDES) permit (Permit No. IL0021784) on February 19, 2020, with an effective date of March 1, 2020, excerpts of which can be found enclosed with this letter (Enclosure 1). KRMA has hired Strand Associates, Inc.® (Strand) to write this letter on its behalf.

Special Condition 20 requires KRMA to develop a NARP to be submitted to the Illinois Environmental Protection Agency (IEPA) by December 31, 2023. The NARP requirement was developed as part of three-party negotiations between the IEPA, Environmental Advocacy Groups, and the Illinois Association of Wastewater Agencies.

It is Strand's understanding there are two scenarios that could trigger the need to include the NARP language into an NPDES permit as summarized in the following:

1. The facility discharges either into or upstream of a waterbody segment, which is listed in the 303d list as impaired for either dissolved oxygen (DO) or total phosphorus (TP).

2. The facility discharges either into or upstream of a waterbody segment that has been determined to be at a risk of eutrophication due to phosphorus levels in the waterbody.

KRMA's effluent discharges to Segment F-12 of the Kankakee River. The segments of the Kankakee River downstream of F-12 include F-04, F-16, and F-01. All four of these river segments are listed on the 2018 303d list as impaired for mercury and polychlorinated biphenyls because of not supporting the fish consumption designated use, but are not listed as impaired because of DO or TP.

Therefore, it is the second scenario that triggered the NARP requirement in KRMA's NPDES permit. A waterbody is considered at risk of eutrophication if it meets at least one of the three following criteria:

1. One water quality sample measuring a pH greater than 9.0 standard units (su) at a given sample site.

2. One water quality sample measuring a median sestonic chlorophyll-a value greater than 26 micrograms per liter at a given sample site.

3. Two consecutive days of sampling where the daily maximum pH is greater than 8.35 su and the daily maximum DO saturation is greater than 110 percent.

The IEPA collected water quality data between 2010 and 2015 at several sites along the Kankakee River, three of which were located downstream of KRMA's discharge. All three sites had water quality sampling data that met the third criteria, which triggered including the NARP language in KRMA's NPDES permit. A summary of the sampling data along the Kankakee River is enclosed (Enclosure 2).

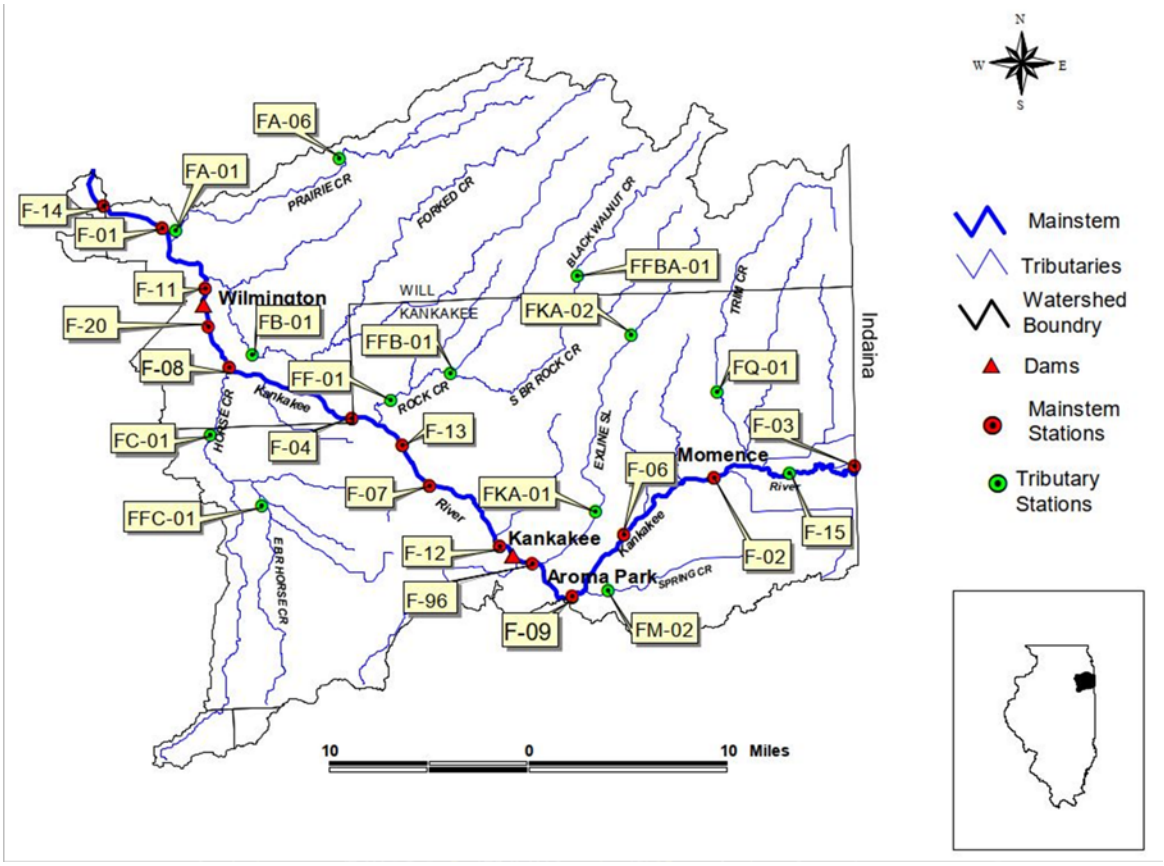
While KRMA acknowledges the criteria for triggering the NARP requirement was met based upon the data collected by the IEPA, Strand's position is KRMA should not have to develop a NARP and KRMA's NPDES permit should be modified to remove the NARP requirements for the following reasons:

1. Even though KRMA's permit did not include TP effluent limitations, KRMA voluntarily implemented biological phosphorus removal (BPR) as part of a $65 million upgrade to its facility between 2013 and 2017. Since the BPR process has become operational in 2017, KRMA's effluent TP has consistently been less than 1.0 milligrams per liter (mg/L). From July 2017 through June 2020, KRMA's average effluent TP concentration was 0.49 mg/L. Furthermore, the BPR process became operational after the IEPA's water quality sampling program, which triggered the need for the NARP requirement in its permit. This is noteworthy for a few reasons. Firstly, water quality in the Kankakee River most likely has improved since KRMA's BPR process became operational and thus a NARP may no longer be appropriate. Secondly, KRMA has already implemented improvements that would mostly likely be recommended if a NARP were to be developed.

2. The purpose of a NARP is to help a waterbody meet water quality standards including its designated uses. While there may, at least according to the IEPA's above-listed criteria, have been a risk of eutrophication in the Kankakee River downstream of KRMA's outfall, it does not appear that it has impacted water quality associated with TP and DO within the Kankakee River to the point that designated uses cannot be met. This is demonstrated in the *2015 Evaluation of Stream Quality and Sport Fisheries in the Kankakee River Basin* that was published in September 2017 by the Illinois Department of Natural Resources (IDNR), which can be found enclosed with this letter (Enclosure 3). The following is an excerpt from the report:

   "The 2015 Kankakee River Basin survey is the fifth IDNR evaluation of fish communities in the watershed since 1994. Additional IDNR surveys on the Kankakee River mainstem date back to 1975, representing a 40-year record of fish collections. **Overall, the Kankakee River remains a high-quality system with relatively stable conditions over the sampling period. Although yearly variations have been noted, no major trends have been observed for species composition, or stream quality… Index of Biotic Integrity (IBI) scores ranged from 36 to 57 (60 maximum), with nine of the 13 historic mainstem stations scoring 50 points or more.**"

The IBI is a scoring system used to measure the health of aquatic species (in this case fish) of a waterbody and thus indirectly measures the cumulative effect of pollution. The IEPA uses a fish IBI threshold of 40 to determine whether a waterbody segment fully supports the designated use for fish. The following map (Figure 1) shows the various sampling locations used to develop the IDNR report.



Source: Evaluation of Stream Quality and Sport Fisheries in the Kankakee River Basin

Figure 1 IDNR Sampling Locations

KRMA's discharge is located between Stations F-12 and F-07. Table 1 summarizes the fish IBI scores for each sampling location along the Kankakee River.

Table 7. Index of Biotic Integrity scores for Kankakee River Basin mainstem stations 1994 - 2015. One-way ANOVA indicated no significant difference among years.

Station location	Code	1994	2000	2005	2010	2015
State Line	F-03	42	52	48	42	57
River Isle	F-15	44	56	48	43	42
Momence	F-02	52	48	49	54	55
DS Rt. 17	F-06	48	50	57	51	55
Aroma Park	F-09	54	54	57	50	52
Kankakee	F-12	52	48	57	45	48
Davis Creek	F-07	40	52	56	44	56
Langham Island	F-13	46	50	54	56	48
Werner Bridge	F-04	50	52	58	43	53
Rivals Club	F-08	50	50	55	52	50
Wilmington	F-11	42	50	59	47	56
I-55 Bridge	F-01	42	48	59	53	56
Confluence	F-14	40	42	41	37	36
	mean	46.3	50.1	53.7	47.46	51.08
	STDEV	4.76	3.28	5.28	5.43	6.03

Source: Evaluation of Stream Quality and Sport Fisheries in the Kankakee River Basin

Table 1 Kankakee River Fish IBI Scores

The table demonstrates the fish IBI scores downstream of KRMA's effluent have been consistently greater than the IEPA threshold of 41. In fact, the sampling location closest to KRMA's discharge (F-07) had the highest IBI score except for the sampling location at the Illinois-Indiana state line. The only location with an IBI less than the IEPA threshold of 41 is location F-14, which is the confluence of the Kankakee River and the Des Plaines River. The report suggests the drop in IBI at this location is habitat-related based upon the impact of the Dresden Dam.

Finally, the report reflects water quality before the completion and implementation of KRMA's BPR process. It can safely be assumed water quality in the Kankakee River has improved since this report was published as a result of KRMA's upgrades.

In summary, while the sampling data collected by the IEPA suggests there may have been a risk of eutrophication in the Kankakee River requiring KRMA to develop a NARP as part of its latest NPDES permit, Strand believes the permit requirement should be removed for the following reasons:

1. The sampling data triggering the NARP requirement does not reflect current conditions (KRMA's voluntary implementation of BPR).

2. Any risk of eutrophication that may exist appears to not be impacting water quality in the Kankakee River downstream of KRMA's effluent discharge based on the fish IBI scores published by the IDNR.

3. KRMA does not have jurisdictional authority over nonpoint sources or any other point-source discharges to the very large Kankakee River watershed. KRMA has already made a significant investment in BPR, which has demonstrated the ability to meet the anticipated future 0.5 mg/L effluent TP limit. KRMA will continue to identify options that are not cost-prohibitive to further reduce effluent TP, though KRMA does not have the resources or capability to implement a NARP for the entire Kankakee River watershed.

Strand would welcome a meeting, either in person or virtual, to discuss the contents of this letter.

Please call with any questions and comments at 815-744-4200 or via e-mail at daniel.small@strand.com.

Sincerely,

STRAND ASSOCIATES, INC.®

Daniel J. Small, P.E., BCEE

Michael G. Ott, P.E.

Enclosures

c/enc.: Dave Tyson, Executive Director, Kankakee River Metropolitan Agency
Art Strother, Superintendent, Kankakee River Metropolitan Agency
Dustin Scheppler, Assistant Superintendent, Kankakee River Metropolitan Agency
Melanie Gossett, Assistant Superintendent, Kankakee River Metropolitan Agency

NPDES Permit No. IL0021784

Illinois Environmental Protection Agency

Division of Water Pollution Control

1021 North Grand Avenue East

Post Office Box 19276

Springfield, Illinois 62794-9276

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Reissued (NPDES) Permit

Expiration Date: February 28, 2025

Issue Date: February 19, 2020
Effective Date: March 1, 2020

Name and Address of Permittee:

Kankakee River Metropolitan Agency
1600 West Brookmont Blvd.
Kankakee, Illinois 60901

Facility Name and Address:

Kankakee River Metropolitan Agency STP
1600 West Brookmont Blvd.
Kankakee, Illinois 60901
(Kankakee County)

Receiving Waters: Kankakee River

In compliance with the provisions of the Illinois Environmental Protection Act, Title 35 of the Ill. Adm. Code, Subtitle C, Chapter I, and the Clean Water Act (CWA), the above-named Permittee is hereby authorized to discharge at the above location to the above-named receiving stream in accordance with the Effluent Limitations, Monitoring, and Reporting requirements; Special Conditions and Attachment H Standard Conditions attached herein.

Permittee is not authorized to discharge after the above expiration date. In order to receive authorization to discharge beyond the expiration date, the Permittee shall submit the proper application as required by the Illinois Environmental Protection Agency (IEPA) not later than 180 days prior to the expiration date.

Amy L. Dragovich

Amy Dragovich, P.E.
Manager, Permit Section
Division of Water Pollution Control

ALD:JAR:18082801

NPDES Permit No. IL0021784

Effluent Limitations, Monitoring, and Reporting

FINAL

Discharge Number(s) and Name(s): 001 STP Outfall

Load limits computed based on a design average flow (DAF) of 25.0 MGD (design maximum flow (DMF) of 45.0 MGD).

From the effective date of this Permit until the expiration date, the effluent of the above discharge(s) shall be monitored and limited at all times as follows:

	LOAD LIMITS lbs/day DAF (DMF)*			CONCENTRATION LIMITS mg/L				
Parameter	Monthly Average	Weekly Average	Daily Maximum	Monthly Average	Weekly Average	Daily Maximum	Sample Frequency	Sample Type
Flow (MGD)							Continuous	
$CBOD_5$**' ****	4,170 (7,506)	8,340 (15,012)		20	40		3 Days/Week	Composite
Suspended Solids****	5,213 (9,383)	9,383 (16,889)		25	45		3 Days/Week	Composite
pH	Shall be in the range of 6 to 9 Standard Units						5 Days/Week	Grab
Fecal Coliform***	Daily Maximum shall not exceed 400 per 100 mL (May through October)						5 Days/Week	Grab
Chlorine Residual***						0.05	3 Days/Week	Grab
Ammonia Nitrogen: (as N)								
March-May/Sept.-Oct.			1647 (2965)			7.9	5 Days/Week	Composite
June-August			1731 (3115)			8.3	5 Days/Week	Composite
Nov.-Feb.			1564 (2815)			7.5	5 Days/Week	Composite
Total Phosphorus (as P)	Monitor Only						5 Days/Week	Composite
Total Nitrogen (as N)	Monitor Only						1 Day/Month	Composite
				Monthly Average not less than	Weekly Average not less than	Daily Minimum		
Dissolved Oxygen								
March-July					6.25	5.0	2 Days/Week	Grab
August-February				6.0	4.5	4.0	2 Days/Week	Grab

*Load limits based on design maximum flow shall apply only when flow exceeds design average flow.
**Carbonaceous BOD_5 ($CBOD_5$) testing shall be in accordance with 40 CFR 136.
***See Special Condition 8.
****BOD_5 and Suspended Solids (85% removal required): In accordance with 40 CFR 133, the 30-day average percent removal shall not be less than 85 percent. The percent removal need not be reported to the IEPA on DMRs but influent and effluent data must be available, as required elsewhere in this Permit, for IEPA inspection and review. For measuring compliance with this requirement, 5 mg/L shall be added to the effluent $CBOD_5$ concentration to determine the effluent BOD_5 concentration. Percent removal is a percentage expression of the removal efficiency across a treatment plant for a given pollutant parameter, as determined from the 30-day average values of the raw wastewater influent concentrations to the facility and the 30-day average values of the effluent pollutant concentrations for a given time period.

Flow shall be reported on the Discharge Monitoring Report (DMR) as monthly average and daily maximum.

Fecal Coliform shall be reported on the DMR as a daily maximum value.

NPDES Permit No. IL0021784

Effluent Limitations, Monitoring, and Reporting

FINAL

Discharge Number(s) and Name(s): 001 STP Outfall (continued)

pH shall be reported on the DMR as minimum and maximum value.

Chlorine Residual shall be reported on DMR as daily maximum value.

Dissolved oxygen shall be reported on the DMR as a minimum value.

Total Phosphorus shall be reported on the DMR as a as monthly average and daily maximum value.

Total Nitrogen shall be reported on the DMR as a daily maximum value. Total Nitrogen is the sum total of Total Kjeldahl Nitrogen, Nitrate, and Nitrite.

Influent BOD_5 and Effluent $CBOD_5$, Fecal Coliform, Chlorine Residual, Ammonia Nitrogen, and Dissolved Oxygen sampling is not required on the following holidays: New Year's Day, Martin Luther King Jr. Day, President's Day, Good Friday, Memorial Day, Fourth of July, Labor Day, Columbus Day, Armistice Day, Thanksgiving Day, the day after Thanksgiving Day, Christmas Day, and the day before Christmas.

NPDES Permit No. IL0021784

Effluent Limitations, Monitoring, and Reporting

FINAL

Discharge Number(s) and Name(s): 003 – Flow Equalization Basin Discharge

Discharges from this facility are subject to Special Condition 12 of this Permit.

To mitigate the adverse impact of any discharge from this facility, any discharge shall be monitored and limited at all times as follows:

Parameter	CONCENTRATION LIMITS mg/L Monthly Average	Sample Frequency	Sample Type
Fecal Coliform	Daily Maximum Shall Not Exceed 400 per 100 mL	Daily When Discharging	Grab
Chlorine Residual	0.75	Daily When Discharging	Grab
pH	Shall be in the range of 6 to 9 standard units	Daily When Discharging	Grab

To assess the adverse impact of any discharge from this facility, any discharge shall be monitored for the following:

Parameter	CONCENTRATION LIMITS mg/L Monthly Average	Sample Frequency	Sample Type
Total Flow (MG)	See Below	Daily When Discharging	Continuous
BOD_5		Daily When Discharging	Grab
Suspended Solids		Daily When Discharging	Grab
Ammonia Nitrogen (as N)		Daily When Discharging	Grab
Total Phosphorus (as P)		Daily When Discharging	Grab

Total flow in million gallons shall be reported on the Discharge Monitoring Report (DMR) in the quantity maximum column.

Report the number of days of discharge in the comments section of the DMR.

Fecal Coliform shall be reported on the DMR as daily maximum.

Chlorine Residual shall be reported on the DMR as a monthly average concentration.

pH shall be reported on the DMR as a minimum and a maximum.

BOD_5 and Suspended Solids shall be reported on the DMR as a monthly average concentration.

Ammonia Nitrogen shall be reported on the DMR as a monthly average concentration.

Total Phosphorus shall be reported on the DMR as a monthly average concentration.

3. Identifies who shall receive the notification;
4. Identifies the specific information that would be reported including actions that will be taken to respond to the overflow;
5. Includes a description of the lines of communication; and
6. Includes the identities and contact information of responsible POTW officials and local, county, and/or state level officials.

For additional information concerning USEPA CMOM guidance and Asset Management please refer to the following web site addresses.
http://www.epa.gov/npdes/pubs/cmom_guide_for_collection_systems.pdf and
http://water.epa.gov/type/watersheds/wastewater/upload/guide_smallsystems_assetmanagement_bestpratices.pdf

SPECIAL CONDITION 17. The provisions of 40 CFR Section 122.41 (m) & (n) are incorporated herein by reference.

SPECIAL CONDITION 18. This Permit may be modified to include alternative or additional final effluent limitations pursuant to an approved Total Maximum Daily Load (TMDL) Study or upon completion of an alternate water quality study.

SPECIAL CONDITION 19.

A. Subject to paragraph B below, an effluent limit of 0.5 mg/L Total Phosphorus 12 month rolling geometric mean (calculated monthly) basis (hereinafter "Limit"), shall be met by the Permittee by January 1, 2030, unless the Permittee demonstrates that meeting such Limit is not technologically or economically feasible in one of the following manners:
   1. the Limit is not technologically feasible through the use of biological phosphorus removal (BPR) process(es) at the treatment facility; or
   2. the Limit would result in substantial and widespread economic or social impact. Substantial and widespread economic impacts must be demonstrated using applicable USEPA guidance, including but not limited to any of the following documents:
      a. Interim Economic Guidance for Water Quality Standards, March 1995, EPA-823-95-002;
      b. Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development, February 1997, EPA-832—97-004;
      c. Financial Capability Assessment Framework for Municipal Clean Water Act Requirements, November 24, 2014; and
      d. any additional USEPA guidance on affordability issues that revises, supplements or replaces those USEPA guidance documents; or
   3. the Limit can only be met by chemical addition for phosphorus removal at the treatment facility in addition to those processes currently contemplated; or
   4. the Limit is demonstrated not to be feasible by January 1, 2030, but is feasible within a longer timeline, then the Limit shall be met as soon feasible and approved by the Agency; or
   5. the Limit is demonstrated not to be achievable, then an effluent limit that is achievable by the Permittee (along with associated timeline) will apply instead, except that the effluent limit shall not exceed 0.6 mg/L Total Phosphorus 12 month rolling geometric mean (calculated monthly).

B. The Limit shall be met by the Permittee by January 1, 2030, except in the following circumstances:
   1. If the Permittee develops a written plan, preliminary engineering report or facility plan no later than January 1, 2025, to rebuild or replace the secondary treatment process(es) of the treatment facility, the Limit shall be met by December 31, 2035; or
   2. If the Permittee decides to construct/operate biological nutrient removal (BNR) process(es), incorporating nitrogen reduction, the Limit shall be met by December 31, 2035; or
   3. If the Permittee decides to use chemical addition for phosphorus removal instead of BPR, the Limit and the effluent limit of 1.0 mg/L Total Phosphorus monthly average shall be met by December 31, 2025; or
   4. If the Permittee has already installed chemical addition for phosphorus removal instead of BPR, and has a 1.0 mg/L Total Phosphorus monthly average effluent limit in its permit, or the Permittee is planning to install chemical addition with an IEPA construction permit that is issued on or before July 31, 2018, the 1.0 mg/L Total Phosphorus monthly average effluent limit (and associated compliance schedule) shall apply, and the Limit shall not be applicable.
   5. The NARP determines that a limit lower than the Limit is necessary and attainable. The lower limit and timeline identified in the NARP shall apply to the Permittee.
   6. If the Permittee participates in a watershed group that is developing a NARP for an impairment related to phosphorus or a risk eutrophication, and IEPA determines that the group has the financial and structural capability to develop the NARP by the deadline specified in the NARP provisions below.

C. The Permittee shall identify and provide adequate justification of any exception identified in paragraph A or circumstance identified in paragraph B, regarding meeting the Limit. The justification shall be submitted to the Agency at the time of renewal of this permit or by December 31, 2023, whichever date is first. Any justification or demonstration performed by the Permittee pursuant to paragraph A or circumstance pursuant to paragraph B must be reviewed and approved by the Agency. The Agency will renew or modify the NPDES permit as necessary. No date deadline modification or effluent limitation modification for any of the exceptions or circumstances specified in paragraphs A or B will be effective until it is included in a modified or reissued NPDES Permit.

D. For purposes of this permit, the following definitions are used:
   1. BPR (Biological Phosphorus Removal) is defined herein as treatment processes which do not require use of supplemental treatment processes at the treatment facilities before or after the biological system, such as but not limited to, chemical addition, carbon supplementation, fermentation, or filtration. The use of filtration or additional equipment to meet other effluent limits is

not prohibited, but those processes will not be considered part of the BPR process for purposes of this permit; and

2. BNR (Biological Nutrient Removal) is defined herein as treatment processes used for nitrogen and phosphorus removal from wastewater before it is discharged. BNR treatment processes, as defined herein, do not require use of supplemental treatment processes at the treatment facilities before or after the biological system, such as but not limited to, chemical addition, carbon supplementation, fermentation or filtration. The use of filtration or additional equipment to meet other effluent limits is not prohibited, but those processes will not be considered part of the BNR process for purposes of this permit.

E. The 0.5 mg/L Total Phosphorus 12 month rolling geometric mean (calculated monthly) effluent limit applies to the effluent from the treatment plant.

SPECIAL CONDITION 20.
The Agency has determined that the Permittee's treatment plant effluent is located upstream of a waterbody or stream segment that has been determined to be at risk of eutrophication due to phosphorus levels in the waterbody. This determination was made upon reviewing available information concerning the characteristics of the relevant waterbody/segment and the relevant facility (such as quantity of discharge flow and nutrient load relative to the stream flow).

A waterbody or segment is at risk of eutrophication if there is available information that plant, algal or cyanobacterial growth is causing or will cause violation of a water quality standard.

The Permittee shall develop, or be a part of a watershed group that develops, a Nutrient Assessment Reduction Plan (NARP) that will meet the following requirements:

A. The NARP shall be developed and submitted to the Agency by December 31, 2023. This requirement can be accomplished by the Permittee, by participation in an existing watershed group or by creating a new group. The NARP shall be supported by data and sound scientific rationale.
B. The Permittee shall cooperate with and work with other stakeholders in the watershed to determine the most cost-effective means to address the risk of eutrophication. If other stakeholders in the watershed will not cooperate in developing the NARP, the Permittee shall develop its own NARP for submittal to the Agency to comply with this condition.
C. In determining the target levels of various parameters necessary to address the risk of eutrophication, the NARP shall either utilize the recommendations by the Nutrient Science Advisory Committee or develop its own watershed-specific target levels.
D. The NARP shall identify phosphorus input reductions from point sources and non-point sources in addition to other measures necessary to remove the risk of eutrophication characteristics that will cause or may cause violation of a water quality standard. The NARP may determine, based on an assessment of relevant data, that the watershed does not have a risk of eutrophication related to phosphorus, in which case phosphorus input reductions or other measures would not be necessary. Alternatively, the NARP could determine that phosphorus input reductions from point sources are not necessary, or that phosphorus input reductions from both point and nonpoint sources are necessary, or that phosphorus input reductions are not necessary and that other measures, besides phosphorus input reductions, are necessary.
E. The NARP shall include a schedule for the implementation of the phosphorus input reductions and other measures. The NARP schedule shall be implemented as soon as possible and shall identify specific timelines applicable to the permittee.
F. The NARP can include provisions for water quality trading to address the phosphorus related risk of eutrophication characteristics in the watershed. Phosphorus/Nutrient trading cannot result in violations of water quality standards or applicable antidegradation requirements.
G. The Permittee shall request modification of the permit within 90 days after the NARP has been completed to include necessary phosphorus input reductions identified within the NARP. The Agency will modify the permit if necessary.
H. If the Permittee does not develop or assist in developing the NARP and such a NARP is developed for the watershed, the Permittee will become subject to effluent limitations necessary to address the risk of eutrophication. The Agency shall calculate these effluent limits by using the NARP and any applicable data. If no NARP has been developed, the effluent limits shall be determined for the Permittee on a case-by-case basis, so as to ensure that the Permittee's discharge will not cause or contribute to violations of the dissolved oxygen or narrative offensive condition water quality standards.

SPECIAL CONDITION 21. The Permittee has undergone a Monitoring Reduction review and the influent and effluent sample frequency has been reduced for $CBOD_5$, Suspended Solids, and Chlorine Residual parameters due to sustained compliance. The IEPA may require that the influent and effluent sampling frequency for these parameters be increased without Public Notice. This provision does not limit EPA's authority to require additional monitoring, information or studies pursuant to Section 308 of the CWA.

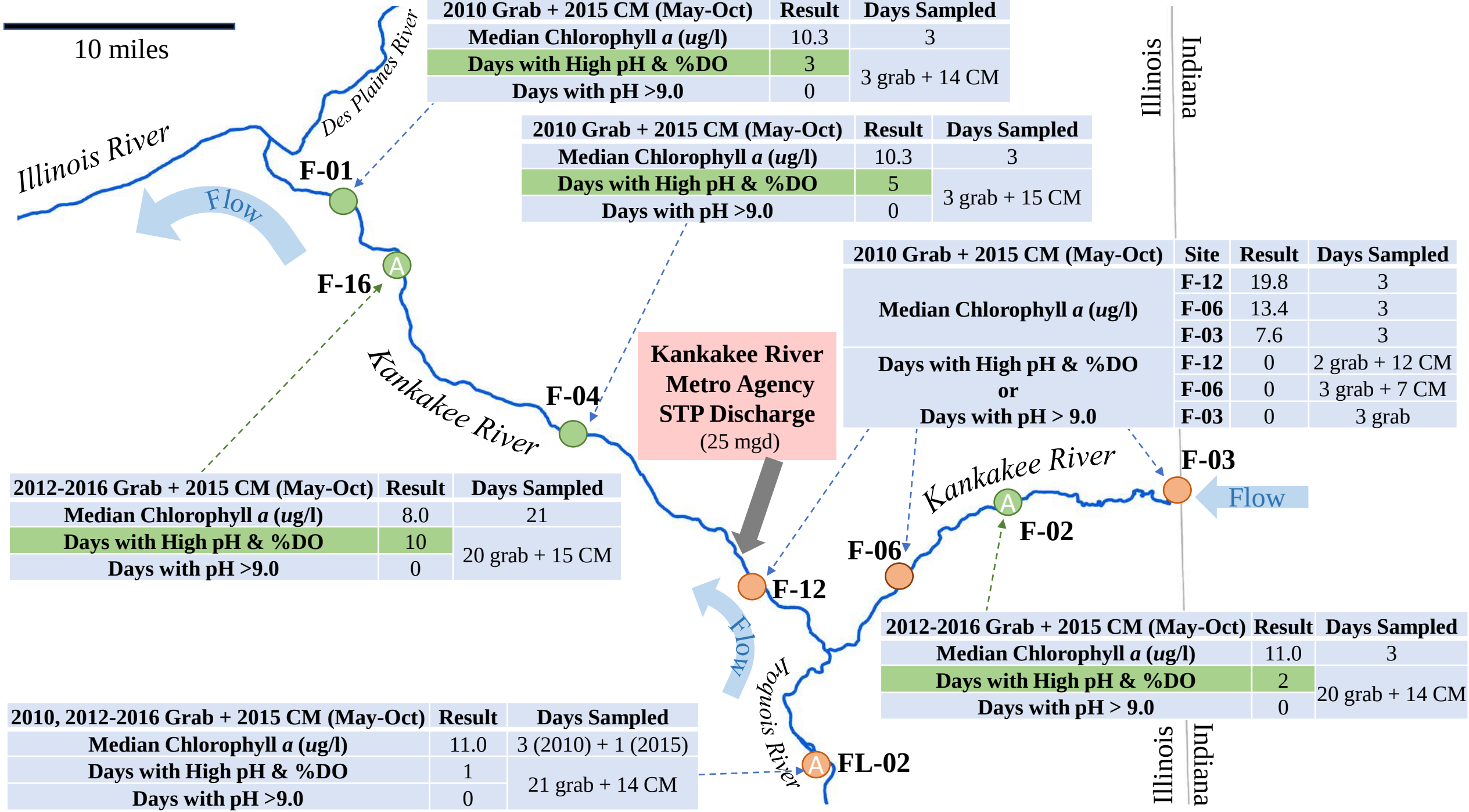
SPECIAL CONDITION 22.

A. The Permittee shall operate and maintain the POTW to optimize existing treatment facilities to maximize phosphorus removal and reduce phosphorus sources into the POTW.

B. The Permittee shall develop a written Phosphorus Discharge Optimization Plan. In developing the plan, the Permittee shall evaluate a range of measures for reducing phosphorus discharges from the treatment plant, including possible source reduction measures, operational improvements, and minor facility modifications that will optimize reductions in phosphorus discharges from the wastewater treatment facility. The Permittee's evaluation shall include, but not necessarily be limited to, an evaluation

of the following optimization measures:

1. WWTF influent reduction measures.
    a. Evaluate the phosphorus reduction potential of users.
    b. Determine which sources have the greatest opportunity for reducing phosphorus (i.e., industrial, commercial, institutional, municipal and others).
        i. Determine whether known sources (i.e., restaurant and food preparation) can adopt phosphorus minimization and water conservation plans.
        ii. Evaluate implementation of local limits on influent sources of excessive phosphorus.
2. WWTF effluent reduction measures.
    a. Reduce phosphorus discharges by optimizing existing treatment processes.
        i. Adjust the solids retention time for either nitrification, denitrification, or biological phosphorus removal.
        ii. Adjust aeration rates to reduce dissolved oxygen and promote simultaneous nitrification-denitrification.
        iii. Add baffles to existing units to improve microorganism conditions by creating divided anaerobic, anoxic, and aerobic zones.
        iv. Change aeration settings in plug flow basins by turning off air or mixers at the inlet side of the basin system.
        v. Minimize impact on recycle streams by improving aeration within holding tanks.
        vi. Reconfigure flow through existing basins to enhance biological nutrient removal.
        vii. Increase volatile fatty acids for biological phosphorus removal.



2010 Grab + 2015 CM (May-Oct)	Result	Days Sampled
Median Chlorophyll *a* (*ug*/l)	10.3	3
Days with High pH & %DO	3	3 grab + 14 CM
Days with pH >9.0	0	

2010 Grab + 2015 CM (May-Oct)	Result	Days Sampled
Median Chlorophyll *a* (*ug*/l)	10.3	3
Days with High pH & %DO	5	3 grab + 15 CM
Days with pH >9.0	0	

2010 Grab + 2015 CM (May-Oct)	Site	Result	Days Sampled
Median Chlorophyll *a* (*ug*/l)	F-12	19.8	3
	F-06	13.4	3
	F-03	7.6	3
Days with High pH & %DO or Days with pH > 9.0	F-12	0	2 grab + 12 CM
	F-06	0	3 grab + 7 CM
	F-03	0	3 grab

2012-2016 Grab + 2015 CM (May-Oct)	Result	Days Sampled
Median Chlorophyll *a* (*ug*/l)	8.0	21
Days with High pH & %DO	10	20 grab + 15 CM
Days with pH >9.0	0	

2012-2016 Grab + 2015 CM (May-Oct)	Result	Days Sampled
Median Chlorophyll *a* (*ug*/l)	11.0	3
Days with High pH & %DO	2	20 grab + 14 CM
Days with pH > 9.0	0	

2010, 2012-2016 Grab + 2015 CM (May-Oct)	Result	Days Sampled
Median Chlorophyll *a* (*ug*/l)	11.0	3 (2010) + 1 (2015)
Days with High pH & %DO	1	21 grab + 14 CM
Days with pH >9.0	0	

Region II, Fisheries
Streams Program
5931 Fox River Drive
Plano, Illinois 60548

Evaluation of Stream Quality and Sport Fisheries in the Kankakee River Basin

September 2017

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Abstract

The 2015 Kankakee River Basin survey is the fifth IDNR evaluation of fish communities in the watershed since 1994. Additional IDNR surveys on the Kankakee River mainstem date back to 1975, representing a 40 year record of fish collections. Overall, the Kankakee River remains a high quality system with relatively stable conditions over the sampling period. Although yearly variations have been noted, no major trends have been observed for species composition, or stream quality. In 2015, fish surveys were conducted at 13 historic stations on the mainstem of the Kankakee River and 11 tributary stations. Two additional stations on the mainstem, one in each of the dam pools at Wilmington and Kankakee were also sampled in 2015. Overall, we collected 16,729 fish representing 76 species for all mainstream and tributary stations combined. Three State Threatened species were collected: Ironcolor Shiner, River Redhorse, and Starhead Topminnow. Asian Carp and Round Goby were not observed or collected. A total of 7,033 fish representing 69 species were collected from the mainstem stations. Species composition was generally similar to previous surveys with minnows, suckers, and sunfishes dominating the catch. Species distribution appeared to be related to stream gradient and longitudinal position, in addition to influence from the dams at Kankakee and Wilmington. Index of Biotic Integrity (IBI) scores ranged from 36 to 57 (60 maximum), with nine of the 13 historic mainstem stations scoring 50 points or more, including four of the five upper river stations between the State Line and Aroma Park. The station located at the confluence with the Des Plaines River was the only historic location with an IBI score below the IEPA threshold (≥41) for full support of aquatic life. This station is impounded by the Dresden Dam located on the Illinois River just below the confluence. The station within the six-mile Kankakee Dam pool also scored below the IEPA threshold with an IBI of 40. The Wilmington Dam pool, which is much shorter (one mile) than the Kankakee Dam pool appeared to maintain some level of free-flowing condition, with an IBI score (46) similar to un-impounded locations. Smallmouth Bass was the most numerous game species collected on the mainstem. Overall catch rate of smallmouth bass was lower in 2015 (14.3 per hour) compared to previous basin surveys (mean = 24.5 per hour), but catch rate of larger individuals (>14 inches) was the highest recorded (7.8 per hour). Young-of-the-year smallmouth bass were in low abundance in 2015, with only four individuals collected. Channel Catfish catch rate (13.8 per hour) was similar to 2010 and above the long term average (6.8 per hour) with many larger fish (>16 inches) present. A total of 9,697 fish representing 42 species were collected at 11 tributary stations. Species composition was similar to previous years with minnows and darters dominating the catch. IBI scores ranged from 30 to 58, with three stations scoring below the level for full support of aquatic life (≥41). Overall, stream quality has been relatively stable since 1994 based on tributary IBI scores, although several stations have had incremental increases in IBI scores in recent years. Larger sportfish were uncommon at tributary sites. However, unlike the mainstem, young-of-the-year Smallmouth Bass were abundant at several locations. Although there has been much discussion and concern regarding the downstream movement of sand from Indiana into the Illinois portion of the Kankakee River, evaluation of fish community and sportfish data from the 2015 basin survey provides no evidence of wide-spread habitat degradation. The Kankakee River is widely acknowledged as one of the most diverse, high quality systems in Illinois, and should remain a high priority for protection and improvement.

Introduction

The Kankakee River Basin was surveyed in 2015 by the Illinois Department of Natural Resources (IDNR) and Illinois Environmental Protection Agency (IEPA) as part of a statewide monitoring program to measure the health of Illinois streams. Data from sampling of fish assemblages, macroinvertebrates, habitat condition, and water quality is used by IEPA for statewide stream quality reporting. Fisheries data from basin surveys is also used for fisheries management permit review, watershed planning, education and outreach, as well as other applications and studies.

This report summarizes results of 2015 fish surveys including species composition, distribution, evaluation of stream quality, and status of the sport fishery. Results were also compared to previous basin surveys conducted in 1994, 2000, 2005, and 2010 as well as other historic records to identify trends for the Kankakee River watershed, widely known as one of the highest quality larger river systems in Illinois. Results of water quality and other parameters will be published separately by IEPA in the biennial 305 (b) report.

Watershed Description

The Kankakee River drains an area of 5,165 square miles, running for a total of 150 miles from its origin near South Bend Indiana to its confluence with the Des Plaines River near Wilmington, IL (Bhowmik and Demissie 2000). In Illinois, the river is 59 miles in length, with a drainage area of 2,169 square miles, encompassing nearly all of Kankakee County, a large portion of Will County, and a small area of Grundy County (Figure 1). The Iroquois River is the largest tributary to the Kankakee River, with its confluence near Aroma Park, IL. Other major tributaries to the Kankakee River include Singleton Ditch, Trim Creek, Spring Creek, Baker Creek/Exline Slough, Rock Creek, Horse Creek, Forked Creek and Prairie Creek. The mainstem of the Kankakee River has been extensively channelized in Indiana, but remains largely unmodified in Illinois (Bhowmik and Demisse 2000). A 12-foot high dam in the city of Kankakee creates a pool that extends upstream to Aroma Park (six miles). The Kankakee Dam fragments the upper and lower section of the river due to the lack of fish passage. Another dam at Wilmington, which is also impassable by fish, impounds a shorter segment of the river (one mile). A third mainstem dam in Momence extends across only one of two channels at this location, leaving

the other channel free-flowing and passable by fish.

The upper Kankakee River from the IL/IN State Line to Momence has a relatively low gradient (2 ft./mi.; Figure 2) meandering through a large floodplain forest known as the Momence Wetlands. After a relatively short increase in gradient at Momence (5 ft./mi.), the channel gradient decreases to 2.5 ft./mi from Momence to Aroma Park Just past Aroma Park, where the river is impounded for roughly six miles by the Kankakee Dam. The substrate upstream of Kankakee contains much bedrock with areas of gravel/cobble and sand substrate (Parker et al. 2017). Areas of sand have reportedly expanded in recent years in the Momence Wetlands and within dam pool which runs from Aroma Park downstream to the Kankakee Dam (Bowmik and Demissee 2001, Terrio and Nazimek 1997). Downstream of the Kankakee Dam, the river increases in gradient to four ft./mi. (Figure 2). The Kankakee River State Park river segment has the highest gradient (six ft./mi.; IDNR 1998), with numerous riffles, pools and islands. In addition to extensive bedrock runs, the substrate includes gravel and cobble areas. Downstream of the Park, gradient decreases to three ft./mi. through Custer Park, before being impounded by the Wilmington Dam. Downstream of the Wilmington Dam, the gradient increases to approximately four ft./mi. to the Des Plaines Conservation Area, where the river is impounded by the Dresden Dam on the Illinois River and becomes very slow-moving, silty and lake-like.

Methods

Fish surveys were conducted at the 13 historic stations on the mainstem of the Kankakee River (Figure 3) from August 11 to September 3, 2015. Eleven tributary stations, (Figure 3) were sampled from August 22 to September 2. Mainstem sampling included 13 historic sites sampled in previous basin surveys and routinely sampled by IDNR from 1975 to 1994 (Pescitelli and Rung 2008). In 2015, we also sampled one station in each of the dam pools at Wilmington and Kankakee in order to evaluate conditions in these impounded reaches. Data from the two dam pool locations were omitted from catch rate and other analysis involving previous collections at the 13 historic locations. Tributary locations were the same as those sampled in 2010. Fewer stations were sampled prior to 2010 (see Table 10). Location information and sampling dates for each 2015 station appear in Table 1. Stream flow was above

normal throughout the survey based on records from USGS Gaging Station at Wilmington (Figure 4). Flow increase somewhat from August 18 to August 26. No sampling was performed during that period.

Locations on the mainstem of the Kankakee River were sampled using DC boat electrofishing. Sampling at each station consisted of two 30 minutes runs, one along each bank. Supplemental collections were made at each boat site with a 30 ft. bag seine with 1/4 inch mesh. Sampling effort for the seine collections consisted of three 50 ft. hauls. All tributary stations were sampled using a 30 ft. electric seine, powered by a single-phase, 2500 watt AC generator (Bayley et al. 1989). At electric seine stations, upstream and downstream limits of each sampling station were blocked by nets to prevent fish escape and/or entry into the station during sampling. Length of the sampling station was approximately 15-20 times the stream width. Sampling with the electric seine was conducted in an upstream direction. For all sampling methods, larger fish were weighed, measured and returned to the stream alive. Smaller individuals were preserved in 10% formalin and identified in the laboratory. Voucher specimens for each species at each station were sent to the Illinois Natural History Survey in Champaign, Illinois.

In addition to fish species abundance, each sampling station was also evaluated using the Index of Biotic Integrity (IBI, Smogor 2004). The IBI is a widely-used stream quality measurement based on attributes of the fish assemblage at a given location. The attributes are evaluated using ten metrics which are compared to established reference conditions for least disturbed streams of similar size and geographic region. The metrics include number and types of species present, and several proportional metrics which evaluate attributes such as food, habitat, spawning substrate, and tolerance to degradation. Each metric receives a score of 0-6 with the sum of the ten metrics equaling the total IBI score, ranging from 0-60 with higher scores indicating better stream quality.

To evaluate differences in IBI among years we performed a one-way analysis of variance (ANOVA) on the mean annual IBI for all stations combined ($\alpha = 0.05$). If ANOVA showed significant variation, a two-tailed T-test with a Bonferroni correction ($\alpha = 0.05$) was used to examine differences between means. Mean IBI scores were correlated to the log-10 of mean

flow during the collection period to examine the effects of stream flows on IBI results for the mainstem stations. In order to analyze patterns in fish communities among the mainstem and tributary stations, non-metric multi-dimensional scaling (NMDS) analysis was performed on catch per unit effort for each species at each sampling locations using the Bray-Curtis (1957) similarity index. For the mainstem stations, analysis included factors based on river segments (established according to longitudinal location), channel gradient and relation to mainstem dams.

Results and Discussion

The 2015 Kankakee River Basin survey is the fifth evaluation of the watershed performed as part of the IDNR/IEPA statewide monitoring program, including surveys completed in 1994, 2000, 2005, and 2010 (Pescitelli and Rung 2012). Results from these studies allow evaluation of conditions over a 21 year period, using similar sampling techniques at historic locations. In addition, IDNR surveys have been conducted at the same 13 locations on the mainstem of the river from 1975 to 1994, allowing identification of trends over a 40 year period.

In 2015, fish were collected at 26 stations throughout the Kankakee River basin, including 15 mainstem (13 historic station and two dam pool stations) and 11 tributary locations (Figure 3, Table 1). Combining all stations, we collected a total of 16,729 individuals from 76 species and 15 families (Table 2). Three State Threatened species were found including Ironcolor Shiner, River Redhorse, and Starhead Topminnow. Ironcolor Shiner and Starhead Topminnow have been collected in each of the last four basin surveys. The State Threatened River Redhorse is relatively common in the mainstem of the river. Abundance and distribution of River Redhorse in 2015 was similar to previous basin surveys (Table 5) and catch rate has been relatively consistent in IDNR collections dating back to 1975 (Pescitelli and Rung 2008). In addition to State Threatened Species, there were eight other fish species collected in 2015 which have been designated as “in Greatest Need of Conservation” (see Table 3) by Illinois Comprehensive Wildlife Plan (IDNR 2005).

Combining all five IDNR basin surveys from 1994 to 2015, a total of 100 fish species have been collected including 93 native and 7 introduced fish species (Table 3). Illinois Natural History Survey records dating back to 1880 (INHS 2015), included 110 fish species with 7 non-native fishes. Non-native fish species recorded in the Kankakee River from previous IDNR surveys include: White Perch (*N*=1; collected in 2005), Threadfin Shad (one individual in 2005 and 2010), and Round Goby collected in 2010. A total of 5 Round Goby were collected at the two stations closest to the confluence with the Des Plaines River (F-01, F-14) below the Wilmington Dam. The Round Goby has become abundant in some areas of northeastern Illinois and could potentially become established in the Kankakee River, especially given the abundance of rocky substrate, their preferred habitat. However, none were collected in the Kankakee Basin in 2015. Grass Carp appeared for the first time in IDNR collections in 2015 at two stations, F-03 and F-04; one at each station. Given the locations of these individuals (upstream of the mainstem dams), the Grass Carp most likely escaped from ponds within the watershed where they are used for aquatic plant control. Although we have not collected Bighead or Silver Carp during any of the basin surveys, sampling by IDNR Aquatic Nuisance Species Program has yielded 63 Silver Carp and 8 Bighead Carp in the Kankakee River downstream of the Des Plaines Conservation Area Boat Ramp (IDNR ANS Database 2015).

Details for the 2015 Kankakee River mainstem and tributary collections are presented below, including discussion of fish species abundance and distribution, stream quality based on the IBI, and status of sportfish populations as well as comparisons to previous basin surveys and routine IDNR monitoring on the mainstem.

Mainstem

Fish Species Abundance and Distribution. A total of 7,033 fish representing 69 fish species were collected at 15 stations on the mainstem of the Kankakee River in 2015 (Table 4). Species richness ranged from 21 (F-08, F-96) to 39 (F-03). The Cyprinid family (minnows) was the most diverse and abundant group on the mainstem with 19 species collected and a total of 4,160 individuals, representing 59% of the total catch. The sucker family (Catostomidae) was also well represented with 1,312 individuals (19% of total) and 13 species. The sunfishes

(Centrachidae) had 12 species and one hybrid taxa with 842 individuals, which was 12% of the total catch.

Fish species with the highest abundance and catch per unit effort (CPUE, no. of fish per hour) for boat electrofishing included (in order of abundance): Shorthead Redhorse, Golden Redhorse, Smallmouth Bass, Channel Catfish, Spotfin Shiner, Sand Shiner, Logperch, Northern Hogsucker, Largemouth Bass, and Gizzard Shad (Table 5). Most of these species had widespread distributions, occurring at 12 or more of the 15 mainstem stations (Table 4). Logperch and Gizzard Shad were only found at 8 of the 15 stations. Other widely distributed fish species (occurring at >75% of the stations) were: Common Carp, Bluntnose Minnow, Quillback, River Redhorse, Silver Redhorse, Flathead Catfish, Longear Sunfish, Bluegill, and Green Sunfish (Table 4). Twenty three fish species had limited distributions, occurring at three stations or less (<25% occurrence; Table 4). The State Threatened species, Starhead Topminnow (*N*=3), and Ironcolor Shiner (*N*=36) were only found at the State Line location (F-03) in an off-channel, backwater area.

Distribution of native species within the mainstem of the Kankakee River appeared to be related to stream gradient, longitudinal position, and the influence of dams at Kankakee and Wilmington, as reported in previous surveys (Pescitelli and Rung 2012). In order to examine the effects of mainstem position on fish assemblages we used NMDS comparing stations in six river segments (Figure 5): UPPER – between the State Line and Aroma Park; SIX MI POOL – Aroma Park to the Kankakee Dam (Impounded area); MID LOWER – from Kankakee Dam to head of the Wilmington Dam pool; US WILM DAM – the Wilmington Dam impoundment (1.5 mi.); LOWER – from Wilmington Dam to Des Plaines Conservation Area; CONFL – between the Des Plaines Conservation Area and confluence with the Des Plaines River, which is impounded by Dresden Dam on the Illinois River..

The influence of channel gradient is implied in the NMDS grouping of stations in the UPPER and MID LOWER segments. Three UPPER stations (F-03, F-06, F-09) grouped together with one MID LOWER station F-08 (Figure 5), which have similar channel gradients (2-3 ft./mi.), despite being located in different stream segments. Conversely, the higher gradient station F-02 at Momence, located in the UPPER segment, grouped together with the higher gradient

stations in the MID LOWER segment. Two stations located below the Wilmington Dam (F-01, F-11) in the segment designated LOWER, grouped together based on similarity in habitat and location. These two stations have a direct connection to the Illinois River, unlike stations upstream of the Wilmington Dam, which is a barrier to fish movement. Station F-14, located near the confluence with the Des Plaines River is unique as indicated by the NMDS plot (CONFL, Figure 5). This river segment is directly connected to the Illinois River but was dissimilar to other stations due to impoundment by the Dresden Dam which creates silty, lake-like conditions. Stations F-96 and F-20 located in the other impounded segments (SIX MI POOL and US WILM DAM) were also unlike all other locations. Despite being located in dam pools, these two stations were dissimilar possible due to the difference in the length of the pool and associated flow conditions, as noted previously. Station F-15 was also not closely associated with other any other location, including other stations in the UPPER segment (Figure 5). The channel throughout much of F-15 was narrow and deep, possibly affecting sampling efficiency.

Although gradient appeared to have an influence on fish species composition and distribution, as found in other Midwestern stream systems (Peterson and Rabeni 2001), the two dams at Kankakee and Wilmington, both of which are impassable to fish, may have also had an influence. For example the stations below the Wilmington Dam were grouped separately in the NMDS plot (Figure 5). The Kankakee Dam may also influence fish species distribution. Longnose Gar and Freshwater Drum were relatively common below the Kankakee Dam but were not observed in the area above the dam (Table 4). Dams have been shown to effect fish species distribution in other northeastern Illinois (Santucci et al. 2005, Slawski et al. 2008) and Midwestern streams (Catalano et al. 2007).

Stream Quality - Index of Biotic Integrity. Although species richness is a useful indicator of habitat diversity and stream condition, the Index of Biotic Integrity (IBI) provides a more comprehensive, ecologically based estimate of stream quality (Simon and Lyons 1995). IBI scores were calculated for each mainstem stations by the extrapolated Smogor (2004) method using boat electrofishing and seine data.

Mainstem IBI scores ranged from 57 to 36 with an overall mean of 50 (Table 6). The lowest IBI score (36) was found at F-14 near the confluence with the Des Plaines River, where

lower gradient, low-flow conditions created areas with extensive silt accumulation. These conditions appeared to favor generalist, non-specialized species resulting in very low scores for related IBI metrics (Table 6). Station F-96, located in lake-like conditions of the 6-mile Kankakee Dam pool, also had a relatively low IBI (40). The Wilmington Dam pool, which impounds only about one mile of river channel, appeared to maintain more riverine conditions with an IBI of 46, similar to some free flowing stations (Table 6).

All stations except the confluence (F-14) and six-mile pool (F-96) had IBI scores greater than 41, which is the minimum threshold for IEPA designation, Full Support of Aquatic Life Use (IEPA 2016). Four stations upstream of the Kankakee Dam at the State Line, Momence, Rt. 17, and Aroma Park had scores of 52 or more, indicating relatively high biotic integrity, despite concerns about accumulation of sand originating from the channelized portion of the the Kankakee River in Indiana (Bhowmik and Demissie 2001). Station F-15 at River Isle has a relatively low score (42) compared to other mainstem stations. The reason for the lower IBI at F-15 is not clear although the narrow, deep channel at this location may have affected sampling effectiveness. IBI scores ranged from 48 to 56 downstream of the Kankakee Dam in the MID LOWER segment with 3 of 5 stations exceeding a score of 50. Both stations in the LOWER segment downstream of the Wilmington Dam had IBI scores of 56, indicating high quality stream conditions.

IBI scores for mainstem stations in 2015 were generally within the range observed for previous basin surveys from 1994 to 2010 (Table 7). No significant differences among years were observed (ANOVA). Some variation in IBI scores is expected, and therefore a difference of >10 IBI points is necessary to represent a “biologically meaningful” change (Smogor 2004). Four stations which decreased by more than 10 IBI points in the 2010 survey (F-12, F-07, F-04, F-11; Pescitelli and Rung 2012) had increased IBI scores in 2015 (Table 7, Figure 6). Aroma Park (F-09) and the State Line (F-03) stations, areas potentially impacted by sand accumulation, have shown relatively stable IBI scores over the sampling period from 1996 to 2015 (Figure 6). Variation in IBI scores was found to be related, in part, to stream flow levels during the collection period (Pescitelli and Rung 2012). Higher flows generally yielded lower IBI scores (Figure 7) possibly related to fish movement patterns or sampling effectiveness.

Sportfish. Smallmouth Bass was the most numerous sportfish species in 2015, with 186 individuals collected at 13 mainstem stations for a mean catch rate of 14.3 per hour of boat electrofishing (Table 5, Figure 5). Smallmouth Bass were present at all 13 historic stations, and were typically more abundant at higher gradient stations such as Momence and the MID LOWER segment stations (Table 4). Fish in the 11 to 16 inch size range made up a large portion of the catch (Figure 9). Young-of-the-year (Y-O-Y, <3 inches) were in very low abundance (N=4) indicating poor reproduction in 2015. The absence of younger fish resulted in a lower overall catch rate compared to previous years. However, the catch rate of fish ≥ 14 inches was very high in 2015 compared to all other years (Figure 8). Catch rates are typically higher for Smallmouth Bass during annual IDNR fall sportfish surveys in the Kankakee River (60-80 per hour, DNR 2016) when water levels are often reduced and lower temperatures help increase capture efficiency. During the 2016 fall sportfish survey Y-O-Y were very abundant, indicating good reproduction.

We collected 180 Channel Catfish by boat electrofishing in 2015 at 13 mainstem stations for a catch rate of 13.8 fish per hour, higher the long term average (Table 5, Figure 10). Channel Catfish were found at all locations, and similar to Smallmouth Bass, were typically more abundant at the higher gradient stations, especially Momence where the catch rate was 48 per hour. The Channel Catfish population was dominated by individuals >16 inches, which made up large portion of the collection (Figure 9). Y-O-Y were very low in abundance.

Catch rate for Rock Bass was four fish per hour in 2015 (Figure 10). Average catch rate for Rock Bass from 1975 to 2005 was 5.5 per hour. Rock Bass were found at 9 of the 15 locations and were most abundant at F-07, downstream of Route 17 (Table 4).

Walleye catch has been similar over the past three surveys with just over 2 fish per hour (Figure 10). Walleye were collected at six stations, with the highest abundance found at the two LOWER segment stations downstream of the Wilmington Dam (Table 4). IDNR initiated a Walleye stocking program in 2000, releasing an average of 90,000, 2-inch fingerlings per year. Only brood stock Walleye from the Kankakee River are used to produce the fingerlings. The stocking program has resulted in an increased number of Walleye in the mainstem. However, electrofishing catch rates during the summer basin survey period have been much lower

compared to the supplemental IDNR spring Walleye sampling which has averaged 30 per hour from 2000 to 2015. Based on recovery of marked individuals, 69% of the fish collected from the Kankakee River were from the IDNR stocking program (Lutterbie et al. 2012). Anglers have also reported higher catch rates of Walleye in recent years.

Northern Pike catch rate in 2015 was 1.2 fish per hour, slightly lower than 2010 (Table 5, Figure 11). All but one of the 18 individuals collected in 2015 were found in the lower gradient areas upstream of the Kankakee Dam (Table 4), where catch rate was 3.1 fish per hour, compared to 0.1 per hour downstream of the dam.

Tributaries

Fish Species Abundance and Distribution. A total of 9,697 fish representing 42 species were collected in 2015 at all tributary stations combined (Table 8). One Ironcolor Shiner, a State Threatened fish species, was collected at Spring Creek. The Minnow family (Cyprinidae) was the most diverse family with 14 native species, accounting for 75% of the total abundance. Darters were also abundant with eight species accounting for 12% of the total catch. Common Carp was the only non-native species captured at the tributary stations.

Fish species richness varied among stations, with the highest number found in Forked Creek (*N*=31) and the lowest number occurring at FKA-02 (Exline Slough) and FF-01 (Rock Creek), each station yielding 12 fish species (Table 8). FKA-02 is a small, channelized creek with very limited habitat, accounting for low fish species richness. Conversely, FF-01 was larger and has very diverse, natural habitat features. Low species richness has been reported in previous years at FF-01, possibly due to a natural rock formation located one mile upstream of the creek mouth, which acts as barrier for fish recruitment from the Kankakee River (Pescitelli and Rung 2008).

Striped Shiner, Bluntnose Minnow, Central Stoneroller, Hornyhead Chub, Mimic Shiner, Rainbow Darter, Johnny Darter, Banded Darter, Rosyface Shiner, and Creek Chub were the most abundant species collected at tributary stations in 2015 (Table 8). Together these species accounted for 83% of the total catch and were widespread in distribution, occurring at eight or more of the 11 locations sampled. One exception was Mimic Shiner, which, similar to previous

surveys, was only found at two locations. Johnny Darter, Smallmouth Bass, Green Sunfish, Rock Bass, and Bluegill and were also widespread, occurring at seven or more stations (Table 8).

Overall, fish species richness and distribution for 2015 Kankakee River tributary sampling stations were similar to previous basin surveys and were largely related to stream size, habitat availability, and location in the watershed. Streams segments in the upstream areas of the watershed were narrower and typically lower gradient than for downstream segments. The upstream segments more likely to be channelized and appeared to have more recent channel clearing or straightening, resulting in poor habitat diversity. Stations located lower in the watershed tended to have less channelization or no recent straightening or channel maintenance.

FM-02 on Spring Creek and FC-01 on lower Horse Creek were unique among the tributary sites as indicated by their separation from other streams in the NMDS plot (Figure 11). Spring Creek is a very low gradient, channelized stream with fine-grained substrate. Station FC-01 was on a channelized segment of Horse Creek with very fine-grained substrate. Both stations had very low overall fish abundance compared to other stations (Table 8). Native minnow species were particularly low in abundance at both locations, perhaps indicating reduced availability of invertebrate forage. Among the other tributary locations, there appeared to be segregation based on longitudinal position, with a cluster of six stations located in the downstream segments of the stream (FB-01, FQ-01, FF-01, FKA-01, FCC-01, and FA-01), separated from three stations in the upstream, channelized segments (FFB-01, FKA-01, and FA-06; Figure 11).

Stream Quality - Index of Biotic Integrity. Tributary IBI scores ranged from 58 on Forked Creek (FB-01) to 30 on Exline Slough (FKA-02; Table 9). The site on Forked Creek was un-channelized with natural habitat features including abundant emergent vegetation. Located lower in the watershed, the channel at FB-01 was relatively wide (Table 1) and within six miles of the Kankakee River (Figure 2). Large habitat area and longitudinal proximity to the mainstem contributed to high fish species richness (*N*=30), including a high number of migratory sucker species. FB-01 had maximum scores on all species metrics (*N*= 6; Table 9). In contrast, the East Branch of Horse Creek (FCC-01) was previously channelized, deeply incised, with a much smaller

channel, yet this location had an IBI score of 55, similar to Forked Creek. FCC-01 was much farther from the mainstem than FB-01 (10 miles; Figure 1) resulting in a low number of sucker species. However, 28 fish species were collected, including many benthic invertivores. Riffle and pool habitat were becoming established at FCC-01 and no recent channel maintenance was evident. FKA-01 on Baker Creek also appeared to be reestablishing natural habitat features following previous channelization, supporting 23 species and an IBI of 48. Trim Creek (FB-01) was never channelized, and retained natural habitat features with a wooded stream corridor and little or no channel incision. FB-01 had an IBI score of 50, but had lower fish species richness than other higher quality sites (Table 9).

The importance of connection to a downstream recruiting source was apparent at FF-01 on Rock Creek, which had only 12 fish species and IBI of 35, despite very high quality habitat and close proximity to the mainstem (2.5 miles). As noted previously, there is a natural rock barrier between the maintstem and FF-01. All other tributary sites had IBI scores ranging from 30 to 44. These stations were generally narrower, channelized stream segments, located in the upstream areas of the watershed.

Three of the eleven tributary stations had IBI scores below the threshold for Full Aquatic Life Use (≥41; IEPA 2016, Table 9). As expected, IBI scores appeared to be somewhat related to habitat conditions. However, as observed in the 2012, Kankakee River tributary habitat quality as estimated by the Qualitative Habitat Evaluation Index (QHEI; Rankin 1989), was poorly correlated with IBI scores (Pescitelli and Rung 2012). Proximity and degree of connection to downstream recruiting sources appeared to be an important factor. As described for Wisconsin streams (Wang et al. 1998), the age of channelization also appeared to influence stream quality for Kankakee River tributaries

IBI scores from the 2015 survey were similar to those in 2010 (Table 10). Differences in scores between the two surveys were minimal at most stations and did not exceed 10 points, the level indicating biologically significant change. IBI scores improved at 7 of the 12 tributary sites, with the largest increase occurring at Trim Creek. Stream quality has been relatively unchanged over the study period from 1994 to 2015 with no significant difference among years (ANOVA, Table 10). Several stations (FB-01, FCC-01, FFB-01, FQ-01) have shown incremental

increases in stream quality in recent surveys (Table 10, Figure 12,).

Sportfish. Rock Bass and Smallmouth Bass were the most abundant sportfish species found at tributary stations in 2015. A total of 189 Rock Bass were collected, appearing at most locations, excluding Prairie Creek and Exline Slough (Table 8). Exline Slough was shallow, with no pool habitat and no other sunfish species. Prairie Creek is a larger stream with diverse habitat, but for unknown reasons has held no Rock Bass in recent surveys. The highest abundance was found in Rock Creek and Baker Creek. Most of the Rock Bass collected were in the four to eight inch size range, with few Y-O-Y present (Figure 13). Smallmouth Bass were also widespread occurring at all locations except Exline Slough (FKA-02). The highest abundance of Smallmouth Bass was found in Rock Creek, typical of past basin surveys. Unlike Rock Bass, Y-O-Y Smallmouth Bass were common, making up a large portion of the population (Figure 13). Few catchable-size individuals were present in the tributaries, with most fish measuring less than 10 inches. The high number of Y-O-Y Smallmouth Bass in the tributaries suggests lower or less variable flows in 2015 compared to the mainstem, where few Y-O-Y were found. Bluegill and Largemouth Bass were also common, but only smaller fish of these species were present. No Channel Catfish were collected at t tributary locations.

Summary

The Kankakee River supports a very diverse assemblage of fishes. Factors contributing to high fish diversity include: a wide range of habitat types, good water quality conditions, and relatively low urban development. Momence Wetlands, one of the few areas in the State with intact forested flood plain, provides unique habitat for rarer fishes preferring low gradient, wetland habitats (Smith 1971). The downstream segments of the Kankakee River provide long, continuous stretches with deep pools, riffles, runs, and side channel habitats. Although the river is not highly fragmented by dams, the two impassable dams on the Kankakee River still appear to effect species distribution.

Sportfish populations in the Kankakee River remain in good condition and among the best in Northeastern Illinois. Smallmouth Bass, historically the most numerous sportfish species in the Kankakee River, continues to be abundant. Although overall numbers were down in

2015, abundance of larger fish was the highest recorded since surveys began in 1975. Y-O-Y were low in abundance in the mainstem in 2015, but were relatively abundant in the tributaries. Smallmouth Bass are known to have variation in reproductive success due to annual variation in river flows during the nesting period (Smith et al. 2005). Supplemental sampling in fall 2016 found high numbers of Y-O-Y at several Kankakee River mainstem locations. Channel catfish numbers remain relatively high, with many catchable sized fish present. Channel Catfish Y-O-Y were also abundant in Fall 2016. Walleye have also been more abundant in recent years due to the IDNR stocking program. However, summer electrofishing catch rates are still relatively low.

The Kankakee River watershed remains largely in agricultural land use. However, one continuing threat to stream quality is urban development. Located just outside the Chicago Metropolitan area, projections for human population growth within the watershed, particularly Will County, have been very high (Openlands 1999). Extensive studies in Northeastern Illinois (Dreher 1996, Harris et al. 2005, Pescitelli et al. 2008) and across the country (Paul and Meyer 2001) demonstrate that increased urban landcover leads to degradation of stream quality, even at levels as low as 10% urban coverage. Although the immediate threat has diminished in recent years due to economic factors, future growth remains a concern, especially if plans for a South Suburban Airport are revived.

There has been much concern regarding downstream movement of sand from Indiana into the Illinois portion of the Kankakee River. IDNR Basin Survey results have provided no clear indication of degradation in the mainstem. Recent studies have documented higher sand levels in the upper river. However, preliminary evidence indicates the sand covered areas are not significantly different in species richness, sportfish abundance, or overall productivity compared to that of rocky areas, although differences were noted for selected species (Parker et al, 2017). Mussel species richness has declined in the Kankakee River since the early 1900's, but overall, the number of mussel species remains high compared to other Illinois Rivers (J. Tiemann, INHS). Additional studies may be warranted to document effects of sand deposition on both localized and river-wide fish and mussel assemblages.

The Kankakee River is widely acknowledged as one the better river systems in Illinois for

native biodiversity (Kwak 1993, Page et al. 1992) and angling opportunities. Protection of this valuable resource should remain a high priority. A wide range of restoration and protection measures have been recommended (Kwak 1993, Bhowmik and Demissie 2000), in addition to studies and discussions among local groups and government agencies related to sedimentation issues.

Acknowledgments

Thanks to all those who contributed to field collection efforts especially Region 2 Fisheries Staff and Illinois IEPA Biologists. Special thanks to Jim Langbein, Regional Fisheries Biologist (retired) for his many years of effort on the Kankakee River including initiating and maintaining routine fisheries monitoring. This study was funded in part by the USFWS Sportfish Restoration Program (F-67-R).

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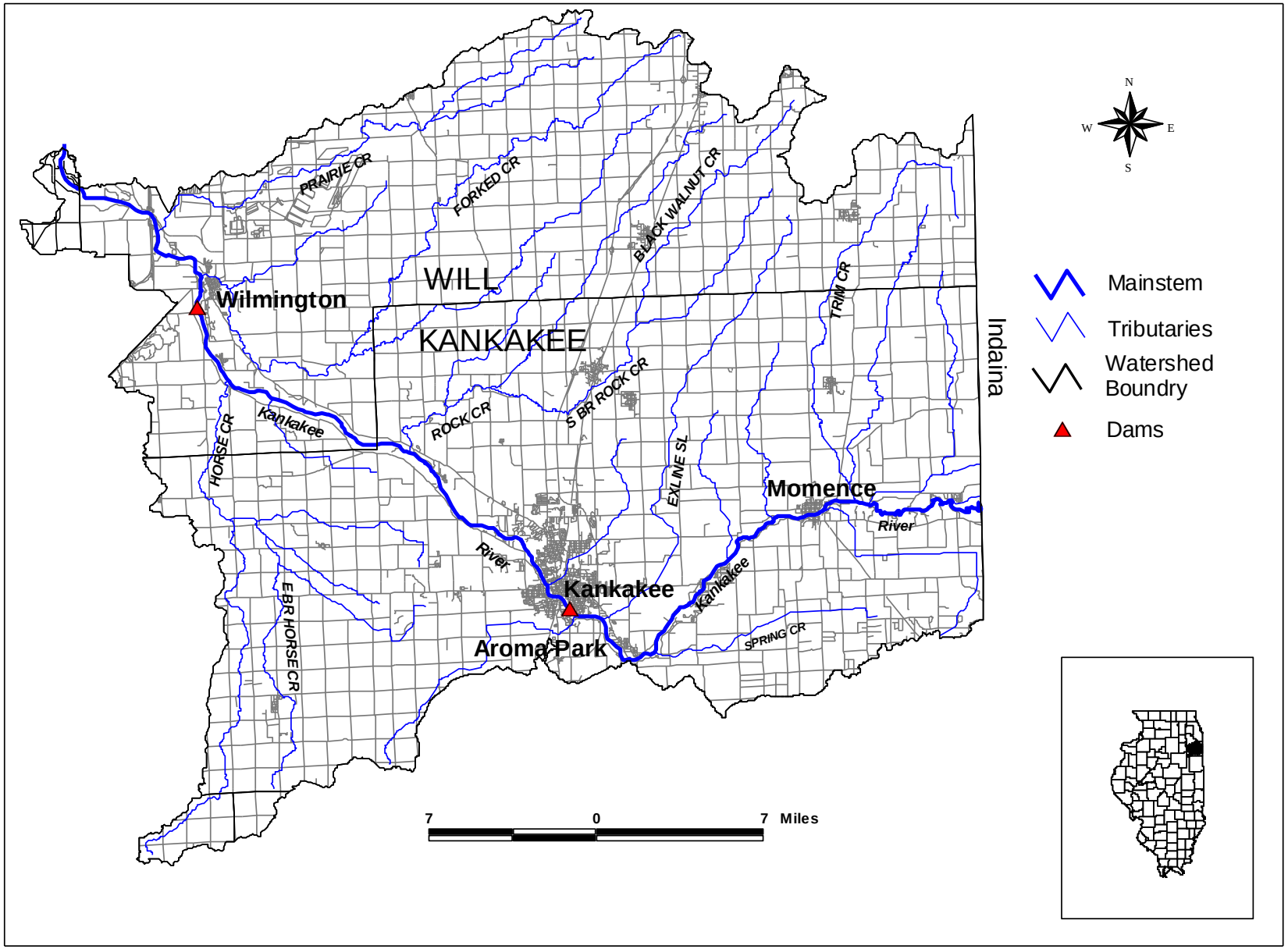


Figure 1. Kankakee River watershed.

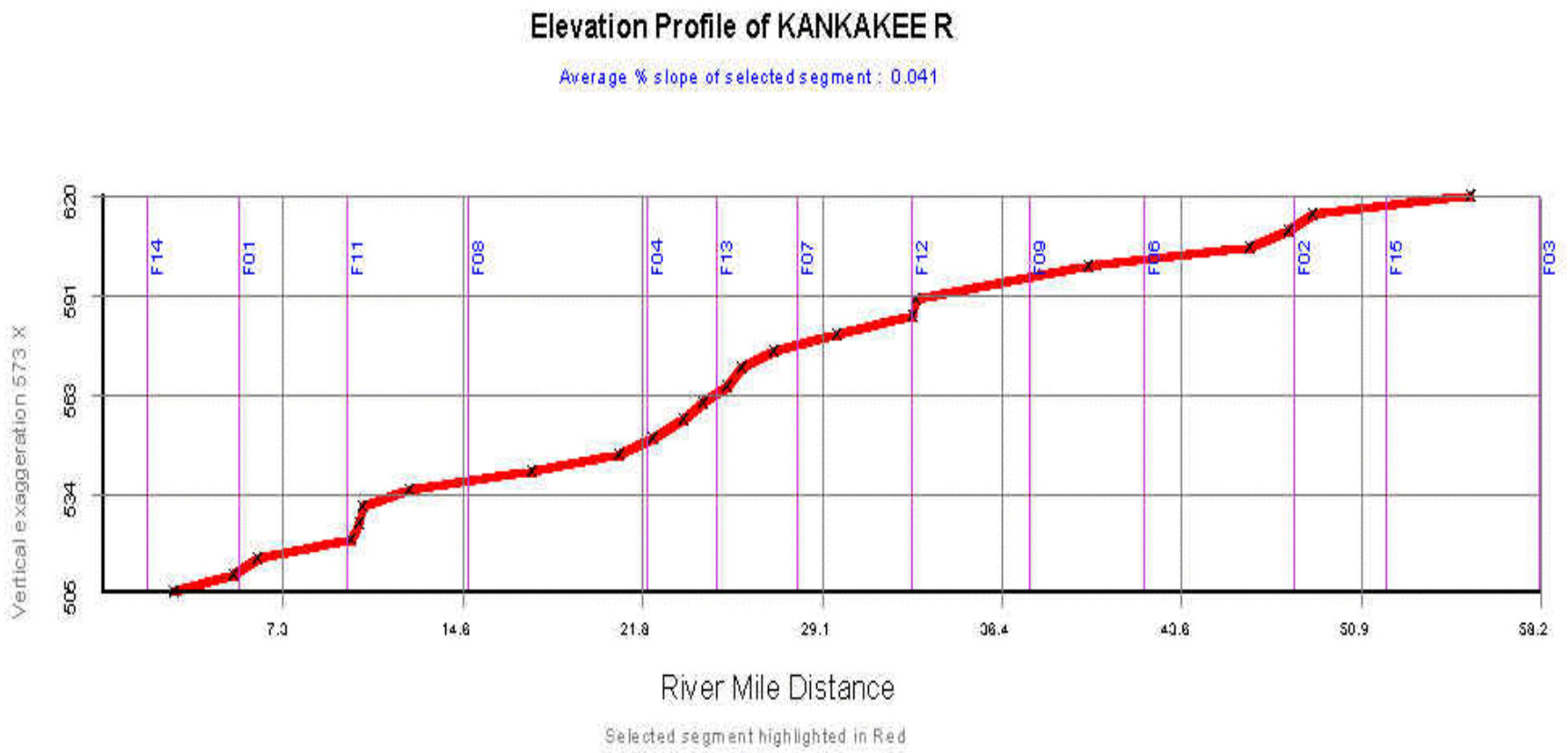


Figure 2. Elevation profile of the Kankakee River mainstem including locations of sampling stations and river mile.

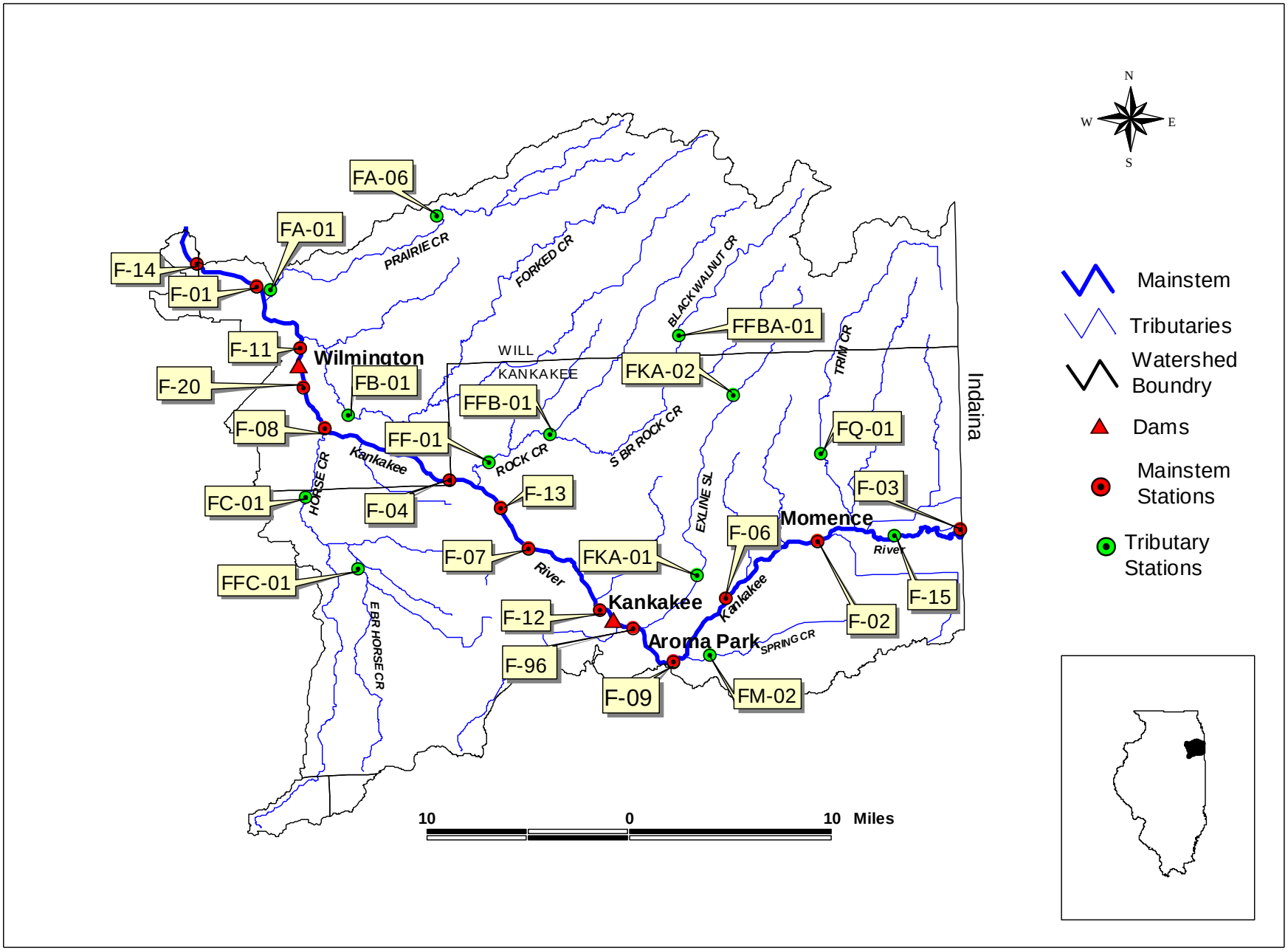


Figure 3. Kankakee River watershed with locations of mainstem and tributary fish sampling locations for the 2015 Basin Survey.

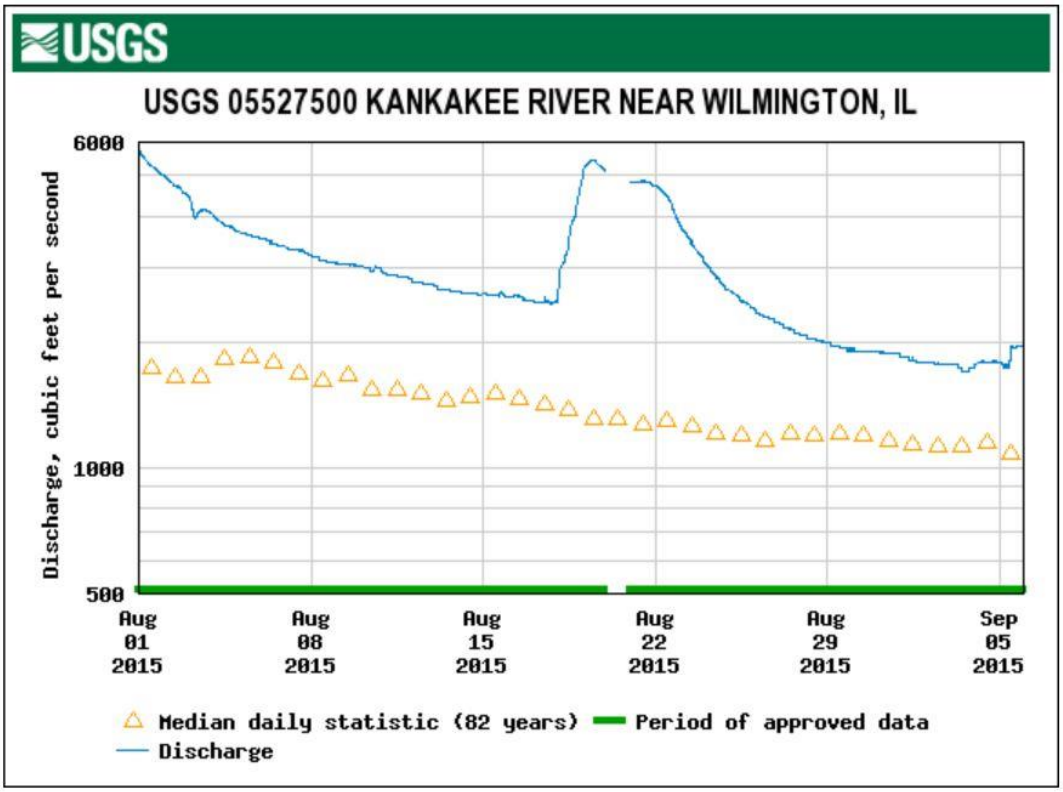
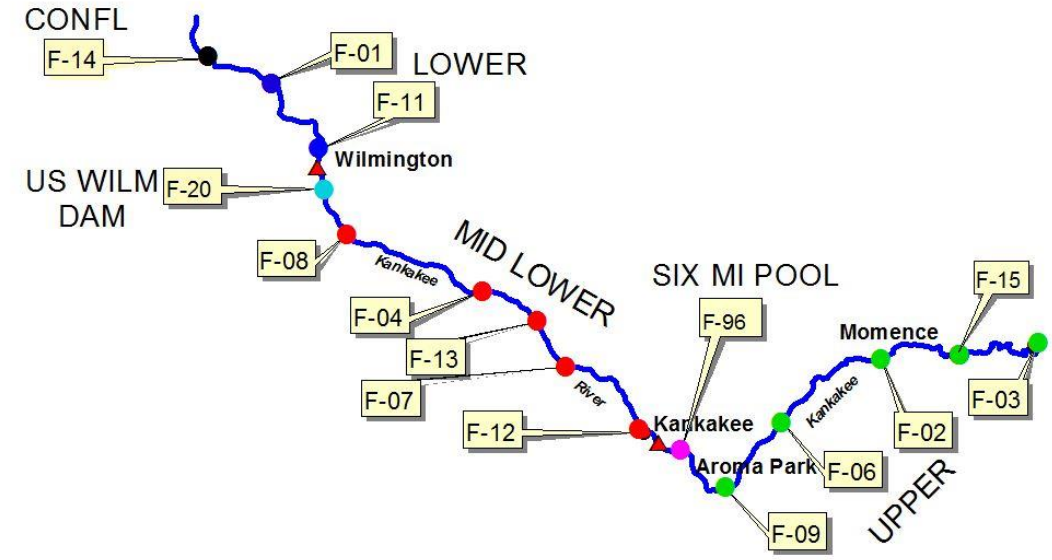


Figure 4. Daily discharge for the Kankakee River during the 2015 basin survey. Data from the United States Geological Survey (USGS) gaging station at Wilmington, recorded in cubic feet per second (cfs).



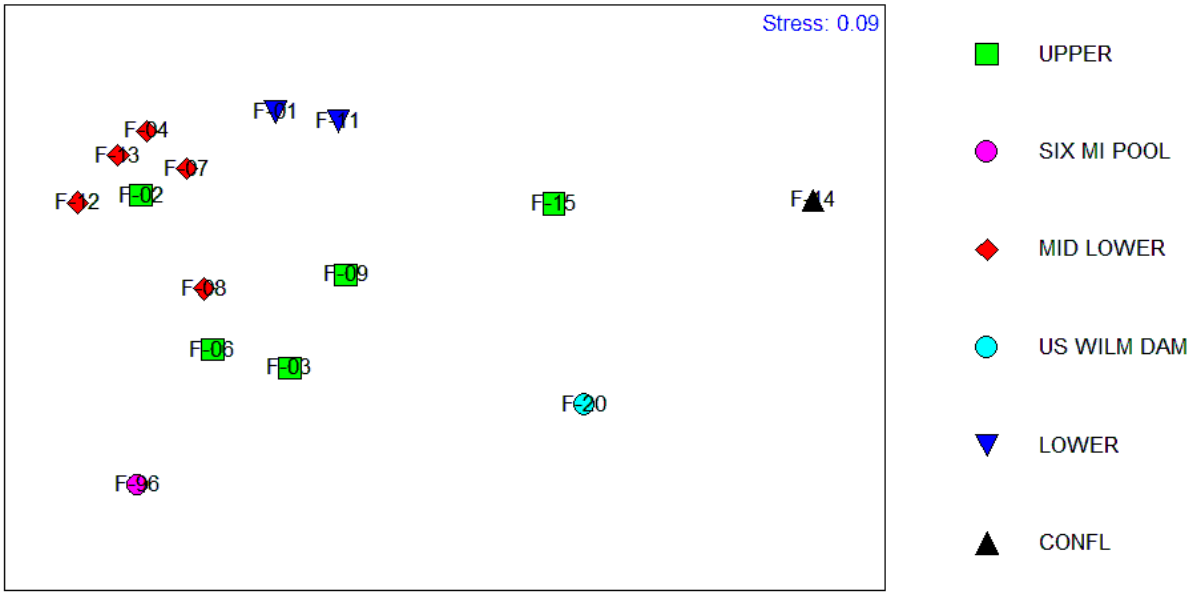


Figure 5. Top: Designated river segments for non-metric multi-dimensional scaling (NMDS) plot of Kankakee River mainstem fish sampling stations. Bottom: NMDS plot based on Bray-Curtis (1957) similarity of catch per unit effort for each fish species at each mainstem station categorized by river segments shown above.

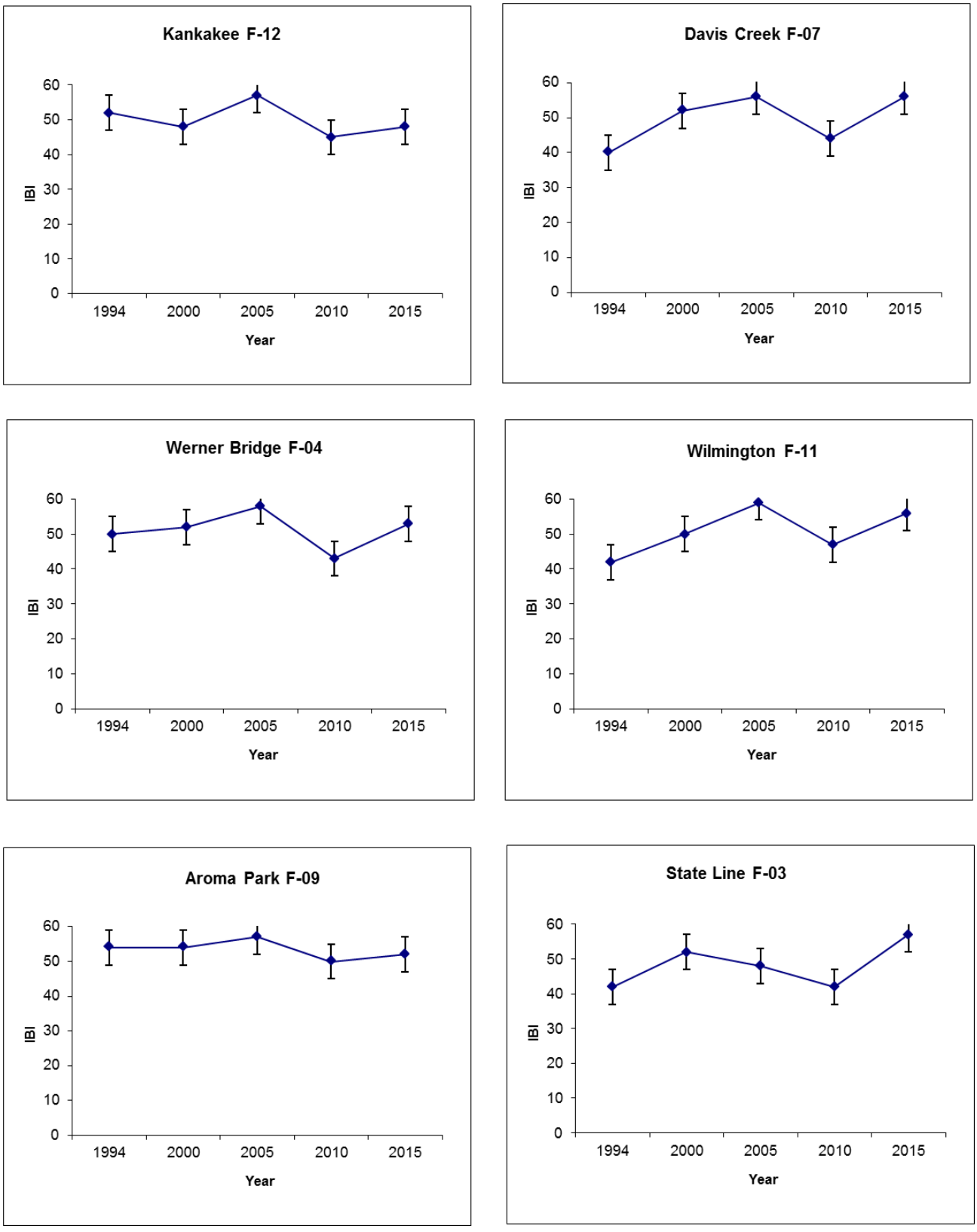


Figure 6. Index of Biotic Integrity (IBI) values for Kankakee River basin surveys at selected mainstem stations from 1994 to 2015. Bars represent range for biologically meaningful change (>10 points, Smogor 2004).

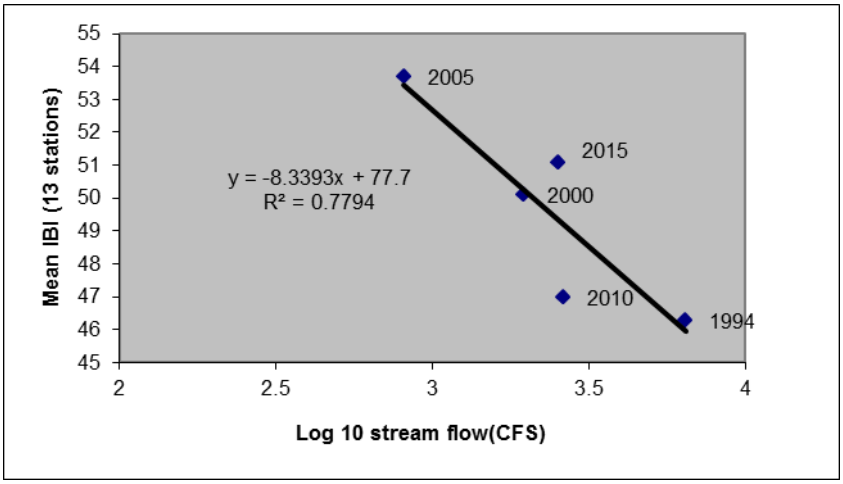


Figure 7. Mean stream flow during fish collection period; Log 10 cubic feet per second (CFS) vs. mean Index of Biotic integrity (IBI) scores for 13 mainstem Kankakee River stations 1994 – 2015.

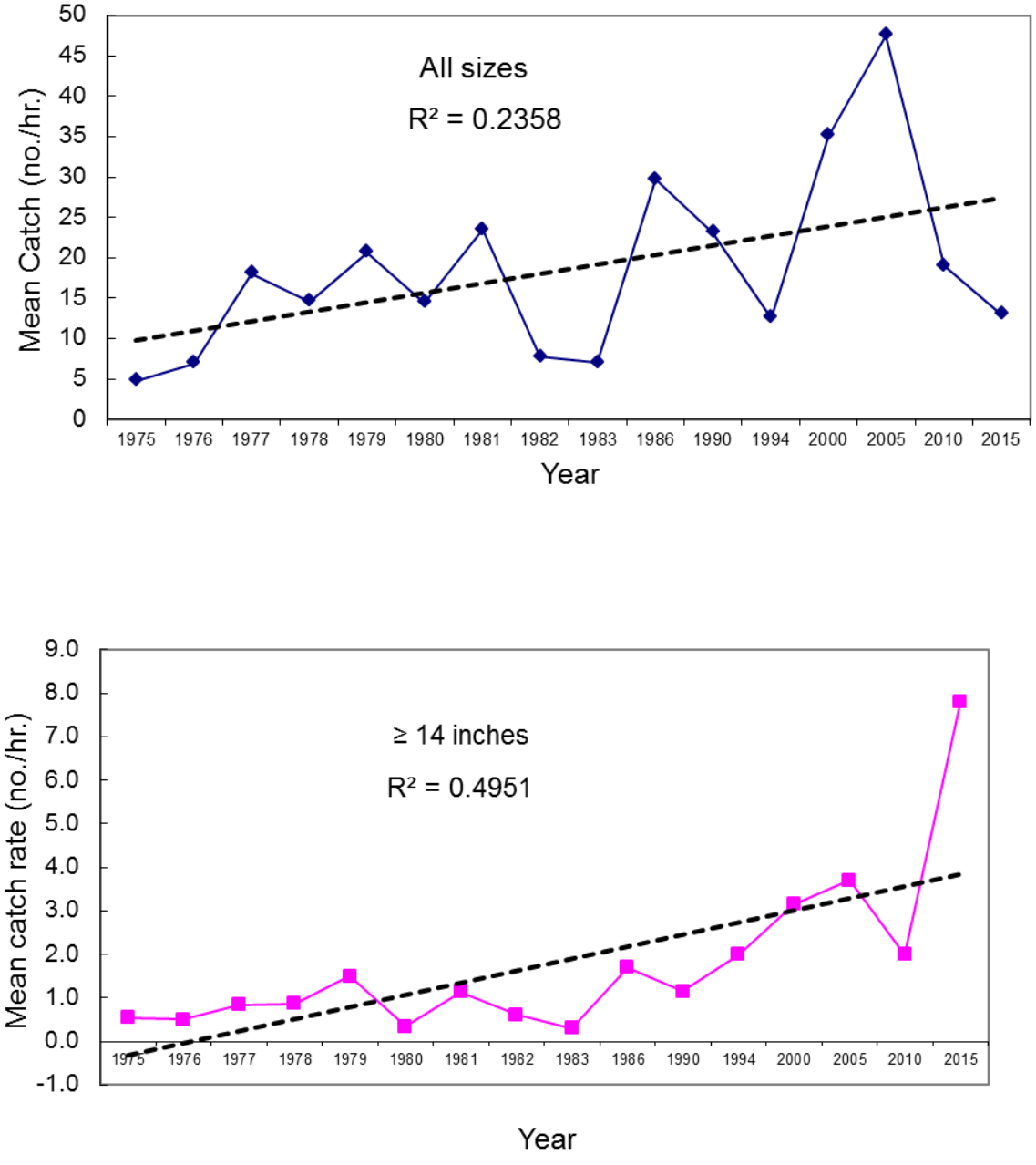
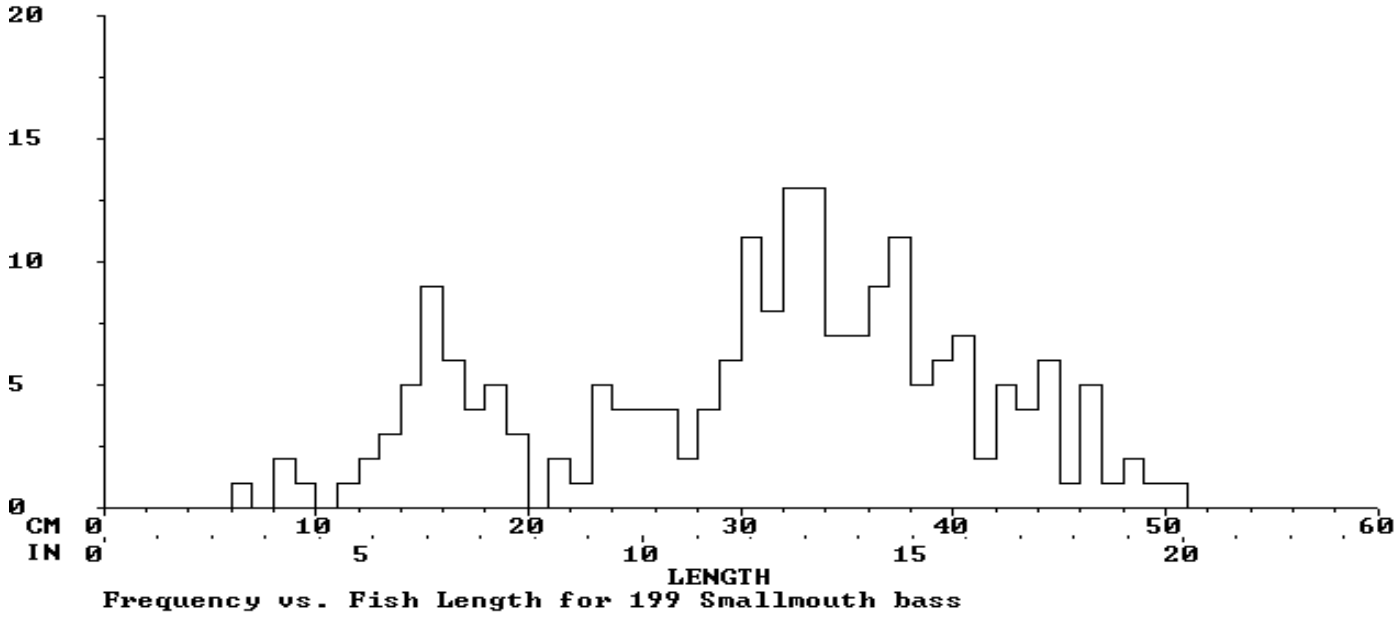


Figure 8. Mean electrofishing catch rate (no. fish/hr.) for Smallmouth Bass of all sizes (top) and for individuals ≥ 14 inches (bottom) at 13 mainstem Kankakee River stations, 1975 to 2015.



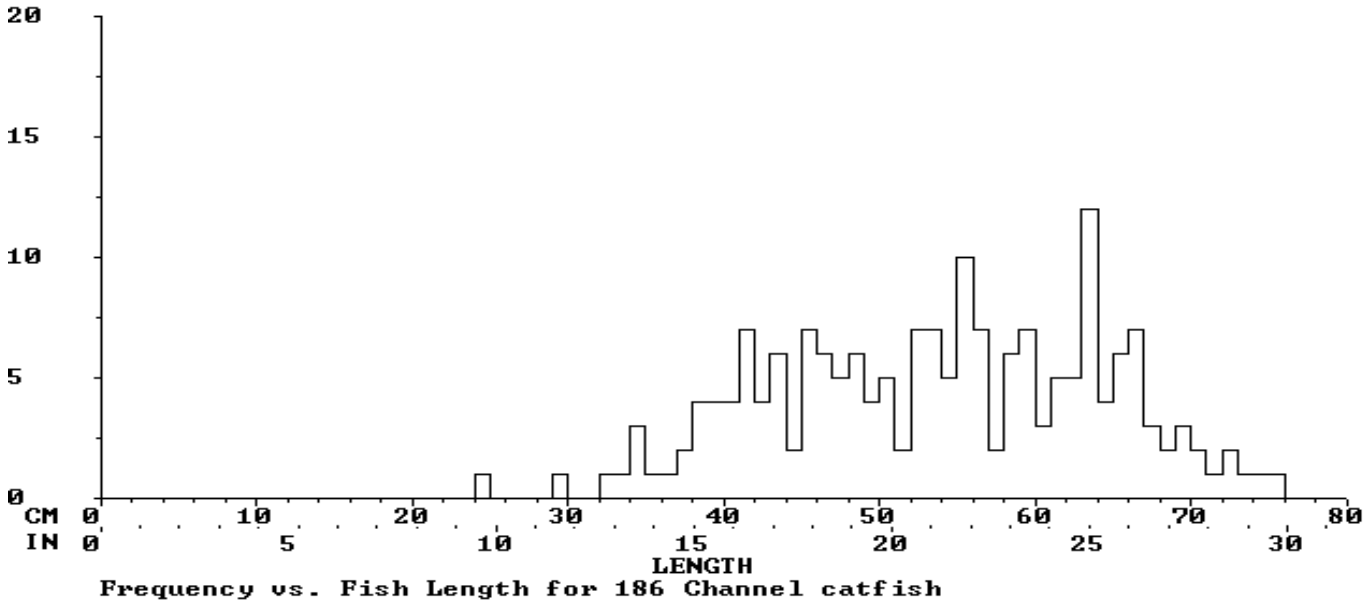


Figure 9. Length-frequency distributions for Smallmouth Bass (top) and Channel Catfish (bottom) at 13 mainstem stations for the 2015 Kankakee River basin survey.

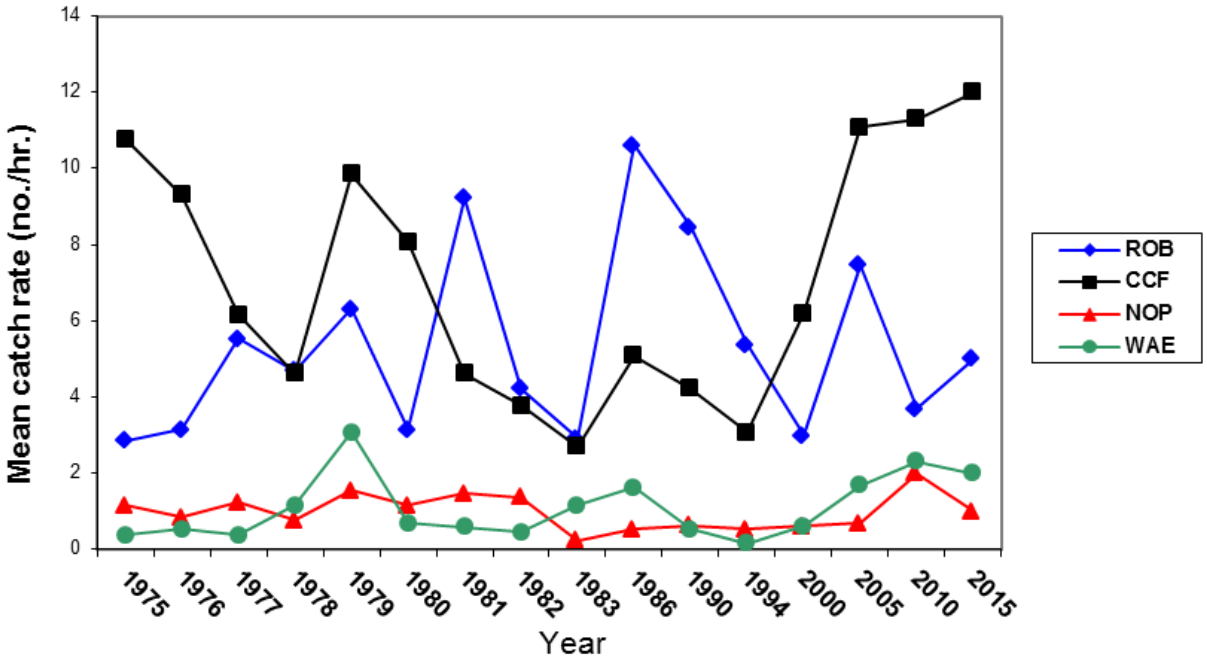


Figure 10. Mean electrofishing rate catch (no. fish/hr.) of Rock Bass (ROB), Channel Catfish (CCF), Northern Pike (NOP), and Walleye (WAE) for 13 mainstem Kankakee River stations from 1975 to 2015.

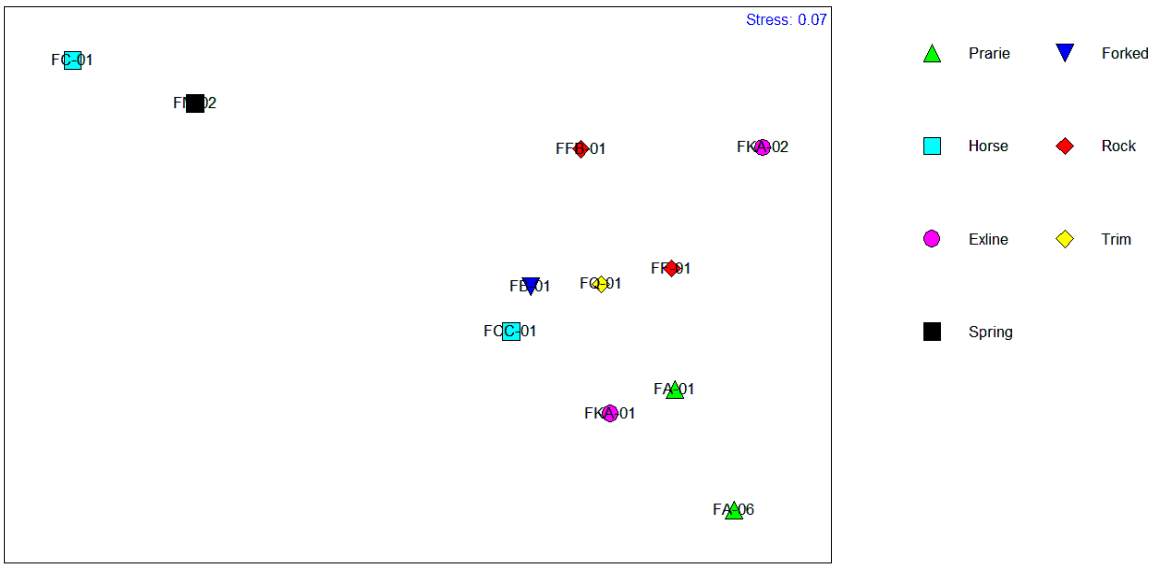


Figure 11. Non-metric multi-dimensional scaling plot based on Bray-Curtis (1957) similarity of catch per unit effort for each fish species at each tributary sampling station.

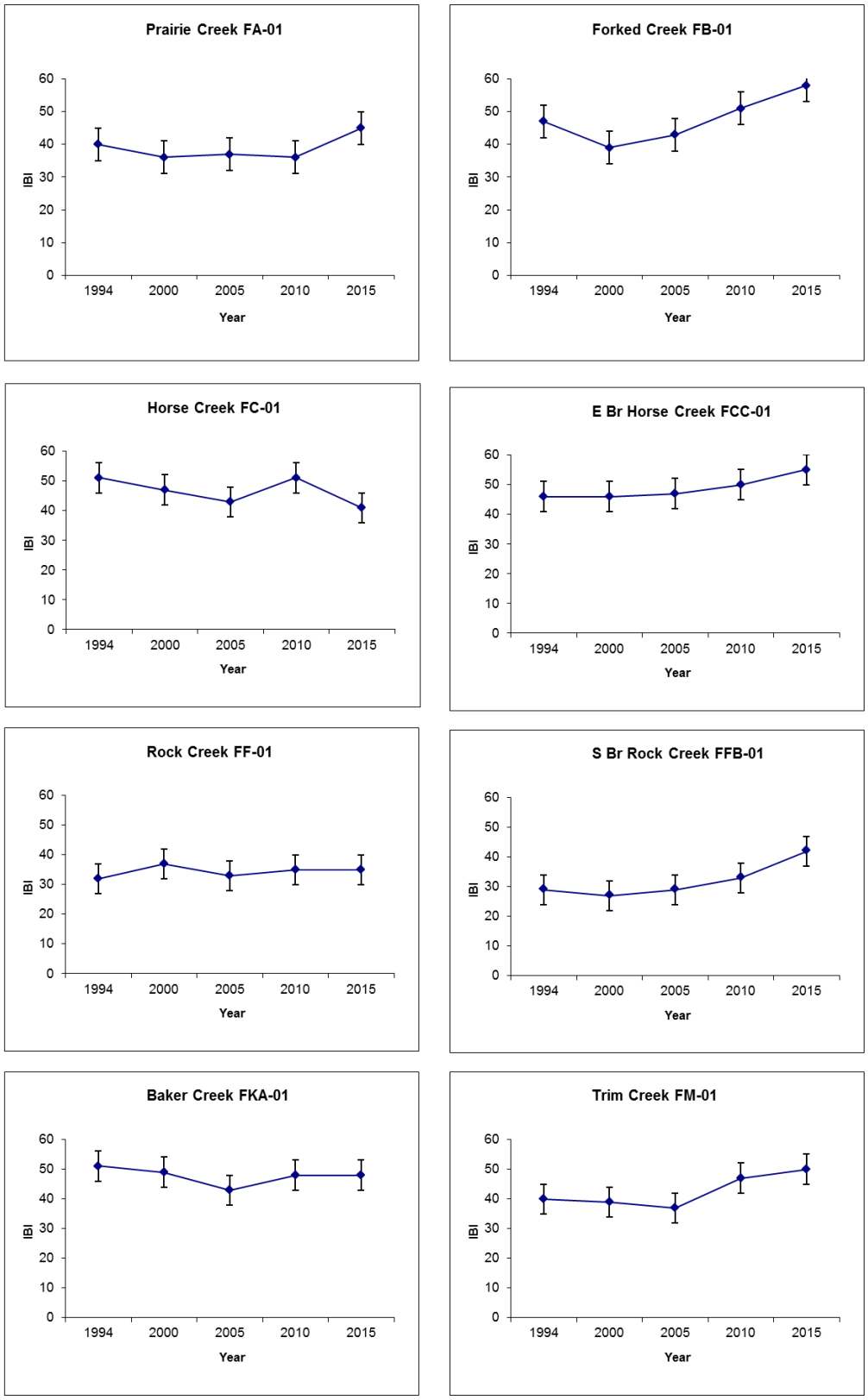
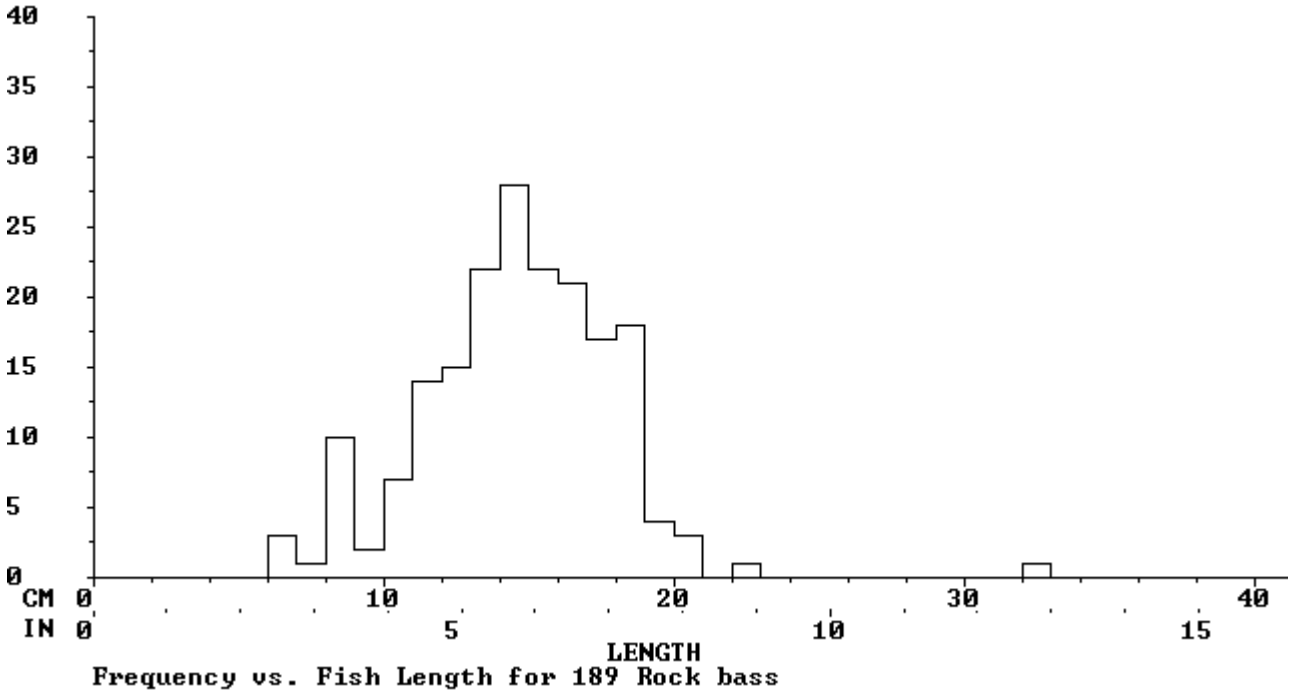


Figure 12. Index of Biotic Integrity (IBI) values for Kankakee River tributaries for stations sampled in all basin surveys from 1994 to 2015. Bar represent range for biologically meaningful change (>10 points, Smogor 2004).



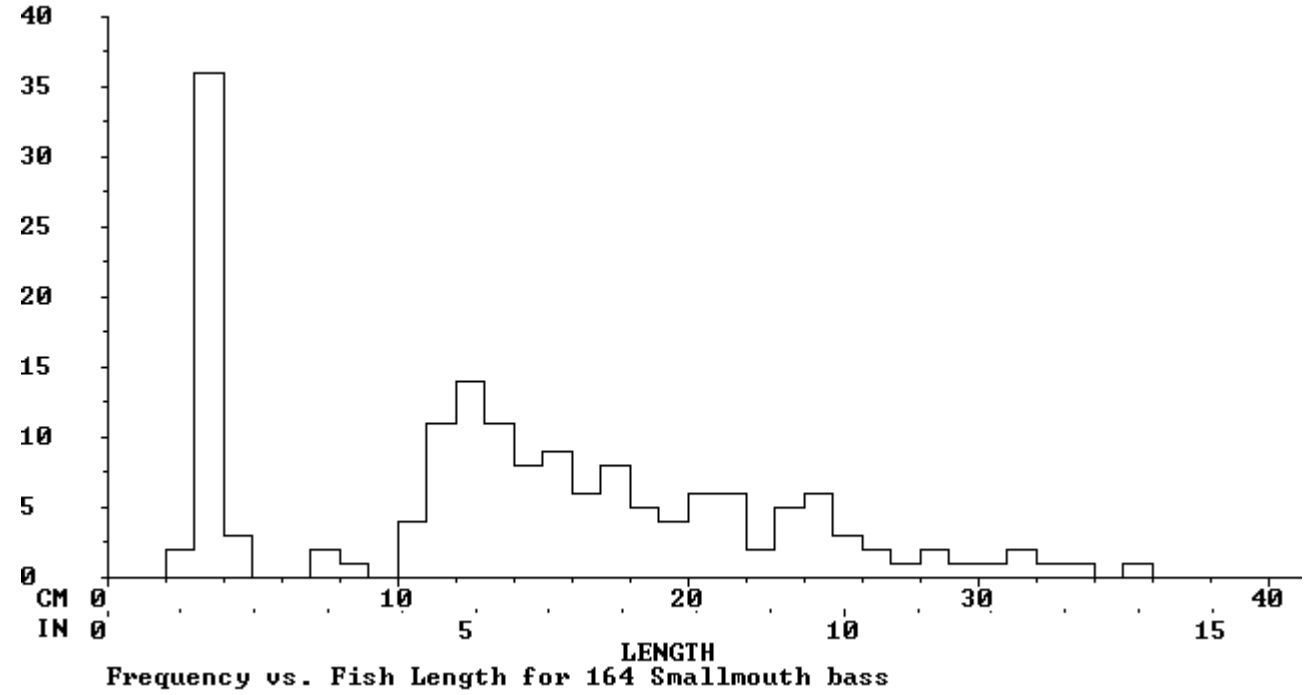


Figure 13. Length-frequency distributions for Rock Bass (top) and Smallmouth Bass (bottom) at 11 tributary stations for the 2015 Kankakee River basin survey.

Table 1. Location, sampling, and station information for 2015 Kankakee River Basin Survey sampling stations, BE = boat electrofishing; SE = seine hauls; ES = electric seine.

IEPA CODE	STREAM	LOCATION	COUNTY	LAT	LONG	SAMPLING DATE	SAMPLING GEAR	SAMPLE TIME (min)	STATION LENGTH (ft.)	STATION WIDTH (ft.)
F-03	KANKAKEE RIVER	ILL-IND STATE LINE	KANKAKEE	41.1660300	-87.5265700	3-Sep	BE, SE	60	NA	125
F-15	KANKAKEE RIVER	2.5 MI W MOMENC,E RIVER ISLE	KANKAKEE	41.1519444	-87.7050000	25-Aug	BE, SE	60	NA	175
F-02	KANKAKEE RIVER	ISLAND PARK MOMENCE	KANKAKEE	41.1601600	-87.6626000	25-Aug	BE, SE	60	NA	250
F-06	KANKAKEE RIVER	1.0 MI DS RT 17 BR 4 MI E KANKAKEE	KANKAKEE	41.1200400	-87.7507700	18-Aug	BE, SE	60	NA	430
F-09	KANKAKEE RIVER	NEAR AROMA PARK	KANKAKEE	41.0825400	-87.8223200	18-Aug	BE, SE	60	NA	410
F-96	KANKAKEE RIVER	UPSTREAM KANKAKEE DAM	KANKAKEE	41.1054810	-87.8585160	17-Aug	BE, SE	60	NA	625
F-12	KANKAKEE RIVER	100 YDS DNS KANKAKEE DAM	KANKAKEE	41.1133600	-87.8683500	17-Aug	BE, SE	60	NA	390
F-07	KANKAKEE RIVER	DAVIS CREEK AREA IN KANK RIVER PARK	KANKAKEE	41.1583900	-87.9378400	14-Aug	BE, SE	60	NA	400
F-13	KANKAKEE RIVER	LANGHAM ISLE IN KANK RIVER ST PARK	KANKAKEE	41.1880556	-87.9633333	14-Aug	BE, SE	60	NA	650
F-04	KANKAKEE RIVER	WILL CO LINE, WERNER BR, KKRSP	WILL	41.2081800	-88.0117700	13-Aug	BE, SE	60	NA	525
F-08	KANKAKEE RIVER	NEAR CUSTER PARK	WILL	41.2475400	-88.1293400	13-Aug	BE, SE	60	NA	460
F-20	KANKAKEE RIVER	UPSTREAM WILMINGTON DAM	WILL	41.2961270	-88.1547450	12-Aug	BE, SE	60	NA	900
F-11	KANKAKEE RIVER	RT 53 BR WILMINGTON	WILL	41.3053972	-88.1517250	12-Aug	BE, SE	60	NA	500
F-01	KANKAKEE RIVER	I-55 BR 3 MI NW WILMINGTON, IL	WILL	41.3500700	-88.1917800	11-Aug	BE, SE	60	NA	600
F-14	KANKAKEE RIVER	17 MI UPS DESPLAINES R	GRUNDY	41.3666694	-88.2492667	11-Aug	BE, SE	60	NA	1050
FQ-01	TRIM CREEK	CO RD 7000N 1M SSW GRANT PK	KANKAKEE	41.2225400	-87.6581400	31-Aug	ES	43	700	22
FM-02	SPRING CREEK	2.2 MI E AROMA PARK ON BOY SCOUT RD	KANKAKEE	41.0797000	-87.7670000	1-Sep	ES	80	460	28
FKA-01	BAKER CREEK	CO RD 0.9 MI SSW EXLINE	KANKAKEE	41.1371500	-87.7775700	1-Sep	ES	45	600	37
FKA-02	EXLINE SLOUGH	5.1MI E MANTENO AT 7000 E US	KANKAKEE	41.2659000	-87.7399000	31-Aug	ES	66	325	20
FF-01	ROCK CREEK	CO RD 5000W KANK R STATE PK	KANKAKEE	41.2212200	-87.9734400	27-Aug	ES	54	700	59
FFB-01	S BR ROCK CREEK	DS 1000W 1.0 MI, OFF BLUEGILL RD,	KANKAKEE	41.2374000	-87.9027000	28-Aug	ES	53	505	50
FC-01	HORSE CREEK	BR 2.5 MI NE ESSEX	KANKAKEE	41.1979800	-88.1479900	26-Aug	ES	45	614	50
FCC-01	E BR HORSE CREEK	CO RD 2000N 2 MI W BONFIELD	KANKAKEE	41.1461800	-88.0998700	27-Aug	ES	70	516	22
FA-01	PRAIRIE CREEK	AT RIVER ROAD	WILL	41.3424000	-88.1824460	2-Sep	ES	34	700	46
FA-06	PRAIRIE CREEK	4.5 E ELWOOD	WILL	41.3931000	-88.0197000	2-Sep	ES	24	432	17
FB-01	FORKED CREEK	AT LEASURE ROAD RITCHIE	WILL	41.2552400	-88.1055700	26-Aug	ES	35	600	52

Table 2. Total number of each fish species collected by all methods for the 2015 Kankakee River Basin Survey, including all mainstem and tributary stations with family, scirentific, and common names.

Family name	Common name	Scientific name	Total	Family name	Common name	Scientific name	Total
Lepistosteidae	Longnose gar	Lepisosteus osseus	41	Catostomidae	Black redhorse	Moxostoma duquesnei	54
Amidae	Bowfin	Amia calva	4		Golden redhorse	Moxostoma erythrurum	391
Clupidae	Gizzard shad	Dorosoma cepedianum	84		Silver redhorse	Moxostoma anisurum	85
	Mooneye	Hiodon tergisus	2	Ictaluridae	Channel catfish	Ictalurus punctatus	185
Escoidae	Grass pickerel	Esox americanus	66		Yellow bullhead	Ameiurus natalis	13
	Northern pike	Esox lucius	18		Flathead catfish	Pylodictis olivaris	29
Cyprinidae	Grass carp**	Ctenopharyngodon idella	3		Stonecat	Noturus flavus	20
	Carp	Cyprinus carpio	117		Tadpole madtom	Noturus gyrinus	22
	Golden shiner	Notemigonus crysoleucas	12		Slender madtom	Noturus exilis	3
	Creek chub	Semotilus atromaculatus	235	Aphredoderidae	Pirate perch	Aphredoderus sayanus	4
	Hornyhead chub	Nocomis biguttatus	872	Cyprinodontidae	Starhead topminnow*	Fundulus notti	3
	Central stoneroller	Campostoma anomalum	969		Blackstripe topminnow	Fundulus notatus	26
	Largescale stoneroller	Campostoma oligolepis	11	Antherinidae	Brook silverside	Labidesthes sicculus	60
	Suckermouth minnow	Phenacobius mirabilis	2	Moronidae	White bass	Morone chrysops	3
	Blacknose dace	Rhinichthys atratulus	1	Centrchidae	Black crappie	Pomoxis nigromaculatus	31
	Striped shiner	Luxilus chrysocephalus	2941		White crappie	Pomoxis annularis	4
	Redfin shiner	Lythrurus umbratilus	71		Rock bass	Ambloplites rupestris	266
	Spotfin shiner	Cyprinella spiloptera	2486		Largemouth bass	Micropterus salmoides	239
	Fathead minnow	Pimephales promelas	4		Smallmouth bass	Micropterus dolomieu	363
	Bluntnose minnow	Pimephales notatus	1996		Green sunfish	Lepomis cyanellus	178
	Bullhead minnow	Pimephales vigilax	53		Bluegill x Green sunfish hybrid	Lepomis macrochirus x L. cyanellus	6
	Emerald shiner	Notropis atherinoides	55		Bluegill	Lepomis macrochirus	279
	Rosyface shiner	Notropis rubellus	350		Redear sunfish	Lepomis microlophus	1
	Ironcolor shiner*	Notropis chalybaeus	37		Pumpkinseed	Lepomis gibbosus	2
	Sand shiner	Notropis ludibundus	446		Longear sunfish	Lepomis megalotis	304
	Mimic shiner	Notropis volucellus	817		Orangespotted sunfish	Lepomis humilis	3
	Spottail shiner	Notropis hudsonius	14	Percidae	Walleye	Stizostedion vitreum	29
	Silverjaw minnow	Notropis buccatus	13		Sauger	Stizostedion canadense	1
Catostomidae	Bigmouth buffalo	Ictiobus cyprinellus	27		Blackside darter	Percina maculata	33
	Smallmouth buffalo	Ictiobus bubalus	50		Slenderhead darter	Percina phoxocephala	16
	Black buffalo	Ictiobus niger	9		Logperch	Percina caprodes	105
	Quillback	Carpiodes cyprinus	47		Johnny darter	Etheostoma nigrum	284
	Highfin carpsucker	Carpiodes velifer	7		Banded darter	Etheostoma zonale	263
	White sucker	Catostomus commersoni	200		Rainbow darter	Etheostoma caeruleum	520
	Spotted sucker	Minytrema melanops	7		Orangethroat darter	Etheostoma spectabile	1
	Lake chubsucker	Erimyzon sucetta	36		Fantail darter	Etheostoma flabellare	76
	Northern hog sucker	Hypentelium nigricans	119		Least darter	Etheostoma microperca	2
	River redhorse*	Moxostoma carinatum	48	Scaenidae	Freshwater drum	Aplodinotus grunniens	31
	Shorthead redhorse	Moxostoma macrolepidotum	524				
						total number	16729
						number fish species	76

Table 3. List of species collected for all Kankakee River Basin surveys 1994 - 2015; all methods and stations combined.

Common name	2015	2010	2005	2000	1994	Common name	2015	2010	2005	2000	1994
American brook lamprey**		X				Northern hog sucker	X	X	X	X	X
Unidentified lamprey					X	River redhorse*	X	X	X	X	X
Shortnose gar				X		Shorthead redhorse	X	X	X	X	X
Longnose gar	X	X	X	X	X	Black redhorse**	X	X	X	X	X
Bowfin	X	X	X	X	X	Golden redhorse	X	X	X	X	X
American eel*					X	Silver redhorse	X	X	X	X	X
Skipjack herring				X	X	Channel catfish	X	X	X	X	X
Gizzard shad	X	X	X	X	X	Yellow bullhead	X	X	X	X	X
Threadfin shad***		X	X			Black bullhead			X		X
Goldeye				X		Brown bullhead				X	
Mooneye	X			X	X	Flathead catfish	X	X	X		X
Central mudminnow		X	X	X		Stonecat	X	X	X	X	X
Grass pickerel	X	X	X	X	X	Tadpole madtom	X	X		X	X
Northern pike**	X	X	X	X	X	Slender madtom	X	X	X	X	X
Goldfish***			X			Trout- perch**					X
Carp***	X	X	X	X	X	Pirate perch	X	X	X	X	X
Grass Carp***	X					Banded Killifish*		X			
Golden shiner	X	X	X	X	X	Starhead topminnow	X	X	X	X	
Southern redbelly dace	X		X	X		Blackstripe topminnow	X	X	X	X	X
Creek chub	X	X	X	X	X	Mosquito fish***		X			
Hornyhead chub	X	X	X	X	X	Brook silverside	X	X	X	X	X
Central stoneroller	X	X	X	X	X	White bass	X			X	X
Largescale stoneroller**	X					Yellow bass	X			X	
Suckermouth minnow	X	X	X	X	X	White perch***			X		
Blacknose dace	X		X	X	X	Black crappie	X	X	X	X	X
Brassy minnow					X	White crappie	X	X	X	X	X
Striped shiner	X	X	X	X	X	Rock bass	X	X	X	X	X
Redfin shiner	X	X	X	X	X	Largemouth bass	X	X	X	X	X
Spotfin shiner	X	X	X	X	X	Smallmouth bass**	X	X	X	X	X
Steelcolor shiner					X	Warmouth		X	X	X	X
Red shiner			X	X	X	Green sunfish	X	X	X	X	X
Fathead minnow	X	X		X	X	Bluegill	X	X	X	X	X
Bluntnose minnow	X	X	X	X	X	Pumpkinseed	X	X	X	X	
Bullhead minnow	X	X	X	X	X	Longear sunfish	X	X	X	X	X
Emerald shiner	X	X	X	X	X	Orangespotted sunfish	X	X	X	X	X
Rosyface shiner**	X	X	X	X	X	Walleye**	X	X	X	X	X
Weed shiner*				X		Sauger**	X	X	X		
Ironcolor shiner*	X	X	X	X		Blackside darter	X	X	X	X	X
Sand shiner	X	X	X	X	X	Slenderhead darter	X	X	X	X	X
Mimic shiner	X	X	X	X	X	Logperch	X	X	X	X	X
Spottail shiner	X		X		X	Johnny darter	X	X	X	X	X
Silverjaw minnow	X	X	X	X	X	Bluntnose darter				X	
Bigmouth buffalo	X	X	X	X	X	Banded darter	X	X	X	X	X
Smallmouth buffalo	X	X	X	X	X	Rainbow darter	X	X	X	X	X
Black buffalo	X	X	X	X	X	Orangethroat darter	X		X	X	
Quillback	X	X	X	X	X	Fantail darter	X	X	X	X	X
River carpsucker		X	X	X	X	Least darter	X	X	X	X	X
Highfin carpsucker**	X	X			X	Freshwater drum	X	X	X	X	X
White sucker	X	X	X	X	X	Round goby***		X			
Spotted sucker	X	X	X	X		Native species	75	74	72	78	74
Creek chubsucker		X				Non- native species	2	3	4	2	1
Lake Chubsucker**	X					Total species	77	77	76	80	75

*State Listed species **IL Species in greatest need of conservation; ***non- native species

Table 4. Number of each fish species collected at fifteen mainstem stations for the 2015 Kankakee River Basin Survey, including number of stations where each fish species was collected. Fish were sampled at each station with DC electofishing (60 minutes) and and seining (3 hauls). Stations are arranged from upstream (left) to downstream (right).

Common Name	Total	No. Stations Occurirng	State Line F-03	River Isle F-15	Mom-ence F-02	Rt. 17 F-06	Aroma Park F-09	US Kank. Dam F-96	Kank akee F-12	Davis Creek F-07	Langham Isle F-13	Werner Road F-04	Horse Creek F-08	US Wilm. Dam F-20	Wilm-ington F-11	I-55 F-01	Confl-uence F-14
Longnose gar	41	8	0	0	0	0	0	0	4	1	2	6	0	1	18	4	5
Bowfin	4	4	1	0	1	1	0	0	0	0	0	0	0	0	1	0	0
Gizzard shad	84	6	1	0	0	0	1	0	0	0	1	0	0	0	18	6	57
Mooneye	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Grass pickerel	39	8	7	1	4	8	0	1	0	0	0	0	1	15	0	0	2
Northern pike	18	6	3	5	7	1	0	1	0	0	0	0	0	1	0	0	0
Grass carp	3	2	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Carp	82	15	10	7	21	3	1	3	7	3	1	3	3	13	4	1	2
Golden shiner	12	5	1	0	0	1	0	0	0	0	0	0	0	2	0	1	7
Hornyhead chub	3	2	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Central stoneroller	19	2	0	8	0	0	0	0	0	0	0	0	0	11	0	0	0
Suckermouth minnow	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Blacknose dace	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Striped shiner	30	6	0	1	0	0	0	3	0	6	1	0	4	0	0	15	0
Redfin shiner	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Spotfin shiner	2417	15	88	360	46	32	21	27	2	60	9	25	74	83	153	97	1340
Fathead minnow	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Bluntnose minnow	830	14	21	26	9	24	58	15	0	4	10	3	1	420	18	4	217
Bullhead minnow	53	5	1	23	0	0	1	0	0	0	0	0	0	26	0	0	2
Emerald shiner	53	4	0	0	0	0	0	0	0	0	0	0	0	6	21	24	2
Rosyface shiner	111	10	0	12	3	0	0	0	0	4	9	5	4	46	11	12	5
Ironcolor shiner*	36	1	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sand shiner	381	12	0	102	5	9	100	1	0	8	0	2	2	81	30	2	39
Mimic shiner	103	7	0	0	2	0	0	0	0	36	0	7	5	5	33	15	0
Spottail shiner	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
Silverjaw minnow	9	2	0	7	0	0	0	0	0	0	0	0	0	2	0	0	0
Bigmouth buffalo	27	6	10	7	0	1	2	6	0	0	0	0	0	0	0	0	1
Smallmouth buffalo	50	10	5	2	3	8	2	4	6	0	0	0	0	0	10	2	8
Black buffalo	9	2	4	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Quillback	47	13	7	6	2	6	5	1	7	4	2	0	0	3	2	1	1
Highfin carpsucker	7	3	2	0	0	4	0	0	0	1	0	0	0	0	0	0	0
Spotted sucker	7	4	0	1	0	4	0	1	0	0	0	0	0	1	0	0	0
Lake chubsucker	36	1	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern hog sucker	99	12	3	0	15	1	12	0	3	9	3	16	6	1	13	17	0
River redhorse*	48	9	0	3	10	3	1	0	15	3	0	0	5	0	5	3	0
Shorthead redhorse	523	15	23	13	119	10	37	2	59	89	51	31	13	1	34	39	2
Black redhorse	19	5	0	0	0	0	0	0	0	6	3	2	2	0	6	0	0
Golden redhorse	359	14	18	6	15	31	20	0	21	23	21	73	15	19	18	71	8
Silver redhorse	81	13	9	6	1	15	6	9	8	4	2	8	9	1	0	3	0
Channel catfish	186	14	5	4	48	14	16	0	17	3	11	19	3	6	25	14	1
Yellow bullhead	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Flathead catfish	29	11	0	1	1	4	3	5	1	4	0	1	0	0	2	1	6
Stonecat	2	2	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Tadpole madtom	14	1	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pirate perch	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Starhead topminnow*	3	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blackstripe topminnow	7	3	1	0	0	5	0	0	0	0	0	0	0	1	0	0	0
Brook silverside	60	10	16	0	0	1	1	6	5	0	1	2	0	5	6	17	0
White bass	3	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
Black crappie	31	6	13	0	4	8	2	0	0	0	0	0	0	0	1	3	0
White crappie	4	4	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0
Rock bass	77	9	11	2	8	22	0	0	1	0	0	8	14	10	0	1	0
Largemouth bass	175	15	35	5	9	15	21	15	10	2	3	2	7	13	9	14	15
Smallmouth bass	199	15	5	17	26	9	7	6	14	20	7	33	12	6	16	15	6
Green sunfish	36	11	0	0	4	2	1	6	1	3	3	3	1	3	0	9	0
Bluegill x Green sunfish hybrid	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Bluegill	113	13	37	2	3	9	5	3	9	10	0	2	4	15	0	3	11
Redear sunfish	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Pumpkinseed	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Longear sunfish	201	14	15	0	1	10	2	2	1	2	2	5	21	131	2	4	3
Orangespotted sunfish	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Walleye	28	6	0	0	0	0	3	0	1	0	1	5	0	0	10	8	0
Sauger	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Blackside darter	16	8	2	2	2	1	5	0	0	0	2	1	0	1	0	0	0
Slenderhead darter	15	4	0	0	0	0	0	0	4	1	0	0	0	0	5	5	0
Logperch	106	6	2	0	1	0	1	0	0	0	0	0	0	0	47	53	2
Johnny darter	18	8	0	2	3	1	4	0	0	3	3	0	0	0	1	1	0
Banded darter	7	5	0	0	2	0	1	0	0	0	0	1	0	2	1	0	0
Freshwater drum	31	5	0	0	0	0	0	0	1	0	0	0	0	1	8	17	4
	7033		446	638	377	264	339	117	198	310	148	265	206	935	531	484	1767
	69		39	29	31	32	28	21	22	26	22	26	21	35	33	35	28

Table 5. Total abundance and catch per unit effort (CPUE, no./hr.) for fish species collected by boat electrofishing at 13 Kankakee River mainstem stations for 2015, and previous Basin Surveys, 1994 – 2010. Fish species with less than 15 individuals not included.

	2015		2010		2005		2000		1994		Mean	
	Total	CPUE	Total	CPUE	Total	CPUE	Total	CPUE	Total	CPUE	Total	CPUE
Shorthead redhorse	518	39.8	511	39.3	464	35.7	453	34.8	244	18.8	438	33.7
Golden redhorse	336	25.8	411	31.6	488	37.5	269	20.7	266	20.5	354	27.2
Smallmouth bass	186	14.3	239	18.4	618	47.5	456	35.1	280	21.5	356	27.4
Channel catfish	180	13.8	147	11.3	144	11.1	105	8.1	47	3.6	125	9.6
Spotfin shiner	136	10.5	316	24.3	207	15.9	695	53.5	169	13.0	305	23.4
Sand shiner	112	8.6	75	5.8	4	0.3	53	4.1	42	3.2	57	4.4
Logperch	104	8.0	56	4.3	64	4.9	27	2.1	17	1.3	54	4.1
Northern hog sucker	95	7.3	62	4.8	43	3.3	109	8.4	47	3.6	71	5.5
Largemouth bass	89	6.8	95	7.3	67	5.2	89	6.8	23	1.8	73	5.6
Gizzard shad	82	6.3	216	16.6	437	33.6	133	10.2	371	28.5	248	19.1
Mimic shiner	74	5.7	102	7.8	122	9.4	14	1.1	1	0.1	63	4.8
Silver redhorse	71	5.5	39	3.0	98	7.5	67	5.2	70	5.4	69	5.3
Carp	66	5.1	58	4.5	87	6.7	133	10.2	132	10.2	95	7.3
Rock bass	62	4.8	44	3.4	67	5.2	73	5.6	98	7.5	69	5.3
Bluegill	51	3.9	139	10.7	217	16.7	137	10.5	10	0.8	111	8.5
Longear sunfish	49	3.8	122	9.4	101	7.8	144	11.1	85	6.5	100	7.7
River redhorse	48	3.7	51	3.9	53	4.1	45	3.5	43	3.3	48	3.7
Emerald shiner	47	3.6	2	0.2	111	8.5	17	1.3	10	0.8	37	2.9
Bluntnose minnow	46	3.5	130	10.0	139	10.7	141	10.8	64	4.9	104	8.0
Smallmouth buffalo	46	3.5	19	1.5	14	1.1	12	0.9	8	0.6	20	1.5
Quillback	43	3.3	40	3.1	30	2.3	39	3.0	48	3.7	40	3.1
Longnose gar	39	3.0	22	1.7	11	0.8	16	1.2	12	0.9	20	1.5
Freshwater drum	30	2.3	69	5.3	32	2.5	61	4.7	63	4.8	51	3.9
Walleye	28	2.2	31	2.4	22	1.7	11	0.8	8	0.6	20	1.5
Flathead catfish	24	1.8	10	0.8	7	0.5	0	0.0	6	0.5	9	0.7
Green sunfish	22	1.7	26	2.0	19	1.5	9	0.7	21	1.6	19	1.5
Bigmouth buffalo	21	1.6	11	0.8	20	1.5	7	0.5	0	0.0	12	0.9
Black redhorse	19	1.5	49	3.8	33	2.5	24	1.8	11	0.8	27	2.1
Grass pickerel	17	1.3	14	1.1	1	0.1	9	0.7	1	0.1	8	0.6
Black crappie	17	1.3	8	0.6	4	0.3	6	0.5	2	0.2	7	0.6
Northern pike	15	1.2	21	1.6	9	0.7	8	0.6	8	0.6	12	0.9
Slenderhead darter	14	1.1	11	0.8	21	1.6	1	0.1	6	0.5	11	0.8
Black buffalo	9	0.7	2	0.2	11	0.8	5	0.4	1	0.1	6	0.4
Johnny darter	9	0.7	5	0.4	24	1.8	2	0.2	5	0.4	9	0.7
Rosyface shiner	7	0.5	10	0.8	2	0.2	21	1.6	3	0.2	9	0.7
Highfin carpsucker	7	0.5	1	0.1	0	0.0	0	0.0	1	0.1	2	0.1
Blackside darter	7	0.5	5	0.4	27	2.1	2	0.2	9	0.7	10	0.8

Table 6. Index of Biotic Integrity (IBI) for 2015 Kankakee River mainstem stations, including values and scores for individual metrics, total range for IB I = 0 to 60, with higher scores indicating better stream quality. Includes data from boat electrofisng

	F-14		F-01		F-11		F-20		F-08		F-04		F-13		F-07		F-12		F-96		F-09		F-06		F-02		F-15		F-03	
Metric	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
Native fish species	27	6	34	6	32	6	34	6	20	4	24	5	21	4	25	5	21	4	19	4	27	6	31	6	30	6	28	6	37	6
Native minnow species	5	6	8	5	7	5	11	6	6	4	5	4	4	3	6	4	1	1	4	3	4	3	4	3	5	4	8	5	7	5
Native sucker species	5	4	7	5	7	5	6	4	6	4	5	4	6	4	8	6	7	5	6	4	8	6	10	6	7	5	9	6	10	6
Native sunfish species	5	5	8	6	4	4	7	6	6	6	6	6	4	4	5	5	6	6	5	5	6	6	8	6	8	6	4	4	8	6
Benthic invertivore species	5	4	9	6	10	6	7	5	6	4	8	5	7	5	9	6	7	5	4	3	10	6	9	6	10	6	9	6	9	6
Intolerant species	2	2	4	4	6	6	6	6	4	4	5	5	4	4	6	6	3	3	2	2	3	3	4	4	4	4	3	3	5	5
Prop. specialist benthic invertivores	0.01	1	0.4	6	0.25	6	0.03	1	0.24	6	0.5	6	0.57	6	0.45	6	0.56	6	0.09	4	0.26	6	0.24	6	0.45	6	0.05	2	0.16	6
Prop. geneneralist feeders	0.96	1	0.35	6	0.55	6	0.71	4	0.47	6	0.25	6	0.26	6	0.45	6	0.25	6	0.6	5	0.63	5	0.44	6	0.38	6	0.87	2	0.51	6
Prop. mineral-substrate spawners	0.01	1	0.5	6	0.32	6	0.11	2	0.41	6	0.69	6	0.68	6	0.53	6	0.64	6	0.18	4	0.27	5	0.36	6	0.53	6	0.11	2	0.25	5
Prop. tolerant species	0.15	6	0.12	6	0.06	6	0.15	6	0.15	6	0.13	6	0.14	6	0.12	6	0.1	6	0.16	6	0.11	6	0.13	6	0.1	6	0.07	6	0.08	6
IBI		36		56		56		46		50		53		48		56		48		40		52		55		55		42		57

Table 7. Index of Biotic Integrity scores for Kankakee River Basin mainstem stations 1994 - 2015. One-way ANOVA indicated no significant difference among years.

Station location	Code	1994	2000	2005	2010	2015
State Line	F-03	42	52	48	42	57
River Isle	F-15	44	56	48	43	42
Momence	F-02	52	48	49	54	55
DS Rt. 17	F-06	48	50	57	51	55
Aroma Park	F-09	54	54	57	50	52
Kankakee	F-12	52	48	57	45	48
Davis Creek	F-07	40	52	56	44	56
Langham Island	F-13	46	50	54	56	48
Werner Bridge	F-04	50	52	58	43	53
Rivals Club	F-08	50	50	55	52	50
Wilmington	F-11	42	50	59	47	56
I-55 Bridge	F-01	42	48	59	53	56
Confluence	F-14	40	42	41	37	36
	mean	46.3	50.1	53.7	47.46	51.08
	STDEV	4.76	3.28	5.28	5.43	6.03

Table 8. Number of each fish species collected at eleven tributary stations for the 2015 Kankakee River Basin Survey, including number of stations where each fish species was collected. All stations were sampled with electric seine.

Common Name	Total	No. of Stations	Prairie Creek FA-06	Prairie Creek FA-01	Forked Creek FB-01	Horse Creek FC-01	East Br. Horse Creek FCC-01	Rock Creek FF-01	So. Br. Rock Creek FFB-01	Baker Creek FKA-01	Exline Slough FKA-02	Trim Creek FQ-01	Spring Creek FM-02
Striped shiner	2911	9	1150	517	222	0	317	106	32	416	31	120	0
Bluntnose minnow	1166	9	564	245	101	0	131	18	21	24	50	12	0
Central stoneroller	950	9	35	205	191	0	50	50	189	38	0	186	6
Hornyhead chub	869	9	144	262	7	0	26	140	70	160	41	19	0
Mimic shiner	714	2	0	0	474	0	240	0	0	0	0	0	0
Rainbow darter	520	7	0	1	32	4	290	0	0	85	0	65	43
Johnny darter	265	11	30	13	29	3	64	1	45	6	14	49	11
Banded darter	255	8	0	0	52	9	78	10	67	8	0	2	29
Rosyface shiner	239	8	17	52	27	0	41	26	31	35	0	10	0
Creek chub	235	9	66	5	4	0	8	23	43	5	2	79	0
White sucker	200	6	84	17	5	2	0	0	53	0	0	39	0
Rock bass	189	8	0	0	22	4	27	38	54	31	0	6	7
Bluegill	166	7	8	2	1	9	6	0	139	0	0	0	1
Smallmouth bass	164	10	18	14	5	3	6	57	45	11	0	1	4
Green sunfish	142	10	27	38	1	3	4	4	20	20	0	23	2
Longear sunfish	103	6	0	1	15	5	29	0	0	52	0	0	1
Fantail darter	76	7	1	26	7	3	21	0	0	11	0	0	7
Redfin shiner	70	7	51	0	1	0	11	0	0	3	1	2	1
Spotfin shiner	69	5	0	8	24	0	1	0	0	32	0	4	0
Sand shiner	65	7	31	8	5	0	2	0	0	1	12	6	0
Largemouth bass	64	10	12	1	1	2	8	2	20	3	0	12	3
Carp	35	3	0	0	2	0	0	0	31	2	0	0	0
Black redhorse	35	1	0	0	35	0	0	0	0	0	0	0	0
Golden redhorse	33	3	17	2	14	0	0	0	0	0	0	0	0
Grass pickerel	27	6	0	8	0	1	12	0	0	0	2	1	3
Northern hogsucker	20	3	0	0	12	1	7	0	0	0	0	0	0
Blackstripe topminnow	19	4	0	0	0	1	1	0	0	0	2	0	15
Stonecat	18	5	3	3	2	0	8	0	0	0	0	2	0
Blackside darter	17	4	0	0	6	3	0	0	0	1	0	0	7
Yellow bullhead	12	4	4	0	0	0	5	0	0	2	0	0	1
Largescale stoneroller	11	1	0	0	11	0	0	0	0	0	0	0	0
Tadpole madtom	8	3	0	0	0	0	5	0	0	1	2	0	0
Bluegill x Green sunfish hybrid	5	2	0	0	0	1	0	0	0	4	0	0	0
Silverjaw minnow	4	1	0	4	0	0	0	0	0	0	0	0	0
Silver redhorse	4	1	0	0	4	0	0	0	0	0	0	0	0
Least darter	4	2	0	0	0	0	2	0	0	0	2	0	0
Slender madtom	3	1	0	0	0	0	3	0	0	0	0	0	0
Pirate perch	3	1	0	0	0	0	0	0	0	0	3	0	0
Emerald shiner	2	1	0	0	0	0	0	0	0	2	0	0	0
Ironcolor shiner	1	1	0	0	0	0	0	0	0	0	0	0	1
Shorthead redhorse	1	1	0	0	1	0	0	0	0	0	0	0	0
Orangespotted sunfish	1	1	0	0	0	0	0	0	0	1	0	0	0
Slenderhead darter	1	1	0	0	1	0	0	0	0	0	0	0	0
Orangethroat darter	1	1	0	0	1	0	0	0	0	0	0	0	0
Total no. individuals	9697		1877	1432	1313	54	1401	475	860	951	162	638	142
No. fish species	42		19	21	31	15	28	12	15	24	12	19	17

Table 9. Index of Biotic Integrity (IBI) for Kankakee River tributary stations including values and scores for individual metrics. Total range for IB I = 0 to 60, with higher scores indicating better stream quality. .

	Prairie Creek FA-06		Prairie Creek FA-01		Forked Creek FB-01		Horse Creek FC-01		E. Br. Horse Ck. FCC-01		Rock Creek FF-01		S. Br. Rock Ck. FFB-01		Baker Creek FKA-01		Exline Slough FKA-02		Trim Creek FQ-01		Spring Creek FM-02	
Metric	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
Native fish species	19	4	21	5	30	6	15	3	28	6	12	2	14	3	23	5	12	3	19	5	17	4
Native minnow species	5	5	9	5	11	6	0	0	10	5	6	4	6	4	10	6	6	3	9	5	3	2
Native sucker species	2	3	2	2	6	6	2	2	1	2	0	0	1	1	0	0	0	0	1	2	0	0
Native sunfish species	5	6	5	6	6	6	6	6	6	6	4	5	5	6	6	6	0	0	4	6	6	6
Benthic invertivore species	4	3	5	4	12	6	6	4	9	6	2	2	2	2	6	4	3	2	4	3	5	4
Intolerant species	3	3	4	4	8	6	4	4	7	6	4	4	4	4	5	5	1	1	5	5	4	4
Prop. specialist benthic invertivores	0.022	1	0.029	1	0.144	5	0.426	6	0.335	6	0.023	1	0.13	5	0.118	4	0.111	4	0.191	6	0.683	6
Prop. geneneralist feeders	0.874	2	0.589	6	0.64	5	0.259	6	0.517	6	0.32	6	0.395	6	0.53	6	0.593	6	0.437	6	0.035	6
Prop. mineral-substrate spawners	0.605	6	0.735	6	0.456	6	0.278	4	0.553	6	0.878	6	0.488	6	0.819	6	0.451	5	0.641	6	0.486	6
Prop. tolerant species	0.263	5	0.19	6	0.167	6	0.133	6	0.143	6	0.25	5	0.357	5	0.217	6	0.167	6	0.211	6	0.118	6
IBI		38		45		58		41		55		35		42		48		30		50		44

Table 10. Index of Biotic Integrity scores for Kankakee River Basin tributary stations 1994 - 2015. One way ANOVA indicated no significant difference among means.

Stream	Code	1994	2000	2005	2010	2015
Prairie Creek	FA-01	40	36	37	36	45
Prairie Creek	FA-06				37	38
Forked Creek	FB-01	47	39	43	51	58
Horse Creek	FC-01	51	47	43	51	41
East. Branch Horse Creek	FCC-01	46	46	47	50	55
Rock Creek	FF-01	32	37	33	35	35
South Branch Rock Creek	FFB-01	29	27	29	33	42
Baker Creek	FKA-01	51	49	43	48	48
Exline Slough	FKA-02			31	34	30
Spring Creek	FM-01			50	37	44
Trim Creek	FQ-01	40	39	37	47	50
	mean	42.0	40.0	39.3	41.7	44.2
	STDEV	7.75	6.73	6.63	7.17	7.95

APPENDIX B
INFORMATIONAL NARP FLYER

Kankakee River Metropolitan Agency

1600 West Brookmont Blvd.
Kankakee, IL 60901
Phone: 815-933-0444
Fax: 815-933-0104

Providing Wastewater Treatment to the Kankakee River Valley

NOTICE OF PUBLIC MEETING
Kankakee River Nutrient Assessment and Reduction Plan
Informational Meeting

WHEN: Thursday, May 5, 2022, from 10:00am-12:00pm (CST)

WHERE: Donald E. Green Public Safety Center
City Council Chamber
385 East Oak Street
Kankakee, Illinois 60901

RSVP: Please RSVP to Art Strother, Kankakee River Metropolitan Agency (KRMA) Superintendent, at art@krmawastewater.com so that we can provide adequate seating.

The Illinois Environmental Protection Agency (IEPA) has determined the Kankakee River is at risk of eutrophication due to phosphorus levels, which means the IEPA has available information that plant, algal, or cyanobacterial growth will cause violation of a water quality standard. IEPA has required KRMA to develop a Nutrient Assessment and Reduction Plan (NARP) to address the Kankakee River's risk of eutrophication.

NARP development is a collaborative effort involving watershed stakeholders with the primary goal to protect the Kankakee River. This is an opportunity for landowners, state/county/municipal agencies, park districts, farm community, non-profit organizations, and other interested stakeholders in the watershed to develop partnerships that promote economical and environmentally compatible land uses that improve water quality in the Kankakee River.

This meeting will include a presentation on the background, what has been accomplished to date, and next steps. Stakeholders can identify issues, opportunities, and interest in assisting with NARP development.

Please make every effort to attend this meeting to learn of and lend your support to the water quality initiatives in the Kankakee River.

Thank You,
KRMA Staff

APPENDIX C
PUBLIC NOTICE

CERTIFICATE OF PUBLICATION

The Daily Journal Company, L.L.C. certifies that it is the publisher of The Daily Journal is a secular newspaper, has been continuously published daily for more than fifty (50) weeks prior to the first publication of the attached notice, is published in the City of Kankakee, County of Kankakee, Township of Kankakee, State of Illinois, is of general circulation throughout that county and surrounding area, and is a newspaper as defined by 715 ILCS 5/5.

A notice, a true copy of which is attached, was published one time in The Daily Journal, namely one time per week for one successive week.
The first publication of the notice was made in the newspaper, dated and published on April 14, 2022, and the last publication of the notice was made in the newspaper dated and published on April 14, 2022.
The notice was also placed on a statewide public notice website as required by 715 ILCS 5/2.1.

In witness, The Daily Journal Company, L.L.C. has signed this certificate by The Daily Journal, its publisher, at Kankakee, Illinois, on April 14, 2022.

The Daily Journal Company, L.L.C.

Cynthia Lipstak

Authorized Agent

(attach notice below this line, do not paste above)

NOTICE OF PUBLIC MEETING
Kankakee River Nutrient Assessment and Reduction Plan Informational Meeting

WHEN: Thursday, May 5, 2022, from 10:00am-12:00pm (CST)

WHERE: Donald E. Green Public Safety Center
City Council Chamber
385 East Oak Street
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This meeting will include a presentation on the background, what has been accomplished to date, and next steps. Stakeholders can identify issues, opportunities, and interest in assisting with NARP development.

Please make every effort to attend this meeting to learn of and lend your support to the water quality initiatives in the Kankakee River.

Thank You,
KRMA Staff

APPENDIX D
NARP STAKEHOLDER MEETING PRESENTATION

Kankakee River Watershed Informational Meeting
May 5, 2022

Nutrient Assessment and Reduction Plan (NARP)

Dan Small, P.E., BCEE, Strand Associates, Inc.®

KRMA
Kankakee River Metropolitan Agency

Agenda

- NARP History
- NARP Requirements
- Kankakee River Watershed
- Next Steps

KRMA
Kankakee River Metropolitan Agency

NARP History

Nutrient Sources

- Agricultural runoff, including fertilizer runoff and runoff from combined animal feeding operations (CAFOs)
- Wastewater discharges
- Urban runoff
- Natural

Illinois Developed Strategy in 2015

Strategy Goals

Address impacts of nutrients on local waterways

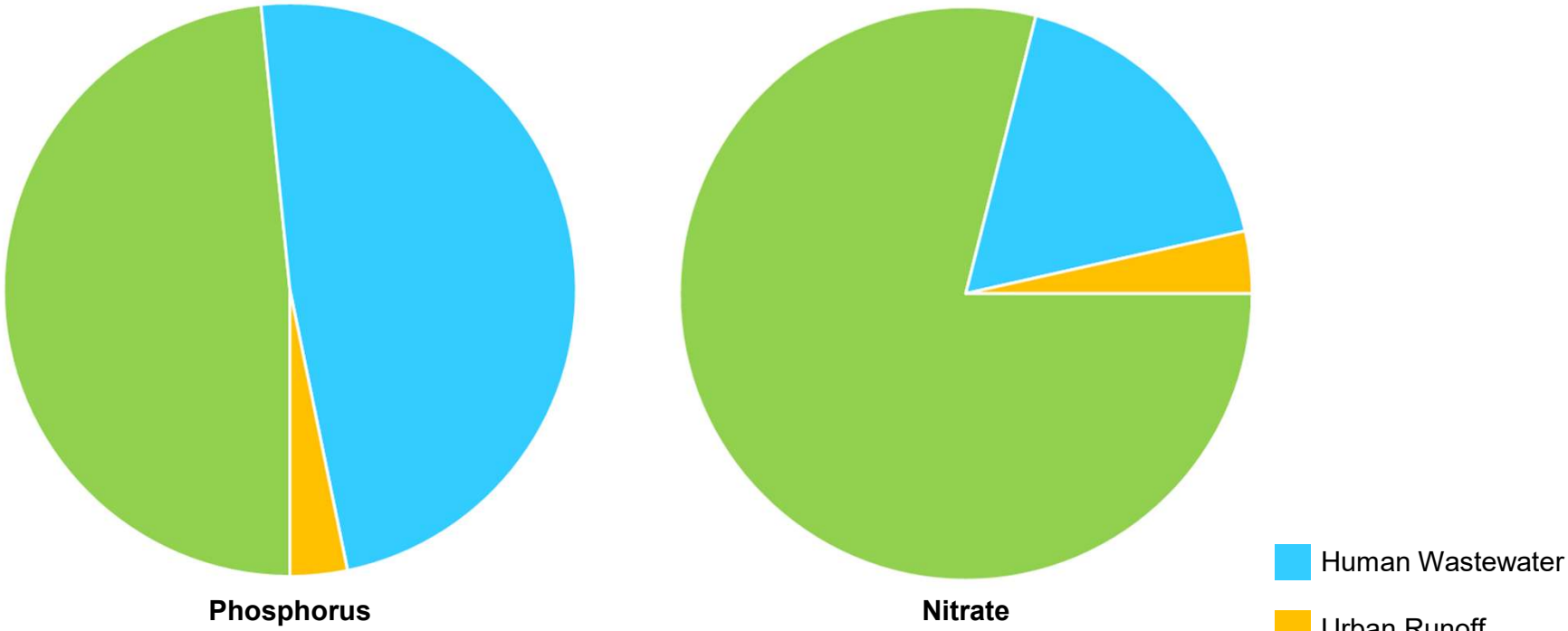
Reduce phosphorus and nitrate loss from Illinois by 45%

2025 Milestone

Nitrate ↓ by 15% Phosphorus ↓ by 25%

KRMA
Kankakee River Metropolitan Agency

Statewide Sources of Nutrients



from 2015 Nutrient Loss Reduction Strategy Science Assessment

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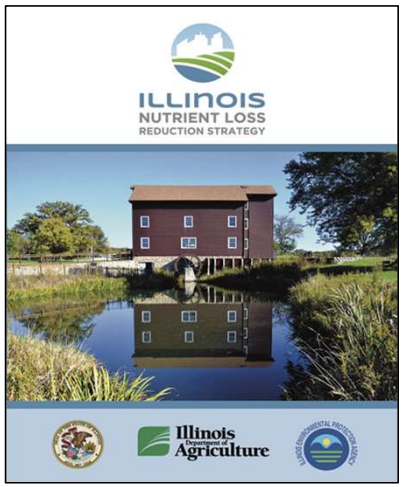
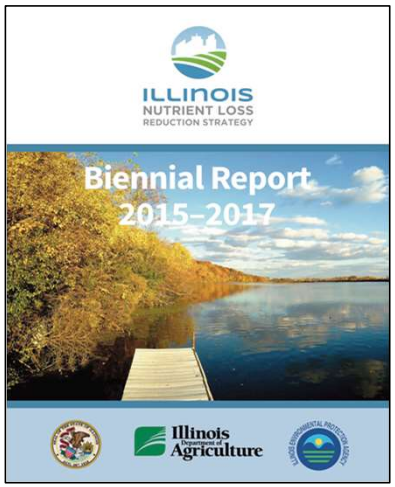
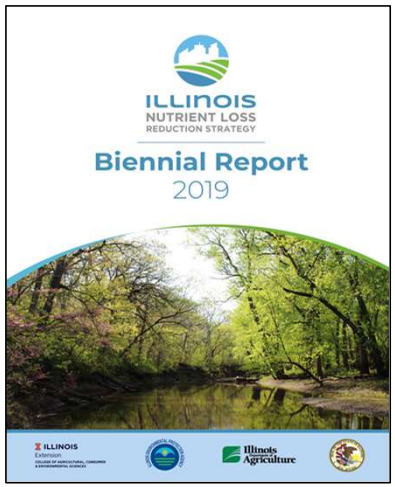
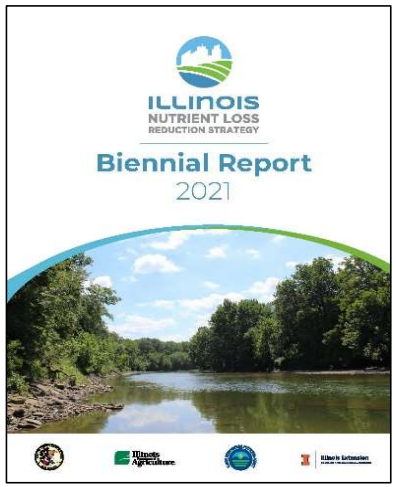
Strategy Implementation Continues









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2022 EPA Nutrient Reduction Memorandum Reinforces Efforts

Strategy 1: Deepen Collaborative Partnerships with Agriculture

Strategy 2: Redouble EPA's Efforts to Support States, Tribes, and Territories to Achieve Nutrient Pollution Reductions from All Sources

Strategy 3: Utilize EPA's Clean Water Act Authorities to Drive Progress, Innovation, and Collaboration

https://www.epa.gov/nutrient-policy-data/2022-epa-nutrient-reduction-memorandum

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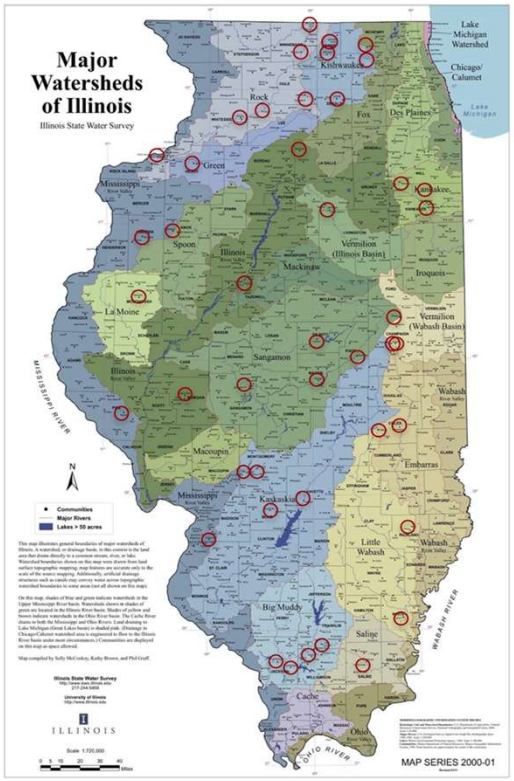
NARP Requirements

Determined by Illinois Environmental Protection Agency (IEPA)

- A facility located upstream of a waterbody or a stream segment that has been determined to have a **phosphorus-related impairment**
- OR determined to be at risk of **eutrophication** due to **phosphorus levels** in the waterbody

KRMA's Permit Requires NARP Development by December 31, 2023



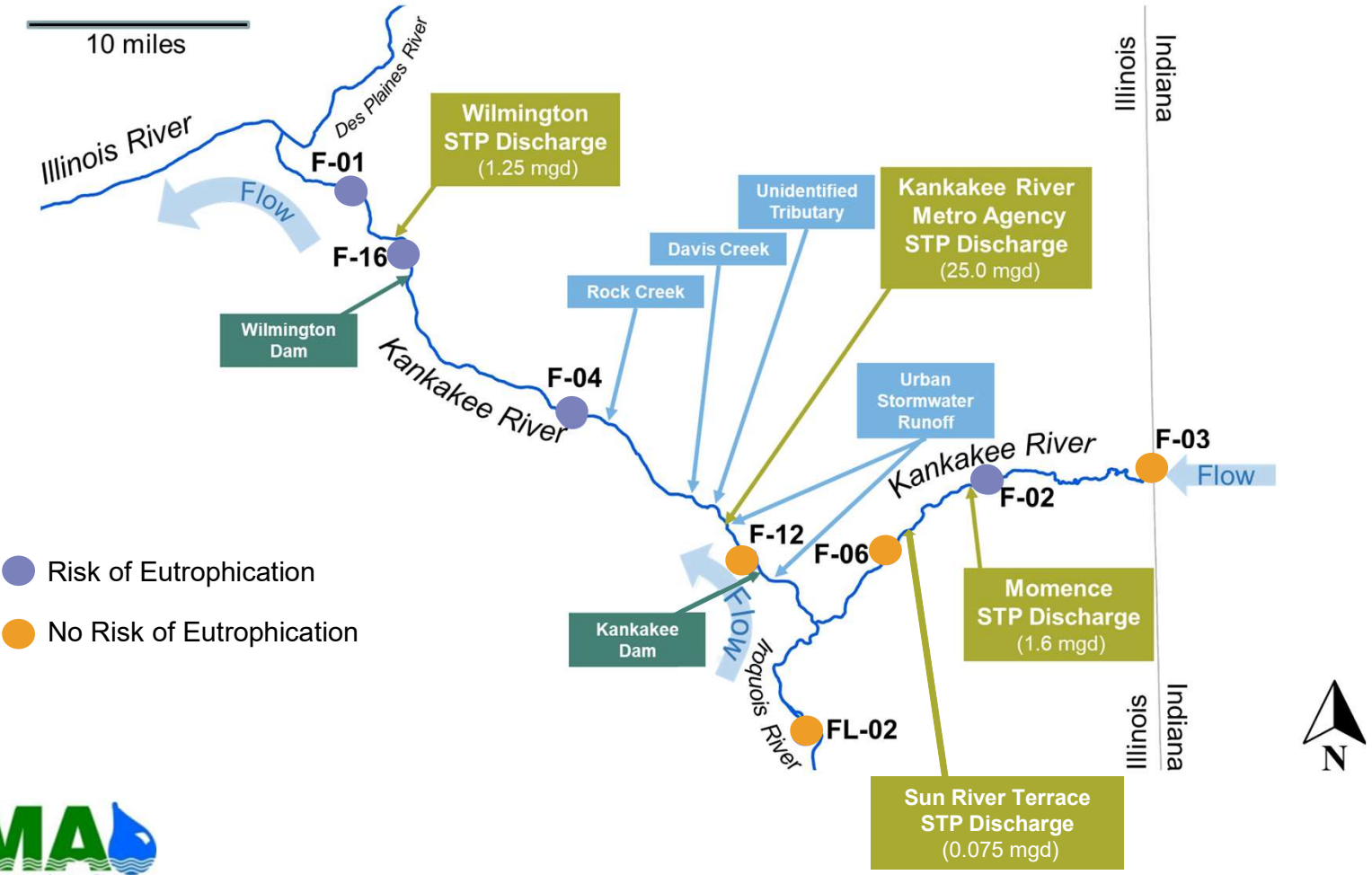
Source: University of Illinois

Facilities with NARP Requirements as of September 2020

Belvidere
Carbondale NW
Carbondale SE
Carmi
Charleston
Clinton SD
Collinsville
Dixon Correctional Center
Decatur
Galesburg
Geneseo
Greenville
Harrisburg
Herrin
Hillsboro
Huntley West
Jacksonville
Kankakee River
Kishwaukee WRD
Litchfield
Macomb
Manteno
Mattoon
Mendota
Moline South
Monticello
Murphysboro
Olney
Pekin
Pittsfield
Poplar Grove South
Rantoul
Rochelle
Rock River WRD
South Beloit
Springfield Spring Creek
Sterling
Streator
Urbana Champaign NE
Urbana Champaign SD SW
Vandalia
West Frankfort
Wilmington
Woodstock North
Woodstock South

KRMA
Kankakee River Metropolitan Agency

IEPA Sampling Data Since 2010 Indicates Risk of Eutrophication



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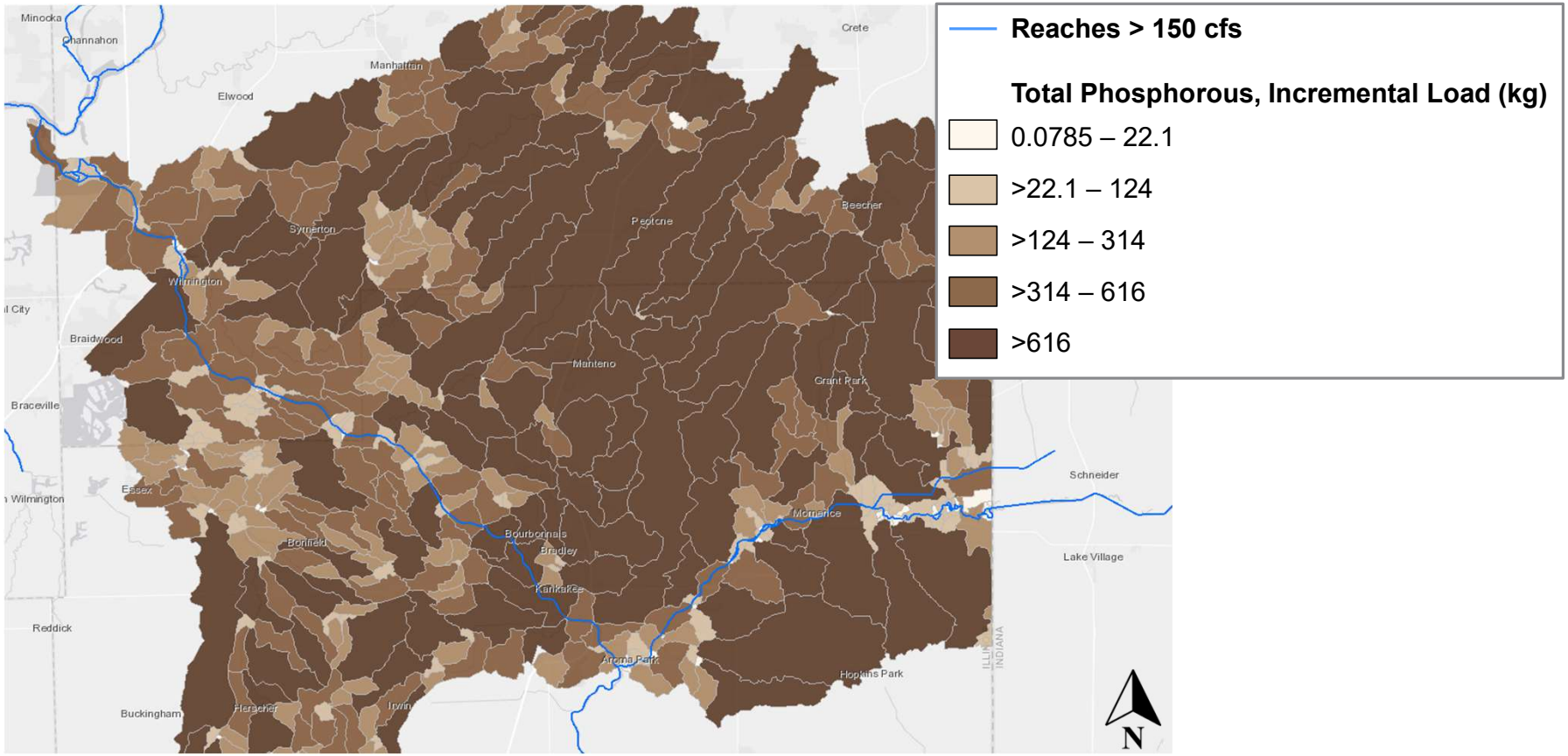
Phosphorus Loads to Kankakee River Come From a Variety of Sources



Source: 2012 USGS Sparrow Model

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Phosphorus Loads to Kankakee River Come From a Variety of Sources

- 64% Farm Fertilizer
- 19% Natural Sources
- 6% Municipal Wastewater Discharges
- 5% Manure
- 5% Urban Runoff

Source: 2012 USGS Sparrow Model

- KRMA - 47%
- Indiana – 31%
- Iroquois watershed – 19%
- Grant Park – 13%
- Manteno – 6%
- Momence – 4%
- Peotone – 2%
- Beecher – 2%
- Wilmington – 1%
- Essex – <1%
- Herscher – <1%
- Sun River Terrace – <1%

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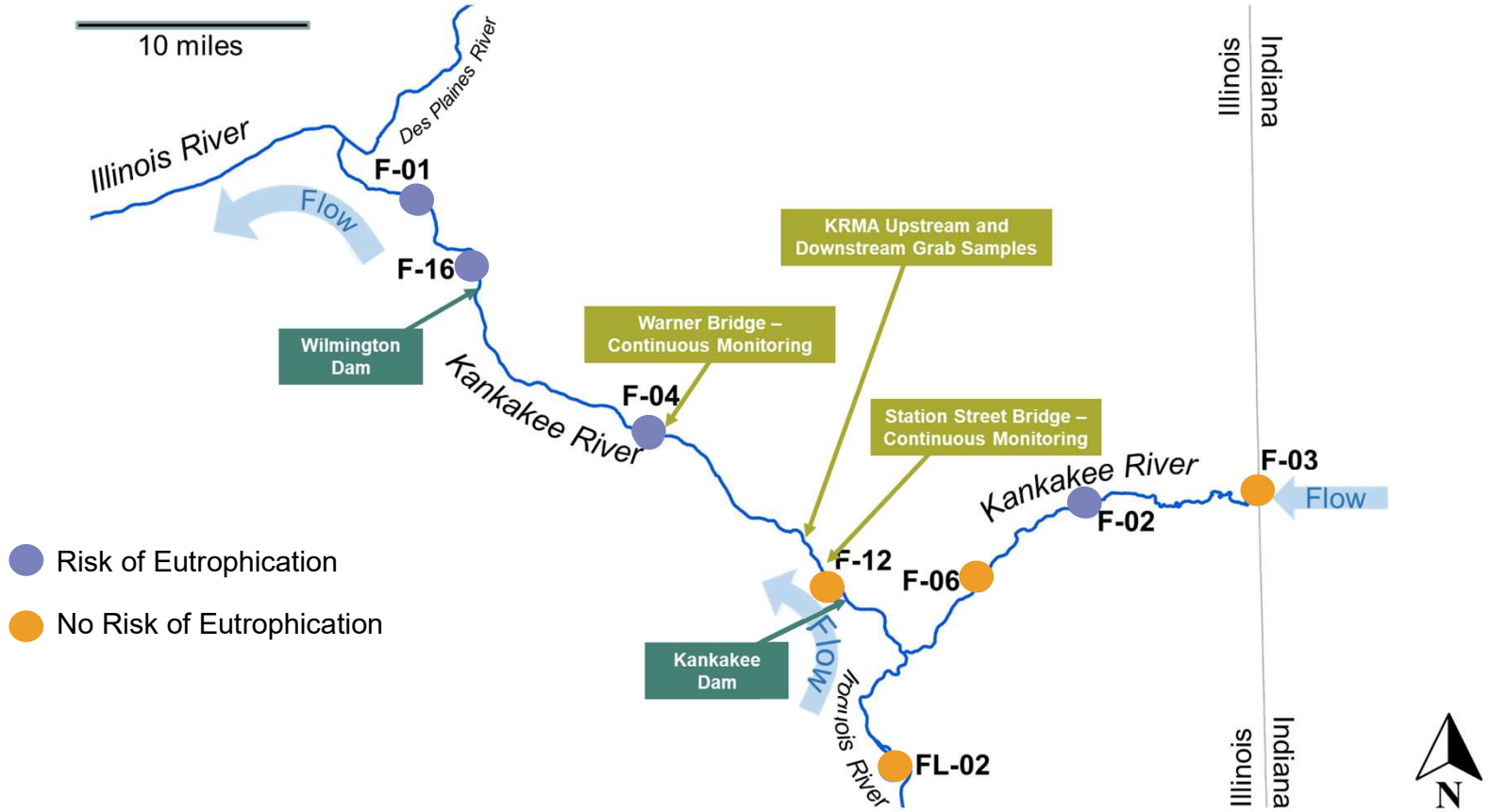
Kankakee River Metropolitan Agency

KRMA Has Made Improvements Since 2012 to Address Phosphorus Removal

- Biological phosphorus removal to achieve annual average 0.5 mg/L effluent total phosphorus
- Phosphorus discharge optimization plan

KRMA
Kankakee River Metropolitan Agency

KRMA's New Sampling Program Will Help Define KRMA's Impacts



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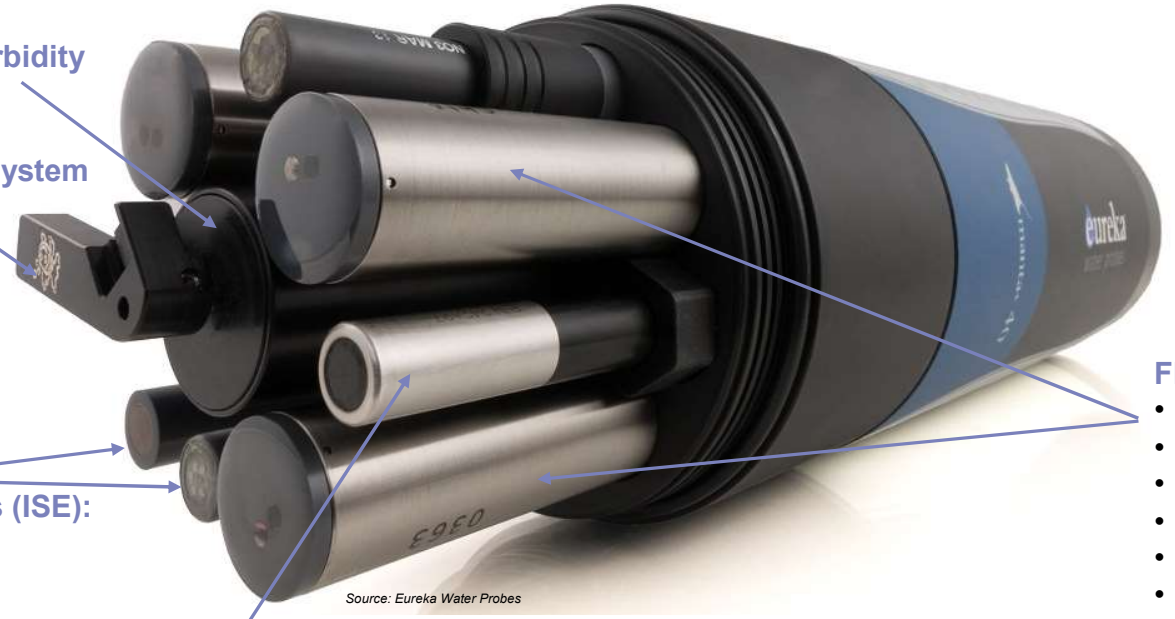
Kankakee River Metropolitan Agency

Sondes Provide Continuous Monitoring May Through October

Mantra+: Available with up to 12 sensors



Source: Eureka Water Probes

Also Includes:
- Temperature
- Depth
- pH/ORP
- Conductivity/Salinity/TDS
  (Sensors not shown)

Ion Selective Electrodes (ISE):
- Ammonium
- Bromide
- Chloride
- Nitrate
- Calcium
- Sodium

Fluorometers:
- Chlorophyll a (blue or red)
- CDOM/FDOM
- Blue Green Algae (Fresh/Marine)
- Tryptophan
- Crude Oil
- Refined Oil
- Rhodamine dye
- Flourescein dye/optical brighteners

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pH – Potential Hydrogen
ORP – Oxygen-Reduction Potential
TDS – Total Dissolved Solids
CDOM – Chromophoric Dissolved Organic Matter
FDOM – Fluorescent Dissolved Organic Matter

Next Steps

- KRMA will continue sampling and NARP development to meet permit requirements
- Request stakeholders share information on completed and planned efforts
- KRMA can be a resource for sampling efforts by other stakeholders

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Kankakee River Metropolitan Agency

Please join in the formation of the Illinois River Watershed Study Group

The Illinois River flows diagonally across the State of Illinois, beginning southeast of Chicago until it joins the Mississippi River at Grafton, near St. Louis as illustrated in the attached map. The Illinois River Watershed drains 55 counties and includes eight major tributaries. The Illinois Nutrient Loss Reduction Strategy - 2021 Biennial Report documents the major rivers in Illinois (see graphs on back). The largest total phosphorus and nitrate-N loads occurred in the Illinois River. This is due to the size of the watershed, landuse, and the discharge of effluent from wastewater treatment facilities located within the watershed.

Illinois River Watershed Map

An informational meeting regarding the establishment of the Illinois River Watershed Study Group will be held from 9:00 AM to 12:00 PM on May 18th, 2022. The meeting will be held virtually over Zoom. Please let us know if you plan to attend.

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Question and Answer

KRMA
Kankakee River Metropolitan Agency

APPENDIX E
NARP STAKEHOLDER MEETING REGISTER

Meeting Register
Kankakee River Nutrient Assessment and Reduction Plan
Informational Meeting
May 5, 2022 10 A.M.

	Name/Representing	Mailing Address	Contact Information
☒	Dan Small Strand Associates, Inc.	1170 South Houbolt Road Joliet, IL 60431	Phone No.: 815-744-4200 Cell No: Fax No.: E-mail: daniel.small@strand.com
☒	Dave Tyson, Executive Director Kankakee River Metropolitan Agency (KRMA)	1600 West Brookmont Boulevard Kankakee, IL 60901	Phone No.: 815-933-0444 Cell No: Fax No.: E-mail: dtyson@krmawastewater.com
☒	Art Strother, Superintendent Kankakee River Metropolitan Agency (KRMA)	1600 West Brookmont Boulevard Kankakee, IL 60901	Phone No.: 815-933-0444 Cell No: Fax No.: E-mail: art@krmawastewater.com
☒	Melanie Gossett, Asst. Superintendent Kankakee River Metropolitan Agency (KRMA)	1600 West Brookmont Boulevard Kankakee, IL 60901	Phone No.: 815-933-0444 Cell No: Fax No.: E-mail: dscheppler@krmawastewater.com
☒	Dustin Scheppler, Asst. Superintendent Kankakee River Metropolitan Agency (KRMA)	1600 West Brookmont Boulevard Kankakee, IL 60901	Phone No.: 815-933-0444 Cell No: Fax No.: E-mail: mgossett@krmawastewater.com
☒	Paul Schore, Mayor KRMA Board and Village of Bourbonnais, IL	600 Main Street N.W. Bourbonnais, IL 60914	Phone No.: 815-937-3570 Cell No: Fax No.: E-mail: mayor@villageofbourbonnais.com
☒	Andy Wheeler Kankakee County	189 E. Court Street Kankakee, IL 60901	Phone No.: 815-954-5085 Cell No: Fax No.: E-mail: awheeler@k3county.net
☒	Del Skimerhorn Kankakee County	189 E. Court Street Kankakee, IL 60901	Phone No.: 815-939-5546 Cell No: Fax No.: E-mail: dskimerhorn@k3county.net

Meeting Register
Kankakee River Nutrient Assessment and Reduction Plan
Informational Meeting
May 5, 2022 10 A.M.

☒	Angie Serafini, Area Manager Aqua Illinois	1000 S. Schuyler Avenue Kankakee, IL 60901	Phone No.: 815-614-2057 Cell No: Fax No.: E-mail: ASerafini@AquaAmerica.com
☒	Melissa Kahoun Aqua Illinois		Phone No.: Cell No: Fax No.: E-mail:
☒	Jennifer Wardrop Aqua Illinois		Phone No.: Cell No: Fax No.: E-mail: jwardrop@aquaamerica.com
☒	John Bobera Aqua Illinois		Phone No.: Cell No: Fax No.: E-mail: jabobera@aquaamerica.com
☒	Dominique Ahramovich Aqua Illinois		Phone No.: Cell No: Fax No.: E-mail: DAAhramovich@aquaamerica.com
☒	Pat Nugent, Superintendent City of Wilmington, IL	1165 S. Water Street Wilmington, IL 60481	Phone No.: 815-476-5663 Cell No: Fax No.: E-mail: pnugent@wilmington-il.com
☒	Austin Omer Illinois Farm Bureau		Phone No.: Cell No: 662-769-8765 Fax No.: E-mail: aomer@ilfb.org
☒	Jim Frogge Farmer / Kankakee Co. Soil & Water Conservation District		Phone No.: 815-953-1507 Cell No: Fax No.: E-mail: Jfrogge@frogge.us
☒	Matt Raymond Kankakee Co. Soil & Water Conservation District		Phone No.: 815-937-8940 x3 Cell No: Fax No.: E-mail: Matt.Raymond@kankakeecountyswcd.org

Meeting Register
Kankakee River Nutrient Assessment and Reduction Plan
Informational Meeting
May 5, 2022 10 A.M.

☒	Crystal Sauder Kankakee Co Soil & Water Conservation District		Phone No.: 815-937-8940 x3 Cell No: Fax No.: E-mail: crystal.sauder@kankakeecountyswcd.org

Meeting Register
Kankakee River Nutrient Assessment and Reduction Plan
Stakeholder Meeting
October 27, 2022 11 A.M.

	Name/Representing	Mailing Address	Contact Information
☑	Dan Small Strand Associates, Inc.	1170 South Houbolt Road Joliet, IL 60431	Phone No.: 815-744-4200 Cell No: Fax No.: E-mail: daniel.small@strand.com
☑	Dave Tyson, Executive Director Kankakee River Metropolitan Agency (KRMA)	1600 West Brookmont Boulevard Kankakee, IL 60901	Phone No.: 815-933-0444 Cell No: Fax No.: E-mail: dtyson@krmawastewater.com
☑	Art Strother, Superintendent Kankakee River Metropolitan Agency (KRMA)	1600 West Brookmont Boulevard Kankakee, IL 60901	Phone No.: 815-933-0444 Cell No: Fax No.: E-mail: art@krmawastewater.com
☑	Melanie Gossett, Asst. Superintendent Kankakee River Metropolitan Agency (KRMA)	1600 West Brookmont Boulevard Kankakee, IL 60901	Phone No.: 815-933-0444 Cell No: Fax No.: E-mail: dscheppler@krmawastewater.com
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☐	Andy Wheeler Kankakee County	189 E. Court Street Kankakee, IL 60901	Phone No.: 815-954-5085 Cell No: Fax No.: E-mail: awheeler@k3county.net
☑	Del Skimerhorn Kankakee County	189 E. Court Street Kankakee, IL 60901	Phone No.: 815-939-5546 Cell No: Fax No.: E-mail: dskimerhorn@k3county.net

Meeting Register
Kankakee River Nutrient Assessment and Reduction Plan
Stakeholder Meeting
October 27, 2022 11 A.M.

☐	Angie Serafini, Area Manager Aqua Illinois	1000 S. Schuyler Avenue Kankakee, IL 60901	Phone No.: 815-614-2057 Cell No: Fax No.: E-mail: ASerafini@AquaAmerica.com
☐	Melissa Kahoun Aqua Illinois		Phone No.: Cell No: Fax No.: E-mail:
☐	Jennifer Wardrop Aqua Illinois		Phone No.: Cell No: Fax No.: E-mail: jwardrop@aquaamerica.com
☐	John Bobera Aqua Illinois		Phone No.: Cell No: Fax No.: E-mail: jabobera@aquaamerica.com
☑	Dominique Ahramovich Aqua Illinois		Phone No.: Cell No: Fax No.: E-mail: DAAhramovich@aquaamerica.com
☒	Pat Nugent, Superintendent City of Wilmington, IL	1165 S. Water Street Wilmington, IL 60481	Phone No.: 815-476-5663 Cell No: Fax No.: E-mail: pnugent@wilmington-il.com
☐	Austin Omer Illinois Farm Bureau		Phone No.: Cell No: 662-769-8765 Fax No.: E-mail: aomer@ilfb.org
☐	Jim Frogge Farmer / Kankakee Co. Soil & Water Conservation District		Phone No.: 815-953-1507 Cell No: Fax No.: E-mail: Jfrogge@frogge.us
☒	Matt Raymond Kankakee Co. Soil & Water Conservation District		Phone No.: 815-937-8940 x3 Cell No: Fax No.: E-mail: Matt.Raymond@kankakeecountyswcd.org

Meeting Register
Kankakee River Nutrient Assessment and Reduction Plan
Stakeholder Meeting
October 27, 2022 11 A.M.

☐	Crystal Sauder Kankakee Co Soil & Water Conservation District		Phone No.: 815-937-8940 x3 Cell No: Fax No.: E-mail: crystal.sauder@kankakeecountyswcd.org
☑	James Gretencord City of Wilmington		Phone No.: 815-671-6837 Cell No: Fax No.: E-mail: JGretencord@wilmington-il.com
☑	Ryan McGinnis City of Kankakee		Phone No.: 815 933 0487 Cell No: Fax No.: E-mail: rpmcginnis@cityKankakee-IL.gov
☑	Lauren Lurkins	Call In.	Phone No.: Cell No: Fax No.: E-mail:
☐			Phone No.: Cell No: Fax No.: E-mail:
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Meeting Register
Kankakee River Nutrient Assessment and Reduction Plan
Stakeholder Meeting
June 14, 2023 10 A.M.

	Name/Representing	Mailing Address	Contact Information
☑	Dan Small Strand Associates, Inc.	1170 South Houbolt Road Joliet, IL 60431	Phone No.: 815-744-4200 Cell No: Fax No.: E-mail: daniel.small@strand.com
☑	Dave Tyson, Executive Director Kankakee River Metropolitan Agency (KRMA)	1600 West Brookmont Boulevard Kankakee, IL 60901	Phone No.: 815-933-0444 Cell No: Fax No.: E-mail: dtyson@krmawastewater.com
☑	Art Strother, Superintendent Kankakee River Metropolitan Agency (KRMA)	1600 West Brookmont Boulevard Kankakee, IL 60901	Phone No.: 815-933-0444 Cell No: Fax No.: E-mail: art@krmawastewater.com
☑	Melanie Gossett, Asst. Superintendent Kankakee River Metropolitan Agency (KRMA)	1600 West Brookmont Boulevard Kankakee, IL 60901	Phone No.: 815-933-0444 Cell No: Fax No.: E-mail: dscheppler@krmawastewater.com
☑	Dustin Scheppler, Asst. Superintendent Kankakee River Metropolitan Agency (KRMA)	1600 West Brookmont Boulevard Kankakee, IL 60901	Phone No.: 815-933-0444 Cell No: Fax No.: E-mail: mgossett@krmawastewater.com
☑	Paul Schore, Mayor KRMA Board and Village of Bourbonnais, IL	600 Main Street N.W. Bourbonnais, IL 60914	Phone No.: 815-937-3570 Cell No: Fax No.: E-mail: mayor@villageofbourbonnais.com
☐	Andy Wheeler Kankakee County	189 E. Court Street Kankakee, IL 60901	Phone No.: 815-954-5085 Cell No: Fax No.: E-mail: awheeler@k3county.net
☐	Del Skimerhorn Kankakee County	189 E. Court Street Kankakee, IL 60901	Phone No.: 815-939-5546 Cell No: Fax No.: E-mail: dskimerhorn@k3county.net

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Kankakee River Nutrient Assessment and Reduction Plan
Stakeholder Meeting
June 14, 2023 10 A.M.

☑	Angie Serafini, Area Manager Aqua Illinois	1000 S. Schuyler Avenue Kankakee, IL 60901	Phone No.: 815-614-2057 Cell No: Fax No.: E-mail: ASerafini@AquaAmerica.com
☐	Melissa Kahoun Aqua Illinois		Phone No.: Cell No: Fax No.: E-mail:
☐	Jennifer Wardrop Aqua Illinois		Phone No.: Cell No: Fax No.: E-mail: jwardrop@aquaamerica.com
☐	John Bobera Aqua Illinois		Phone No.: Cell No: Fax No.: E-mail: jabobera@aquaamerica.com
☐	Dominique Ahramovich Aqua Illinois		Phone No.: Cell No: Fax No.: E-mail: DAAhramovich@aquaamerica.com
☑	Pat Nugent, Superintendent City of Wilmington, IL	1165 S. Water Street Wilmington, IL 60481	Phone No.: 815-476-5663 Cell No: Fax No.: E-mail: pnugent@wilmington-il.com
☐	Austin Omer Illinois Farm Bureau		Phone No.: Cell No: 662-769-8765 Fax No.: E-mail: aomer@ilfb.org
☐	Jim Frogge Farmer / Kankakee Co. Soil & Water Conservation District		Phone No.: 815-953-1507 Cell No: Fax No.: E-mail: Jfrogge@frogge.us
☒	Matt Raymond Kankakee Co. Soil & Water Conservation District		Phone No.: 815-937-8940 x3 Cell No: Fax No.: E-mail: Matt.Raymond@kankakeecountyswcd.org

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☑	Crystal Sauder Kankakee Co Soil & Water Conservation District		Phone No.: 815-937-8940 x3 Cell No: Fax No.: E-mail: crystal.sauder@kankakeecountyswcd.org
☐	James Gretencord City of Wilmington		Phone No.: 815-671-6837 Cell No: Fax No.: E-mail: JGretencord@wilmington-il.com
☐	Ryan McGinnis City of Kankakee		Phone No.: 815-933-0487 Cell No: Fax No.: E-mail: rpmcginnis@citykankakee-il.gov
☐	Lauren Lurkins IL Farm Bureau		Phone No.: ell No: x No.: mail: LLurkins@ilfb.org
☑	Alan Stark AQUA		one No.: 815-614-2032 ll No: 847-846-6228 x No.: mail: AESTARK@AQUAWATER.COM
☑	Amelia Cheek IL Farm Bureau		one No.: ll No: 217 553 4261 x No.: mail: acheek@ilfb.org
☑	Chad Miller		one No.: 815-932-7474 Cell No: Fax No.: E-mail: Rankft6@sbcglobal.net
☑	Karoline Qasem Geosyntec → Wilmington	1420 Kensington Road, Suite 103 Oak Brook, IL 60523	Phone No.: 630-203-3344 Cell No: Fax No.: E-mail: KQasem@Geosyntec.com
☑	Don Bixby Chamlin → Wilmington		Phone No.: Cell No: Fax No.: E-mail: donb@chamlin.com

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Environmental Compliance Manager
Aqua Illinois
O: 815.614.2032 x59032 • M: 847.846.6228
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1000 S. Schuyler Avenue, Kankakee, IL 60901
AQUA An Essential Utilities Company

APPENDIX F
KRMA SAMPLING PLAN

Strand Associates, Inc.®
1170 South Houbolt Road
Joliet, IL 60431
(P) 815.744.4200

January 10, 2022

Mr. Scott Twait, Water Quality Section Manager
Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, Illinois 62702

Re: Nutrient Assessment Reduction Plan (NARP) Year 1 Sampling Plans
Kankakee River Metropolitan Agency, Illinois (KRMA)

Dear Mr. Twait:

Strand Associates, Inc.® (Strand) has developed and is submitting a Kankakee River Sampling Plan (Plan) on behalf of KRMA for review. We respectfully request comments no later than February 25, 2022, so KRMA has time to address comments before the Plan commences on May 2, 2022.

The general purpose of the Plan is to collect Kankakee River water quality data both upstream and downstream of KRMA's effluent discharge to assess the impact KRMA's effluent has on water quality in the Kankakee River. Additionally, the water quality data will form the basis upon which KRMA develops its NARP, which is required by Special Condition 20 in its National Pollutant Discharge Elimination System Permit (NPDES) IL0021784. The details of the Plan are outlined in the following. In general, the Plan will consist of two components: a continuous sampling plan and a grab sampling plan.

1. Continuous Sampling Plan

Continuous water quality sampling will be conducted using two continuously monitoring multiparameter sondes. The sondes being deployed will be Manta+35A Multiprobes manufactured by Eureka Water Probes; see Attachment 1 for Manufacturer Literature. The sondes will be placed at predetermined locations on the Kankakee River, one upstream and one downstream of the KRMA Wastewater Treatment Plant as shown in Attachment 2 and summarized in the following table.

a. Sampling Parameters

The following water quality parameters will be monitored by each sonde:

(1) pH
(2) Dissolved oxygen (DO)
(3) Conductivity
(4) Water temperature
(5) Chlorophyll-a
(6) Turbidity

The following table shows the probes and meters to be used, range of each meter, accuracy of each meter, and resolution of the meter.

Sensor	Parameter	Meter Range	Resolution	Accuracy
pH/ORP	pH	0 to 14 units	0.01	±0.1 within 10 °C of calibration; 0.2 otherwise
DO	Concentration	0 to 50 mg/L	0.01	±0.1 at less than or equal to 20 mg/L, ±0.15 between 20 mg/L and 30 mg/L, and ±5 percent of reading above 30 mg/L
Conductivity	Specific Conductance	0 to 100 mS/cm	0.1	±1 percent of reading ±0.001
Water Temperature	Temperature	-5 to 50 C	0.01	±0.1
Fluorometer	Chlorophyll-a	0 to 500µg/L	0.01	Linearity of 0.99 R^2
Turbidity	Turbidity	0 to 4,000 FNU	0.01	±0.3 FNU or ±2 percent of reading, whichever is greater (w.i.g.). up to 1,000 FNU and ±4 percent above 1,000 FNU

ORP=oxidation-reduction potential
FNU=formazin nephelomettric units
mg/L=milligrams per liter
µg/L=micrograms per liter
mS/cm=millisiemens per centimeter

b. Sampling Frequency

The sondes will record samples once an hour continuously each day for a total of 24 samples collected daily.

c. Sampling Locations

Sampling location is critical to the success and quality of the Plan. Locations for deploying continuous monitoring sondes are often limited to bridges due to the need to secure the sonde and the need to consistently access the sonde for data downloads. As a result, two bridges were selected as the sampling points for the Plan.

Site Name	Location	Latitude	Longitude
Upstream	Station Street Bridge	41.118885	-87.875132
Downstream	Warner Bridge Road	41.208106	-88.011826

The upstream sampling point in located approximately 1.5 miles upstream of KRMA's effluent discharge. The upstream sampling point is intended to collect data to understand water quality of the Kankakee River upstream of KRMA's discharge and estimate the impacts of upstream discharges, both point and nonpoint, before KRMA's effluent discharge.

The downstream sampling location is approximately 8.7 miles downstream of KRMA's discharge. The downstream sampling point is intended to collect data to understand what impact, if any, KRMA's effluent has on water quality in the Kankakee River. Each sonde will be placed on the downstream side of the bridge to reduce the potential for debris to affect the installation.

It should be noted, there are several potential sources of pollution, both nonpoint and point sources, between the upstream sampling location, KRMA's discharge location, and the downstream sampling location. Theoretical calculations will be used to estimate the loading of

these other pollution sources to be used in conjunction with the data collected to assess the impact of KRMA's effluent discharge on the Kankakee River water quality.

d. Sampling Method

The Operation and Maintenance (O&M) Manual for the sonde, which is included as Attachment 3, provides detailed step-by-step deployment, retrieval, and calibration instructions to be used throughout the Plan.

Two sondes will be deployed during the sampling period, which is anticipated to run from May through October 2022, at a minimum. Each sonde will be secured within polyvinyl chloride or stainless-steel pipes to protect the monitors from in-stream debris and vandalism. The housing enclosures are to be mounted on the bridges identified in the previous table. The vertical enclosure extends from the bottom of the riverbed to the top of the bridge railing. The submerged portion of the protective enclosure will be perforated to allow water from the Kankakee River to flow freely past the Sondes monitoring sensors. Sondes will be suspended above the riverbed with stainless steel wire rope.

Sondes will be maintained in the field by KRMA staff. Sondes will be returned monthly to KRMA's facility for calibration verification, new batteries, and routine maintenance.

e. Sample Handling and Custody

All sample measurements will be performed in-situ; therefore, these is no need for sample collection, preservation, shipment, or storage.

A chain of custody process will be used to track the sonde during all phases (such as calibration, transport to the field, and field installation). An example of the chain of custody form is included in Attachment 4.

f. Data Retrieval

KRMA staff will visit each sampling location once per week to download data and inspect the installation, including checking remaining battery life on each sonde. KRMA staff could elect to decrease the frequency of visits to once every two weeks if it determined the sonde battery life is sufficient and the data appears to be high quality.

g. Quality Control

A quality control procedure will be in place to maximize the quality of data collected. First, all staff members tasked with deploying, maintaining, calibrating, and handling the sondes will be adequately trained to perform such tasks. Training will include a review of this Plan along with O&M materials provided by the sonde manufacturer.

Second, all equipment used for executing the Plan will be properly maintained and decontaminated in accordance with the manufacturer's recommendations. Additionally, logbooks of calibration and maintenance of equipment will be kept, documenting all procedures conducted on equipment through the Plan's duration.

Third, each field visit to download sampling data will include an inspection of the sonde installation. The inspection will include a visual check of the sonde casing for integrity, cleaning of the sonde exterior and instrumentation with a soft brush, and cleaning of the housing enclosures, as necessary, to remove any debris that has been caught on it.

Finally, laboratory and field calibrations will be used to maximize data accuracy. Each sonde will be calibrated in a laboratory by the manufacturer before deployment. Once each sonde has been deployed, field calibration checks will be performed approximately every week initially and then every two weeks when staff visits each site to download data. The field calibration checks will include checking for adequate battery voltage and improbable data trends. If an improbable data trend is observed, a handheld device will be used to collect in-situ data to compare to the data being collected by the sonde. If it is determined the sonde is not collecting accurate data, it will be removed from service and either recalibrated or replaced.

2. Grab Sampling Plan

A grab sampling plan will be used to supplement the water quality monitoring being collected by the sondes and summarized above. The grab sampling plan will consist of four sampling locations, the two continuous sampling locations as well as two additional sampling locations. The two additional sampling locations will include one location upstream and one location downstream of KRMA's discharge effluent location as shown in the table below and Attachment 5.

a. Sampling Parameters

The grab samples will collect data of the water quality parameters: Total Phosphorus (TP).

b. Sampling Frequency

Grab samples will be collected on a once per week basis regardless of weather conditions during the sampling period, which is intended to coincide with the continuous sampling previously described. The samples can be taken at any time during the day; however, the collection time should be consistent from week to week.

In addition to weekly samples, grab samples for up to five wet weather events will be collected during the sampling period. A wet weather event is defined as a rain event wherein at least 0.5 inches of total rain falls in the Kankakee area in 24 hours as measured by the rain gauge at KRMA's facility if the rainfall produces runoff. A total of four grab samples will be collected starting approximately one hour after runoff begins and continuing approximately every two hours after, for a total of three or four grab samples per station for each event.

c. Sampling Locations

The proposed additional grab sampling locations are shown in Attachment 5 and summarized in the following table. Please note the locations shown in Attachment 5 and the following table are in addition to grab samples that will be collected at the continuous monitoring locations. Furthermore, the proposed additional grab sampling locations are the same locations used for KRMA's Plan, dated December 20, 2010, which was successfully used for determining site specific ammonia water quality criteria and metals translators. In KRMA's Plan, it was demonstrated the downstream sampling location is a point where the effluent is completely mixed with the river water. It should be noted, the samples should be collected starting with the most downstream location and moving upstream.

Site Name	Location	Latitude	Longitude
Upstream	1,000 feet from Outfall	41.136259	-87.887202
Downstream	1,150 feet from Outfall	41.141413	-87.890570

d. Sampling Method

Grab samples will be taken mid-depth and as far away from the riverbank as can safely be collected on foot. Wet weather samples may be collected from the riverbank for safety reasons. Samples for TP shall be conducted using the Illinois Environmental Protection Agency method 365.2, *Phosphorus, All Forms,* which is provided in Attachment 6.

e. Sample Handling and Custody

All sample containers will be chilled in an ice-filled cooler immediately after collection and kept on ice during transport to or pickup by the laboratory. The City of Kankakee Laboratory will supply the sample containers, labels, and coolers. All preservatives will be provided in the sample containers. The preservative for testing TP is sulfuric acid.

Samples will be shipped to the laboratory within the prescribed holding times. Samples will be shipped to the laboratory after each individual sampling or at the conclusion of a wet weather event sampling series. KRMA staff will be responsible for contacting the laboratory and coordinating sample delivery.

The laboratory shall record temperature upon arrival at the laboratory using a thermometer calibrated against a National Institute of Standards and Technology traceable certified thermometer. Samples that require thermal preservation will be refrigerated after sample acceptance at the laboratory.

When received by the laboratory, the samples will be logged into the laboratory logbook and/or laboratory database. Maximum holding times before analysis, as stated in applicable method laboratory method standard operating procedures, will be followed.

f. Reporting

Grab sampling information will be provided to Strand at a similar frequency as the continuous monitoring data.

g. Quality Control

All field operations personnel are responsible for ensuring that proper sampling methods, sample preservation, and sample custody of the delivered samples to the designated laboratory are followed.

The accuracy and precision of all data measurements must be quantifiable. Analytical procedures used for data analysis must be performed according to approved standard methods. Data measurements should be recorded in a controlled environment in which a quality control program can be maintained.

3. Data Review and Reporting

Data collected by KRMA staff will be sent to Strand for review, verification, and validation. Strand will develop a technical report summarizing the Plan and the results of the data collection and analysis. KRMA will use the information within the technical report to develop a path forward for developing its NARP.

On behalf of KRMA, thank you for your assistance and consideration of this Plan. If you have any questions, please call 815-744-4200.

Sincerely,

STRAND ASSOCIATES, INC.®

Daniel J. Small, P.E.

Attachments

c/encl. Brant Fleming, IEPA
Mila Marshall, Sierra Club
Dave Tyson, KRMA
Art Strother, KRMA
Dustin Scheppler, KRMA
Melanie Gossett, KRMA

eureka™
water probes

Multiprobes built for the field technician™

manta+™

manta+™

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+ any other sensor

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Temp
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conductivity
Turbidity (or any medium sensor)

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Temp
pH
conductivity
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Turbidity (or any medium sensor)

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small sensor options

sodium
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TDG

temp
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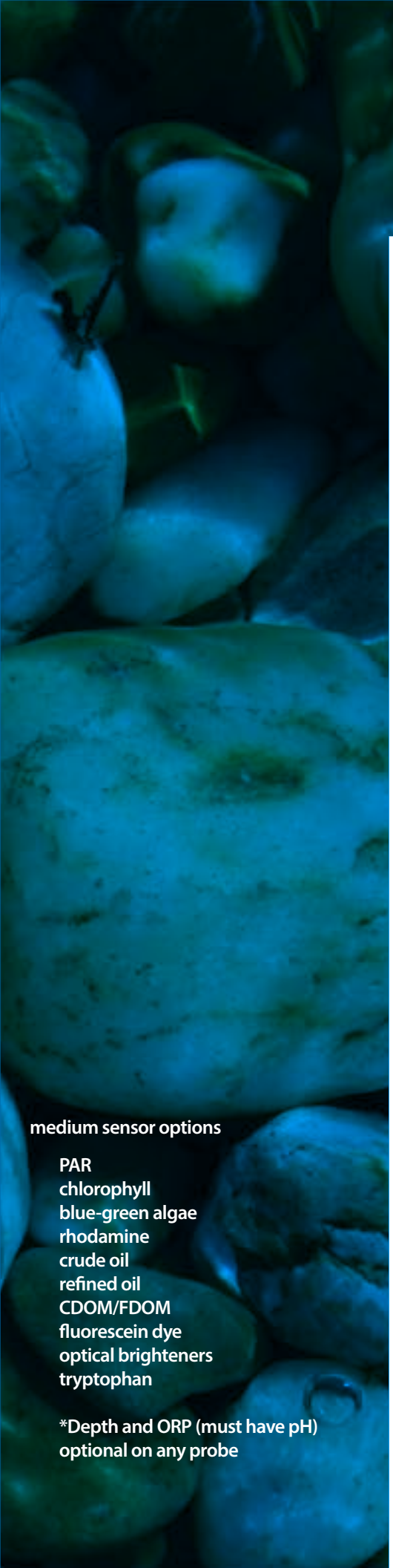
optical DO
universal wiper
turbidity

standard on 35/40



Rugged

- Anti-corrosive housings and sensors
- Industry leading 3 year warranty
- Anti-fouling options

Intelligent

- Sensor health indicator
- Automatic recording of internal calibration data
- LED status indicator

Simple

- One touch and automatic data capture
- Fast easy calibration
- Intuitive software

medium sensor options

PAR
chlorophyll
blue-green algae
rhodamine
crude oil
refined oil
CDOM/FDOM
fluorescein dye
optical brighteners
tryptophan

***Depth and ORP (must have pH) optional on any probe**

Products

Trimeter - Three Parameters at the Lowest Possible Cost

Get all the features of a Manta, including top-grade sensors and simple software, in an instrument designed for economy. Each Trimeter employs one of any sensor that Eureka offers, plus optional temperature and depth sensors.

A Data Display for Every Application and Budget

The Amphibian2 is a waterproof, full-function Windows Mobile PDA incorporating the Manta Manager user-interface, with GPS, camera and cell phone options. It is also easy to read in bright sunlight and super rugged!

Use your own smart phone or other display! The Leapfrog Bluetooth provides power to the Manta, and wireless communication to any Bluetooth-enabled display running the Manta Manager application - Windows Mobile, Windows for PC, or Android and iOS.

Manta Plus

The Manta family offers up to 12 sensors in one, integrated package. Each Manta comes standard with a weighted sensor guard, storage and calibration cups, temperature sensor, embedded memory for internal logging, marine connector, electronic manual, MantaManager software and standard three year warranty.

Available sensors include temperature, optical DO, pH, ORP, conductivity, depth, level, turbidity, fluorometers including chlorophyll a, chlorophyll red, phycocyanin, phycoerythrin, fDOM, fDOM II, rhodamine, fluorescein, crude oil, refined fuels, optical brighteners, and tryptophan/BOD, CO2, ammonium, nitrate, sodium, calcium, bromide, chloride, TDG, PAR, dual PAR, and transmissivity.

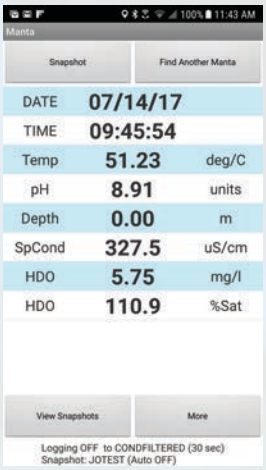
Field-Proven Methods to Minimize Fouling

The Extended Turbidity Brush cleans turbidity and other sensors, such as DO, chlorophyll, and BG algae.

The MiniCleaner is a stand-alone wiper system used when you don't have an Extended Turbidity Brush.

The Copper-Gauze Kit wraps the sensors in copper gauze that slowly dissolves, bathing the sensors with the copper ions that discourage biofouling. Copper gauze is superior to solid copper, which becomes ineffective once oxidized.

Mobile Version

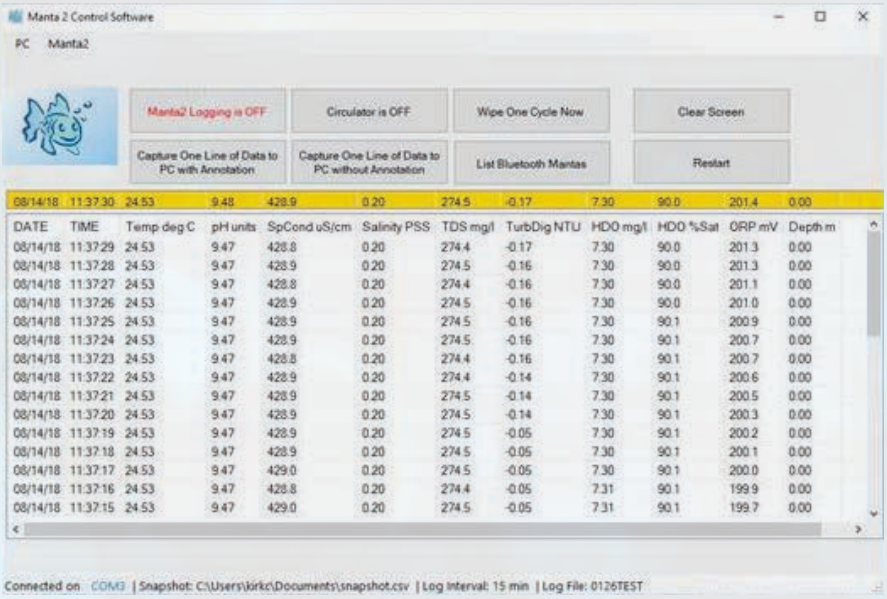


Android **iOS**

MantaLink software is available for Android and iOS with small screen features like "swipeable" pages and large, high-contrast numbers for easier visibility in sunlight.

Manta Software

The Manta Software features simple to use, intuitive menus. Instructions take the user through the calibration of each sensor. Easy set-up for discrete sampling "snapshot" files or log files for internal logging, using Windows architecture. All filies are in .csv format.



Accessories for Every Application

Standard accessories include flow cells, copper-gauze anti-fouling kits, cable reels, SDI-12 converters, hard-sided cases, soft padded backpacks, pipe kits to protect logging units in the field, weather stations, Leapfrog Bluetooth, and a full line of calibration standards including secondary calibration standards for fluorometers.

Applications

lakes, rivers, ground water, storm water, estuaries, streams, ponds, near-shore oceanographic, process waters, waste waters, laboratory research

Site to Site Profiling

Process Monitoring

Unattended Logging

Ground Water

Telemetered Deployments

Buoy Deployments

Manta+™ Multiprobe Specifications

	Trimeter	Manta+20	Manta+25	Manta+30	Manta+35	Manta+40
Diameter	1.85"	1.95"	2.45"	2.95"	3.5"	4.00"
Length - w/o Battery Pack	13.5"	19"	19"	19"	19"	19"
- Add Internal Battery Pack	22"	27"	27"	27"		
Weight - with IBP	2.8 lbs	2.4 lbs	2.5 lbs	5.0 lbs	9.0 lbs	10.0 lbs
- without battery	2.2 lbs	1.8 lbs	2.2 lbs	3.6 lbs	5 lbs	6.2 lbs
Number of sensors	Any single sensor plus depth and temp option	Up to 6	Up to 6	Up to 7	Up to 11	Up to 13
Battery Pack	3 "D"	3 "D"	3 "D"	8 "C"	6 "C"	6 "C"
Operating Temperature	-5 to 50 C					
Depth Rating	200 m, Max depth for ISE and TDG sensors is 15 meters					
Communications	RS-232, SDI-12, USB or Bluetooth					
Sample Rate	1 Hz					
Data Memory	>1,000,000 logged readings					

Amphibian2 Handheld Display

Size	3.6" W x 7.25" L x 1.5" D
Weight	1.3 lbs
Operating System	Microsoft® Windows Embedded Handheld 6.5.3
IP Rating	IP68
Memory and Data Storage	512MB RAM; 8 GB - > 8,000,000 logged readings

Sensor Specifications

sensor	parameter	range and units	resolution	accuracy	comments
temperature	temperature	-5 to 50 C	0.01	±0.1	calibration not required
pH/ORP	pH	0 to 14 units	0.01	±0.1 within 10 C of calibration; 0.2 otherwise	refillable reference electrode; corrected for temperature; typical sensor life >6 years; optional ORP sensor is combined with pH sensor
	ORP	-999 to 999 mV	0.1	±20 mV	
turbidity	turbidity	0 to 1000 FNU	0.01	±0.3 FNU or ±2% of reading w.i.g.	filtered for non-turbidity spikes; includes wiper to clean the optics; FNU and NTU are interchangeable
		1000 to 4000 FNU		±4% of reading	
transmissivity	transmissivity	0 to 100% transmission	0.01	linearity of 0.99 R^2	transmissometer mounts externally to Manta
dissolved oxygen (optical sensor)	concentration	0 to 20 mg/l	0.01	±0.1	compensated for temperature and salinity; EPA approved "lifetime" luminescence method; typical sensor cap life > 6 years
		20 to 30 mg/l	0.01	±0.15	
		30 to 50 mg/l	0.01	±5% of reading	
	% saturation	0 to 500% saturation	0.1	corresponds with the accuracy of the concentration reading	
conductivity	specific conductance, µS/cm	0 to 5000 µS/cm	0.1	±0.5% of reading or ±1 w.i.g.	corrected for temperature; four easy-to-clean graphite electrodes; optional sensor provides ±0.5% of reading accuracy to 100 mS/cm.
	specific conductance, mS/cm	0 to 100 mS/cm	0.001	±1% of reading ±0.001	
		100 to 275 mS/cm	0.001	±2% of reading	
	salinity	0 to 70 PSU	0.01	±2% of reading	calculated from conductivity and temperature, PSU is equivalent to ppt
	total dissolved solids (TDS)	0 to 65 g/l	0.1	±5% of reading	
pressure	depth	0 to 25 m	0.01	±0.05	compensated for temperature and salinity
		0 to 200 m		±0.4	
	vented depth	0 to 10 m	0.001	±0.003	compensated for temp, salinity, barometric pressure
	barometric pressure	400 to 900 mm Hg	0.1	±1.5	included with depth sensor
	total dissolved gas (TDG)	400 to 1,400 mm Hg	0.1	±1	compensated for temperature; maximum depth 15m
fluorometers	chlorophyll a - blue	0 to 500 µg/l	0.01	linearity of 0.99 R^2	highest-quality fluorometric sensors; fluorometers often require non-trivial calibration; custom optics available upon request
	chlorophyll a - red	0 to 500 µg/l			
	rhodamine dye	0 to 1000 ppb			
	Phycocyanin (freshwater BGA)	0 to 4500 ppb			
	Phycoerythrin (marine BGA)	0 to 750 ppb			
	CDOM/FDOM	0 to 1500/3000 ppb			
	optical brightener	0 to 2500 ppb			
	tryptophan	0 to 5000 ppb			
	fluorescein dye	0 to 500 ppb			
	PTSA	0 to 650 ppb			
	refined oil	0 to 20 ppm			
	crude oil	0 to 1500 ppb			
ion-selective electrodes (ISE's)	ammonium	0 to 100 mg/l as nitrogen	0.1	±10% of reading or 2mg/L w.i.g.	corrected for ionic strength (via conductivity readings); the accuracy specification relies on non-trivial maintenance practice and frequent calibration near the temperature of measurement; sensors require periodic tip replacement
	nitrate	0 to 100 mg/l as nitrogen			
	chloride	0.5 to 18,000 mg/l			
	sodium	0.05 to 20,000 mg/l			
	calcium	0 to 40,000 mg/l			
	bromide	0 to 80,000 mg/l			
PAR	photometric PAR	10,000 µmol/cm2	0.1	±5% of reading	LiCor spherical sensor
CO2	carbon dioxide	0 to 2000 ppm	0.1	±3% of full scale	other ranges available

Warranty

Manta+ Multiprobe	3 years *	Underwater cables	3 years
Amphibian2 Handheld	2 years	Leapfrog Bluetooth	3 years (battery – 90 days)
Optical DO Cap	3 years	Turbidity Wiper	2 years

FOR BEST ACCURACY, ALWAYS CALIBRATE NEAR THE ANTICIPATED FIELD READINGS, AND NEAR THE TEMPERATURE OF THE ANTICIPATED FIELD READINGS.
*All sensors included except ISE's (Ammonia/nitrate/chloride);
pH sensor included in 3 year warranty
Specifications indicate typical performance and are subject to change. See www.waterprobes.com for current specifications.

About Us

Eureka was formed in 2002 by industry veterans who believed there was considerable room in the multiprobe market for improvements in technology and customer service. Eureka is an employee-owned partnership with extensive history in the water quality industry.

Eureka Water Probes continues to provide innovative, reliable multiprobes backed by market-leading customer service. Designing and manufacturing the world's best multiprobes remains our sole focus.

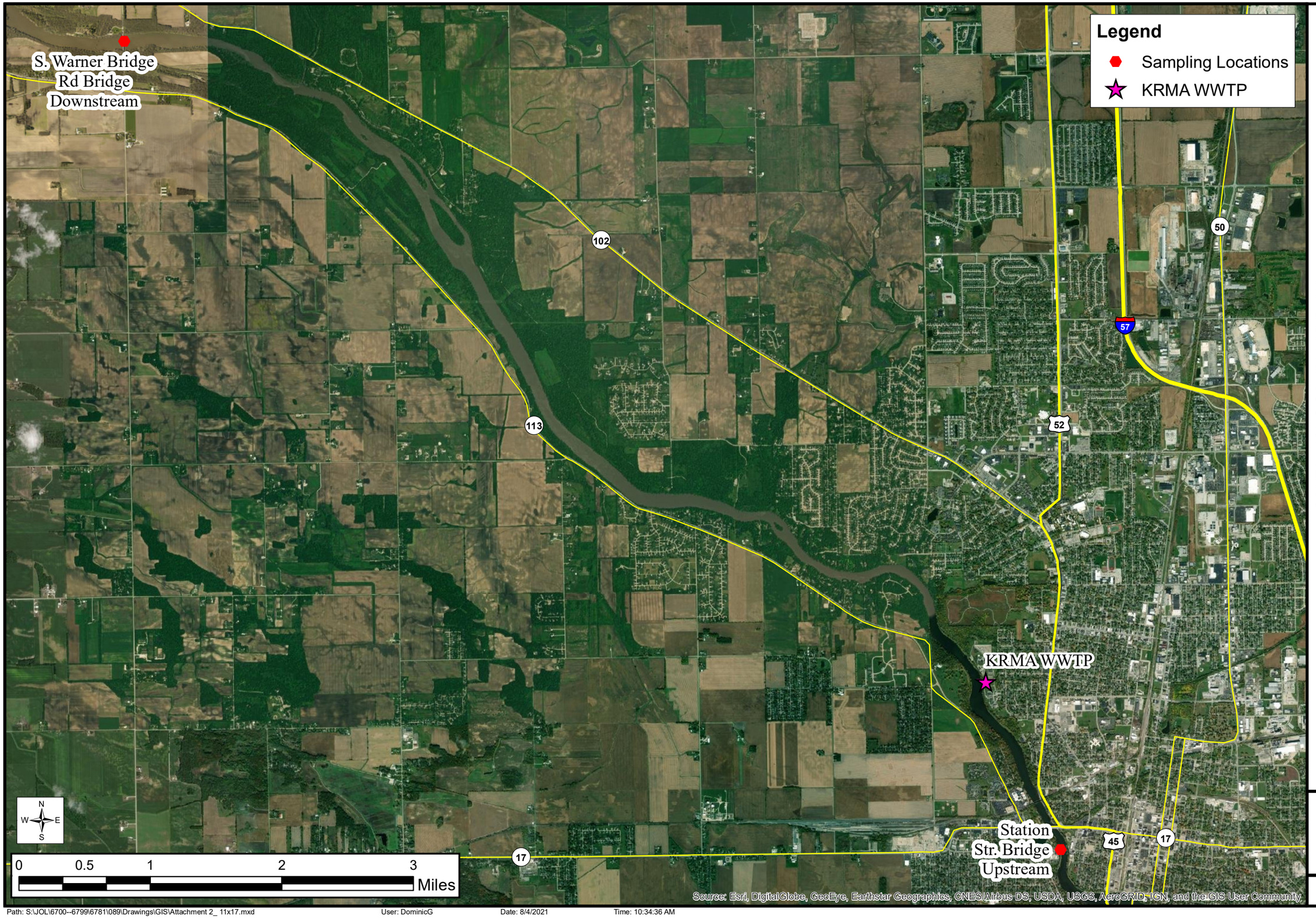
Give us a call! We can make your data-collection easier, better, and more cost effective.

Worldwide Distribution

Eureka Water Probes
2113 Wells Branch Parkway
Austin , TX 78728
Tel +1.512-302-4333
www.waterprobes.com

For a complete list of our international partners,
please see www.waterprobes.com/international-distributors
sales@waterprobes.com and support@waterprobes.com

eureka
water probes



CONTINUOUS SAMPLING PLAN
SAMPLING LOCATIONS
KRMA SAMPLING PLAN
KANKAKEE RIVER METROPOLITAN AGENCY
KANKAKEE COUNTY, ILLINOIS

STRAND ASSOCIATES®

ATTACHMENT 2
6781.089

Path: S:\JOL\6700--6799\6781\089\Drawings\GIS\Attachment 2_ 11x17.mxd User: DominicG Date: 8/4/2021 Time: 10:34:36 AM

eureka™
water probes

MANTA and TRIMETER MULTIPROBE MANUAL

This manual (rev. 11-2018) covers Eureka's Manta2, Manta+, and Trimeter models.

For simplicity the term "Manta" is used collectively for all models.

CONTENTS

Additional Documents

For more information on various subjects, please check your Eureka Flash Drive (that comes with each instrument) and the Eureka Web site (www.WaterProbes.com) under the Documents tab shown on the Home Page.

As this manual was written, these documents and videos were on the Flash Drive:

1. Calibrating Ion-Selective Electrodes: The Difference between Activity and Concentration
2. Standardizing Eureka's Turner Fluorometers
3. Calibrating Eureka's Turner Fluorometers
4. Manta Comm Protocol
5. Manta SDI-12 Adapter
6. MODBUS Communications
7. Performance Verification Statement for the Eureka Manta2 pH Sensor (2015)
8. Evaluation of the Eureka Manta2 Water-Quality Multiprobe Sonde (USGS, 2017)
9. Installing Manta Control Software on an Android Data Display
10. Manta Logging with an Uninterrupted Power Supply
11. Manta Power Options
12. Eureka Outperforms the Competition
13. Conductivity Sensor Calibration
14. Multiprobe Setup Instructions
15. Manta2 Multiprobe Calibration
16. Unboxing Video

All Eureka videos are also available on YouTube at www.youtube.com/channel/UCKSC0BpD9pS-55mFAWt_jRQ .

Do you need help?

Eureka has the best customer service in the multiprobe market, so there's no reason to get bogged down with a problem. We welcome your call at 512-302-4333 x111, or email at service@WaterProbes.com.

Eureka Water Probes 2113 Wells Branch Parkway Suite 4400 Austin TX 78728

A. LEARNING THE MANTA IN 30 MINUTES

A.1 See Your Manta

1. The Manta Multiprobe is configured with your choice of sensors, and with or without a battery pack.
2. The Underwater Cable connects the Manta to a Data Display (PC, Amphibian, logger, telemetry device or, using the Bluetooth Battery, a tablet or smart phone).
3. The Storage/Calibration Cup protects the sensors when the Manta is not in use (keep a few ounces of tap water in the S/C Cup when the Manta is not being used). And with the lid removed, it holds your calibration solutions.
4. The Manta Flash Drive contains the software for connecting your Manta to your PC or other Data Display, plus a digital copy of this manual, several instructional videos, and several technical notes.
5. The optional Data Cable lets you communicate conveniently with your Manta when an Underwater Cable is not needed, for instance, during Calibration.The USB Adapter connects between your Underwater Cable (or Data Cable) and a USB port on your Display Device. The USB

Adapter can also connect an external power supply to your Manta if USB power is not adequate (particularly with long Underwater Cables or large number of sensors).

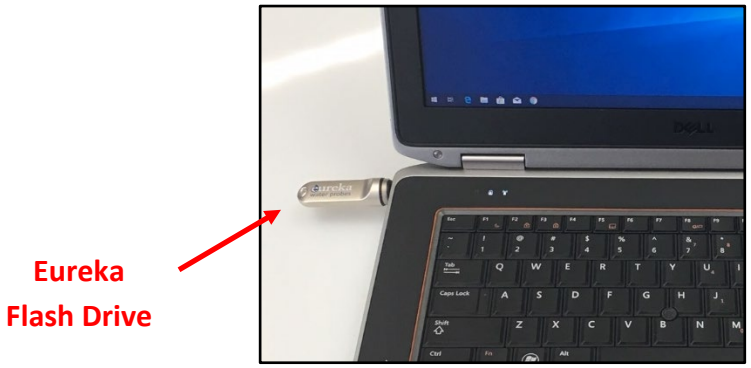
Do not use the USB Adapter with anything but a USB port and a Manta.

6. The Maintenance Kit contains all the tools and maintenance items needed to keep your Manta in top shape.
7. The Weighted Sensor Guard replaces the Storage/Calibration Cup to protect the sensors during deployment, and to help the Manta sink.

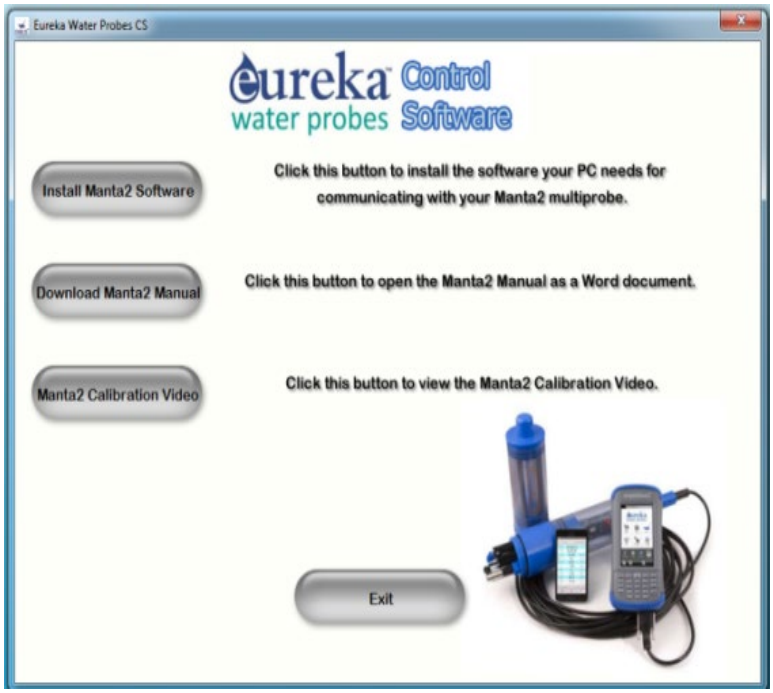
A.2 Talk to Your Manta

Please follow the steps below to install Eureka software on your PC or laptop (collectively, PC).

1 Plug the Manta Flash Drive into one of your PC's USB ports.



2 When the dialog box shown below opens, click Install Manta Software to upload the Manta User Interface software and the USB Driver software onto your PC.



Depending on which version of Windows you are accursed with, you might have to answer the usual questions about your intention to load new software on your PC. Once you're through with that, you'll be returned to the same screen that you started with, meaning that your Manta software and USB Driver are installed.

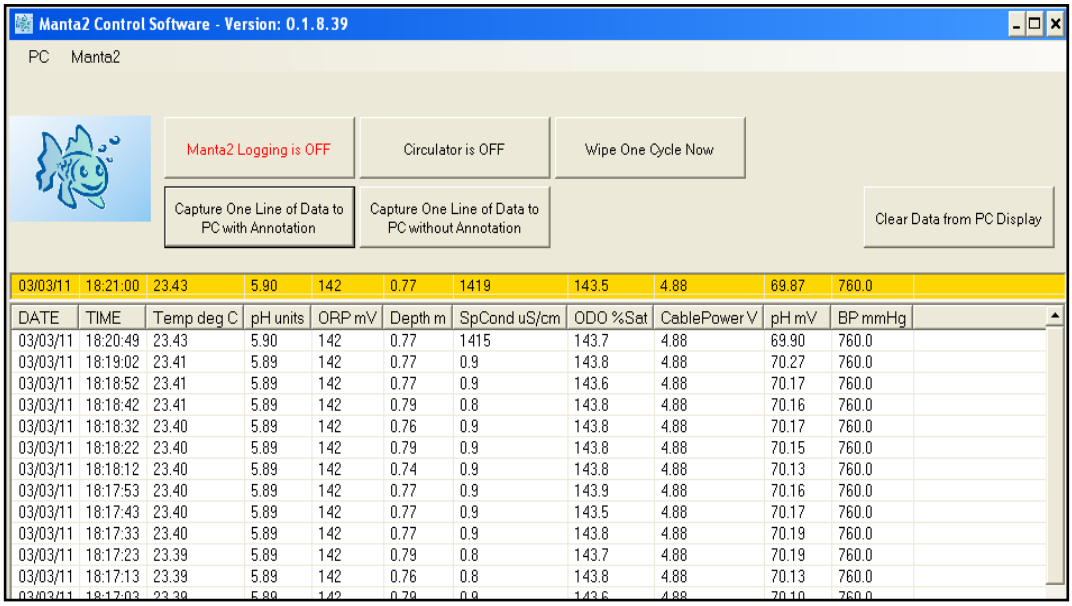
Click the X in the upper right corner of the dialog box to close the installation process.

This software installation process should take only a few minutes. Please call us (512-302-4333, Ext 1111) if you have any problems.

Note that you can download the Manta manual and various videos and technical documents that are stored on the Eureka Flash Drive.

3 If your Windows did not create on your Desktop a shortcut to the Manta Control Software, and you would like to have one, click the Start button in the lower left of your screen, click All Programs, click the Eureka folder, right-click "Manta 2 Control Software", and drag it to your desktop.

4 Now connect your Manta to the USB Adapter using either a Manta Data Cable or Underwater Cable. Click the Eureka "fish" icon to connect your PC and Manta. The Home Page will appear, showing the Manta's real-time data and various menu options. You can close the program by clicking the X in the upper right corner.

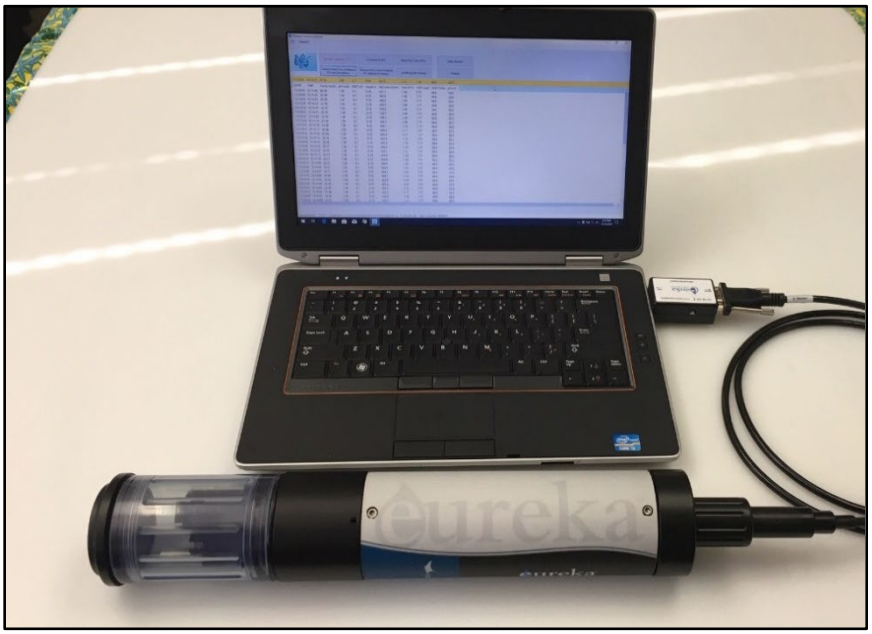


If your Manta does not connect with your PC, it may be that your organization's network firewall prevented the installation of the USB driver. Consult your IT department if you do not see the Prolific USB driver listed in your device-driver menu (which is usually found in Settings after clicking the Start button in the lower-left screen).

A.3 A Short Exercise

Let's do a quick exercise to show how easy the Manta is to use. We will connect the instrument to a PC, calibrate conductivity, and check the Calibration Log for the conductivity calibration information.

1 Connect your Manta to your PC with the USB Adapter and either a Data Cable or Underwater Cable.



2 Click the Eureka icon to launch the Manta Control Software. Soon you will see the Home Page and the data being sent from your Manta.

3 Fill the Storage/Calibration Cup with tap water or conductivity standard and wait for the conductivity reading to stabilize.

4 Click the Manta pull-down menu on the Home Page and click Calibrate, and then click SpCond on the next screen.

5 Type in the approximate conductivity of your tap water or the value of your conductivity standard and click OK.

6 Click on OK in the next screen to finalize the calibration and be returned to the Home Page. (D.5)

7 Click the Manta pull-down menu on the Home Page then click Cal Log on the next screen. At the bottom of the list are the details of the calibration that you just did.

8 Click on OK to return to the Home Page.

Was that easy, or what? Don't you wish you had back all those frustrating, life-shortening, soul-crushing hours you spent trying to decipher those other multiprobe manufacturers' software?

B MANTA BASICS

Eureka is the only major multiprobe manufacturer that provides a three-year warranty that covers all sensors, including pH and DO.

B.1 Deployment Specifications

The Manta can be used in natural water up to 50 degrees C and 200 meters deep, except that ISE's are rated to 10 meters deep, and TDG sensors and low-range depth should go no deeper than 25 meters.

B.2 Manta Control Software Flow Chart

Please see the first page in Section C.

B.3 The Manta Has Four Basic Applications

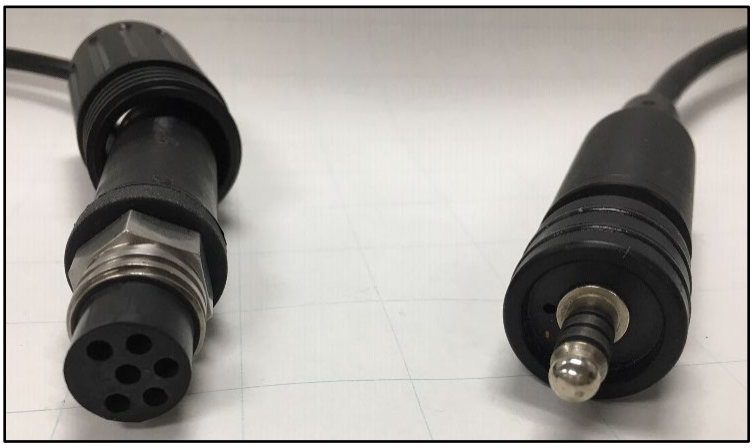
1. Manual Data Collection, also known as profiling, surveying, site-to-site measurements, etc., means that the user is present at the monitoring site and uses a Data Display for observing measurements. This allows the user to make data-based decisions in the field in real-time, and lets the user visit multiple monitoring sites in one day. The Data Display can be a laptop, Amphibian2, or almost any tablet or smart phone. The user makes note of measurements either with pen and paper or, preferably, by using the Manta's Snapshot or Automatic Snapshot features. You might "snapshot" a series of measurements in one or more lakes or streams during the day, and then download the data to your desktop PC that evening. (C.3, E.1)
2. Unattended Logging means that the user has set the multiprobe into its Logging mode, deployed the multiprobe in the proper location in the water, and then left the site. The Manta can run for weeks at a time with cable-supplied power or an optional Manta integral battery pack. You can, for instance, set the instrument to take a set of readings every half-hour, anchor it in an estuary, and return after two weeks to retrieve the instrument and download the data to a PC, laptop, or Android device.
3. Telemetry Relay means that the user has connected the multiprobe to a telemetry device, deployed the Manta in the proper location in the water, and then left the site. A cable connects the multiprobe to the telemetry system. The telemetry device uses satellite or cell-phone communication to periodically report data collected by the multiprobe to the user's office PC or to a proprietary Web page. In many telemetry systems, the user can also contact the multiprobe and request transmission of the most recent data. Telemetry Relay allows the user to collect data all night and all day for weeks

without being present at the monitoring site and allows the user remote access to those data at any time. Telemetry is helpful in deciding when a trip to the field for multiprobe calibration or maintenance is necessary. Telemetry is also ideal in locations for which access is dangerous or expensive.

4 On-Line Monitoring, also known as process-control monitoring, means that the multiprobe is connected to a PLC, SCADA system, etc. An example is monitoring the input to a water-treatment plant for salinity or chlorophyll. On-Line Monitoring allows the user to make water-quality-based decisions in real-time. The Manta is particularly effective in this application when more than one parameter is used in the control loop.

B.4 Underwater Cables

The later Manta Underwater Cables have a marine-style connector (left), while the early Manta Underwater Cables had an audio-style connector (right).



Vented Underwater Cables, which are used with the optional Vented Level sensor, have a small tube within the VUC to connect the sensor to the surface of the water so that changes in barometric pressure do not affect level readings. That vent tube is connected to a desiccant pack at the top of the VUC to prevent water from condensing inside the vent tube. Later VUC's are fixed to the Manta and cannot be removed.

B.5 Operating the Manta with Eureka's Amphibian2

(Please see F.4.a if you wish to connect to your Amphibian2 via Bluetooth instead of a cable.)

1 Power on the Amphibian2 Data Display.

1 On the start-up screen, select “Amp_2_2_X” to launch the Manta control software.

2 Connect the Amphibian2 to your Manta cable’s 9-pin connector and turn the Amphibian2 on.

3 You should see scrolling data from the Manta's sensors.

The Manta Control Software loaded on the Amphibian2 mirrors the version for the PC with some concessions for the small screen.

Section 5 has more information about small-screen Data Displays.

B.6 What do the LED lights mean?

The Manta has three light-emitting diodes (LED’s), mounted on the circuit board visible through the instrument housing, to help you understand what’s happening, and to provide information when troubleshooting a failure.

The green light blinks every second when receiving adequate operating voltage via the cable; it does not blink when the Manta operates under its own battery power.

The red light blinks five times upon power-up when Logging is enabled.

The amber light blinks when the Manta is receiving RS-232 communications from an external device (such as a PC or logger).

A sequence of red and amber LED flashes tell you the voltage of your battery pack if you have activated Logging. When you first power-up your Manta, the red LED will blink five times to indicate that Logging is activated and to indicate the first 3.5 volts of battery power, and then one amber blink for each volt, and one red blink for each half volt.

For instance, five reds, five ambers, and a red means 3.5 + 5 + 0.5 = 9 battery volts.

B.7 The USB Converter

Eureka’s USB Converter converts your Manta’s data stream to a USB port. Newer models have a power port on the side that you can use to provide power to the Manta if USB power is insufficient, or to protect your laptop’s battery. The connector is fairly standard for power supplies, so you can plug in many third-party power supplies – but do not use a power supply providing over 14 VDC.

If you are using a power supply that plugs into the wall, please use a GFI-equipped circuit.

B.8 Accessories

Eureka provides a number of accessories for the Manta, including carrying cases, anti-fouling kits, SDI-12 converters, data displays, telemetry systems, cable reels, etc. Please see the Eureka Web page (www.WaterProbes.com) for more details.

B.9 Flow Cell

If it is more convenient to bring the water to the Manta than the Manta to the water, for instance when monitoring a ground-water well, you can simply screw a Flow Cell onto the Manta as you would normally screw on a sensor guard.

Be sure to limit the pressure in your sample lines to 15 psi so that you don't damage the flow cell.

B.10 Routine Maintenance

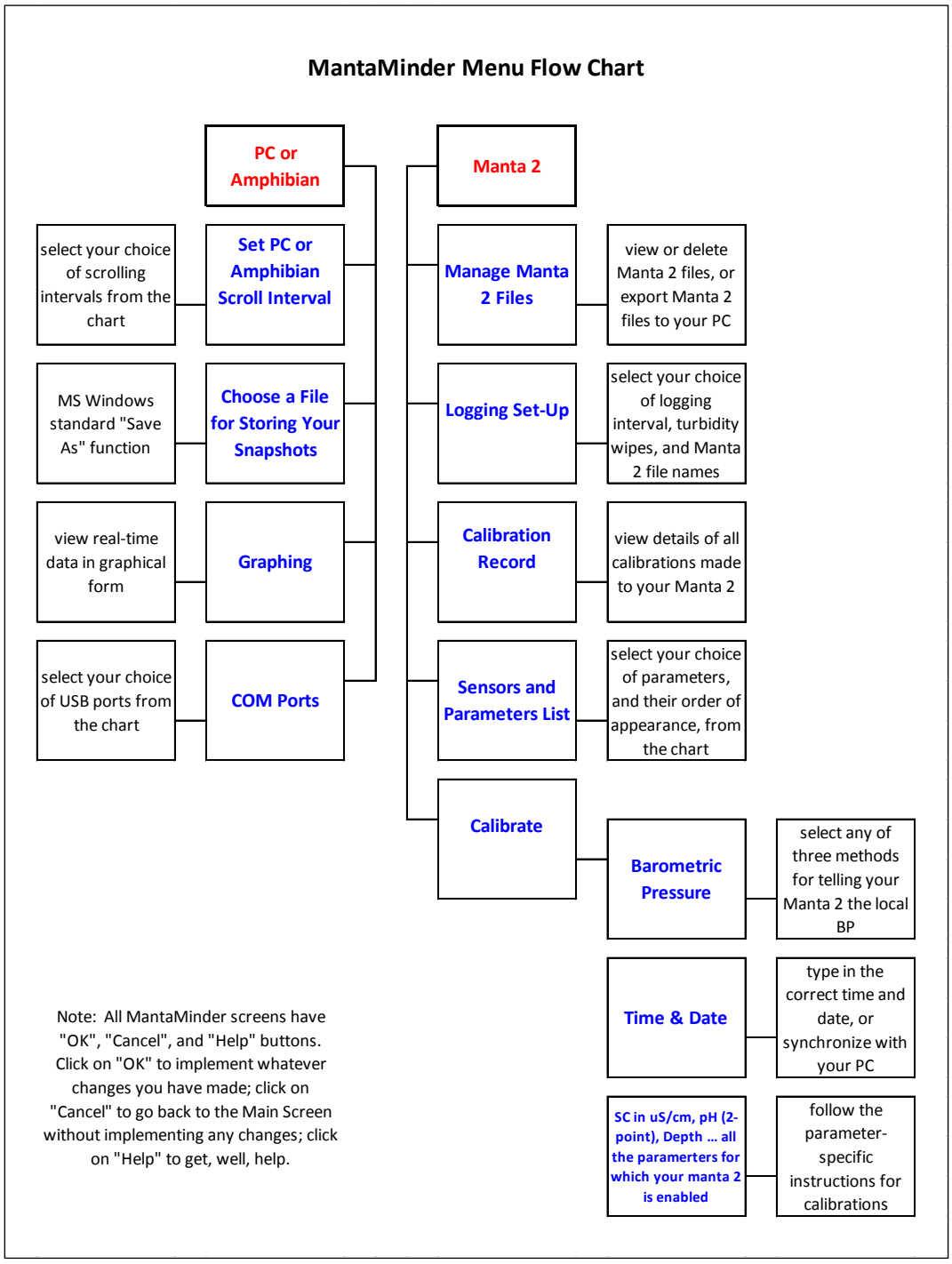
Clean your instrument periodically with warm soapy water. Liquid dishwashing soap is fine. Do not use abrasives. Do not use acetone. Do not clean with gasoline, kerosene, or industrial cleaners. Mild household cleaners work well. Clean sensor stems with a soft brush.

Rinse well with tap water, and store sensors with tap water in the storage cup.

Replace any o-rings with visible cracks. Keep o-rings greased with silicon grease (found in your Maintenance Kit). Always remove batteries and clean your Manta prior to storing it for prolonged periods.

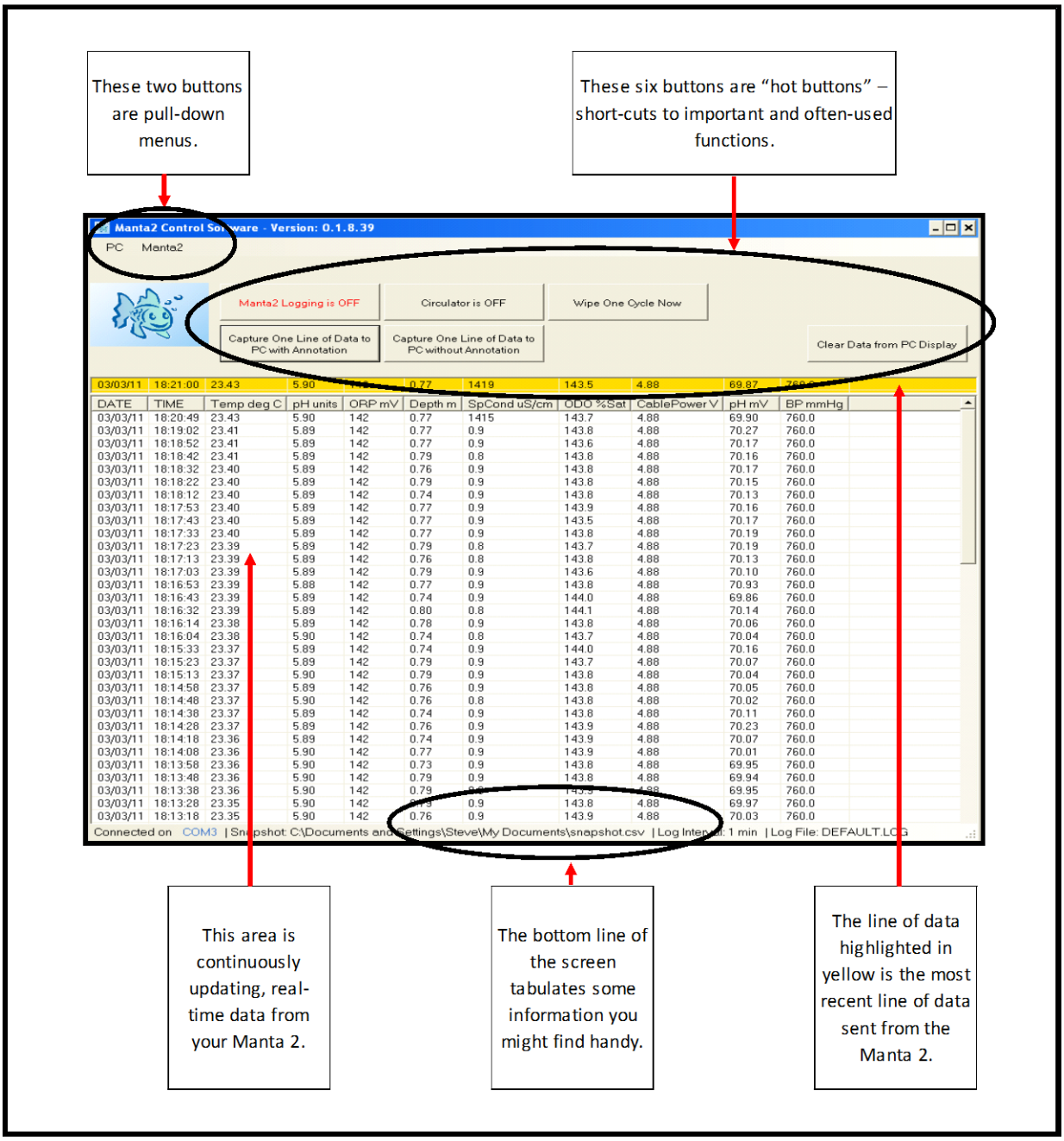
C THE MANTA CONTROL SOFTWARE

C.1 Manta Control Software Map



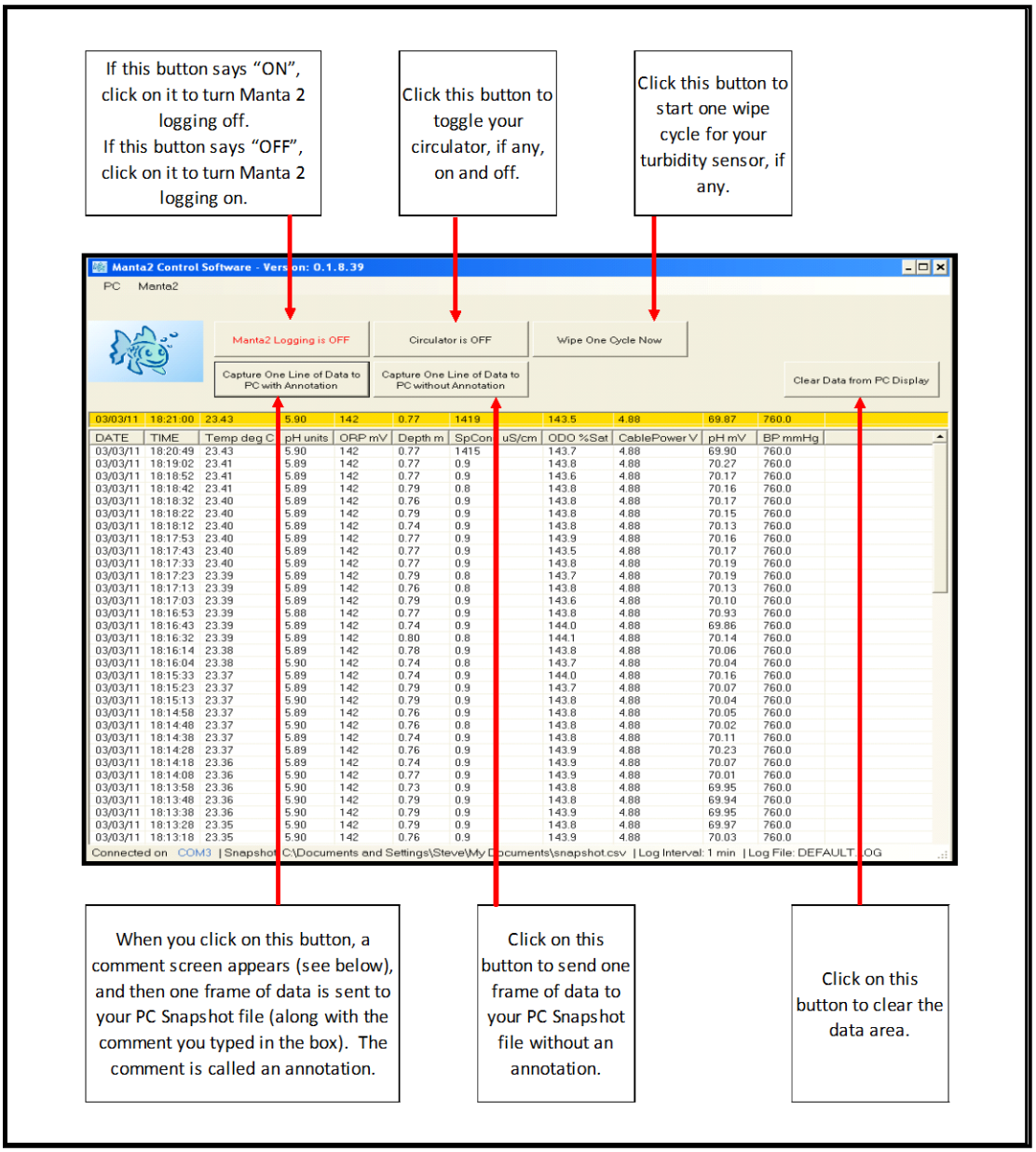
C.2 Home Page

We call the Manta Control Software's Home Page the "Home Page" because you can access all the Manta functions from this screen. The Home Page functions are:



C.3 Hot Buttons

"Hot Buttons" are the little squares you can click on to do something important without leaving the Home Page. The Hot Buttons are:



1 Click the "Manta logging is OFF" (or, "Manta logging is ON") hot button to enable or disable the Manta's Logging function. It lets you tell the Manta that you will be deploying it in the field for unattended Logging. Clicking the hot button toggles the Logging on and off. Generally, Logging should be off – turn Logging to ON only when you're preparing for unattended deployment.

2 Click the “Wipe one cycle now” hot button to activate one cycle of the turbidity sensor’s wiper. If your Manta doesn’t have turbidity, you can still click this button, but nothing will happen.

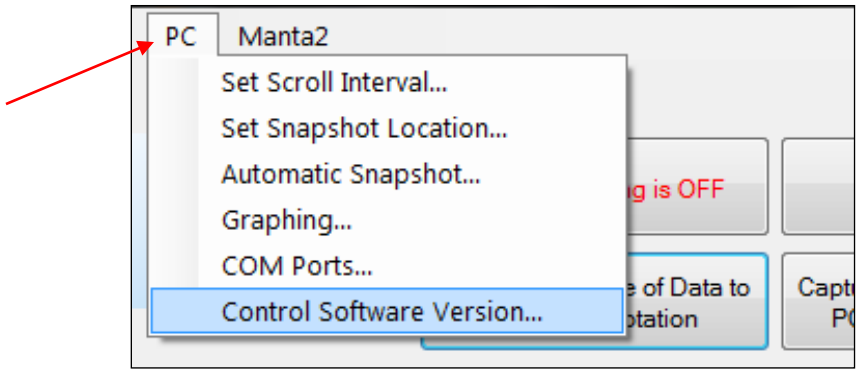
3 Click the “Capture One Line of Data to PC without Annotation” hot button to save the most recent line of data (as shown in the yellow band on the Home Page) in your Snapshot file. (C.3.b)

4 Click the “Capture One Line of Data to PC with Annotation” hot button to save the most recent line of data (as shown in the yellow band on the Home Page) to your Snapshot file, along with a brief note that you might wish to append to the data. Type that note in the annotation box. The note will be saved, along with the data, in your Snapshot file. (C.3.b)

5 Click the “Clear Data from PC Screen” hot button to remove the data you see on the screen and start over with only the most recent data. Clicking this button does not close the program.

C.4 “PC” Pull-Down Menu

The Manta has two pull-down menus, called PC and Manta. They’re called pull-downs because when you click on them, a bunch of hidden buttons appear. When you click on the “PC” pull-down menu, you get six buttons to choose from:



1 Click Set Scroll Interval if you wish to change the time for which lines of data on your Data Display screen are updated. You can click on a specific scroll interval or type in your own.

2 Click Set Snapshot Location if you wish to specify the file in which your Snapshots are to be filed. This calls up the standard “Save As” (or equivalent) function of your Data Display’s operating system. Follow the instructions just as if you were saving, for instance, a new Word document.

A “Snapshot” is what happens when you choose to log, or store, one line of data. That line can be representative of, say, stabilized readings at 10 meters in a particular lake, or any other line of data you find interesting. (C.4, E.1)

If you want to find those interesting lines of data later, it's a good idea to put them in a file whose location you can actually remember.

Notice that the active Snapshot File location is listed on the bottom line of the Home Page.

3 Click Automatic Snapshot if you wish log data automatically and quickly, for instance to catch a transient situation or if you are rapidly profiling a column of water. You can also use Automatic Snapshot to save data while you go to lunch. The data are stored in the Snapshot file as determined by "Set Snapshot Location". (C.4, E.1)

In Automatic Snapshot, data are logged at the same interval as they are displayed on your Data Display screen when you're not in Automatic Snapshot. For instance, if you have set your PC scroll interval to 10 seconds, Automatic Snapshot will record data at 10-second intervals.

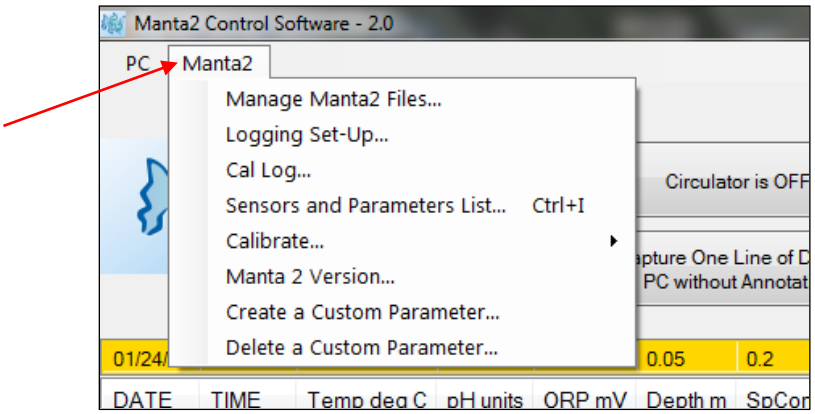
4 Click Graphing to see your Manta real-time data in graphical form. The graph view is helpful when profiling to watch for sensor stability. For example, Dissolved Oxygen readings are temperature and salinity corrected, so when the probe goes through water with thermal or saline stratification, it's important to wait for stable readings before recording a Snapshot.

5 Click COM Ports to change the USB port that your Manta Control Software uses to talk to your Manta. Normally the Manta Control Software searches all active USB ports until it finds a Manta to talk to, and then it stops looking. But you might have more than one Manta connected to your PC at one time, for instance if you are calibrating several Manta's at the same time or are using your PC to monitor several Manta's at the same time (like in a fish hatchery with multiple tanks). In that case, you can click COM Ports to see the list all the COM ports that your PC knows about and choose another COM port corresponding to another for the Manta.

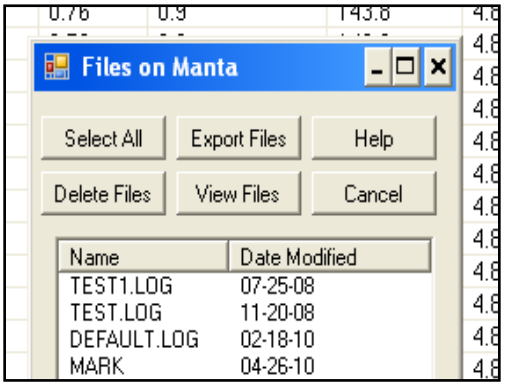
6 Click Control Software Version to get a screen that tells you the software version that your Data Display is using to talk to your Manta.

C.5 "Manta" Pull-Down Menu

The Manta has two pull-down menus, called PC and Manta. They're called pull-downs because when you click on them, a bunch of hidden buttons appear. When you click on the "Manta" pull-down menu, you get eight buttons to choose from:



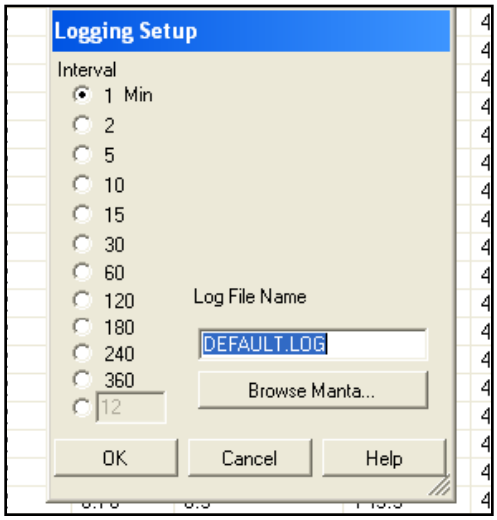
C.5.a Manage Manta Files



Click on Manage Manta Files to see the names of all the data files that are stored in your Manta. Highlight the file you're interested in by clicking on it. Then, with the other buttons on the screen, you can then view that file on your Data Display screen, delete that file, or export it to your Data Display (via the Save As function standard to Windows).

You may highlight multiple files to select for export.

C.5.b Logging Setup

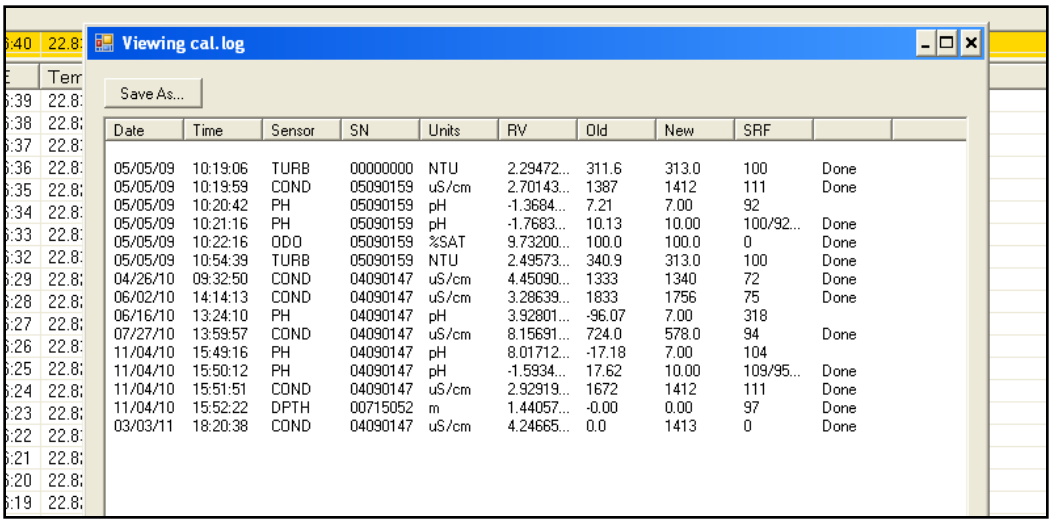


All Mantas include data memory and software that automatically logs (stores) a line of data any time you want. The Logging Set-Up screen lets you change the instructions the Manta will follow when Logging. You can click on your preferred Logging interval. You can also elect to append any new data to a file that already exists in the Manta by clicking "Browse Manta", then selecting a file and clicking on "OK", or you can create a new Manta logging file by typing the new file name under "Log File Name".

For your convenience, the active logging file name is displayed in the bottom line of the Home Page.

C.5.c Calibration Log

Click on the Cal Log button to see, you guessed it, the calibration record. This is a lifetime, permanent record of all calibration changes for your Manta. (D.4)

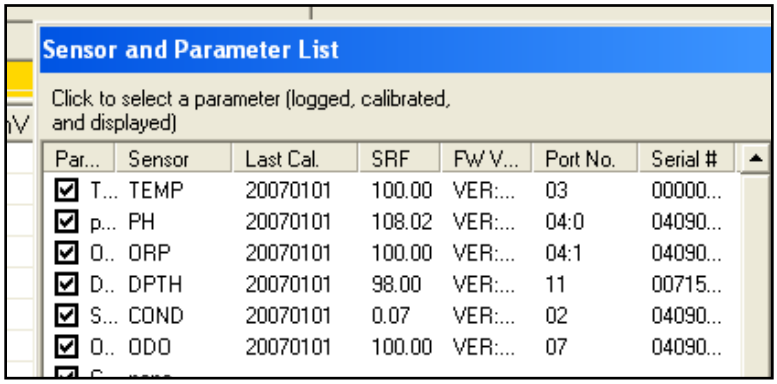


C.5.d Sensors and Parameters List

Enable the parameters listed by clicking the box (to the left of the parameter name) to produce the check mark. Clicking on a box with a check mark removes the check mark and disables that parameter.

Note that if you enable a parameter but don't have a sensor for that parameter, it would be a huge coincidence if the data were accurate.

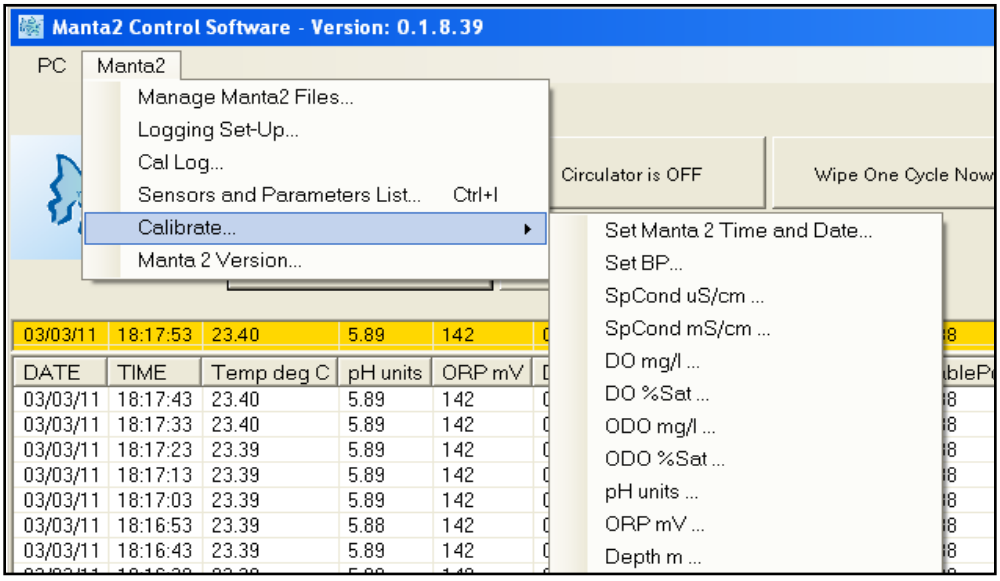
The order of the enabled parameters in this list is the order in which the parameters will appear in your Data Display Home Page, the order in which they will appear in Logging files, and the order in which they will appear in Snapshot files. You can change the parameter order by clicking on (i.e. highlighting) the parameter name and then moving the highlighted name up or down by clicking on the up- and down-arrows at the bottom of the screen.



C.5.e Calibrate

Click on the Calibrate button in the Manta pull-down menu to get a screen listing all the parameters that can be calibrated in a Manta. Click on the parameter you wish to calibrate to see its Calibrate screen. This screen has calibration instructions for the specific parameter and shows the current reading for that parameter.

If your calibration requires a calibration standard, type your calibration standard value where it says “enter calibration value”. When the parameter reading has stabilized in the calibration solution, click on the OK button. If your calibration has an acceptable SRF (Sensor Response Factor, an indication of the sensor condition (D.4); the calibration will be accepted, and you will be returned to the Home Page. If you click on “OK”, the calibration will be accepted despite a deviant SRF, and you will be returned to the Home Page). If you click on “Cancel”, you’ll go back to the Calibrate screen.



How do I know if I need to calibrate?

The simple answer is that frequent calibration will give you better data. The more meticulous you are with calibration, the better data you will gather. If you are uncertain whether you need to calibrate, check your sensors against a known sample. If the reading is within the accuracy specification and/or your accuracy expectations, there is no need to calibrate.

Experience and your program’s accuracy expectations will help determine calibration frequency for the various sensors. If, for instance, your reservoir discharge is hovering near

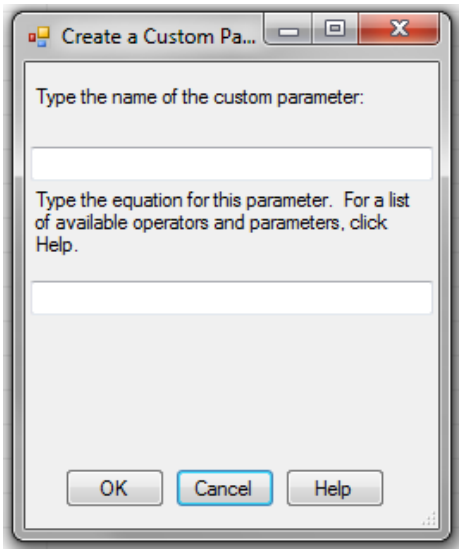
the regulatory minimum for dissolved oxygen, you should pay special attention to DO calibration frequency and technique. On the other hand, if a conductivity accuracy of +/- 10% is OK, you needn't calibrate conductivity very often.

C.5.f Manta Version

Click this button to see the version number for the software that your Manta uses.

C.5.g Create a Custom Parameter

Suppose you determined the relationship, specific to your waters, between conductivity and total dissolved solids (TDS). Or suppose you had an algorithm relating water level to flow for a certain site. With the Manta, you can create new parameters – call them, for instance, My TDS and Site 4b Flow – that will show up on your Home Page and logged data just like temperature, pH, and all the other parameters.



To make this happen, click on the Manta pull-down menu, and click on Create Custom Parameter. Follow the instructions to name your new parameter, specify the units that you wish the new parameter reported in (e.g. mg/l for TDS), and tell the Manta how to calculate your new parameter (using mathematical operators as you would in Excel).

Note: Enclose the entire expression in parentheses. After creating or deleting a parameter, restart your CPU. Custom Parameters cannot be created with the Amphibian2 Manta Control Software.

C.5.h Delete a Custom Parameter

Suppose you're having second thoughts about the customer parameter you created. Click on the Manta pull-down menu and click on Delete Custom Parameter. Follow the instructions.

C.6 Software Update of November 2018

A new Manta software version, 7.09, was implemented in late November 2018. The new software makes the following improvements to the turbidity parameter:

1) The Sensors and Parameters List now contains the parameter "Turb_FNU", which replaces "Turb NTU". Turb_FNU is the same measurement as Turb NTU, except altered slightly to make its true ISO 2027 response linear with formazin.

2) The Sensors and Parameters List now contains the parameter “Turb_Mod”, which is the same measurement as Turb_FNU, except NOT altered to make its response linear with formazin. It is numerically equal to the earlier parameter Turb NTU.

3) The Sensors and Parameters List now contains the parameter “Turb_NTU”. Turb_NTU is the same measurement as Turb_FNU, except with units of NTU instead of FNU if you prefer that your data are labeled NTU. Calibrating Turb_NTU also calibrates Turb_FNU, and vice-versa.

4) The Sensors and Parameters List now contains the parameter “Turb2_FNU”. Turb2_FNU is the same measurement as Turb_FNU (or Turb_NTU, if you prefer NTU’s), except multiplied by a Turbidity Scale Factor. Turb2_FNU is a unique parameter that helps you match Eureka turbidity readings with readings from other types of turbidity sensors for the sake of data continuity.

   For instance, suppose you found that a Eureka turbidity sensor read 89 while another turbidity sensor read 78 in the same sample. The Turbidity Scale Factor is 78/89 = 0.88. You can type that Turbidity Scale Factor into the Manta when calibrating Turb2_FNU. Thereafter, all Turb2_FNU readings will be the Eureka turbidity readings multiplied by 0.88 to mimic the readings that you would get with the other turbidity sensor.

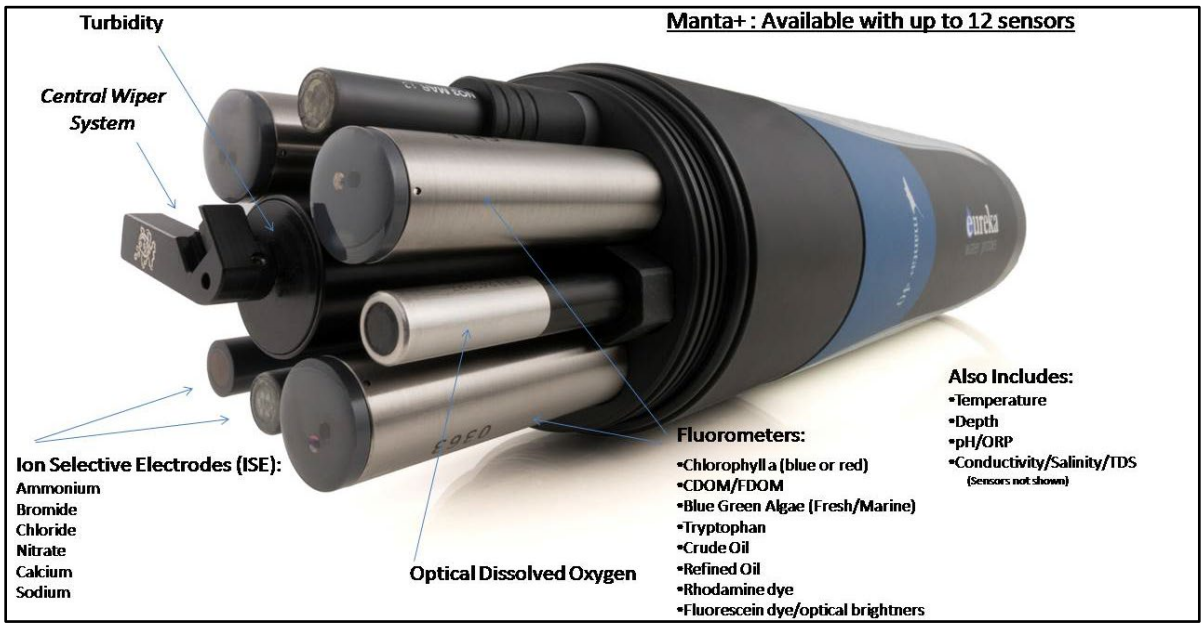
The software specific to turbidity has changed as well, from 5.21 to 5.22.

In most cases, you can update your Manta’s software with these new softwares if you wish to take advantage of the new features dealing with turbidity.

D SENSORS AND CALIBRATIONS

D.1 The Difference between Sensors and Parameters

A sensor is a basic element, like a thermistor or a pH glass electrode. Each sensor has one or more parameters. For instance, we use a thermistor to measure both Temperature °F and Temperature °C – that's one sensor with two parameters. A conductivity sensor can be read as Specific Conductance µS/cm, Specific Conductance mS/cm, Total Dissolved Solids mg/l, and Salinity (PSS) – that's one sensor with four parameters.



D.2 Basics of Parameter Calibrations

The Manta never guesses parameter values, so you have to calibrate it from time to time by simply telling the instrument what it should read in a calibration situation for which the correct parameter value is known. Here's the general procedure; instructions for specific parameters will follow beginning with D.5:

1. Clean the sensor and perform any necessary sensor-specific maintenance.
2. Select a calibration standard whose value is close to the values you expect to see in the field. For best results, use fresh calibration solutions, and discard once they have been used.
3. Rinse sensors thoroughly (more than once may be required) with DI (deionized) water, especially if you have been using other calibration solutions. Pour the water into the calibration cup, position the "stopper" side of the lid on top and shake the Manta vigorously to remove traces of old calibration solutions – repeat if necessary.

4 Rinse the sensors twice with a small quantity of your calibration standard. Discard the used calibration standard.

5 Immerse the sensor in the calibration standard. This is usually accomplished by pouring the standard into the Manta's calibration cup once it has been screwed onto the Manta housing. Secure your Manta with the sensors pointing up and fill the calibration cup with your calibration standard. Make sure the standard covers the sensor entirely, and that it also covers the thermistor for those parameters that are temperature-compensated. For turbidity sensors and other fluorometers fill the cup to at least 1 ½ inches above the sensor's lens surface.

6 Select the parameter to be calibrated by clicking on the Manta pull-down menu in the Home Page, then clicking on Calibrate, and then clicking on the parameter you wish to calibrate. First, enter the calibration value and press enter; when the reading has stabilized, press enter to calibrate. The Manta will report the resulting Sensor Response Factor (SRF); then press Y to accept the calibration, N to back up one step, or Exit to leave the sensor uncalibrated. (C.5.e)

D.3 Choosing Calibration Standards

For best results, choose a calibration standard whose value is close to what you expect to see in the field. For example, calibrate with a 1413 µS/cm Specific Conductance standard if you expect to see Specific Conductance readings between 500 and 1000 µS/cm in the field. Calibrating with a sea water standard or a very low standard would not be appropriate in that case. Similarly, if your waters tend toward the acidic, calibrate with a 4-buffer instead of a 10-buffer.

If you are moving your multiprobe across wide ranges of water conditions, you may wish to recalibrate to match the new situations. For instance, if you are measuring a clear lake during the morning and a high-sediment stream in the afternoon, you might consider recalibrating at noon with a high-range turbidity standard.

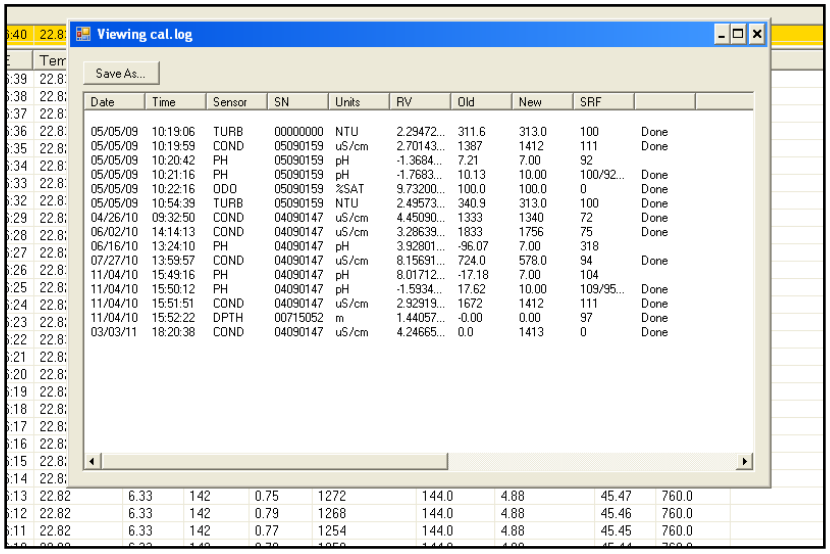
The table below shows common calibration practices.

Sensor	Standard Method of Calibration	Available Calibration Solutions	Comments
Temperature	never requires calibrating	N/A	
pH / pH reference	2 or 3 points	pH 4, pH 7, pH 10	pH7, pH 10 most common
ORP	1 point	ORP Standard 200 mV	
Conductivity	1 point	CD Standard, 0.5 Molar, 58670 Micro S CD Standard, 0.1 Molar, 12856 Micro S CD Standard, 0.01 Molar, 1412 Micro S CD Standard, 0.001 Molar,147 Micro S	brackish/saltwater borderline brackish typical freshwater very pure fresh/glacial

Sensor	Standard Method of Calibration	Available Calibration Solutions	Comments
Reference Electrode	calibration not required	N/A	replace pH electrolyte solution at routine calibration
Depth	adjust for barometric pressure	N/A	recalibrate at deployment site for best accuracy
Turbidity	2 points	0 NTU, 10 NTU, 100 NTU, 400 NTU	calibrate near expected value
HDO (Optical DO)	calibrate at 100% saturated water	DI water -shake vigorously to oxygenate	set BP before calibrating, recal at deployment site for best accuracy
Chlorophyll	2 points	secondary solid or 40µg/L solution or lab sample	
Rhodamine	2 points	secondary solid standard or rhodamine	
Blue Green Algae	2 points	secondary solid standard or lab sample	
Ammonium (NH4+)	2 points	Lo 4.63 mg/l; Hi 46.3 mg/l	
Nitrate (NO3+)	2 points	Lo 4.62 mg/l; Hi 46.2 mg/l	
Chloride (CL-)	2 points	CD Standard 147 Micro S CD Standard 1412 Micro S	enter 34.3 during calibration for low enter 319.3 mg/L for high

D.4 Calibration Record ("Cal Log")

Every Manta has a dedicated data file called CAL.LOG. The CAL.LOG records every calibration that your instrument has accepted. In this file are the time and date of the calibration, the parameter calibrated, the reading before the calibration was accepted, the reading after the calibration was accepted, the SRF, and a few other details. If you wished to know, for instance, the last time that Conductivity was calibrated, the Calibration Record would tell you when the most recent Conductivity calibration was accepted, the value of the calibration standard, and the instrument's reading in the standard before the calibration was made (to tell you exactly how much the instrument was changed during calibration). This data cannot be altered within the Manta, so don't try any funny business.



D.5 Sensor Response Factor (SRF)

Also included in the Calibration Record is each calibration's Sensor Response Factor (SRF). Suppose that a typical Conductivity sensor reports 100 µA in a 1413 µS/cm standard. If your Conductivity sensor reports 100 µA in that same calibration solution, then your SRF is 100% (some parameters, such as pH, have a more complex SRF calculation, but the effect is the same). If your response is 80 µA, your SRF would be 80%. When you press the OK button to accept a calibration, the Manta automatically accepts your calibration if the SRF is between 60% and 140%. If the SRF falls outside that range, you will be cautioned to check your standard value, make sure the sensor is clean, make sure the reading has stabilized, etc. But you can elect to accept any SRF.

D.6 Temperature

The Temperature sensor is an electrical resistor (thermistor) whose resistance changes predictably with temperature. The sensor is protected by a stainless-steel tube. Thermistors are very stable with time, and so do not require calibration.

D.7 Dissolved Oxygen

The optical dissolved-oxygen sensor comprises a blue-light source, a sensing surface, and a red-light receiver. The sensing surface is an oxygen-active compound stabilized in an oxygen-permeable polymer, usually silicone. When the sensing surface is exposed to water (or air, for that matter), oxygen diffuses into the sensing surface according to the amount (partial pressure) of oxygen in the water. The oxygen-

active compound fluoresces – that is, it absorbs energy in the form of blue light and then emits energy as red light. In each measurement cycle, the blue light is first turned on, and then turned off. The red-light receiver measures the time it takes, after the blue light is turned off, for the fluorescence to die off. This value is proportional to dissolved oxygen.

The sensor output is corrected for the temperature and salinity of the water.

Eureka is an advocate of the "air-saturated water" calibration method – that's different from the "water-saturated air" calibration commonly used in the past. Here are the steps to air-saturated water calibration:

1. Make sure your instrument's Barometric Pressure setting is accurate. (D.18)
2. Put a half-liter of tap water in a liter jar, put on the lid and shake the jar vigorously for one minute. Take the lid off the jar and let the water stand for about five minutes to let the air bubbles float out.
3. Screw your calibration cup onto the Manta housing. With the sensors pointed upward, fill the calibration cup until your aerated water covers the DO cap by a centimeter or so.
4. Wait a few minutes for the temperature to equilibrate.
5. Follow the Manta Control Software calibration instructions – remember that you are calibrating % sat, not mg/l, so select % sat from the list.

What's the real story on optical DO sensitivity to fouling?

Glad you asked. Several years ago, there was rumor floating around that optical DO sensors were not affected by fouling. The rumor was only half true.

Suppose you put an optical DO sensor in a river. If you're just downstream of a rendering plant or oil patch, your sensor might become coated with grease or oil. Unless that coating is impermeable to oxygen, your sensor will still give accurate readings (though it may be slow to respond to changes in oxygen). That's because the coating is not oxygen-active, i.e. it doesn't produce or consume oxygen.

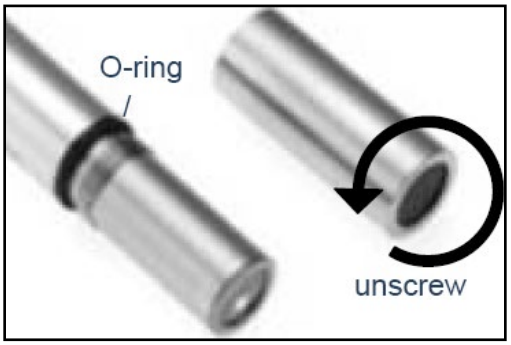
On the other hand, if your sensor picks up an oxygen-active coating, for instance of photosynthetic algae. The algae's respiration can cause the sensor to report exaggerated swings in diurnal oxygen pressure because the algae have their own micro-environment of oxygen pressure – and the optical DO sensor thinks that the oxygen pressure immediately adjacent its membrane is representative of the rest of the world.

The manufacturers of optical-DO sensors recommend that you not calibrate the zero-DO point. However, we support zero-DO calibration in the Manta software, and think it's a good idea to check your sensor's zero from time to time in either of three ways:

1. Dissolve a few grams of sodium sulfite and a pinch of cobalt chloride in a half-liter of tap water. You can buy this solution ready-to-use but be careful not to aerate the solution by pouring it numerous times.
2. If you're like me and think the sodium-sulfite method is yesterday's news, you can prepare zero-oxygen water by bubbling nitrogen through water. Use bottled gas and an aquarium-type airstone. (If you're using a high-pressure gas bottle, please use a two-stage regulator to prevent unnecessary excitement.) After bubbling the gas through, say, a liter of water for, say, 10 minutes, you should have a good zero.
3. The simplest way to check zero response is with nitrogen gas. Wrap the sensor-end of your Manta with a plastic bag, and feed nitrogen gas into the bag. Make sure there's another hole at the opposite end of the bag for the air to escape, otherwise you won't get a good zero and the exploding bag will cause excitement. (If you're using a high-pressure gas bottle, please use a two-stage regulator.)

Optical dissolved-oxygen sensor maintenance is little more than occasionally cleaning the sensing surface (the black material; about a centimeter diameter) with a cloth and soapy water.

Optical dissolved-oxygen sensors *usually* have very low drift rates (compared to the old Clark sensors), so practice will show you how often to calibrate your optical sensor. You might also find that one or other of the calibration points does not require calibration every time you set the other point.



The tip of the Eureka optical dissolved oxygen sensor (HDO) must be replaced periodically, typically once every 4 years. If your SRF reports less than 100% or if you notice that the sensor's readings are getting noisy (i.e. jumpy), then it's probably time to change the tip by unscrewing the old tip and replacing it with a new tip. Recalibrate and you're ready to go.

D.8 Conductivity

Eureka uses the four-electrode method to determine water conductivity. Two pairs of graphite electrodes are situated in a stable geometry (you can barely see the electrodes; they look like two bull's eyes inside the slot on the conductivity sensor).

A constant voltage is applied to one of each electrode pair, and the amount of current required to maintain that voltage is measured. As the conductivity of the water increases, the current increases.

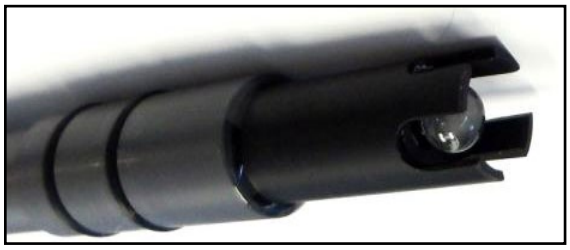
The zero point for the sensor is set electronically, so you need only set the “slope” point:

1 Fill the calibration cup with your conductivity standard to cover the conductivity sensor. Tap gently on the cup to make sure there aren’t bubbles trapped in the conductivity sensor.

2 Follow the Manta 2 Control Software’s calibration instructions.

The Manta normally reports Specific Conductance – that’s Conductivity standardized to 25°C. Your reading is thus the conductivity of your water if that water were heated or cooled to exactly 25°C. Conductivity has several other forms, Total Dissolved Solids (TDS) and Salinity. You can’t calibrate TDS or salinity directly because they are calculated from Conductivity. You can, however, “calibrate” TDS with a TDS standard by adjusting the conductivity calibration point up or down until the TDS standard produces the desired TDS reading. The same is true for Salinity if you’re using a standard qualified on the Practical Salinity Scale (PSS). "Enable" TDS and/or Salinity by checking the box next to those parameters in the "Sensors and Parameters" section.

D.9 pH



pH is measured as the voltage drop across the glass membrane of a pH electrode. A reference electrode is used to complete the voltage-measuring circuit. The pH glass is specially formulated to absorb water so that ions (particularly H+ and OH-) in the water are attracted to the glass to offset the ionic constituency of the pH electrode’s internal electrolyte. As a result, there is a charge separation across the glass, and that’s the voltage we measure. pH readings are automatically compensated for temperature.

pH electrode maintenance is nothing more than occasionally cleaning the glass surface with a soft cloth and soapy water. Do not use anything abrasive. The really important part of pH maintenance is refilling the reference electrode. (D.10)

You can choose a two- or three-point pH calibration. The two-point calibration, a seven buffer and a second buffer whose value is near that of the waters you intend to monitor, is recommended. If you are measuring in waters whose pH might range above and below seven, you can increase your accuracy slightly by choosing a three-point calibration (the third buffer should be on the other side of seven). pH calibration is simple:

2 Rinse your sensors several times with the pH buffer you’ll use for calibration.

3 Fill the calibration cup with enough buffer to cover both the pH and reference electrodes.

4 Follow the Manta Control Software calibration instructions.

5 Repeat steps 1, 2, and 3 if you choose to calibrate with one or two more standards.

D.10 Reference Electrode

The key to reliable pH, ORP, and ISE measurements is a well-maintained reference electrode. Recall that a reference electrode is required to complete voltage measurement for pH readings.

Reference electrode maintenance is simple:

1 Remove the reference cap by unscrewing it from the reference sleeve and discard old reference electrolyte.

2 Fill the sleeve completely with fresh pH reference electrolyte (KCl saturated with silver chloride). Tap the Manta a few times to dislodge any bubbles.

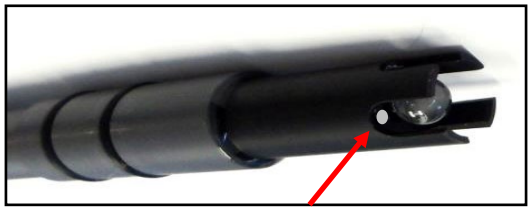
3 Screw the reference cap back on to the sleeve. As you screw the sleeve into place, air and excess electrolyte is forced out of the sleeve through the reference electrode junction (the white, porous circle at the end of the sleeve). This not only purges bubbles from the electrolyte, but also cleans nasty stuff out of the junction.

Other manufacturers may tell you that their integral, or combination, reference electrode is better. This is not true.

First of all, every year or so you have to buy a new combination electrode for about $300 and install the whole thing yourself. Second, combination electrodes usually employ "gelled" electrolyte, and are therefore inclined to calibrating easily in standard pH buffers but measure poorly in low-conductivity waters (like < 200umhos). With the Eureka-style reference electrode you spend a few pennies and a few minutes every month or two refilling the electrolyte. And its "free-flowing" junction performs well in low-conductivity waters.

D.11 ORP

ORP is measured as the voltage drop across the platinum membrane of an ORP electrode. The actual ORP sensor is the 1 mm silver-colored dot you can see when looking down at the pH sensor – if your Manta has ORP. A reference electrode is used to complete the voltage-measuring circuit. Because platinum does not react with ions in the water, it won't give or take any electrons from those ions unless they are very persuasive. The potential (voltage) created by this refusal is what you're actually measuring as ORP.



ORP electrode maintenance is nothing more than occasionally cleaning the platinum surface with a soft cloth and soapy water. If the platinum is discoloured, you can polish the ORP electrode with very light abrasive, like 900-grit wet-and-dry sandpaper (please be careful not to polish the pH glass bulb). The important part of ORP maintenance is refilling the reference electrode. (D.9)

ORP uses a one-point calibration:

1. Rinse your sensors several times with the ORP standard you'll use for calibration.
2. Fill the calibration cup with enough ORP standard to cover both the ORP and reference electrodes.
3. Follow the Manta Control Software calibration instructions after selecting ORP_mV to calibrate.

D.12 Depth and Vented Depth (Stage)

Depth is measured by a strain-gauge transducer as hydrostatic water pressure. The deeper you go in the water, the higher the pressure.

Eureka's depth sensors are usually inside the instrument, with a small pressure port that can be seen on the outside of the Manta bottom cap. They require no regular maintenance, but you might check occasionally to make sure the pressure port is not clogged. If it is, use something soft, like a toothpick, to clear the port of obstruction.

Depth calibration is nothing more than "zeroing" the sensor in air, where one assumes the depth to be zero:

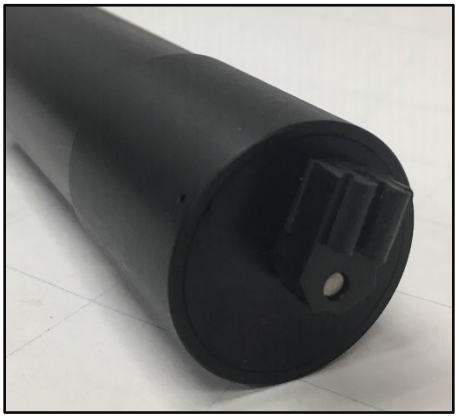
1. Make sure the Manta is not in the water.
2. Follow the Manta Control Software's calibration instructions.

Notice that the Depth sensor cannot distinguish between water pressure and the air pressure over that water (i.e. barometric pressure). After you have zeroed the sensor, any change in barometric pressure will be measured as a change in water pressure. Fortunately, water on Earth is considerably heavier than air, so the error introduced by barometric pressure changes is small.

If that's not good enough for you, there's always Vented Depth, or Stage. Vented Depth uses the same transducer as does Depth, except that there's a tiny hole in the back of the transducer. If you have a vented cable (a cable that has a tube running through it), atmospheric pressure is sensed by the transducer via the little hole. Changes in barometric pressure will not affect the depth reading.

Vented-Depth cables have a desiccant-filled housing at their surface end. The desiccant keeps water from condensing in the vent tube by letting vapor escape through a small Gortex patch. Keep that housing clean and replace the desiccants every year or so.

D.13 Turbidity



Turbidity is measured as the fraction of an infrared light beam that is scattered at 90° to that beam. More particles in the water mean more of that light is scattered, so the Turbidity reading is higher. Any

material that accumulates on the optical surfaces of the Turbidity sensor is indistinguishable from material in the water, so most Turbidity sensors have little wipers to clean the window(s).

Turbidity sensors require no regular maintenance, but you might check occasionally to make sure the optical window (i.e. the little glass port on the front of the sensor) has not been damaged by overzealous wiping.

Turbidity uses a two-point calibration; one point is zero turbidity and the other point should be a standard approximating the turbidity of the water you intend to monitor.

Make sure you use enough calibration standard to cover the sensor's "optical volume" – imagine a tennis ball stuck on the end of the sensor; make sure there are no objects in the volume represented by that ball. One common method is keeping calibration solutions in one-liter, dark, wide-neck bottles with a non-reflective finish (such as Nalgene 2106 bottles in amber, available from Eureka).

For the zero calibration:

1. Make sure the Turbidity sensor is fully immersed (i.e. at least 1 ½ inches of solution over the sensor) in zero-turbidity standard and has an unobstructed optical path.
2. Follow the Manta2 Control Software's calibration instructions.

For the other calibration point:

1. Rinse your sensors several times with the standard you'll use for calibration.
2. Make sure the Turbidity sensor is fully immersed (i.e. at least 1 ½ inches of solution over the sensor) in the standard and has an unobstructed optical path.

3 Follow the Manta Control Software's calibration instructions.

A clean wiper means better measurements. If the wiper pad has deteriorated or is clogged with debris from your water (algae, silt, etc.), you should change it. For best results, you might consider changing the wiper pad prior to each long-term deployment. To change the wiper pad:

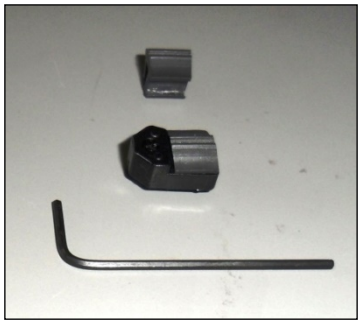
1 Make sure you have the 1.5mm hex key and a new pad for the wiper. Loosen the small set screw on the wiper arm.

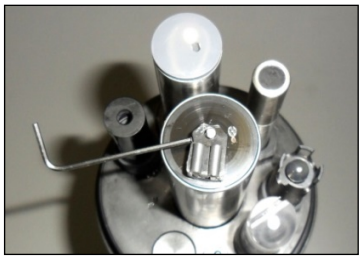
2 Remove the wiper pad from the wiper arm and replace the pad.

3 Place a new wiper arm on the motor shaft so that the set screw faces the flat spot on the motor shaft.

4 Gently press the wiper pad against the face of the probe until the pad is compressed to roughly three quarters of its original thickness. It is important that the wiper arm does not make contact with the probe face – only the pad should be in contact. A gap of 0.5 mm between the wiper arm and the probe face is typical when a new pad has been installed. Another way of setting the pad gap is to place the pad such that you can slide a small piece of paper under the pad, but snug enough that the pad will hold the paper.

5 Tighten the set screw.

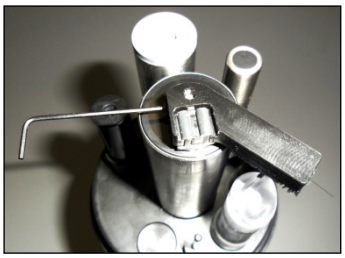
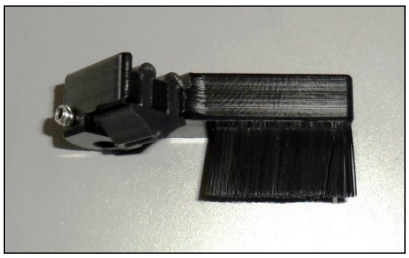
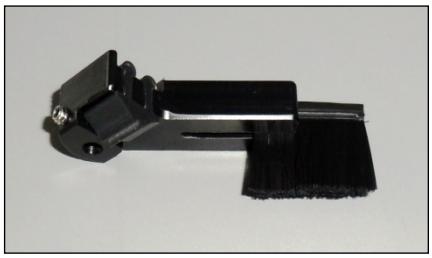




Do not over-tighten the set screw on the little rotating arm that holds the wiper pad; that will strip the threads, and that will cause cursing once you realize what you did. And don't rotate the wiper arm manually; that will strip the gears and stick you with a big, hard-to-explain repair bill.

Your turbidity sensor may be equipped at the factory with an extended brush arm. For best results, change the brush frequently by pulling the old brush out of the brush arm body, and sliding a fresh brush into the brush slot as shown below.

Use the first Allen wrench from your wiper kit to remove the standard turbidity sensor wiper. Use the other Allen wrench to install the Eureka brush arm. Notice that the Allen set screw seats on the flat side of the wiper motor shaft.

In late November 2018, Eureka released a new Manta software version that adds several turbidity features for the hard-core turbidity people. Please see C.6.

D.14 Fluorometers

Eureka's chlorophyll, rhodamine, blue-green algae, CDOM, fluoroscein, and crude oil sensors are Turner Designs fluorometric sensors, with each tuned to the slightly different wavelengths.

Fluorescence occurs when a molecule absorbs light at one wavelength and then emits that energy at a different wavelength. More molecules of analyte produce a higher level of that different-wavelength light. Fluorometric sensors emit light at a certain wavelength, and look for a very specific, different wavelength in return. The magnitude of the return light is relatable to the amount of analyte present.

Note that there are two types of blue-green algae sensors – fresh-water and marine.

Note that CDOM, or Colored Dissolved Organic Matter, is also known as fDOM (fluorescent Dissolved Organic Matter), chromophoric dissolved organic matter, yellow substance, and gelbstoff.

Note that there are many different types of crude oil, and each has a relatively unique fluorescence response.

We use Turner Designs fluorometers because Turner is recognized as the world's leading manufacturer of miniature fluorescence sensors.

There are several conventional ways to calibrate fluorometers; those are explained in Calibrating Eureka's Turner Fluorometers. Eureka also has a new method for "standardizing" fluorometers if you do not use a conventional calibration method; that is explained in Standardizing Eureka's Turner Fluorometers. Both of these documents can be found on Eureka's Flash Drive and Web page (www.WaterProbes.com).

The maintenance procedure is pretty much the same for all fluorometers:

1. cleaning the sensor – Rinse the chlorophyll sensor in fresh water following each deployment, ideally until it is completely clean again. Do not let the chlorophyll sensor come in contact with any organic solvents, such as acetone and methanol, or strong acids and bases.
2. cleaning the optics – Visually inspect the optical window after each deployment following a soaking in fresh water. Use optical tissue to clean the window with soapy water, if needed.

D.15 Ion-Selective Electrodes (ISE's)

ISE's are traditionally used in the laboratory at a constant, moderate temperature, with ionic strength adjusters added to each sample so that the sample and calibration solution have roughly the same ionic strength. ISE's can provide valuable information in the field, for instance in watching short-term trends, but their calibration requirements, stability, and accuracy are not nearly as simple and reliable as those for DO, conductivity, turbidity, etc. For field use, Eureka makes several theoretical and empirical corrections to elicit the best possible field performance.

ISE's operates much like a pH electrode except that the pH glass is replaced by a membrane that is selective for the analyte of interest (ammonium, chloride, nitrate, sodium). The electrode's filling solution contains a salt of the analyte, and the difference between that salt's concentration and the analyte concentration in your water produces a charge separation. That charge separation is measured, relative to the reference electrode, as a voltage that changes predictably with changes in the analyte concentration in the water adjacent the membrane.

It's best not to let your ISE dry out, so place a small amount of tap water in the storage cup to ensure 100% humidity. The sensing elements (tip) for Nitrate and Ammonium ISE's have lifetimes of about 90 days. Then, you must replace the tip by unscrewing it from the sensor body and screwing in a new tip.

Each sensor body is programmed for a specific ISE; the ISE is identified by a series of rings or dots. One ring or dot means the sensor body is programmed for a Chloride ISE; two mean Calcium, three mean Nitrate, four mean Ammonium, 5 mean Bromide, and six mean Sodium.

It's a good idea to limit the submersion of ISE's to about 10 meters. If you need to go deeper than that with the other sensors, you can use a plug for the ISE electrode.

Note that the Ammonium ISE senses ammonium, but at pH's higher than about 8 the ammonium (NH4+) is mostly converted into ammonia gas (NH3). Eureka's software uses the pH, Conductivity, and

Temperature of the sample water to calculate Ammonia (as mg/L-N). You can also display Total Ammonia; the sum of Ammonia and Ammonium.

Note that Ammonium and Nitrate ISE's suffer interference from positive ions, especially potassium and sodium, and Sodium ISE's suffer interference from positive ions, especially potassium and ammonium. The Chloride ISE does not normally suffer from interfering ions.

Note that Eureka's Sodium ISE has a plastic membrane with a wider pH range (pH 3 – 10) and less pH interference than the traditional sodium ISE's (which are made with glass membranes). This sensor is specified to have a 10-second response time and a range of 0.05 – 2,300 mg/L Na+. The sodium ISE can be immersed to 15 meters of water without damage, but there may be a pressure effect on the reading. Although Eureka testing on a limited sample size showed this error to be within our ±20% accuracy specification, we recommend that users check the performance of their particular sensors under actual field conditions.

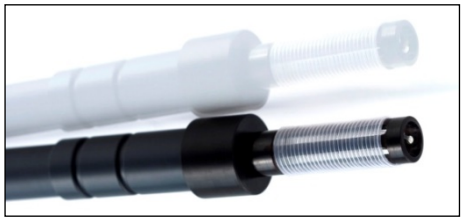
Note that that the Sodium ISE has a slow response to changes in temperature and may take many minutes to reach a final reading when the temperature changes significantly.

If your Manta is equipped with more than one ISE, use care when replacing tips so that you don't put a tip on the wrong sensor (for example put a Nitrate on the Sodium sensor).

ISE calibration is more complex than calibrations for most other sensors, but we've made it as simple as possible in Calibrating Ion-Selective Electrodes: The Difference between Activity and Concentration. This document can be found on the Eureka Flash Drive and Eureka's Web page (www.WaterProbes.com).

D.16 Total Dissolved Gas (TDG)

The TDG sensor is a pressure transducer (the same one used for the 10-meter depth sensor) attached to a "membrane". This membrane is a long piece of thin-wall, silicone tubing whose job is matching gas partial pressures inside the tube with those of the surrounding water. The sum of those partial pressures is measured by the transducer, and that's the TDG of the water.



Aside from keeping the membrane as clean as possible without tearing the tubing, the TDG sensor requires no maintenance. When the membrane is torn or is just too dirty, the membrane assembly must be replaced. Simply unscrew the old membrane and screw on a new membrane. Screw it on finger-tight, plus 1/4 turn.

Silicone rubber is chosen for the membrane material because gases pass through silicone readily. This means that response time for silicone is much faster than if the membrane were, say, Teflon. However, if the membrane is soaked in water for more than a few hours, the silicone absorbs just enough water to slow the gas transfer considerably. This is not usually a problem for unattended monitoring applications (the TDG doesn't change very quickly anyway) but can be annoying if you are doing daily spot-checks. In

that case, it's best to dry out the membrane between stations by using only a few drops of water in the storage cup instead of a few ounces.

D.17 PAR

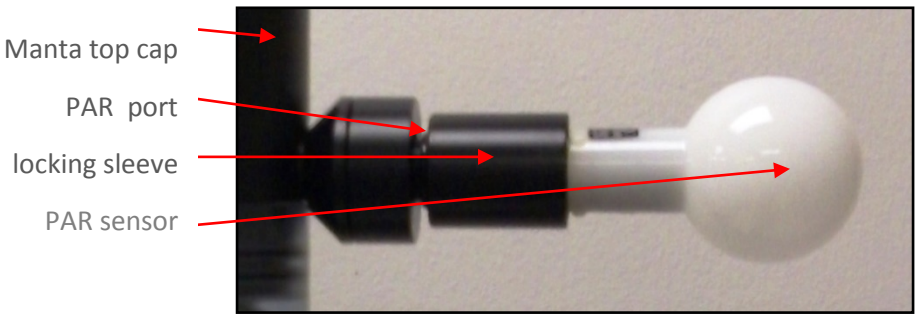
The PAR (photosynthetically active radiation) sensor measures the amount of light available to biota for photosynthesis. It's units of measurement are micro-moles of photons per square meter per second, or photon µmoles/m^2 second. This is also referred to as micro-Einsteins per square meter per second.

The sensor looks like a light bulb and receives light from all directions except the "blind spot" at its base. Eureka mounts the PAR sensor a few inches away from the multiprobe, facing away from the multiprobe, so that the multiprobe is in the blind spot.

PAR sensors are supplied with a dummy plug so that you can use the Manta 2 without the PAR sensor attached.

PAR measurement is accessed for display through the menu structure just like all other sensors. The PAR sensor is calibrated at the LI-COR factory, and cannot be calibrated by the user. LI-COR recommends that the sensor be returned to the factory every couple of years to be re-calibrated.

PAR sensors are not attached to the multiprobe when shipped from Eureka; there is a dummy plug in the PAR port. To attach the PAR sensor, simply unscrew the dummy plug's locking sleeve (it's the same type locking sleeve used for Eureka cables) and pull the dummy plug out of the port. Slide the locking sleeve onto the non-light-bulb end of the PAR sensor and push the PAR sensor into the port as you tighten the locking sleeve. This may take a little bit of practice, as the locking sleeve's off-center hole has to shift slightly to center of the PAR sensor and its port.



There is no need to tighten the locking sleeve more than finger-tight.

Reverse the process to remove the PAR sensor if you wish to make calibration easier, or for cleaning, or for storage if you want extra protection for the PAR sensor. Simply unscrew the locking sleeve, pull the

sensor away from the multiprobe, re-install the dummy plug, and re-install the locking sleeve. The dummy plug seals the PAR port, so you can submerge the multiprobe without the PAR sensor attached.

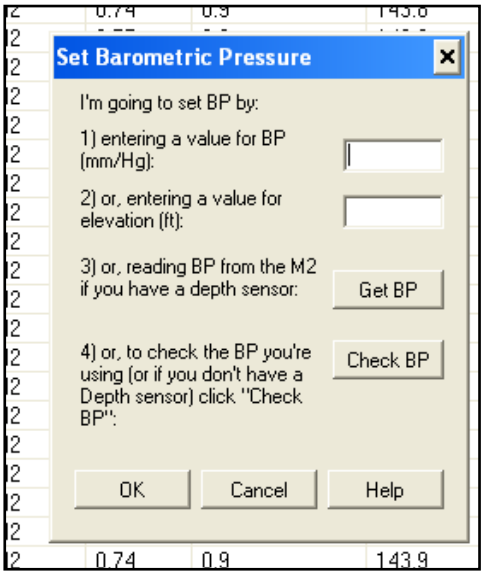
The PAR sensor is made of acrylic plastic for optical reasons. Acrylic is somewhat brittle, so don't step on the sensor. It's also rather soft, so clean the sensor only with soapy water and a soft, wet cloth.

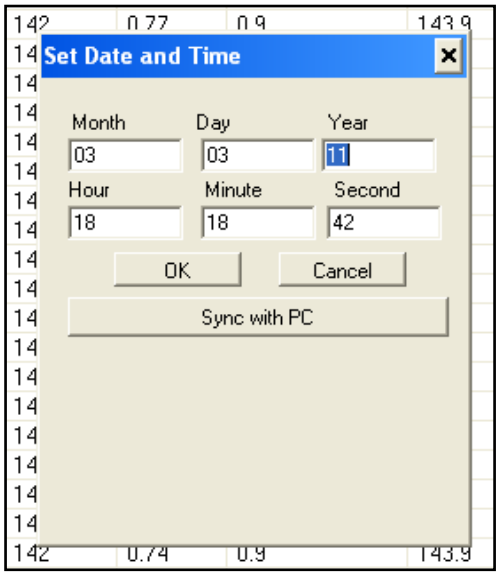
A copy of LI-COR's PAR instruction manual is included with the PAR sensor; it's well-done and worth reading.

D.18 Set Barometric Pressure and Set Time and Date

Your Manta needs to know the local Barometric Pressure (BP) if you have a Clark or Optical Dissolved Oxygen sensor, so click on the Set Barometric Pressure button (it's in the Calibrate menu). You can set the BP by typing the correct value (in mm Hg) in the first box of the Set BP screen (below, left). Or, you can set the approximate BP by typing your altitude (in feet) in the second box. Notice that if you type in BP, altitude is automatically calculated, and vice-versa. The third method for setting BP is asking your Manta the value (if your Manta is equipped with an un-vented depth sensor). If you choose this method, remove the calibration cup from the Manta and make sure the depth sensor is exposed to air. The correct values will automatically appear in the BP and altitude boxes.

Click on the Set Time and Date button to see the Manta's opinion on time and date. If you wish to change any of those values, just type the new value in the appropriate box or click the box at the bottom of the screen (above, right) to synchronize the Manta time and date with that of the device you're using to read the Manta, i.e. your PC or Amphibian.





E DATA LOGGING

Batteries loaded backwards (reversed polarity) can damage any battery pack and may cause pressure to build up inside the battery pack. So please pay careful attention to the polarity markers found on all Eureka battery packs.

E.1 What's the difference between "Logging" and "Snapshot"?

"Logging" always refers to unattended data capture and storage in the Manta. "Snapshot" refers to the manual capture of data into your Data Display (PC or small-screen device).

E.2 Why We Do Logging the Way We Do

Lesser manufacturers may require that you type in long strings of digits to specify start time, start date, end time, end date and logging interval. One wrong digit and you might get no data. The Manta requires only that you click one Hot Button, install batteries, and (for Manta 35 and 40 models) flip the battery-pack switch to "ON". No typing. Once this is done, the red LED will blink five times to confirm that Logging is activated, and the green LED will blink briefly to confirm that the Manta is receiving adequate voltage to start Logging. It's fast and fool-proof.

Another user-friendly feature of the Manta Logging time uniformity. For instance, if your logging interval is 15 minutes and you turn Logging on at five minutes past 10 AM, your first data will be logged at exactly 10:15, and then every 15 minutes thereafter. If your logging interval is one hour and you turn Logging on at five minutes past 10 AM, your first data will be logged exactly at exactly 11 AM, and then every hour thereafter. Your data are cleaner, and it's easier to match times if you wish to merge data logs.

E.3 Sensor Warm-Up

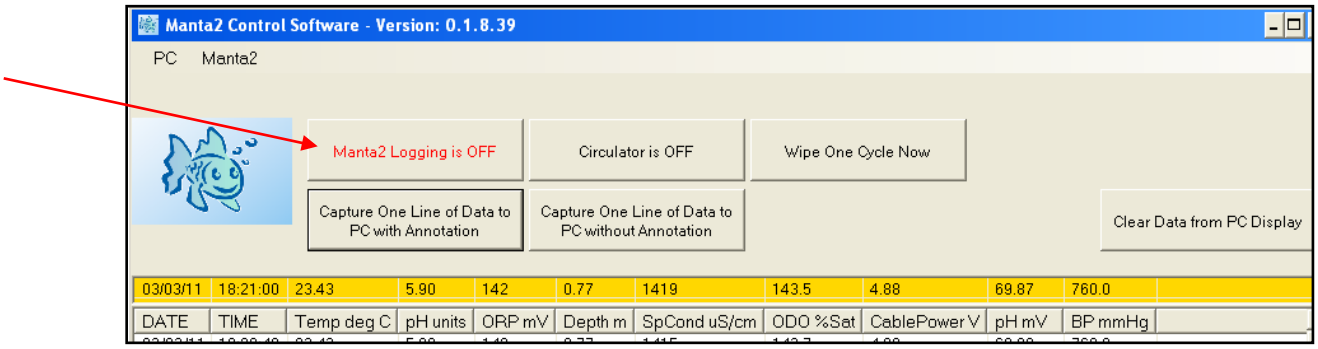
Your Manta knows the warm-up times required for all the sensors you have enabled. It figures out exactly when to turn the various sensors on so that a frame of data can be taken exactly at the correct time. For instance, the HDO Dissolved Oxygen sensor takes 20 seconds to warm up and the turbidity sensor takes 25 seconds to warm up. So, the Manta turns on the DO sensor 20 seconds, and the turbidity sensor 25 seconds, ahead of the time data is required. This minimizes power consumption.

E.4 Setting Up Logging Runs, Logging File Management, Logging Interval

These Manta logging functions are software-driven and explained in Section C.5.b.

E.5 Activating Manta Logging

To initiate Logging, you must "activate" Logging by clicking the "Manta2 Logging is OFF" Hot Button so that it changes to "Manta2 Logging is ON".



Then all you have to do to start Logging for Trimeter and Manta 20, 25, and 30 models is load batteries. For convenience, you may wish to take a Data Display to the field so that you can activate Logging right before you place the Manta in the water. Don't forget to activate Logging.

All you have to do to start Logging for Manta 35 and 40 models is load batteries and, when you get to the field, turn the IBP switch on the top cap to "ON". Don't forget to activate Logging.

Don't forget that the blinking green LED tells you that you have adequate voltage to begin logging, and the blinking red LED tells you that Logging is indeed enabled.

E.6 Am I using Battery Pack power or cable power?

Most users log data using an Internal Battery Pack (IBP) or External Battery Pack (EBP). But you can also log using power from a secondary power source (such as a solar-recharged storage battery located above the water surface) via the Underwater Cable. If you have an IBP or EBP and a secondary power source attached, the Manta will use power coming from the secondary power source as long as its voltage is sufficient. If the Manta cannot find adequate voltage in the Underwater Cable, it will use the IBP or EBP.

This scheme preserves your Manta batteries when possible. Other manufacturers, for reasons unknown, use the power source with the highest voltage, meaning that your Manta batteries may be consumed quickly.

More information can be found in Manta Logging with an Uninterrupted Power Supply and Manta Power Options.

E.7 Logging with an Internal Battery Pack

All Mantas may be ordered with an optional Internal Battery Pack (IBP), a watertight housing with a cassette for batteries that is permanently fixed to the Manta. Most IBP's are used for logging, but they can also be used to power the Manta while it is connected to a Data Display.

E.7.a Changing IBP Batteries in Manta 20, 25, and Trimeters and Activating Logging

1 Replace all batteries at the same time and use the same brand of battery.

2 Clean all moisture, dirt, grit and any other debris off the Manta because you are going to expose sealing surfaces as you change the batteries.

3 Grasp the clear battery sleeve that covers the battery housing and unscrew it until it detaches from the IBP body.

4 Remove the spent batteries and install the new ones carefully following the polarity diagram. Your Manta is now logging, if you have activated Logging. De-activate Logging if you don't want to be Logging now.

5 Clean all moisture, dirt, grit and any other debris off the exposed O-ring surfaces and the inside of the battery sleeve. Add a small amount of silicone grease to the O-rings and to the inside of the battery sleeve where the O-rings will seat.

6 Carefully screw the battery sleeve back into place. You don't have to tighten it closely to the IBP body; finger-tight is fine.

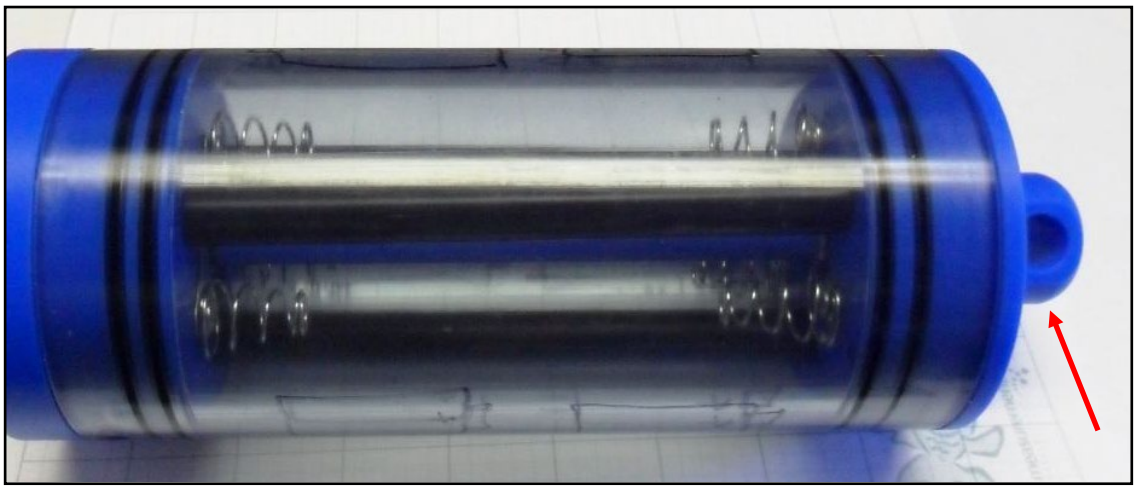
7 Remember that you must first activate Manta Logging by clicking the "Manta2 Logging is OFF" Hot Button so that it changes to "Manta Logging is ON". (C.3, E.5)

8 Remember to look for the red LED to blink five times to confirm that Logging is activated, and the green LED blink briefly to confirm that the Manta is receiving adequate voltage to start Logging.

E.7.b Changing IBP Batteries in Manta 30 Models and Activating Logging

1 Replace all batteries at the same time and use the same brand of battery.

2 Clean all moisture, dirt, grit and any other debris off the Manta because you are going to expose sealing surfaces as you change the batteries.



3 Grasp the polymer "eyebolt" on the top of the battery housing and unscrew it until the top cap and clear housing detach from the Manta body.

4 Remove the spent batteries and install eight C-cell batteries (or six D-cell batteries) carefully following the polarity diagram.

5 Clean all moisture, dirt, grit and any other debris off the exposed O-ring surfaces and the inside of the battery sleeve. Add a small amount of silicone grease to the O-rings and to the inside of the battery sleeve where the O-rings will seat.

6 Carefully place the top cap – clear housing back into place, and screw the eyebolt until the clear housing seats on the Manta. You don't have to tighten it closely to the IBP body; finger-tight is fine.

7 Remember that you must first activate Manta Logging by clicking the "Manta2 Logging is OFF" Hot Button so that it changes to "Manta2 Logging is ON". (C.3, E.5)

8 Remember to look for the red LED to blink five times to confirm that Logging is activated, and the green LED blink briefly to confirm that the Manta is receiving adequate voltage to start Logging.

E.7.c Changing IBP Batteries in Manta 35 and 40 Model and Activating Logging

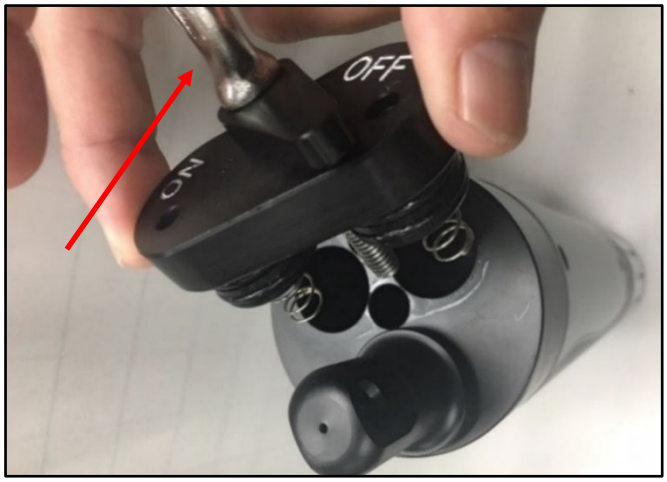
1 Replace all batteries at the same time and use the same brand of battery.

2 Clean all moisture, dirt, grit and any other debris off the Manta because you are going to expose sealing surfaces as you change the batteries.

3 Unscrew the eye-bolt until you are able to completely remove the battery plug.

4 Remove the spent batteries and install six C-cell batteries carefully following the polarity diagram.

5 Clean all moisture, dirt, grit and any other debris off the exposed O-ring surfaces and the inside of the battery tubes. Add a small amount of silicone grease to the O-rings and to the inside of the battery tubes where the O-rings will seat.



6 Re-attach the battery plug by turning the eye-bolt. You don't have to tighten it closely to the Manta; finger-tight is fine.

7 Remember that you must first activate Manta Logging by clicking the "Manta2 Logging is OFF" Hot Button so that it changes to "Manta2 Logging is ON". (C.3, E.5)

8 When you are ready to deploy the Manta, turn the battery switch to "ON". (And turn the switch back to "OFF" when you retrieve the Manta).

9 Remember to look for the red LED to blink five times to confirm that Logging is activated, and the green LED blink briefly to confirm that the Manta is receiving adequate voltage to start Logging.

10 Your Manta is now logging and will continue logging until you turn the battery switch to its "OFF" position, or your batteries are depleted.

E.8 Logging with an External Battery Pack

E.8.a The External Battery Pack

All Manta models (except the Manta 35 and 40 models with Internal Battery Packs) can utilize the optional External Battery Pack, a watertight housing with a cassette for batteries that can be removed from the Manta. Most EBP's are used for logging, but they can also be used to power the Manta while it is connected to a Data Display if the Data Display cannot provide sufficient power.

The EBP simply screws into the Manta multiprobe where normally you would find the Underwater Cable and its locking sleeve. The EBP is installed immediately before a Logging deployment, and later removed so your Manta can upload data to a Data Display or be calibrated.

E.8.b Changing EBP Batteries and Activating Logging

1. Replace all batteries at the same time and use the same brand of battery.
2. Clean all moisture, dirt, grit and any other debris off the Manta because you are going to expose sealing surfaces as you change the batteries.
3. Unscrew the black knob at the top of the EBP it until the battery sleeve detaches from the EBP body.

4. Remove the spent batteries and install eight C-cell batteries (or six D-cell batteries) carefully following the polarity diagram.
5. Clean all moisture, dirt, grit and any other debris off the exposed O-ring surfaces and the inside of the battery sleeve. Add a small amount of silicone grease to the O-rings and to the inside of the battery sleeve where the O-rings will seat.
6. Carefully screw the battery sleeve back into place. You don't have to tighten it closely to the EBP body; finger-tight is fine.
7. Remember that you must first activate Manta Logging by clicking the "Manta2 Logging is OFF" Hot Button so that it changes to "Manta2 Logging is ON". (C.3, E.5)

8 Remember to look for the red LED to blink five times to confirm that Logging is activated, and the green LED blink briefly to confirm that the Manta is receiving adequate voltage to start Logging.

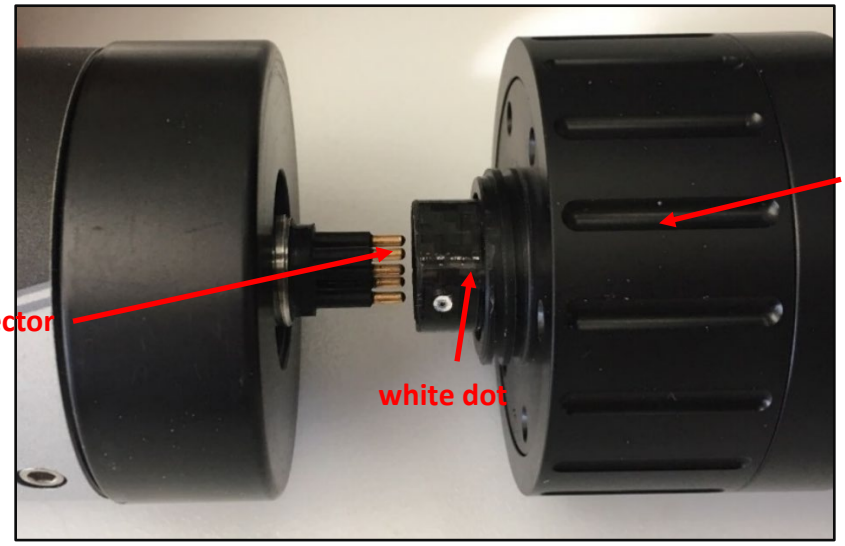
E.8.c Installing and Removing the EBP

1 Remove the marine connector protector or, if a cable is attached to your Manta, remove the locking sleeve and then the cable.

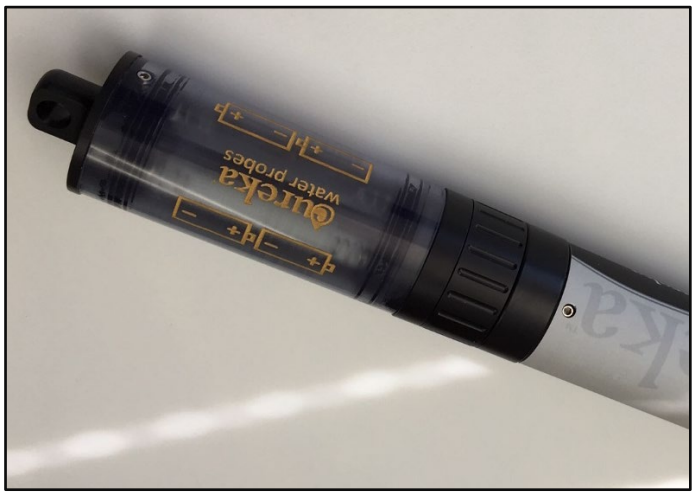
2 Clean the connectors on the EBP and Manta and add a little silicone grease to each.

3 Find the white dot on the hexagonal sleeve on the bottom of the EBP and note that the Manta connector has six pins with a gap in the outer circle of pins.

4 Line up the white dot with the gap in the connector pins and slowly push them together. Very little force is needed.



5 Grasping only the Manta and EBP locking sleeve (the portion of the lower EPB with the serrations), turn the EBP locking sleeve so that it screws into the threads where the Underwater Cable locking sleeve is normally fitted. You may have to jiggle the EBP a bit so that the hexagonal sleeve fits properly over the hexagonal base of the connector.



6 Tighten the EBP locking sleeve firmly, but not so tightly that you will have difficulty removing it later.

7 Remember that you must first activate Manta Logging by clicking the "Manta2 Logging is OFF" Hot Button so that it changes to "Manta Logging is ON". (C.3, E.5)

8 Remember to look for the red LED to blink five times to confirm that Logging is activated, and the green LED blink briefly to confirm that the Manta is receiving adequate voltage to start Logging.

Your Manta is now logging, and will continue logging until you remove the EBP, or your batteries are depleted.

To remove the EBP, grasp the Manta with one hand and the EBP locking sleeve with the other, and unscrew the EBP locking sleeve. Pull the Manta and EBP apart

Twist only the EBP locking sleeve - twisting the entire EBP body only creates unhappiness.

E.9 Batteries and Battery Life

When the batteries in a Manta battery pack are spent, logging simply ceases. It may begin again after a few hours if your batteries recover sufficiently during that time.

Unfortunately, there are so many different combinations of sensors, water temperature, Logging Intervals, types of batteries, etc. that estimation of battery life may not be very accurate. We recommend that you run the Manta in the field to see how long the batteries will last in your specific application.

We recommend using the highest quality alkaline batteries available, such as Duracell Copper Tops. Rechargeable batteries can be used, but their battery life is typically only half that of non-rechargeable batteries.

We strongly recommend that you do not use lithium batteries in any Eureka battery pack. Lithium batteries don't like water and may cause a dangerous build-up of pressure if they get wet during a deployment. That pressure can damage the instrument and/or you.

It's a good idea to remove the batteries from the Manta battery pack if the Manta is not going to be used for a while. This helps prevent battery leakage.

E.10 Logging Redundantly with Telemetry

If you wish to add redundancy to your data collection, you can connect a Manta to a third-party data logger, telemetry device, etc. to store data in the Manta (using its standard Logging function) and in the third-party device (according to its manufacturer's instructions).

Since you will be using an Underwater Cable, you can run power to the Manta from a surface power supply to provide power to Mantas – you don't need a Manta Battery Packs.

Or, the surface power supply can power Mantas with IBP's, thus saving your batteries for emergencies such as the failure of the surface power supply.

Either way, you will end up with data records in both the Manta and the third-party device.

More information can be found in Manta Logging with an Uninterrupted Power Supply and Manta Power Options.

E.11 Controlling Sensor Fouling

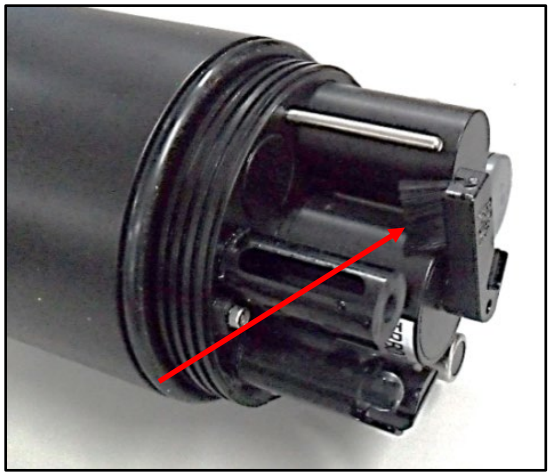
Fouling cannot be eliminated altogether, but Eureka offers three effective options to minimize sensor fouling and maximize data quality.

1 Eureka's unique Copper Gauze Antifoulant is a double-wall sensor guard (below) envelops the sensors with copper gauze. Unlike copper screen, the copper gauze dissolves with time, killing or discouraging biota that would otherwise collect on the sensors. Available on all Mantas.

The copper-gauze method works better than copper screen or copper parts. Solid copper rapidly develops an oxide coating – stuff may not grow on the copper part, but the copper will not protect the sensors. The copper gauze dissolves slowly, bathing the sensors in copper ions that discourage biological growth.

2 The Extended Turbidity Brush attaches to the turbidity sensor and cleans the measurement surfaces of several sensors, including the Turner fluorometers (chlorophyll, blue-green algae, etc.) and the Dissolved Oxygen sensor. Available on Manta 30, 35, and 40 models with turbidity sensors.

3 Eureka's MiniCleaner is used for sensor brushing when the Manta does not have a turbidity sensor (and hence cannot have the Extended Turbidity Brush). It can be programmed for frequency of brush cycles and number of sweeps per cycle.



E.12 Pipe Kit

For extra protection for your Manta during deployments in areas with boat traffic, flooding, debris in the waterway, etc., you can use a Pipe Kit. A Pipe Kit, which come in several diameters, is a PVC pipe with a locking, sealed cap on the top end and water-passage slots at the bottom end. An eye-bolt in the cap lets you tether the Pipe Kit if needed.

Because on a new Pipe Kit the cap is not glued to the slotted pipe, you can add more pipe (available at home-improvement centers) before fixing the cap in place.

F SMALL-SCREEN DATA DISPLAYS

F.1 Small-Screen Data Displays

Small-screen Data Displays include the Amphibian2, smart phones, and tablets. They run the same Manta Control Software used for PC's, but with some concessions to make the small screens readable (especially in bright sunlight). Nonetheless, the small-screen menu structures are nearly identical to the screens you see when operating a Manta with a PC. (C.1)

F.2 Connecting the Amphibian2 with a Cable

(Please see F.4.a if you wish to connect to your Amphibian2 via Bluetooth instead of a cable.)

1. Power-on the Amphibian2 Data Display.
2. Connect the Manta and Underwater Cable to the Amphibian2 using the nine-pin connector on the bottom end of the Amphibian2.
3. On the lower right corner of the start-up screen, select "Amp_2_2_X or Manta_2_2_X" to launch the Manta control software.
4. You should see scrolling data from the Manta.

F.3 Bluetooth Battery

The Amphibian2 connects directly to a Manta via a Data Cable or Underwater Cable. But smart phones and tablets seldom have conventional USB ports, so we connect to them using Bluetooth.

Eureka's Bluetooth Battery contains a Bluetooth transmitter and receiver, an on/off switch, and a rechargeable battery sized to get you through a full day of field work.

The Bluetooth Battery's Bluetooth address is shown on a label on the back side.

F.4 Establish Bluetooth Communication

Follow the directions below for establishing Bluetooth communication between your Bluetooth Battery and Data Display; it should take just a few minutes to set up. However, anything having to do with Bluetooth can be tedious because of all the different versions of Bluetooth hardware and software floating around the world. If you run into a problem, don't give up. Call us at 512-302-4333 Ext. 1111 or send us an email at sales@waterprobes.com.

F.4.a Connecting the Amphibian2 with Bluetooth for the First Time

(Please see F.2 if you wish to connect to your Amphibian2 with a cable instead of via Bluetooth.)

1. Power-on the Amphibian2 Data Display.
2. Turn on the Manta Bluetooth Battery by pushing the on/off button. You will see the LED begin flashing indicating that the unit is "ON" (if not, recharge the battery using the recharger provided).
3. Enable Bluetooth (BT) on the Amphibian2 by pushing the BT ICON on the start-up screen. Make sure the BT ICON turns green and says "Discoverable".
4. On the Amphibian2 Home Page select "Settings", then "Connections", and then select the "Bluetooth" ICON (not the BT COM ICON). Delete any BT devices listed by pressing and holding, then select delete.
5. Select "Add New Device", select the Bluetooth ID of your Manta BT when it appears, then select "Next".
6. Enter the password "1234", select 'Next", and the display will connect to your Manta BT. Select the Manta BT device, and put a checkmark on the serial port and then select "Save".
7. Now select "COM Ports" at the top of the screen. Next select "New Outgoing Port", then your Manta BT will show up highlighted. Select "Next" from the bottom and use the pull-down menu to select an available COM port, such as COM5. Once selected, select "Finish" and then "OK". Select "X" to return to Home Page.
8. On the Home Page, select "Amp_2_2_X" to launch the Manta control software. Upon connection, the blinking light on the Manta BT will turn solid. Once the software is running and the Amphibian2 is connected via the Manta BT, you should see data scrolling.
9. From now on when the Amphian2 is on, with Bluetooth enabled, and the Manta BT Battery is switched "ON", the Manta will be found on the previously-selected COM port, unless you change the settings.

F.4.b Connect to "Classic Bluetooth" Android Data Displays

1. Install the Classic Bluetooth version of the software app Manta Control Software™ from *Google Play Store*. The software can also be downloaded at www.waterprobes.com under the Support tab on the Home Page, then the Software tab. See Installing Manta Control Software on an Android Data Display.
2. Power up the Bluetooth Battery by pressing the on/off button.
3. For the initial pairing of the BT module to the Data Display, go to "MORE" (Smartphone), or "⋮" (tablet) and select "Android", "Scan Filter". Clear any settings in field, Select "OK"
4. Go to the "Bluetooth SETTINGS" on the Data Display and select the Bluetooth ID of your Manta Bluetooth Battery. The device IDs for Classic Bluetooth have normally had the format "Manta2xxx" or "MantaEDRXXXX".

   Do not select the address with format MantaBLExxxx for Classic Bluetooth utilities, as the hardware and firmware of Low Energy Bluetooth (discussed below) is NOT compatible with Classic Bluetooth and will interfere with making this device connection.
5. Enter the password "1234".

Once the password is accepted, the devices are paired, and you should now see scrolling data.

F.4.c Connect to "Bluetooth Low-Energy" (BLE) Data Displays (Including the IPhone)

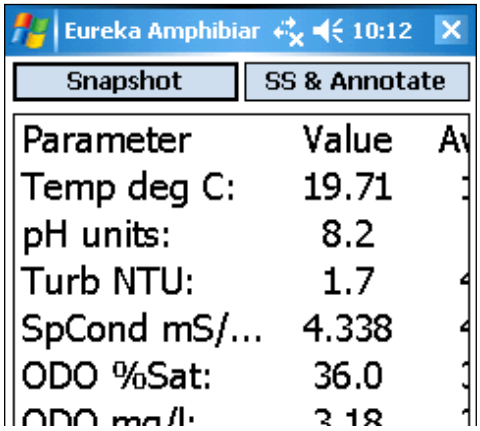
1. Install the MantaLink™ application from the Apple App Store.
2. Click "Tap to Connect".
3. On the *Nearby Devices* screen select your Manta Bluetooth device, which normally has had a Bluetooth ID with format MantaBLEXXXX. The Home Page will open with current data.

F.5 Example Screens from Small-Screen Data Displays

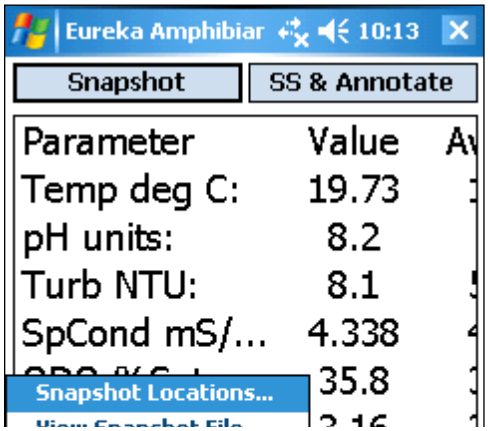
While the basic structure of the user-interface software (Manta Control Software) on small-screen data displays (smart phones, Amphibian2, some tablets) is the same as that of large-screen data displays (PC, laptop, some tablets), some modifications have been made to ensure that the various types and sizes of small-screen displays are easy to read and navigate.

Below are examples of small-screen displays from the Amphibian2 Data Display to help you understand the differences between the large and small screens. You can compare those of the small screen to those shown in Section C.

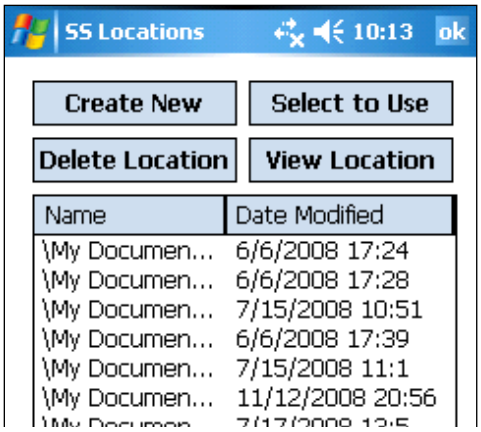
Home Page



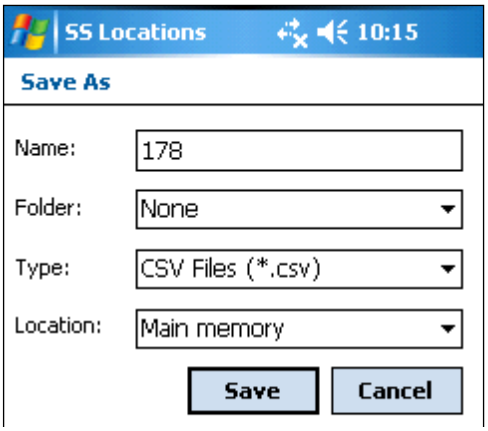
Snapshot Menu



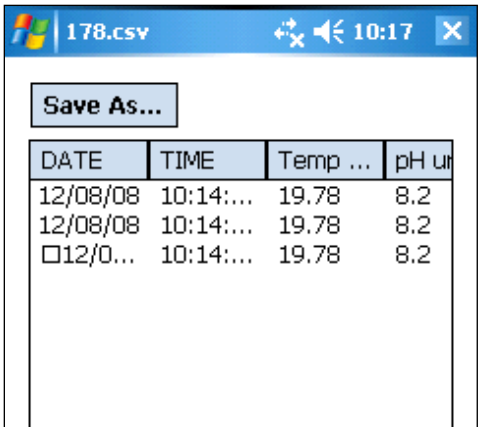
Snapshot Files



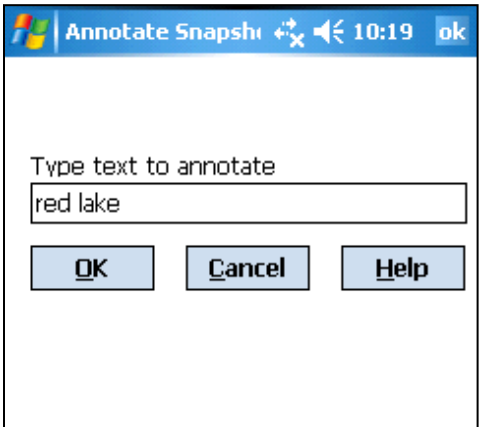
Create New Snapshot File



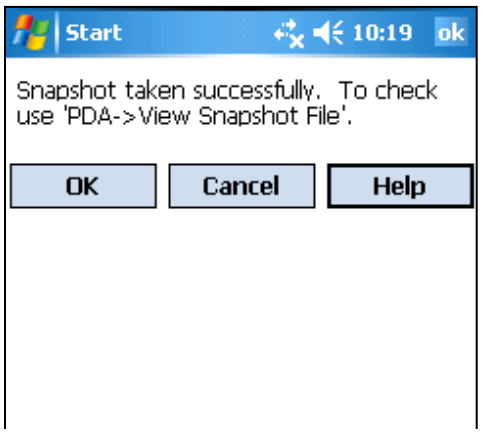
View Snapshot File Contents



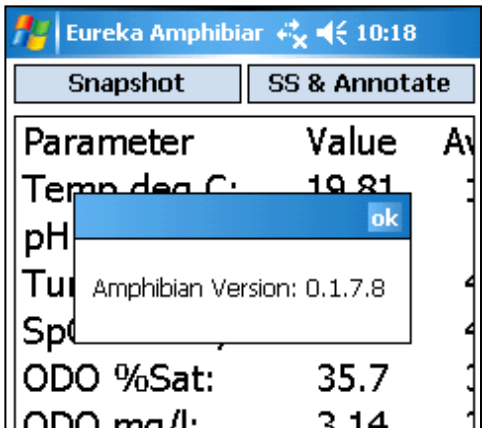
Snapshot Annotation



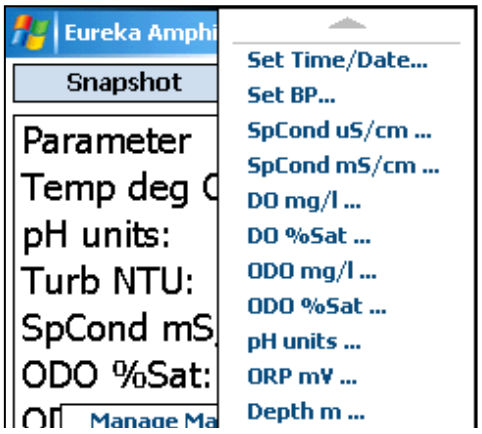
Snapshot Report



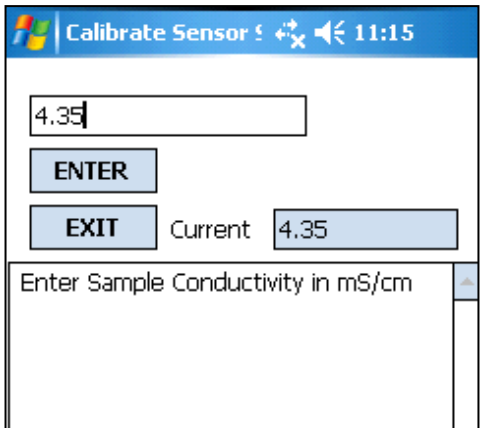
About: Amphibian Software Version



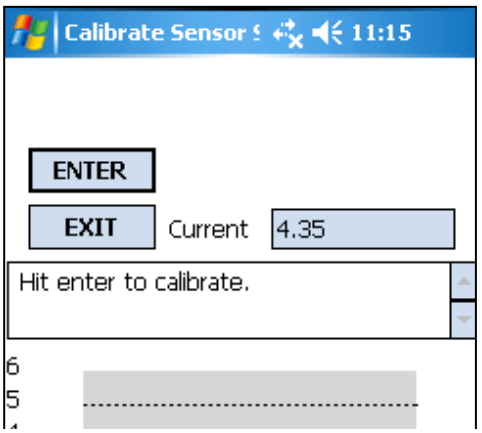
Calibrate Menu



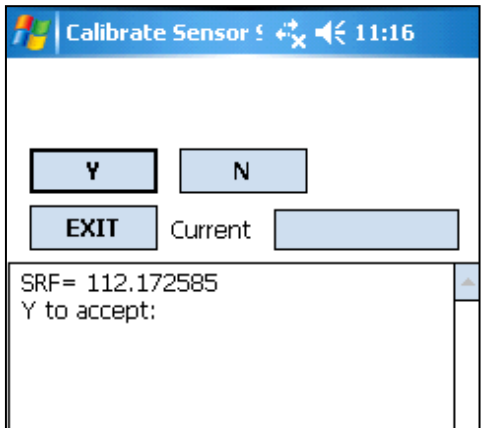
Calibration: Conductivity 1



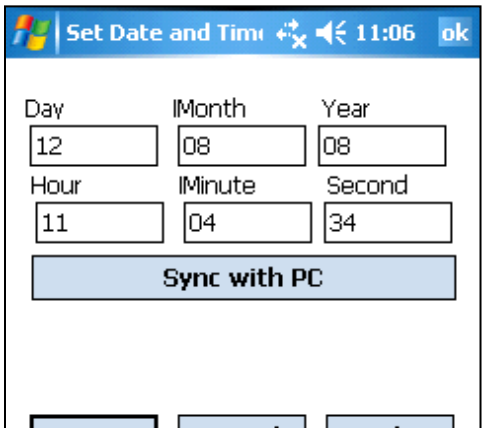
Calibration: Conductivity 2



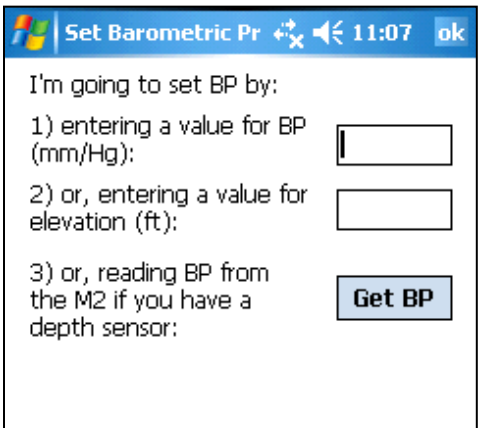
Calibration: Acceptance



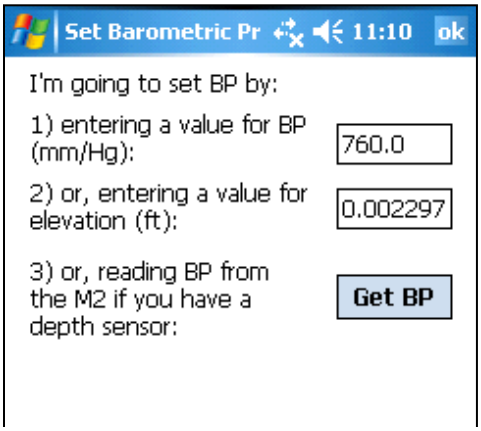
Calibrate: Set Time and Date



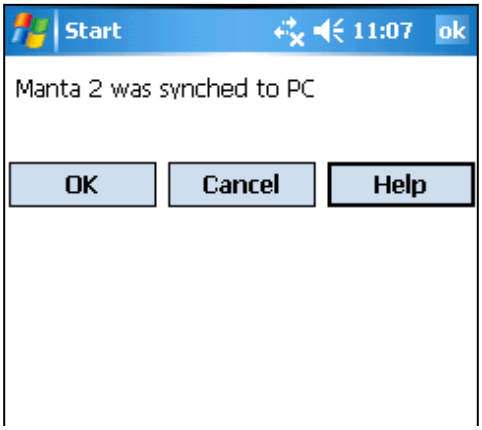
Calibration: Barometric Pressure 1



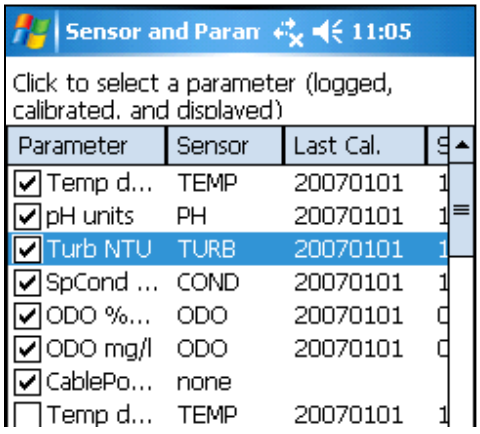
Calibration: Barometric Pressure 2



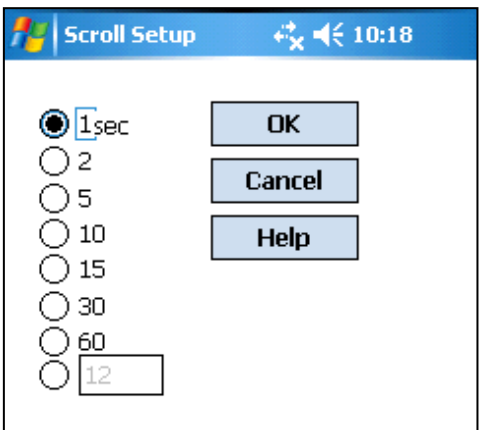
PC Sync Report



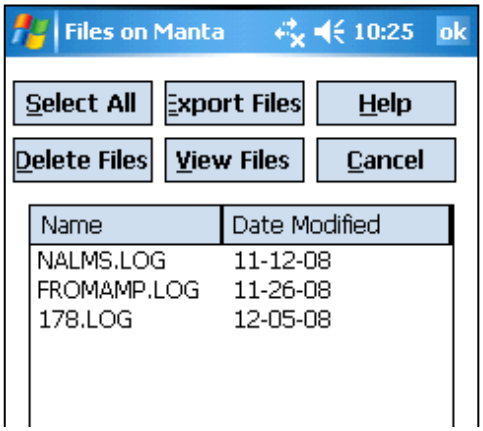
Sensor and Parameter List



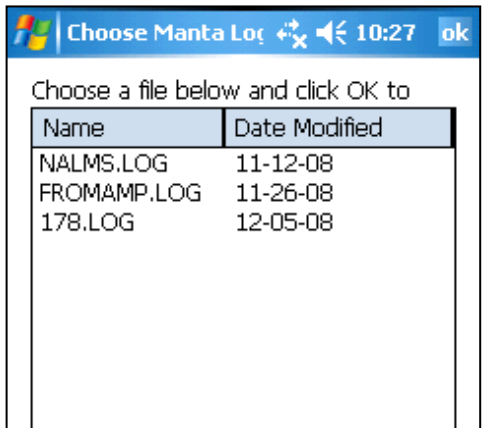
Set Scroll Interval



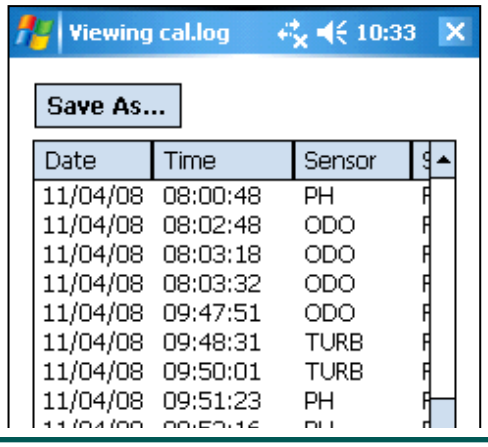
Manage Manta Files



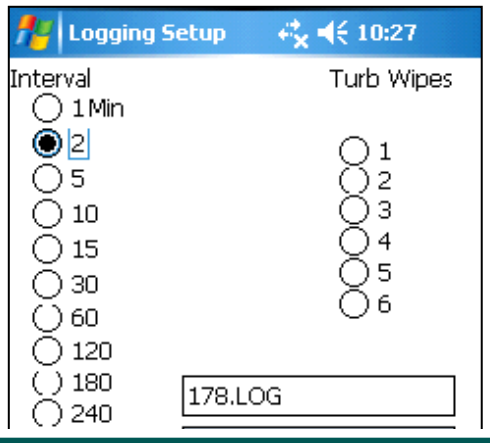
Logging Setup: Browse



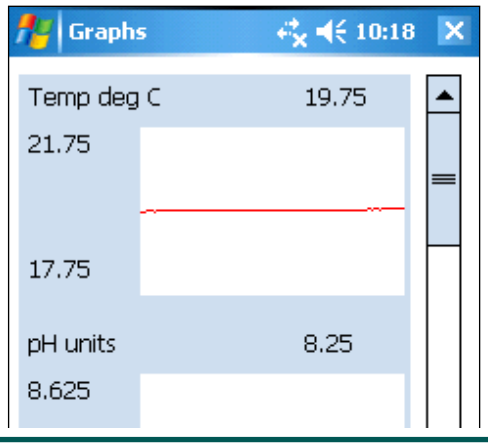
Logging Setup: Interval and Wiping



Logging Setup: Interval and Wiping



Graphs Turned On



G FREQUENTLY ASKED QUESTIONS

G1 Our Three Most Frequently Asked Questions

1 How does Eureka dare to offer a three-year warranty that includes the turbidity, optical dissolved-oxygen, and pH sensors?

I'm afraid it wasn't for altruistic purposes. We simply looked at our repair records and realized that a three-year warranty will cost us a trivial amount of money. It's a marketing edge, because the other multiprobe manufacturers can't warranty their pH and DO sensors for more than one or two years.

2 Are you guys really that good, or just a bunch of blowhards?

Our customers maintain that we are both.

3 You guys ever invent anything?

Glad you asked. In its continuing effort to make your life easier, Eureka developed the first multiprobes with:

1) USB power capability
2) LED status indicators
3) standard memory and logging functions
4) a permanent calibration log
5) snapshot and automatic snapshot functions
6) custom-parameter feature
7) optical DO caps that never need replacement
8) turbidity-mimicking software
9) PDA-based data display
10) Bluetooth connectivity
11) Cell phone as a data display
12) a digital instruction manual
13) smart sensors that were actually smart
14) fool-proof logging activation
15) a full, three-year warranty
16) a cell-phone-based telemetry system

G2 Sensors

1 How do I know which sensor is which?

Please see D.1.

2 How do I know when I need to maintain sensors?

Judgment gained from observing your field conditions and data requirements tells you when to maintain sensors. If you are logging data over long periods, the time when you collect your data from the Manta is a good time for maintenance and calibration. (B.10)

3 Why is it important to check SC reading in air? What should it be?

A well-dried SC sensor should produce a zero reading in air. This lets you know that a one-point calibration is adequate.

4 Can I see the slope calculation for pH?

Sure you can – just look at the mV readings in your calibration log. But there's no need to do that with your Eureka multiprobe because the reference electrode seldom need replacement, i.e. you need only monitor pH slope for those manufacturer's whose reference electrodes are always moving toward the failure that requires replacement of the pH/reference sensor.

5 What is the range of millivolts for each pH solution?

You asked that question because you've been taught to worry about pH mV by another multiprobe manufacturer, didn't you? Because you have become used to worrying about mV's because that multiprobe requires frequent replacement of the pH/reference electrode? With a Manta, just refill your reference electrode every two months or so and forget about mV's. You have more important things to do than worry about mV's.

6 How do I get the barometric pressure reading for the DO calibration? Do I need to check it to a certified Barometer?

You can enter an exact BP from, say, your lab barometer (don't use the weather station's BP – it's corrected to sea level). Or, you can enter your elevation and the Manta will estimate your BP. Or, if your Manta has a Depth sensor, the Manta can use it to measure BP.

7 Will my Manta also report TDS and/or Salinity?

Yes; please see Section D.8.

8 How often should I change the pH electrolyte?

Electrolyte usually lasts two months or more. But if you are logging data, or monitoring in very low Conductivity waters, change your electrolyte each time before you recalibrate pH to be safe. You may learn a better rule of thumb as you review your data. (D.10)

9 How long with my DO cap last?

You've been paying $200 a year to replace DO caps, haven't you? It's OK; lots of people have been in the same boat. Now that you are a Manta owner, you can expect your DO caps to last five years or more. You can see the condition of your cap when you calibrate DO. (D.7)

10 How often should I change my turbidity wipers?

Wipers usually last for years, but you should change yours if it gets stiff or has nicks in it. (D.13)

11 Can I customize the Manta with different configurations of sensors?

We can fit up to 12 sensors in just about any combination you need. (D.1)

12 Can I replace the sensors myself, or do I have to ship the Manta back to Eureka?

You have been led to believe that sensors need "wet-mateable connectors", haven't you? So that you can change failed sensors easily? Eureka sensors seldom need replacement – that's why they have a three-year warranty instead of the one-year warranty offered for lesser sensors. But if you have a problem, Manta sensors are easy to replace. Contact Eureka Customer Service for assistance.

13 Why can your turbidity read negative?

We let the Turbidity reading go negative to indicate a problem with the Turbidity Low calibration. If, for instance, you calibrate at zero with water that is actually 5 NTU, then any sample less than 5 NTU will read negative. Recalibration would be in order. Some manufacturers "clip" their Turbidity readings at zero to avoid this question, but that's misleading and throwing away perfectly good information. (D.13)

14 How long do ISE tips last?

The usual rule is six weeks, but you may get more or less than that. Change tips often to be safe, but you may learn a better rule of thumb as you review your data. (D.15)

G3 Calibration and Maintenance

1 How do I know when I need to calibrate my sensors?

The simple answer is that frequent calibration will give you better data. The more meticulous you are with calibration, the better data you will gather. If you are uncertain whether you need to calibrate, check your sensors against a known sample. If the reading is within the accuracy specification and/or your accuracy expectations, there is no need to calibrate.

Experience and your program's accuracy expectations will help determine calibration frequency for the various sensors. If, for instance, your reservoir discharge is hovering near the regulatory minimum for dissolved oxygen, you should pay special attention to DO calibration frequency and technique. On the other hand, if a conductivity accuracy of +/- 10% is OK, you needn't calibrate conductivity very often. (D.2)

2 How often should you calibrate your multiprobe?

That depends on a number of factors, including the nature of the waters being monitored and your expectations for accuracy. We suggest that you start by calibrating once per week and shorten or lengthen that interval as the data suggest. (D.2)

3 How Do I Choose Calibration Standards?

For best results, choose a calibration standard whose value is close to what you expect to see in the field. For example, calibrate with a 1413 µS Specific Conductance standard if you expect to see Specific Conductances between 500 and 1000 µS in the field. Don't calibrate with a sea water standard. And if your waters tend toward the acidic, calibrate with a 4-buffer instead of a 10-buffer.

If you are moving your multiprobe across wide ranges of water conditions, you may wish to recalibrate to match the new situations. For instance, if you are measuring a clear lake during the morning and a high-sediment stream in the afternoon, you might consider recalibrating at noon with a high-range turbidity standard. (D.3)

4 What is an SRF?

Suppose that a typical Conductivity sensor reports 100 µA in a 1413 µS/cm standard. If your particular Conductivity sensor reports 100 µA in that same calibration solution, then your SRF is 100% (some parameters, such as pH, have a more complex SRF calculation, but the effect is the same). If your response is 80 µA, your SRF would be 80%. When you click the OK button to accept a calibration, the Manta automatically accepts your calibration if the SRF is between 60% and 140%. If the SRF falls outside that range, you will be cautioned to check your standard value, make sure the sensor is clean, make sure the reading has stabilized, etc. But you can elect to accept any SRF.

Each sensor calibration's Sensor Response Factor (SRF) is automatically logged into the Cal Record with the details of that calibration. (D.5)

5 Do I Have to Calibrate Temperature?

No; the Temperature sensor is so stable that it needs no calibration. (D.6)

6 What is the Basic Calibration Procedure?

The Manta never guesses parameter values, so you have to calibrate it from time to time by simply telling the instrument what it should read in a known calibration situation. The general procedure is shown below. (D.2)

1) Clean the sensor and perform any necessary sensor-specific maintenance.
2) Select a calibration standard whose value is close to the values you expect to see in the field.
3) Rinse sensors thoroughly (more than once may be required) with DI (deionized) water, especially if you have been using other calibration solutions. Shake the Manta so the DI can vigorously remove traces of old calibration solutions and cleaning agents – repeat if necessary.

4) Rinse the sensors twice with a small quantity of your calibration standard. Discard the used calibration standard because it is probably contaminated with DI water.

5) Immerse the sensor in the calibration standard. This is usually accomplished by securing your Manta with the sensors pointing up, screwing the Cup onto the Manta, and filling the Cup with your calibration standard. Make sure the standard covers the sensor entirely, and that it also covers the thermistor for those parameters that are temperature-compensated.

6) Watch the parameter readings until they have stabilized.

7) Select the parameter to be calibrated by clicking on the Calibrations button in the Manta Manager Home Screen, then clicking on Calibrate, and then clicking on the parameter you wish to calibrate. For Parameters that have two calibration points, you will specify which you wish to calibrate (usually High or Low). Enter the calibration value and click on OK. The Manta will report the resulting Sensor Response Factor (SRF); then click on OK to accept the calibration or Quit to leave the sensor uncalibrated. (D.5)

8) Each sensor calibration's Sensor Response Factor (SRF) is automatically logged into the Cal Record with the details of that calibration.

7 Can I Use Cal Solutions More Than Once?

If your QC protocol requires fresh cal solutions for every calibration, then you might as well discard the once-used solutions. If not, then your sensitivity cost and accuracy will determine whether you can re-use cal solutions. If, for instance, you really want your field conductivity readings to be within 1% of reading, then fresh conductivity cal solution, which is not very expensive, should be used for each calibration. If you are not so keen on turbidity accuracy, then you can probably reuse your turbidity cal solution once or twice because it's pretty expensive. (D.3)

8 What standard should I use to calibrate SC? What type?

For any parameter, use a calibration standard that is near the highest reading you anticipate in the field. For instance, if your lake usually runs about 1000 µS/cm, then calibrate with the readily available 1413 µS/cm KCl standard. Note that some sensors (not SC) have two calibration points; the second point should be set at a convenient low point, usually zero. (D.3)

9 What is the different between calibrating % sat or milligrams per liter for DO?

Percent saturation tells you how much oxygen you have compared to how much you would have if the water were saturated with oxygen. Milligrams per liter tells you just that: how many milligrams of oxygen are dissolved in one liter of water. For instance, if your Manta was reading 6.0 mg/l and the saturation tables told you that at that temperature, salinity, and barometric pressure the saturation value was 8.0 mg/l, then your % sat would be 6/8 = 75%. You can use either measurement, or both, but % sat is helpful during DO calibration because it should always be 100%. (D.7)

10 What is the different between the Amco Clear turbidly standard and StablCal?

Amoco Clear is made of polymer beads while StablCal is a formazin compound. Most people want their turbidity measurements referenced to formazin, and so use formazin or StablCal for calibrations. The polymer beads are cheaper and more stable, BUT you must know the equivalent formazin value for any polymer bead standard. You cannot rely on what's written on the polymer-bead label; you must check it with your own instrument after it has been calibrated with formazin or StablCal. (D.13)

11 How do I cal BG algae?

There are several ways to calibrate fluorometers. Please read Standardizing Eureka's Turner Fluorometers and please read Calibrating Eureka's Turner Fluorometers; they can be found on the Eureka Web site or the Eureka Flash Drive. (D.14)

12 What is a good SRF?

Generally, and SRF between 80 and 120 is good, and 60 to 140 is acceptable. It your SRF is outside those limits, you should check your standard value and the maintenance condition of your sensor. (D.5)

13 How often should I change the pH electrolyte?

To be safe, change your electrolyte every month or so. That's probably overkill, but changing electrolyte takes only a minute and is basically free. (D.10)

14 Where do I buy calibration solutions for the various sensors?

You can buy most cal solutions from Eureka, lab supply companies, or most catalog houses (such as Cole Parmer). (D.2, D.3)

G4 Communication and Software

1 What is the range of the Bluetooth?

Hard to say because of the differences in Bluetooth technology over the years, variations in Data Display Bluetooth implementations, and because Bluetooth is different for Android and Apple applications. You can estimate Bluetooth range of your Bluetooth by connecting your Manta to your Bluetooth Battery, pairing with a Data Display, and then walking away with the Data Display until the connection breaks. (F.3, F.4)

2 How long does the Bluetooth Battery take to charge?

We recommend charging overnight, but you can get a partial charge in an hour or two. (F.3)

3 How does the Manta2 communicate (SDI-12, etc.)?

Mantas speak RS-232 as their native language, but Eureka provides converters for SDI-12 and MODBUS if you prefer. (Manta Comm Protocol, Manta SDI-12 Adapter, and MODBUS Communications on Eureka's Web site)

4 What com port should I use?

Most people should never have to worry about choosing a COM port; just let the PC do the work. (C.4)

5 Is the colored top line an average of the values or the latest readings?

No; the data in the colored band is the most recent line of data obtained from your Manta. (C.2)

G5 Deployment and Applications

1 How long can I expect my batteries to last?

Battery life is difficult to predict because it varies with Logging Interval, quality of batteries, number and type of sensors, and water temperature. Battery life is best determined by experimenting with your specific Manta in your specific applications. (E.9)

2 For my battery pack when looking in the log file at battery voltage, at what point will the Manta2 stop logging?

The Manta can show the voltage provided via the cable and the voltage provided by an Internal Battery Pack. The voltage provided by an External Battery Pack is shown as cable voltage. There is no fixed cut-off point, but any time the battery pack or cable voltage drops below about 5 VDC, the voltage may not be adequate for the Manta to boot properly. (E.9)

3 What How do I deploy my sonde when there is no bail hook? Is it OK to hang by the cable? How much weight will the cable hold?

When properly attached, the Manta Underwater Cable can support well over 50 pounds without using a Bail Kit. You can hang the Manta by the Underwater Cable if the load is not likely to exceed 50 pounds. (B.4)

4 How do I attach the underwater cable to the sonde?

Please see B.4.

5 What anti-fouling products to you offer?

We offer three anti-fouling aids, including the uniquely effective copper-gauze method. (E.11)

6 Can I use re-chargeable or Lithium batteries in the Internal Battery Pack or External Battery Pack?

We strongly discourage use of lithium batteries in enclosed housings if there is any chance the batteries could get wet – such as in the IBP or EBP. (E.9)

7 Why is it important to check water temperature in a range of temperatures in the lab before deployment? How often?

It's not really that important; the Manta design has been checked may times to make sure it accounts for water temperature everywhere necessary, such as when calculating DO saturation. However, it might be instructive to check the performance of your Manta in cold water if you often operate in cold waters.

G6 General FAQ's

1 What do the LED's mean?

Please see B.6.

4 Is your sonde approved by the EPA, USGS, or has it been tested at ACT (Alliance for Coastal Technologies)?

Yes, and you can see the test reports, including ACT's Performance Verification Statement for the Eureka Manta2 pH Sensor (2015), Evaluation of the Eureka Manta2 Water-Quality Multiprobe Sonde (USGS, 2017), and Eureka Outperforms the Competition, on Eureka's Web site.

5 Can I add sensors to my Manta2?

The Manta can handle as many as 12 sensors. If you have fewer than 12 and wish to add one or more sensors, we can do it.

6 Where did you people come from anyway?

Eureka was formed as Eureka Environmental Engineering in 2002 to take advantage of the market leaders' inattention to product development and customer service. Eureka's staff, mostly former Hydrolab and YSI employees with over 100 man-years experience in all areas of the multiprobe industry, produced the Manta1 Water-Quality Multiprobe and the Amphibian1 Data Display in 2003. The Manta1 sported such industry firsts as direct connection to USB ports, unbreakable cable connections, transparent multiprobe housing, LED's for easy operation and troubleshooting, and software easily understood by regular people. The Amphibian1 was the industry's first PDA-based data display.

The Manta2, the first multiprobe in the world with "smart" sensors that were actually smart, was introduced in 2008. It was even more reliable and easy to use than the Manta1 and has been accepted by the most discerning field practitioners around the world.

Eureka was acquired by Measurement Specialties, Inc. in 2011 in the usual belief that multiple synergies would make everyone happy. But the multiprobe market just doesn't work well in a large, corporate framework, so partners from Europe, Asia, and America purchased the "old Eureka" in 2014. They resumed business seamlessly as Eureka Water Probes.

The MantaPlus takes all the field-proven qualities of the Manta2, adds a user-interface with a dozen new features that is still easy to use, and adds a three-year warranty and marine-type connectors.

7 Why do you build the Manta the way you do?

Unlike the products of lesser manufacturers, the Manta uses the same basic electronic and mechanical components regardless of how many sensors you order. Most importantly, we have a No-Cramming Rule that prevents our stuffing too many sensors into an artificially small instrument diameter. Yes, we know that you like small instruments, but cramming sensors together results in sensors whose performance, reliability, reparability, and/or maintenance ease is compromised. We choose the best sensors available on the world market for your needs and build the Manta around them.

So, when you ordered your Manta, one of the Eureka product specialists determined the optimum housing diameter for the sensors you selected. The Manta sizes (outside diameters) are 2 inches (actually 1.95), 2.5 inches (2.45), 3 inches (2.95), 3.5 inches (3.50), 4 inches (4.00), and occasionally even 4.5 inches (4.50).

Anytime you wish to add or subtract sensors, we can use all of your Manta's circuit boards and sensors in a larger or smaller housing. Cost is minimized, and you still have a conventional Manta instead of having to change to a different instrument model.

We know that stuff - bad stuff - happens in the field, so we designed the Manta so you don't need a factory expert for troubleshooting if something goes wrong. If the multiprobe turns on and reads any of its parameters correctly, then the basic communication circuitry is OK - if not, you need a new CPU board. If the multiprobe reads temperature, but not, say, conductivity, then you need a new conductivity sensor. You call Eureka, we send you the replacement component by FedEx, and you install it yourself in a few minutes. There's no labor charge, and only one day of down-time. It really is that easy.

And, of course, the Manta continues Eureka's tradition of user software that is so easy that most users rarely read this instruction manual. In fact, you are the only person who has ever read this far.

KANKAKEE RIVER METROPOLITAN AGENCY
SONDE CHAIN OF CUSTODY FORM

Sonde I.D. (Location ID-serial no.-mmddyy): _____

Site/Location _____

Accessories deployed

Cable:	
Plastic Base:	
Weighted guard:	

Sonde Release from Laboratory for Stream Sampling:

Sonde Relinquished by *(Name)* : _____

Company/Municipality: _____

Date: _____

Time: _____

Sonde Received by *(Name):* _____

Company/Municipality: _____

Date: _____

Time: _____

Sonde Placed in Stream Housing:

Name: _____

Company/Municipality: _____

Date: _____

Time: _____

Sonde Removal from Stream for Maintenance / Return

Sonde Removed from Stream Housing:

Name: _____

Company/Municipality: _____

Date: _____

Time: _____

Sonde Relinquished to Laboratory or Courier by:

Name: _____

Company/Municipality: _____

Date: _____

Time: _____

Sonde Received in Laboratory by:

Name: _____

Company/Municipality: _____

Date: _____

Time: _____

Accessories Returned

Cable:	
Plastic Base:	
Weighted guard:	

Maintenance Record on Reverse Side (Page Over)

Sonde Maintenance Readings/Battery Checks

Field meter readings

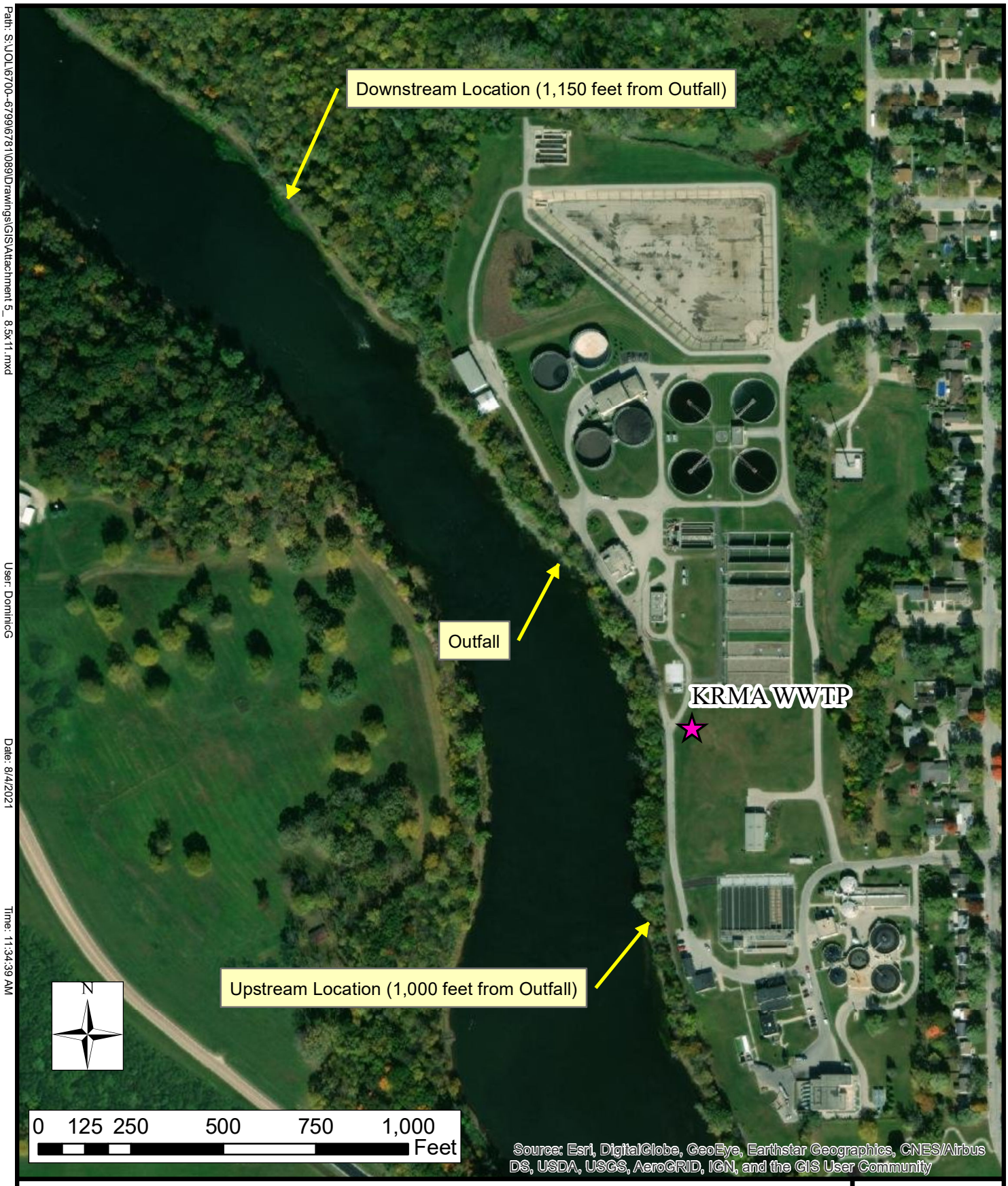
Battery Reading in Millivolts:	DO:
Name:	pH:
Company/Municipality:	Temp:
Date:	notes:
Time:	

Battery Reading in Millivolts:	DO:
Name:	pH:
Company/Municipality:	Temp:
Date:	notes:
Time:	

Battery Reading in Millivolts:	DO:
Name:	pH:
Company/Municipality:	Temp:
Date:	notes:
Time:	

Battery Reading in Millivolts:	DO:
Name:	pH:
Company/Municipality:	Temp:
Date:	notes:
Time:	

Battery Reading in Millivolts:	DO:
Name:	pH:
Company/Municipality:	Temp:
Date:	notes:
Time:	



Path: S:\JOL\6700-6799\6781\089\Drawings\GIS\Attachment 5_ 8.5x11.mxd

User: DominicG

Date: 8/4/2021

Time: 11:34:39 AM

ADDITIONAL GRAB SAMPLING LOCATIONS

KRMA SAMPLING PLAN
KANKAKEE RIVER METROPOLITAN AGENCY
KANKAKEE COUNTY, ILLINOIS

STRAND ASSOCIATES®

ATTACHMENT 5
6781.089

METHOD #: 365.2 Approved for NPDES (Issued 1971)

TITLE: Phosphorous, All Forms (Colorimetric, Ascorbic Acid, Single Reagent)

ANALYTE: CAS # P Phosphorus 7723-14-0

INSTRUMENTATION: Spectrophotometer

STORET No. See Section 4

1.0 Scope and Application

1.1 These methods cover the determination of specified forms of phosphorus in drinking, surface and saline waters, domestic and industrial wastes.

1.2 The methods are based on reactions that are specific for the orthophosphate ion. Thus, depending on the prescribed pre-treatment of the sample, the various forms of phosphorus given in Figure 1 may be determined. These forms are defined in Section 4.

1.2.1 Except for in-depth and detailed studies, the most commonly measured forms are phosphorus and dissolved phosphorus, and orthophosphate and dissolved orthophosphate. Hydrolyzable phosphorus is normally found only in sewage-type samples and insoluble forms of phosphorus are determined by calculation.

1.3 The methods are usable in the 0.01 to 0.5 mg P/L range.

2.0 Summary of Method

2.1 Ammonium molybdate and antimony potassium tartrate react in an acid medium with dilute solutions of phosphorus to form an antimony-phospho-molybdate complex. This complex is reduced to an intensely blue-colored complex by ascorbic acid. The color is proportional to the phosphorus concentration.

2.2 Only orthophosphate forms a blue color in this test. Polyphosphates (and some organic phosphorus compounds) may be converted to the orthophosphate form by sulfuric acid hydrolysis. Organic phosphorus compounds may be converted to the orthophosphate form by persulfate digestion[(2)].

3.0 Sample Handling and Preservation

3.1 If benthic deposits are present in the area being sampled, great care should be taken not to include these deposits.

3.2 Sample containers may be of plastic material, such as cubitainers, or of Pyrex glass.

3.3 If the analysis cannot be performed the day of collection, the sample should be preserved by the addition of 2 mL conc. H_2SO_4 per liter and refrigeration at 4°C.

4.0 Definitions and Storet Numbers

4.1 Total Phosphorus (P)--all of the phosphorus present in the sample, regardless of form, as measured by the persulfate digestion procedure. (00665)

4.1.1 Total Orthophosphate (P, ortho)--inorganic phosphorus [$(PO_4)^{-3}$] in the sample as measured by the direct colorimetric analysis procedure.

(70507)

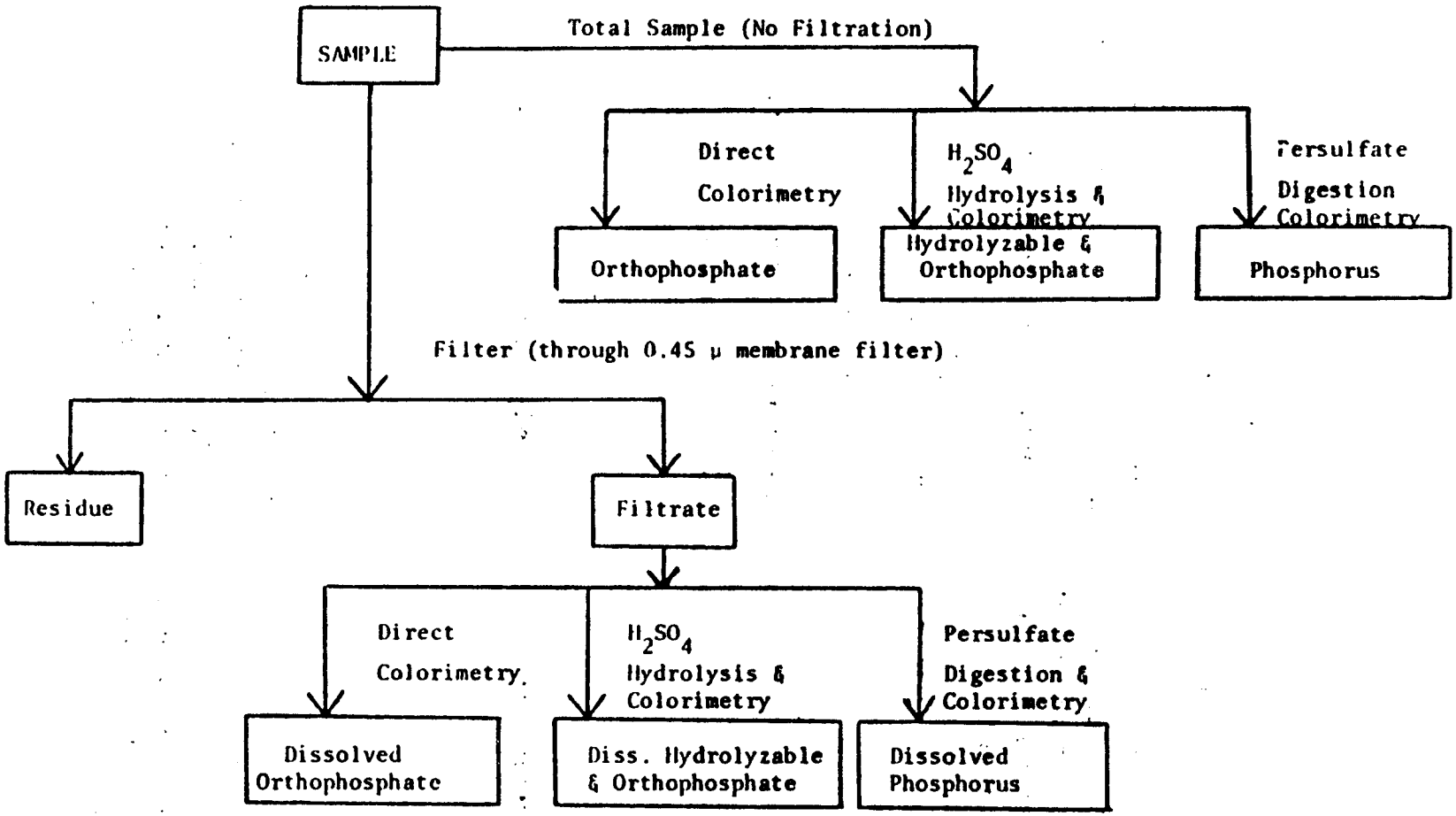


FIGURE 1. ANALYTICAL SCHEME FOR DIFFERENTIATION OF PHOSPHORUS FORMS

4.1.2 Total Hydrolyzable Phosphorus (P, hydro) - phosphorus in the sample as measured by the sulfuric acid hydrolysis procedure, and minus pre-determined orthophosphates. This hydrolyzable phosphorus includes polyphosphorus. [$(P_2O_7)^{-4}$, $(P_3O_{10})^{-5}$, etc.] plus some organic phosphorus. (00669)

4.1.3 Total Organic Phosphorus (P, org)--phosphorus (inorganic plus oxidizable organic) in the sample measured by the persulfate digestion procedure, and minus hydrolyzable phosphorus and orthophosphate. (00670)

4.2 Dissolved Phosphorus (P-D)--all of the phosphorus present in the filtrate of a sample filtered through a phosphorus-free filter of 0.45 micron pore size and measured by the persulfate digestion procedure. (00666)

4.2.1 Dissolved Orthophosphate (P-D, ortho)--as measured by the direct colorimetric analysis procedure. (00671)

4.2.2 Dissolved Hydrolyzable Phosphorus (P-D, hydro)--as measured by the sulfuric acid hydrolysis procedure and minus pre-determined dissolved orthophosphates. (00672)

4.2.3 Dissolved Organic Phosphorus (P-D, org)--as measured by the persulfate digestion procedure, and minus dissolved hydrolyzable phosphorus and orthophosphate. (00673)

4.3 The following forms, when sufficient amounts of phosphorus are present in the sample to warrant such consideration, may be calculated:

4.3.1 Insoluble Phosphorus (P-I) = (P)-(P-D). (00667)

4.3.1.1 Insoluble orthophosphate (P-I, ortho)=(P, ortho)-(P-D, ortho). (00674)

4.3.1.2 Insoluble Hydrolyzable Phosphorus (P-I, hydro)=(P, hydro)-(P-D, hydro). (00675)

4.3.1.3 Insoluble Organic Phosphorus (P-I, org)=(P, org) - (P-D, org). (00676)

4.4 All phosphorus forms shall be reported as P, mg/L, to the third place.

5.0 Interferences

5.1 No interference is caused by copper, iron, or silicate at concentrations many times greater than their reported concentration in sea water. However, high iron concentrations can cause precipitation of and subsequent loss of phosphorus.

5.2 The salt error for samples ranging from 5 to 20% salt content was found to be less than 1%.

5.3 Arsenate is determined similarly to phosphorus and should be considered when present in concentrations higher than phosphorus. However, at concentrations found in sea water, it does not interfere.

6.0 Apparatus

6.1 Photometer - A spectrophotometer or filter photometer suitable for measurements at 650 or 880 nm with a light path of 1 cm or longer.

6.2 Acid-washed glassware: All glassware used should be washed with hot 1:1 HCl and rinsed with distilled water. The acid-washed glassware should be filled with distilled water and treated with all the reagents to remove the last traces of phosphorus that might be adsorbed on the glassware. Preferably, this glassware should be used only for the determination of phosphorus and after use it should

be rinsed with distilled water and kept covered until needed again. If this is done, the treatment with 1:1 HCl and reagents is only required occasionally. Commercial detergents should never be used.

7.0 Reagents

7.1 Sulfuric acid solution, 5N: Dilute 70 mL of conc H_2SO_4 with distilled water to 500 mL.

7.2 Antimony potassium tartrate solution: Weigh 1.3715 g $K(SbO)C_4H_4O•1/2H_2O$ dissolve in 400 mL distilled water in 500 mL volumetric flask, dilute to volume. Store at 4°C in a dark, glass-stoppered bottle.

7.3 Ammonium molybdate solution: Dissolve 20 g $(NH_4)_6Mo_70_{24}•4H_2O$ in 500 mL of distilled water. Store in a plastic bottle at 4°C.

7.4 Ascorbic acid, 0.1 M: Dissolve 1.76 g of ascorbic acid in 100 mL of distilled water. The solution is stable for about a week if stored at 4°C.

7.5 Combined reagent: Mix the above reagents in the following proportions for 100 mL of the mixed reagent: 50 mL of 5N H_2SO_4, (7.1), 5 mL of antimony potassium tartrate solution (7.2), 15 mL of ammonium molybdate solution (7.3), and 30 mL of ascorbic acid solution (7.4). Mix after addition of each reagent. All reagents must reach room temperature before they are mixed and must be mixed in the order given. If turbidity forms in the combined reagent, shake and let stand for a few minutes until the turbidity disappears before proceeding. Since the stability of this solution is limited, it must be freshly prepared for each run.

7.6 Sulfuric acid solution, 11 N: Slowly add 310 mL conc. H_2SO_4 to 600 mL distilled water. When cool, dilute to 1 liter.

7.7 Ammonium persulfate.

7.8 Stock phosphorus solution: Dissolve in distilled water 0.2197 g of potassium dihydrogen phosphate, KH_2PO_4, which has been dried in an oven at 105°C. Dilute the solution to 1000 ml; 1.0 mL = 0.05 mg P.

7.9 Standard phosphorus solution: Dilute 10.0 mL of stock phosphorus solution (7.8) to 1000 mL with distilled water; 1.0 mL = 0.5 μg P.

7.9.1 Using standard solution, prepare the following standards in 50.0 mL volumetric flasks:

mL of Standard Phosphorus Solution (7.9)	Conc., mg/L
0	0.00
1.0	0.01
3.0	0.03
5.0	0.05
10.0	0.10
20.0	0.20
30.0	0.30
40.0	0.40
50.0	0.50

7.10 Sodium hydroxide, 1 N: Dissolve 40 g NaOH in 600 mL distilled water. Cool and dilute to 1 liter.

8.0 Procedure

8.1 Phosphorus

8.1.1 Add 1 mL of H_2SO_4 solution (7.6) to a 50 mL sample in a 125 mL Erlenmeyer flask.

8.1.2 Add 0.4 g of ammonium persulfate.

8.1.3 Boil gently on a pre-heated hot plate for approximately 30-40 minutes or until a final volume of about 10 mL is reached. Do not allow sample to go to dryness. Alternatively, heat for 30 minutes in an autoclave at 121°C (15-20 psi).

8.1.4 Cool and dilute the sample to about 30 mL and adjust the pH of the sample to 7.0 ±0.2 with 1 N NaOH (7.10) using a pH meter. If sample is not clear at this point, add 2-3 drops of acid (7.6) and filter. Dilute to 50 mL. Alternatively, if autoclaved see NOTE 1.

8.1.5 Determine phosphorus as outlined in 8.3.2 Orthophosphate.

8.2 Hydrolyzable Phosphorus

8.2.1 Add 1 mL of H_2SO_4 solution (7.6) to a 50 mL sample in a 125 mL Erlenmeyer flask.

8.2.2 Boil gently on a pre-heated hot plate for 30-40 minutes or until a final volume of about 10 mL is reached. Do not allow sample to go to dryness. Alternatively, heat for 30 minutes in an autoclave at 121°C (15-20 psi).

8.2.3 Cool and dilute the sample to about 30 mL and adjust the pH of the sample to 7.0 ±0.2 with NaOH (7.10) using a pH meter. If sample is not clear at this point, add 2-3 drops of acid (7.6) and filter. Dilute to 50 mL. Alternatively, if autoclaved see NOTE 1.

8.2.4 The sample is now ready for determination of phosphorus as outlined in 8.3.2 Orthophosphate.

8.3 Orthophosphate

8.3.1 The pH of the sample must be adjusted to 7 ± 0.2 using a pH meter.

8.3.2 Add 8.0 mL of combined reagent (7.5) to sample and mix thoroughly. After a minimum of ten minutes, but no longer than thirty minutes, measure the color absorbance of each sample at 650 or 880 nm with a spectrophotometer, using the reagent blank as the reference solution. NOTE 1: If the same volume of sodium hydroxide solution is not used to adjust the pH of the standards and samples, a volume correction has to be employed.

9.0 Calculation

9.1 Prepare a standard curve by plotting the absorbance values of standards versus the corresponding phosphorus concentrations.

9.1.1 Process standards and blank exactly as the samples. Run at least a blank and two standards with each series of samples. If the standards do not agree within ±2% of the true value, prepare a new calibration curve.

9.2 Obtain concentration value of sample directly from prepared standard curve. Report results as P, mg/L. SEE NOTE 1.

10.0 Precision and Accuracy

10.1 Thirty-three analysts in nineteen laboratories analyzed natural water samples containing exact increments of organic phosphate, with the following results:

Increment as Total Phosphorus mg P/liter	Precision as Standard Deviation mg P/liter	Accuracy as Bias, %	Accuracy as Bias, mg P/liter
0.110	0.033	+3.09	+0.003
0.132	0.051	+11.99	+0.016
0.772	0.130	+2.96	+0.023
0.882	0.128	-0.92	-0.008

(FWPCA Method Study 2, Nutrient Analyses)

10.2 Twenty-six analysts in sixteen laboratories analyzed natural water samples containing exact increments of orthophosphate, with the following results:

Increment as Orthophosphorus mg P/liter	Precision as Standard Deviation mg P/liter	Accuracy as Bias, %	Accuracy as Bias mg P/liter
0.029	0.010	-4.95	-0.001
0.038	0.008	-6.00	-0.002
0.335	0.018	-2.75	-0.009
0.383	0.023	-1.76	-0.007

(FWPCA Method Study 2, Nutrient Analyses)

Bibliography

1. Murphy, J., and Riley, J., "A modified Single Solution for the Determination of Phosphate in Natural Waters", Anal. Chim. Acta., 27, 31(1962).
2. Gales, M., Jr., Julian, E., and Kroner, R., "Method for Quantitative Determination of Total Phosphorus in Water", Jour. AWWA, 58, No. 10, 1363 (1966).
3. Annual Book of ASTM Standards, Part 31, "Water", Standard D515-72, Method A, p 389 (1976).
4. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 476 and 481, (1975).

APPENDIX G
KRMA GRAB SAMPLING RESULTS

KRMA Grab Sampling

Date	Total Phosphorus @ Station Street Bridge (mg/L)	Total Phosphorus - KRMA Upstream (mg/L)	Total Phosphorus - KRMA Downstream (mg/L)	Total Phosphorus @ Warner Bridge (mg/L)
8/11/2021	0.039	0.073	0.043	0.019
8/18/2021	0.070	0.041	0.041	0.046
8/25/2021	0.085	0.094	0.079	0.037
9/1/2021	0.120	0.095	0.110	0.114
9/8/2021	0.055	0.054	0.093	0.082
9/15/2021	0.045	0.008	0.045	0.019
9/22/2021	0.096	0.055	0.077	0.052
9/29/2021	0.074	0.068	0.052	0.074
10/6/2021	0.187	0.128	0.171	0.201
10/13/2021	0.240	0.215	0.238	0.254
10/20/2021	0.118	0.073	0.141	0.132
10/27/2021	0.701	0.466	0.453	0.619
5/4/2022	0.100	0.113	0.107	0.086
5/11/2022	0.119	0.092	0.122	0.124
5/18/2022	0.064	0.104	0.072	0.067
5/25/2022	0.060	0.050	0.079	0.050
6/1/2022	0.064	0.051	0.060	0.051
6/8/2022	0.152	0.159	0.154	0.194
6/15/2022	0.105	0.104	0.115	0.108
6/22/2022	0.104	0.088	0.087	0.084
6/29/2022	0.085	0.058	0.070	0.057
7/6/2022	0.064	0.054	0.181	0.092
7/13/2022	0.131	0.103	0.142	0.128
7/20/2022	0.102	0.080	0.103	0.098
7/27/2022	0.164	0.153	0.178	0.186
8/3/2022	0.088	0.065	0.090	0.081
8/10/2022	0.087	0.080	0.098	0.090
8/17/2022	0.073	0.069	0.099	0.062
8/24/2022	0.056	0.096	0.092	0.050
8/31/2022	0.073	0.084	0.148	0.050
9/7/2022	0.121	0.117	0.138	0.113
9/14/2022	0.069	0.064	0.101	0.080
05/03/23	0.050	0.050	0.050	0.050
05/10/23	0.363	0.297	0.335	0.189
05/17/23	0.095	0.069	0.093	0.079
05/24/23	0.059	0.051	0.068	0.054
05/31/23	0.070	0.055	0.050	0.050
06/07/23	0.080	0.061	0.072	0.081
06/14/23	0.069	0.062	0.075	0.076
06/21/23	0.060	0.050	0.104	0.050
06/28/23	0.081	0.055	0.077	0.066
07/05/23	0.083	0.075	0.091	0.093
07/12/23	0.087	0.071	0.116	0.091
07/19/23	0.087	0.061	0.076	0.080
07/26/23	0.058	0.050	0.050	0.050
08/02/23	0.090	0.058	0.087	0.067
08/09/23	0.341	0.299	0.385	0.349
08/16/23	0.183	0.136	0.238	0.166
08/23/23	0.104	0.101	0.088	0.086
08/30/23	0.070	0.077	0.079	0.053
09/06/23	0.056	0.103	0.064	0.050
09/13/23	0.061	0.050	0.050	0.050
09/20/23	0.061	0.050	0.055	0.050
09/27/23	0.055	0.056	0.053	0.050
10/04/23	0.057	0.050	0.053	0.050
10/11/23	0.050	0.050	0.087	0.050
10/18/23	0.088	0.081	0.080	0.092
10/25/23	0.050	0.094	0.064	0.050

APPENDIX H
STATION STREET BRIDGE CONTINUOUS MONITORING RESULTS

Continous Sonde Monitoring @ Station Street Bridge in Kankakee, IL

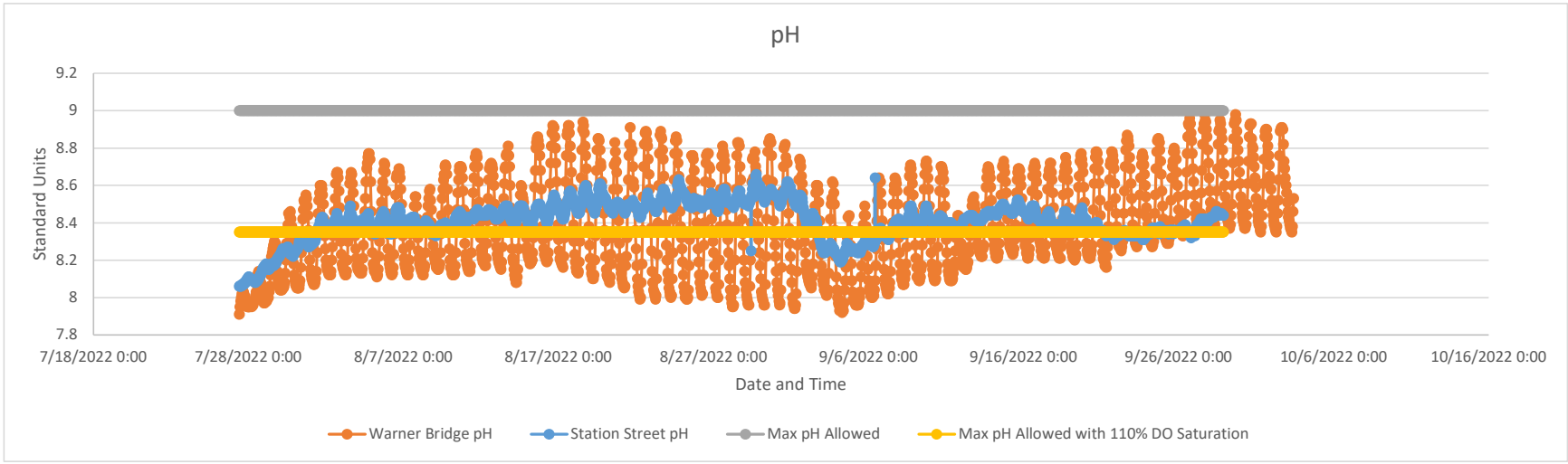
DATE	TIME	pH_units	SpCond_uS/cm	Turb_FNU	HDO_%Sat	HDO_mg/l	Chl_ug/l	Int_Batt_V	Temp_deg_F
7/27/2022	10:00:00	8.06	493.5	16.66	85.3	7	3.73	9.06	74.78
7/27/2022	11:00:00	8.06	493	15.53	85.5	7.02	3.83	9.08	74.83
7/27/2022	12:00:00	8.06	492.2	16.28	85.8	7.04	3.77	9.04	74.91
7/27/2022	13:00:00	8.06	492.8	15.7	85.7	7.03	4.17	9.11	74.86
7/27/2022	14:00:00	8.07	493.9	15.26	86.2	7.06	3.83	9.14	75.14
7/27/2022	15:00:00	8.07	494.4	16.34	86.4	7.05	3.88	9.09	75.35
7/27/2022	16:00:00	8.07	493	14.96	86.7	7.06	3.97	9.06	75.58
7/27/2022	17:00:00	8.07	493.6	14.49	87.3	7.08	3.8	8.94	75.94
7/27/2022	18:00:00	8.08	494.3	13.93	87.7	7.1	4.12	9.08	76.09
7/27/2022	19:00:00	8.08	494.2	12.75	88	7.12	4.39	8.98	76.29
7/27/2022	20:00:00	8.08	478.2	15.19	88.4	7.13	4.41	9.08	76.46
7/27/2022	21:00:00	8.09	492.3	13.24	88.7	7.15	4.22	9.11	76.62
7/27/2022	22:00:00	8.1	494.3	13.27	89.2	7.18	4.31	9.03	76.75
7/27/2022	23:00:00	8.1	494.9	12.78	89.5	7.2	4.14	9.09	76.86
7/28/2022	0:00:00	8.11	420.4	12.58	89.4	7.19	4.21	9.01	76.86
7/28/2022	1:00:00	8.11	430.7	13.36	89.1	7.17	4.29	9.13	76.76
7/28/2022	2:00:00	8.1	414.5	13.84	88.8	7.16	4.43	9.03	76.61
7/28/2022	3:00:00	8.1	495	15.09	88.5	7.13	4.51	9.06	76.54
7/28/2022	4:00:00	8.1	472.1	13.53	88.2	7.12	4.41	9.06	76.44
7/28/2022	5:00:00	8.09	477.7	15.34	87.5	7.08	4.26	9.08	76.31
7/28/2022	6:00:00	8.09	492.1	14.19	87	7.05	4.51	9.04	76.1
7/28/2022	7:00:00	8.09	497.8	14.51	86.7	7.04	4.52	9.08	75.9
7/28/2022	8:00:00	8.09	495.9	13.5	86.5	7.03	4.61	9.06	75.74
7/28/2022	9:00:00	8.09	501	13.87	86.2	7.02	4.29	9.06	75.53
7/28/2022	10:00:00	8.08	489.2	14.38	86.1	7.02	4.39	9.04	75.39
7/28/2022	11:00:00	8.08	502	13.37	85.9	7.03	4.34	9.04	75.22
7/28/2022	12:00:00	8.09	506.9	14.18	86.6	7.07	4.4	9.04	75.3
7/28/2022	13:00:00	8.09	502.8	13.92	86.7	7.08	4.18	9.08	75.31
7/28/2022	14:00:00	8.09	480	12.43	86.6	7.08	4.21	8.99	75.2
7/28/2022	15:00:00	8.1	513.1	10.57	87.3	7.13	4.52	9.03	75.41
7/28/2022	16:00:00	8.1	518.4	12.56	87.6	7.14	4.6	9.04	75.48
7/28/2022	17:00:00	8.11	518.3	13.01	87.9	7.15	4.36	9.03	75.62
7/28/2022	18:00:00	8.12	510.9	12.9	88.3	7.18	4.99	9.03	75.77
7/28/2022	19:00:00	8.12	525	12.22	88.8	7.2	5.35	9.08	75.95
7/28/2022	20:00:00	8.13	522.7	11.83	89.2	7.23	4.9	9.01	76.08
7/28/2022	21:00:00	8.14	527.6	12.52	89.6	7.25	5.57	8.99	76.22
7/28/2022	22:00:00	8.15	531.1	10.96	90.4	7.3	4.92	8.98	76.37
7/28/2022	23:00:00	8.16	533	10.83	90.9	7.33	4.58	9.03	76.51
7/29/2022	0:00:00	8.16	532.3	10.13	91	7.33	5.2	9.06	76.61
7/29/2022	1:00:00	8.17	519.7	10.27	91.5	7.37	5.35	9.03	76.67
7/29/2022	2:00:00	8.17	535.9	9.86	91.4	7.36	5.11	8.89	76.7
7/29/2022	3:00:00	8.18	532.3	10.62	91.1	7.34	4.98	8.99	76.67
7/29/2022	4:00:00	8.17	548	10.23	90.5	7.3	4.82	8.91	76.51
7/29/2022	5:00:00	8.17	544.8	9.99	89.7	7.25	4.62	8.99	76.31
7/29/2022	6:00:00	8.16	510.3	10.27	88.9	7.2	4.87	9.03	76.1
7/29/2022	7:00:00	8.15	548.4	11.06	88.3	7.17	4.34	8.96	75.87
7/29/2022	8:00:00	8.15	549.6	11.6	88.4	7.19	3.92	9.03	75.73
7/29/2022	9:00:00	8.16	553.5	11.19	88.7	7.22	3.83	8.94	75.72
7/29/2022	10:00:00	8.16	553.6	11.53	89	7.24	4.14	8.96	75.68
7/29/2022	11:00:00	8.18	551.9	12.13	89.6	7.28	4.13	8.93	75.73
7/29/2022	12:00:00	8.18	562.1	10.83	89.3	7.26	4.26	8.99	75.65
7/29/2022	13:00:00	8.18	565.5	11.15	89.3	7.28	4.41	9.01	75.54
7/29/2022	14:00:00	8.17	565.4	13.64	89.3	7.28	4.42	8.93	75.56
7/29/2022	15:00:00	8.17	552	11.18	88.9	7.25	4.35	8.98	75.38
7/29/2022	16:00:00	8.18	555	10.9	90.1	7.34	4.44	8.96	75.58
7/29/2022	17:00:00	8.19	504.1	11.2	90.2	7.34	4.68	8.96	75.61
7/29/2022	18:00:00	8.18	562.1	11.22	90.3	7.34	4.75	8.96	75.73
7/29/2022	19:00:00	8.19	573	10.17	90.4	7.35	5.42	8.91	75.74
7/29/2022	20:00:00	8.2	574.8	9.99	90.8	7.37	5.41	8.96	75.86
7/29/2022	21:00:00	8.21	571.9	10.28	91.4	7.41	6.04	8.94	75.99
7/29/2022	22:00:00	8.21	578.3	8.58	92.1	7.46	5.43	8.94	76.12
7/29/2022	23:00:00	8.22	553.9	8.47	92.4	7.48	5.27	8.96	76.23
7/30/2022	0:00:00	8.22	551.2	8.38	92.6	7.49	5.73	8.89	76.24
7/30/2022	1:00:00	8.23	510	8.17	92.5	7.48	5.97	8.93	76.27
7/30/2022	2:00:00	8.23	543.7	8.62	92.5	7.48	5.49	8.91	76.35

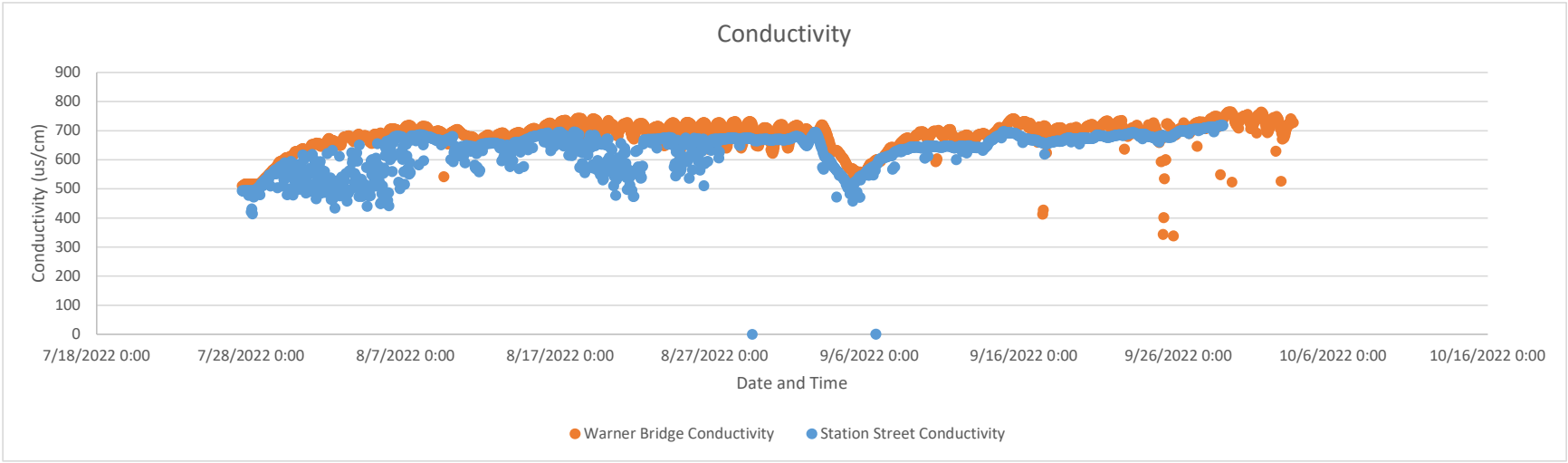
APPENDIX I
WARNER ROAD BRIDGE CONTINUOUS MONITORING RESULTS

Continous Sonde Monitoring @ Warner Road Bridge in Kankakee County, IL

DATE	TIME	pH_units	SpCond_uS/cm	Turb_FNU	HDO_%Sat	HDO_mg/l	Chl_ug/l	Int_Batt_V	Temp_deg_F
7/27/2022	10:00:00	7.91	510.1	28	83	6.74	3.81	8.96	75.89
7/27/2022	11:00:00	7.95	510.7	31.95	85	6.86	3.8	8.99	76.45
7/27/2022	12:00:00	7.98	512.3	27.77	87.9	7.05	3.67	9.03	77.08
7/27/2022	13:00:00	8	514.3	26.44	89.5	7.15	3.59	9.03	77.45
7/27/2022	14:00:00	8.02	516.2	27.11	91.4	7.27	3.56	9.01	77.96
7/27/2022	15:00:00	8.02	517.2	27.25	92.3	7.31	3.46	9.03	78.29
7/27/2022	16:00:00	8.03	517.4	25.13	93.2	7.37	3.54	8.99	78.51
7/27/2022	17:00:00	8.02	517.4	23.11	92.1	7.28	3.5	9.03	78.53
7/27/2022	18:00:00	8.01	517	23.26	91.1	7.22	3.63	8.99	78.29
7/27/2022	19:00:00	8	516.8	24.91	89.2	7.1	3.47	9.01	77.85
7/27/2022	20:00:00	7.98	516.4	25.49	86.2	6.91	3.47	9.03	77.19
7/27/2022	21:00:00	7.96	516.2	21.91	84	6.77	3.98	8.94	76.63
7/27/2022	22:00:00	7.95	515.7	25.04	82.5	6.68	3.78	9.01	76.16
7/27/2022	23:00:00	7.95	515.5	22.49	81.8	6.65	3.58	8.99	75.8
7/28/2022	0:00:00	7.95	515.9	22.34	81.5	6.64	3.63	9.03	75.47
7/28/2022	1:00:00	7.95	516	24.18	81.2	6.64	3.49	8.93	75.3
7/28/2022	2:00:00	7.95	516	22.89	81.2	6.64	3.59	8.99	75.18
7/28/2022	3:00:00	7.96	515.5	21	81.2	6.65	3.64	9.03	75.13
7/28/2022	4:00:00	7.96	515.3	20.99	81.4	6.66	3.7	8.96	75.11
7/28/2022	5:00:00	7.95	515.5	22.77	81.5	6.67	3.49	8.98	75.1
7/28/2022	6:00:00	7.96	515.5	21.48	81.5	6.67	3.63	9.01	75.09
7/28/2022	7:00:00	7.96	515	24.67	81.8	6.69	3.72	8.98	75.12
7/28/2022	8:00:00	7.97	514.6	25.23	82.5	6.75	3.45	8.94	75.21
7/28/2022	9:00:00	7.98	514.3	23.16	83.4	6.81	3.59	8.93	75.37
7/28/2022	10:00:00	7.99	514.9	24.51	85	6.91	3.46	8.98	75.73
7/28/2022	11:00:00	8.01	515.2	22.61	87.8	7.11	3.7	8.98	76.19
7/28/2022	12:00:00	8.03	516.6	21.93	91.1	7.32	3.66	8.93	76.87
7/28/2022	13:00:00	8.07	517.4	22.73	96.1	7.65	3.51	8.91	77.76
7/28/2022	14:00:00	8.11	519.2	22.47	100.2	7.92	3.45	8.89	78.49
7/28/2022	15:00:00	8.13	521.1	19.84	102.7	8.08	3.39	8.93	78.94
7/28/2022	16:00:00	8.14	523.5	22.13	103.6	8.14	3.5	8.94	79.18
7/28/2022	17:00:00	8.13	525.8	19.87	102.4	8.05	3.5	8.91	79.08
7/28/2022	18:00:00	8.11	527.8	18.02	99.7	7.87	3.54	8.94	78.65
7/28/2022	19:00:00	8.08	530.1	18.33	95.5	7.6	3.67	8.88	77.94
7/28/2022	20:00:00	8.05	532.6	18.57	90.9	7.29	3.91	8.91	77.11
7/28/2022	21:00:00	8.01	535	19.39	87	7.03	3.73	8.93	76.29
7/28/2022	22:00:00	7.99	537.1	19.45	83.7	6.82	3.64	8.96	75.58
7/28/2022	23:00:00	7.98	539.5	19.86	82.4	6.75	3.66	8.86	75.09
7/29/2022	0:00:00	7.97	541	18.41	81.6	6.71	3.72	8.94	74.67
7/29/2022	1:00:00	7.97	543.7	17.44	81.3	6.71	3.57	8.83	74.37
7/29/2022	2:00:00	7.98	546.6	18.16	81.1	6.7	3.71	8.88	74.2
7/29/2022	3:00:00	7.98	548.2	17.73	81.2	6.71	3.54	8.94	74.11
7/29/2022	4:00:00	7.98	550.7	18.42	81.3	6.73	3.54	8.89	74.07
7/29/2022	5:00:00	7.99	553.4	17.22	81.5	6.74	3.59	8.88	74.04
7/29/2022	6:00:00	8	556.2	16.29	81.5	6.75	3.66	8.93	74.02
7/29/2022	7:00:00	8	558.4	18.01	82.3	6.81	3.42	8.93	74.09
7/29/2022	8:00:00	8.03	561.1	16.79	84.2	6.95	3.57	8.81	74.39
7/29/2022	9:00:00	8.06	563.7	17.21	88.3	7.23	3.3	8.88	75.02
7/29/2022	10:00:00	8.12	565.7	17.97	94.8	7.69	3.18	8.89	75.96
7/29/2022	11:00:00	8.17	566.9	17.76	101.1	8.12	3.14	8.94	76.96
7/29/2022	12:00:00	8.22	568.7	17.68	105.7	8.41	3.1	8.84	77.85
7/29/2022	13:00:00	8.24	570.7	17	109.4	8.63	3.02	8.89	78.66
7/29/2022	14:00:00	8.26	573.3	16.97	111.2	8.73	3.12	8.89	79.12
7/29/2022	15:00:00	8.28	575.6	15.45	113.6	8.87	3	8.89	79.68
7/29/2022	16:00:00	8.3	578.6	15.67	115.8	9.02	3.03	8.89	79.99
7/29/2022	17:00:00	8.28	581.6	15.52	112.8	8.82	3.01	8.89	79.52
7/29/2022	18:00:00	8.29	586.4	14.3	111.7	8.75	3.05	8.91	79.34
7/29/2022	19:00:00	8.24	590.1	12.73	105.2	8.3	3.22	8.89	78.61
7/29/2022	20:00:00	8.19	593.2	13.74	98.6	7.85	3.35	8.84	77.81
7/29/2022	21:00:00	8.14	594	15.2	92.3	7.41	3.06	8.86	76.98
7/29/2022	22:00:00	8.09	593.6	15.1	86.9	7.03	3.36	8.83	76.15
7/29/2022	23:00:00	8.06	595.7	14.08	83.9	6.84	3.24	8.86	75.44
7/30/2022	0:00:00	8.05	597.2	14.04	82.4	6.76	3.21	8.84	74.86
7/30/2022	1:00:00	8.04	597.2	15.17	81.5	6.72	3.1	8.84	74.39
7/30/2022	2:00:00	8.04	598.9	15.17	81	6.7	3.19	8.86	74.06
7/30/2022	3:00:00	8.04	601.2	14.74	80.8	6.7	3.12	8.86	73.81
7/30/2022	4:00:00	8.04	602.6	13.64	80.8	6.71	3.32	8.88	73.68
7/30/2022	5:00:00	8.05	605.4	13.57	81	6.73	3.19	8.88	73.59
7/30/2022	6:00:00	8.05	606.3	14.77	81.1	6.75	3.36	8.81	73.52
7/30/2022	7:00:00	8.06	607.2	14.17	82.2	6.84	3.26	8.83	73.57

APPENDIX J
2022 CONTINUOUS MONITORING RESULTS


pH
9.2
9
8.8
8.6
8.4
8.2
8
7.8
Standard Units
7/18/2022 0:00
7/28/2022 0:00
8/7/2022 0:00
8/17/2022 0:00
8/27/2022 0:00
9/6/2022 0:00
9/16/2022 0:00
9/26/2022 0:00
10/6/2022 0:00
10/16/2022 0:00
Date and Time
Warner Bridge pH
Station Street pH
Max pH Allowed
Max pH Allowed with 110% DO Saturation


Conductivity
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800
700
600
500
400
300
200
100
0
Conductivity (us/cm)
7/18/2022 0:00
7/28/2022 0:00
8/7/2022 0:00
8/17/2022 0:00
8/27/2022 0:00
9/6/2022 0:00
9/16/2022 0:00
9/26/2022 0:00
10/6/2022 0:00
10/16/2022 0:00
Date and Time
Warner Bridge Conductivity
Station Street Conductivity

APPENDIX K
CITY OF WILMINGTON NARP DEVELOPMENT

Geosyntec consultants

CITY OF WILMINGTON NARP UPDATE

KANKAKEE RIVER NARP STAKEHOLDER MEETING

June 14, 2023

WILMINGTON
THE ISLAND CITY

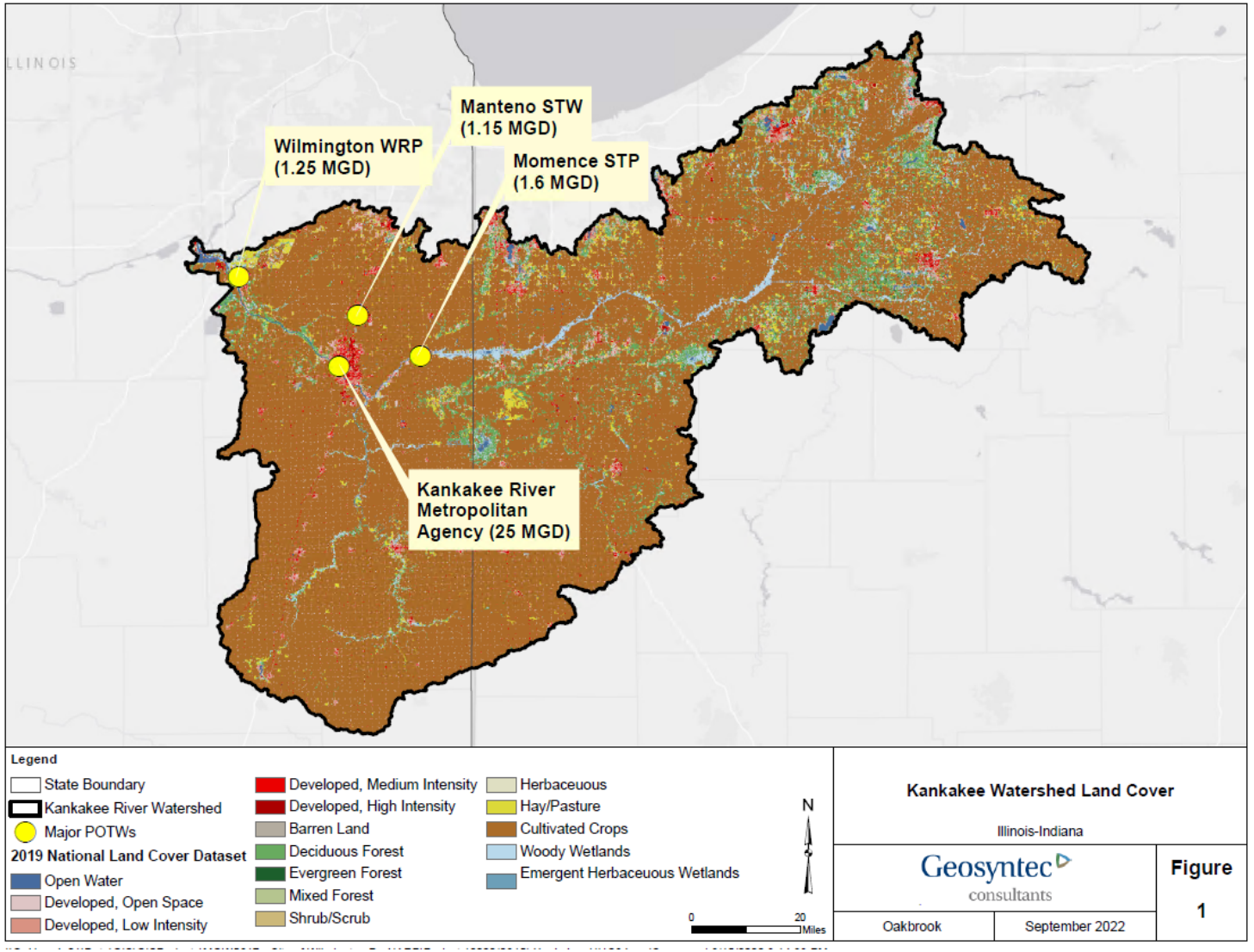
AGENDA

- Watershed Overview
- Wilmington NARP Schedule
- NARP Objectives
- Proposed Sampling

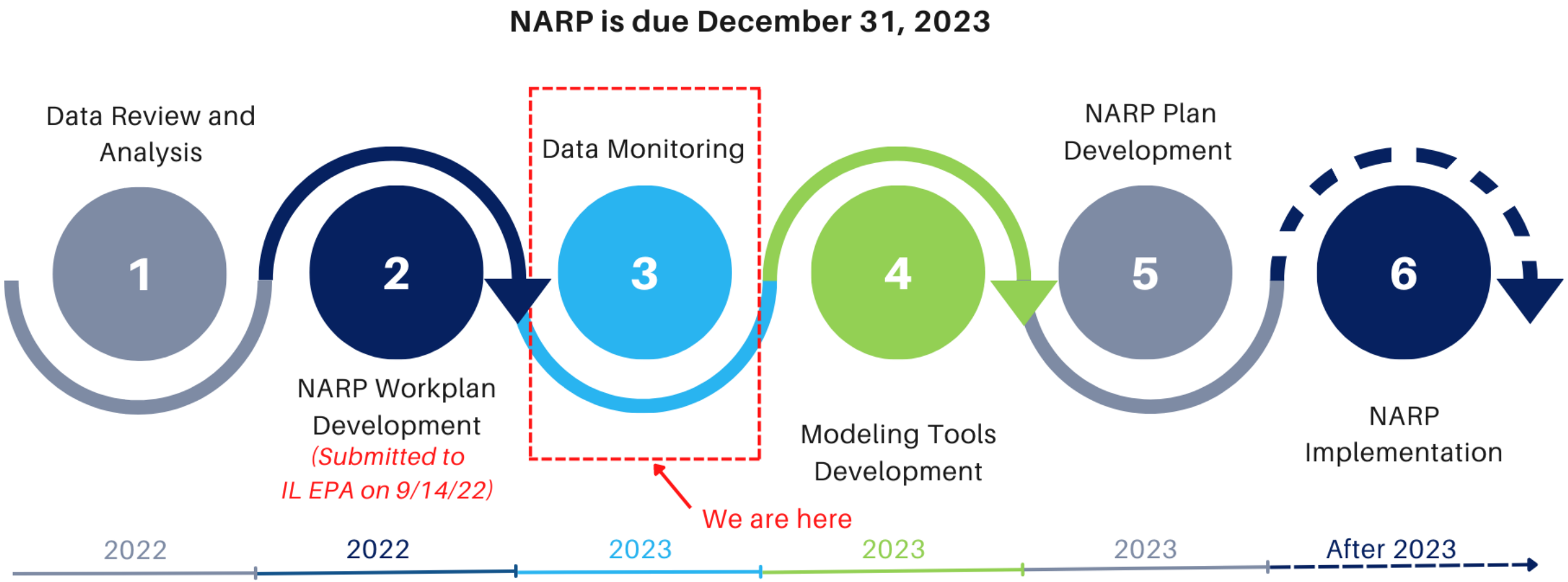
Watershed Overview

- Land Use
  - Predominantly agriculture

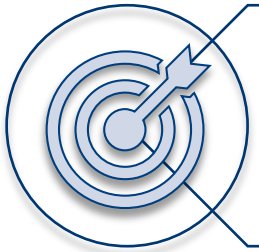
NLCD Class	Total Coverage (%)
Cultivated Crops	63.8
Developed, Low Intensity	9.5
Developed, Open Space	6.4
Deciduous Forest	6.2
Hay/Pasture	5.4
Developed, Medium Intensity	3.7



City of Wilmington NARP Schedule



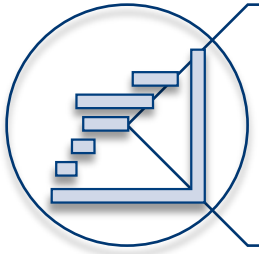
Wilmington NARP Objectives



1) Establish watershed-specific nutrient targets

2) Determine the control measures to eliminate TP-related impairment DS of Wilmington's outfall

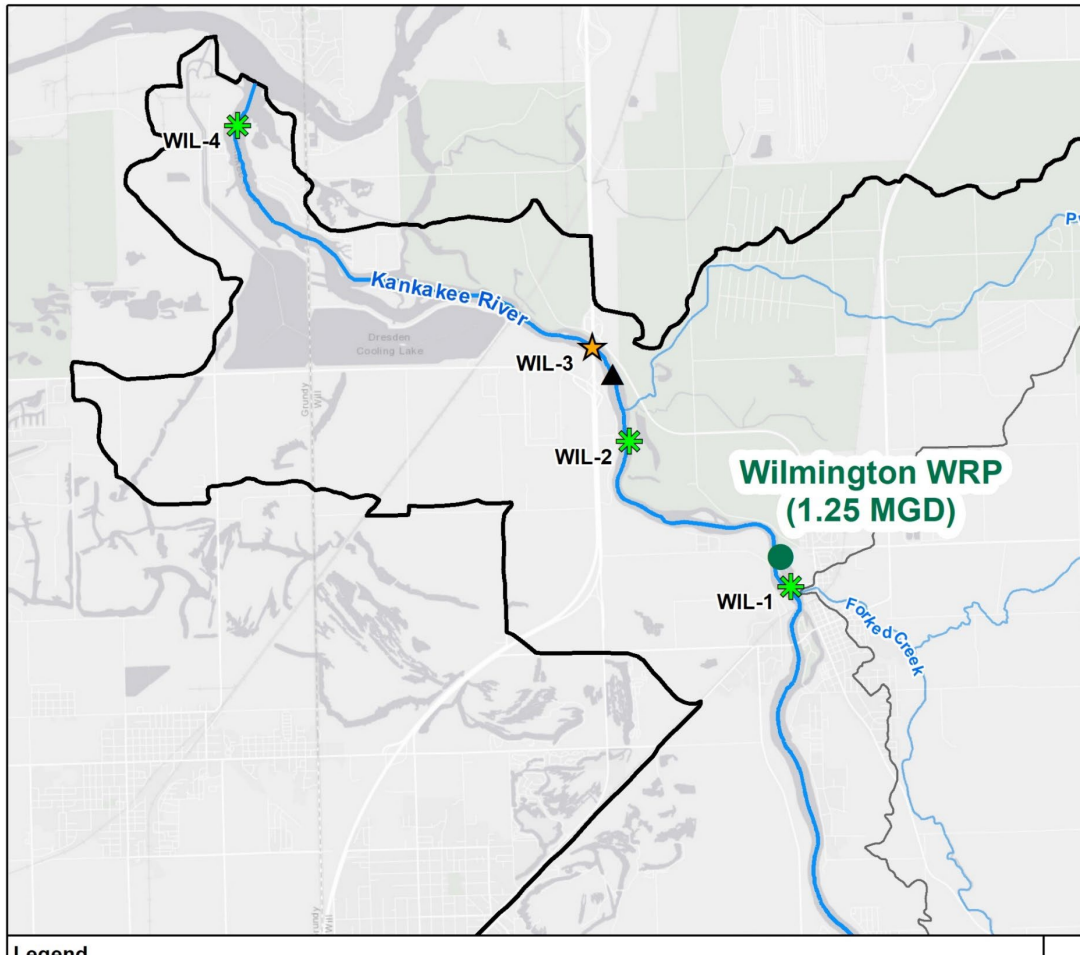
a. How does upstream TP reduction affect the downstream impairment?
b. Will there be a benefit of Wilmington doing additional TP removal?



3) Develop a plan for tracking and reporting progress

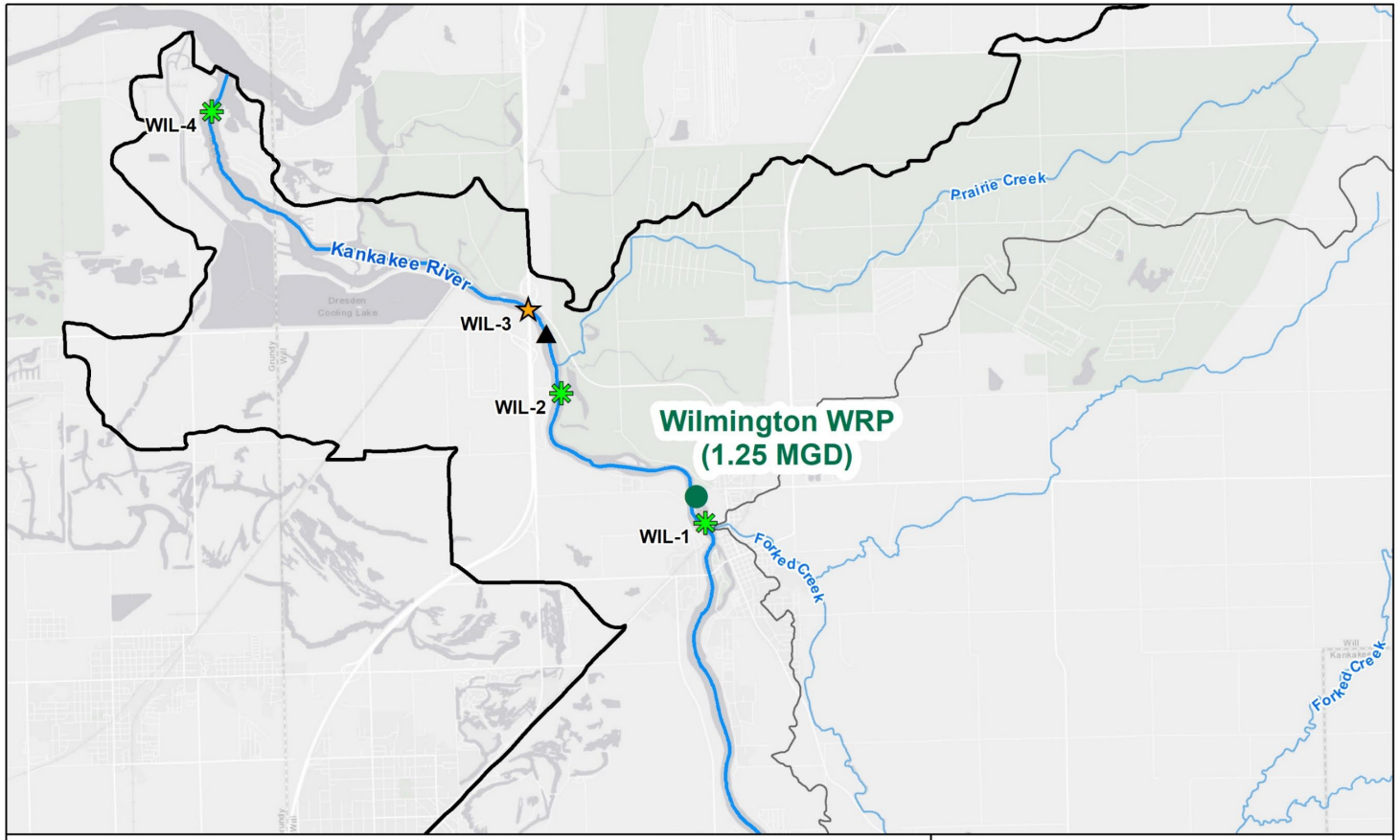
Proposed Modeling

- A steady-state Qual2k model
  - The City is doing an individual NARP
  - Only one major discharger – a fraction of the load from upstream sources, including KRMA
  - The tributaries are much smaller than the upstream boundary (will have a minimal impact)
  - Identifying a condition with low flow and high TP load will be representative of conservative conditions



Proposed Monitoring (Low Flow Condition, June-July 2023)

- Continuous (2 weeks per site*)
  - Dissolved oxygen
  - Temperature
  - pH
  - Specific conductivity
- Discrete (2 samples per site)
  - Nutrients
  - $CBOD_5$
  - Chlorophyll-a (sestonic)
  - Temperature
  - Dissolved oxygen
  - Specific conductance
  - pH
  - Turbidity



\\Oakbrook-01\Data\GIS\GISProjects\MOW5617 - City of Wilmington PreNARP\Projects\2022(0725)\Wilmington_Proposed_Monitoring_Stations_Zoomed_Updated.mxd 8/9/2022 10:42:22 AM

NARP Workplan Tasks and Schedule

	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
1) Conduct Data Monitoring & Data Analysis	■	■					
2) Develop Modeling Tools	■	■	■				
3) Watershed Management Scenarios				■			
4) Implementation Plan and Schedule					■	■	■
5) Project Managemnent	■	■	■	■	■	■	■

Geosyntec consultants

Questions?

Karoline Qasem, Ph.D., P.E.

Water Resources Engineer

Geosyntec Consultants

Email: Kqasem@Geosyntec.com

Phone: 630-203-3344

APPENDIX L
KANKAKEE COUNTY SWCD EVENTS

KANKAKEE COUNTY SOIL & WATER CONSERVATION DISTRICT PRESENTS

Cover Before Corn

Curious about planting cover crops before corn?
Hear farmer recommendations for cover crop species selection, planting, maintenance, and termination methods that will help you to keep cover in your crop rotation.

Cover Crop Considerations Before Corn
Frank Rademacher, Rademacher Farms, Gifford IL
Laura Lant, Midwest Grass & Forage Agronomist

Soil on Demand Tool for Kankakee Farmers
Conservation Cost-Share Opportunities

FREE EVENT | PLEASE RSVP

Thursday, January 26, 2023
9:30 AM –11:30 AM

Coffee & Light Breakfast Provided

Herscher Legion Community Center
102 S Oak Street
Herscher, IL 60941

Please RSVP by January 20 to reserve your seat!

Call **(815) 937-8940 ext. 3**

or visit **www.kankakeecountyswcd.org/district-events**

Kankakee County Soil and Water Conservation District

The Nature Conservancy

MGF MIDWEST GRASS & FORAGE

FUTURE *of Farming*

FRI, AUG 11TH
9AM-11AM

Details:
Check out the latest ag tech innovations with us including live demonstrations by aerial drone and robot seeding companies. Midwest Grass & Forage will also be sharing techniques to maximize cover crop benefits.

Location:
Value Partner Seeds
4529 S 7000W Rd.
Herscher, IL 60941

Scan to RSVP

Kankakee County
Soil and Water
Conservation District

COMPEER FINANCIAL®

Kankakee County Soil & Water Conservation District cordially invites you to attend a special event!

Kankakee County "Farming for the Future" Conservation Bus Tour

Tuesday, April 4, 7:45AM -12:30PM

Join us to learn about agriculture's vital role in water quality and conservation. Meet local farmers and view on-farm solutions that reduce erosion, increase soil health, and keep nutrients out of waterways.

Farm stops will include cover crops, edge-of-field conservation, tillage solutions, & wetland restoration practices.

Due to limited space this event is by invitation only. Please RSVP by calling the office at (815) 937-8940 ext. 3

Kankakee County
Soil and Water
Conservation District

685 Larry Power Rd. Bourbonnais, IL 60914
(815) 937-8940 ext. 3 | www.kankakeecountyswcd.org

Most people today have noticed the increased attention in the news that is being placed on our climate. It seems drought has reached corners of our country on an almost routine basis with water shortages for many people living in those regions. Locally, while not suffering from drought, we have experienced excess rainfall cutting short the planting season as recent as 2019. Things have definitely changed.

Corresponding with extreme weather events is the seemingly daily use of the words sustainability, climate change and regenerative farming practices. All of those topics can be a mouthful to understand, let alone to make them relatable locally.

The defining geographic feature of Kankakee County is unquestionably the Kankakee River. The surrounding landscape which contributes to its' flow of water is predominantly farmland. A resource which contributes significantly to the economic livelihood of all those who call Kankakee home. With so much conversation swirling around about how human interactions with our environment may be contributing to environmental decline, those of us at the SWCD thought it was about time to share what is, and what can be, done to improve our natural resources within the county.

I am grateful for the opportunity to finally invite all of you to our Kankakee County Conservation Bus Tour this spring. This tour has been an idea floating around for quite some time and we at the Soil and Water Conservation District are looking forward to finally sharing the strides that farmers have been making to protect the land and water resources of Kankakee County. Although not inclusive of all possible farm level activities, we will literally step foot on some current practices that have made significant differences in soil and water quality.

With all of the attention that the Kankakee River has rightfully been garnering, we believe that now is the best time ever to showcase farmer efforts to date. We also believe we can strengthen relationships by demonstrating how clean water and healthy soil makes a better Kankakee County for all.

Please join us for this event!

KANKAKEE COUNTY SOIL & WATER CONSERVATION DISTRICT AND
WILL-SOUTH COOK SOIL AND WATER CONSERVATION DISTRICT PRESENT:

Cover Crop Termination

Join us to hear farmers' experiences and recommendations for both chemical and mechanical methods of cover crop termination.

Cover Crop Termination: Rolling and More
Jay Whalen, ProHarvest Seed Specialist and Farmer
Frank Rademacher, The Nature Conservancy, Rademacher Farms
Corey Johnson, Will County Farmer

Soil on Demand Tool for Kankakee Farmers
Conservation Cost-Share Opportunities

FREE EVENT | PLEASE RSVP

Thursday, February 23, 2023
9:30 AM –11:30 AM

Coffee & Light Breakfast Provided

Will County Fairgrounds
Atrium–North End
710 S West St.
Peotone, IL 60468

Please RSVP by February 17 to reserve your seat!
Call **(815) 937-8940 ext. 3**
or visit **www.kankakeecountyswcd.org/district-events**

Kankakee County Soil and Water Conservation District
Will/South Cook Soil & Water Conservation District
The Nature Conservancy
ProHarvest Seeds

C3 Carbon, Covers, & Conservation

THUR, SEPT 7TH
9AM-11AM

Coffee & light breakfast provided

Scan to RSVP
or call the office at
815-937-8940 ext 3

This event made possible through a grant from:

COMPEER FINANCIAL

Details:
Join us to learn how carbon markets, cover crops, and conservation practices can work together to benefit your farming operation.

Location:
U of I Extension Office
1650 Commerce Drive
Bourbonnais, IL 60914

Presenters:
Matt Raymond, Kankakee Co. SWCD

Brogan Schanz, Soil & Water Outcomes Fund (SWOF)

Bruce Henrikson, Saving Tomorrow's Ag Resources (S.T.A.R.)

Kankakee County Soil and Water Conservation District

Soil and Water Outcomes Fund®

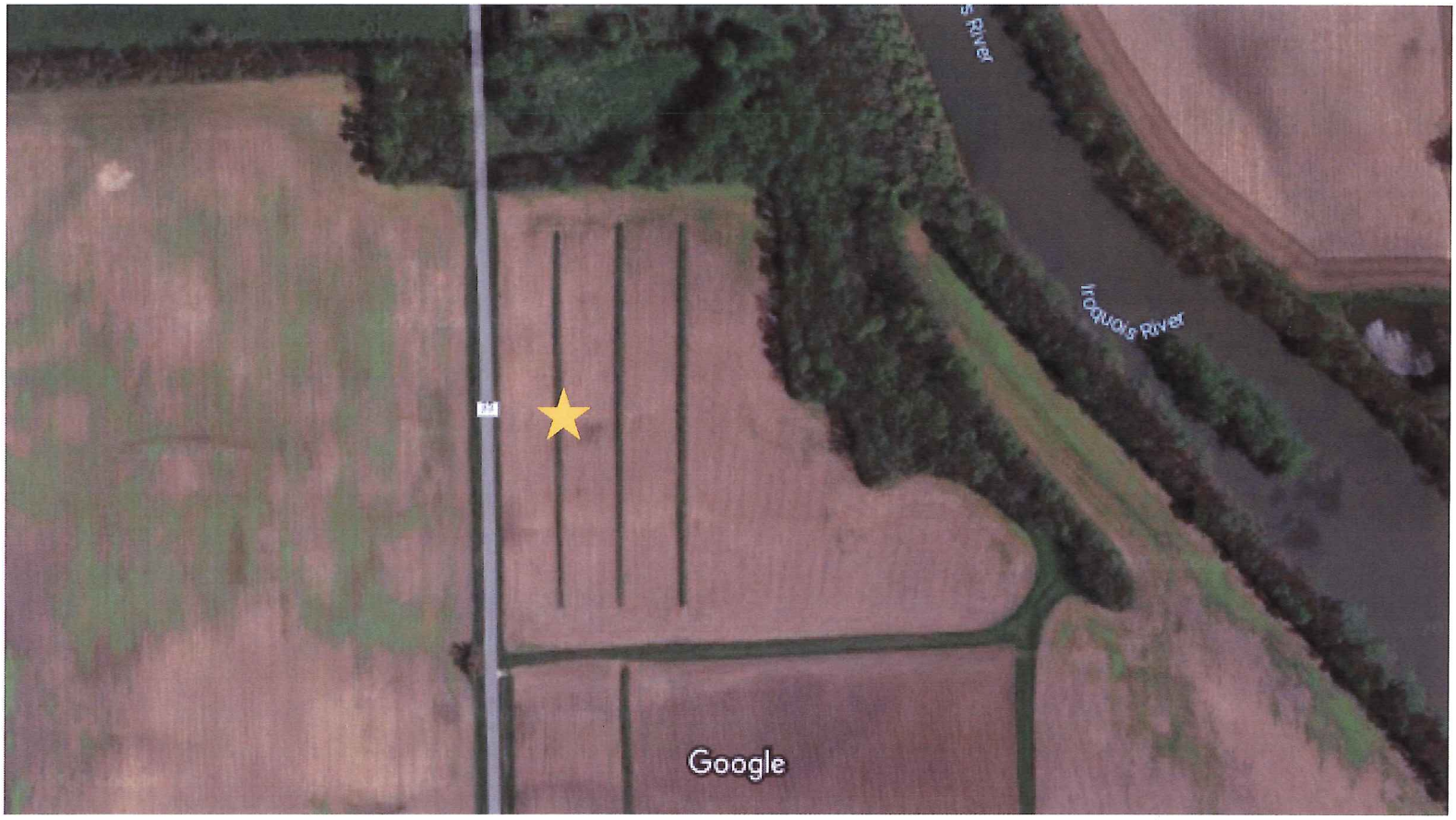
SAVING TOMORROW'S STAR AGRICULTURE RESOURCES

Kankakee County Soil and Water Conservation District

COMPEER FINANCIAL

Conservation Farm Tour Stop #1:

Terraces Along the Iroquois River



Presentations By:

Doug Flageole- Farmer Site Host

Jim Isermann - IL Sustainable Ag Partnership, Soil Health Specialist

Conservation Practices:

- **Cover Crops**
- **Terraces (WASCOBs)**
- **Wildlife Habitat**

Conservation Practice Benefit Examples

Based on a 18 acre field starting with moderate tillage practices

PRACTICE	SOIL SAVED (tons)	SEDIMENT REDUCTION (tons)	NITROGEN REDUCTION (lbs)	PHOSPHORUS REDUCTION (lbs)
No Till	175	54	114	57
Strip Till	135	42	86	43
Cover Crop	49	15	29	15

Kankakee County
Soil and Water
Conservation District

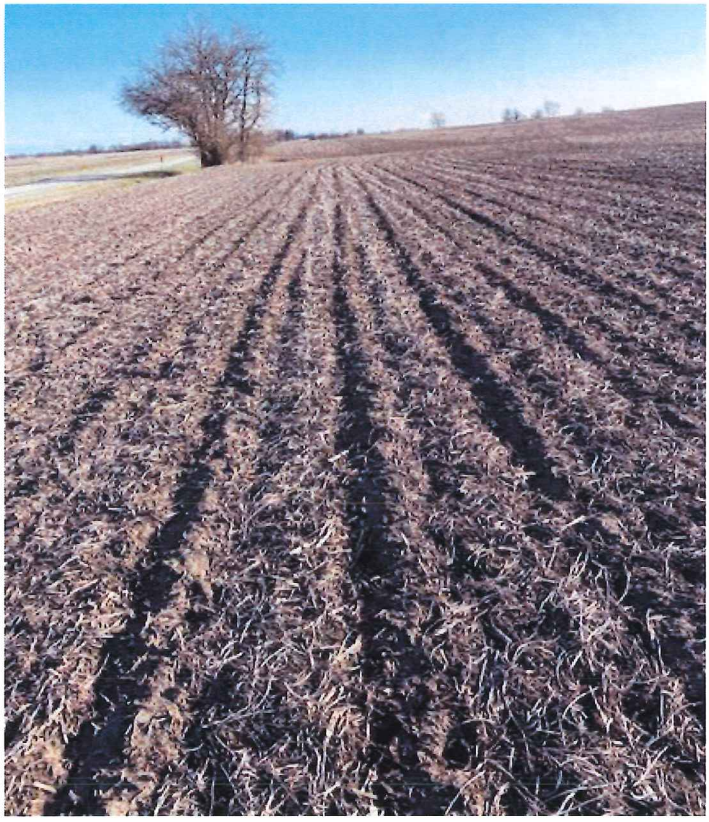
COMPEER FINANCIAL

Conservation Farm Tour Stop #1:

Terraces (WASCOBs) & Cover Crops

Cover Crop - Cereal Rye

Terraces (WASCOB)



Strip Tillage (across road)

For more location information please visit www.strand.com

Office Locations

Ames, Iowa | 515.233.0000

Brenham, Texas | 979.836.7937

Cincinnati, Ohio | 513.861.5600

Columbus, Indiana | 812.372.9911

Columbus, Ohio | 614.835.0460

Joliet, Illinois | 815.744.4200

Lexington, Kentucky | 859.225.8500

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