Monitoring Results for the Fox Illinois River Basin TMDL

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1. PROJECT BACKGROUND

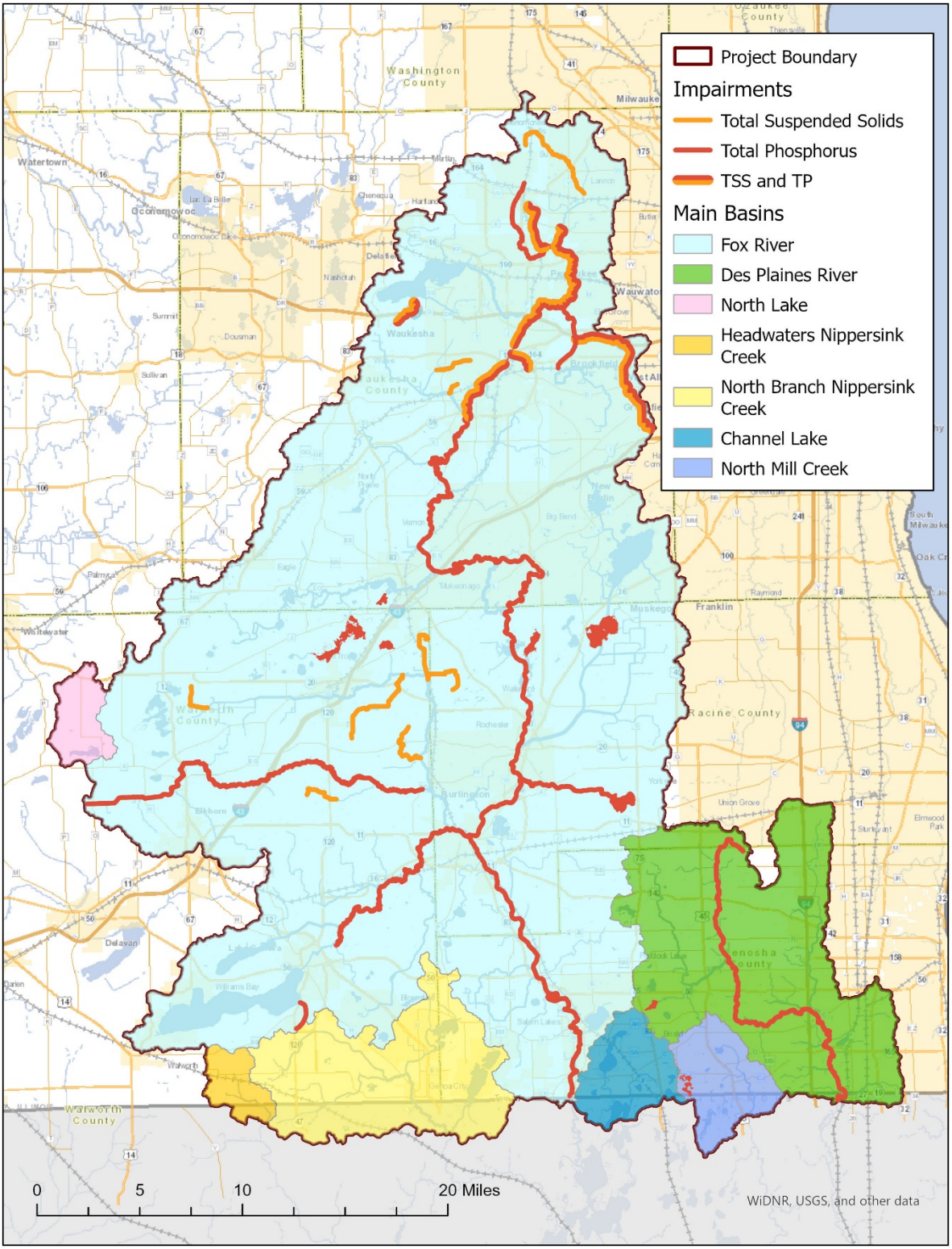
The Department of Natural Resources (DNR), together with many partners, is working to improve the surface water quality of tributaries, streams, rivers, and lakes within the Fox Illinois River Basin. To strengthen these ongoing efforts, the Department will be developing a Total Maximum Daily Load (TMDL) for the river basin. The TMDL for this study area, referred to as the Fox Illinois River TMDL, will be a multi-year effort to address surface water quality impairments caused by phosphorus and total suspended solids. The TMDL study will provide a strategic framework and pollutant reduction goals for surface water quality improvement within the river basins.

The first step in developing a TMDL is collecting monitoring data to characterize existing conditions in the watershed and to support modeling efforts. The monitoring efforts for this project included chemistry, stage, and flow data collection for many sites in the TMDL basin. Monitoring was directed by the DNR and was supported by an outside contractor.

The Fox Illinois River TMDL study area is located in southeastern Wisconsin. The study area includes the Fox River, the Des Plaines River, Nippersink Creek, North Mill Creek, and Channel Lake watersheds. The study area is primarily located in Racine, Kenosha, Walworth, and Waukesha counties. It is approximately bounded by Waukesha to the north, Lake Geneva to the southwest, and the western portions of Kenosha to the southeast. The TMDL study area covers approximately 1,060 square miles within Wisconsin, which is approximately 2 percent of the state. Within the study area, some lakes and streams are impaired (WDNR, 2022b), which means they are not meeting their water quality criteria. The extent of the TMDL and the waterbodies that are currently impaired are shown in Figure 1.1.

FIGURE 1.1

The Fox Illinois TMDL Study Area and Impairments



2. TMDL MONITORING METHODS

Prior to this project, existing flow and chemistry data were available within the study area. However, there was not sufficient data to develop a model to estimate flows and loads throughout the watersheds. To supplement existing data, a large-scale monitoring program was conducted. The monitoring program lasted from December 2019 through May 2022. Water chemistry, water level, and flow data was collected. The following sections describe the methods used for the monitoring program.

2.1. Chemistry Sampling

Thirteen locations in the study area that required chemistry monitoring were identified. Monitoring was conducted by both the DNR and a private consultant, Cadmus. The DNR was responsible for five sites, and Cadmus was responsible for eight sites. Chemistry samples for total phosphorus, orthophosphate, and total suspended solids were collected. Two of DNR's sites, the Fox River at Cth I Bridge and the Fox River near New Munster, were already being monitored as part of the long-term trends program, and these sites were incorporated into the sampling efforts. A list of the monitoring stations is provided in Table 2.1, and the location of the stations is displayed in Figure 2.1. A monitoring report that summarizes Cadmus' efforts was developed by Cadmus and is provided in Appendix A.

Samples were analyzed by the Wisconsin State Lab of Hygiene, which is a certified lab affiliated with the University of Wisconsin at Madison. The State Lab of Hygiene uses approved methods for their analyses. A summary of their methods is provided in Table 2.2.

TABLE 2.1
Fox Illinois River TMDL Chemistry Monitoring Sites

SWIMS ID	SWIMS Station Name	Monitoring Entity	Chemistry Parameters
683205	Fox River - Ds Sunset Dr Bridge (Waukesha)	DNR	TP, TSS
683096	Fox River at Cth I Bridge	DNR	TP, TSS, TN, DOP, NO3, NH4
10046937	Fox River at CTH ES	Cadmus	TP, TSS, DOP
303066	Fox River (Il) - Nr New Munster Cthjb	DNR	TP, TSS, TN, DOP, NO3, NH4
10032437	Fox River at STH 20/30 Waterford	Cadmus	TP, TSS, DOP
10053867	Fox River at Case Eagle Park Bridge[1]	Cadmus	TP, TSS, DOP
10010534	Mukwonago River (1) - Upstream of HWY 83	Cadmus	TP, TSS, DOP
643555	Muskego (Big Muskego) Lake - Outlet Near Wind Lake	DNR	TP, TSS
10013090	Wind Lake Canal_Wind Lake Upstream To Ceasars Dam	DNR	TP, TSS
10040134	Honey Creek at CTH DD/Academy Rd	Cadmus	TP, TSS, DOP
10029083	Sugar Creek at Potter Road	Cadmus	TP, TSS, DOP
10012203	White River - 10 M Upstream Of Hwy 36	Cadmus	TP, TSS, DOP
303054	Des Plaines River at Cth ML	Cadmus	TP, TSS, DOP

1. The Fox River at Case Eagle Park replaced an original monitoring site at Fox River above Rochester Dam at Highway D (10021230) due to unsatisfactory conditions at the original site.

Parameters: DOP = Dissolved orthophosphate, NH4 = Ammonium, NH3 = Nitrate, TN = Total Nitrogen, TP = Total Phosphorus, TSS = Total Suspended Solids

FIGURE 2.1

Fox Illinois River TMDL Chemistry Monitoring Locations

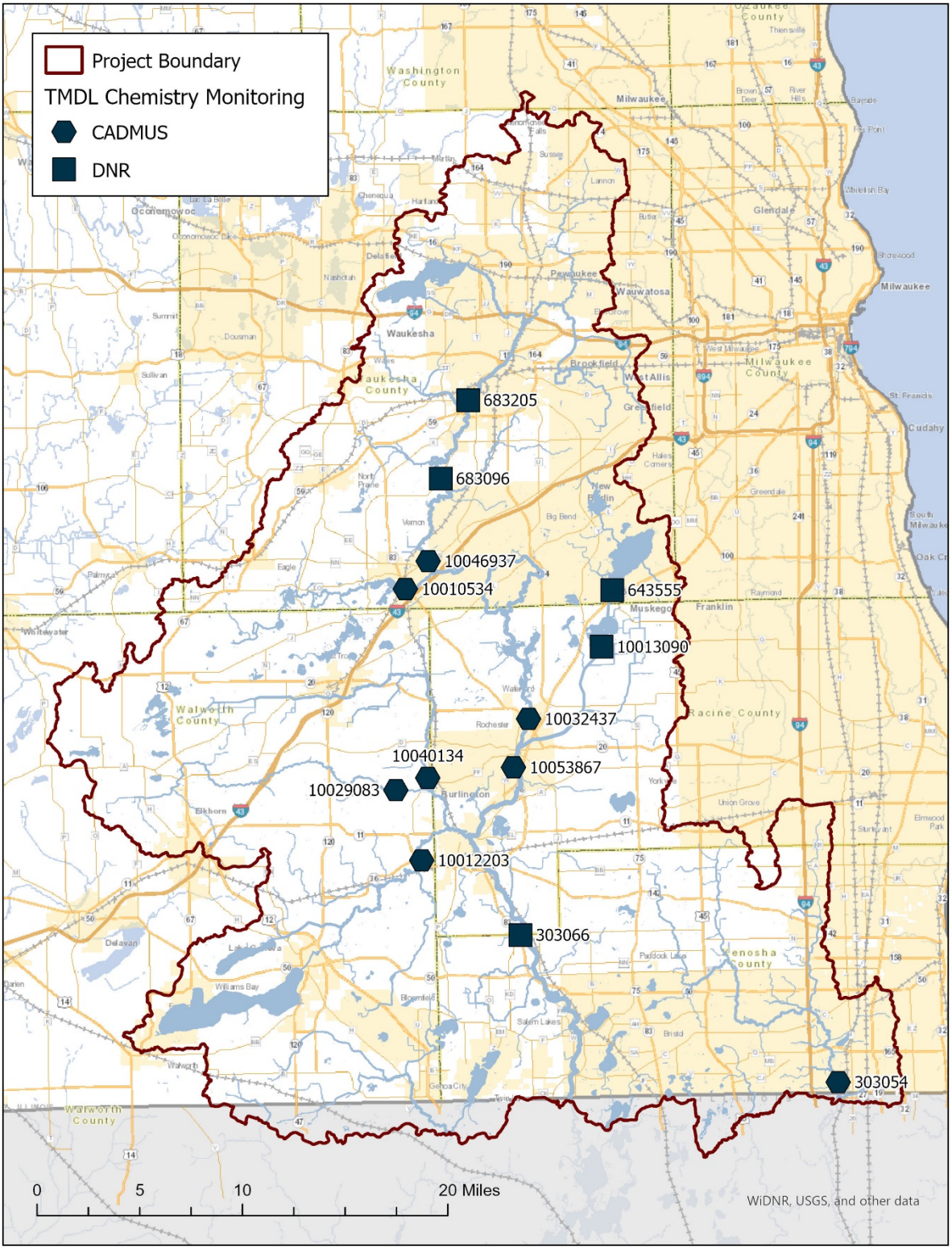


TABLE 2.2
Laboratory Methods for Sample Analysis

Parameter	Parameter Code	Method	Units	LOD	LOQ
Total Suspended Solids	530	SM2540D	MG/L	2.5	2.5
Phosphate Ortho DISS	671	EPA 365.1	MG/L	0.00400	0.0130
Phosphorus Total	665	EPA 365.1	MG/L	0.00900	0.0300

2.2. Stage and Flow Monitoring

In addition to chemistry monitoring, stage and flow monitoring was required. The DNR monitored both flow and stage data at five sites and monitored only flow data at four sites. The sites with only flow measurements were located near gages maintained by the United States Geological Survey (USGS) that had available stage data. A summary of the stage and flow monitoring sites is provided in Table 2.3, and the location of each site is provided in Figure 2.2.

TABLE 2.3
Fox Illinois Rivers TMDL Stage and Flow Monitoring Sites

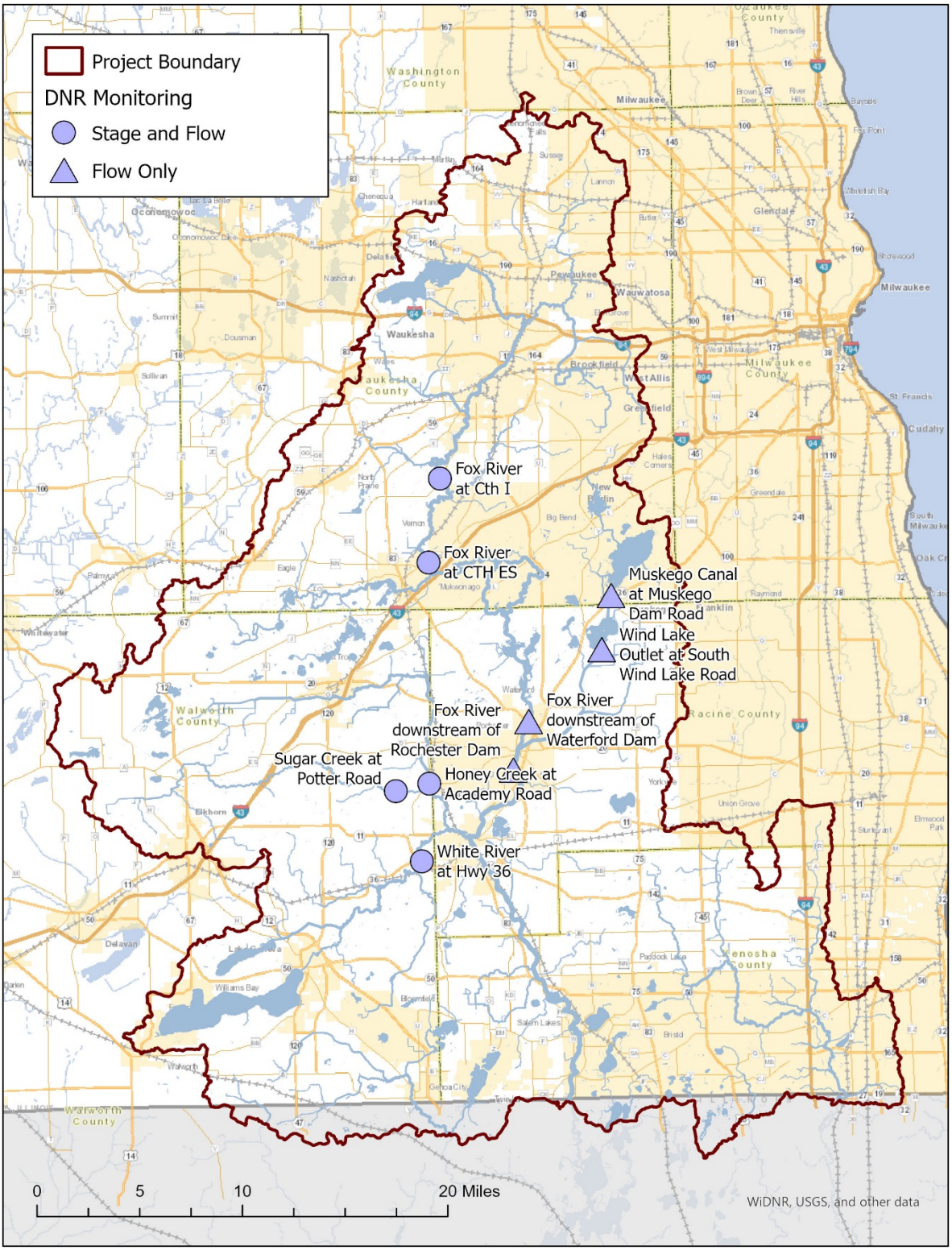
Stage and Flow Measurement Location	Stage data	Flow Data
Fox River at Cth I	DNR	DNR
Fox River at CTH ES	DNR	DNR
Honey Creek at Academy Road	DNR	DNR
Sugar Creek at Potter Road	DNR	DNR
White River at Hwy 36	DNR	DNR
Fox River downstream of Waterford Dam	USGS	DNR
Fox River downstream of Rochester Dam	USGS	DNR
Muskego Canal at Muskego Dam Road	USGS	DNR
Wind Lake Outlet at South Wind Lake Road	USGS	DNR

Continuous stage data were measured using HOBO pressure transducers. The pressure transducers were installed in the water, and the elevation of the transducers were surveyed relative to a specified benchmark to establish a water surface elevation. Sites were periodically visited so staff could download data and resurvey the pressure transducer elevation to evaluate any movement of the transducer. The pressure transducers measured water temperature and total pressure at 15-minute intervals. The data were corrected for atmospheric pressure to calculate total water depth above the transducer.

Flow monitoring data were collected using a Teledyne Acoustic Doppler Current Profiler (ADCP). The ADCPs were deployed from a boat traveling perpendicular to the current and measured cross-section geometry and flow velocities to calculate a total flow rate. Multiple passes across the river were completed until an adequate flow measurement was established. Flow measurements were collected on a monthly basis with a goal of measuring the river or stream at low, average, and high flow rates.

FIGURE 2.2

Fox Illinois River TMDL Stage and Flow Monitoring Locations



3. TMDL MONITORING RESULTS

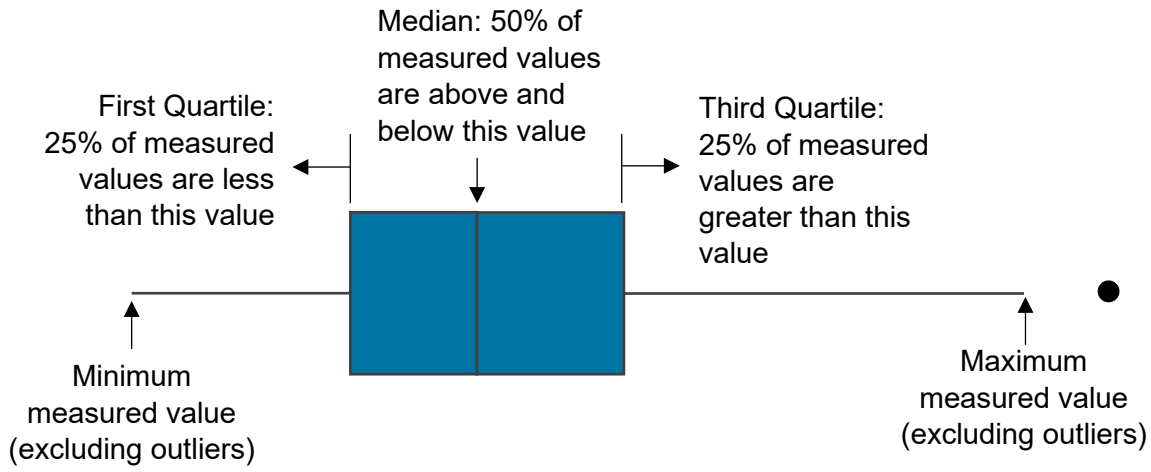
The monitoring strategy described in the previous section resulted in a large dataset that will be used to develop a model to estimate the loadings and concentrations in surface waters in the study area. The dataset includes both chemistry data and stage and flow data. The following sections summarize the results of the monitoring.

3.1. Surface Water Chemistry

Surface water chemistry is commonly evaluated for different time periods. First, data over the course of the entire year can be combined and compared to estimate average annual water quality. Additionally, data can be summarized using only data from the growing season, which spans from May 1 to October 31 for flowing waters. Both methods provide insights about the sources and dynamics of nutrients and sediment in surface water.

The distribution of measured samples is visualized using boxplots, which are explained in Figure 3.1. Results from the water quality monitoring for the TMDL are provided in Figure 3.2 for total phosphorus, Figure 3.3 for orthophosphate, and Figure 3.4 for total suspended solids. The figures display the distribution of results for both samples collected for all months of the year and samples collected during the growing season. Additional information about the water chemistry sampling is provided in Appendix B.

FIGURE 3.1
Explanation of Boxplots



Note: Points indicate outliers, which are measured values that area abnormal distance from other values

FIGURE 3.2

Total Phosphorus Concentrations at TMDL Monitoring Sites

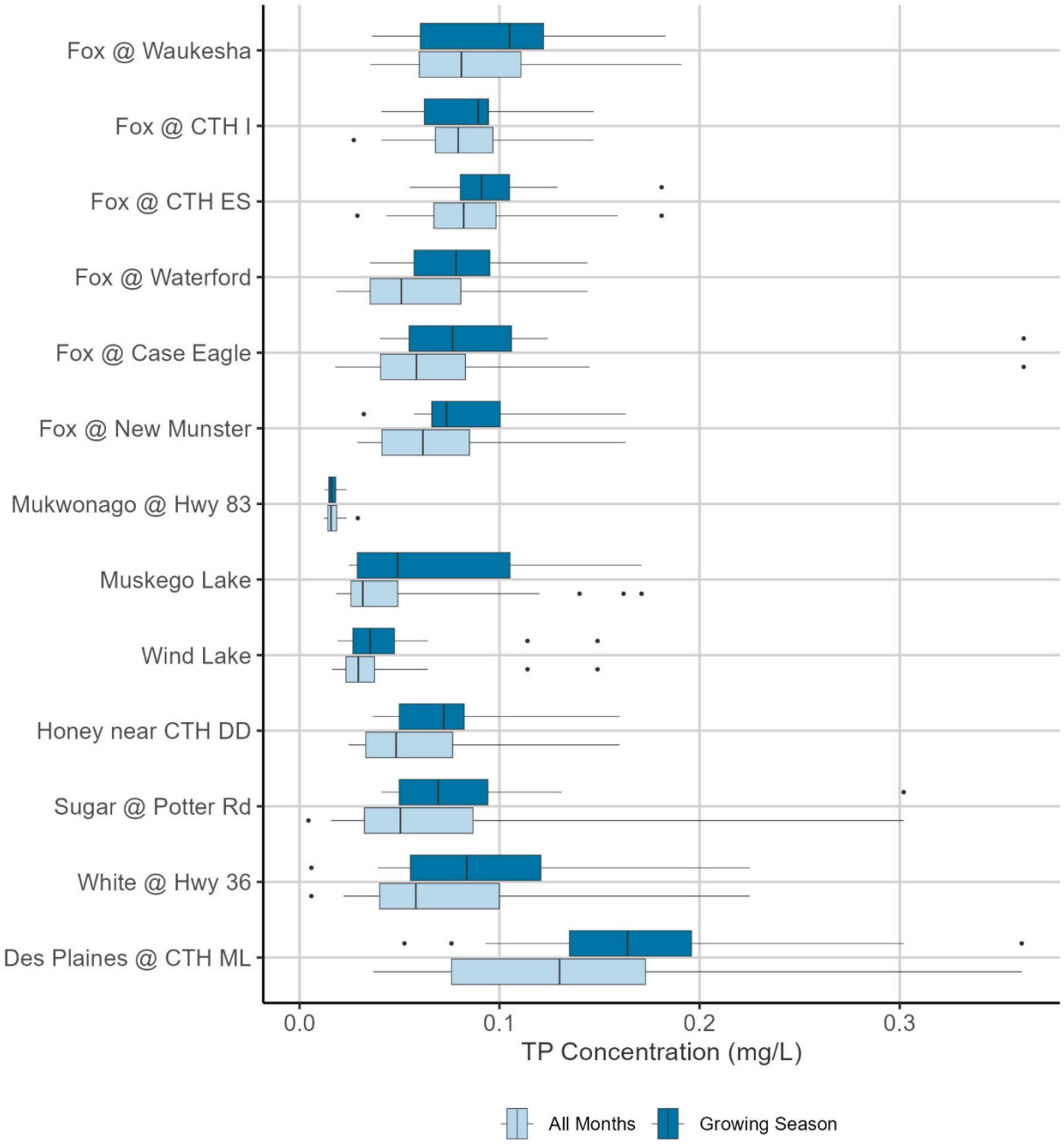


FIGURE 3.3

Orthophosphate Concentrations at TMDL Monitoring Sites

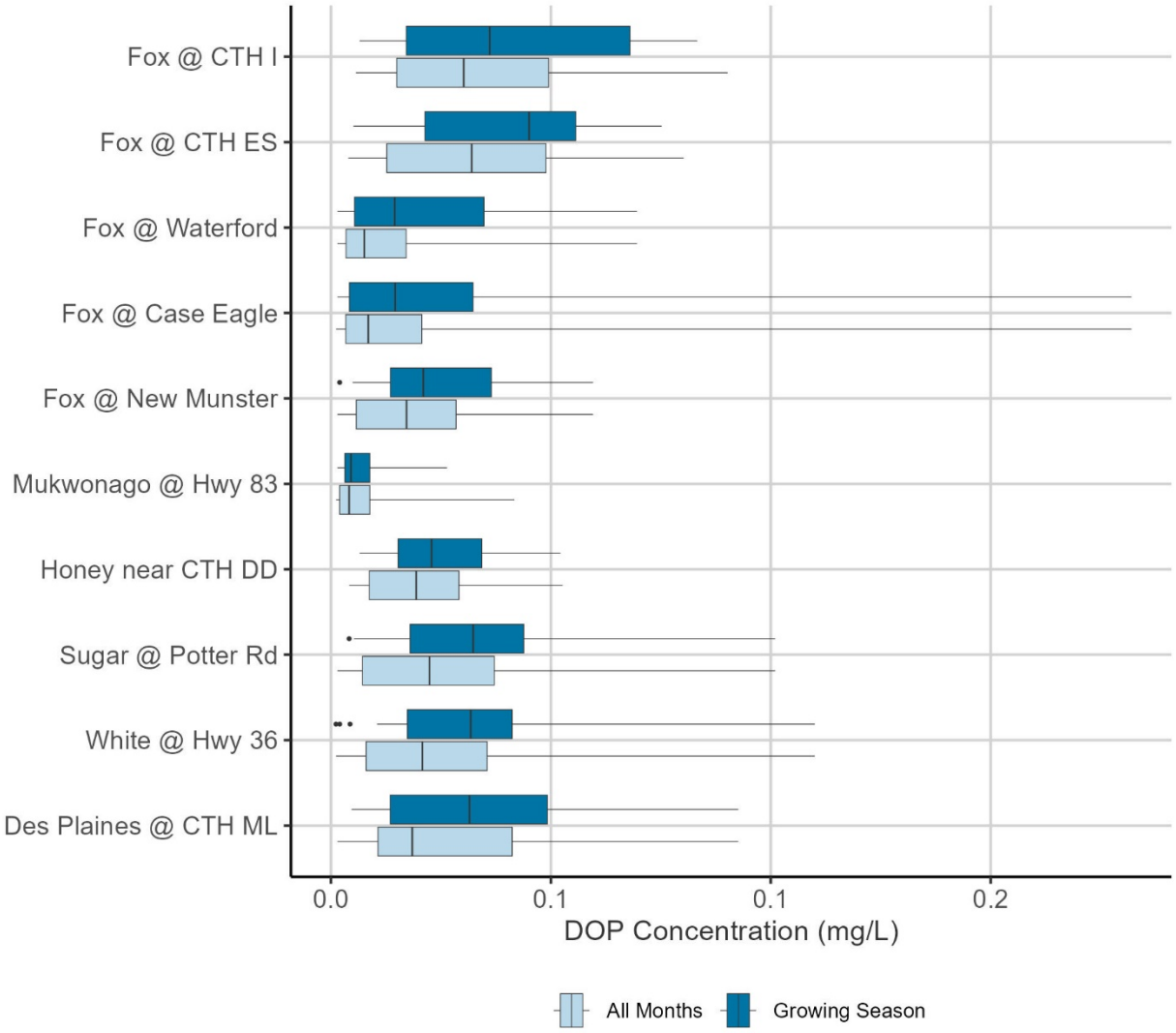
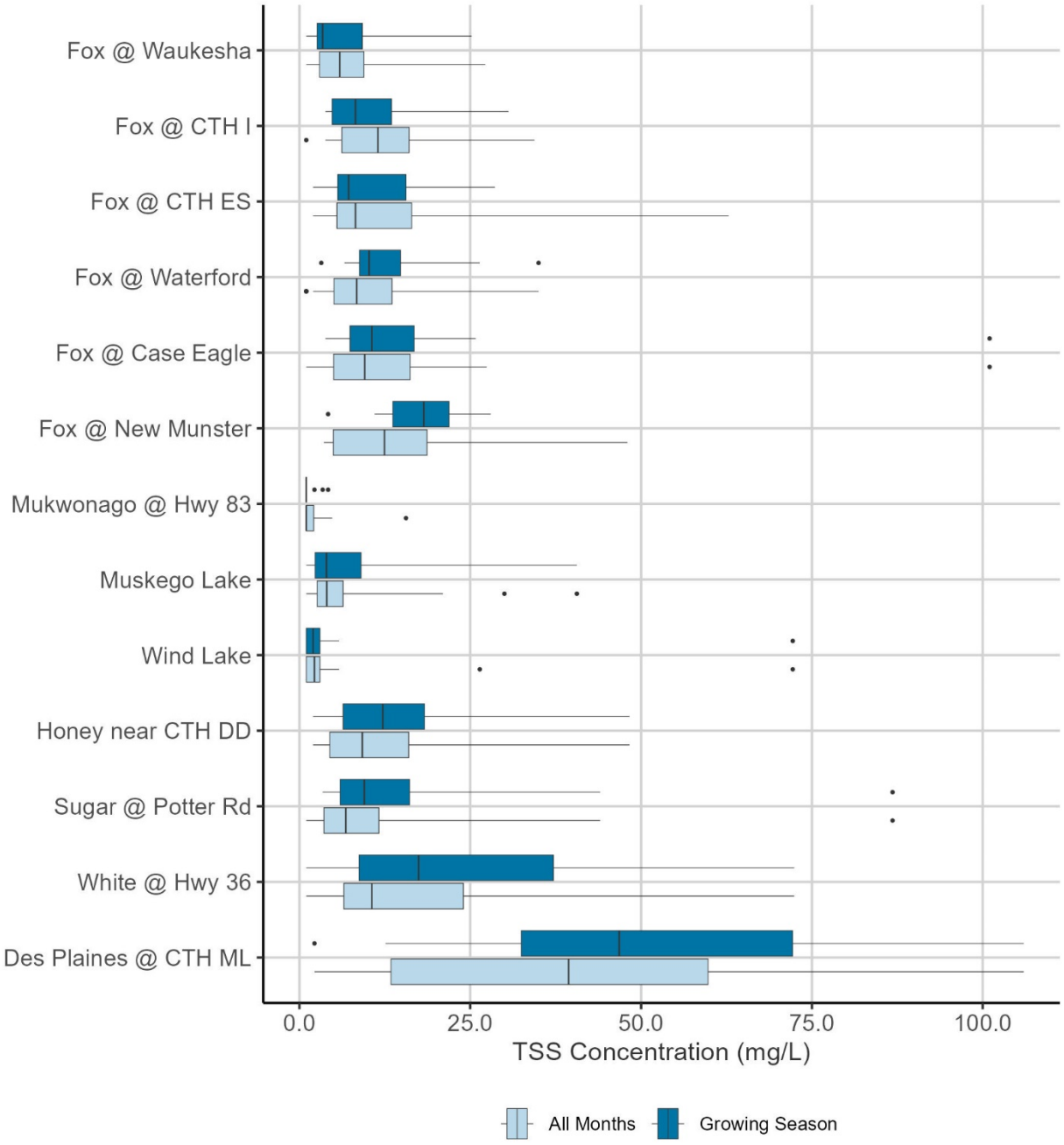


FIGURE 3.4

Total Suspended Solids Concentrations at TMDL Monitoring Sites



3.2. Stage and Flows

Stage and flow data were measured at the sites identified in Section 2. The following sections summarize the results of the stage and flow measurements.

3.2.1. Stage

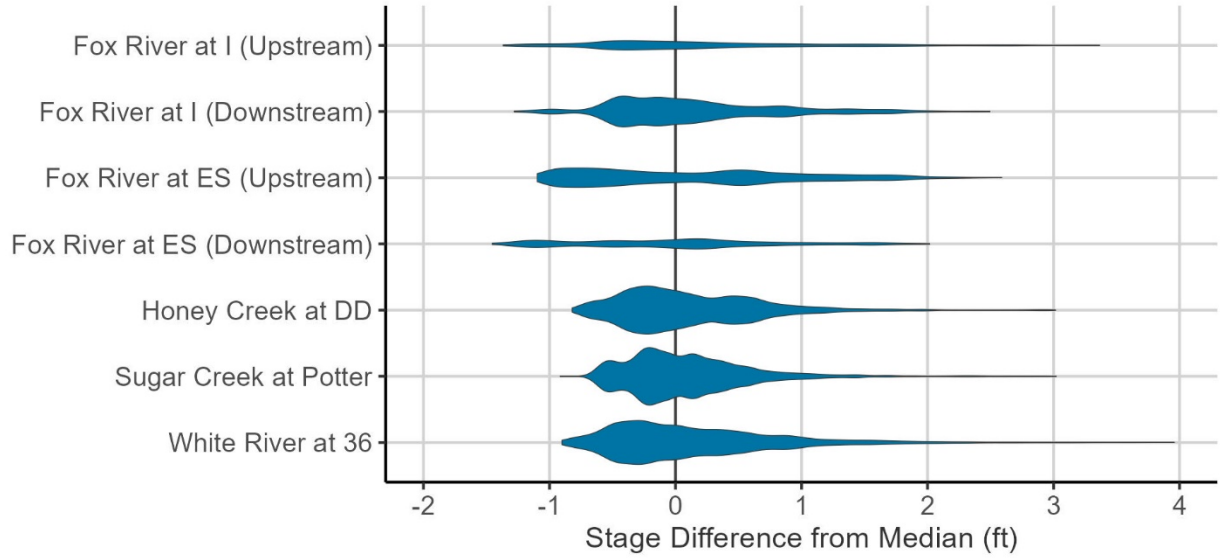
Stage data were calculated using the measurements from the pressure transducers described in Section 2. The pressure transducers were deployed near the sites listed in Table 2.3. Pressure transducers for the Fox River at Highway I and the Fox River at ES were relocated during the monitoring period due to site conditions. A summary of stage data and data notes for the pressure transducers over the monitoring period are provided in Appendix C.

Calculating the depth of water above the pressure transducer and a corresponding stage requires adjusting the pressure measurements from the pressure transducers. The adjustment requires data about atmospheric pressure, air temperature, and water temperature. Stage represents the height of water above the water surface relative to a specified benchmark. A detailed summary of the process of converting measurements from the pressure transducers to depth and stage data is provided in Appendix C.

The range of stages measured at each site is provided in Figure 3.5. The figure shows the distribution of measurements relative to the median measured stage during the monitoring period. The thickness of the blue areas in the figure represents the frequency of measurements at that specific stage. Thicker areas in the figure indicate many measurements at that stage, and thinner areas indicate few measurements at that stage. The total width of the measurements represents the total range in depth differences measured. For example, the depth of Honey Creek varied by about 3.5 feet during the monitoring period, and the depth of the White River varied by about 5 feet during the monitoring period.

FIGURE 3.5

Distribution of Stage Measurements during Monitoring Period



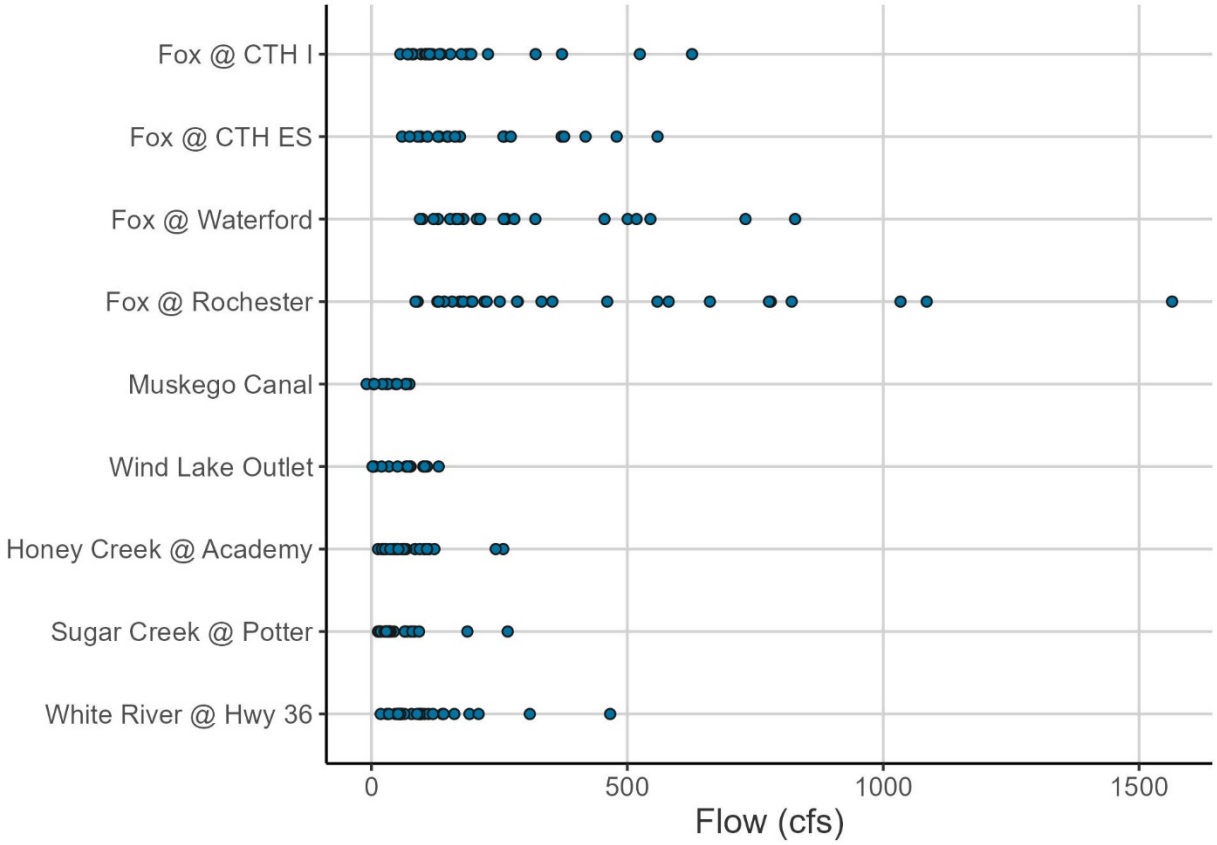
3.2.2. Flows

Flow data were collected between December 2019 and May 2022. The monitoring strategy aimed to obtain monthly flow measurements at each of the 9 stations across the 30 month monitoring period. Additional measurements were collected in September 2020 and April 2022. Throughout the monitoring period, some measurements were not collected. The challenges leading to data not being collected are summarized in Appendix D.

A summary of flow measurements collected during the monitoring period is provided in Figure 3.6. Each of the points on the graph represent a single flow measurement. Additional details about the flow measurements are provided in Appendix D.

FIGURE 3.6

Flow Measurements Collected during the Monitoring Period



4. SUPPLEMENTAL DATA

The data collected for the project were required to ensure proper development and calibration of a watershed model. However, additional water chemistry and flow data are available in the basin. This supplemental data may also be incorporated into model development, and the available data are described in the following sections.

4.1. WDNR LTT Sites

The DNR maintains long-term trends (LTT) sites for major water bodies throughout the state. Water chemistry data are collected at these sites on a regular basis to track water quality changes over time. Two LTT sites are located within the study area: one at the Fox River below Waukesha and one at the Fox River near New Munster. Parameters at these sites include total phosphorus, orthophosphate, and total suspended solids. The DNR maintains an online viewer to visualize the changes in water quality over time (WDNR, 2022a). A summary of seasonal concentration estimates provided in the viewer are displayed in Table 4.1. Detailed outputs from the viewer are provided in Appendix E.

TABLE 4.1
Seasonal Concentrations at Fox River Long-Term Trends Sites

			Seasonal Estimate of River Concentration (mg/L) at Mean Flow (2020)			
Location	Location	Trend since 2012	Winter	Spring	Summer	Fall
Total Phosphorus	Waukesha	Decreasing	0.071	0.095	0.12	0.088
	New Munster	Decreasing	0.035	0.071	0.11	0.057
Orthophosphate	Waukesha	Decreasing	0.030	0.018	0.058	0.049
	New Munster	No Trend	0.008	0.018	0.047	0.020
Total Suspended Solids	Waukesha	No Trend	10.8	24.7	16.6	10.7
	New Munster	Decreasing	4.23	12.6	27.8	11

4.2. Additional Water Chemistry Data

The Department of Natural Resources and other entities – such as USGS, citizen monitors, sewer utilities, and watershed groups – have collected data in the Fox Illinois TMDL project area that are separate from the targeted monitoring that was conducted for the TMDL project. Additional water chemistry data were downloaded from the DNR's Surface Water Integrated Monitoring System, which is also known as SWIMS (WDNR, 2023a). SWIMS consolidates water quality data collected by a number of partners and entities performing water quality monitoring in Wisconsin. These data will be used to supplement the data described in Sections 2 and 3.

Data from SWIMS for stations within the project area were downloaded for samples collected between 2011 through 2022. The timeframe was chosen because it corresponds with the time period that will be modeled with the watershed model. These data were further filtered to only include data from lake stations with two or more years with four or more samples and river stations with 12 or more samples. The thresholds for the number of samples were chosen because they correspond to the data requirements for classifying total phosphorus impairments (WDNR, 2023b)

and river load estimation (Runkel and others, 2004). The supplemental data may be used during the calibration and validation of the watershed model.

Locations of the SWIMS monitoring sites are shown in Figure 4.1. Data are available for both lakes and rivers. Total phosphorus measurements for rivers and lakes are summarized in Figures 4.2 and 4.3. Orthophosphate measurements for rivers and lakes are summarized in Figures 4.4 and 4.5. Total suspended solids measurements for rivers are summarized in Figure 4.6. The summaries present results for samples collected during all months and samples collected during the growing season. The growing season is defined as May 1st through October 31st for rivers and June 15th through September 15th for lakes. Additional information about the water quality data available for the study area is provided in Appendix F.

FIGURE 4.1

Additional Monitoring Stations in the Fox Illinois River Study Area

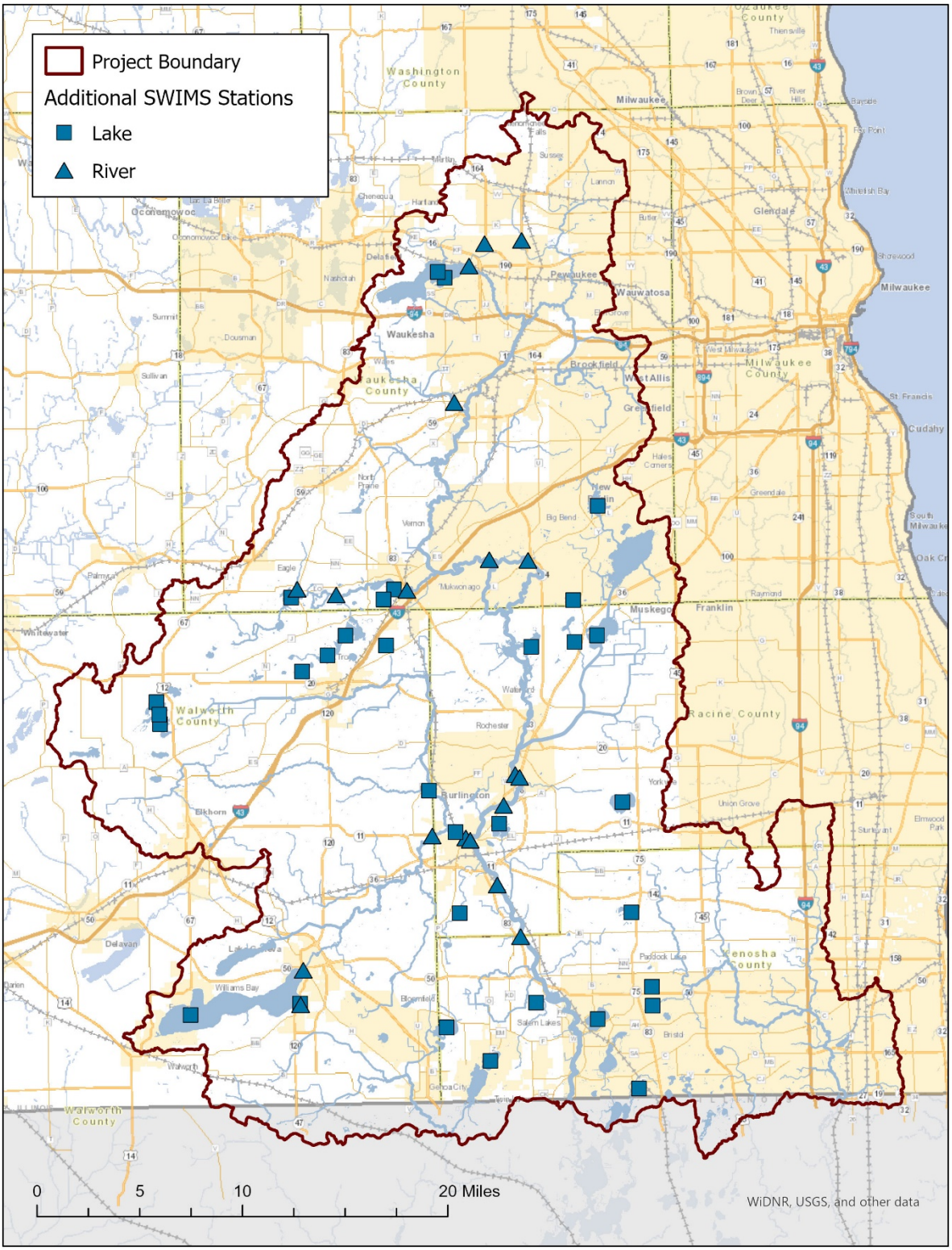


FIGURE 4.2

Total Phosphorus Concentrations at River Monitoring Sites

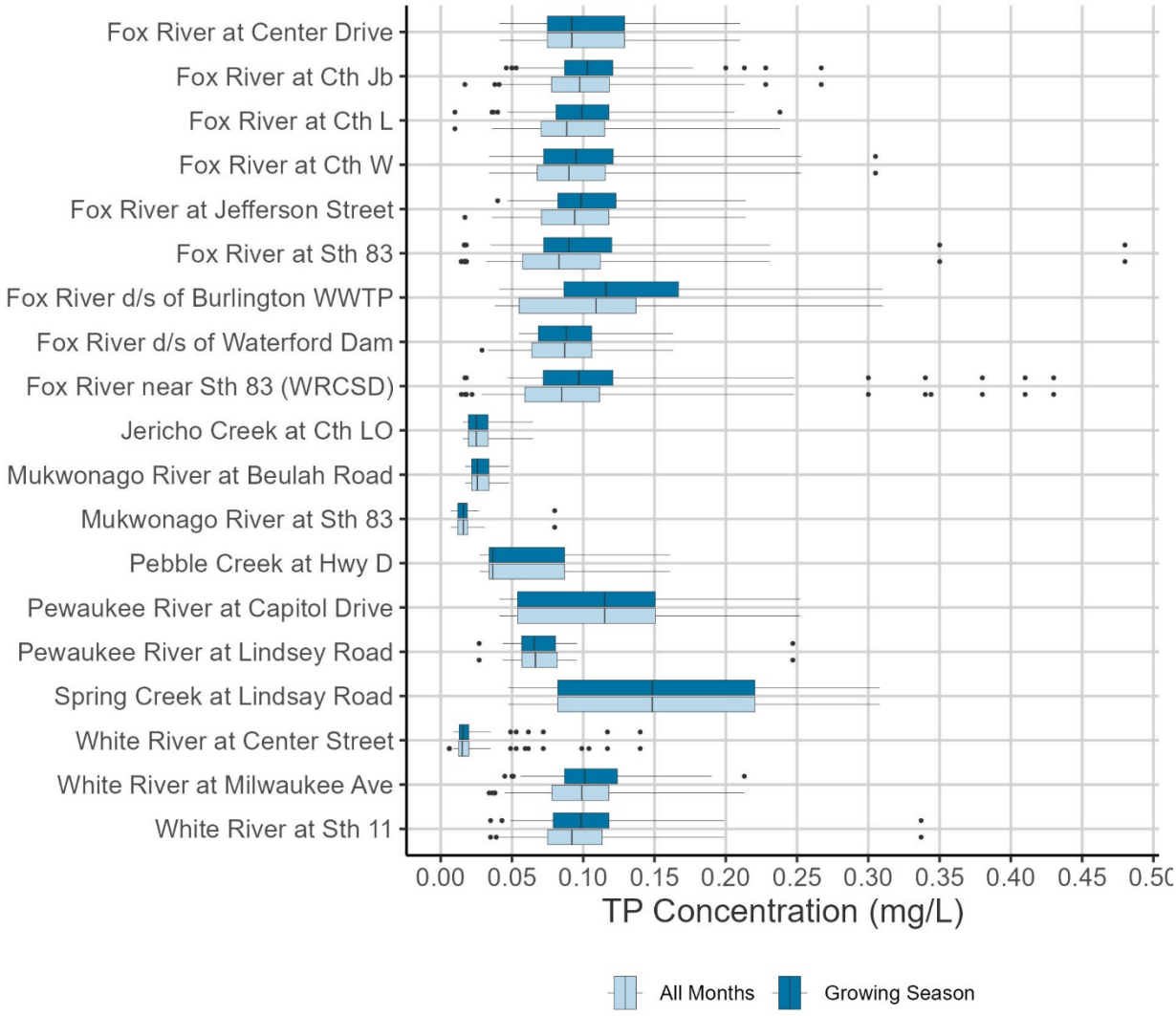


FIGURE 4.3

Total Phosphorus Concentrations at Lake Monitoring Sites

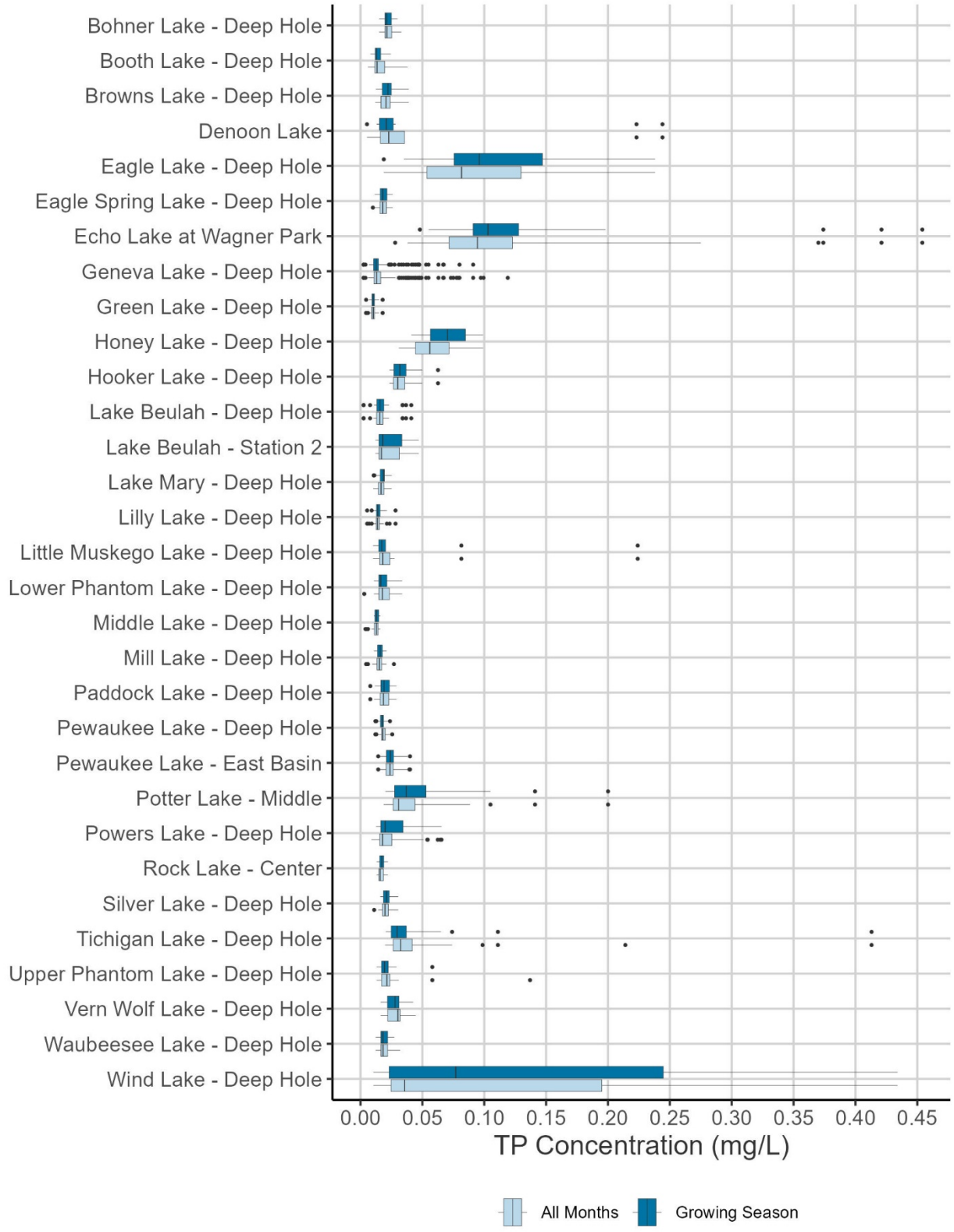


FIGURE 4.4

Orthophosphate Concentrations at River Monitoring Sites

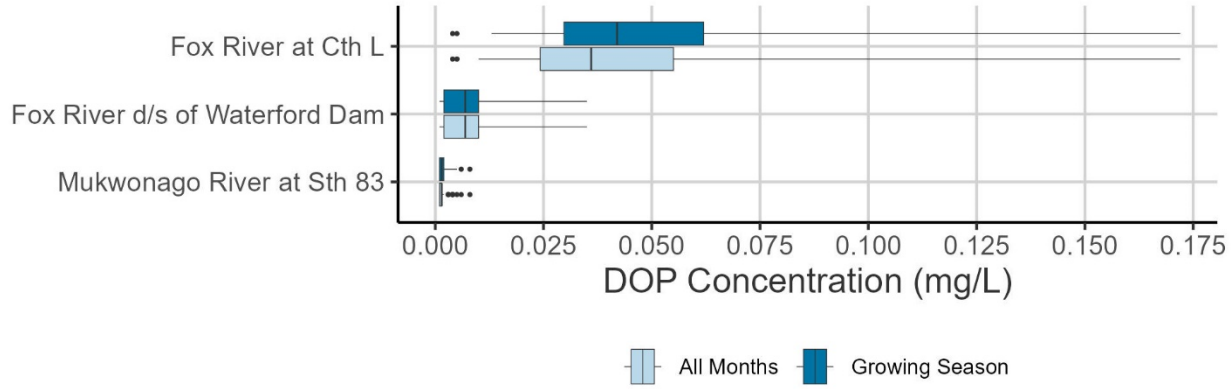


FIGURE 4.5

Orthophosphate Concentrations at Lake Monitoring Sites

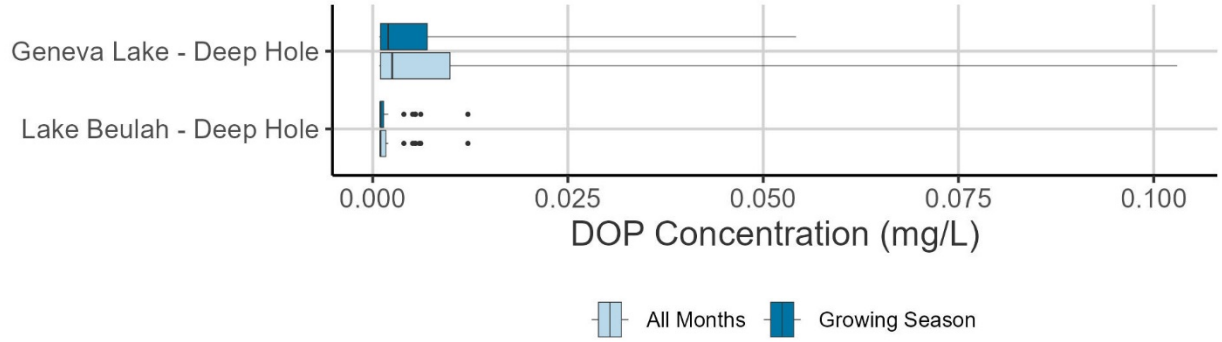
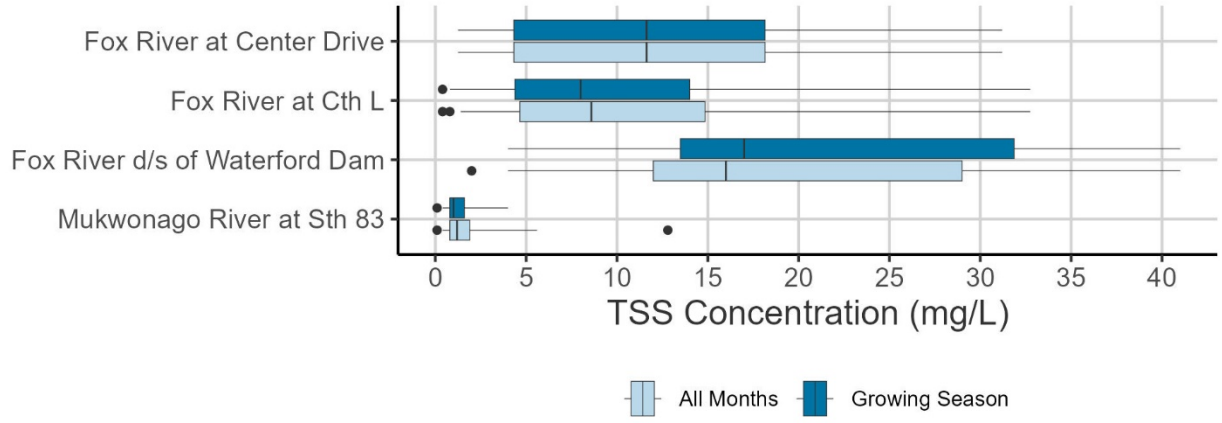


FIGURE 4.6

Total Suspended Solids Concentrations at River Monitoring Sites



4.3. USGS Gages

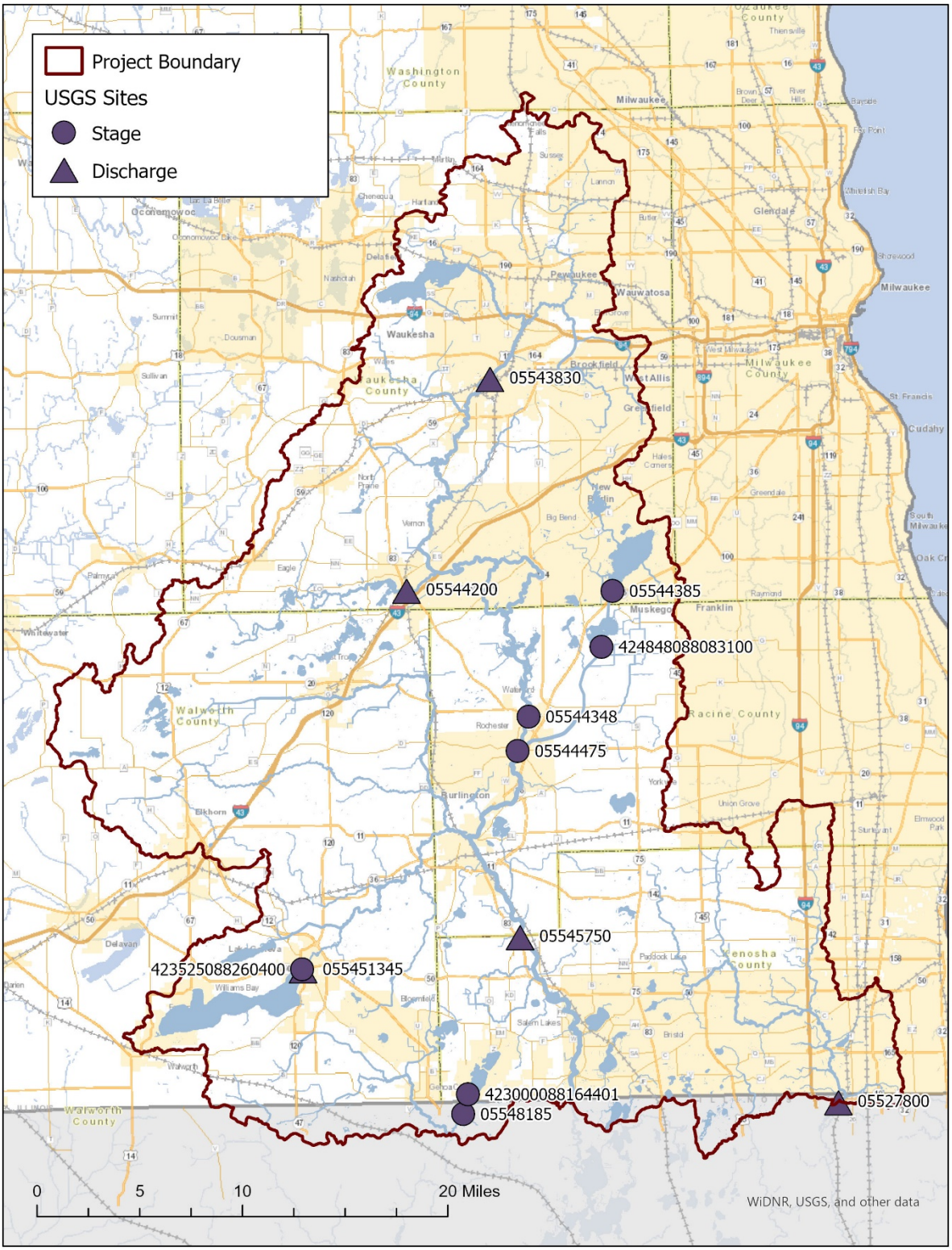
The United States Geological Survey (USGS) maintains a number of gages in the study area (USGS, 2023). Data from the gages are reported as stage, flow, or stage and flow. Gages with stage data provide continuous measurements of the depth of water above a pre-specified point. Gages with flow data provide continuous measurements of flow based on the stage and a calculated rating curve that relates stage to flow. Twelve USGS gages in the study area are active and report data that are useful for assessing the watersheds. The USGS gages evaluated are listed in Table 4.2, and the location of the gages is provided in Figure 4.7.

TABLE 4.2
USGS Stations in the Fox Illinois River TMDL Study Area

Station ID	Station Name	Type
5527800	Des Plaines River at Russell, IL	Flow
5543830	Fox River at Waukesha, WI	Flow
5545750	Fox River near New Munster, WI	Flow
5544200	Mukwonago River at Mukwonago, WI	Flow
55451345	White River at Center Street at Lake Geneva, WI	Flow
423000088164401	Elizabeth Lake at Twin Lakes, WI-IL	Stage
5548185	Elizabeth Lake Drain near Twin Lakes, WI-IL	Stage
5544475	Fox River at Rochester, WI	Stage
5544348	Fox River at Waterford Dam, at Waterford, WI	Stage
423525088260400	Geneva Lake at Lake Geneva, WI	Stage
5544385	Muskego (Big Muskego) Lake Outlet Nr Wind Lake, WI	Stage
424848088083100	Wind Lake at Outlet at Wind Lake, WI	Stage

FIGURE 4.7

Location of USGS Gages in the Fox Illinois River Study Area



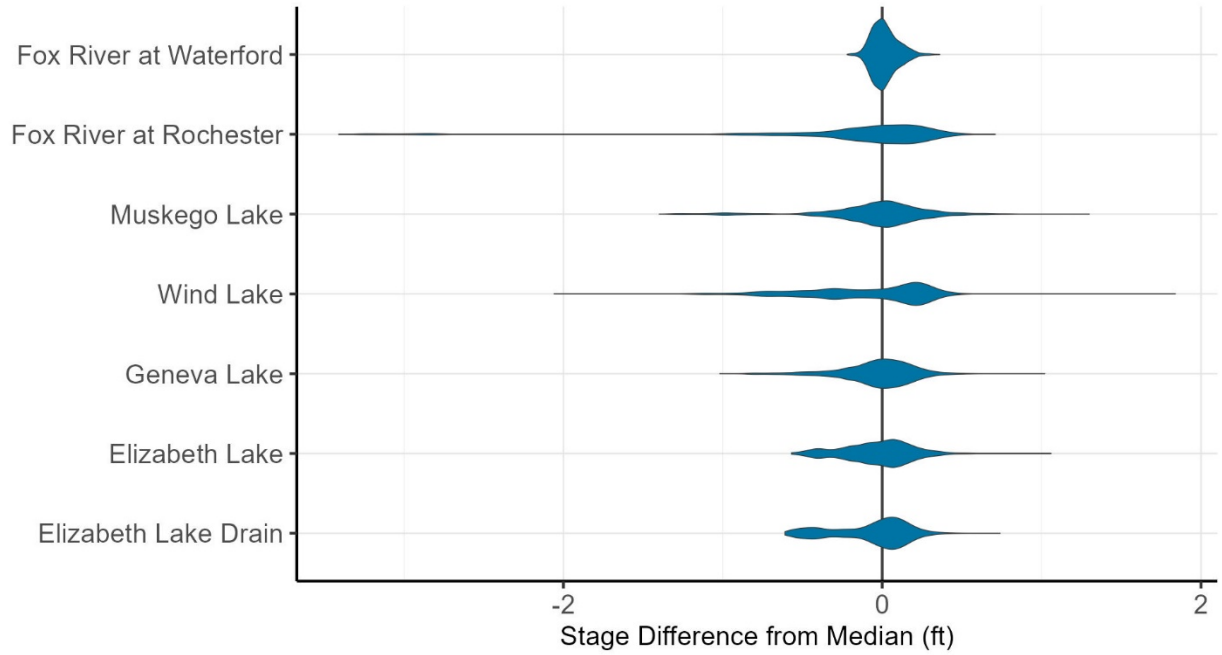
4.3.1. Stage

Seven active stage gages measure the stage at rivers and lakes in the study area. Gages are located in Elizabeth Lake, the Fox River, Geneva Lake, Muskego Lake, and Wind Lake. For the sites on flowing waterbodies that only have stage data, flow data are not estimated because USGS has not defined a rating curve at these sites.

The distribution of stages measured at each USGS site is provided in Figure 4.8. The figure shows the distribution of measurements relative to the median measured stage for the entire period of record. The thickness of the blue areas in the figure represents the frequency of measurements at that specific stage. Thicker areas in the figure indicate many measurements at that stage, and thinner areas indicate few measurements at that stage. The total width of the measurements represents the total range in depth differences measured.

FIGURE 4.8

Distribution of Stage Measurements at USGS Monitoring Sites



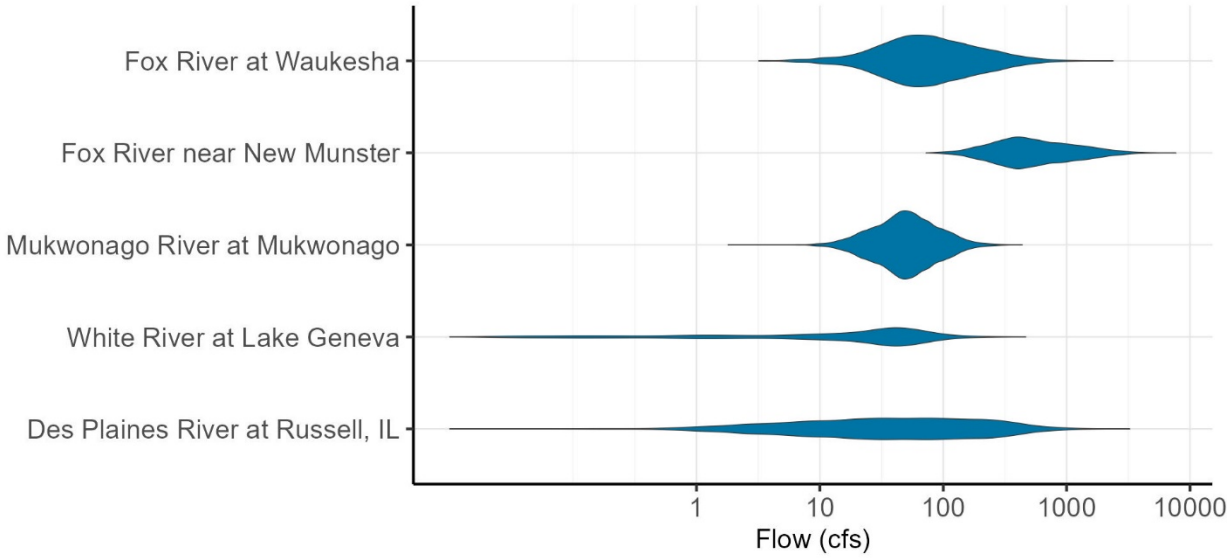
4.3.2. Flow

Five active flow gages measure the flow on rivers in the study area. The gages are located in the Fox River, the Mukwonago River, the White River, and the Des Plaines River. Flow data are estimated by applying a rating curve to measured stage data. The rating curve describes the relationship between stage and flow in a specific river. Rating curves for the five flow gages are provided in Appendix G.

The distribution of flow data for each site is displayed in Figure 4.9. The figure shows the distribution of flow rates over the period of record. The thickness of the blue areas in the figure represents the frequency of flows at that specific stage. Thicker areas in the figure indicate many measurements at that flows, and thinner areas indicate few measurements at that flow. The total width of the measurements represents the total range in flows for each site. Note that the figure is plotted on a logarithmic scale.

FIGURE 4.9

Distribution of Flow Rates at USGS Monitoring Sites



5. MONITORING DATA APPLICATIONS

The chemistry and flow data collected during the TMDL monitoring period and the supplemental data available from other sources are essential for the development and calibration of a watershed model. In order to use the data in watershed modeling, additional transformations and calculations are required. The transformations and calculations required include development of rating curves load estimates. The following sections summarize these steps.

5.1. Rating Curve Development

Continuous stage data are collected at a high frequency, but flow data are only collected periodically. A continuous record of estimated flow can be developed by combining observed stage data with observed flow data to create rating curves. A rating curve establishes a relationship between flow and stage over a range of flow conditions. After rating curves are developed, they are applied to the stage data to provide a continuous estimate of flow during the entire monitoring period.

5.2. Load Estimation

When a large dataset of chemistry data and flow data is available, estimates of continuous pollutant loads can be determined. The following steps outline the process for load estimation:

1. Identify the flow on the dates of all pollutant concentration measurements.
2. Calculate a relationship between flow and pollutant concentration.
3. Combine the flow/concentration relationship with the continuous flow dataset to estimate continuous pollutant concentrations.
4. Combine the estimates of continuous pollutant concentrations with the continuous flow data to estimate continuous pollutant loads.

5.3. Watershed Model Development and Calibration

Watershed models are tools that represent and simulate natural processes that occur on the landscape. The first step in the development of a watershed model is splitting a study area into smaller watersheds. Watersheds are delineated using information about topography, hydrography, point sources, land use, and monitoring locations. The delineated watersheds and data about point sources, land use, soils, agricultural practices, and weather are incorporated into the model.

Results from the model are compared to water quality data, continuous flow estimates, and continuous load estimates to evaluate how closely the model is matching observed conditions. Model parameters are adjusted to ensure the model will better represent observations. The process of adjusting model parameters to better match observed data is known as calibration and validation.

5.4. Next Steps for the FOXIL TMDL

The steps described in the previous sections will be completed for the Fox Illinois River TMDL basin study area. For the TMDL study, the watershed model will be developed using the Soil and Water Assessment Tool, or SWAT. Like other watershed models, SWAT uses information about watershed characteristics and weather to estimate nonpoint source loadings from background sources, agricultural sources, and urban stormwater sources (Neitsch and others, 2011).

First, the results from the SWAT model will be used to calculate existing loads from the watershed. Second, the model will be used to estimate a loading capacity, which is the maximum amount of a pollutant a waterbody can receive without exceeding water quality standards. Finally, the loading capacity will be compared to existing loads from the watershed and information about permitted point sources to determine reductions that must occur for waters to meet water quality criteria.

ACKNOWLEDGEMENTS

A special thank you to Rachel Sabre at the Wisconsin DNR, who coordinated the monitoring efforts. Additional DNR staff who assisted with the project include Mike Shupryt, Mike Sorge, Craig Helker, Arthur Watkinson, Michelle Soderling, Amanda Schmitz, Mica Kromrey, Sarah Fanning, Camille Bruhn, Kim Kuber, Holly Stagemann, Loretha Jack, Breanna Crane, Jim Amrhein, and Tim Asplund. Cadmus and EOR, with funding from USEPA, also contributed to the collection of monitoring data. Thank you to everyone who worked through challenging conditions to gather these important data.

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APPENDIX A

CADMUS REPORT ON WATER QUALITY MONITORING

Prepared by: The Cadmus Group and Emmons & Olivier Resources (EOR)

For the U.S. Environmental Protection Agency

USEPA Contract Number EP-C-17-044

Cadmus Task Order 0273

Wisconsin Fox River (Illinois) Monitoring Project

Monitoring of Total Phosphorus, Total Suspended Solids, and Dissolved Orthophosphates (2020-2022)

Document Revision History

Version Number	Version Date	Description and Reason for Change
0	7/6/2022	Initial Draft Version
1	8/2/2022	Final Version incorporating review comments from WI DNR and EPA

TABLE OF CONTENTS

THE FOLLOWING APPENDICES ARE NOT INCLUDED WITHIN THIS DOCUMENT DUE TO THEIR SIZE. THEY ARE STAND-ALONE FILES.

LIST OF FIGURES

None in main body of report. See Appendix A for site location maps and Appendix B for data plots.

LIST OF TABLES

LIST OF ACRONYMS

Abbreviation	Meaning
DI Water	Deionized Water
DOP	Dissolved Orthophosphate
LTT	Long-Term Trend
LOD	Limit of Detection
LOQ	Limit of Quantification
QAPP	Quality Assurance Project Plan
SOP	Standard Operating Procedures
TMDL	Total Maximum Daily Load
TP	Total Phosphorous
TSS	Total Suspended Solids
WDNR	Wisconsin Department of Natural Resources
WSLH	Wisconsin State Laboratory of Hygiene
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

1. PROJECT BACKGROUND

1.1. Overview

The Fox (Illinois) River has been identified as the next TMDL project for WDNR under the TMDL Vision process. This monitoring project collected water chemistry data for watershed model calibration. The monitoring approach supplemented ongoing monitoring at the two LTT sites and at the USGS gages in the basin. Parameters, including TP, DOP, and TSS, were to be collected at eight sites in or near the Fox River watershed two times a month for eight summer months and one time per month for four winter months (excluding the first month of the first project year), for a total of 40 sampling events. Project sampling began in February 2020 and the once-monthly samples were collected in February and March 2020. Sampling was suspended in early April 2020 due to the onset of the Covid-19 pandemic and was resumed under slightly modified protocols in late June 2020. Sampling continued uninterrupted from then until the final samples were collected in May 2022.

1.2. Roles

EOR was primarily responsible for writing the project QAPP, developing the sampling approach, sample collection and laboratory drop-off, sample result compilation, creating monthly status reports, authoring this project report, and providing all digital project data at project closure.

The Cadmus Group was responsible for contract management, tracking of overall project milestones and schedules and managing with EPA any major workplan modifications, providing review and QC of the monitoring program (including QAPP), contributing to monthly project calls, and reviewing final project documents.

The WDNR defined the sampling locations, maintained monitoring equipment and collected data at the eight sites, provided guidance for dealing with site issues, provided liaison with WisDOT for bridge closures, and contributed to monthly project calls. In addition, WDNR collected the project samples in December and January of both winters, in response to project schedule changes. Sample schedule and WDNR sample collection dates are discussed further in **Section 2**.

The USEPA was responsible for project oversight, QAPP review and approval, contract management tracking of overall project milestones and schedules and managing with CADMUS any major workplan modifications, contributing to the monthly project calls, and final deliverable approval.

2. SAMPLING AND MONITORING EFFORTS

2.1. Sampling Program

The sampling program, including site locations, protocols, and QA/QC, adhered to the QAPP developed at the project onset. Key elements of the program are described below.

2.1.1. Locations

The project sampling locations are shown in **Appendix A** and listed in **Table 1**. Seven of the sites were in the Fox River watershed and one site (Des Plaines River) was in the Des Plaines River watershed. Site 1 was moved from its original location (ID 10021230) due to WDNR concerns about unmixed river conditions caused by a lateral canal inflow upstream of the bridge. Only the first two sample events were conducted at the original location; the remaining samples were taken at Station ID 10053867.

Table 1. Sample Locations.

Site	Station ID	Description	Water Body Name	Latitude	Longitude	Sample Location
1	10021230	Fox River Above Rochester Dam	Fox River	42.7414	-88.2245	Bridge Crossing
1	10053867	Fox River at Case Eagle Park	Fox River	42.7291	-88.2290	Bridge Crossing
2	10032437	Fox River at STH 20/30 Waterford	Fox River	42.7631	-88.2134	Bridge Crossing
3	10010534	Mukwonago River - Upstream of Hwy 83	Mukwonago River	42.8568	-88.3277	Bridge Crossing
4	10046937	Fox River at CTH ES	Fox River	42.8757	-88.3065	Bridge Crossing
5	10040134	Honey Creek 1400ft N of CTH DD/Academy Rd	Honey Creek	42.7195	-88.3094	Bridge Crossing
6	10029083	Sugar Creek at Potter Road	Sugar Creek	42.7147	-88.3418	Bridge Crossing
7	10012203	White River – 10 M Upstream of Hwy 36	White River	42.6649	-88.3184	Bridge Crossing
8	303054	Des Plaines River at 122nd St. (CTH ML)	Des Plaines River	42.5021	-87.9256	Bridge Crossing

2.1.2. Sample Collection and Lab Delivery

Field Staff

The original field sampling plan was developed by EOR's Ben Nelson, Environmental Scientist, and Nick Hayden, P.E., Water Resources Engineer. Nick Hayden was responsible for leading the field sampling program for the duration of the project. His responsibilities including conducting the initial rounds of sampling to identify challenges or modify protocols, reviewing all field paperwork, receiving and logging lab results, writing monthly status reports, and authoring this report. Other field staff involved in field prep and sample collection were:

- Nick Jaeckels, Water Resources Engineer
- Sean Barry, Engineering Technician
- Kim Walsh, Water Resources Engineer and Environmental Scientist
- Ethan Hau, Environmental Scientist

Nick Hayden directly trained new project staff by accompanying them on their first sample collection. Field sampling was conducted by two staff members, for both safety reasons and quality assurance.

The WDNR agreed to collect the single December and January sample in both project winters (four total). All WDNR samples were collected by Rachel Sabre, Senior Water Resources Management Specialist, who was also responsible for coordinating WDNR site data collection including flow and depth monitoring. Prior to each round of winter sampling, Nick Hayden and Rachel Sabre conducted a phone meeting to discuss any site-specific procedures or challenges for the WDNR winter samples to ensure continuity.

Field Procedures

All sites except the Fox River at CTH ES (ID 10046937) were collected from the bridge deck using a Van Dorn sampler. At the CTH ES site, the procedures were modified to collect from the downstream right bank with a 15' extendable dip sampler due to unsafe bridge conditions (narrow shoulder, busy, poor sight lines) and because the bridge was under construction for several months in 2020.

That difference aside, the following procedure was followed at each site:

- One staff member was the "Sampler", and the other was the "Recorder"
- Both staff were responsible for maintaining a safe working site, including wearing safety vests, using a car-mounted flasher, setting out traffic cones, and setting up a "Men Working" sign
- The Sampler was responsible for:
    - Rinsing the chosen sampler with DI water and then with ambient river water three times
    - Collecting a mid-depth water column sample from the proper location or filling the sampler with DI water (blank)
    - Filling the appropriate sample bottles; TSS was directly poured, TP was poured then treated with lab-provided sulfuric acid, and DOP was field-filtered using GOPRO 0.45 Micron (700 sq cm) filters
    - Securing lids and placing samples into iced coolers, with direct contact of sample bottles to wet ice for immediate cooling
- The Recorder was responsible for:

    - Entering site information in the Sample Collection Data Sheet (see Appendix D)
        - Qualitative data (weather, water conditions, etc.) and quantitative data (time, water level)
        - Clearly describing any departures from the QAPP
    - Entering site information on the Sample Submission Form (chain-of-custody) (see Appendix E)
    - For each sample site (or blank), filling out a unique Lab Request Form with all three parameters including time of sample, Site ID, and sulfuric acid label
    - Reviewing the filled sample bottles to be certain that the bottle labels were complete and were for the correct site
- Prior to leaving the final site, both staff members checked that all samples were accounted for and properly iced, and that all required paperwork was complete (field data verification)

Initially the samples were then delivered to the WSLH in Madison, WI the next morning, due to lab concerns with end-of-day sample receiving. However, the field work ended earlier in the day than anticipated. In order for the lab to meet the DOP 48-hour lab-holding time, the samples were dropped off the same day as completed. Lab Request Forms were photographed or scanned prior to drop off. Digital copies of the other forms were created once the Sample Submission Form was signed by lab staff.

2.1.3. QA/QC and Monthly Reporting

The following procedures were performed in the office after sampling and after receiving lab results:

- Nick Hayden confirmed digital backup of field forms on EOR server (data verification)
- Nick Hayden reviewed lab results for completeness, data quality flags, or other issues (data verification)
- Nick Hayden entered PDF lab results in Excel table and plotted data by parameter
- Pat Conrad independently performed the following data validation steps:
    - Check that verified data (sample results) matched lab reports
    - Check LOD and LOQ against WSLH SOPs
    - Confirm analytical methods
    - Check blanks returned "no detection" value
    - Review data flags
    - Review data for unexpected, unexplained results

The monthly status reports provided to the project team confirmed these procedures, and explained any deviations from the QAPP, data flags, or other sampling issues that warranted further discussion or documentation.

2.2. Sampling Summary including Project Modifications

EOR conducted thirty-seven sample events and WDNR conducted four sample events, for a total of forty-one project sample events. **Table 2** summarizes project samples including date, number of river samples collected, blank collection, and notes on any deviations or project modifications. Including all individual

samples for each parameter, 960 ambient samples were successfully collected, and 100 sample blanks were collected.

Table 2. Sampling Summary.

Sample #	Date	Ambient Samples	Blank Samples	Note
1	2/26/2020	24	3	
2	3/17/2020	24	3	
3	6/24/2020	24	3	
4	7/7/2020	24	3	
5	7/28/2020	24	3	
6	8/11/2020	24		
7	8/26/2020	24	3	
8	9/9/2020	24	3	
9	9/23/2020	24	3	
10	10/13/2020	24		
11	10/27/2020	24	3	
12	11/10/2020	24	3	
13	11/24/2020	24	3	
14	12/15/2020	24	3	WDNR
15	1/12/2021	24		WDNR
16	2/23/2021	18	3	Two sites iced over
17	3/16/2021	24	3	
18	4/8/2021	24	3	
19	4/22/2021	24	3	
20	5/11/2021	24		
21	5/25/2021	24	3	
22	6/10/2021	24	3	
23	6/25/2021	24	3	
24	7/12/2021	24	3	
25	7/27/2021	24		
26	8/11/2021	24	3	
27	8/25/2021	24	3	
28	9/9/2021	24	3	
29	9/27/2021	24	3	
30	10/11/2021	24		
31	10/25/2021	24	3	

Sample #	Date	Ambient Samples	Blank Samples	Note
32	11/9/2021	24	3	
33	11/23/2021	24	3	
34	12/16/2021	24	1	WDNR
35	1/18/2022	15	3	WDNR; Three sites iced over
36	2/15/2022	18	3	Two sites iced over
37	3/15/2022	24	3	
38	4/11/2022	24	3	
39	4/26/2022	21	3	One site inaccessible (bridge construction/closure)
40	5/10/2022	24		
41	5/26/2022	24	3	
Total		**960**	**100**	

The most significant departure from the original project plan was the gap between 3/17/2020 and 6/24/2020, which was caused by the Covid-19 pandemic outbreak. WDNR cancelled all field activities at the onset of the pandemic, which meant that the paired data (flow) required to analyze these data were not being collected. This gap occurred during the spring thaw, and to compensate for missing Spring 2020 the sampling duration was extended to May 2022 to make sure that two spring runoff cycles were captured in the monitoring.

Other project modifications included:

- Moving site 1 from Station ID 10021230 to Station ID 10053867 due to mixing concerns described above
- Changing sample drop-off to be on the same day as sample collection to increase likelihood of meeting DOP holding time
- Changing sampling method for Station ID 10046937 from Van Dorn sampler via bridge to dip sampler from the banks due to safety and bridge construction issues
- WDNR collecting December and January samples

3. LABORATORY ANALYSIS

3.1. Methods

All laboratory analysis was done at Wisconsin State Laboratory of Hygiene, 2810 Walton Commons Ln, Madison, WI 53718. In accordance with the project requirements and the QAPP, the following analyses were performed:

- TSS: SM2540D
- TP: EPA 365.1
- DOP: EPA 365.1

Per WSLH, the DOP method listed as SM4500-PF on laboratory results received for the first two project samples was run on Lachat by EPA 365.1 using the same chemistry and technology, which is approved under NR 219 and 40 CFS part 136. For samples received starting July 2020, DOP method was simply identified as "EPA 365.1 – Ortho-Phosphate".

All analyses were done according to WSLH's SOPs, which for most analyses are updated on an annual basis during the lab's reaccreditation processes. Since the project lasted over two years, analyses were done under different SOP versions. The most notable changes were that the LOD and LOQ for TP and DOP changed over the course of the project. Changes to these values were noted in monthly reports and LOD/LOQ is listed for every parameter in each lab report.

3.2. Results and Data Flags

A spreadsheet of all sample results and a plot of each parameter are **included** in **Appendix B** and the original lab reports are included as **Appendix C**.

There were a variety of sample comments and data flags over the course of the project. The implications of comments and flags are discussed further in **Section 4 - Quality Assurance**. Comments and flags from the lab included:

- Standard lab qualifier codes including ND for "none detected", F for a result between the LOD and LOQ, and Z for a result between zero and the LOD. These codes were common given that we collected field blanks and that ambient surface water concentrations of these parameters were often below the LOQ, especially for sites downstream of dams.

- Holding Time Exceedances for DOP. The 48-hour holding time for DOP EPA 365.1 was difficult for the WSLH to meet due to Covid-19-related staffing shortages, particularly during the summer of 2020. DOP samples that were sampled after 48 hours are clearly noted on the Sample Comments section of each report. As described above, EOR shifted to delivering samples immediately on return to Madison on the same day of collection, usually by 2 pm, which maximized the time that the lab had to run samples within the holding time.

- Ice Melted / No Ice was recording during one early sampling event, when the samples were dropped off the morning following sampling. The receiving technician used a temperature scanner to check sample temperatures, and verbally stated that the temperatures were below 6

degrees Celsius and were therefore acceptable. However, this temperature information was not recorded on their lab reports and only the "ice melted" comment is shown. After receiving these results, field lead Nick Hayden reiterated to all field staff the importance of always having the samples completely immersed in wet ice from collection until drop-off.

- DOP field filtering did not occur within 15 minutes of sample collection for a single WDNR sampling event.
- DOP lab QC comments included "DOP lab blank exceeded LOD criteria" and "DOP matrix spike QC exceeded" for a few samples, indicating that lab SOP targets were not met but analysis QC results did not vary enough to discard the result and re-run the test.

The numbers of samples that received data quality comments are shown in **Table 3**. Most of the comments are related to DOP and note that some DOP samples had multiple flags or comments. Therefore, **Table 4** is a better assessment of the percentage of total samples that were potentially impacted due to data quality concerns, as samples with multiple DOP issues have been combined. That table shows that 97.5% of the TP and TSS samples had no data quality comments, while 84.7% of the DOP samples had no data quality comments. Overall, 93.2% of project samples had no data quality comments.

Table 3. Tally of Sample Comments.

Issue:	Ice Melted	DOP Holding Time Exceeded	DOP not Filtered within 15 Minutes	DOP Lab Blank Exceeded LOD Criteria	DOP Matrix Spike QC Exceeded
# of Samples	27	30	8	12	8

Table 4. Comparison of Data Quality Comments to Total Project Samples.

Parameter	Samples with One or More Data Quality Comments	Total Samples	Percentage of Samples with no Data Quality Comments
TSS	9	353	97.5%
DOP	54	353	84.7%
TP	9	354	97.5%
Total	**72**	**1060**	**93.2%**

4. QUALITY ASSURANCE

As prescribed in the project QAPP, this Quality Assurance section evaluates the project's overall data quality objectives, including precision, accuracy, completeness, representativeness, comparability, and sensitivity of the sampling data. It includes an assessment of the overall usability of the data and describes any limitations on its use. While there were no project audits, corrective actions taken to address problems are discussed.

4.1. Data Quality Objectives

4.1.1. Precision

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Since field duplicates were not part of project design, precision was maintained by laboratory duplicates as described in their SOPs: a laboratory duplicate is prepared for at least 1 of every 10 samples, and the result must be within 10% relative difference for TP and DOP and 15% relative difference for TSS. The WSLH reported no lab duplicates failed these criteria over the course of the project, indicating that the precision objective was met.

4.1.2. Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value. Data accuracy was monitored though field and laboratory blanks and the analysis of standard reference materials in the laboratory. Field blanks consistently returned as "None Detected", with only two blank samples, one blank DOP and one blank TP, measuring trace values below the LOQ. This indicates accuracy in both field collection and lab analysis methods.

For lab blanks and matrix spikes, there were twelve samples where the Lab Blank exceeded LOD criteria and eight samples where the Matrix Spike QC was exceeded. All these exceedances were for DOP samples, but none was high enough to warrant re-running the samples per the SOP.

TP and TSS are therefore considered to be highly accurate, while DOP results may have been impacted by laboratory test accuracy issues.

4.1.3. Completeness

Completeness assesses the amount of data collected as compared to the amount needed to ensure that the uncertainty or error is within acceptable limits. For this project, the goal for data completeness was 100 percent, however, the project was not to be considered compromised if 90 percent or greater of the intended samples collected met acceptability criteria.

No samples were considered unacceptable during the field collection, as the EOR field staff followed a consistent protocol and made reasonable adaptations when sampling conditions required improvisation.

As previously shown in **Table 4**, the percentage of samples that had no lab analysis comments was 97.5% for TP and DOP and 84.7% for DOP, with an overall rate of 93.2%. EOR's opinion is this 93.2% represents the **minimum** estimate of acceptability rate, which exceeds the 90 percent minimum requirement. This assumes that any data quality comment is unacceptable however, which is probably not the case as the

WSLH's own SOPs did not deem the matrix or lab blank exceedances to be of a magnitude that required rerunning the analyses. This also assumes the samples flagged as "ice melted" are unacceptable, despite the WSLH checking the samples with a temperature sensor and verbally reporting they were properly cooled.

If the samples flagged as "ice melted" are considered acceptable given the temperature check, then the revised acceptable sample percentages become 100% for TP and TSS and 87.3% for DOP, with an **overall rate of 95.8%**. The remainder of the comments, especially the holding time issues with DOP, are likely legitimate concerns and those samples should be considered to not meet acceptability criteria.

In summary:

- EOR's estimate is that between 93-96% of the samples should be considered to meet acceptability criteria
- Completeness of TP and TSS was very high, nearing or at 100 percent
- Completeness of DOP was slightly lower, largely because of unavoidable lab holding time challenges due to Covid-19 staffing issues

4.1.4. Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, which is primarily addressed in the sample design (sites, number of samples, timing of collection, etc.). In the laboratory, it is ensured by proper handling and processing of samples and analyzing within the specified holding times.

For the field sampling portion, representativeness was ensured by:

- Properly and consistently training all field staff to follow EOR project sampling protocols and sampling at consistent locations, depths, etc.
- Following the project sample design, including consulting with WDNR and EPA when site conditions presented challenges or modifications
- At the WDNR's direction, changing the Rochester site location so that samples were more representative of the river
- Following a consistent sampling schedule, with sampling on the 10th and 25th of each month with two samples and the 15th for months with a single sample. Date shifting was kept to a minimum, and typically only done as needed to conduct sampling during weekdays and when WSLH would accept DOP samples (Monday through Thursday).
- Following discussions with the EPA and WDNR, extending the sampling schedule through May 2022 so that two full spring seasons could be monitored (Spring 2020 was interrupted by the pandemic)

In the lab, representativeness was ensured by WSLH processes including standards continuously reevaluated as part of their accreditation processes. As previously discussed, DOP holding times were not always met, particularly early in the project. As a result, reported DOP values may be slightly lower than actual values for those samples due to sample decay, although typically the holding time was exceeded by 24 hours or less.

4.1.5. Comparability

Comparability is the measure of the confidence with which one dataset can be compared to another, and primarily addressed in sampling design through use of consistent and comparable procedures at different locations and times. Comparability was ensured on this project by using comparable methods at the different sites and keeping sampling procedures consistent for the duration of the project. At most sites the original proposed approach was used throughout the project: collecting water with a Van Dorn sampler from a bridge, at the middle point of the channel, with the sampler at mid-depth of the water column. When it became apparent that another method was needed for sites with bridge closures or safety concerns, the following efforts were made to make that method comparable to the bridge samples:

- Procuring a long (15') extendable dip sampler that allowed the sample to be taken in well-mixed water away from the channel margins
- Following the same rinsing DI and ambient rinsing protocols for the dip sampler as for the Van Dorn
- Pouring the dip sampler water into the rinsed Van Dorn sampler, which was then used to fill the sample bottles

Comparability is also assessed in the laboratory using quality control samples. As reported in 4.1.1, no lab duplicate samples were reported as varying beyond the allowable threshold.

Based on the field procedures and lab quality control results, the project met the comparability data objective.

4.1.6. Sensitivity

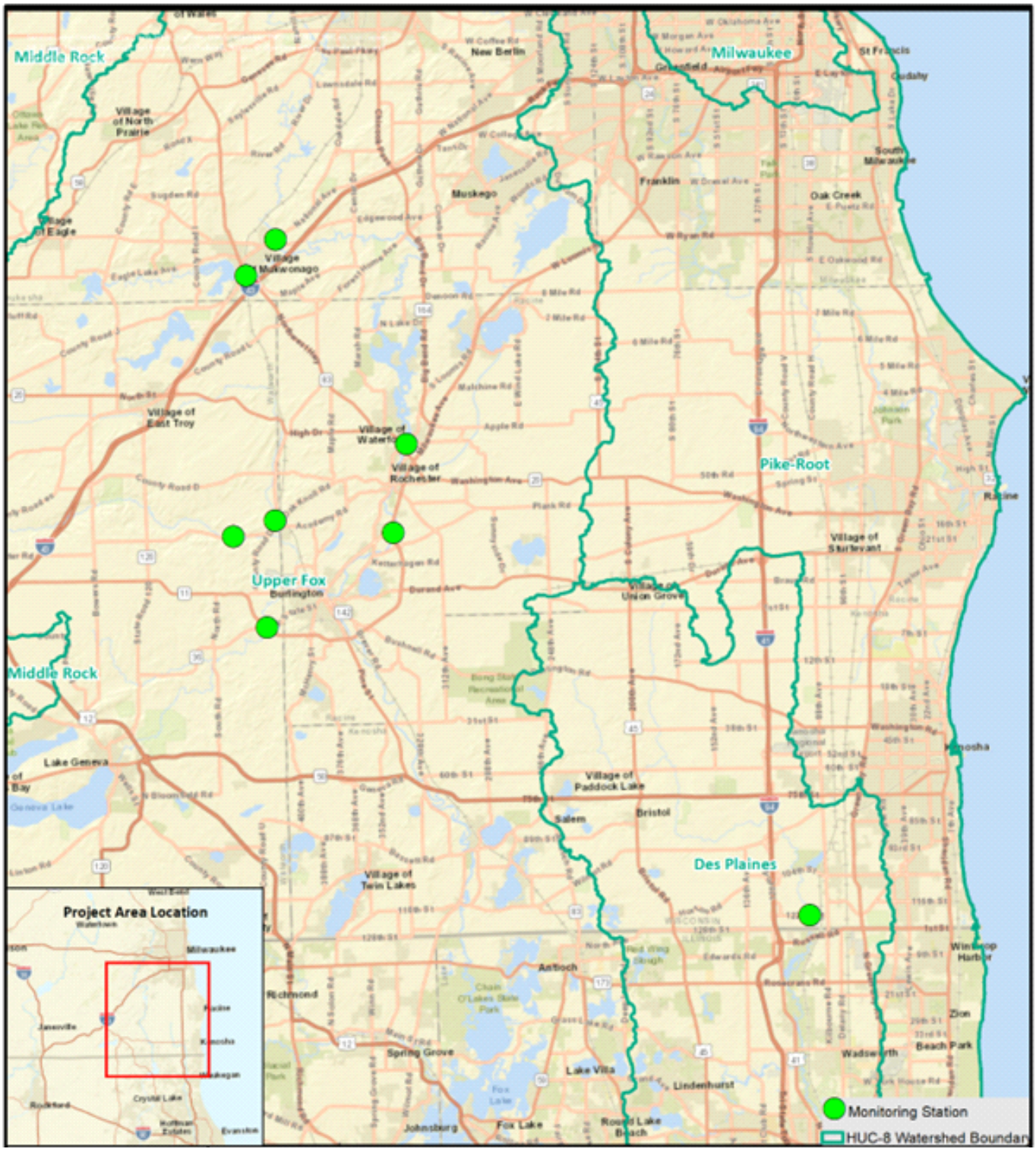
Sensitivity is the capability of a test method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. Project sensitivity was primarily addressed by selecting the analytical methods for each parameter, which was done by the EPA based on their experience with these parameters and similar studies. Sensitivity was then maintained in the laboratory by following their SOPs, including the use of standards, blanks, and dilution. LOD values were verified or reestablished as part of annual SOP updates.

Based on analytical methods and WSLH procedures, this project met the sensitivity data objective.

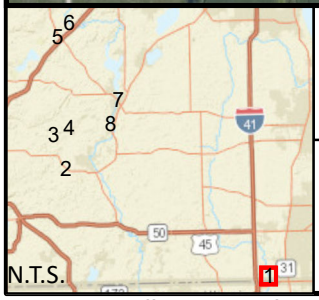
4.2. Data Usability and Limitations

The project team has considered the data quality issues outlined in this report and has, based on the objectives of the project, deemed the data to be adequate for use in TMDL modeling and establishment for the Fox River basin. The holding time exceedances with DOP were unfortunate, but during the project WDNR staff stated that a) the 48-hour holding time for EPA 365.1 is often difficult to meet; b) projects across Wisconsin during this same timeframe all had similar issues with DOP holding times due to Covid-19; and c) DOP is seen as informative to model validation, but TP and TSS were the key parameters to be used as water quality modeling input. In that context, the data from this project for TP and TSS should be considered highly usable and without limitations. The DOP data may be considered useful but limited, and further investigation of the implications of holding time exceedances and laboratory comments for specific sample results may be warranted, depending on how the DOP data are ultimately used.

APPENDIX A. SAMPLE LOCATION MAPS



Sample Location Overview



Sampling Sites

Fox River Monitoring

N

0 250 500 1,000 Feet

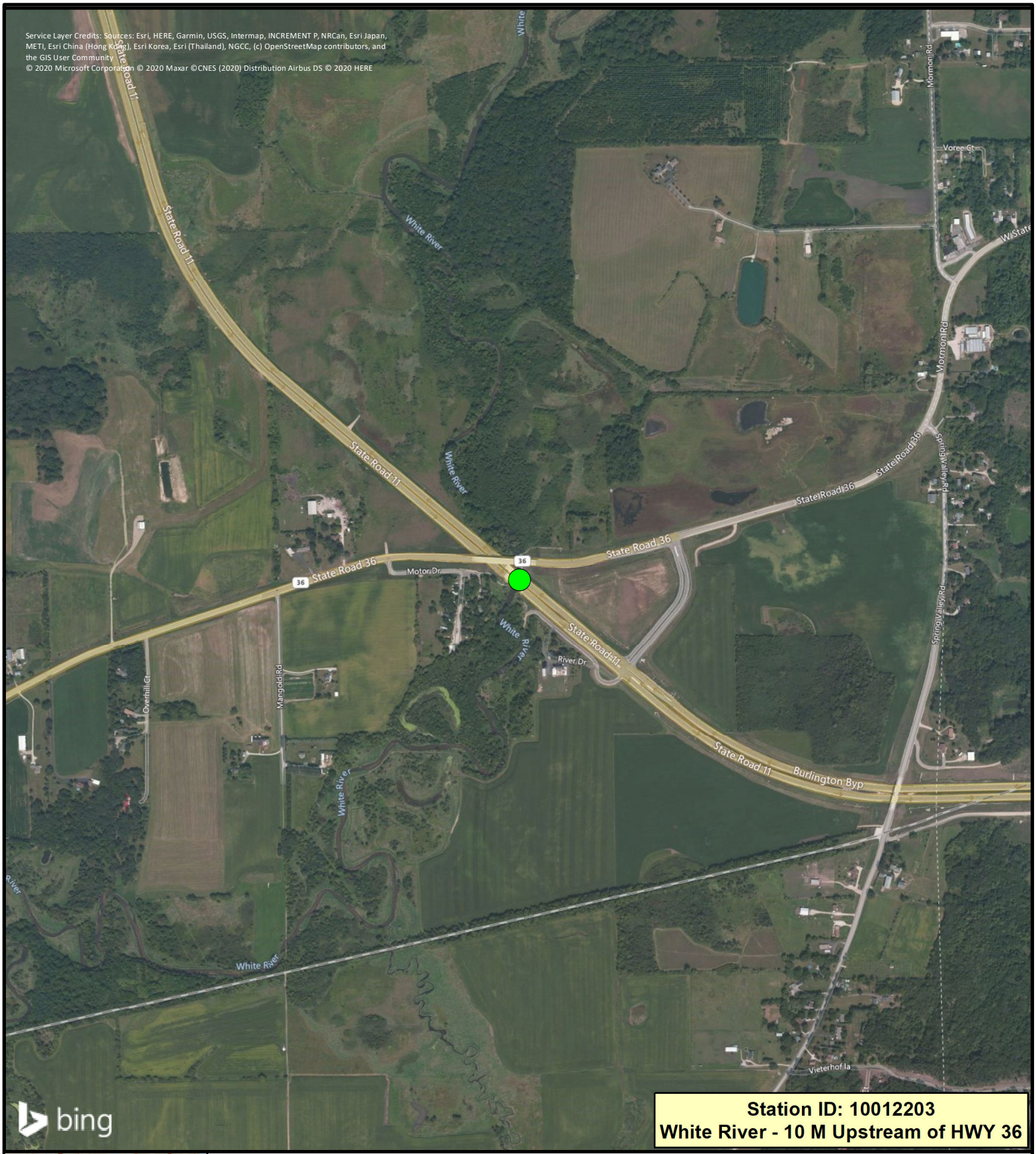
MARS-EOR water-ecology-community

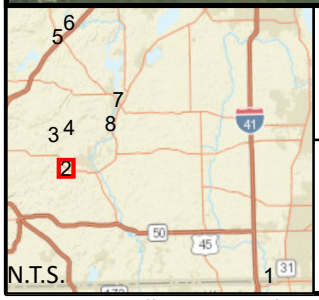
Legend

Monitoring Station

Emmons & Olivier Resources, Inc.
119 South Main St.
Cottage Grove, WI 53527
www.eorinc.com
(608) 839-4422

Drawn by: NLJ | 7/8/2020 | Map Projection: NAD 1983 HARN State Plane WI South





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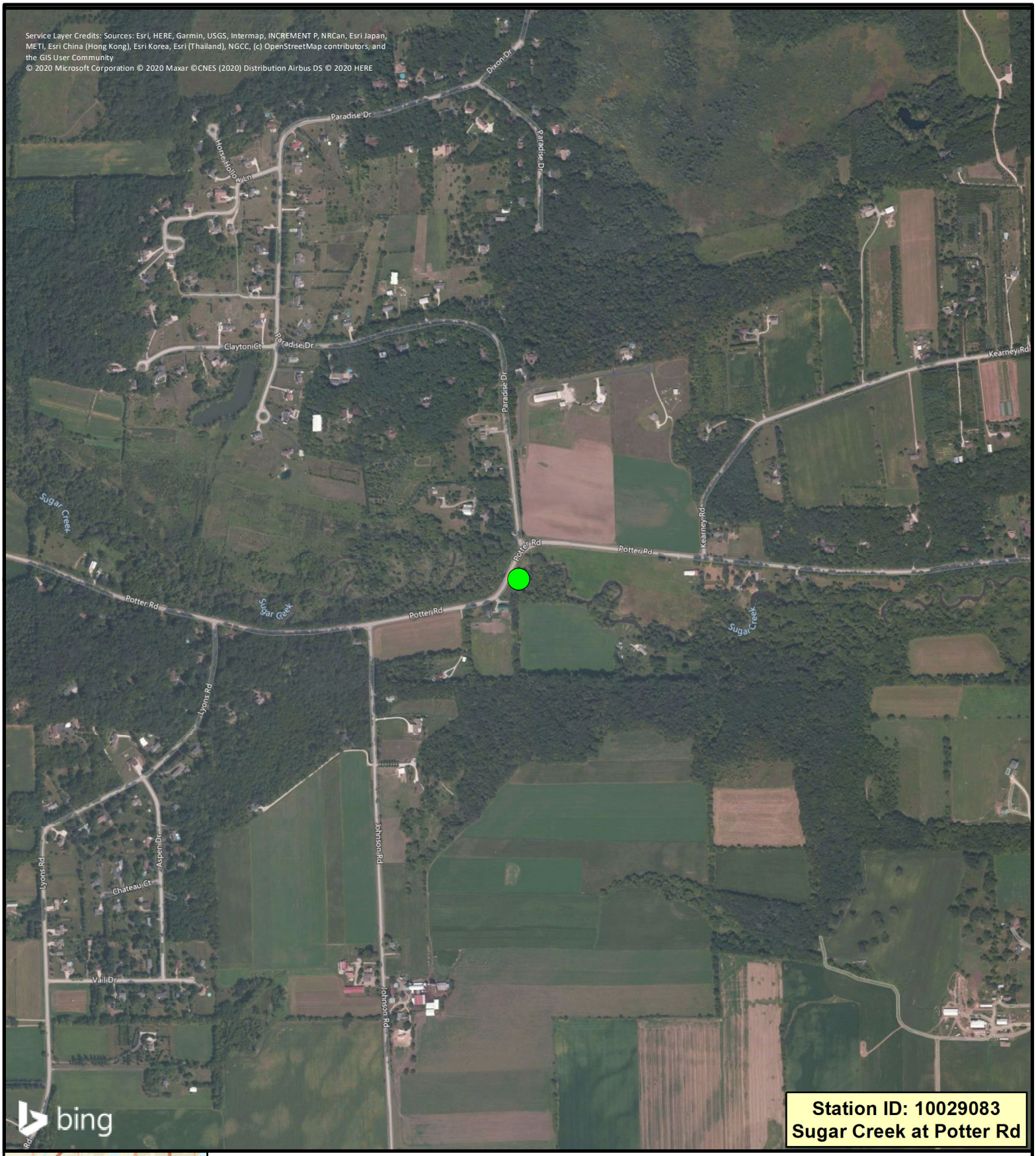

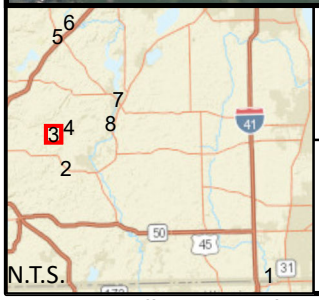

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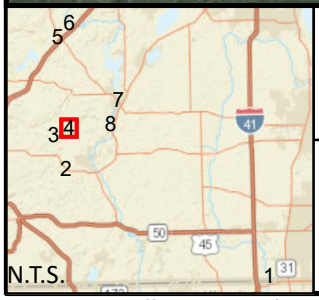

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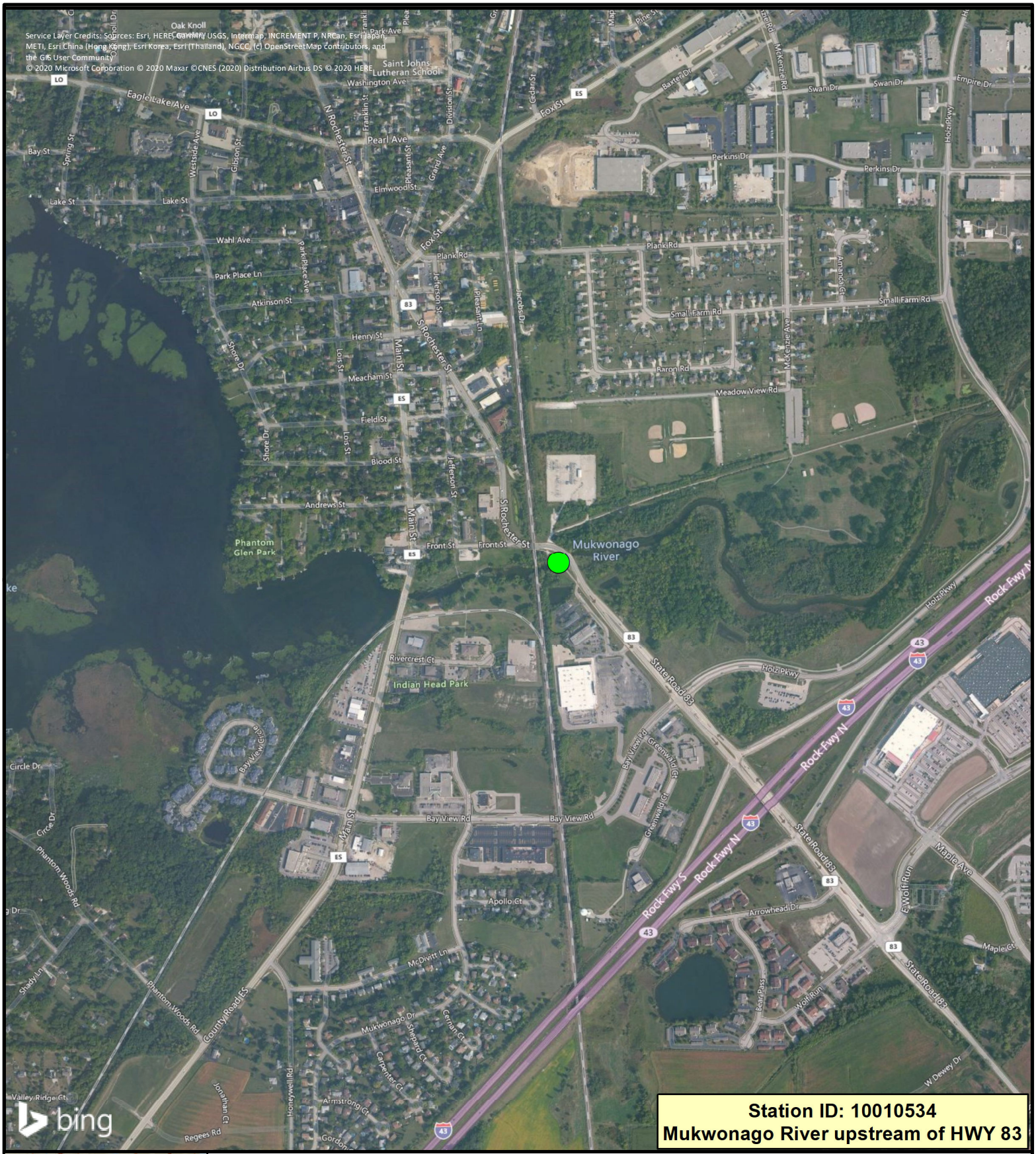

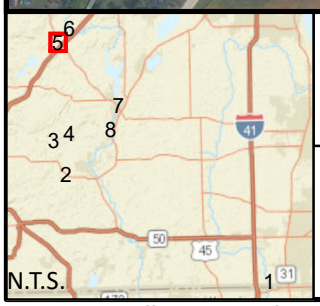

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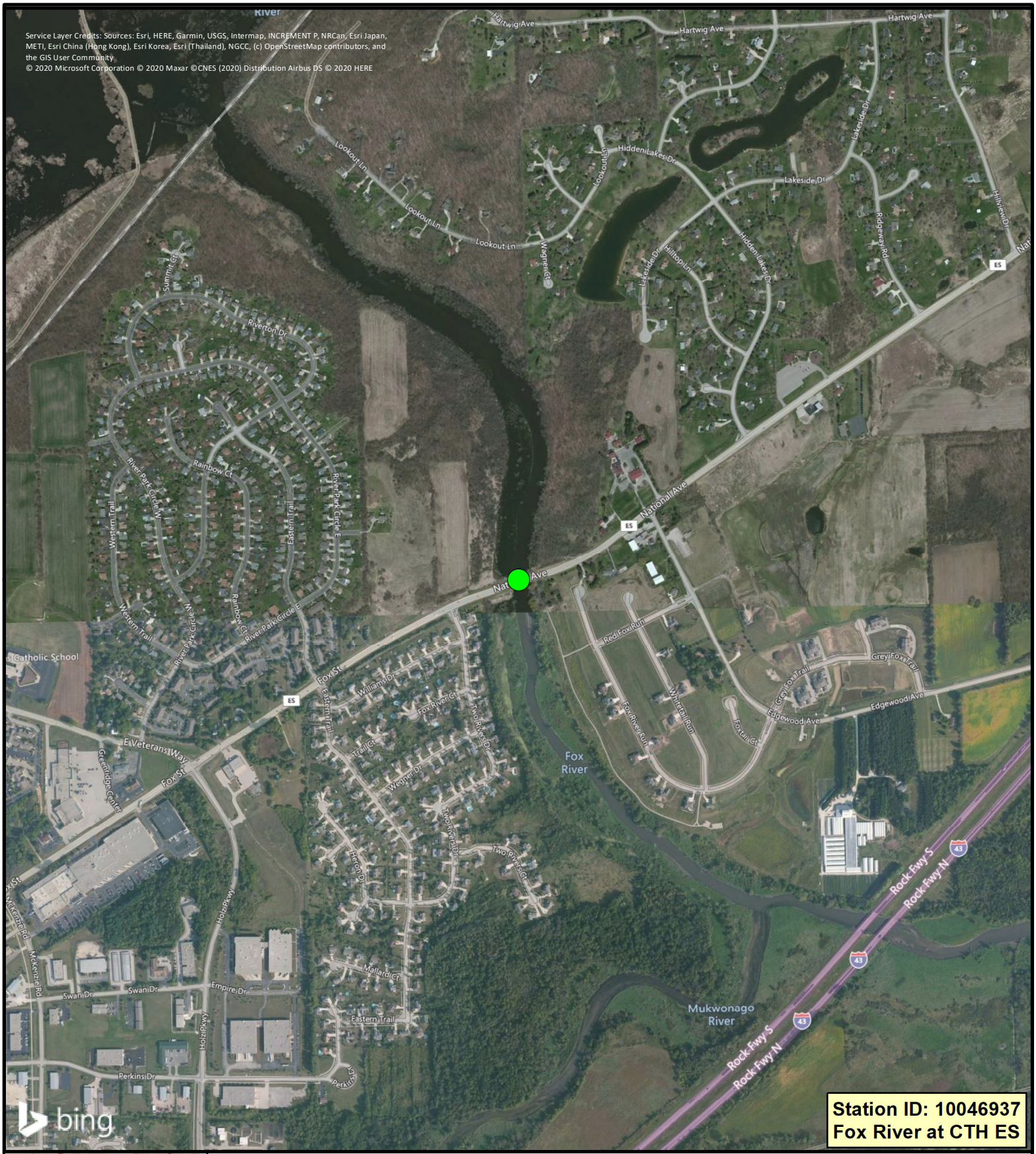

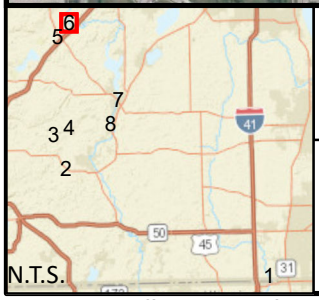

Sampling Sites

Fox River Monitoring

N

0 250 500 1,000 Feet

MARS-EOR water-ecology-community

Legend

Monitoring Station

Page 6 of 8

Emmons & Olivier Resources, Inc.
119 South Main St.
Cottage Grove, WI 53527
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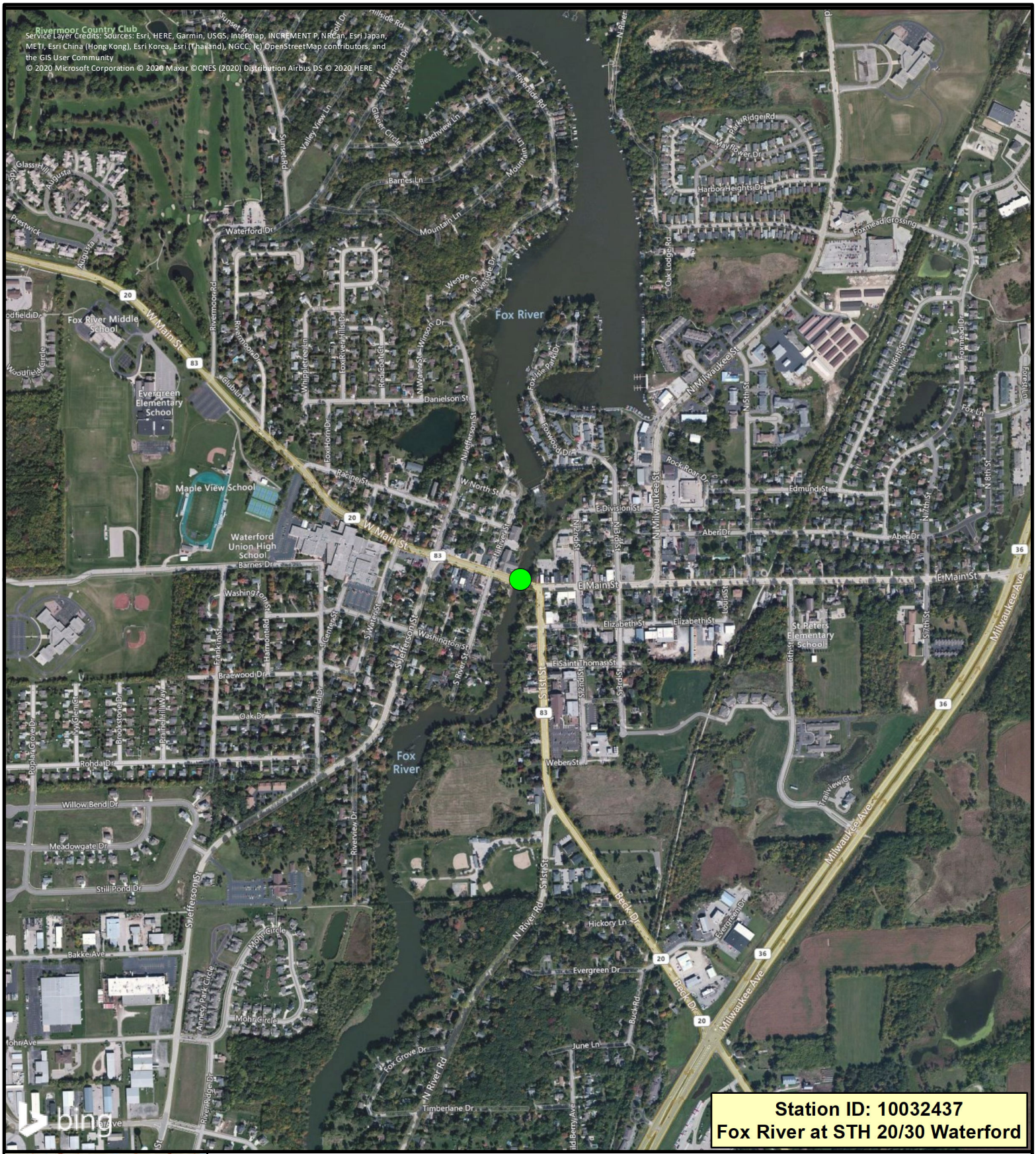

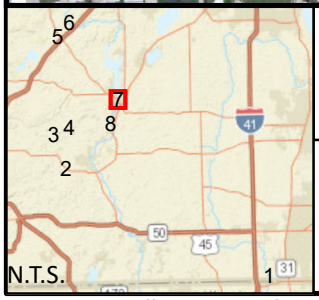

Sampling Sites

Fox River Monitoring

N

0 250 500 1,000 Feet

MARS-EOR water-ecology-community

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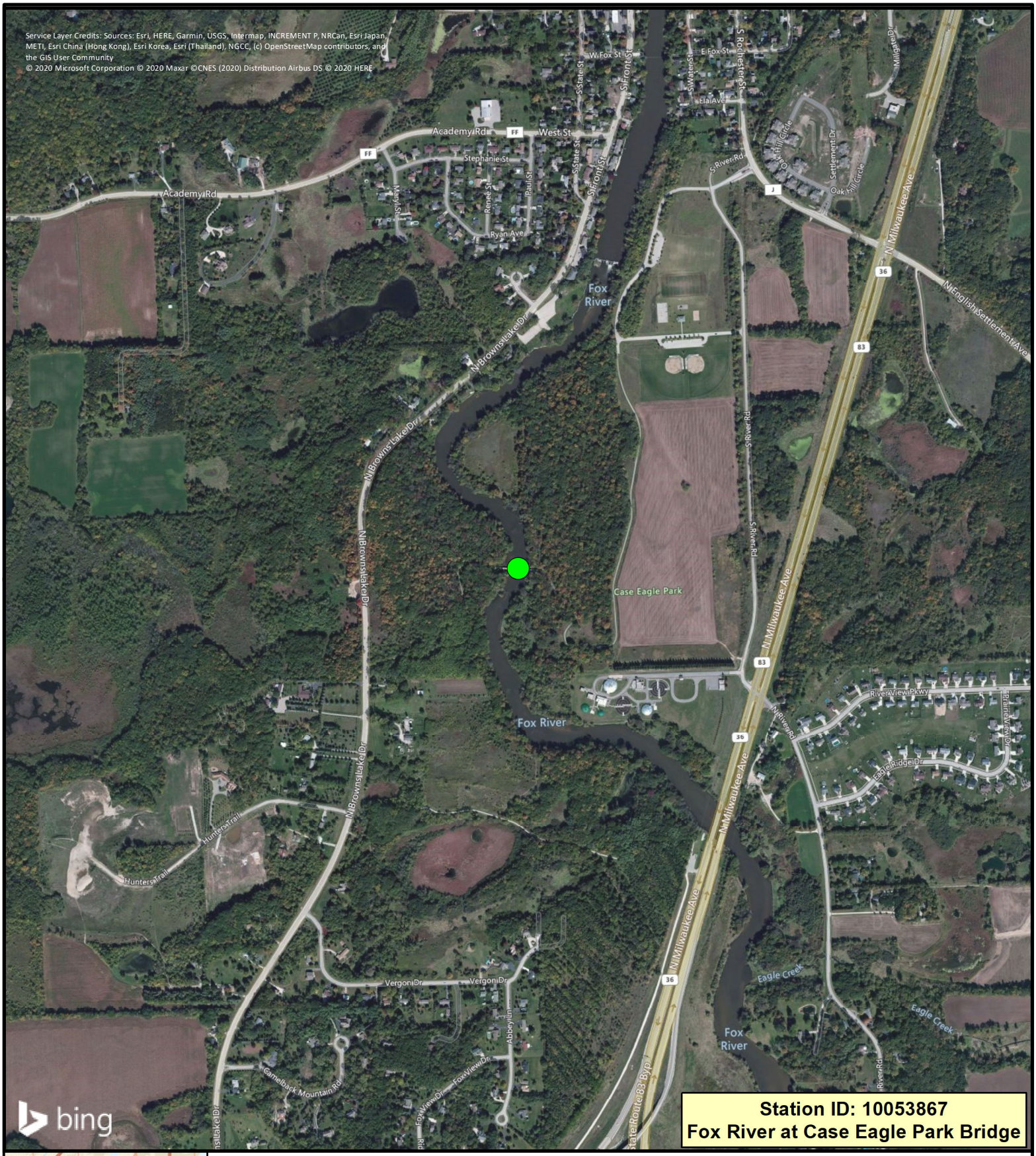

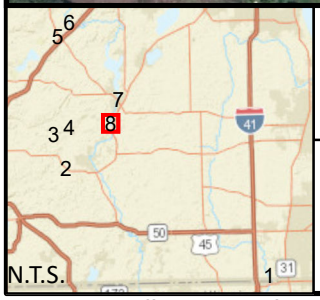

Sampling Sites

Fox River Monitoring

N

0 250 500 1,000 Feet

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APPENDIX B. SAMPLE RESULTS

Sample #	Sample Date	Location	Site ID	Blank	TSS (mg/L) raw	Orthophosphorus (mg/L) raw	Total Phosphorus (mg/L) raw
1	2/26/2020	Des Plaines River at 122nd St (CTH ML)	303054	N	29.6	0.0169	0.101
1	2/26/2020	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	ND	0.0101F
1	2/26/2020	White River - 10 M Upstream of Hwy 36	10012203	Y	ND	ND	ND
1	2/26/2020	White River - 10 M Upstream of Hwy 36	10012203	N	3.00	ND	0.0280
1	2/26/2020	Fox River above Rochester Dam	10021230	N	2.20	ND	0.0256F
1	2/26/2020	Sugar Creek at Potter Rd	10029083	N	2.20	0.00476F	0.0298
1	2/26/2020	Fox River at STH 20/30 Waterford	10032437	N	2.80	0.00579F	0.0260F
1	2/26/2020	Honey Creek at CTH DD/Academy Rd	10040134	N	8.60	0.00615F	0.0349
1	2/26/2020	Fox River at CTH ES	10046937	N	9.60	0.0224	0.0679
2	3/17/2020	Des Plaines River at 122nd St (CTH ML)	303054	N	5.20	0.0218	0.0623
2	3/17/2020	Des Plaines River at 122nd St (CTH ML)	303054	Y	ND	ND	ND
2	3/17/2020	White River - 10 M Upstream of Hwy 36	10012203	N	3.80	ND	0.0267F
2	3/17/2020	Sugar Creek at Potter Rd	10029083	N	4.00	0.0158	0.0368
2	3/17/2020	Honey Creek at CTH DD/Academy Rd	10040134	N	4.20	0.00906F	0.0276F
2	3/17/2020	Fox River above Rochester Dam	10021230	N	2.60	0.00499F	0.0323
2	3/17/2020	Fox River at STH 20/30 Waterford	10032437	N	ND	0.00623F	0.0303
2	3/17/2020	Mukwonago River - Upstream of Hwy 83	10010534	N	2.20	ND	0.0141F
2	3/17/2020	Fox River at CTH ES	10046937	N	3.00	0.0216	0.0461
3	6/24/2020	Fox River at CTH ES	10046937	N	5.40	0.0455	0.0970
3	6/24/2020	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.00746F	0.0176F
3	6/24/2020	Fox River at STH 20/30 Waterford	10032437	N	9.00	0.0507	0.117
3	6/24/2020	Fox River at Case Eagle Park Bridge	10053867	N	11.2	0.0391	0.122
3	6/24/2020	Sugar Creek at Potter Rd	10029083	N	15.6	0.0432	0.0853
3	6/24/2020	Honey Creek at CTH DD/Academy Rd	10040134	N	16.2	0.0297	0.0748
3	6/24/2020	White River - 10 M Upstream of Hwy 36	10012203	N	38.6	0.0355	0.123
3	6/24/2020	Sugar Creek at Potter Rd	10029083	Y	ND	ND	ND
3	6/24/2020	Des Plaines River at 122nd St (CTH ML)	303054	N	106	0.00687F	0.302
4	7/7/2020	Honey Creek at CTH DD/Academy Rd	10040134	Y	ND	ND	ND
4	7/7/2020	Sugar Creek at Potter Rd	10029083	N	3.60	0.0429	0.0610
4	7/7/2020	White River - 10 M Upstream of Hwy 36	10012203	N	40.0	0.0279	0.128
4	7/7/2020	Des Plaines River at 122nd St (CTH ML)	303054	N	76.8	0.0528	0.200
4	7/7/2020	Fox River at CTH ES	10046937	N	6.80	0.0607	0.129
4	7/7/2020	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.00732F	0.0150F
4	7/7/2020	Fox River at STH 20/30 Waterford	10032437	N	13.6	0.0696	0.144
4	7/7/2020	Fox River at Case Eagle Park Bridge	10053867	N	9.60	0.0548	0.124
4	7/7/2020	Honey Creek at CTH DD/Academy Rd	10040134	N	18.2	0.0278	0.0729
5	7/28/2020	Fox River at Case Eagle Park Bridge	10053867	N	10.2	0.0470	0.112
5	7/28/2020	Fox River at STH 20/30 Waterford	10032437	N	10.2	0.0685	0.134
5	7/28/2020	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.0125F	0.0177F
5	7/28/2020	Fox River at CTH ES	10046937	N	4.00	0.0738	0.121
5	7/28/2020	Des Plaines River at 122nd St (CTH ML)	303054	N	42.8	0.0488	0.163
5	7/28/2020	White River - 10 M Upstream of Hwy 36	10012203	N	30.6	0.0412	0.101
5	7/28/2020	Sugar Creek at Potter Rd	10029083	N	11.4	0.0418	0.0758
5	7/28/2020	Honey Creek at CTH DD/Academy Rd	10040134	N	14.0	0.0269	0.0722
5	7/28/2020	Fox River at Case Eagle Park Bridge	10053867	Y	ND	ND	ND
6	8/11/2020	Fox River at STH 20/30 Waterford	10032437	N	8.00	0.0528	0.0952

Sample #	Sample Date	Location	Site ID	Blank	TSS (mg/L) raw	Orthophosphorus (mg/L) raw	Total Phosphorus (mg/L) raw
6	8/11/2020	Fox River at Case Eagle Park Bridge	10053867	N	101	0.182	0.362
6	8/11/2020	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.0172	0.0137F
6	8/11/2020	Fox River at CTH ES	10046937	N	4.60	0.0555	0.0923
6	8/11/2020	Honey Creek at CTH DD/Academy Rd	10040134	N	30.8	0.0522	0.160
6	8/11/2020	Sugar Creek at Potter Rd	10029083	N	86.8	0.101	0.302
6	8/11/2020	White River - 10 M Upstream of Hwy 36	10012203	N	33.2	0.110	0.225
6	8/11/2020	Des Plaines River at 122nd St (CTH ML)	303054	N	74.0	0.0601	0.195
7	8/26/2020	Fox River at CTH ES	10046937	N	6.60	0.0593	0.105
7	8/26/2020	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.0116F	0.0155F
7	8/26/2020	Fox River at STH 20/30 Waterford	10032437	Y	ND	ND	0.00848F
7	8/26/2020	Fox River at STH 20/30 Waterford	10032437	N	9.80	0.0308	0.0864
7	8/26/2020	Fox River at Case Eagle Park Bridge	10053867	N	5.00	0.0323	0.0751
7	8/26/2020	Sugar Creek at Potter Rd	10029083	N	3.40	0.0323	0.0519
7	8/26/2020	White River - 10 M Upstream of Hwy 36	10012203	N	12.2	0.0326	0.0733
7	8/26/2020	Des Plaines River at 122nd St (CTH ML)	303054	N	66.4	0.0374	0.173
7	8/26/2020	Honey Creek at CTH DD/Academy Rd	10040134	N	5.20	0.0291	0.0506
8	9/9/2020	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.0240	0.0128F
8	9/9/2020	Honey Creek at CTH DD/Academy Rd	10040134	N	21.2	0.0397	0.0935
8	9/9/2020	Fox River at Case Eagle Park Bridge	10053867	N	7.40	0.0415	0.0641
8	9/9/2020	Sugar Creek at Potter Rd	10029083	N	44.0	0.0599	0.131
8	9/9/2020	White River - 10 M Upstream of Hwy 36	10012203	N	42.4	0.0527	0.136
8	9/9/2020	Mukwonago River - Upstream of Hwy 83	10010534	Y	ND	ND	ND
8	9/9/2020	Fox River at CTH ES	10046937	N	8.20	0.0550	0.0804
8	9/9/2020	Des Plaines River at 122nd St (CTH ML)	303054	N	66.5	0.0412	0.184
8	9/9/2020	Fox River at STH 20/30 Waterford	10032437	N	6.80	0.0379	0.0637
9	9/23/2020	Fox River at CTH ES	10046937	N	3.00	0.0503	0.0566
9	9/23/2020	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.0264	0.0126F
9	9/23/2020	Fox River at Case Eagle Park Bridge	10053867	N	6.00	0.0349	0.0433
9	9/23/2020	Fox River at CTH ES	10046937	Y	ND	ND	ND
9	9/23/2020	Fox River at STH 20/30 Waterford	10032437	N	6.60	0.0348	0.0475
9	9/23/2020	Sugar Creek at Potter Rd	10029083	N	8.00	0.0498	0.0505
9	9/23/2020	Des Plaines River at 122nd St (CTH ML)	303054	N	81.7	0.0403	0.131
9	9/23/2020	Honey Creek at CTH DD/Academy Rd	10040134	N	10.0	0.0390	0.0407
9	9/23/2020	White River - 10 M Upstream of Hwy 36	10012203	N	10.6	0.0359	0.0533
10	10/13/2020	Fox River at STH 20/30 Waterford	10032437	N	9.00	0.0171	0.0450
10	10/13/2020	Fox River at CTH ES	10046937	N	7.20	0.0562	0.0821
10	10/13/2020	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.0215	0.0138F
10	10/13/2020	Fox River at Case Eagle Park Bridge	10053867	N	7.40	0.0146F	0.0411
10	10/13/2020	Sugar Creek at Potter Rd	10029083	N	4.20	0.0458	0.0468
10	10/13/2020	Honey Creek at CTH DD/Academy Rd	10040134	N	4.20	0.0405	0.0367
10	10/13/2020	White River - 10 M Upstream of Hwy 36	10012203	N	8.40	0.0476	0.0659
10	10/13/2020	Des Plaines River at 122nd St (CTH ML)	303054	N	53.0	0.0166	0.0931
11	10/27/2020	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.0159	0.0142F
11	10/27/2020	Fox River at STH 20/30 Waterford	10032437	N	3.20	0.0218	0.0353
11	10/27/2020	Fox River at CTH ES	10046937	N	2.00	0.0464	0.0551
11	10/27/2020	Fox River at Case Eagle Park Bridge	10053867	N	3.80	0.0224	0.0401

Sample #	Sample Date	Location	Site ID	Blank	TSS (mg/L) raw	Orthophosphorus (mg/L) raw	Total Phosphorus (mg/L) raw
11	10/27/2020	Honey Creek at CTH DD/Academy Rd	10040134	N	9.20	0.0343	0.0511
11	10/27/2020	Sugar Creek at Potter Rd	10029083	N	15.2	0.0579	0.0955
11	10/27/2020	White River - 10 M Upstream of Hwy 36	10012203	N	9.80	0.0318	0.0506
11	10/27/2020	Des Plaines River at 122nd St (CTH ML)	303054	N	12.6	0.0926	0.158
11	10/27/2020	Des Plaines River at 122nd St (CTH ML)	303054	Y	ND	ND	ND
12	11/9/2020	Fox River at CTH ES	10046937	N	13.3	0.0411	0.0722
12	11/9/2020	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.0176	0.0146F
12	11/9/2020	Fox River at STH 20/30 Waterford	10032437	N	6.60	0.00847F	0.0354
12	11/9/2020	Fox River at Case Eagle Park Bridge	10053867	N	5.80	0.00814F	0.0346
12	11/9/2020	Honey Creek at CTH DD/Academy Rd	10040134	N	3.80	0.0330	0.0329
12	11/9/2020	White River - 10 M Upstream of Hwy 36	10012203	N	4.00	0.0283	0.0401
12	11/9/2020	Sugar Creek at Potter Rd	10029083	N	ND	0.0299	0.0329
12	11/9/2020	White River - 10 M Upstream of Hwy 36	10012203	Y	ND	ND	ND
12	11/9/2020	Des Plaines River at 122nd St (CTH ML)	303054	N	39.4	0.0185	0.0865
13	11/24/2020	Sugar Creek at Potter Rd	10029083	N	ND	0.0215	0.0218F
13	11/24/2020	Sugar Creek at Potter Rd	10029083	Y	ND	ND	ND
13	11/24/2020	White River - 10 M Upstream of Hwy 36	10012203	N	4.00	0.0249	0.0338
13	11/24/2020	Des Plaines River at 122nd St (CTH ML)	303054	N	6.67	0.0120F	0.0514
13	11/24/2020	Honey Creek at CTH DD/Academy Rd	10040134	N	3.20	0.0258	0.0246F
13	11/24/2020	Fox River at Case Eagle Park Bridge	10053867	N	3.20	0.0100F	0.0260F
13	11/24/2020	Fox River at STH 20/30 Waterford	10032437	N	3.40	0.0111F	0.0253F
13	11/24/2020	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.0147F	0.0123F
13	11/24/2020	Fox River at CTH ES	10046937	N	4.40	0.0489	0.0665
14	12/15/2020	Des Plaines River at 122nd St (CTH ML)	303054	N	18.9	0.181	0.308
14	12/15/2020	White River - 10 M Upstream of Hwy 36	10012203	N	10.6	0.0172	0.0468
14	12/15/2020	Sugar Creek at Potter Rd	10029083	N	8.60	0.0291	0.0633
14	12/15/2020	Honey Creek at CTH DD/Academy Rd	10040134	N	15.4	0.0198	0.0521
14	12/15/2020	Fox River at Case Eagle Park Bridge	10053867	N	4.00	0.0285	0.0645
14	12/15/2020	Fox River at STH 20/30 Waterford	10032437	N	2.00	0.0108F	0.0289
14	12/15/2020	Fox River at CTH ES	10046937	N	11.4	0.0367	0.0833
14	12/15/2020	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.0114F	0.0212F
14	12/15/2020	Honey Creek at CTH DD/Academy Rd	10040134	Y	ND	ND	ND
15	1/12/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	7.20	0.0327	0.0505
15	1/12/2021	White River - 10 M Upstream of Hwy 36	10012203	N	7.60	0.0361	0.0346
15	1/12/2021	Sugar Creek at Potter Rd	10029083	N	3.60	0.0468	0.0262F
15	1/12/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	8.60	0.0527	0.0346
15	1/12/2021	Fox River at Case Eagle Park Bridge	10053867	N	2.00	0.0332	0.0255F
15	1/12/2021	Fox River at STH 20/30 Waterford	10032437	N	ND	0.0369	0.0271F
15	1/12/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.0417	0.0158F
15	1/12/2021	Fox River at CTH ES	10046937	N	11.8	0.0802	0.0973
16	2/23/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	4.60	0.00702F	0.0369
16	2/23/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.00288F	0.0131F
16	2/23/2021	Sugar Creek at Potter Rd	10029083	N	2.40	0.00956	0.0239F
16	2/23/2021	Fox River at Case Eagle Park Bridge	10053867	Y	ND	ND	ND
16	2/23/2021	Fox River at STH 20/30 Waterford	10032437	N	ND	0.0162	0.0336
16	2/23/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	9.40	0.00728F	0.0329

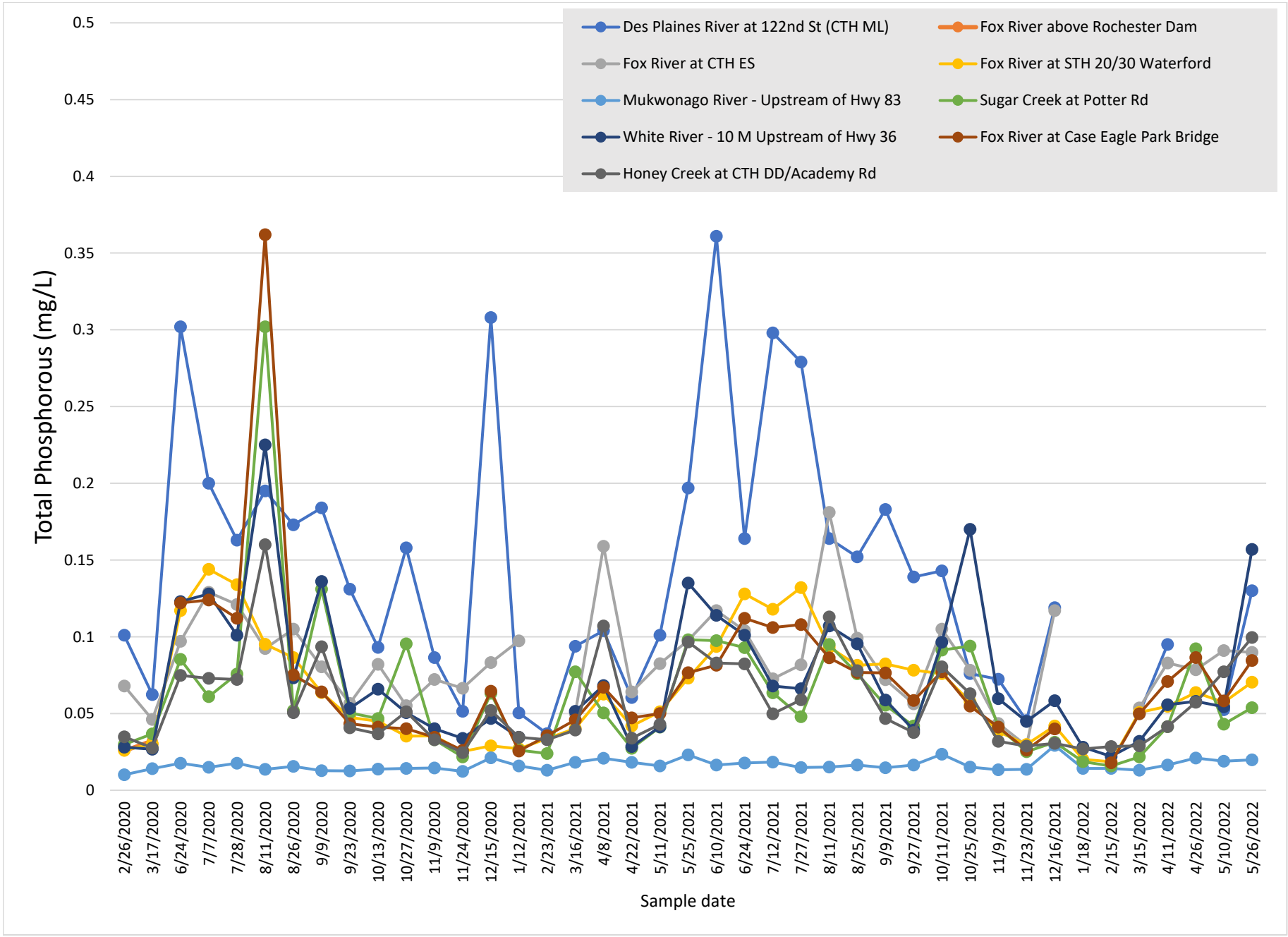
Sample #	Sample Date	Location	Site ID	Blank	TSS (mg/L) raw	Orthophosphorus (mg/L) raw	Total Phosphorus (mg/L) raw
16	2/23/2021	Fox River at Case Eagle Park Bridge	10053867	N	ND	0.0146	0.0356
17	3/16/2021	Fox River at Case Eagle Park Bridge	10053867	N	4.00	0.00487F	0.0458
17	3/16/2021	Sugar Creek at Potter Rd	10029083	N	10.6	0.0284	0.0772
17	3/16/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	7.60	0.00941	0.0393F
17	3/16/2021	White River - 10 M Upstream of Hwy 36	10012203	N	8.80	0.00998	0.0514
17	3/16/2021	Fox River at STH 20/30 Waterford	10032437	N	2.60	0.00429F	0.0403
17	3/16/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	4.00	0.0474	0.0938
17	3/16/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	ND	0.0182F
17	3/16/2021	Fox River at CTH ES	10046937	N	3.20	0.0111	0.0502
17	3/16/2021	Fox River at STH 20/30 Waterford	10032437	Y	ND	ND	ND
18	4/8/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	46.8	0.00860	0.104
18	4/8/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	4.80	ND	0.0208F
18	4/8/2021	Mukwonago River - Upstream of Hwy 83	10010534	Y	ND	ND	ND
18	4/8/2021	Sugar Creek at Potter Rd	10029083	N	7.80	0.00538F	0.0505
18	4/8/2021	White River - 10 M Upstream of Hwy 36	10012203	N	24.0	0.00973	0.0682
18	4/8/2021	Fox River at STH 20/30 Waterford	10032437	N	13.4	0.00322F	0.0626
18	4/8/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	24.8	0.0103	0.107
18	4/8/2021	Fox River at CTH ES	10046937	N	57.5	0.0217	0.159
18	4/8/2021	Fox River at Case Eagle Park Bridge	10053867	N	16.4	ND	0.0670
19	4/22/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	15.0	0.00282F	0.0605
19	4/22/2021	White River - 10 M Upstream of Hwy 36	10012203	N	4.60	0.00412F	0.0285F
19	4/22/2021	Sugar Creek at Potter Rd	10029083	N	2.60	0.00333F	0.0274F
19	4/22/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	6.00	0.00854	0.0340F
19	4/22/2021	Fox River at Case Eagle Park Bridge	10053867	N	9.56	ND	0.0472
19	4/22/2021	Fox River at STH 20/30 Waterford	10032437	N	7.20	0.00251F	0.0419
19	4/22/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	2.20	ND	0.0182F
19	4/22/2021	Fox River at CTH ES	10046937	N	8.20	0.0124	0.0641
19	4/22/2021	Fox River at CTH ES	10046937	Y	ND	ND	ND
20	5/11/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	2.20	0.00320F	0.0158F
20	5/11/2021	Fox River at Case Eagle Park Bridge	10053867	N	9.00	0.00374F	0.0500
20	5/11/2021	Fox River at CTH ES	10046937	N	11.6	0.0191	0.0825
20	5/11/2021	Fox River at STH 20/30 Waterford	10032437	N	9.40	0.00537F	0.0512
20	5/11/2021	Sugar Creek at Potter Rd	10029083	N	6.40	0.00525F	0.0411
20	5/11/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	36.0	0.0133	0.101
20	5/11/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	9.40	0.0125	0.0429
20	5/11/2021	White River - 10 M Upstream of Hwy 36	10012203	N	7.00	0.0105	0.0413
21	5/25/2021	Des Plaines River at 122nd St (CTH ML)	303054	Y	ND	ND	ND
21	5/25/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	91.5	0.0107	0.197
21	5/25/2021	White River - 10 M Upstream of Hwy 36	10012203	N	52.8	0.0208	0.135
21	5/25/2021	Sugar Creek at Potter Rd	10029083	N	24.8	0.0271	0.0981
21	5/25/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	34.4	0.0150	0.0966
21	5/25/2021	Fox River at Case Eagle Park Bridge	10053867	N	10.6	0.0107	0.0766
21	5/25/2021	Fox River at STH 20/30 Waterford	10032437	N	7.60	0.0115	0.0731
21	5/25/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.00468F	0.0231F
21	5/25/2021	Fox River at CTH ES	10046937	N	17.3	0.0173	0.0976
22	6/10/2021	Sugar Creek at Potter Rd	10029083	N	18.6	0.0348	0.0975

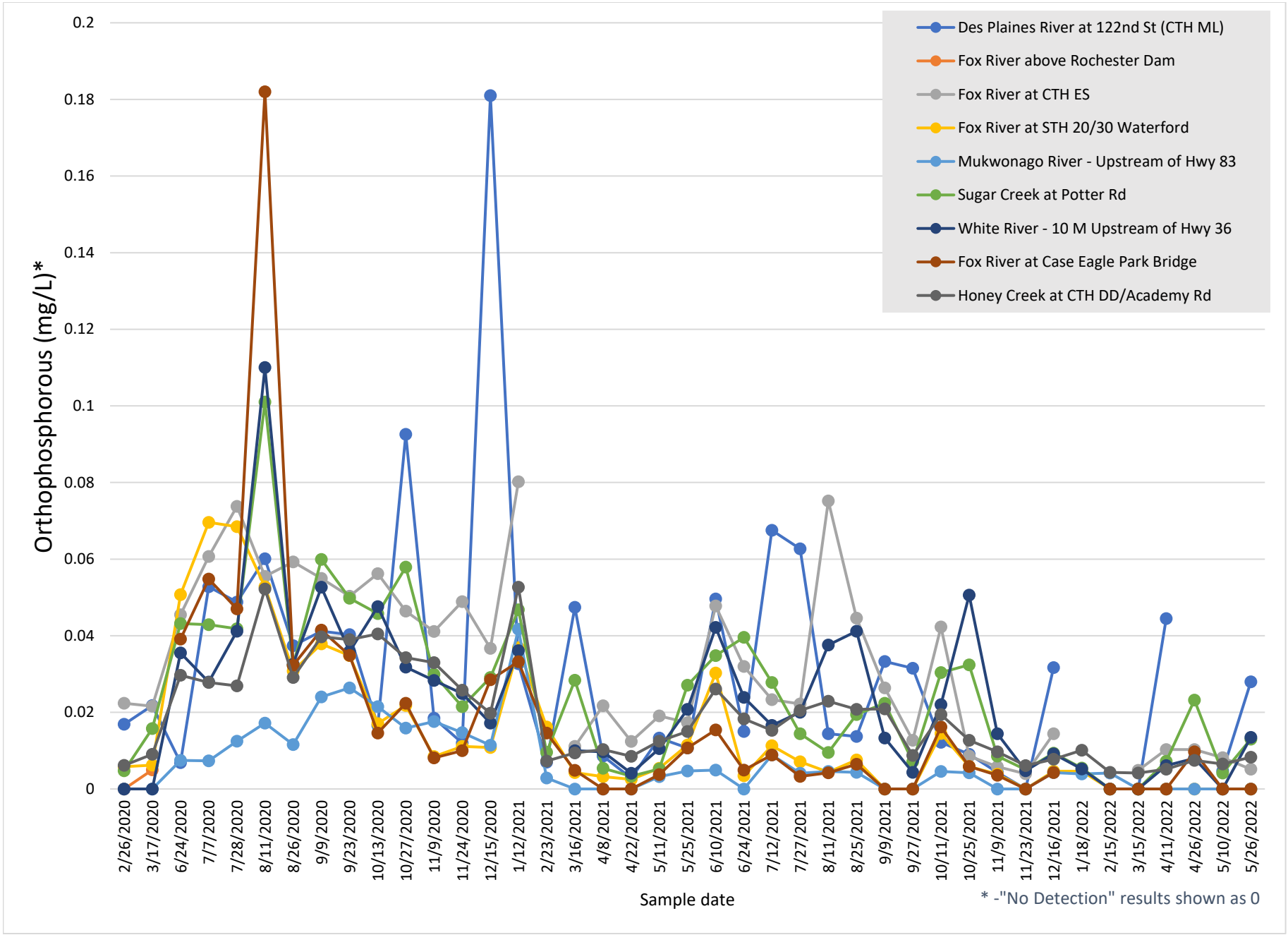
Sample #	Sample Date	Location	Site ID	Blank	TSS (mg/L) raw	Orthophosphorus (mg/L) raw	Total Phosphorus (mg/L) raw
22	6/10/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	104	0.0496	0.361
22	6/10/2021	Fox River at CTH ES	10046937	N	9.20	0.0478	0.117
22	6/10/2021	White River - 10 M Upstream of Hwy 36	10012203	N	24.0	0.0422	0.114
22	6/10/2021	White River - 10 M Upstream of Hwy 36	10012203	Y	ND	ND	ND
22	6/10/2021	Fox River at STH 20/30 Waterford	10032437	N	8.80	0.0303	0.0937
22	6/10/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	18.3	0.0261	0.0829
22	6/10/2021	Fox River at Case Eagle Park Bridge	10053867	N	7.20	0.0154	0.0815
22	6/10/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.00493F	0.0165F
23	6/24/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	59.8	0.0150	0.164
23	6/24/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	ND	0.0178F
23	6/24/2021	White River - 10 M Upstream of Hwy 36	10012203	N	42.8	0.0239	0.101
23	6/24/2021	Sugar Creek at Potter Rd	10029083	N	17.8	0.0396	0.0930
23	6/24/2021	Sugar Creek at Potter Rd	10029083	Y	ND	ND	ND
23	6/24/2021	Fox River at STH 20/30 Waterford	10032437	N	35.0	0.00344	0.128
23	6/24/2021	Fox River at CTH ES	10046937	N	15.6	0.0320	0.104
23	6/24/2021	Fox River at Case Eagle Park Bridge	10053867	N	25.8	0.00493	0.112
23	6/24/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	14.8	0.0183	0.0824
24	7/12/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	41.6	0.0675	0.298
24	7/12/2021	White River - 10 M Upstream of Hwy 36	10012203	N	12.6	0.0166	0.0680
24	7/12/2021	Sugar Creek at Potter Rd	10029083	N	7.20	0.0278	0.0635
24	7/12/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	4.40	0.0153	0.0499
24	7/12/2021	Honey Creek at CTH DD/Academy Rd	10040134	Y	ND	0.00348F	ND
24	7/12/2021	Fox River at Case Eagle Park Bridge	10053867	N	16.8	0.00887F	0.106
24	7/12/2021	Fox River at STH 20/30 Waterford	10032437	N	24.0	0.0113	0.118
24	7/12/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.00885F	0.0183F
24	7/12/2021	Fox River at CTH ES	10046937	N	6.40	0.0233	0.0727
25	7/27/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	70.4	0.0627	0.279
25	7/27/2021	White River - 10 M Upstream of Hwy 36	10012203	N	6.80	0.0200	0.0661
25	7/27/2021	Sugar Creek at Potter Rd	10029083	N	4.20	0.0144	0.0479
25	7/27/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	6.40	0.0205	0.0589
25	7/27/2021	Fox River at Case Eagle Park Bridge	10053867	N	16.0	0.00329F	0.108
25	7/27/2021	Fox River at STH 20/30 Waterford	10032437	N	23.8	0.00713F	0.132
25	7/27/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.00413F	0.0149F
25	7/27/2021	Fox River at CTH ES	10046937	N	5.60	0.0222	0.0818
26	8/11/2021	Sugar Creek at Potter Rd	10029083	N	10.0	0.00955F	0.0950
26	8/11/2021	White River - 10 M Upstream of Hwy 36	10012203	N	28.4	0.0376	0.107
26	8/11/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	46.4	0.0144	0.164
26	8/11/2021	Fox River at Case Eagle Park Bridge	10053867	N	16.8	0.00421F	0.0863
26	8/11/2021	Fox River at Case Eagle Park Bridge	10053867	Y	ND	ND	ND
26	8/11/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	24.4	0.0229	0.113
26	8/11/2021	Fox River at CTH ES	10046937	N	20.6	0.0752	0.181
26	8/11/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.00456F	0.0151F
26	8/11/2021	Fox River at STH 20/30 Waterford	10032437	N	17.8	0.00441F	0.0933
27	8/25/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	29.3	0.0137	0.152
27	8/25/2021	White River - 10 M Upstream of Hwy 36	10012203	N	15.2	0.0412	0.0954
27	8/25/2021	Sugar Creek at Potter Rd	10029083	N	12.4	0.0194	0.0759

Sample #	Sample Date	Location	Site ID	Blank	TSS (mg/L) raw	Orthophosphorus (mg/L) raw	Total Phosphorus (mg/L) raw
27	8/25/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	12.2	0.0208	0.0779
27	8/25/2021	Fox River at Case Eagle Park Bridge	10053867	N	10.4	0.00644F	0.0768
27	8/25/2021	Fox River at STH 20/30 Waterford	10032437	N	12.6	0.00759F	0.0815
27	8/25/2021	Fox River at STH 20/30 Waterford	10032437	Y	ND	ND	ND
27	8/25/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.00436F	0.0164F
27	8/25/2021	Fox River at CTH ES	10046937	N	7.20	0.0446	0.0991
28	9/9/2021	Mukwonago River - Upstream of Hwy 83	10010534	Y	ND	ND	ND
28	9/9/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	ND	0.0147F
28	9/9/2021	Fox River at CTH ES	10046937	N	6.20	0.0264	0.0721
28	9/9/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	2.80	0.0209	0.0468
28	9/9/2021	Fox River at Case Eagle Park Bridge	10053867	N	17.6	ND	0.0765
28	9/9/2021	Fox River at STH 20/30 Waterford	10032437	N	26.4	ND	0.0823
28	9/9/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	46.8	0.0333	0.183
28	9/9/2021	White River - 10 M Upstream of Hwy 36	10012203	N	7.40	0.0133	0.0588
28	9/9/2021	Sugar Creek at Potter Rd	10029083	N	6.40	0.0224	0.0554
29	9/27/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	26.0	0.0315	0.139
29	9/27/2021	White River - 10 M Upstream of Hwy 36	10012203	N	6.00	0.00435F	0.0392
29	9/27/2021	Fox River at Case Eagle Park Bridge	10053867	N	12.0	ND	0.0585
29	9/27/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	2.00	0.00873F	0.0376
29	9/27/2021	Sugar Creek at Potter Rd	10029083	N	4.80	0.00711F	0.0419
29	9/27/2021	Fox River at STH 20/30 Waterford	10032437	N	20.2	ND	0.0783
29	9/27/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	3.40	ND	0.0164F
29	9/27/2021	Fox River at CTH ES	10046937	N	8.80	0.0127	0.0563
29	9/27/2021	Fox River at CTH ES	10046937	Y	ND	ND	ND
30	10/11/2021	Fox River at STH 20/30 Waterford	10032437	N	13.6	0.0145	0.0760
30	10/11/2021	Fox River at Case Eagle Park Bridge	10053867	N	15.6	0.0162	0.0772
30	10/11/2021	Fox River at CTH ES	10046937	N	19.2	0.0423	0.105
30	10/11/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.00459F	0.0235F
30	10/11/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	27.8	0.0122	0.143
30	10/11/2021	White River - 10 M Upstream of Hwy 36	10012203	N	20.0	0.0220	0.0965
30	10/11/2021	Sugar Creek at Potter Rd	10029083	N	9.80	0.0304	0.0913
30	10/11/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	17.2	0.0194	0.0804
31	10/25/2021	Des Plaines River at 122nd St (CTH ML)	303054	Y	ND	ND	ND
31	10/25/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	19.6	0.00906F	0.0760
31	10/25/2021	White River - 10 M Upstream of Hwy 36	10012203	N	72.4	0.0506	0.170
31	10/25/2021	Sugar Creek at Potter Rd	10029083	N	22.8	0.0324	0.0940
31	10/25/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	10.2	0.0127	0.0630
31	10/25/2021	Fox River at Case Eagle Park Bridge	10053867	N	12.2	0.00589F	0.0548
31	10/25/2021	Fox River at STH 20/30 Waterford	10032437	N	14.8	0.00588F	0.0576
31	10/25/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.00421F	0.0151F
31	10/25/2021	Fox River at CTH ES	10046937	N	26.8	0.00858F	0.0783
32	11/9/2021	Fox River at Case Eagle Park Bridge	10053867	N	13.0	0.00359F	0.0412
32	11/9/2021	Fox River at STH 20/30 Waterford	10032437	N	7.60	0.00388F	0.0382
32	11/9/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	ND	0.0133F
32	11/9/2021	Fox River at CTH ES	10046937	N	7.60	0.00580F	0.0435
32	11/9/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	27.2	0.00431F	0.0724

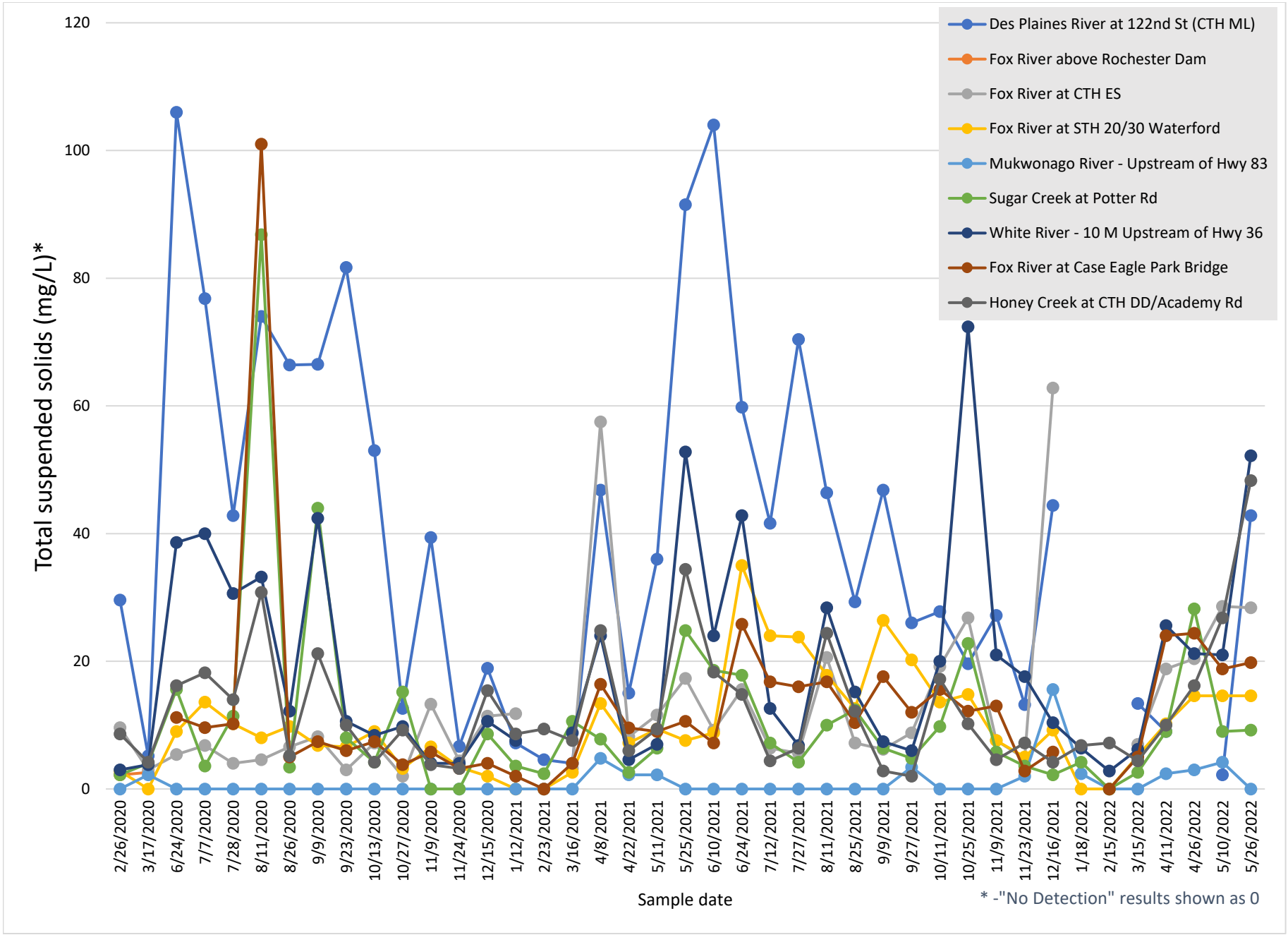
Sample #	Sample Date	Location	Site ID	Blank	TSS (mg/L) raw	Orthophosphorus (mg/L) raw	Total Phosphorus (mg/L) raw
32	11/9/2021	White River - 10 M Upstream of Hwy 36	10012203	Y	ND	ND	ND
32	11/9/2021	White River - 10 M Upstream of Hwy 36	10012203	N	21.0	0.0144	0.0597
32	11/9/2021	Sugar Creek at Potter Rd	10029083	N	5.80	0.00860F	0.0412
32	11/9/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	4.60	0.00971F	0.0319
33	11/23/2021	Fox River at CTH ES	10046937	N	4.80	0.00397F	0.0290F
33	11/23/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	13.2	ND	0.0454
33	11/23/2021	White River - 10 M Upstream of Hwy 36	10012203	N	17.6	0.00473F	0.0448
33	11/23/2021	Sugar Creek at Potter Rd	10029083	Y	ND	ND	ND
33	11/23/2021	Sugar Creek at Potter Rd	10029083	N	3.60	0.00502F	0.0251F
33	11/23/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	7.20	0.00612F	0.0288F
33	11/23/2021	Fox River at Case Eagle Park Bridge	10053867	N	2.80	ND	0.0262F
33	11/23/2021	Fox River at STH 20/30 Waterford	10032437	N	5.00	ND	0.0299F
33	11/23/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	2.00	ND	0.0137F
34	12/16/2021	Des Plaines River at 122nd St (CTH ML)	303054	N	44.4	0.0317	0.119
34	12/16/2021	White River - 10 M Upstream of Hwy 36	10012203	N	10.4	0.00918F	0.0584
34	12/16/2021	Sugar Creek at Potter Rd	10029083	N	2.20	0.00933F	0.0313
34	12/16/2021	Honey Creek at CTH DD/Academy Rd	10040134	N	4.20	0.00775F	0.0305
34	12/16/2021	Honey Creek at CTH DD/Academy Rd	10040134	Y			ND
34	12/16/2021	Fox River at Case Eagle Park Bridge	10053867	N	5.80	0.00427F	0.0400
34	12/16/2021	Fox River at STH 20/30 Waterford	10032437	N	9.20	0.00461F	0.0419
34	12/16/2021	Mukwonago River - Upstream of Hwy 83	10010534	N	15.6	0.00428F	0.0292F
34	12/16/2021	Fox River at CTH ES	10046937	N	62.8	0.0144	0.117
35	1/18/2022	White River - 10 M Upstream of Hwy 36	10012203	N	6.40	0.00522F	0.0281F
35	1/18/2022	Sugar Creek at Potter Rd	10029083	N	4.20	0.00548F	0.0186F
35	1/18/2022	Honey Creek at CTH DD/Academy Rd	10040134	N	6.80	0.0101	0.0269F
35	1/18/2022	Fox River at STH 20/30 Waterford	10032437	N	ND	0.00466F	0.0202F
35	1/18/2022	Mukwonago River - Upstream of Hwy 83	10010534	N	2.40	0.00393F	0.0142F
35	1/18/2022	Honey Creek at CTH DD/Academy Rd	10040134	Y	ND	ND	ND
36	2/15/2022	White River - 10 M Upstream of Hwy 36	10012203	N	2.80	ND	0.0221F
36	2/15/2022	Sugar Creek at Potter Rd	10029083	N	ND	ND	0.0158F
36	2/15/2022	Honey Creek at CTH DD/Academy Rd	10040134	N	7.20	0.00436F	0.0285F
36	2/15/2022	Fox River at Case Eagle Park Bridge	10053867	N	ND	ND	0.0179F
36	2/15/2022	Fox River at Case Eagle Park Bridge	10053867	Y	ND	ND	ND
36	2/15/2022	Fox River at STH 20/30 Waterford	10032437	N	ND	ND	0.0186F
36	2/15/2022	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	0.00414F	0.0143F
37	3/15/2022	Des Plaines River at 122nd St (CTH ML)	303054	N	13.4	ND	0.05
37	3/15/2022	White River - 10 M Upstream of Hwy 36	10012203	N	6.20	ND	0.0319
37	3/15/2022	Sugar Creek at Potter Rd	10029083	N	2.60	ND	0.0217F
37	3/15/2022	Honey Creek at CTH DD/Academy Rd	10040134	N	4.40	0.00416F	0.0290F
37	3/15/2022	Fox River at Case Eagle Park Bridge	10053867	N	5.00	ND	0.0499
37	3/15/2022	Fox River at STH 20/30 Waterford	10032437	Y	ND	ND	ND
37	3/15/2022	Fox River at STH 20/30 Waterford	10032437	N	5.20	ND	0.0507
37	3/15/2022	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	ND	0.0131F
37	3/15/2022	Fox River at CTH ES	10046937	N	7.00	0.00484F	0.0537
38	4/11/2022	Des Plaines River at 122nd St (CTH ML)	303054	N	9.00	0.0445	0.0950
38	4/11/2022	Sugar Creek at Potter Rd	10029083	N	9.00	0.00725F	0.0415

Sample #	Sample Date	Location	Site ID	Blank	TSS (mg/L) raw	Orthophosphorus (mg/L) raw	Total Phosphorus (mg/L) raw
38	4/11/2022	Fox River at Case Eagle Park Bridge	10053867	N	24.0	ND	0.0709
38	4/11/2022	Fox River at STH 20/30 Waterford	10032437	N	10.2	ND	0.0547
38	4/11/2022	Mukwonago River - Upstream of Hwy 83	10010534	N	2.40	ND	0.0165F
38	4/11/2022	Mukwonago River - Upstream of Hwy 83	10010534	Y	ND	ND	ND
38	4/11/2022	Fox River at CTH ES	10046937	N	18.8	0.0103F	0.0829
38	4/11/2022	White River - 10 M Upstream of Hwy 36	10012203	N	25.6	0.00611F	0.0557
38	4/11/2022	Honey Creek at CTH DD/Academy Rd	10040134	N	10.0	0.00519F	0.0415
39	4/26/2022	White River - 10 M Upstream of Hwy 36	10012203	N	21.2	0.00799F	0.0580
39	4/26/2022	Sugar Creek at Potter Rd	10029083	N	28.2	0.0232	0.0922
39	4/26/2022	Honey Creek at CTH DD/Academy Rd	10040134	N	16.2	0.00745F	0.0573
39	4/26/2022	Fox River at Case Eagle Park Bridge	10053867	N	24.4	0.00970F	0.0864
39	4/26/2022	Fox River at STH 20/30 Waterford	10032437	N	14.6	ND	0.0637
39	4/26/2022	Mukwonago River - Upstream of Hwy 83	10010534	N	3.00	ND	0.0210F
39	4/26/2022	Fox River at CTH ES	10046937	N	20.4	0.0103F	0.0785
39	4/26/2022	Fox River at CTH ES	10046937	Y	ND	ND	ND
40	5/10/2022	Des Plaines River at 122nd St (CTH ML)	303054	N	2.20	0.00471F	0.0525
40	5/10/2022	White River - 10 M Upstream of Hwy 36	10012203	N	21.0	ND	0.0544
40	5/10/2022	Honey Creek at CTH DD/Academy Rd	10040134	N	26.8	0.00653F	0.0772
40	5/10/2022	Sugar Creek at Potter Rd	10029083	N	9.00	0.00416F	0.0431
40	5/10/2022	Fox River at Case Eagle Park Bridge	10053867	N	18.8	ND	0.0582
40	5/10/2022	Fox River at STH 20/30 Waterford	10032437	N	14.6	ND	0.0573
40	5/10/2022	Mukwonago River - Upstream of Hwy 83	10010534	N	4.20	ND	0.0190F
40	5/10/2022	Fox River at CTH ES	10046937	N	28.6	0.00818F	0.0910
41	5/26/2022	Des Plaines River at 122nd St (CTH ML)	303054	Y	ND	ND	ND
41	5/26/2022	Des Plaines River at 122nd St (CTH ML)	303054	N	42.8	0.0280	0.130
41	5/26/2022	White River - 10 M Upstream of Hwy 36	10012203	N	52.2	0.0135	0.157
41	5/26/2022	Sugar Creek at Potter Rd	10029083	N	9.20	0.0130	0.0538
41	5/26/2022	Honey Creek at CTH DD/Academy Rd	10040134	N	48.3	0.00826F	0.0996
41	5/26/2022	Fox River at Case Eagle Park Bridge	10053867	N	19.8	ND	0.0845
41	5/26/2022	Fox River at STH 20/30 Waterford	10032437	N	14.6	ND	0.0705
41	5/26/2022	Mukwonago River - Upstream of Hwy 83	10010534	N	ND	ND	0.0198F
41	5/26/2022	Fox River at CTH ES	10046937	N	28.4	0.00515F	0.0898


Des Plaines River at 122nd St (CTH ML)
Fox River above Rochester Dam
Fox River at CTH ES
Fox River at STH 20/30 Waterford
Mukwonago River - Upstream of Hwy 83
Sugar Creek at Potter Rd
White River - 10 M Upstream of Hwy 36
Fox River at Case Eagle Park Bridge
Honey Creek at CTH DD/Academy Rd
Total Phosphorous (mg/L)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2/26/2020
3/17/2020
6/24/2020
7/7/2020
7/28/2020
8/11/2020
8/26/2020
9/9/2020
9/23/2020
10/13/2020
10/27/2020
11/9/2020
11/24/2020
12/15/2020
1/12/2021
2/23/2021
3/16/2021
4/8/2021
4/22/2021
5/11/2021
5/25/2021
6/10/2021
6/24/2021
7/12/2021
7/27/2021
8/11/2021
8/25/2021
9/9/2021
9/27/2021
10/11/2021
10/25/2021
11/9/2021
11/23/2021
12/16/2021
1/18/2022
2/15/2022
3/15/2022
4/11/2022
4/26/2022
5/10/2022
5/26/2022
Sample date



Appendix B - Sample Results


Total suspended solids (mg/L)*
120
100
80
60
40
20
0
2/26/2020
3/17/2020
6/24/2020
7/7/2020
7/28/2020
8/11/2020
8/26/2020
9/9/2020
9/23/2020
10/13/2020
10/27/2020
11/9/2020
11/24/2020
12/15/2020
1/12/2021
2/23/2021
3/16/2021
4/8/2021
4/22/2021
5/11/2021
5/25/2021
6/10/2021
6/24/2021
7/12/2021
7/27/2021
8/11/2021
8/25/2021
9/9/2021
9/27/2021
10/11/2021
10/25/2021
11/9/2021
11/23/2021
12/16/2021
1/18/2022
2/15/2022
3/15/2022
4/11/2022
4/26/2022
5/10/2022
5/26/2022
Sample date
Des Plaines River at 122nd St (CTH ML)
Fox River above Rochester Dam
Fox River at CTH ES
Fox River at STH 20/30 Waterford
Mukwonago River - Upstream of Hwy 83
Sugar Creek at Potter Rd
White River - 10 M Upstream of Hwy 36
Fox River at Case Eagle Park Bridge
Honey Creek at CTH DD/Academy Rd
* -"No Detection" results shown as 0

APPENDIX B

WATER QUALITY MONITORING RESULTS FOR THE FOX ILLINOIS RIVER BASIN TMDL

1. WATER QUALITY SAMPLES FOR ALL MONTHS

Samples at the monitoring sites were collected during every month of the year. Table B.1 summarizes the number of samples collected at each site, and Figure B.1 shows the dates at which samples were collected at each site. The gap in samples between March and July 2020 was due to field activities being stopped due to COVID-19.

Total phosphorus, orthophosphate, and total suspended solids concentrations for all samples in all months collected are summarized in Tables B.2 to B.4. In the tables, 'Min' is the minimum value measured, 'Q1' is the value at which 25% of sample were smaller, the 'Median' is the median, 'Q3' is the value at which 25% of the samples were greater, and 'Max' represents the maximum value measured. Figures B.2 to B.4 provide a visual summary of the values in the tables. The vertical lines represent – from left to right – Q1, the median, and Q3. The vertical bars represent the approximate spread of the data. The points on the figure represent outliers based on a log-transformed measurements.

TABLE B.1

Summary of Samples Collected During Monitoring Period

		Number of Samples		
SWIMS ID	Station Name	TP	Ortho-P	TSS
683205	Fox River - Ds Sunset Dr Bridge (Waukesha)	40	-	40
683096	Fox River at Cth I Bridge	24	23	24
10046937	Fox River at CTH ES	43	41	43
10032437	Fox River at STH 20/30 Waterford	46	45	46
10053867	Fox River at Case Eagle Park Bridge	43	42	43
303066	Fox River (II) - Nr New Munster Cthjb	24	24	24
10010534	Mukwonago River (1) - Upstream of HWY 83	35	34	35
643555	Muskego (Big Muskego) Lake - Outlet Near Wind Lake	41	-	41
10013090	Wind Lake Canal_Wind Lake Upstream To Ceasars Dam	38	-	38
10040134	Honey Creek 1400ft N of CTH DD/Academy Rd	46	45	46
10029083	Sugar Creek at Potter Road	44	43	44
10012203	White River - 10 M Upstream Of Hwy 36	46	45	46
303054	Des Plaines River at 122nd St (CTH ML)	37	37	37

FIGURE B.1

Timing of Samples Collected During Monitoring Period

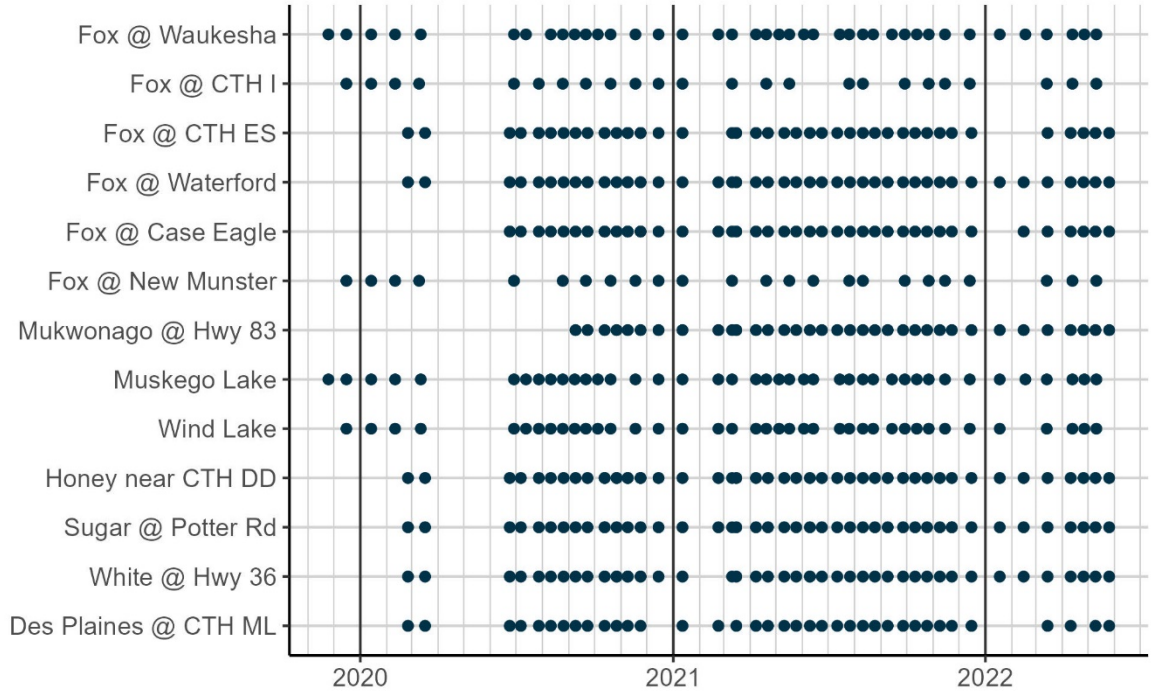


TABLE B.2

Total Phosphorus Concentrations at Monitoring Sites (All Samples)

		TP Concentration (µg/L)				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
683205	Fox @ Waukesha	36	60	81	111	191
683096	Fox @ CTH I	27	68	79	97	147
10046937	Fox @ CTH ES	29	67	82	98	181
10032437	Fox @ Waterford	19	35	51	81	144
10053867	Fox @ Case Eagle	18	41	59	83	362
303066	Fox @ New Munster	29	41	62	85	163
10010534	Mukwonago @ Hwy 83	12	14	16	19	29
643555	Muskego Lake	19	26	32	49	171
10013090	Wind Lake	16	23	29	38	149
10040134	Honey near CTH DD	25	33	48	77	160
10029083	Sugar @ Potter Rd	5	33	51	87	302
10012203	White @ Hwy 36	6	40	58	100	225
303054	Des Plaines @ CTH ML	37	76	130	173	361

FIGURE B.2

Total Phosphorus Concentrations at Monitoring Sites (All Samples)

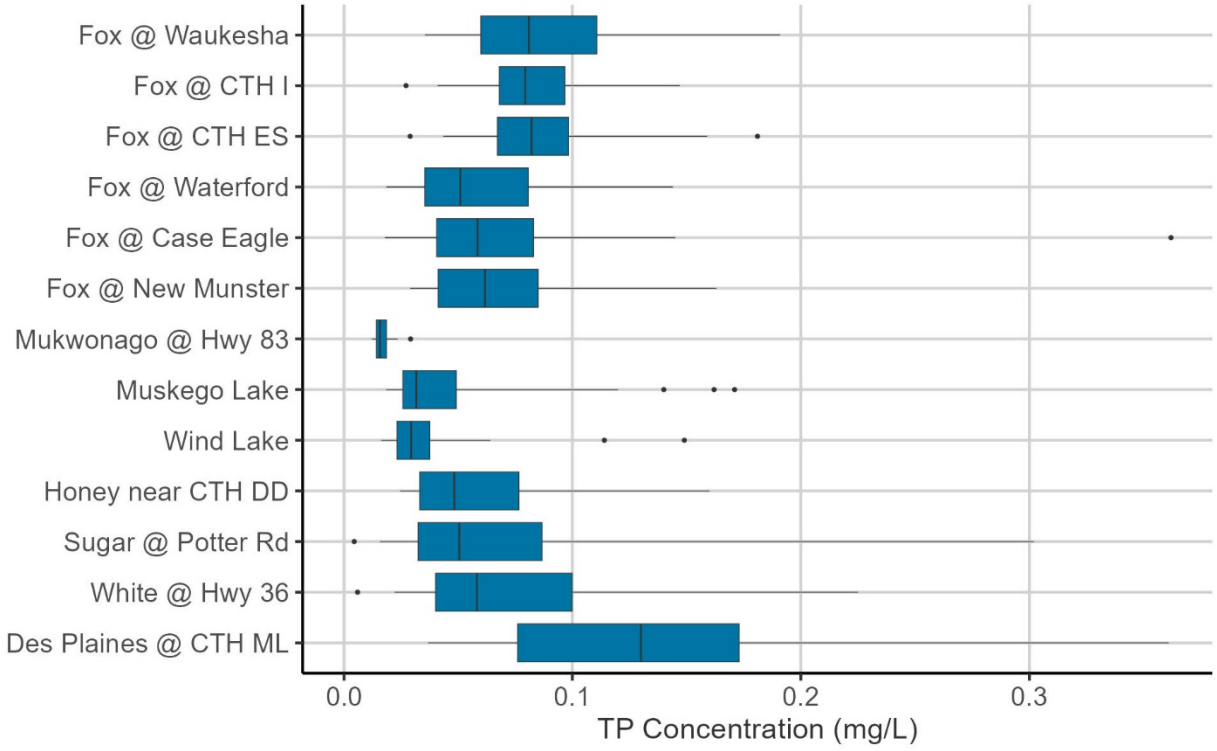


TABLE B.3

Orthophosphate Concentrations at Monitoring Sites (All Samples)

		DOP Concentration (µg/L)				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
683096	Fox @ CTH I	5.7	15.1	30.2	49.9	90.2
10046937	Fox @ CTH ES	4.0	12.7	32.0	48.9	80.2
10032437	Fox @ Waterford	1.5	3.4	7.6	17.1	69.6
10053867	Fox @ Case Eagle	1.2	3.4	8.5	20.9	182.0
303066	Fox @ New Munster	1.5	5.8	17.2	28.5	59.6
10010534	Mukwonago @ Hwy 83	1.2	2.0	4.1	8.9	41.7
10040134	Honey near CTH DD	4.2	8.7	19.4	29.1	52.7
10029083	Sugar @ Potter Rd	1.5	7.2	22.4	37.2	101.0
10012203	White @ Hwy 36	1.2	8.0	20.8	35.5	110.0
303054	Des Plaines @ CTH ML	1.5	10.7	18.5	41.2	92.6

FIGURE B.3

Orthophosphate Concentrations at Monitoring Sites (All Samples)

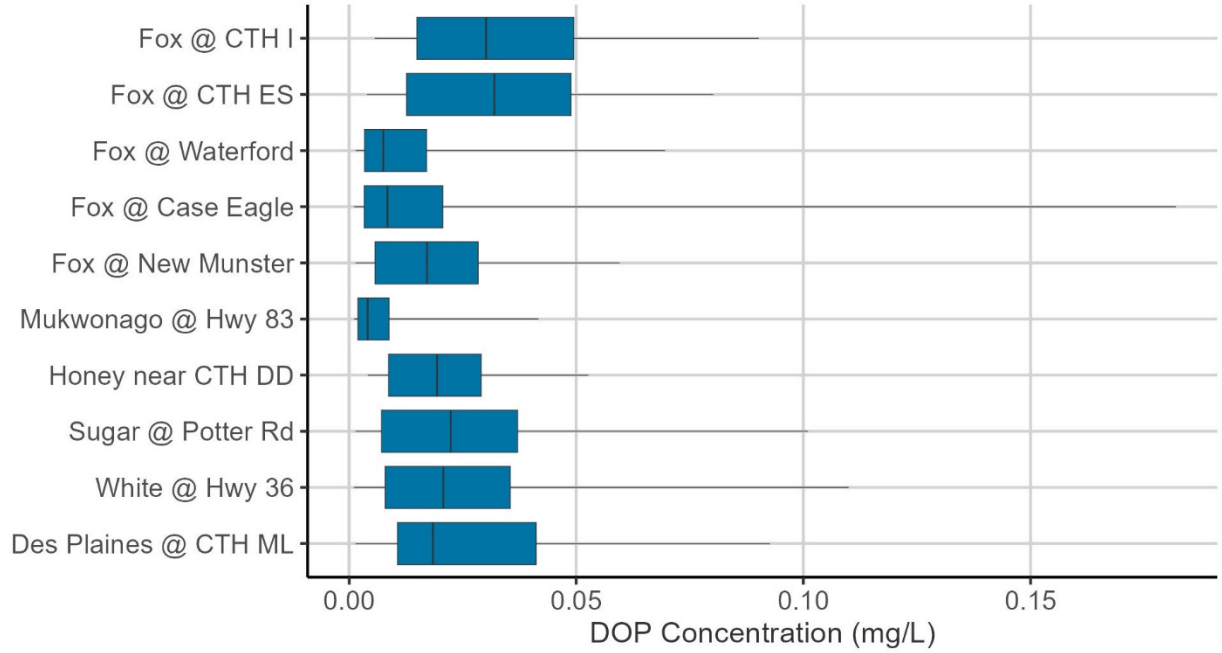
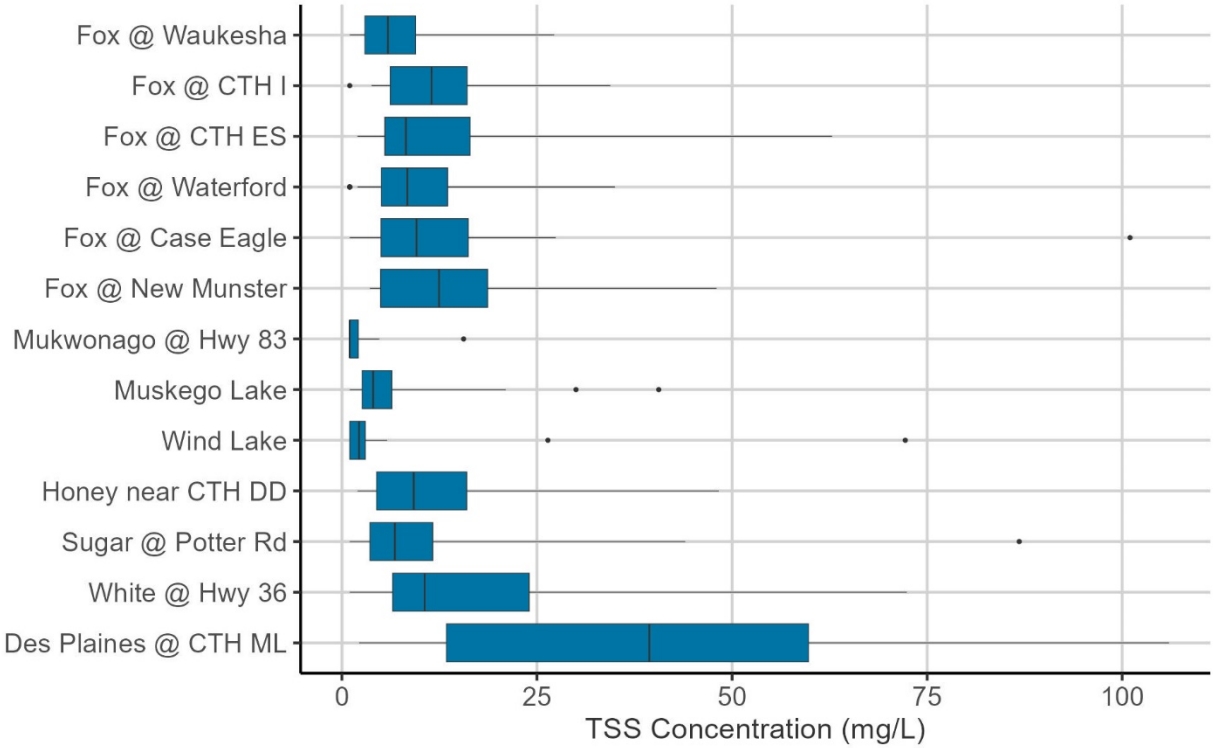


TABLE B.4

TSS Concentrations at Monitoring Sites (All Samples)

		TSS Concentration (mg/L)				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
683205	Fox @ Waukesha	1.0	3.0	5.9	9.5	27.2
683096	Fox @ CTH I	1.0	6.2	11.5	16.1	34.4
10046937	Fox @ CTH ES	2.0	5.5	8.2	16.5	62.8
10032437	Fox @ Waterford	1.0	5.1	8.4	13.6	35.0
10053867	Fox @ Case Eagle	1.0	5.0	9.6	16.2	101.0
303066	Fox @ New Munster	3.6	5	12.5	18.7	48
10010534	Mukwonago @ Hwy 83	1.0	1.0	1.0	2.1	15.6
643555	Muskego Lake	1.0	2.6	4.0	6.4	40.6
10013090	Wind Lake	1.0	1.0	2.2	3.0	72.2
10040134	Honey near CTH DD	2.0	4.5	9.2	16.0	48.3
10029083	Sugar @ Potter Rd	1.0	3.6	6.8	11.7	86.8
10012203	White @ Hwy 36	1.0	6.5	10.6	24.0	72.4
303054	Des Plaines @ CTH ML	2.2	13.4	39.4	59.8	106.0

FIGURE B.4
TSS Concentrations at Monitoring Sites (All Samples)



2. GROWING SEASON

Samples at the monitoring sites were collected during every month of the year, but they are summarized for only the months during the growing season, which spans from May 1st through October 31st. Table B.5 summarizes the number of samples collected during the growing season at each site. Results for samples collected during the growing season are summarized in Tables B.6 to B.8. In the tables, 'Min' is the minimum value measured, 'Q1' is the value at which 25% of sample were smaller, the 'Median' is the median, 'Q3' is the value at which 25% of the samples were greater, and 'Max' represents the maximum value measured. Figures B.5 to B.7 provide a visual summary of the values in the tables. The vertical lines represent – from left to right – Q1, the median, and Q3. The vertical bars represent the approximate spread of the data. The points on the figure represent outliers based on a log-transformed measurements.

TABLE B.5

Samples Collected During the Growing Season

		Number of Samples		
SWIMS ID	Station Name	TP	Ortho-P	TSS
683205	Fox River - Ds Sunset Dr Bridge (Waukesha)	21	-	21
683096	Fox River at Cth I Bridge	11	11	11
10046937	Fox River at CTH ES	25	24	25
10032437	Fox River at STH 20/30 Waterford	25	25	25
10053867	Fox River at Case Eagle Park Bridge	25	25	25
303066	Fox River (II) - Nr New Munster Cthjb	11	11	11
10010534	Mukwonago River (1) - Upstream of HWY 83	18	18	18
643555	Muskego (Big Muskego) Lake - Outlet Near Wind Lake	22	-	22
10013090	Wind Lake Canal_Wind Lake Upstream To Ceasars Dam	21	-	21
10040134	Honey Creek 1400ft N of CTH DD/Academy Rd	25	25	25
10029083	Sugar Creek at Potter Road	24	24	24
10012203	White River - 10 M Upstream Of Hwy 36	26	26	26
303054	Des Plaines River at 122nd St (CTH ML)	23	23	23

TABLE B.6

Total Phosphorus Concentrations at Monitoring Sites (Growing Season)

		TP Concentration (µg/L)				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
683205	Fox @ Waukesha	36	60	105	122	183
683096	Fox @ CTH I	41	64	89	95	147
10046937	Fox @ CTH ES	55	80	91	105	181
10032437	Fox @ Waterford	35	57	78	95	144
10053867	Fox @ Case Eagle	40	55	77	106	362
303066	Fox @ New Munster	32	66	74	100	163
10010534	Mukwonago @ Hwy 83	13	15	16	18	24
643555	Muskego Lake	25	29	49	105	171
10013090	Wind Lake	19	27	35	48	149
10040134	Honey near CTH DD	37	50	72	82	160
10029083	Sugar @ Potter Rd	41	50	70	94	302
10012203	White @ Hwy 36	6	56	84	121	225
303054	Des Plaines @ CTH ML	53	135	164	196	361

FIGURE B.5

Total Phosphorus Concentrations at Monitoring Sites (Growing Season)

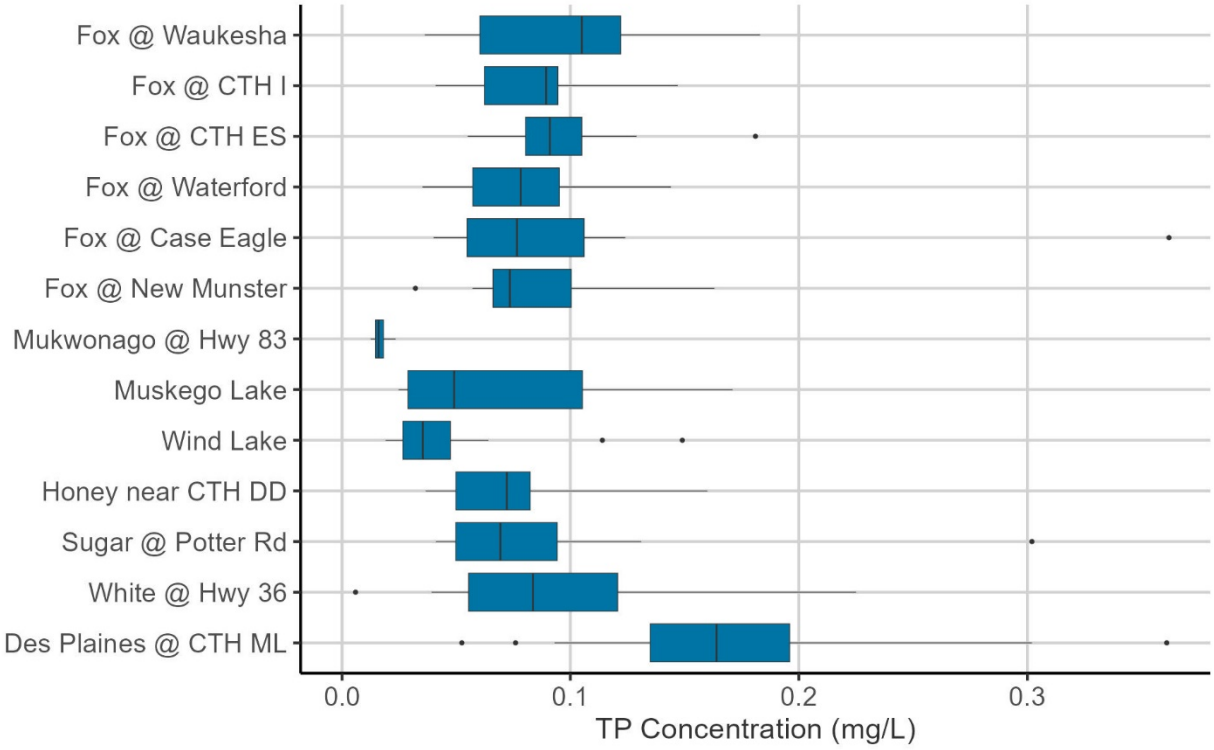


TABLE B.7

Orthophosphate Concentrations at Monitoring Sites (Growing Season)

		DOP Concentration (µg/L)				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
683096	Fox @ CTH I	6.5	17.2	36.1	68.0	83.3
10046937	Fox @ CTH ES	5.2	21.4	45.1	55.7	75.2
10032437	Fox @ Waterford	1.5	5.4	14.5	34.8	69.6
10053867	Fox @ Case Eagle	1.5	4.2	14.6	32.3	182.0
303066	Fox @ New Munster	2	14.2	21	37.5	59.6
10010534	Mukwonago @ Hwy 83	1.5	3.2	4.6	8.9	26.4
10040134	Honey near CTH DD	6.5	15.3	22.9	34.3	52.2
10029083	Sugar @ Potter Rd	4.2	18.2	32.4	43.9	101.0
10012203	White @ Hwy 36	1.2	17.5	31.8	41.2	110.0
303054	Des Plaines @ CTH ML	4.7	13.5	31.5	49.2	92.6

FIGURE B.6

Orthophosphate Concentrations at Monitoring Sites (Growing Season)

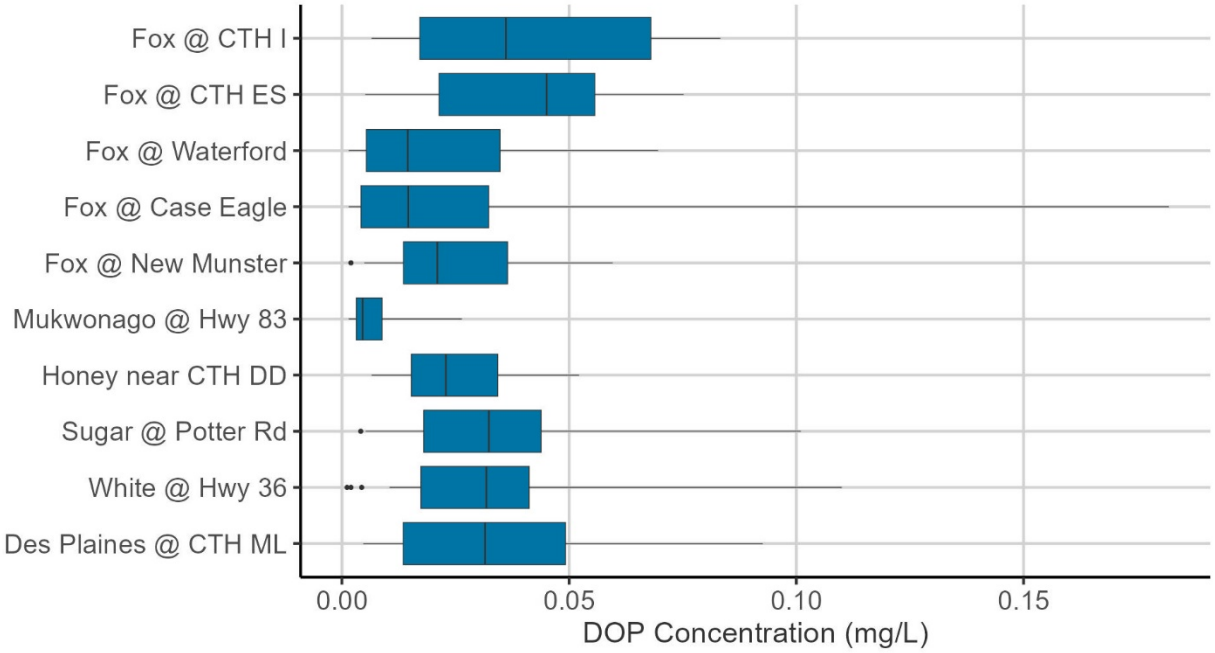


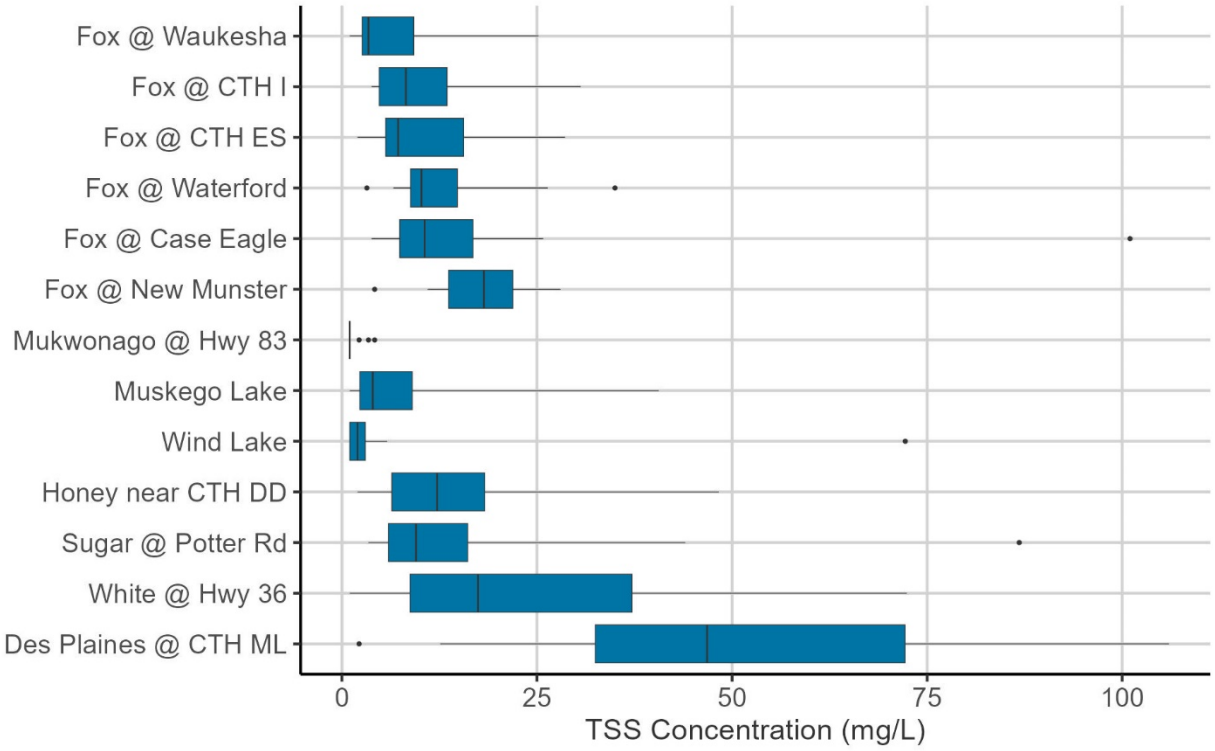
TABLE B.8

TSS Concentrations at Monitoring Sites (Growing Season)

		TSS Concentration (mg/L)				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
683205	Fox @ Waukesha	1.0	2.6	3.4	9.2	25.2
683096	Fox @ CTH I	3.8	4.8	8.2	13.5	30.6
10046937	Fox @ CTH ES	2.0	5.6	7.2	15.6	28.6
10032437	Fox @ Waterford	3.2	8.8	10.2	14.8	35.0
10053867	Fox @ Case Eagle	3.8	7.4	10.6	16.8	101.0
303066	Fox @ New Munster	4.2	13.8	18.2	21.9	28
10010534	Mukwonago @ Hwy 83	1.0	1.0	1.0	1.0	4.2
643555	Muskego Lake	1.0	2.3	4.0	9.2	40.6
10013090	Wind Lake	1.0	1.0	2.0	3.0	72.2
10040134	Honey near CTH DD	2.0	6.4	12.2	18.3	48.3
10029083	Sugar @ Potter Rd	3.4	6.0	9.5	16.2	86.8
10012203	White @ Hwy 36	1.0	8.8	17.6	37.3	72.4
303054	Des Plaines @ CTH ML	2.2	32.7	46.8	72.2	106.0

FIGURE B.7

TSS Concentrations at Monitoring Sites (Growing Season)



APPENDIX C

STAGE MONITORING RESULTS FOR THE FOX ILLINOIS RIVER BASIN TMDL

1. CALCULATION OF STAGE DATA FROM PRESSURE TRANSDUCERS

Calculating the depth of water above the pressure transducer required four primary sources of data: barometric pressure, air temperature, pressure from the pressure transducer, and water temperature. Barometric pressure and air temperature data were downloaded from the National Centers for Environmental Information for the Kenosha Regional Airport (GHCND:USW00004845). The difference in pressure between the pressure measured at the pressure transducer and the barometric pressure was calculated, and the pressure difference was converted to a water depth.

After the depth of water above the pressure transducer was calculated, the estimated stage was calculated. Stage refers to the water level relative to a fixed benchmark. When the pressure transducers were deployed and maintained, detailed surveys were conducted to determine if elevation of the pressure transducer changed since the previous survey. Details of the steps used to convert pressure transducer to stage data are provided below.

Step 1: Download pressure and water temperature data from pressure transducers and calculate hourly averages

Step 2: Download barometric pressure and temperature data from Kenosha airport weather station

Station Information:
Name: Kenosha Regional Airport
Site ID: GHCND:USW00004845; 7265004845
Latitude: 42.59529
Longitude: -87.9383
Elevation: 223.47 meters

Data source: https://www.ncei.noaa.gov/data/global-hourly/access/

Step 3: Adjust barometric pressure by elevation (Barometric formula)

$$P = P_b \times \exp\left[\frac{-g_0 \times M \times (h - h_b)}{R \times T_b}\right]$$

P: Pressure (kPa)
P_b: Reference pressure (kPa)
T_b: Reference temperature (K)
h: Adjusted elevation (m)
h_b: Reference elevation (m)
g_0: Gravitational acceleration (9.80665 m/s2)
M: Molar mass of Earth's air (0.028964 kg/mol)
R: Universal gas constant (8.3144598 J/(mol*K))

Step 4: Calculate water density at the measured temperature (Kell, 1975)

$$\rho = (999.83952 + 16.945176 \times T \quad - 7.9870401 \times 10^{-3} \times T^2 - 46.170461 \times 10^{-6} \times T^3 + 105.56302 \times 10^{-9} \times T^4 - 280.54253 \times 10^{-3} \times T^5) \div (1 + 16.8978550 \times 10^{-3} \times T)$$

ρ: Density (kg/m^3)
T: Temperature (deg-C)

Kell, G.S., 1975, Density, thermal expansivity, and compressibility of liquid water from 0C to 150C: Corrections and tables for atmospheric pressure and saturation reviewed and expressed on 1968 temperature scale: Journal of Chemical Engineering Data, v. 20, 97-105.

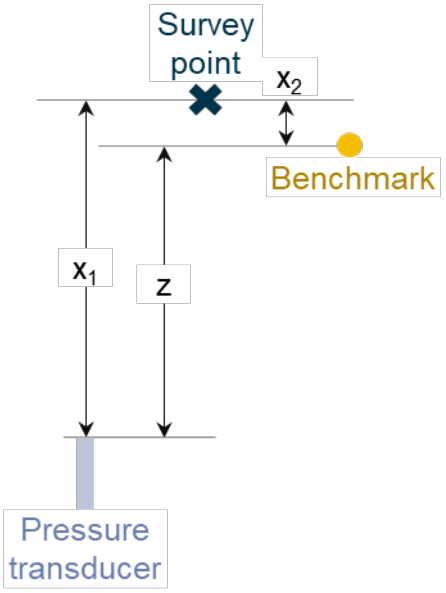
Step 5: Calculate depth of water above the pressure transducer by calculating difference between barometric pressure and pressure transducer data

$$d = \frac{(P_{pt} - P_{bp}) \times \alpha_{psi-kPa}}{\rho_w} \times \alpha_{in2-ft2}$$

d: Depth of water (ft)
P_{pt}: Pressure of pressure transducer (kPa)
P_{bp}: Barometric pressure at pressure transducer (Pa)
ρ_w: Density of water at measured water temperature (lb/ft^3)
$\alpha_{psi-kPa}$: Conversion factor for kPa to psi (0.1450377 psi/kPa)
$\alpha_{in2-ft2}$: Conversion factor for in^2 and ft^2 (144 in^2/ft^2)

Step 6: Calculate stage data using water depth and pressure transducer surveys

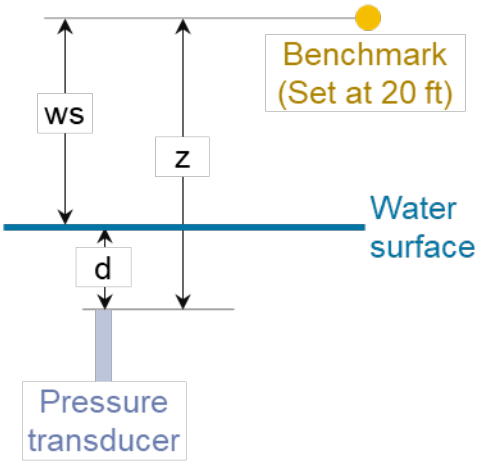
Step 6a: Calculate difference in elevation between benchmark and pressure transducer using survey data



x_1: Height difference between survey point and pressure transducer

x_2: Height difference between survey point and benchmark
z: Height difference between pressure transducer and benchmark (x_1-x_2)

Step 6b. Determine stage by calculating difference between benchmark and water surface elevation



z: Height difference between pressure transducer and benchmark
d: Depth of water above pressure transducer (calculated in Step 5)
ws: Height difference between benchmark and water surface (z-d)

Note: The stage is calculated by subtracting the height difference between the benchmark and water surface (ws) from the benchmark elevation, which is set at an arbitrary value of 20 ft to maintain a positive value of stage for all gages.

Step 6c. Adjust stage data to reflect the movement of the pressure transducer over time

Assuming the change in pressure transducer elevation over time is constant, the difference in pressure transducer elevation at the beginning and end of the deployment can be linearly interpolated over time. The stage is calculated over time by subtracting the depth from the elevation of the pressure transducer.

2. SUMMARY OF RESULTS FROM PRESSURE TRANSDUCER DATA

A summary of pressure transducer data at the five sites is provided in Table C.1. Note that the pressure transducers at the Fox River at CTH I and The Fox River at CTH ES have multiple rows in the table. The pressure transducers at these locations were moved for various reasons, which are outlined in the notes. The stage data corresponding to each row of Table C.1 are provided in Figures C.1 through C.8.

TABLE C.1

Summary of Pressure Transducer Data

			Stage (ft)			
Location	**Start Date**	**End Date**	**Mean**	**Min**	**Max**	**Notes**
Fox River at CTH I (Upstream)	1/9/2020	9/22/2020	5.44	3.83	8.57	The location of the pressure transducer was moved to a more suitable location on 9/22/2020
Fox River at CTH I (Downstream)	9/22/2020	6/22/2022	4.89	3.47	7.24	The original benchmark was lost between 5/10/2021 and 9/22/2021. The change in elevation of the pressure transducer could not be determined due to the missing benchmark. To account for the missing benchmark, an assumption was made that the pressure transducer did not change elevation during this time period. Additionally, on 9/22/2021, the pressure transducer was lowered by approximately 0.475 ft.
Fox River at CTH ES (Downstream #1)	11/18/2019	8/20/2020	5.28	3.84	7.31	Data between 11/18/2019 and 8/20/2020 may not be reliable due to malfunctions with the pressure transducer. Additionally, the pressure transducer was exposed to air at various times during the deployment, so data does not accurately reflect river stage. An additional pressure transducer was deployed to a more suitable site upstream of CTH ES on 11/19/2020.
Fox River at CTH ES (Downstream #2)	8/20/2020	6/22/2020	-	-	-	The pressure transducer was exposed to air at various times during the deployment, so data does not accurately reflect river stage. An additional pressure transducer was deployed to a more suitable site upstream of CTH ES on 11/19/2020.
Fox River at CTH ES (Upstream)	11/19/2020	6/22/2022	7.39	6.17	9.85	The pressure transducer was installed upstream of CTH ES to replace the original pressure transducer.
Honey Creek at Academy Road	11/11/2019	6/22/2022	8.91	7.97	11.81	Data from 7/10/2020 to 8/20/2020 are missing. Data from 9/6/2020 to 10/7/2020 are unusable due to issues with instrumentation.

			Stage (ft)			
Location	Start Date	End Date	Mean	Min	Max	Notes
Sugar Creek at Potter Road	11/11/2019	6/22/2022	8.59	7.58	11.51	Data from 7/10/2020 to 8/20/2020 are missing. Data from 1/20/2022 to 2/20/2022 are unusable due to ice impacts.
White River at Hwy 36	11/18/2019	6/22/2022	2.23	1.17	6.33	Data from 7/10/2020 to 8/20/2020 are missing.

FIGURE C.1

Stage Data for Fox River Upstream of Hwy I

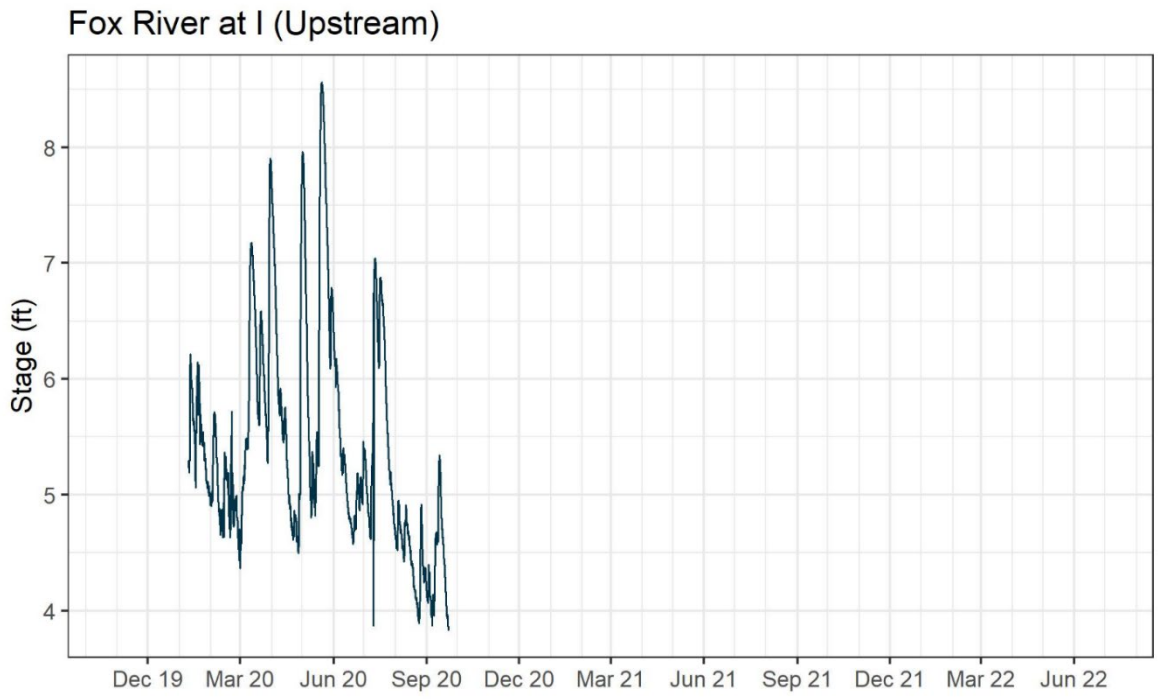


FIGURE C.2

Stage Data for Fox River Downstream of Hwy I

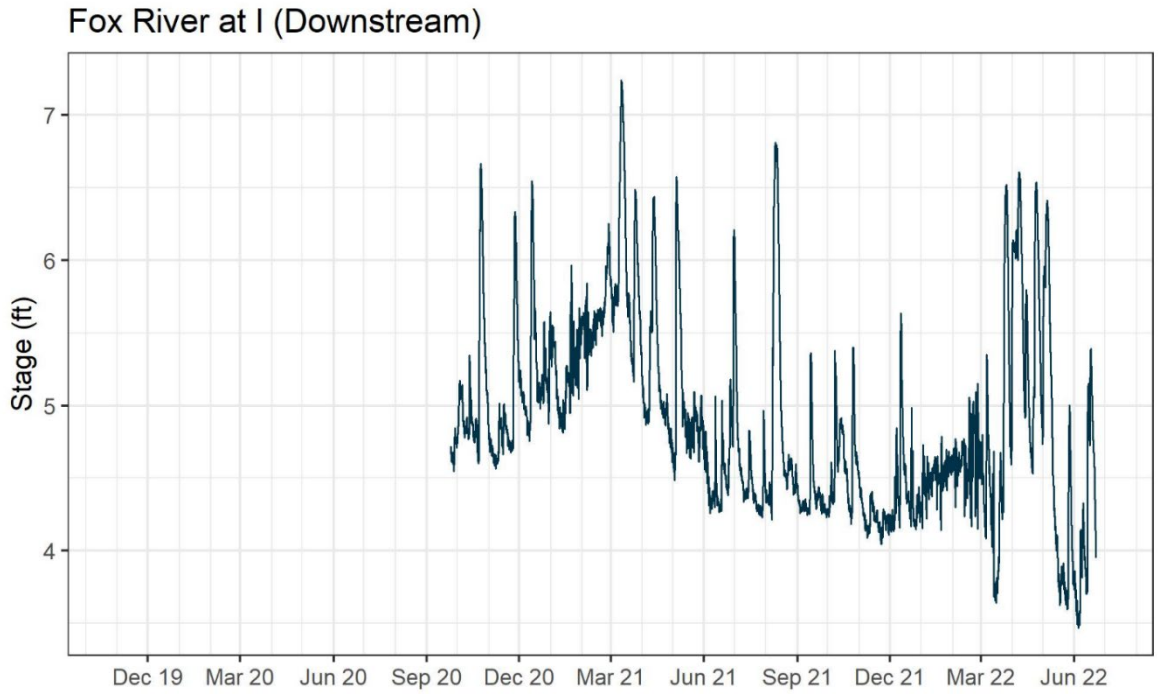


FIGURE C.3

Stage Data for Fox River Downstream of ES (Deployment #1)

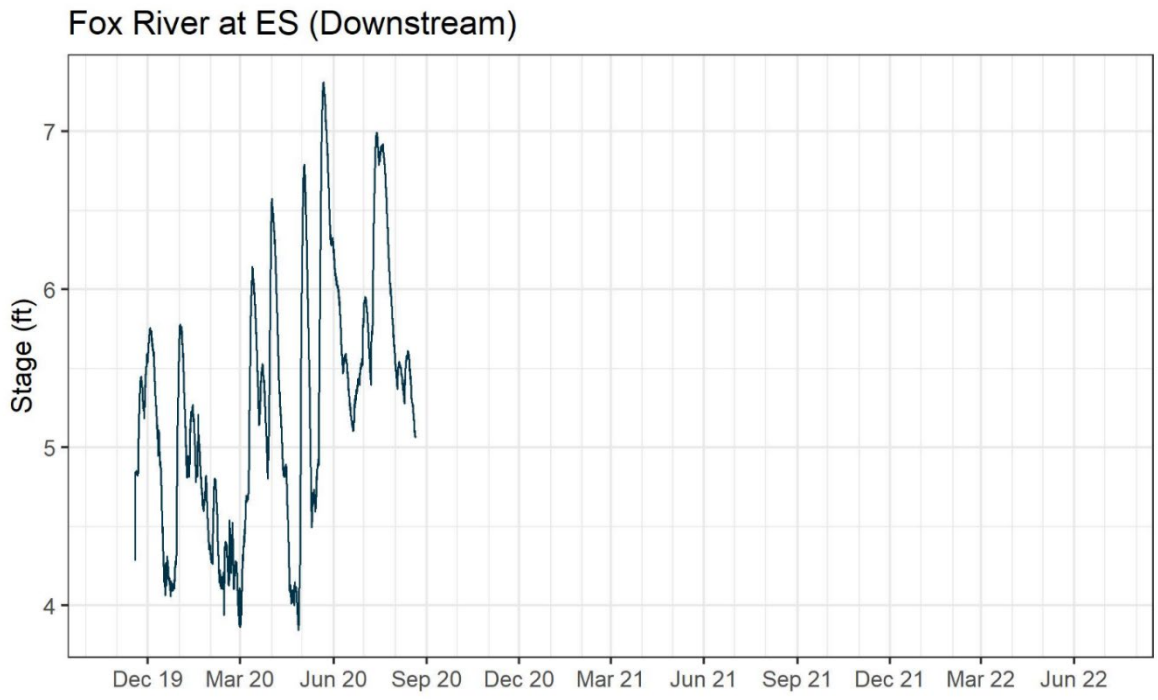


FIGURE C.4

Stage Data for Fox River Downstream of ES (Deployment #2)

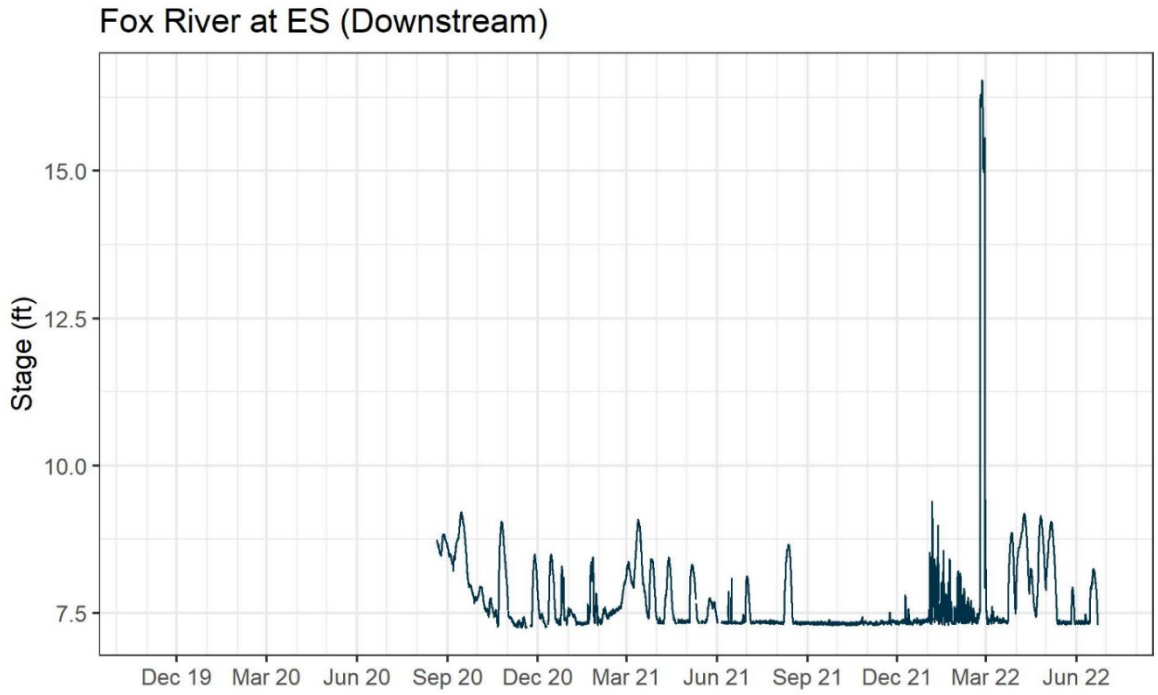


FIGURE C.5
Stage Data for Fox River Upstream of ES

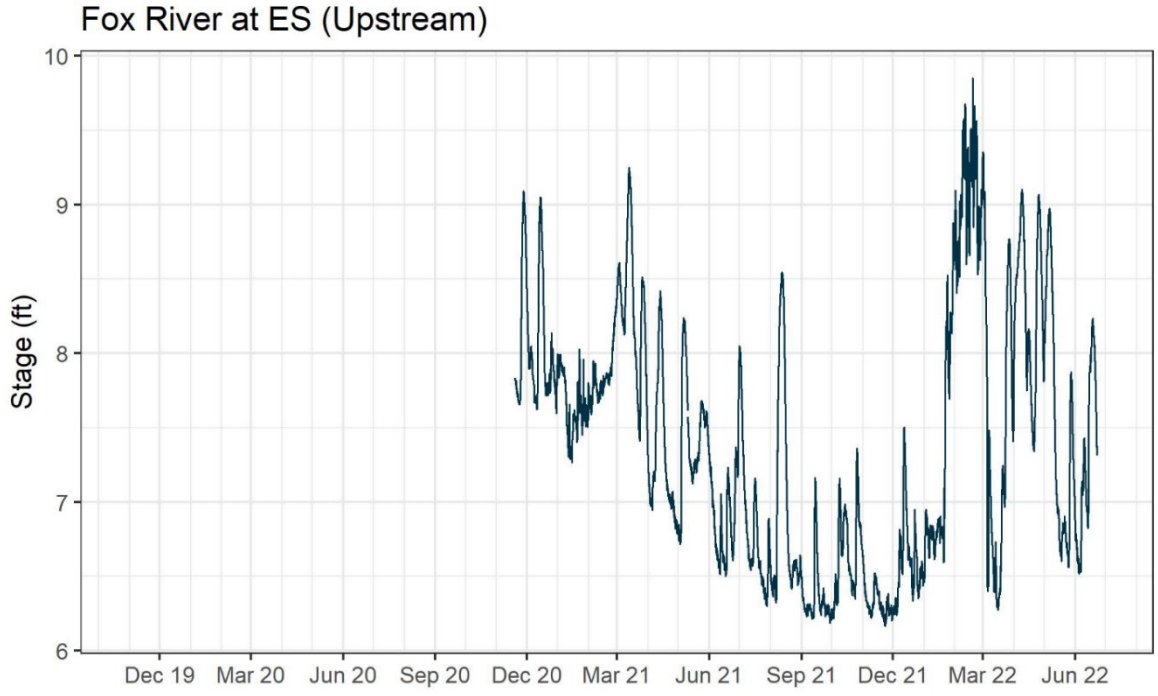


FIGURE C.6
Stage Data for Honey Creek at DD

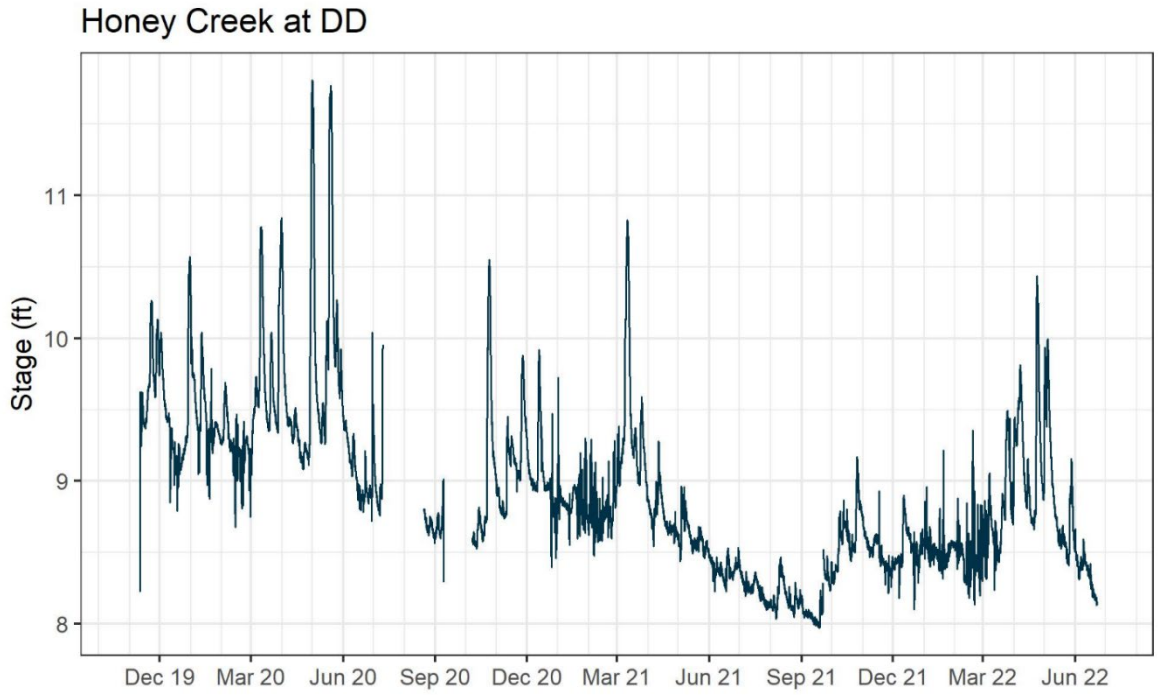


FIGURE C.7
Stage Data for Sugar Creek at Potter

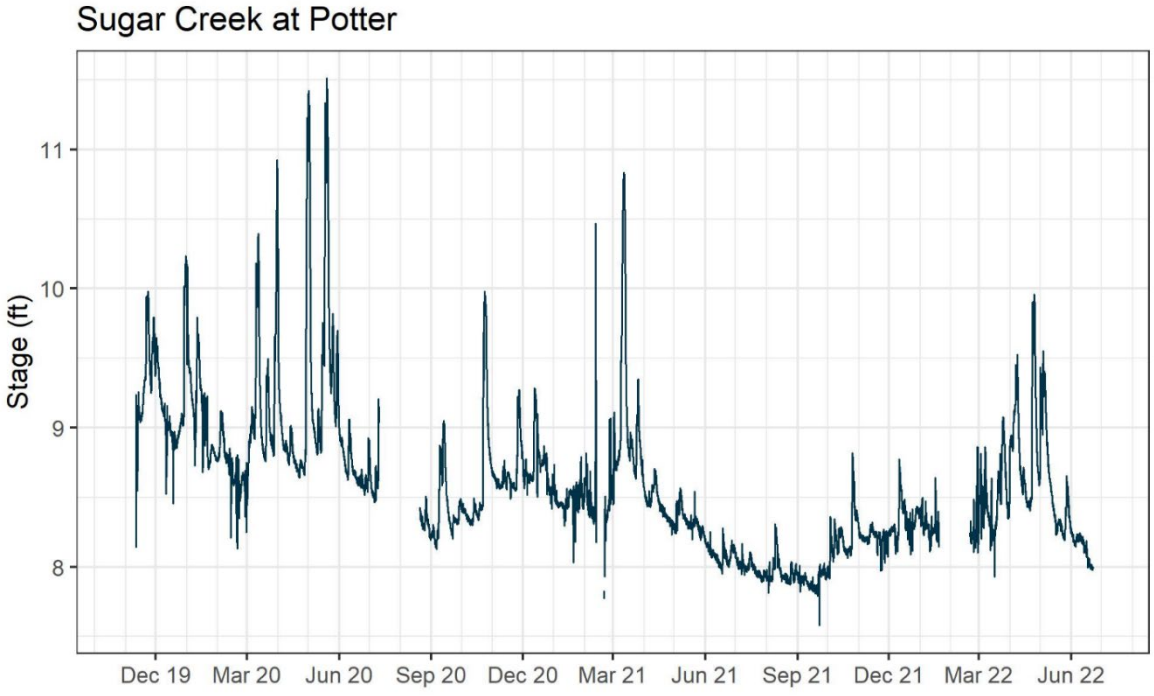
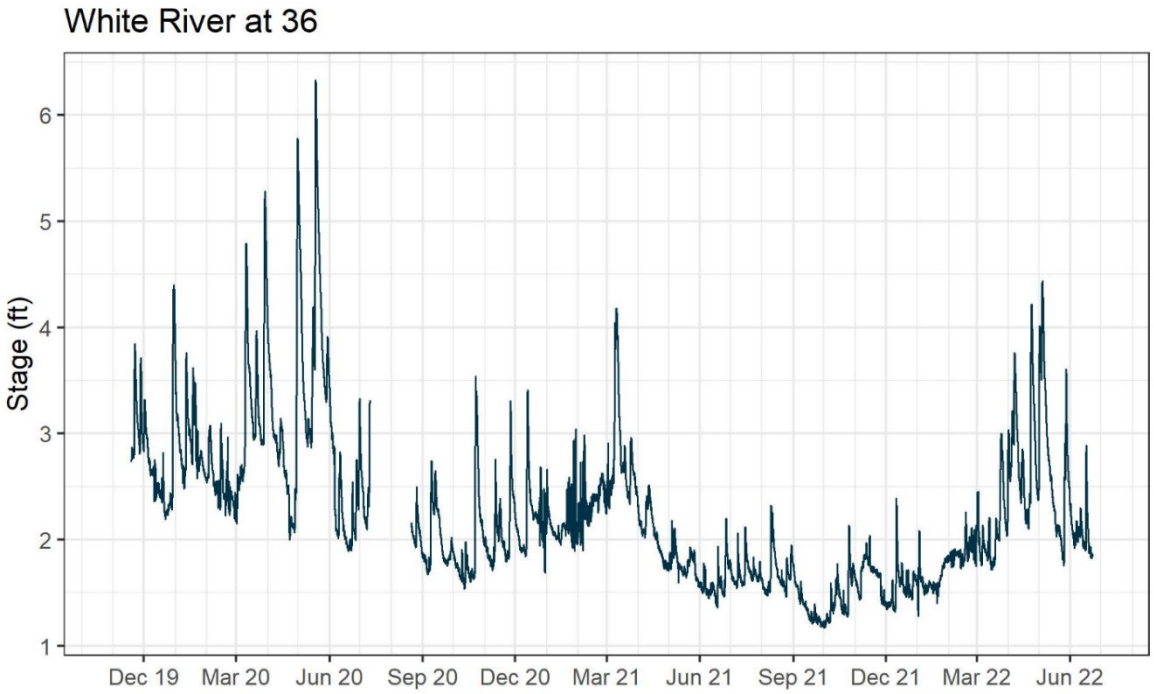


FIGURE C.8
Stage Data for White River at 36



APPENDIX D

FLOW MONITORING RESULTS FOR THE FOX ILLINOIS RIVER BASIN TMDL

Flow measurements were collected by the DNR at nine sites for the duration of the monitoring study. The goal for flow monitoring was to collect a measurement every month, but some barriers prevented samples from being collected in all months. Table D.1 summarizes circumstances that resulted in flow measurements not being collected. The results from the monitoring are summarized in Table D.2, and the results for each location are presented in Figures D.1 through D.9.

TABLE D.1
Causes of Missing Flow Measurements

Station	Missing PT	Ice	COVID	Meas. Inaccurate	Site Not Accessible	No/Low Flow	Total
Fox River at Cth I	2	3	2	0	3	0	10
Fox River at CTH ES	0	3	3	1	5	0	12
Fox River downstream of Waterford Dam	0	2	3	0	4	0	9
Fox River downstream of Rochester Dam	0	2	3	0	0	0	5
Muskego Canal at Muskego Dam Road	0	1	2	3	0	12	18
Wind Lake Outlet at South Wind Lake Road	0	3	3	1	0	9	16
Honey Creek at Academy Road	0	2	3	0	0	1	6
Sugar Creek at Potter Road	0	3	3	0	0	0	6
White River @ Hwy 36	0	3	3	0	0	1	7
Total	**2**	**22**	**25**	**5**	**12**	**23**	**89**

TABLE D.2
Summary of Flow Measurements Collected By DNR

Location	# Meas.	First Meas.	Last Meas.	Flow (cfs)		
				Median	Min	Max
Fox River at Cth I	23	1/14/2020	5/15/2022	133	56	626
Fox River at CTH ES	20	12/9/2019	5/15/2022	156	60	559
Fox River downstream of Waterford Dam	23	7/13/2020	5/15/2022	212	95	828
Fox River downstream of Rochester Dam	27	12/9/2019	5/15/2022	285	86	1564
Muskego Canal at Muskego Dam Road	13	12/9/2019	4/25/2022	32	-10	74
Wind Lake Outlet at South Wind Lake Road	14	12/9/2019	4/25/2022	69	2	131
Honey Creek at Academy Road	26	12/9/2019	5/15/2022	56	13	258
Sugar Creek at Potter Road	26	12/9/2019	5/15/2022	35	13	266
White River at Hwy 36	25	12/9/2019	5/15/2022	94	18	466

FIGURE D.1
Flow Measurements for Fox River at CTH I

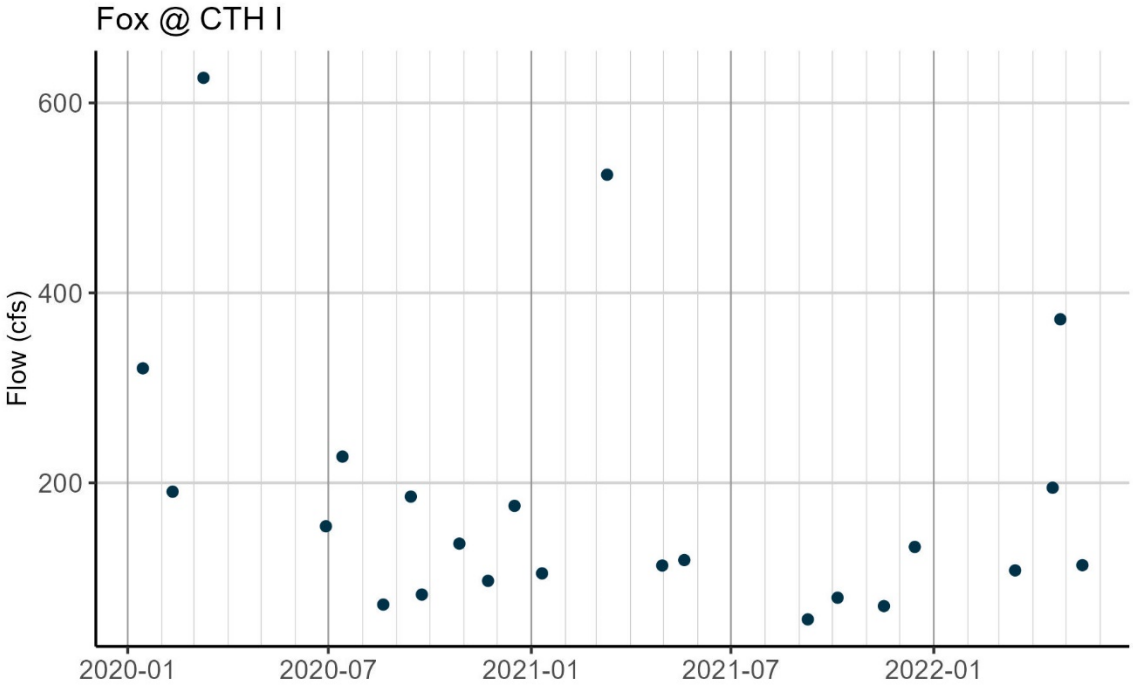


FIGURE D.2
Flow Measurements for Fox River at CTH ES

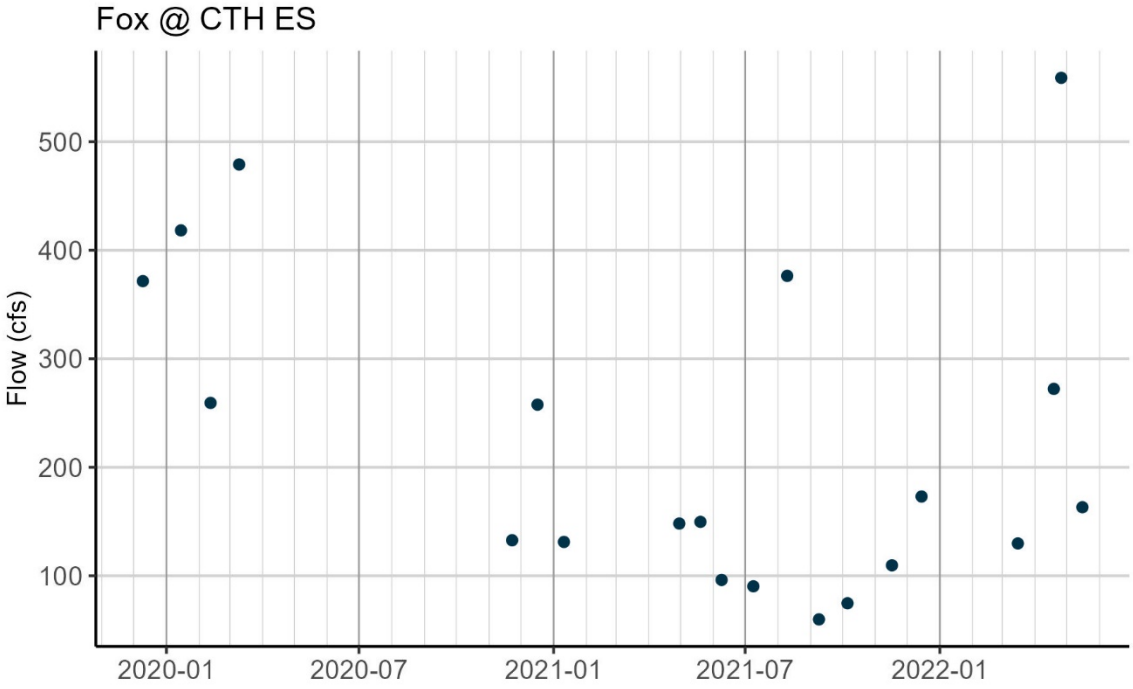


FIGURE D.3
Flow Measurements for Fox River at Waterford

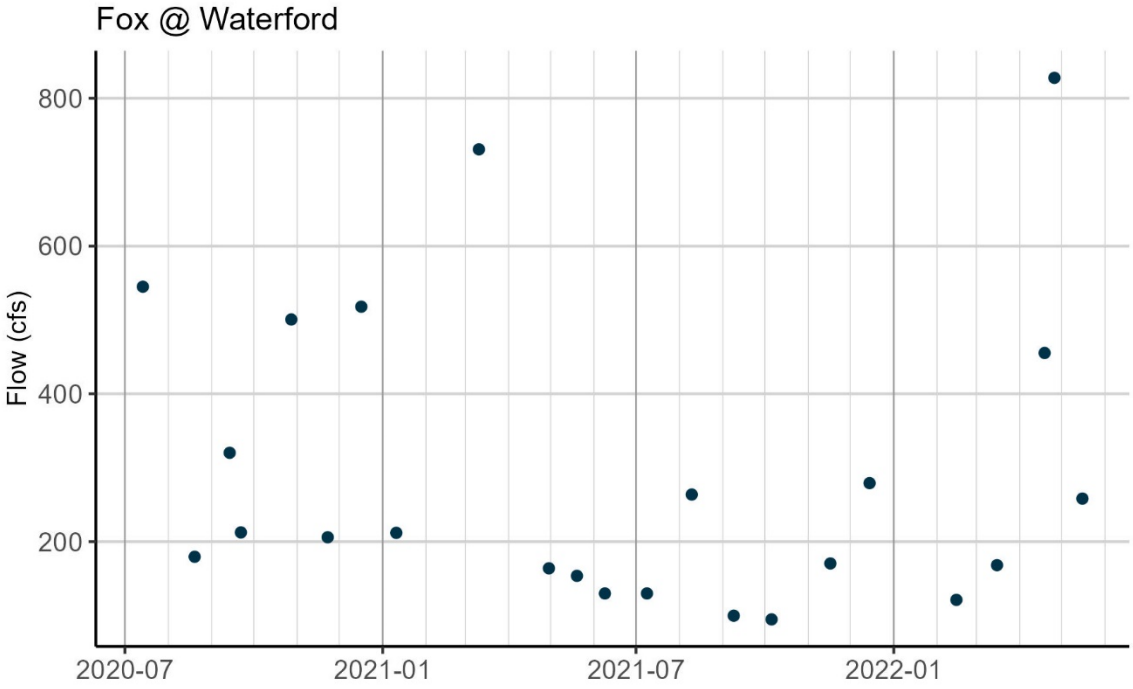


FIGURE D.4
Flow Measurements for Fox River at Rochester

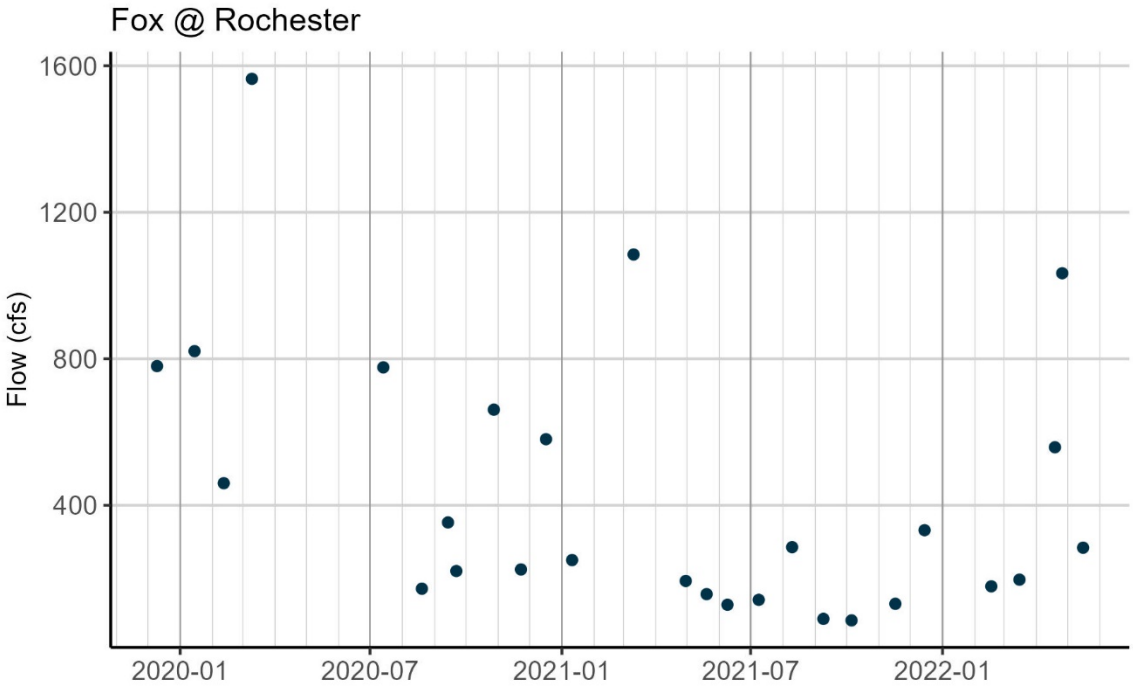


FIGURE D.5
Flow Measurements for Muskego Canal

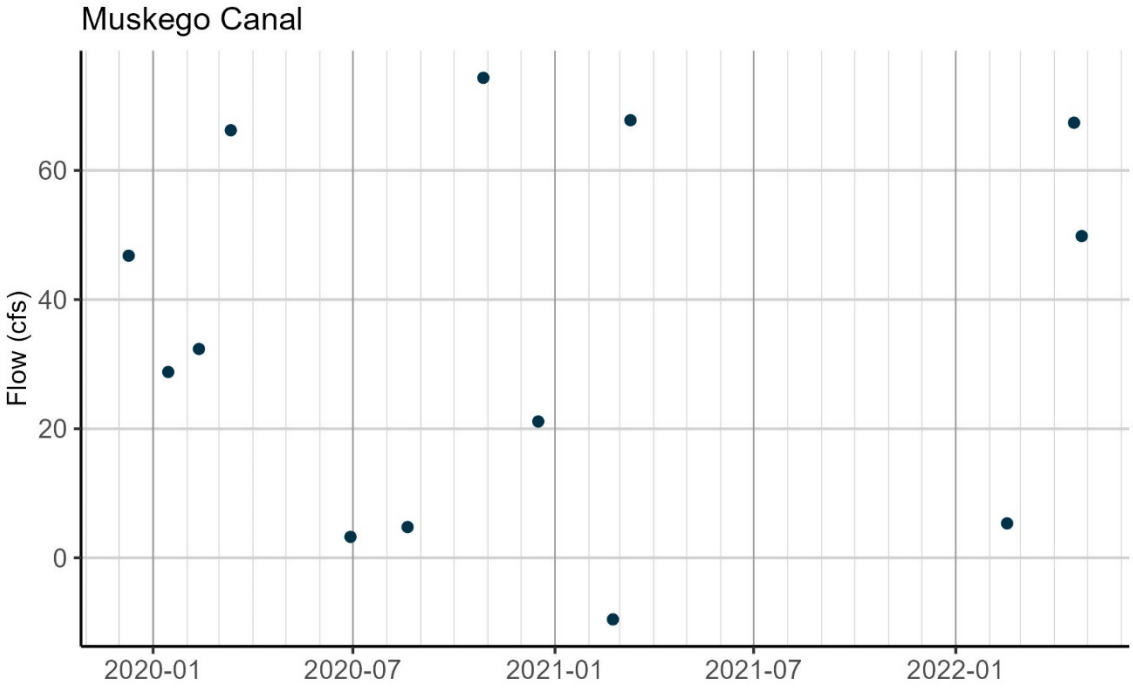


FIGURE D.6
Flow Measurements for Wind Lake Outlet

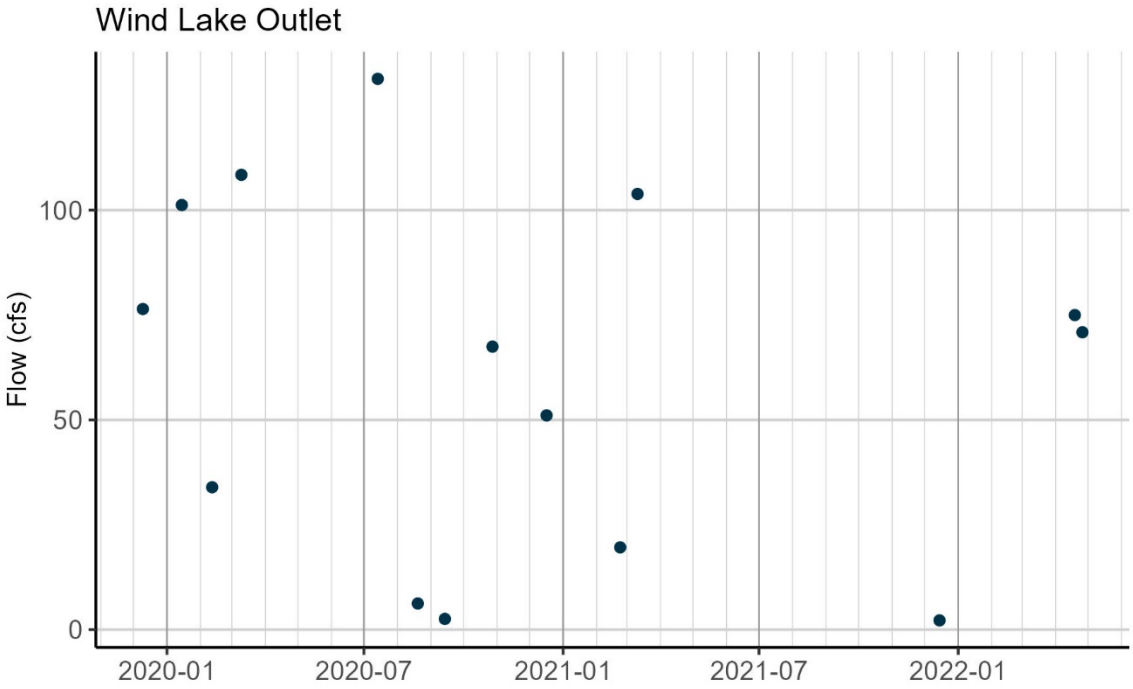


FIGURE D.7

Flow Measurements for Honey Creek at Academy Road

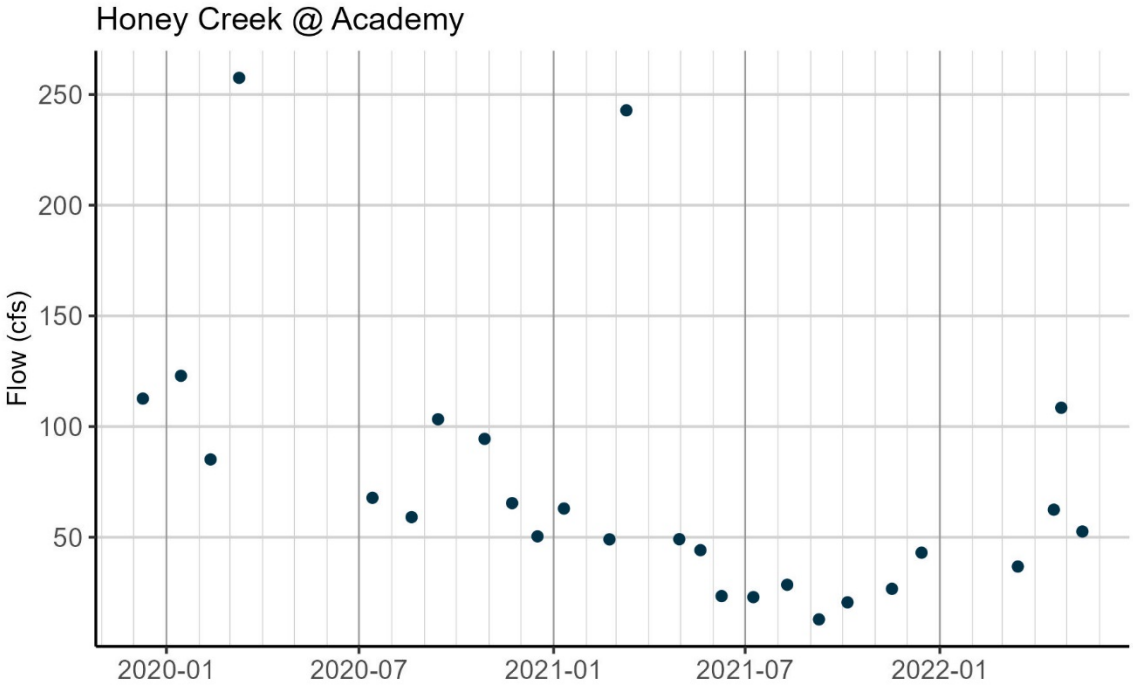


FIGURE D.8

Flow Measurements for Sugar Creek at Potter Road

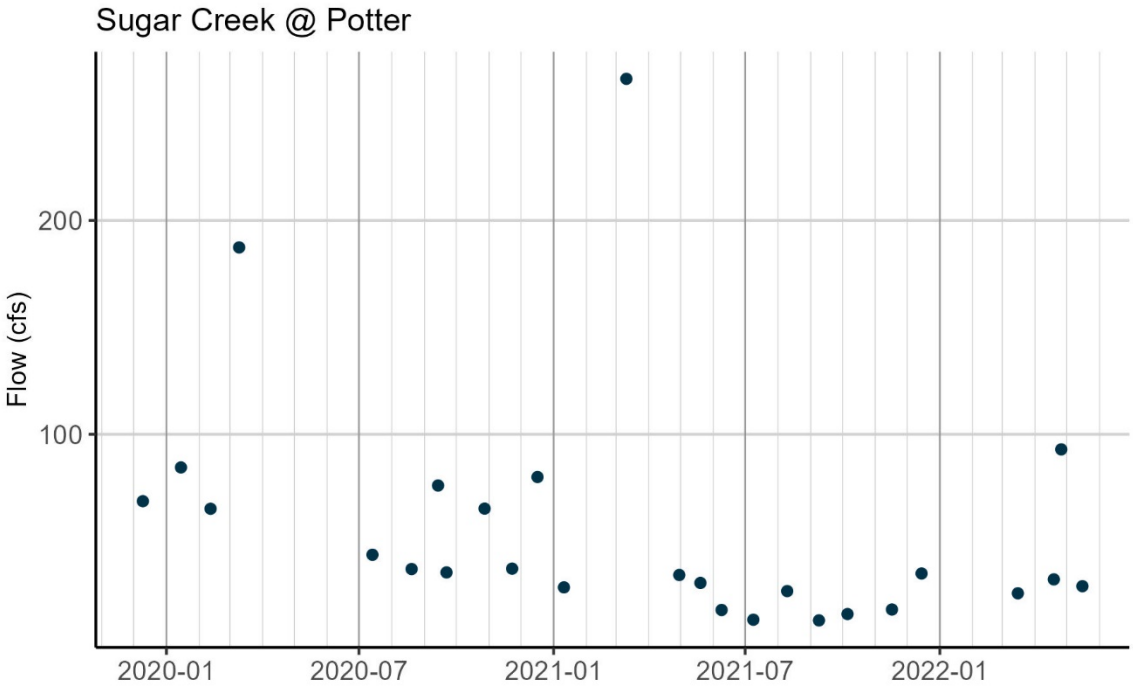
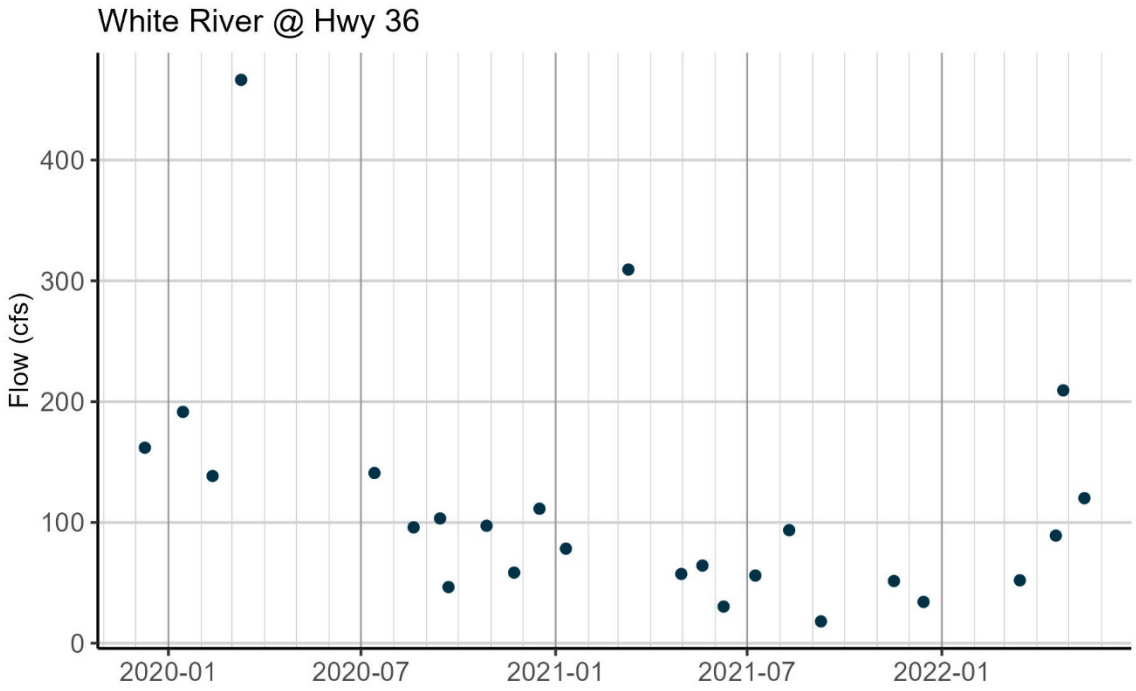


FIGURE D.9

Flow Measurements for White River at Highway 36



APPENDIX E

WDNR LONG-TERM TRENDS DATA IN THE FOX ILLINOIS RIVER BASIN TMDL STUDY AREA

The Department of Natural Resources maintains long-term monitoring stations to evaluate trends over time at specific stations across the state. Two of these locations – the Fox River below Waukesha and the Fox River near New Munster – are within the Fox Illinois River TMDL study site. Results from the long-term trends monitoring are summarized on the DNR's Long-Term River Water Quality web application. The estimated trends since 2012 for total phosphorus, orthophosphate, and total suspended solids are shown in Figures E.1 through E.3. Estimates of total phosphorus, orthophosphate, and total suspended solids for the two sites are summarized in Figures E.3 through E.15. All figures from the appendix are copied directly from DNR's Long-Term Trend application.

FIGURE E.1

Trend of Total Phosphorus for Sites in the Study Area (Since 2012)

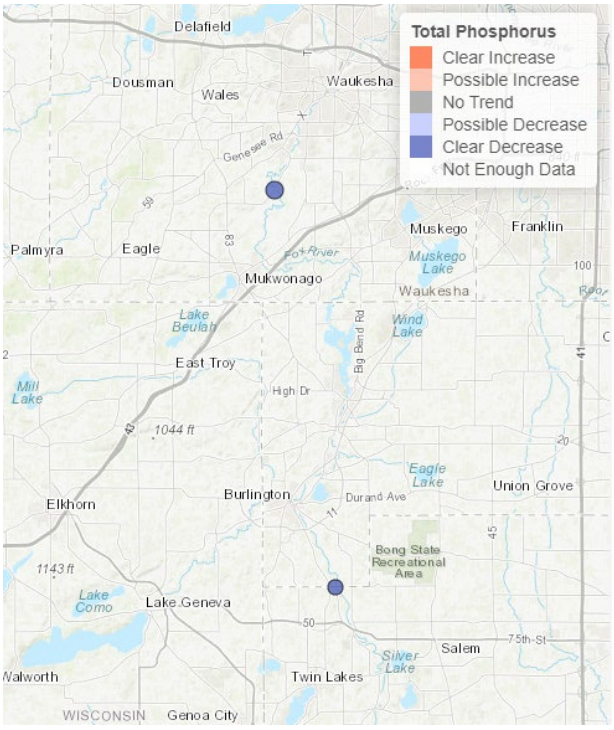


FIGURE E.2

Trend of Orthophosphate for Sites in the Study Area (Since 2012)

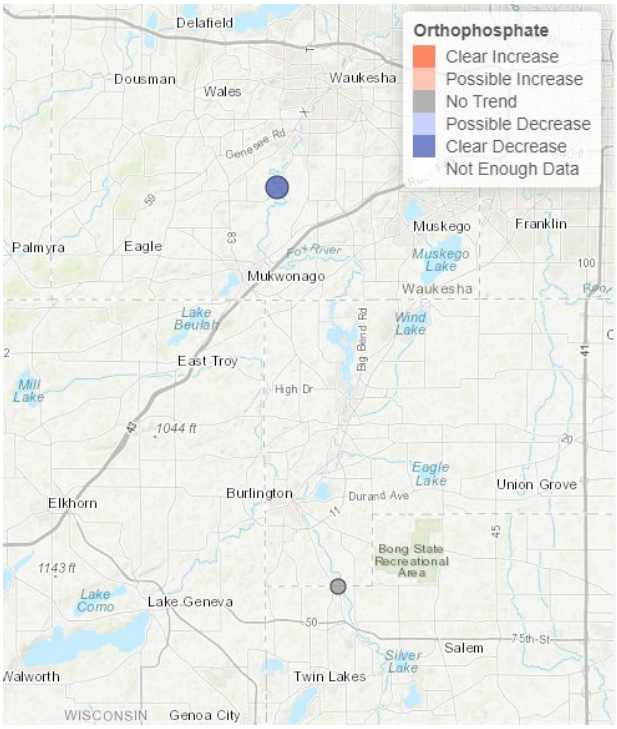


FIGURE E.3

Trend of Total Suspended Solids for Sites in the Study Area (Since 2012)

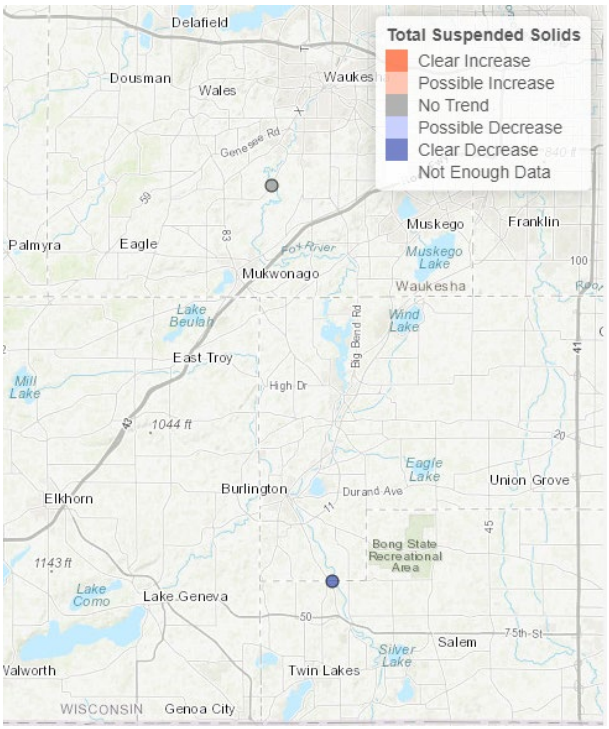


FIGURE E.4

Annual Trend of Total Phosphorus at Fox River below Waukesha

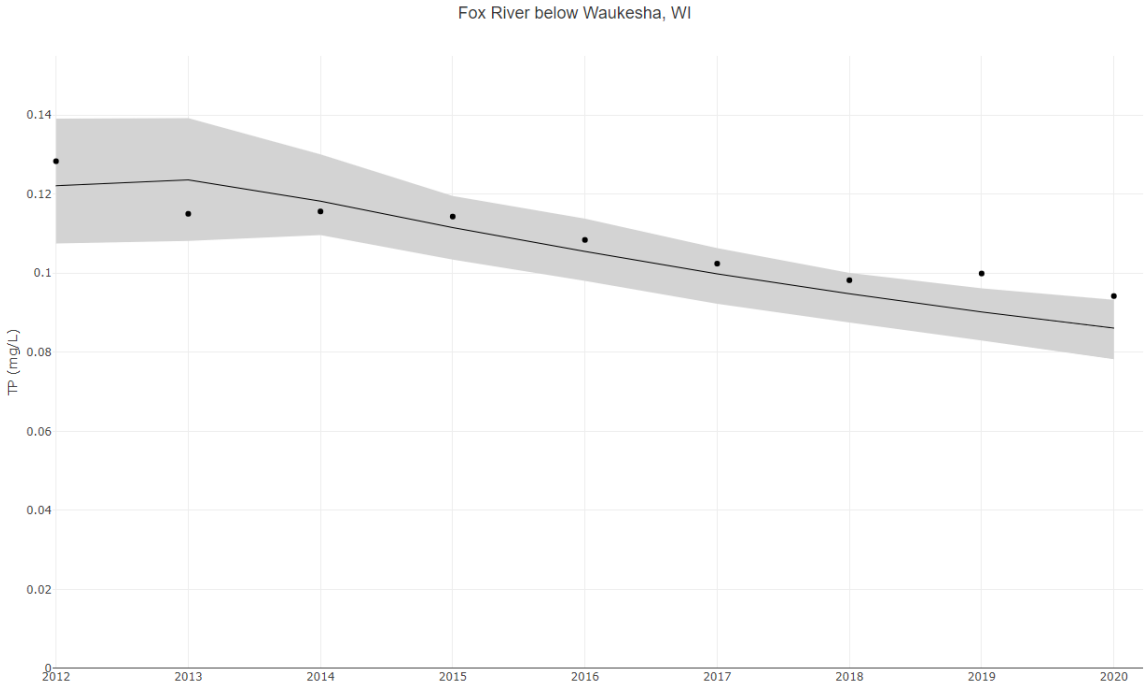


FIGURE E.5

Daily Total Phosphorus and Flows at Fox River below Waukesha

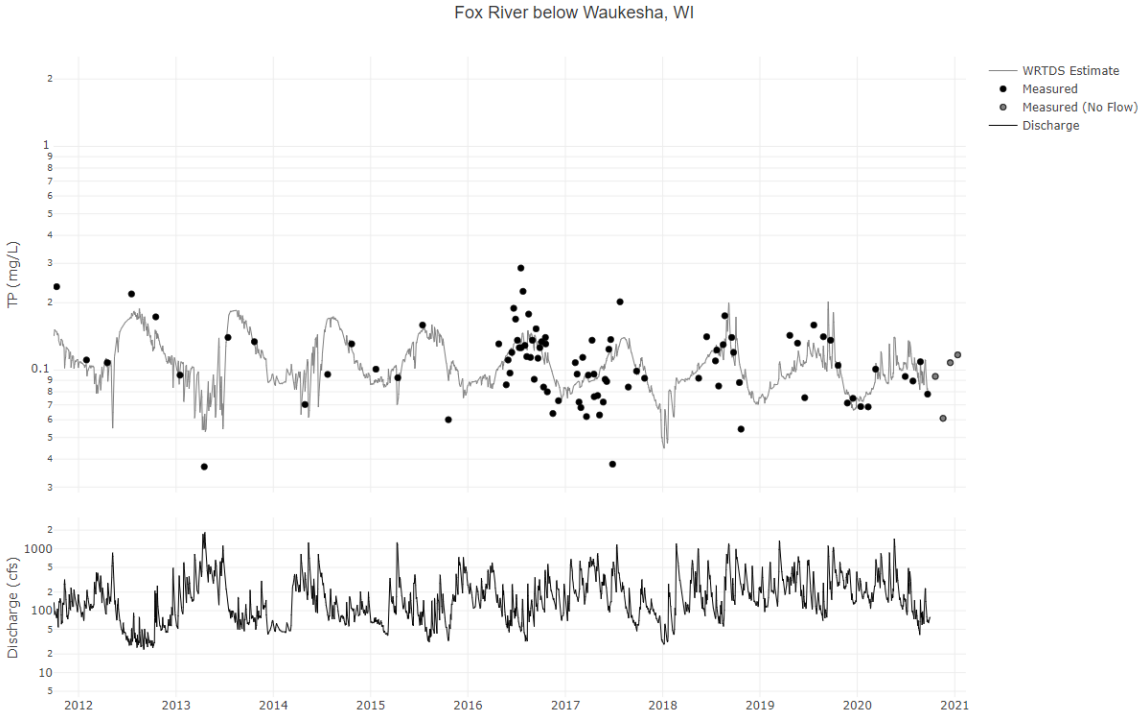


FIGURE E.6

Annual Trend of Total Phosphorus at Fox River near New Munster

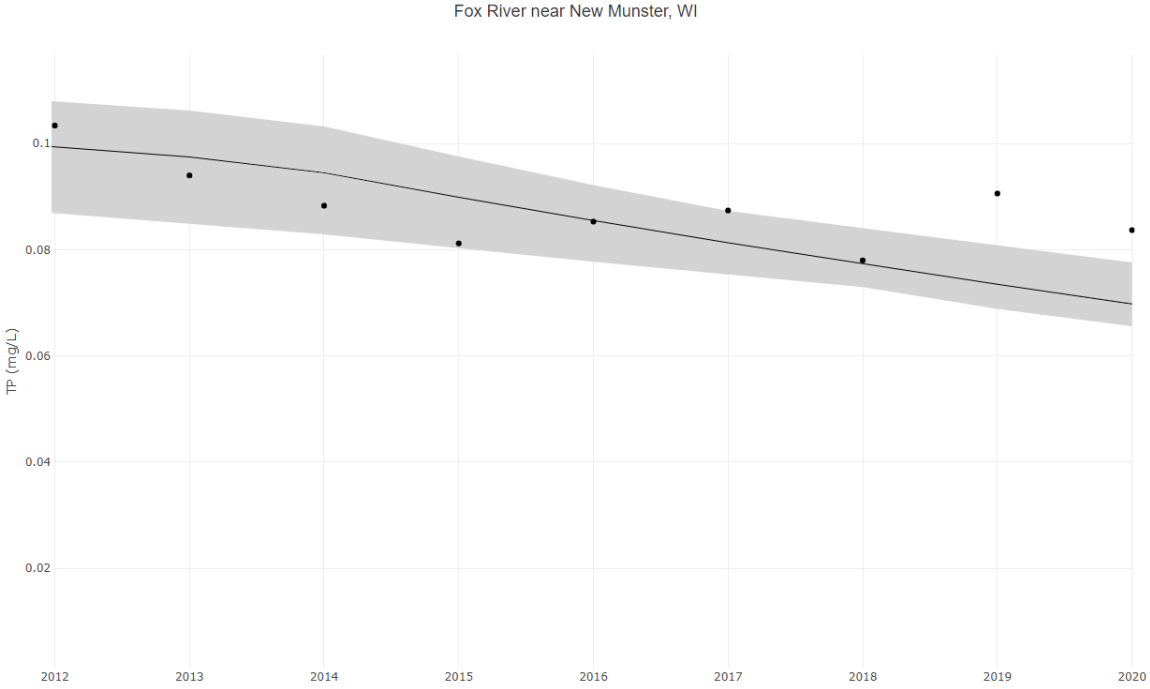


FIGURE E.7

Daily Total Phosphorus and Flows at Fox River near New Munster

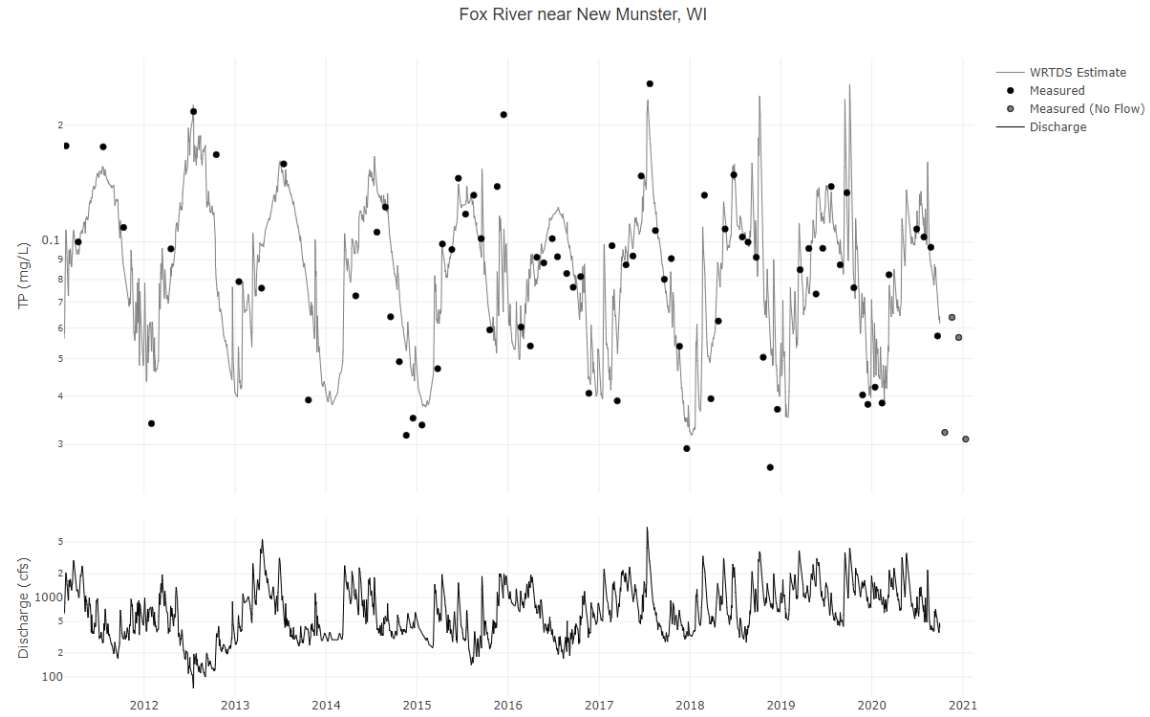


FIGURE E.8

Annual Trend of Orthophosphate at Fox River below Waukesha

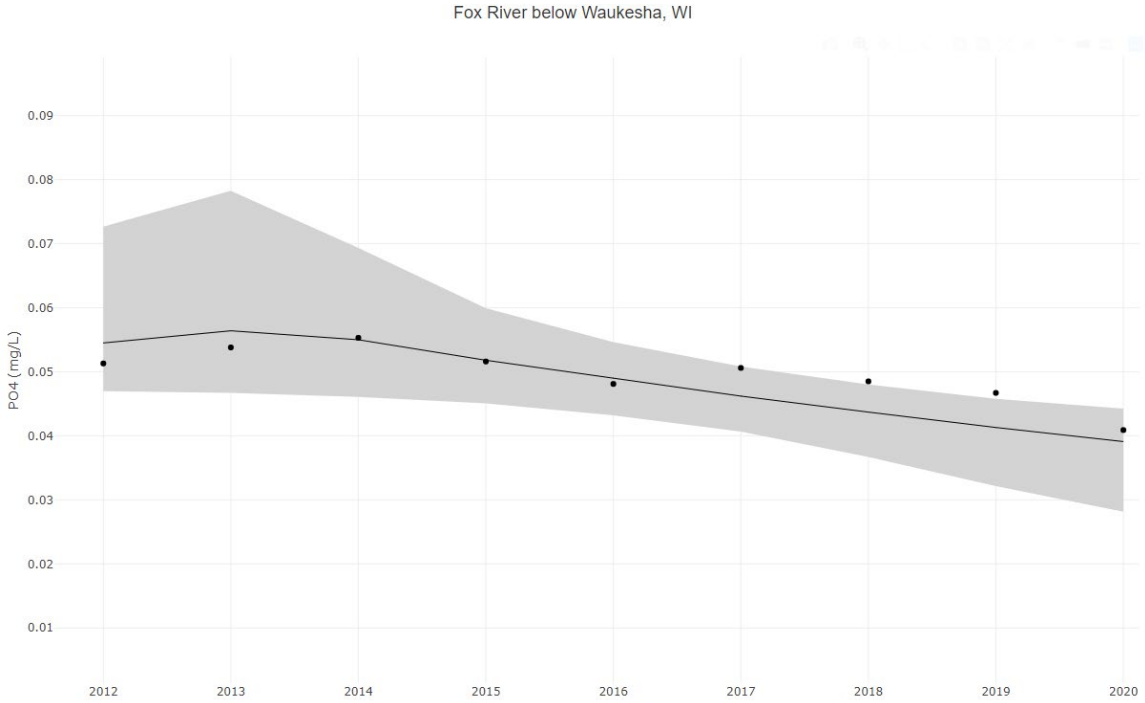


FIGURE E.9

Daily Orthophosphate and Flows at Fox River below Waukesha

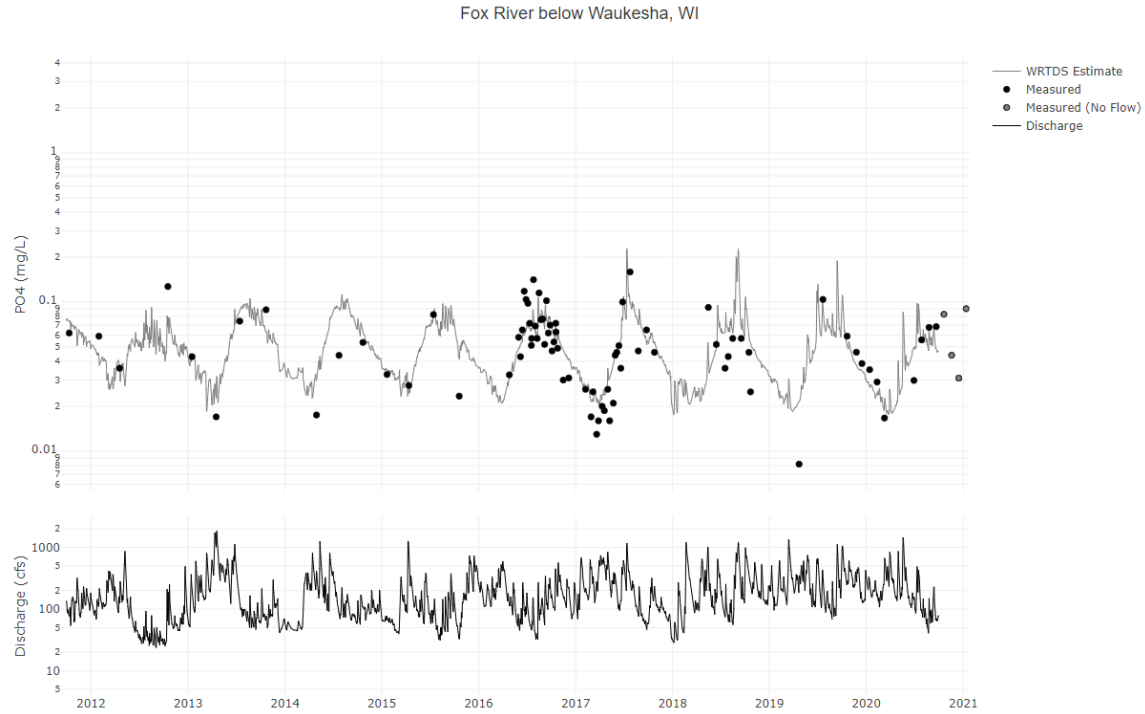


FIGURE E.10

Annual Trend of Orthophosphate at Fox River near New Munster

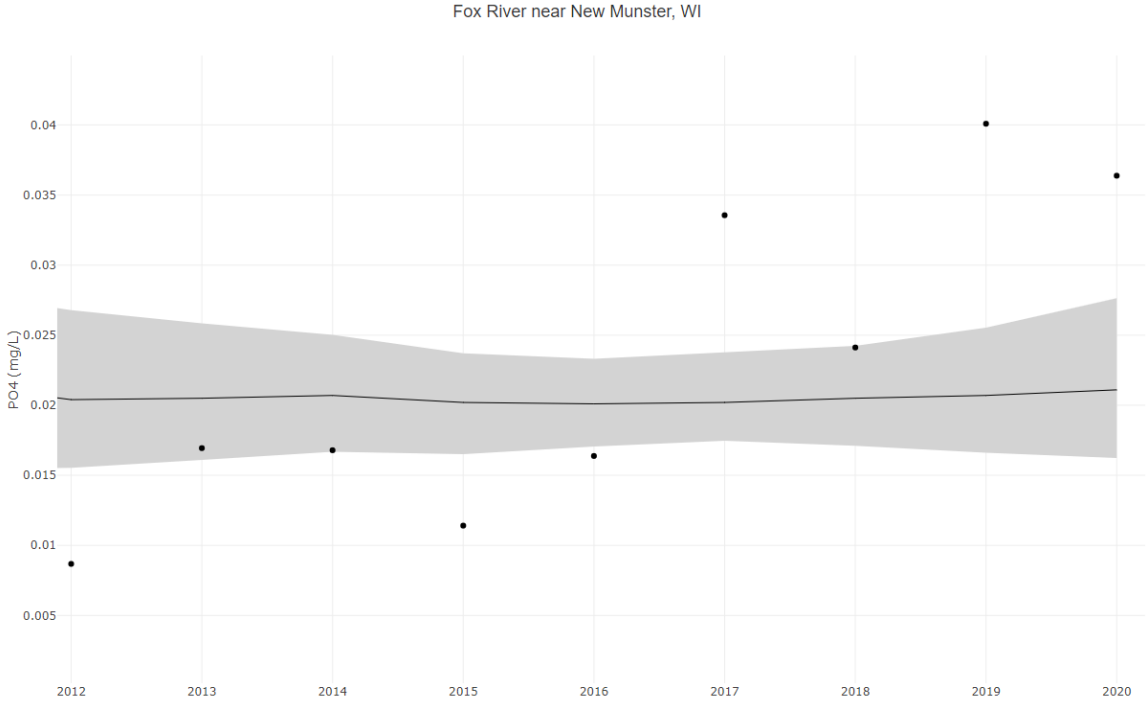


FIGURE E.11

Daily Orthophosphate and Flows at Fox River near New Munster

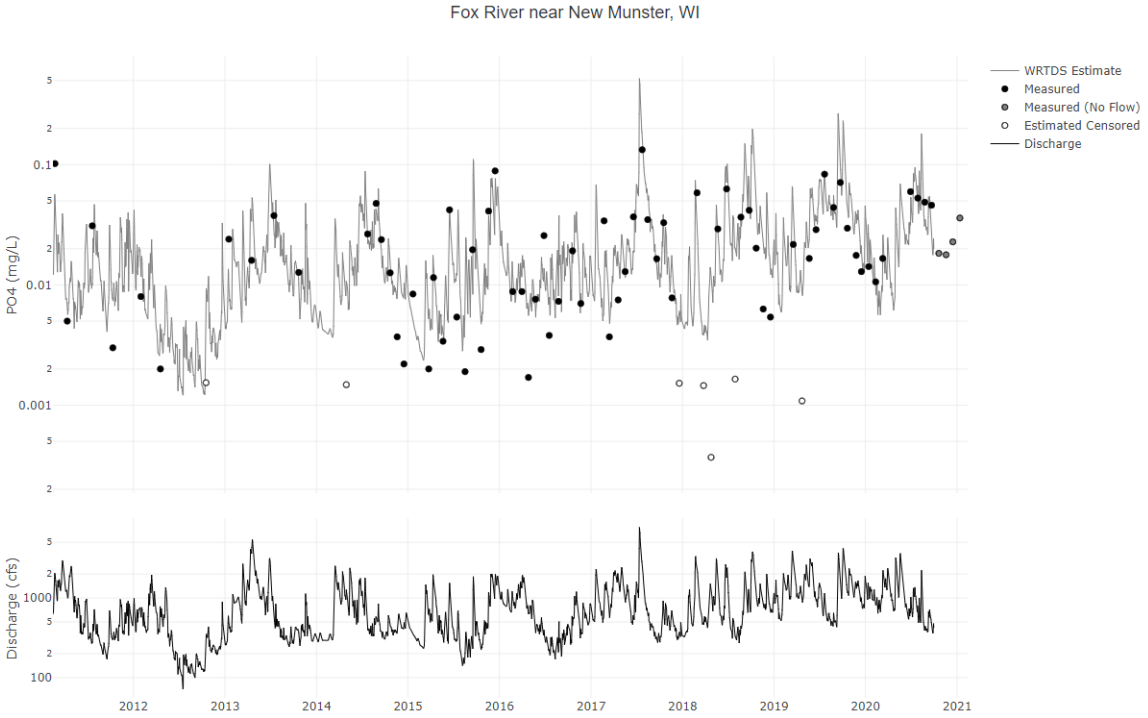


FIGURE E.12
Annual Trend of TSS at Fox River below Waukesha

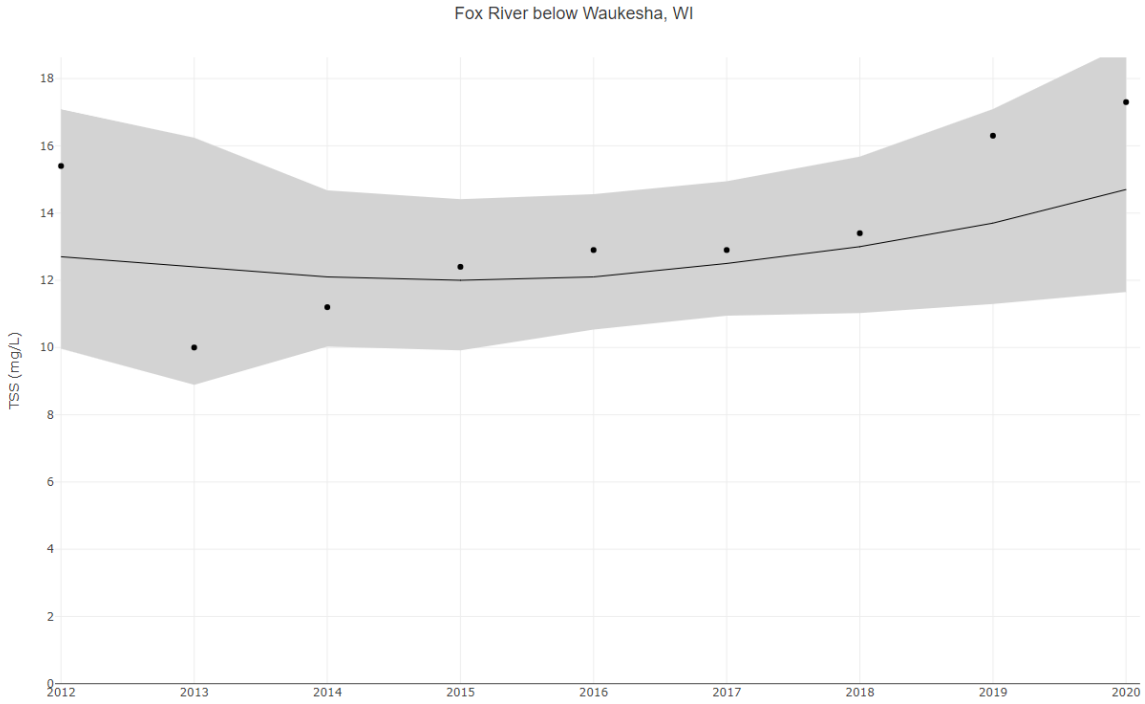


FIGURE E.13
Daily TSS and Flows at Fox River below Waukesha

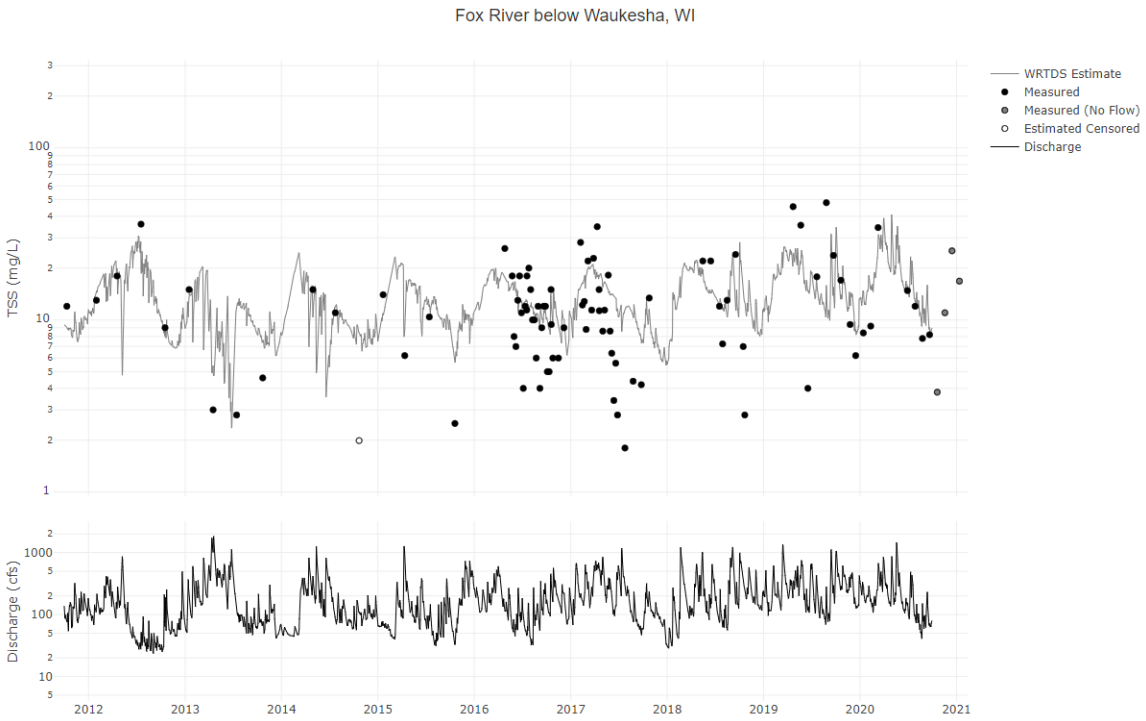


FIGURE E.14

Annual Trend of TSS at Fox River near New Munster

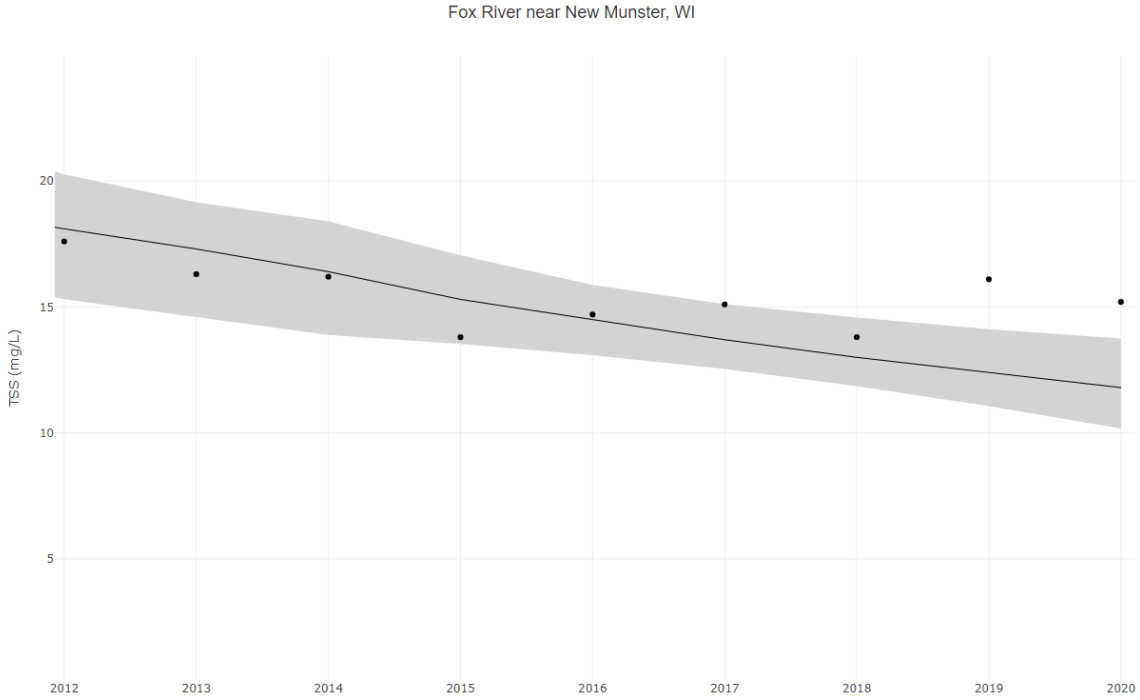
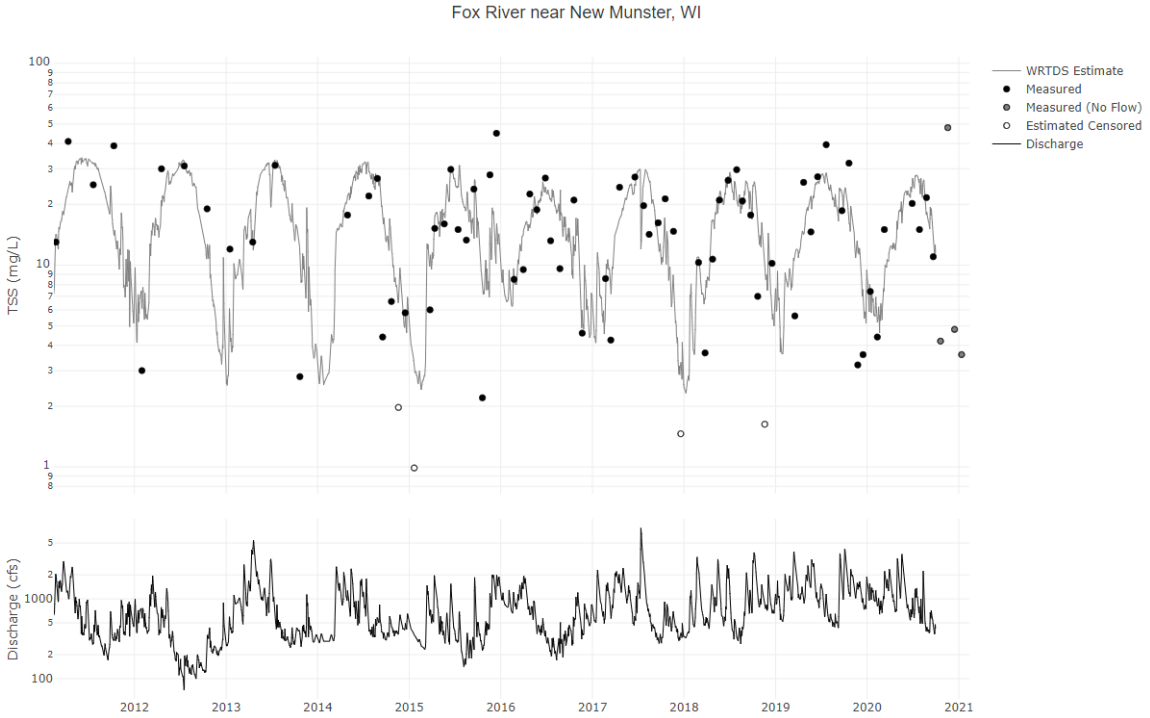


FIGURE E.15

Daily TSS and Flows at Fox River near New Munster



APPENDIX F

SUPPLEMENTAL WATER QUALITY DATA FROM SWIMS

In addition to the water quality data collected during the monitoring project for the TMDL, water quality sampling at a variety of sites in the basin was performed by the DNR and other entities. Total phosphorus, orthophosphate, and total suspended solids data from 19 river sites and 31 lake sites were downloaded from the DNR's Surface Water Integrated Monitoring System. A summary of the locations and the number of available samples are provided in Table F.1 for rivers and Table F.2 for lakes. Results from the downloaded data are summarized in Tables F.3 through F.15. The summaries are presented for samples collected during all months and samples collected during the growing season. The growing season is defined as May 1st through October 31st for rivers and June 15th through September 15th for lakes.

TABLE F.1

River SWIMS Samples for Simulation Period (All Months)

		# Samples - All Months		
SWIMS ID	Station Location	TP	Ortho-P	TSS
683207	Fox River at Center Drive	17	-	12
523093	Fox River at Cth Jb	124	-	-
10046947	Fox River at Cth L	56	54	58
523092	Fox River at Cth W	124	-	-
10052246	Fox River at Jefferson Street	124	-	-
10052205	Fox River at Sth 83	187	-	-
10054212	Fox River d/s of Burlington WWTP	49	-	-
10042192	Fox River d/s of Waterford Dam	25	24	25
10052207	Fox River near Sth 83 (WRCSD)	187	-	-
683299	Jericho Creek at Cth LO	17	-	-
10029281	Mukwonago River at Beulah Road	12	-	-
10032435	Mukwonago River at Sth 83	57	54	58
683458	Pebble Creek at Hwy D	13	-	-
10029788	Pewaukee River at Capitol Drive	12	-	-
10029789	Pewaukee River at Lindsey Road	11	-	-
10039464	Spring Creek at Lindsay Road	12	-	-
653267	White River at Center Street	93	-	-
10052247	White River at Milwaukee Ave	122	-	-
653104	White River at Sth 11	124	-	-

TABLE F.2

Lake SWIMS Samples for Simulation Period (All Months)

		# Samples - All Months	
SWIMS ID	Station Location	TP	Ortho-P
523132	Bohner Lake - Deep Hole	23	-
653219	Booth Lake - Deep Hole	56	-
523120	Browns Lake - Deep Hole	42	-
10014964	Denoon Lake	13	-
523131	Eagle Lake - Deep Hole	28	-
683258	Eagle Spring Lake - Deep Hole	42	-
10052245	Echo Lake at Wagner Park	122	-
653122	Geneva Lake - Deep Hole	281	130
653123	Green Lake - Deep Hole	49	-
653289	Honey Lake - Deep Hole	11	-
303053	Hooker Lake - Deep Hole	23	-
653121	Lake Beulah - Deep Hole	69	30
653135	Lake Beulah - Station 2	21	-
303121	Lake Mary - Deep Hole	43	-
303126	Lilly Lake - Deep Hole	41	-
683127	Little Muskego Lake - Deep Hole	16	-
683260	Lower Phantom Lake - Deep Hole	59	-
653124	Middle Lake - Deep Hole	48	-
653125	Mill Lake - Deep Hole	48	-
303122	Paddock Lake - Deep Hole	45	-
683143	Pewaukee Lake - Deep Hole	44	-
10033632	Pewaukee Lake - East Basin	41	-
653220	Potter Lake - Middle	58	-
303050	Powers Lake - Deep Hole	107	-
10029908	Rock Lake - Center	10	-
303123	Silver Lake - Deep Hole	28	-
523122	Tichigan Lake - Deep Hole	53	-
683259	Upper Phantom Lake - Deep Hole	27	-
303130	Vern Wolf Lake - Deep Hole	18	-
523117	Waubeesee Lake - Deep Hole	35	-
523124	Wind Lake - Deep Hole	168	-

TABLE F.3

Total Phosphorus Concentrations at River SWIMS Sites (All Months)

		TP Concentration (µg/L) - All Months				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
683207	Fox River at Center Drive	41	75	92	129	210
523093	Fox River at Cth Jb	17	78	98	118	267
10046947	Fox River at Cth L	10	71	89	115	238
523092	Fox River at Cth W	34	68	90	116	305
10052246	Fox River at Jefferson Street	17	71	94	118	214
10052205	Fox River at Sth 83	15	58	83	112	480
10054212	Fox River d/s of Burlington WWTP	38	55	109	137	310
10042192	Fox River d/s of Waterford Dam	29	64	87	106	163
10052207	Fox River near Sth 83 (WRCSD)	15	59	85	112	430
683299	Jericho Creek at Cth LO	16	20	25	33	65
10029281	Mukwonago River at Beulah Road	17	22	26	34	48
10032435	Mukwonago River at Sth 83	7	12	16	19	80
683458	Pebble Creek at Hwy D	27	34	37	87	161
10029788	Pewaukee River at Capitol Drive	41	54	115	151	252
10029789	Pewaukee River at Lindsey Road	27	57	67	82	247
10039464	Spring Creek at Lindsay Road	47	82	149	221	308
653267	White River at Center Street	6	13	15	20	140
10052247	White River at Milwaukee Ave	34	78	99	118	213
653104	White River at Sth 11	35	75	92	113	337

TABLE F.4

Total Phosphorus Concentrations at Lake SWIMS Sites (All Months)

		TP Concentration (µg/L) - All Months				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
523132	Bohner Lake - Deep Hole	15	20	21	25	33
653219	Booth Lake - Deep Hole	6	12	13	20	38
523120	Browns Lake - Deep Hole	12	16	21	24	39
10014964	Denoon Lake	5	16	23	36	244
523131	Eagle Lake - Deep Hole	19	54	82	130	238
683258	Eagle Spring Lake - Deep Hole	10	16	18	21	26
10052245	Echo Lake at Wagner Park	28	72	95	123	454
653122	Geneva Lake - Deep Hole	3	11	13	16	119
653123	Green Lake - Deep Hole	5	9	10	11	18
653289	Honey Lake - Deep Hole	31	45	56	72	99
303053	Hooker Lake - Deep Hole	23	27	30	36	63

		TP Concentration (µg/L) - All Months				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
653121	Lake Beulah - Deep Hole	3	13	16	18	41
653135	Lake Beulah - Station 2	12	15	17	31	47
303121	Lake Mary - Deep Hole	10	14	17	19	25
303126	Lilly Lake - Deep Hole	5	13	14	15	28
683127	Little Muskego Lake - Deep Hole	10	15	18	24	224
683260	Lower Phantom Lake - Deep Hole	3	15	18	23	34
653124	Middle Lake - Deep Hole	4	11	13	14	16
653125	Mill Lake - Deep Hole	5	13	15	17	27
303122	Paddock Lake - Deep Hole	8	16	19	23	29
683143	Pewaukee Lake - Deep Hole	12	17	18	20	26
10033632	Pewaukee Lake - East Basin	14	21	24	26	40
653220	Potter Lake - Middle	19	26	31	44	200
303050	Powers Lake - Deep Hole	9	15	18	25	65
10029908	Rock Lake - Center	13	15	16	18	22
303123	Silver Lake - Deep Hole	11	18	20	22	30
523122	Tichigan Lake - Deep Hole	20	26	32	42	413
683259	Upper Phantom Lake - Deep Hole	13	17	21	24	137
303130	Vern Wolf Lake - Deep Hole	16	22	30	32	45
523117	Waubeesee Lake - Deep Hole	12	16	18	22	32
523124	Wind Lake - Deep Hole	10	25	36	195	434

TABLE F.5

Orthophosphate Concentrations at River SWIMS Sites (All Months)

		DOP Concentration (µg/L) - All Months				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
10046947	Fox River at Cth L	4.0	24.3	36.0	55.0	172.0
10042192	Fox River d/s of Waterford Dam	1.0	2.0	7.0	10.0	35.0
10032435	Mukwonago River at Sth 83	1.0	1.0	1.5	1.5	8.0

TABLE F.6

Orthophosphate Concentrations at Lake SWIMS Sites (All Months)

		DOP Concentration (µg/L) - All Months				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
653122	Geneva Lake - Deep Hole	0.9	1.0	2.5	9.9	103.0
653121	Lake Beulah - Deep Hole	1.0	1.0	1.0	1.8	12.2

TABLE F.7

TSS Concentrations at River SWIMS Sites (All Months)

		TSS Concentration (mg/L) - All Months				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
683207	Fox River at Center Drive	1.3	4.4	11.7	18.2	31.2
10046947	Fox River at Cth L	0.4	4.7	8.6	14.9	32.8
10042192	Fox River d/s of Waterford Dam	2.0	12.0	16.0	29.0	41.0
10032435	Mukwonago River at Sth 83	0.1	0.8	1.2	1.9	12.8

TABLE F.8

River SWIMS Samples for Simulation Period (Growing Season)

		# Samples - Growing Season		
SWIMS ID	Station Location	TP	Ortho-P	TSS
683207	Fox River at Center Drive	17	-	12
523093	Fox River at Cth Jb	98	-	-
10046947	Fox River at Cth L	45	46	47
523092	Fox River at Cth W	98	-	-
10052246	Fox River at Jefferson Street	98	-	-
10052205	Fox River at Sth 83	126	-	-
10054212	Fox River d/s of Burlington WWTP	35	-	-
10042192	Fox River d/s of Waterford Dam	23	22	23
10052207	Fox River near Sth 83 (WRCSD)	126	-	-
683299	Jericho Creek at Cth LO	17	-	-
10029281	Mukwonago River at Beulah Road	12	-	-
10032435	Mukwonago River at Sth 83	46	46	47
683458	Pebble Creek at Hwy D	13	-	-
10029788	Pewaukee River at Capitol Drive	12	-	-
10029789	Pewaukee River at Lindsey Road	10	-	-
10039464	Spring Creek at Lindsay Road	12	-	-
653267	White River at Center Street	51	-	-
10052247	White River at Milwaukee Ave	98	-	-
653104	White River at Sth 11	98	-	-

TABLE F.9

Lake SWIMS Samples for Simulation Period (Growing Season)

		# Samples - Growing Season	
SWIMS ID	Station Location	TP	Ortho-P
523132	Bohner Lake - Deep Hole	18	-
653219	Booth Lake - Deep Hole	28	-
523120	Browns Lake - Deep Hole	31	-
10014964	Denoon Lake	11	-
523131	Eagle Lake - Deep Hole	19	-
683258	Eagle Spring Lake - Deep Hole	35	-
10052245	Echo Lake at Wagner Park	62	-
653122	Geneva Lake - Deep Hole	208	65
653123	Green Lake - Deep Hole	38	-
653289	Honey Lake - Deep Hole	6	-
303053	Hooker Lake - Deep Hole	21	-
653121	Lake Beulah - Deep Hole	57	27
653135	Lake Beulah - Station 2	18	-
303121	Lake Mary - Deep Hole	31	-
303126	Lilly Lake - Deep Hole	31	-
683127	Little Muskego Lake - Deep Hole	12	-
683260	Lower Phantom Lake - Deep Hole	41	-
653124	Middle Lake - Deep Hole	37	-
653125	Mill Lake - Deep Hole	37	-
303122	Paddock Lake - Deep Hole	37	-
683143	Pewaukee Lake - Deep Hole	33	-
10033632	Pewaukee Lake - East Basin	34	-
653220	Potter Lake - Middle	37	-
303050	Powers Lake - Deep Hole	70	-
10029908	Rock Lake - Center	8	-
303123	Silver Lake - Deep Hole	22	-
523122	Tichigan Lake - Deep Hole	36	-
683259	Upper Phantom Lake - Deep Hole	14	-
303130	Vern Wolf Lake - Deep Hole	12	-
523117	Waubeesee Lake - Deep Hole	27	-
523124	Wind Lake - Deep Hole	120	-

TABLE F.10

Total Phosphorus Concentrations at River SWIMS Sites (Growing Season)

		TP Concentration (µg/L) - Growing Season				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
683207	Fox River at Center Drive	41	75	92	129	210
523093	Fox River at Cth Jb	46	87	103	121	267
10046947	Fox River at Cth L	10	81	99	118	238
523092	Fox River at Cth W	34	72	95	121	305
10052246	Fox River at Jefferson Street	40	82	99	123	214
10052205	Fox River at Sth 83	17	72	90	120	480
10054212	Fox River d/s of Burlington WWTP	41	87	116	167	310
10042192	Fox River d/s of Waterford Dam	55	69	88	106	163
10052207	Fox River near Sth 83 (WRCSD)	17	72	97	121	430
683299	Jericho Creek at Cth LO	16	20	25	33	65
10029281	Mukwonago River at Beulah Road	17	22	26	34	48
10032435	Mukwonago River at Sth 83	7	12	16	19	80
683458	Pebble Creek at Hwy D	27	34	37	87	161
10029788	Pewaukee River at Capitol Drive	41	54	115	151	252
10029789	Pewaukee River at Lindsey Road	27	57	66	81	247
10039464	Spring Creek at Lindsay Road	47	82	149	221	308
653267	White River at Center Street	9	13	16	20	140
10052247	White River at Milwaukee Ave	45	87	101	124	213
653104	White River at Sth 11	35	79	99	118	337

TABLE F.11

Total Phosphorus Concentrations at Lake SWIMS Sites (Growing Season)

		TP Concentration (µg/L) - Growing Season				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
523132	Bohner Lake - Deep Hole	15	20	21	25	30
653219	Booth Lake - Deep Hole	8	12	13	16	25
523120	Browns Lake - Deep Hole	12	18	22	25	39
10014964	Denoon Lake	5	15	21	27	244
523131	Eagle Lake - Deep Hole	19	76	96	147	238
683258	Eagle Spring Lake - Deep Hole	12	16	18	21	26
10052245	Echo Lake at Wagner Park	48	91	103	128	454
653122	Geneva Lake - Deep Hole	3	11	13	14	91

		TP Concentration (µg/L) - Growing Season				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
653123	Green Lake - Deep Hole	5	9	10	11	18
653289	Honey Lake - Deep Hole	41	57	71	85	99
303053	Hooker Lake - Deep Hole	23	27	32	37	63
653121	Lake Beulah - Deep Hole	3	13	16	19	41
653135	Lake Beulah - Station 2	12	15	18	33	47
303121	Lake Mary - Deep Hole	11	16	18	19	25
303126	Lilly Lake - Deep Hole	5	13	14	16	28
683127	Little Muskego Lake - Deep Hole	10	15	17	20	224
683260	Lower Phantom Lake - Deep Hole	11	15	16	21	34
653124	Middle Lake - Deep Hole	11	12	13	15	16
653125	Mill Lake - Deep Hole	11	14	16	18	21
303122	Paddock Lake - Deep Hole	8	17	19	23	29
683143	Pewaukee Lake - Deep Hole	12	16	18	19	24
10033632	Pewaukee Lake - East Basin	14	21	24	27	40
653220	Potter Lake - Middle	20	28	37	53	200
303050	Powers Lake - Deep Hole	13	16	20	34	65
10029908	Rock Lake - Center	13	16	17	19	22
303123	Silver Lake - Deep Hole	16	18	21	23	30
523122	Tichigan Lake - Deep Hole	20	25	30	37	413
683259	Upper Phantom Lake - Deep Hole	13	17	19	22	58
303130	Vern Wolf Lake - Deep Hole	16	22	28	31	43
523117	Waubeesee Lake - Deep Hole	12	16	18	22	27
523124	Wind Lake - Deep Hole	10	23	77	245	434

TABLE F.13

Orthophosphate Concentrations at River SWIMS Sites (Growing Season)

		DOP Concentration (µg/L) - Growing Season				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
10046947	Fox River at Cth L	4.0	29.8	42.0	62.0	172.0
10042192	Fox River d/s of Waterford Dam	1.0	2.0	7.0	10.0	35.0
10032435	Mukwonago River at Sth 83	1.0	1.0	1.5	2.0	8.0

TABLE F.14

Orthophosphate Concentrations at Lake SWIMS Sites (Growing Season)

		DOP Concentration (µg/L) - Growing Season				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
653122	Geneva Lake - Deep Hole	0.9	1.0	2.0	7.0	54.2
653121	Lake Beulah - Deep Hole	1.0	1.0	1.0	1.5	12.2

TABLE F.15

TSS Concentrations at River SWIMS Sites (Growing Season)

		TSS Concentration (mg/L) - Growing Season				
SWIMS ID	Station Location	Min	Q1	Median	Q3	Max
683207	Fox River at Center Drive	1.3	4.4	11.7	18.2	31.2
10046947	Fox River at Cth L	0.4	4.4	8.0	14.0	32.8
10042192	Fox River d/s of Waterford Dam	4.0	13.5	17.0	32.0	41.0
10032435	Mukwonago River at Sth 83	0.1	0.8	1.0	1.6	4.0

APPENDIX G

USGS STAGE AND FLOW DATA

USGS maintains stage and flow gages throughout the study area. Stage data are available at seven locations, and flow data are available at five locations. Table G.1 summarizes the available stage data, and Table G.2 summarizes the available flow data. The start date in the tables represent the date of the earliest available data. An end date is not provided because all gages are still active. The tables also include some summary variables. 'Min' is the minimum value measured, 'Q1' is the value at which 25% of sample were smaller, the 'Median' is the median, 'Q3' is the value at which 25% of the samples were greater, and 'Max' represents the maximum value measured.

Average daily stage data for the seven stage gages are presented in Figures G.1 through G.7. Stage in the figures is presented for November 2019 through the end of 2022, which roughly corresponds with the timeframe of DNR's modeling. Stage-discharge curves – also known as rating curves – for the five USGS flow gages are presented in Figures G.8 through G.12. The rating curves show the relationship between depth and flow. Average daily flow for the five flow gages is presented in Figures G.12 through G.16. Data for these figures are also presented from November 2019 through the end of 2022.

TABLE G.1

Summary of Stage Data at USGS Gages in the Study Area

			Stage (ft)				
Site Number	Site Location	Start Date	Min	Q1	Med	Q3	Max
5544348	Fox River at Waterford	10/22/2015	1.44	1.62	1.66	1.72	2.02
5544475	Fox River at Rochester	3/19/2011	1.02	4.2	4.43	4.6	5.14
5544385	Muskego Lake	6/3/2010	10.3	11.54	11.7	11.84	13
424848088083100	Wind Lake	3/6/1985	5.96	7.66	8.02	8.23	9.86
423525088260400	Geneva Lake	9/10/1997	1.47	2.35	2.49	2.61	3.51
423000088164401	Elizabeth Lake	9/19/2018	793.58	793.98	794.15	794.26	795.21
5548185	Elizabeth Lake Drain	9/21/2018	793.44	793.81	794.05	794.15	794.79

FIGURE G.1

Average Daily Stage at USGS Gage in Fox River at Waterford Dam

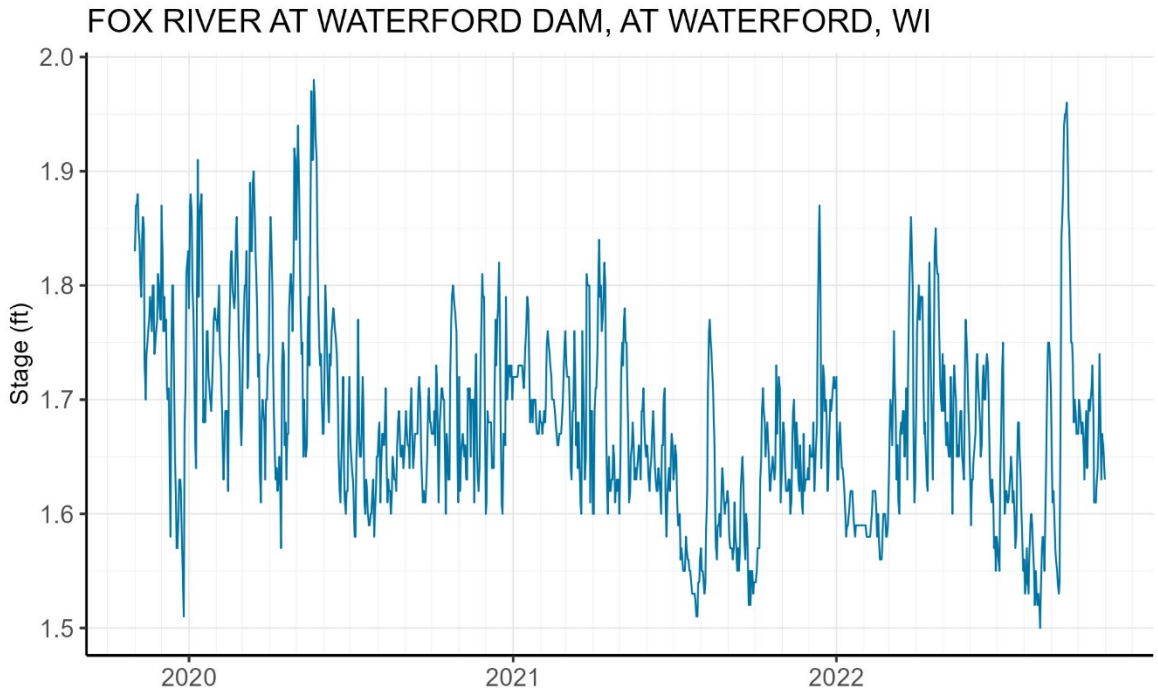


FIGURE G.2

Average Daily Stage at USGS Gage in Fox River at Rochester

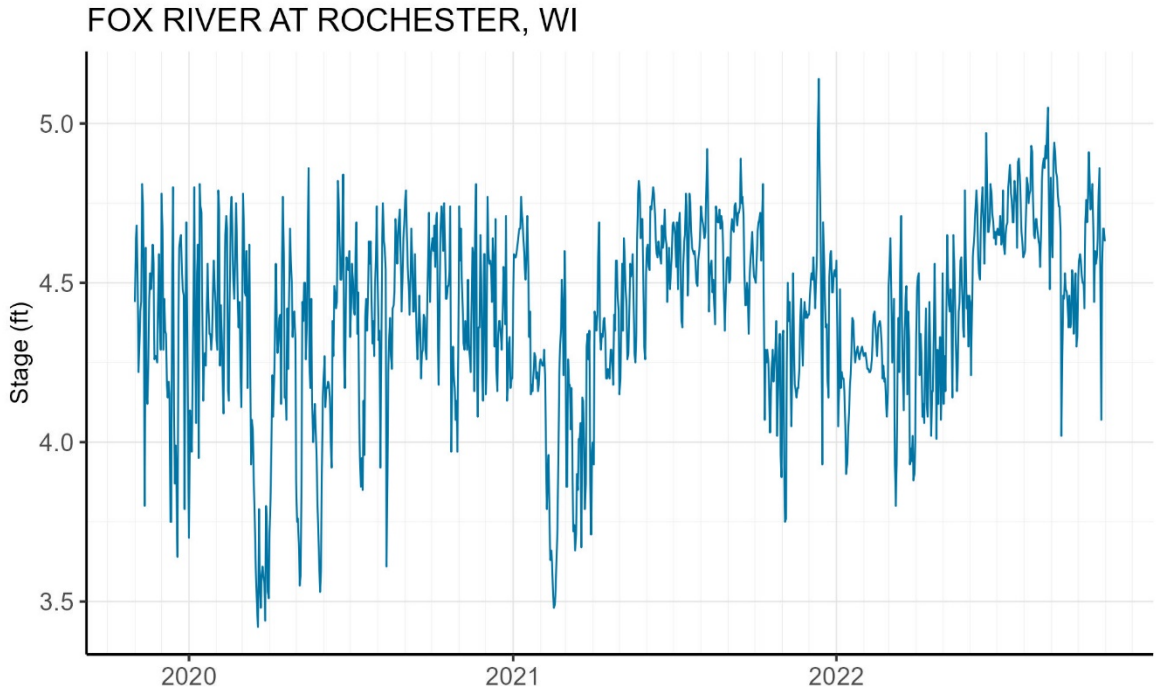


FIGURE G.3

Average Daily Stage at USGS Gage in Muskego Lake

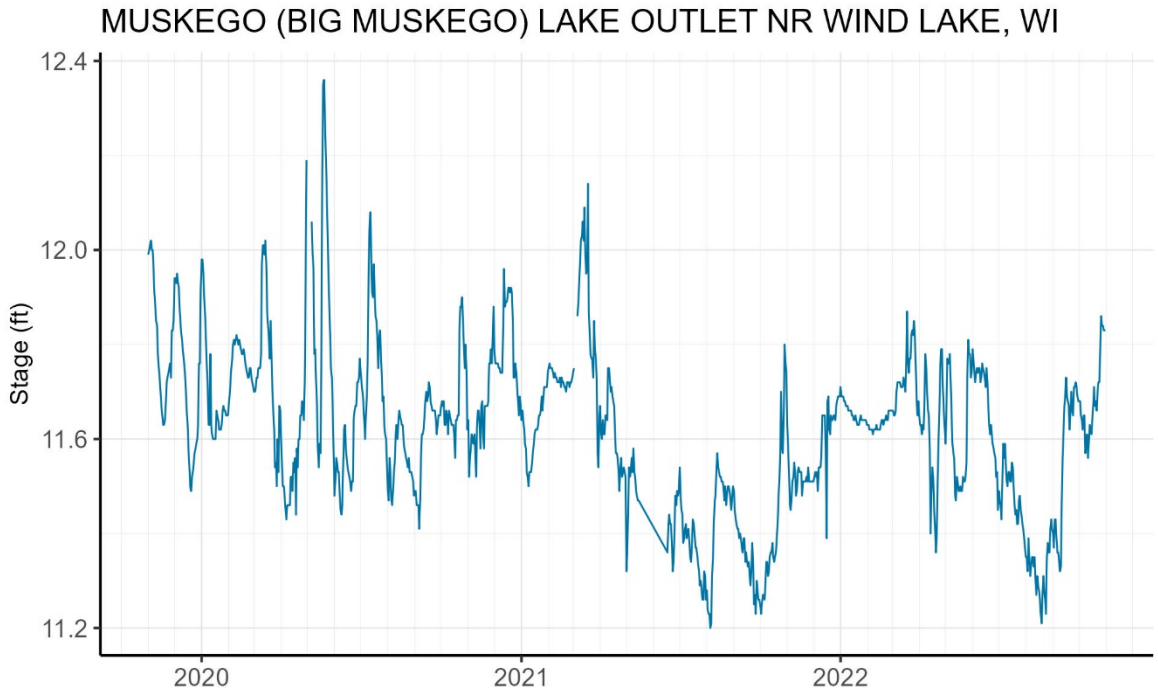


FIGURE G.4

Average Daily Stage at USGS Gage at Wind Lake Outlet

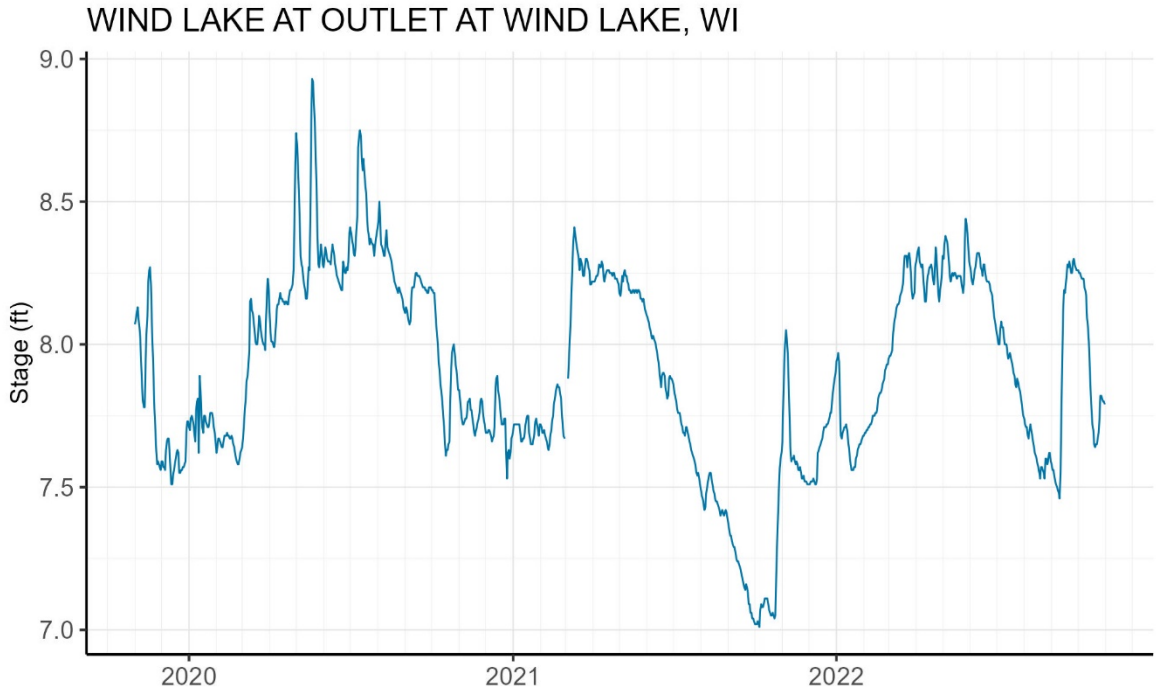


FIGURE G.5

Average Daily Stage at USGS Gage at Geneva Lake

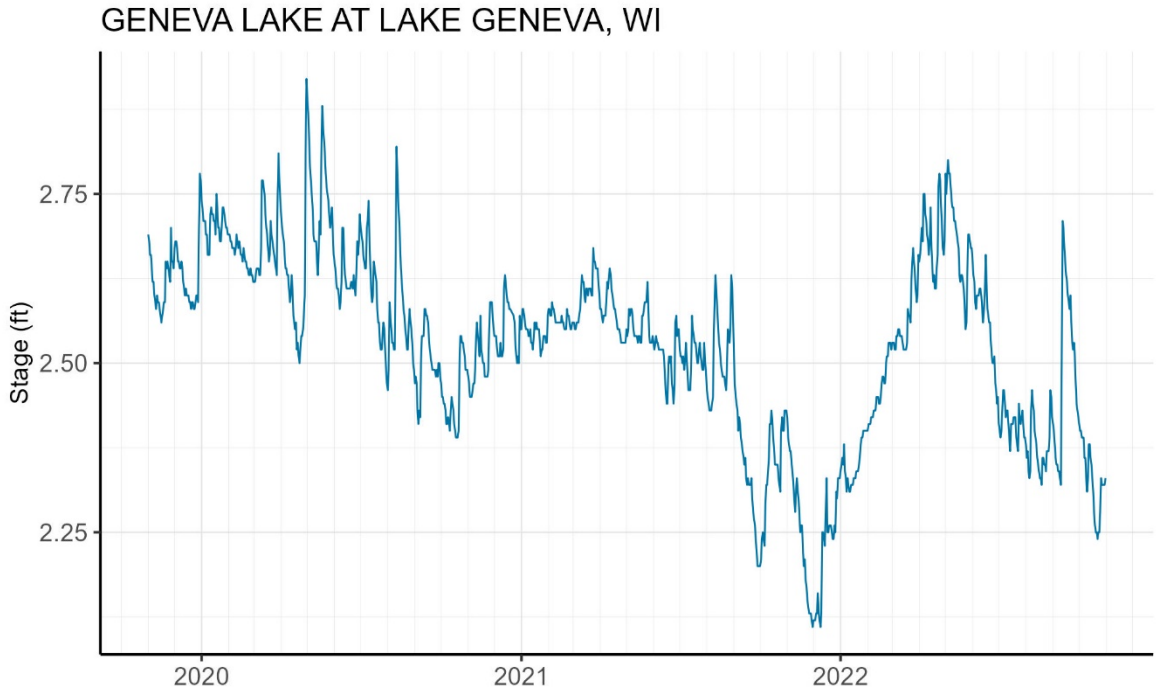


FIGURE G.6

Average Daily Stage at USGS Gage at Elizabeth Lake

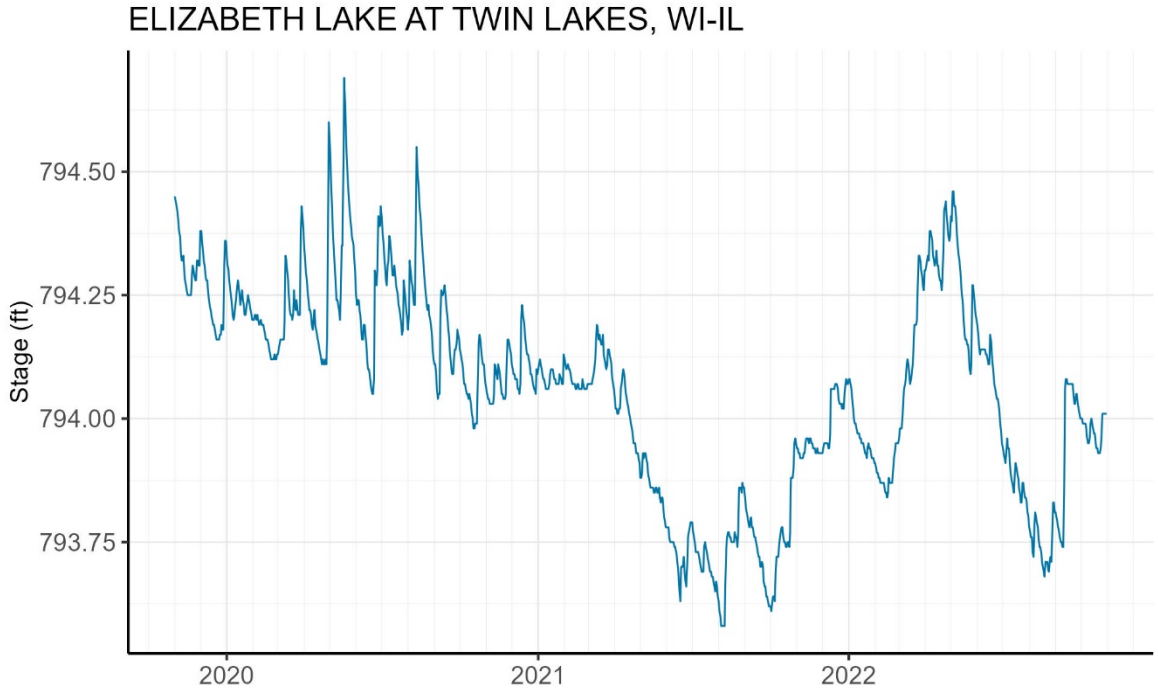


FIGURE G.7

Average Daily Stage at USGS Gage at Elizabeth Lake Drain

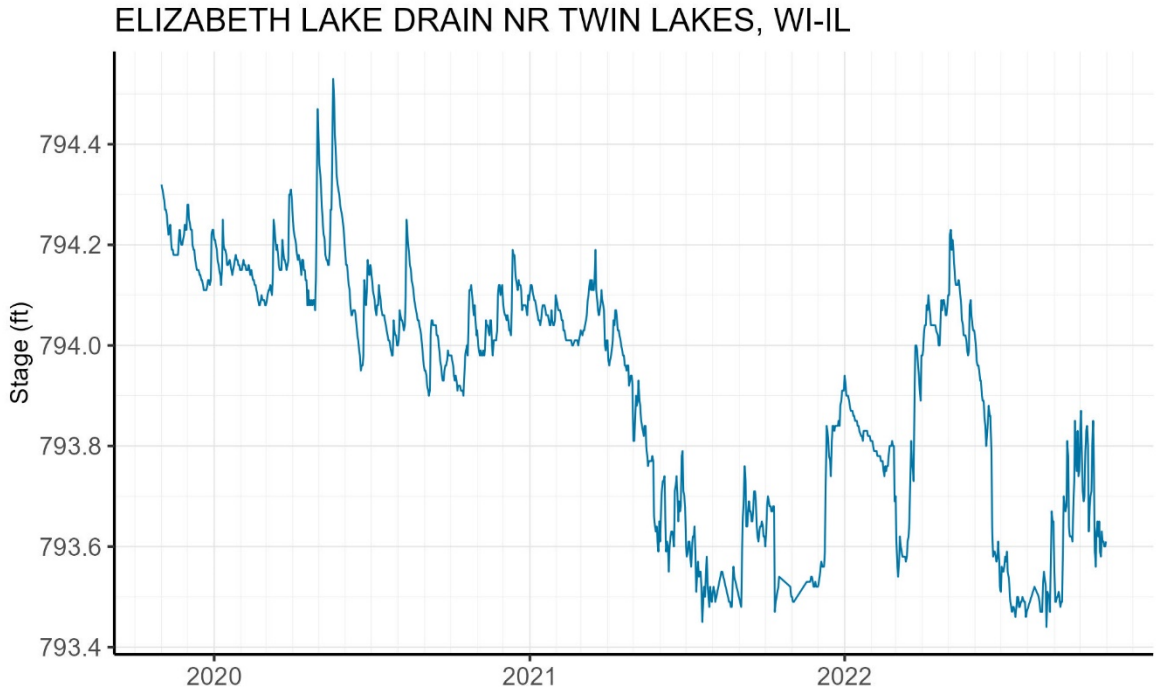


TABLE G.2

Summary of Flow Data at USGS Gages in the Study Area

Site Number	Site Location	Start Date	Flow (cfs)					
			Mean	Min	Q1	Med	Q3	Max
05543830	Fox R. at Waukesha	1/1/1963	116	3	41	73	139	2390
005545750	Fox R. near New Munster	9/30/1993	723	72	315	495	901	7710
05544200	Mukwonago R.	6/20/1973	59	2	33	50	74	439
055451345	White R. at Lake Geneva	9/30/1997	31	0	2	24	45	467
05527800	Des Plaines R. at Russell	7/1/1967	105	0	9	36	126	3260

FIGURE G.8

USGS Rating Curve for Fox River at Waukesha, WI

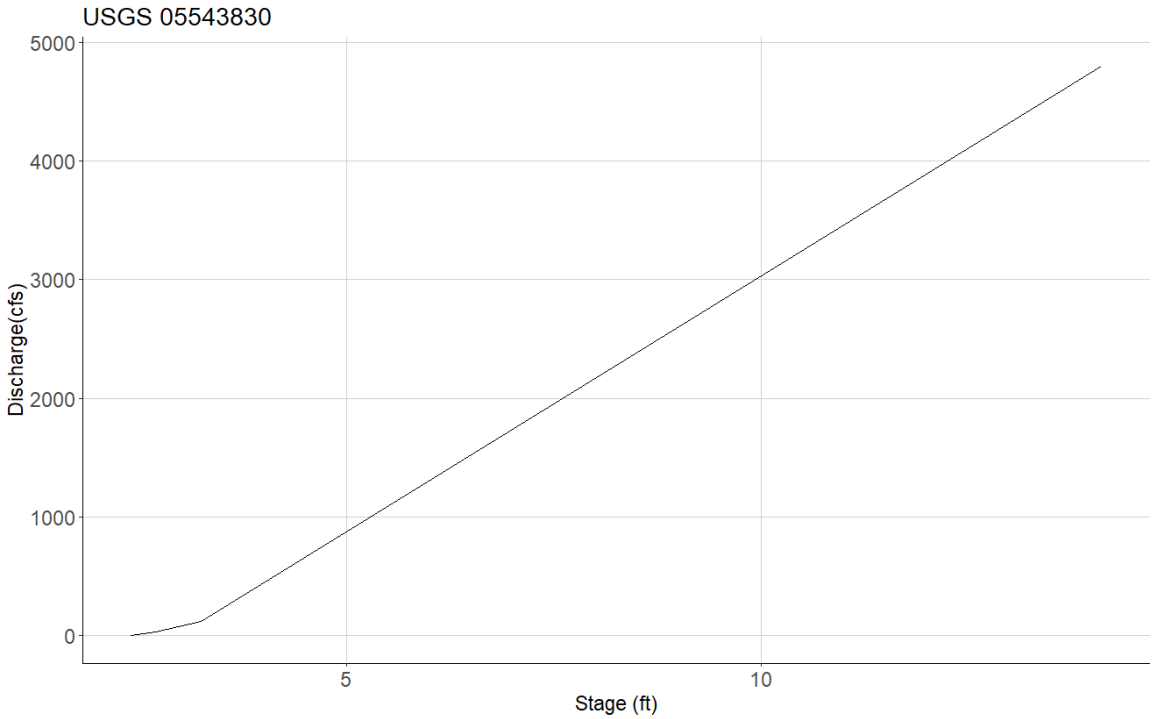


FIGURE G.9

USGS Rating Curve for Fox River at New Munster, WI

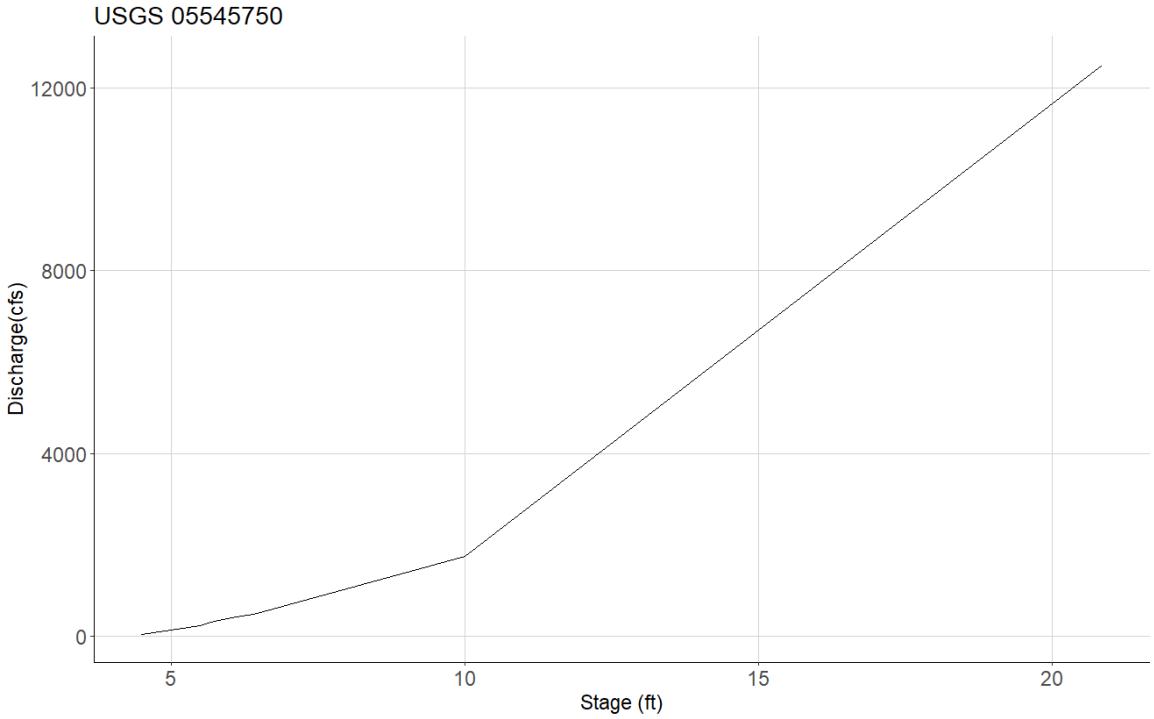


FIGURE G.10

USGS Rating Curve for Mukwonago River at Mukwonago, WI

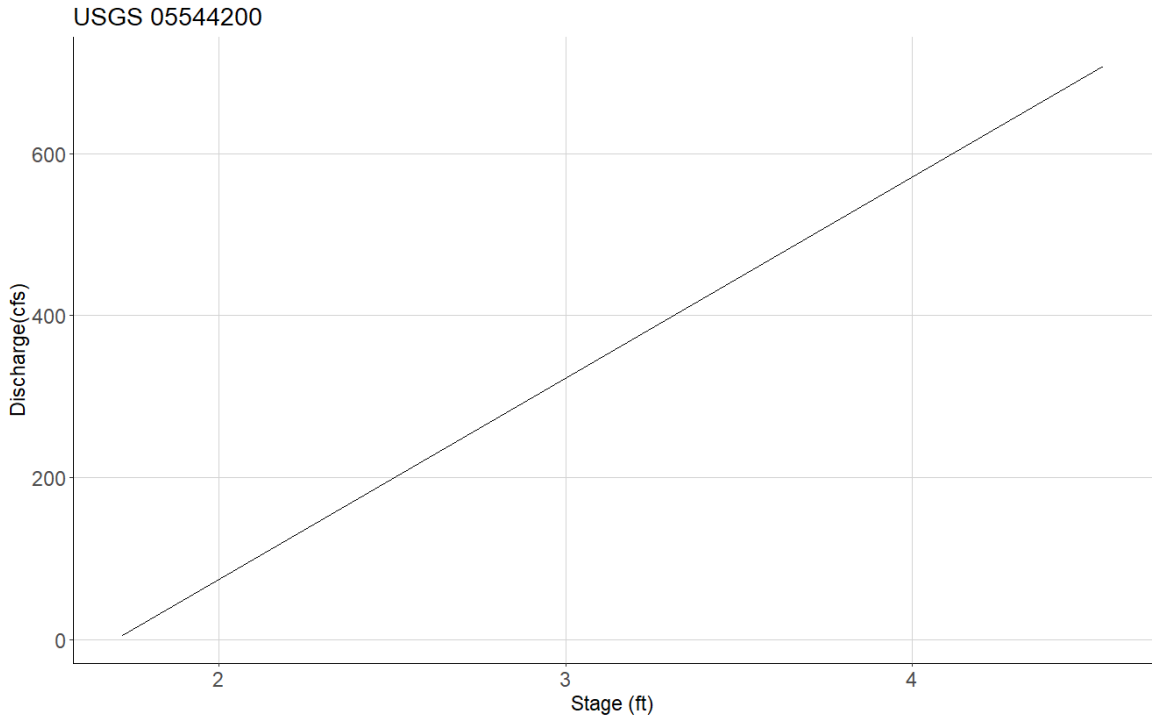


FIGURE G.11

USGS Rating Curve for White River at Lake Geneva, WI

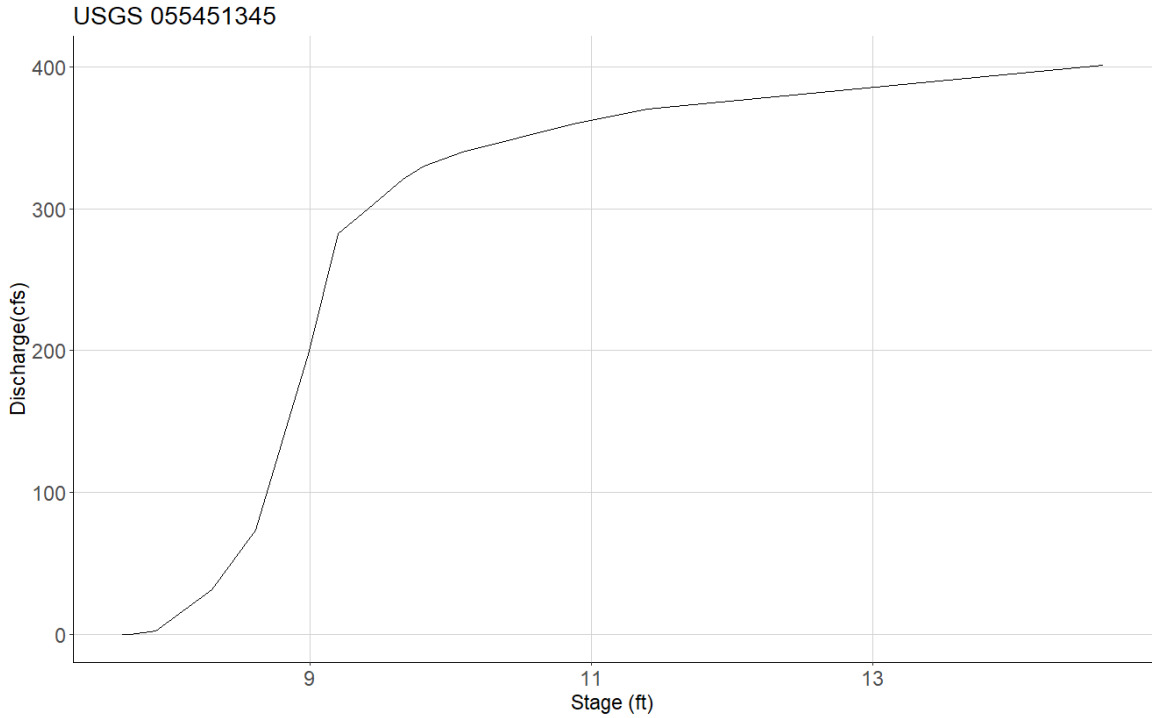


FIGURE G.12

USGS Rating Curve for Des Plaines River at Russell, IL

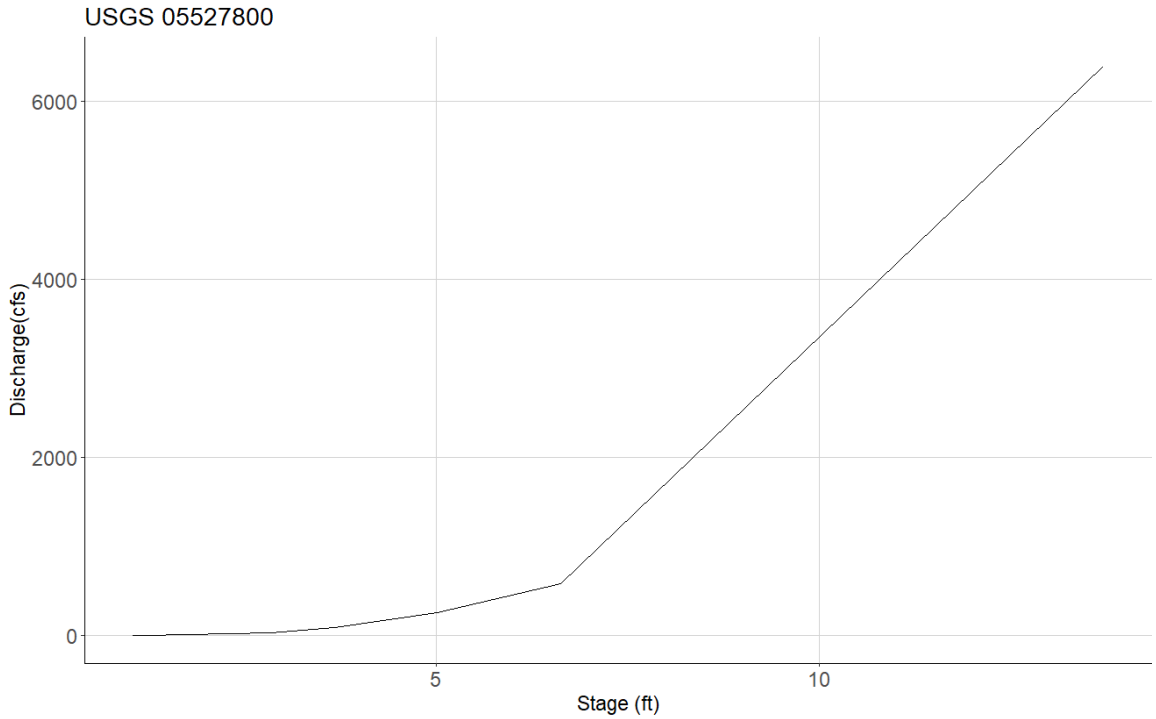


FIGURE G.13

Average Daily Flow at USGS Gages in the Fox River

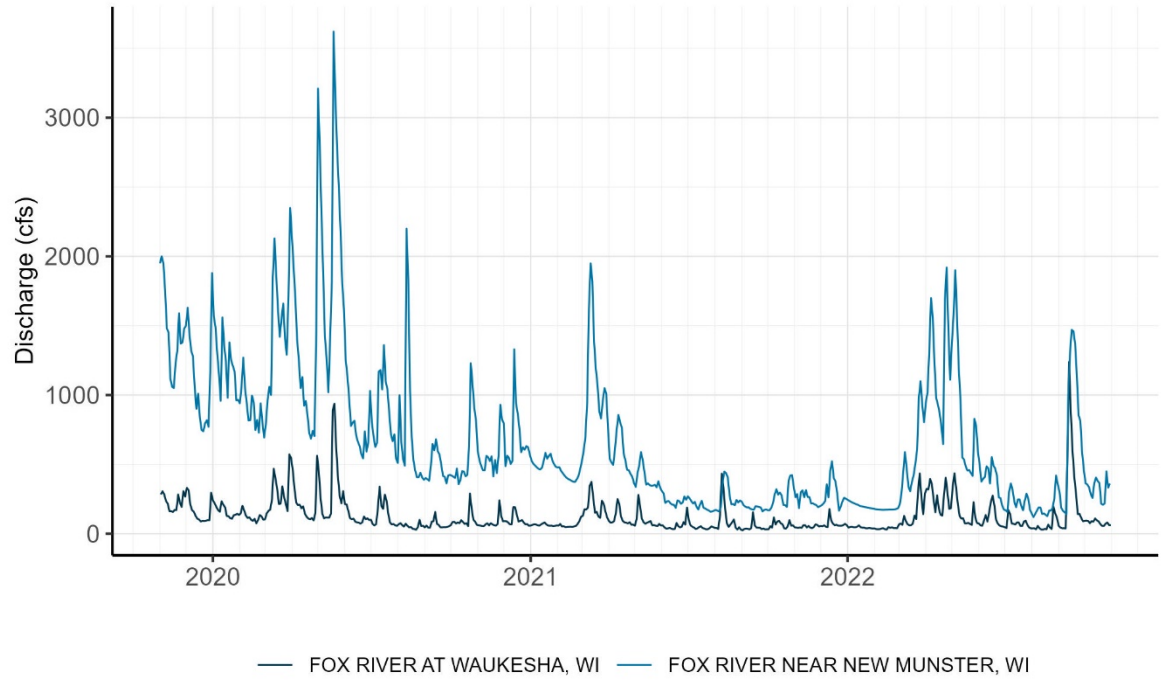


FIGURE G.14

Average Daily Flow at USGS Gage in the Mukwonago River

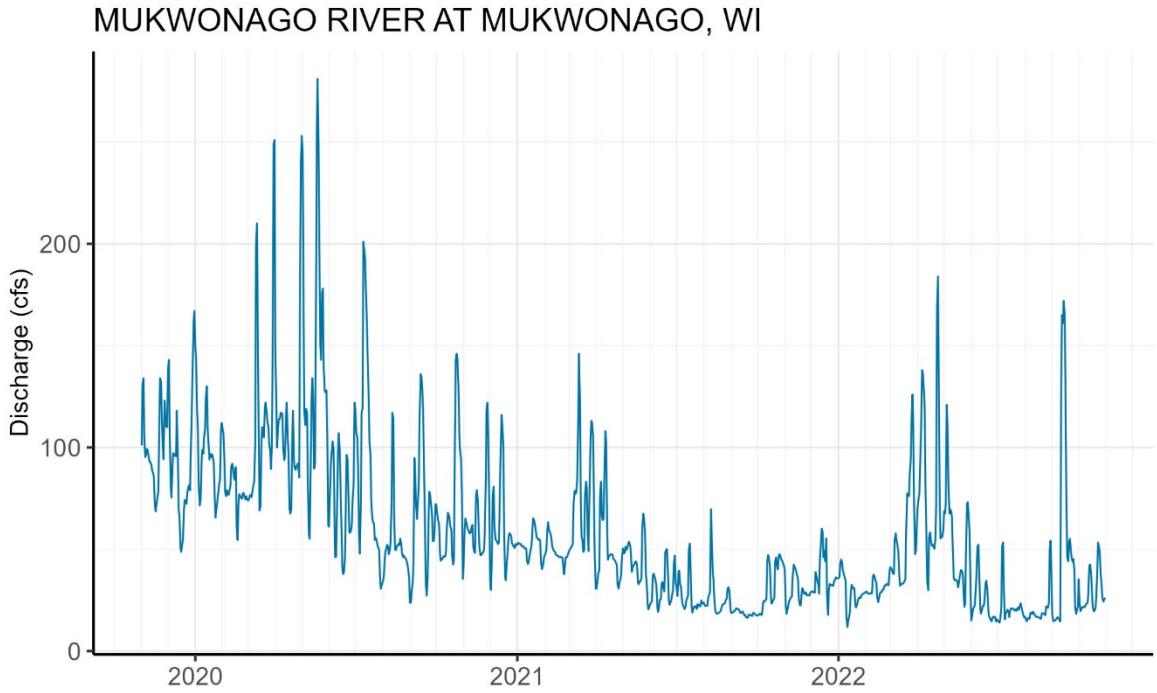


FIGURE G.15

Average Daily Flow at USGS Gage in the White River

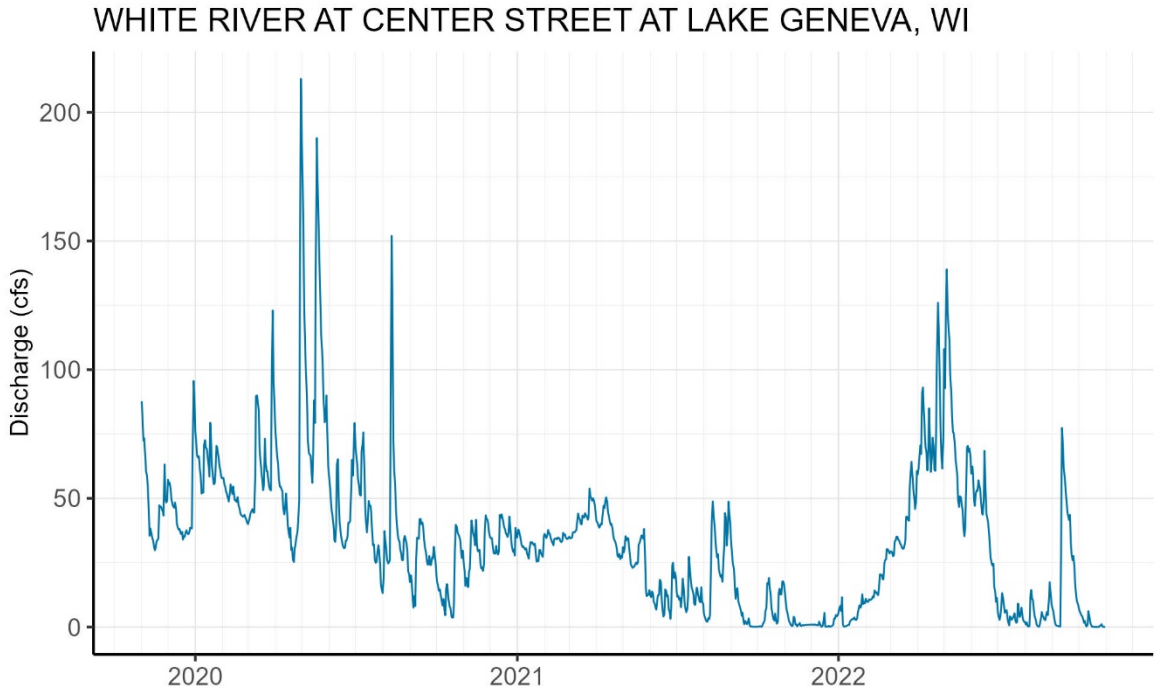


FIGURE G.13

Average Daily Flow at USGS Gage in the Des Plaines River