Upper Mississippi River Basin
Interstate Water Quality Assessment

Reaches 8-9 Pilot Field Operations Manual

September 2020

IOWA DEPARTMENT OF NATURAL RESOURCES

MISSOURI DEPARTMENT OF CONSERVATION

MISSOURI DEPARTMENT OF NATURAL RESOURCES

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

Upper Mississippi River Basin Association

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Acknowledgements

The content of this manual builds largely on the prior work of USEPA's Environmental Monitoring and Assessment Program Great Rivers Ecosystems, Upper Mississippi River Restoration Long Term Resource Monitoring, state monitoring protocols, and the documents developed by the Midwest Biodiversity Institute for the UMRBA Water Quality Task Force.

The cover photo is provided courtesy of the US Fish and Wildlife Service.

1. INTRODUCTION

1.1 UMR Monitoring Plan Overview

The Upper Mississippi River Clean Water Act Recommended Monitoring Plan is structured as a series of sampling networks designed to uniquely and comprehensively support assessment of aquatic life, fish consumption, recreation, and drinking water use attainment on the UMR ("Monitoring Plan;" UMRBA, 2014; Figure 1). The interagency Upper Mississippi River Basin Association (UMRBA) Water Quality Task Force developed the Monitoring Plan to achieve a coordinated, comprehensive Clean Water Act (CWA) monitoring approach on the Upper Mississippi River (UMR).

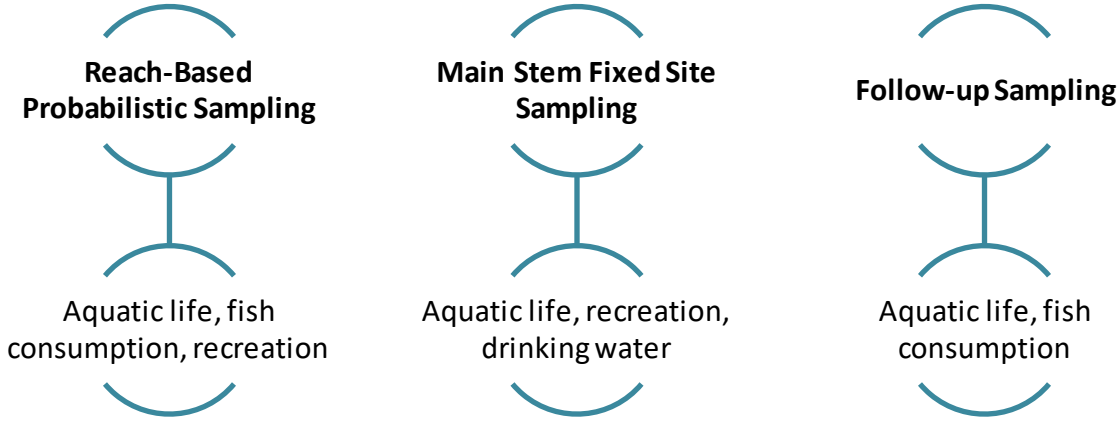

Figure 1: Illustration of UMR Recommended Monitoring Plan, including constituent networks and designated uses which can be assessed utilizing data from these networks

From May 2016 to April 2017, UMR states employed a field pilot in a portion of the UMR's reaches 0-3 in Minnesota and Wisconsin and focused on the implementation of the probabilistic and fixed site components of the Monitoring Plan. Implementation of a pilot in Reaches 8-9 with Missouri, Illinois, and Iowa state agencies will begin in January 2020.

1.2 Field Operations Manual Scope

This UMR Pilot Monitoring Project Field Operations Manual (FOM) was developed to provide the technical and procedural detail necessary to implement the Reaches 8-9 pilot and enhance consistency

across field sampling efforts. While the FOM will inform sampling procedures UMR-wide, the nature of the pilot study is that changes and improvements are expected as a result of this effort.

This FOM describes sampling that will occur during the pilot and does not necessarily provide all the information needed to implement full monitoring river-wide. The following components have been modified for the Reaches 8-9 pilot monitoring project:

- While aquatic vegetation does occur in Reaches 8-9, the Monitoring Plan does not require sampling as a part of the aquatic life use assessment. Therefore, no monitoring will be done for aquatic vegetation.
- Follow-up sampling and monitoring for secondary indicators (e.g., sediment chemistry) is not explicitly addressed in the pilot, though such monitoring may occur at the discretion of the states.
- Cyanotoxin monitoring will be conducted for recreation use and drinking water use assessments. This sampling is in addition to the Monitoring Plan and was recommended by the Reaches 0-3 pilot planning team.
- Metals will not be sampled at probabilistic sites during the pilot project. They will be sampled at fixed sites.
- Pesticides/herbicides, carbamates and glyphosate will be added to the drinking water use assessment.
- Index site monitoring will not be part of the pilot project.
- The tributary loading network will not be sampled as part of the pilot project.

This FOM is focused on field activities and does not provide extensive detail on sample site selection, laboratory analytical methods, data management, data analysis/score calculation – though some discussion of these functions are included.

2. MONITORING OVERVIEW AND GENERAL PROCEDURES

2.1 Geographic Extent

The Monitoring Plan organizes monitoring around the "minimum Clean Water Act assessment reaches" established via an interstate Memorandum of Understanding in 2003. These reaches follow HUC-8 boundaries (Figure 2).

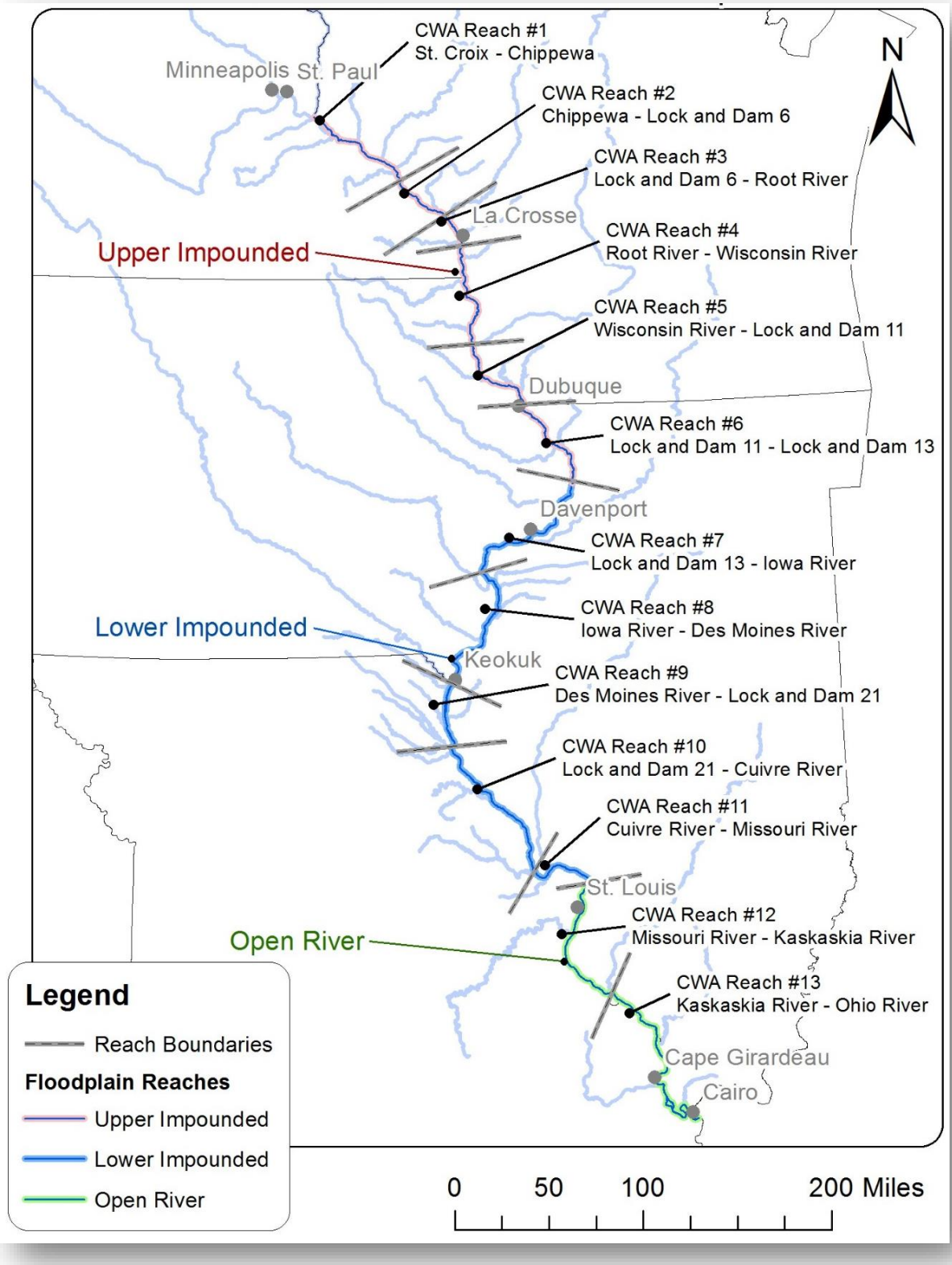

Figure 2: Minimum, interstate UMR CWA assessment reaches

The geographic extent of the pilot monitoring project is the main stem UMR from the Iowa River confluence (USACE River Mile 434) to the Lock and Dam 21 (River Mile 324.9). This includes the UMR assessment reaches 8 and 9 (Table 1). All sampling takes place in the river's main channel and adjacent shoreline throughout the run of the river.

Table 1: Geographic extent of pilot monitoring program, UMR assessment reaches 8 and 9

Reach Number	**Reach Name** (Description/8-digit HUC code)	**River Miles**	**Segment Length (miles)**
8	Assessment Reach 8 (Flint-Henderson) (Iowa River to Des Moines River/HUC 07080104)	434.0 - 361.4	72.6
9	Assessment Reach 9 (Bear-Wyaconda) (Des Moines River to Lock & Dam 21/HUC 07110001)	361.4 – 324.9	36.5

2.2 Scope of Indicators Monitored

The monitoring plan specifies sampling across a wide extent of parameters. The pilot monitoring project focuses only on fixed and probabilistic sites of CWA assessment-focused networks. Tributary loading network, which is specified in the full plan, is not sampled in this pilot study (Table 2). Bottle sizes for the various parameters can be found in Table A-1. Note that drinking water use assessment parameters are included in Table 2, but will not be described in detail. A companion document developed for public - drinking water suppliers is called the *Public Water Supplier Sampling Manual*.

Table 2: Summary of parameters monitored in pilot project, where X is sampled in pilot study, ▲ is sampled in full plan, and — is neither sampled in pilot study nor full plan.

Indicator Group	**Indicators**	**Probabilistic Monitoring** (15 sites/reach)	**Mainstem Fixed Network** (20 sites UMR-wide)
Biological Communities	Fish	X	—
	Vegetation[#]	X	—
	Macroinvertebrates	X	—
Fish Tissue	Mercury (Hg)	X	—
	PCBs	X	—
Field	Water Temperature	X	X
	DO (conc.& sat)	X	X
	pH	X	X
	Conductivity	X	X
	Turbidity	X	X
	Secchi Depth	X	▲
Nutrients	NO3+NO2	X	X
	TN	X	X

	NHx	X	X
	TP	X	X
	DP	X	X
	Chlorophyll a	X	X
Bacteria	*Escherichia coli*	X	X (April-October)
Cyanotoxin	Microcystin	X	X
	Cylindrospermopsin	X	X
Miscellaneous	BOD	X	X
	Chloride	X	X
	Sulfate	X	X
	TSS	X	X
	TOC	X	X
	Hardness (Ca & Mg)	X	X
	Alkalinity	X	X
	Fluoride*	X	X
Metals&	Aluminum (Al)	▲	X
	Calcium (Ca)	▲	X
	Cadmium (Cd)	▲	X
	Chromium (Cr)	▲	X
	Copper (Cu)	▲	X
	Iron (Fe)	▲	X
	Lead (Pb)	▲	X
	Manganese (Mn)	▲	X
	Magnesium (Mg)	▲	X
	Potassium (K)	▲	X
	Sodium (Na)	▲	X
	Zinc (Zn)	▲	X
Other%	Arsenic (As)	X	X
	Mercury (Hg)	▲	X
	Selenium (Se)	X	X
	Perfluorinated compounds	—	X
Organics*%	VOCs	—	X
	Herbicides/Pesticides	—	X
	Carbamates	—	X
	Glyphosate	—	X
	Total Phenols	—	X
Physical Habitat and Characteristics	Substrate	X	—
	Depth	X	—
	Velocity	X	—
	Discharge^	▲	X

Sampled only in reach 1-6 only.
* Sampled only at fixed sites in proximity to a drinking water intake.
^ From existing gages near sampling sites, when available.
% These parameters are collected as part of the drinking water use assessment
& All metals in the 200.7 method will be reported. Metals not listed are Antimony (Sb), Arsenic (As), Barium (Ba), Beryllium (Be), Boron (B), Cobalt (Co), Lithium (Li), Molybdenum (Mo), Nickel (Ni), Selenium (Se), Silver (Ag), Strontium (Sr), Thallium (Tl), Tin (Sn), and Vanadium (V)

2.3 Overview of Fixed-Site and Probabilistic Monitoring

The pilot project focuses on the fixed sites and probabilistic network, which are central to providing a robust characterization of the UMR's condition.

Fixed Site Network

Site Locations: The entire UMR fixed site network is composed of 20 stations spread over 13 reaches. At least 1 fixed sampling site is placed in each assessment reach and additional sites are positioned at drinking water intakes if present. A total of 6 fixed sampling sites will be sampled in Reaches 8 and 9: 3 sites are drinking water intakes (Table A-2) and 3 sampling sites routinely monitored by Illinois EPA (Table 3, Figure 3, and Figure 4). Note that there are 6 drinking water intakes in Reaches 8-9, but 3 public water suppliers are participating in the pilot: Keokuk, Warsaw, and Quincy.

Table 3: Fixed sites in the pilot monitoring area. The upper fixed sampling site is technically located in Reach 7 based on the HUC-8 watershed division but is included in this pilot study to represent the beginning of the study.

Reach	River Mile	Location	Agency Sampling	Previously Sampling Location	Nearby USGS or Corps Gage	HUC-8	Easting, Northing
Fixed Site Sampling							
7	437	Lock & Dam 17 at New Boston, IL	Iowa DNR	Illinois EPA (IL L-04)	Corps: MR at L&D 17	07080101	663001.830, 4561702.709
8	364.6	Lock & Dam 19 at Keokuk, IA	Iowa DNR*	Illinois EPA (IL K-22)	Corps: MR at L&D 19 USGS: 5474500	07080104	638158.926, 4472924.415
9	325	Lock & Dam 21, 0.75 miles SW of Quincy, IL	Missouri DoC*	Illinois EPA (IL K-17)	Corps: MR at L&D 21	07110001	634150.708, 4418270.995
Drinking Water Sampling							
8	364		Warsaw Water Department	Warsaw Water Department		07080104	
8	365		Keokuk Municipal Water Works#	Keokuk Municipal Water Works		07080104	
9	327		Quincy Water Department	Quincy Water Department		07110001	

*Illinois EPA annually monitors these fixed sites in January, March, June, and September. Iowa DNR and Missouri DoC will sample these sites other 8 months during the pilot study.
#Keokuk will not collect PFAS samples as a part of the drinking water use assessment

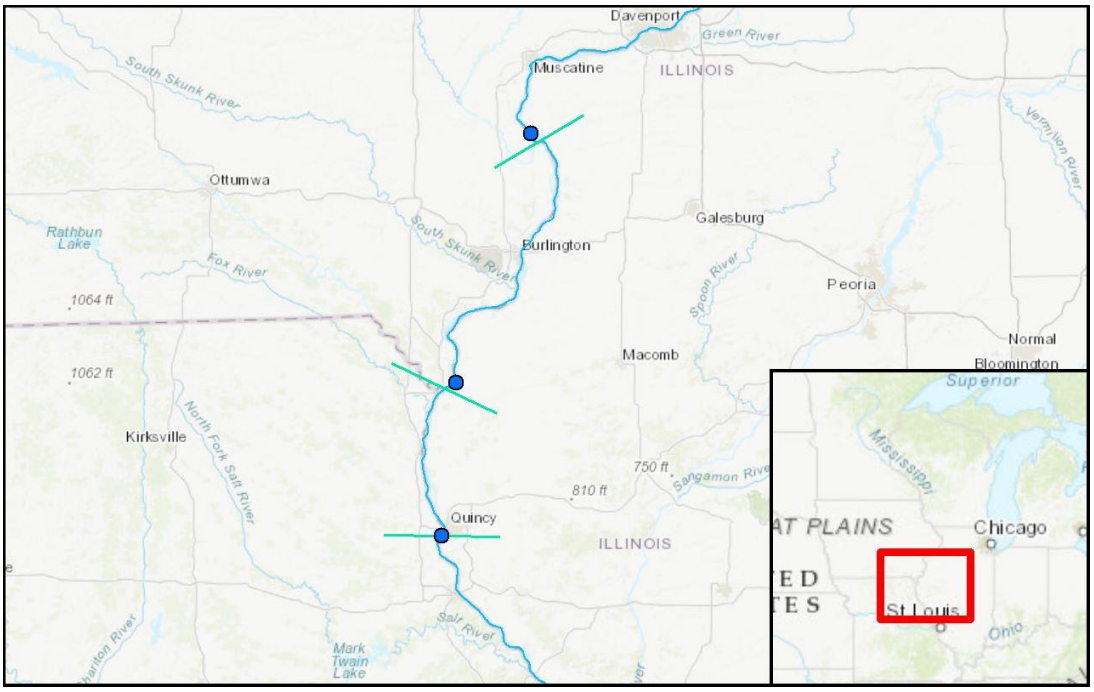

Figure 3: Fixed sample sites in pilot area (blue dots)

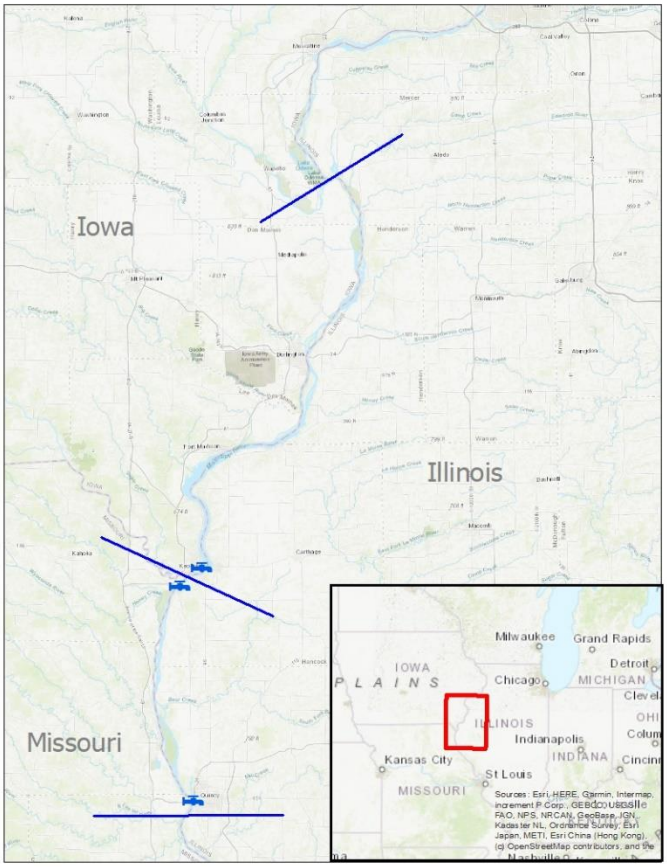

Figure 4: Public water suppliers participating in the Reaches 8-9 pilot (blue spigot).

Indicators: Field parameters, nutrients, discharge, and other water chemistry are monitored at all fixed sites monthly year-round. Bacteria *(E. coli)* is sampled monthly from April through October (Table 4). In addition to abovementioned parameters, drinking-water contaminants (e.g., VOCs, pesticides/herbicides, phenols, fluoride) are sampled at 6 fixed sites located at drinking water intakes.

Table 4: Sampling summary of fixed mainstream monitoring network sites. Samples are taken every month.

Parameters	Sampling Period	Sampling Frequency	Total Number of Sites
Water Chemistry	January-December	12 times a year, monthly	3
Nutrients	January-December	12 times a year, monthly	6
Discharge	January-December	12 times a year, monthly	3
Cyanotoxin – Targeted Recreation	April-October	7 times a year, monthly	3*
Cyanotoxin – Fixed and Drinking Water	January-December	12 times a year, monthly	6
E. coli – Targeted Recreation	April-October	7 times a year, monthly	3*
E. coli – Fixed	April-October	7 times a year, monthly	3
VOCs, Pesticides, Phenols, and Other	January-December	12 times a year, monthly	3

*Note: As a part of targeted recreation use sampling, sites near Quincy, IL will be sampled for cyanotoxins. This is a separate effort from monthly cyanotoxin sampling as a part of the drinking water use assessment. Monthly samples from intake stations will be collected by public water supply operators.

General Sampling Procedures: Fixed site monitoring is typically conducted from "hard structures" (e.g., bridges, locks and dams) and does not require the use of a boat. Fixed sites are monitored year-round and the modification of winter sampling techniques might be considered. Personnel estimates for fixed site sampling can be found in Table A-3.

The location of fixed sites in Reaches 8-9 is predetermined and can be found on online by clicking the hyperlink: pilot project viewer. All fixed sites in the pilot area are the sites previously sampled quarterly by Illinois Environmental Protection Agency (Illinois EPA). Sampling crews may wish to communicate with other organizations regarding site access and other site considerations, such as identifying special equipment needed to reach the water surface, equipment to break ice in winter. Samples should be taken at the "x-point" centerline (i.e., USACE navigation sailing line), but the sampling locations can be adjusted, if needed, taking into account the presence of physical structures, site accessibility, etc.

Probabilistic Network

Site Locations: There are 30 probabilistic sites in the pilot project area (15 sites per reach) (Figure 5). The sites are allocated along the river's centerline, defined by USACE navigation sailing line. These sites are

randomly selected by USEPA for this project and meet some predefined location conditions. Sampling responsibilities of agencies are divided based on the reaches.

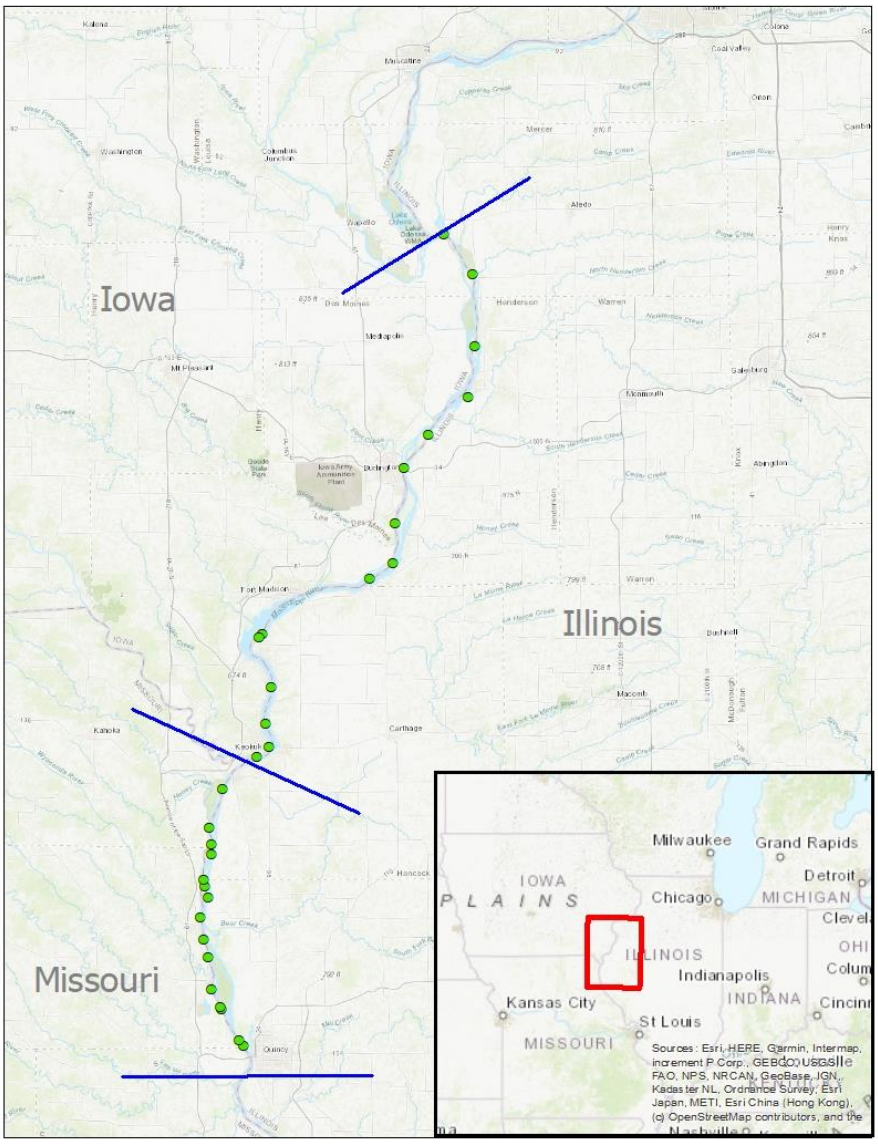

Figure 5: Probabilistic monitoring locations in pilot area (blue dots)

Indicators: Biology (fish and macroinvertebrates), water chemistry, field parameters, and site characteristics, are all sampled at the probabilistic locations from July to September (Table 5). Biological samples are only collected during one sampling event, but water chemistry parameters and *E. coli*, and cyanotoxins are sampled three times during the index period.

Table 5: Sampling summary of reach-based probabilistic monitoring sites

Parameters	Sampling Period	Sampling Frequency	Number of Sites per Reach
Water chemistry	July-September	3 times during sampling period	15
E. coli	July-September	3 times during sampling period	15
Cyanotoxins	July-September	3 times during sampling period	15
Fish and habitat	July-September	1 time during sampling period	15
Macroinvertebrates	July-September	1 time during sampling period	15

General Sampling Procedures: Probabilistic sites are boat-based and more equipment-intensive compared to fixed monitoring sites. Multiple trips to the probabilistic monitoring sites might be necessary to complete sampling. Note that *E. coli* and cyanotoxin samples should be collected concurrently with water chemistry samples. Personnel estimates for probabilistic sampling can be found in Table A-3.

In general, for *probabilistic* sampling:

- **Water chemistry samples** are taken as grab samples at the centerline "x-point" at locations established in advance by USEPA randomized draw (Figure 6). Water quality samples are collected at 0.2-meter depth using equipment (bucket, Van Dorn sampler, etc.) selected by the sampling agency
- **Biological (fish) sampling** is conducted on 5-200-meter long MCS transects. Each MCS transect is centered at the intersection of the cross-channel transect, which is established perpendicular to the river flow through predetermined centerline "x-point". Each MCS contains ten subsites and are located on both the left and right side of the river. Five of the ten candidate subsites are randomly selected (Figure 6). If the specified transect cannot be sampled because of safety, access, or other reasons, then the remaining 5 subsites may be sampled. The randomized list of subsites should be followed (Table A-4).
- **Biological (macroinvertebrate) sampling** is conducted on the first of 5-200-meter long main-channel shoreline (MCS) transects (Figure 6). Each MCS transect is centered at the intersection of the cross-channel transect, which is established perpendicular to the river flow through predetermined centerline "x-point". MCS transects are located either on the river right or left side. River sides are pre-designated during sample selection and determined when facing downstream.

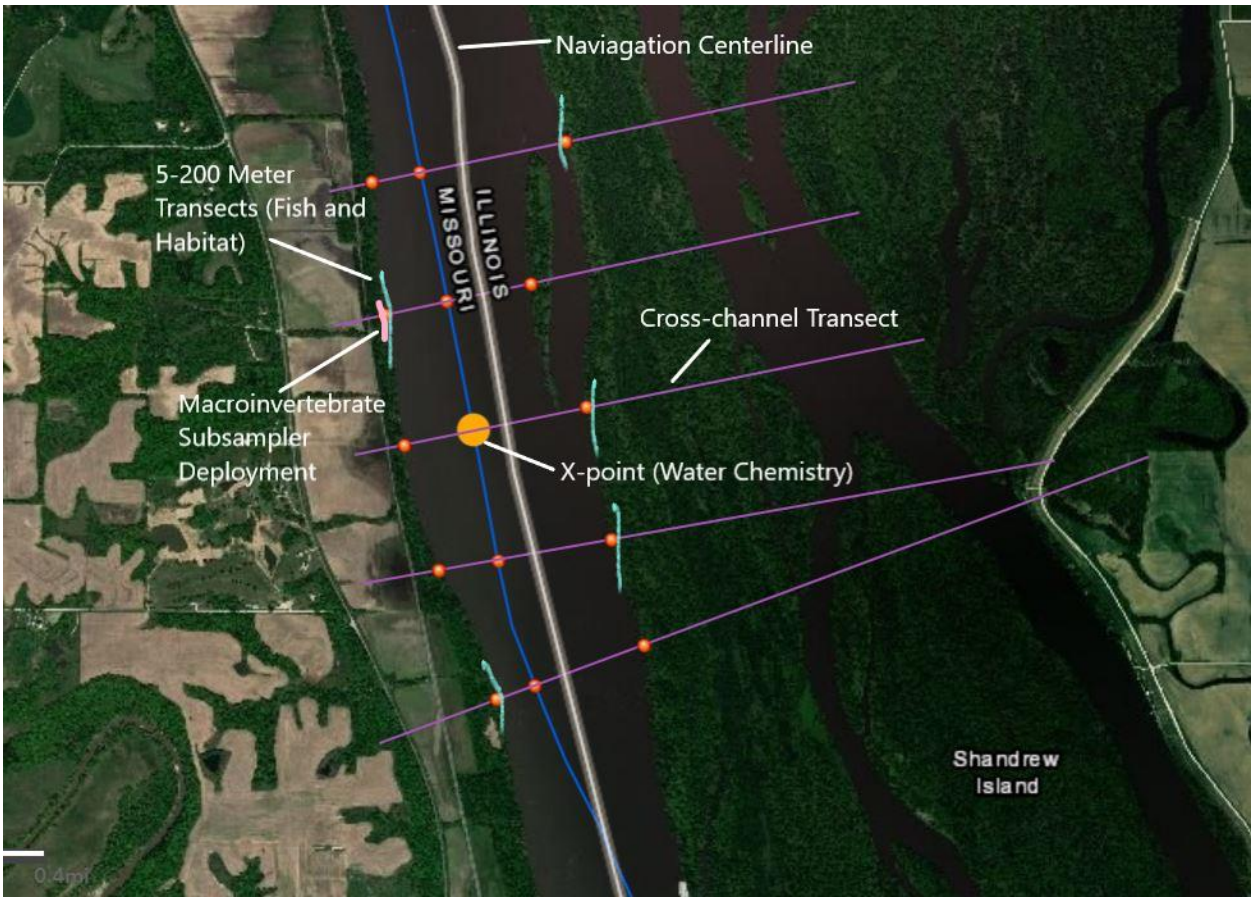

Figure 6: General arrangement of probabilistic sample sites (x-point) and 5-200-meter long main-channel fish transects (drawn in light blue) and the site of macroinvertebrate artificial subsampler deployment (light pink).

2.4 Site Descriptions/Information

Site Naming

All fixed and probabilistic sites utilized in the pilot project have a unique identifier (Table 6; Table A-5, Table A-6).

Table 6: Site naming convention

Site Type	Project ID	Site ID Format	Site ID Example
Fixed	UMR	UMR-XXX.X	UMR-815.6
Fixed Duplicate	UMR	UMR-	UMR-
Probabilistic	UMR	UMR15-XXXX*	UMR15-0303
Probabilistic Duplicate	UMR	UMR-	UMR-

*Number 15 in the probabilistic site codes indicate 2015, a year when these sites were generated by USEPA.

Coordinate System

A common coordinate system is used to maintain spatial congruency across multiple sampling crews. UTM Zone 15N is chosen for this pilot study because the entire study area lies within this UTM coordinate system zone. NAD83 is selected as refence datum.

2.5 Overview of Agency Roles

Field Crews

The sampling crews from Iowa, Illinois, and Missouri will be engaged in pilot monitoring (Table 7).

Table 7: Field crews engaged in pilot monitoring

Monitoring Network	Reaches	Water Chemistry*	Fish**	Macroinvertebrates	Drinking Water
Fixed	8	Iowa DNR – Des Moines and Illinois EPA			Warsaw and Keokuk Water Departments
	9	Missouri DoC and Illinois EPA			Quincy Water Department
Probabilistic	8	Iowa DNR – Fairport	Iowa DNR – Fairport	Iowa DNR – Fairport	
	9	Missouri DoC	Missouri DoC	Missouri DoC	

*Includes field parameters, nutrients, bacteria, cyanotoxin, miscellaneous, metals, and other parameters.
**Includes site characterization (habitat).

Laboratories

There are six laboratories involved in analyzing samples from pilot monitoring (Table 8). In general, the Contract Coordinators request one week's notice of the field samplers schedule, so the laboratory is prepared for sample arrival and aware of the sample's holding time.

Table 8: Laboratories utilized in pilot monitoring

Laboratory	Submitting Agencies	Types of Samples Analyzed	Contract Coordinator
Illinois Environmental Protection Agency#	Illinois EPA	Water chemistry (fixed sites)	Anna Belyaeva, Anna.Belyaeva@illinois.gov (217) 557-8761
Iowa Department of Natural Resources	Missouri DoC, Iowa DNR	Cyanotoxins (fixed and probabilistic sites)	Dan Kendall, Daniel.Kendall@dnr.iowa.gov (515) 725-8379
Iowa State Hygienic Laboratory	Missouri DoC, Iowa DNR	*E. coli* (fixed sites)	Dan Kendall, Daniel.Kendall@dnr.iowa.gov (515) 725-8379

Missouri Department of Natural Resource Chemical Analysis Section (Jefferson City, MO)	Missouri DoC, Iowa DNR, Public water suppliers	*E. coli* (fixed and probabilistic sites) Water chemistry (fixed and probabilistic sites) Drinking water (fixed sites)	Robert Voss, Robert.Voss@dnr.mo.gov (573) 522-4505
Pace Laboratories (Green Bay, WI)	Missouri DoC, Iowa DNR	Fish tissue (probabilistic sites)	Lauren Salvato, lsalvato@umrba.org (651) 224-2880
Missouri Department of Conservation (Cape Girardeau, MO)	Missouri DoC, Iowa DNR	Macroinvertebrate (probabilistic sites)	Molly Sobotka Molly.Sobotka@mdc.mo.gov (573) 290-5858 x 4483
US Environmental Protection Agency Chicago Regional Laboratory (Chicago, IL)	Missouri DoC, Iowa DNR, Illinois EPA	PFAS (fixed sites and public water supplier intake stations)	Rob Snyder, snyder.robert@epa.gov (312) 353-9083

#Illinois EPA will process samples for all fixed sites for four out of the 12 months sampled in 2020: January, March, June and September

2.6 General Safety Precautions

Sampling crews should not sample during adverse conditions, such as in the presence of lightning, swift current and flooding, gusts and waves greater than the boat can safely navigate, air temperatures below 0°F and wind chill below -20° F.

Sampling crews should conduct pre-trip boat, vehicle, and trailer inspections, follow road rules, and be respectful to other drivers. Crews should have emergency contact number to get assistance in case of car accident, locked keys, etc.

Crews should follow all applicable boating safety rules and regulations established by their agencies. Personal flotation devices (PFDs) must be easily accessible when the boat is in operation and/or occupied, including throwable flotation devices (Type IV PFDs). The motor kill switch should be attached to the boat operator (clip to PFD or wrap around wrist) to prevent the control loss if boat operator falls out of the boat.

The barge traffic related to transportation and dredging operations and recreational traffic should always be given the right of way when navigating to the sampling location on the Mississippi River. To avoid dangerous situations, special attention should be paid when crossing the navigation channel, navigating to and from sampling locations, and during mid-channel sampling.

Electrofishing is potentially hazardous, and safety measures should be insured. The pilot must be aware of the crew, other boaters, people on shore, as well as water conditions, both submerged and above-water hazards, the control box settings, outboard engine conditions, beginning and end points of the sampling run, timer, etc. It is highly recommended that agencies require training for large river sampling, electrofishing boat operation, and first aid and CPR.

Sampling crew should follow all field safety protocols established by their agencies. Sampling staff that use chemicals (e.g., sulfuric acid, nitric acid, and methanol) for sample preservation should consult its Safety Data Sheets for proper handling to avoid inhalation, eye/skin irritation, and other health problems. If exposure of acid and base compounds occurred, flush eyes and wash skin immediately with fresh water for a minimum of 15 minutes.

Because sampling crews come in direct contact with waterborne pathogens. It is recommended to wash hands with soap and fresh water or clean hand with ethanol-based hand sanitizer after handling samples.

2.7 Quality Assurance (QA)/Quality Control (QC) Procedures

QA/QC procedures will be utilized specific to the indicator group. For chemistry, fish, and macroinvertebrate sampling, 10% of samples will be replicated. This translates to two sample sites per reach (Table A-7). Note one exception that replicate sampling is not expected to be part of fish tissue monitoring. Replicate samples should not be biased towards certain locations, time periods or water quality conditions and should be collected a minimum of one week later than the initial sampling (but within the same index period) and ideally at a similar river stage.

For chemistry sampling, a range of 5-10% split samples is recommended. At least one water splitting event should be attempted prior to the beginning of the index period to provide a baseline and allow for modifications if necessary. Within-season splitting events will be necessary to keep a continuous record of comparability between laboratory results.

Two sites per reach will have duplicate Hester-Dendy samplers deployed (Table A-7). Sampler should be in similar flow and depth conditions, within close proximity to each other. Duplicate samplers should not be immediately up/downstream of each other. They should side by side, or up/downstream and offset so they are not receiving the same flow, and drift.

QA of fish sample processing depends on correct identification of specimens. Crew members should have sufficient training to identify most fish that are collected. Questionable fish should be retained as preserved specimens, to be identified in the lab or sent out for confirmed identification by a taxonomist.

3. DATA FLOW AND MANAGEMENT

Because agencies differ in how they record, process, and store sampling information, the data flow and management section represents an agreed upon process over the course of pilot planning and implementation. It is presumed that all participating agencies will exercise care in collecting and recording data, follow good QA/QC protocols in proofing and managing data sets and data transfer, and will keep appropriate records to document what was done at various steps in the process.

The data flow describes the process from field sampling to laboratory processing and data analysis. The process is simplified by using single laboratories to process samples for all state agencies (Table 10). And, resources are housed in a shared location via the Reaches 8-9 Google Drive folder and data are housed on an Access database that can be connected to remotely by all participating agencies. Field sampling crews will collect and enter data onto the Access database and scan data collection sheets onto the Google Drive folder (Figure 8). Laboratories will process samples and once analyzed, the results should be directed to the Contract Coordinator. The Contractor Coordinator should enter the results to the Access database. State agencies can also use their databases as a repository but the Access database and Google Drive folder should serve as the main repositories. Following the completion of the pilot, UMRBA will submit data to USEPA's Water Quality Exchange (WQX) database.

3.1 Short-term data management (before and during pilot implementation)

Format

Recording field data on paper forms or computer data entry applications are acceptable formats. Field sampling crews are encouraged to enter paper forms electronically within 1-2 months of collection to the Access database. Scans of the paper forms and electronic data sheets should be uploaded to the Google Drive folder in the appropriate use assessment folder. Agencies should follow their "typical" process for retaining paper and computer forms outside of Google Drive.

Chain of custody forms should be filled out by field sampling crews and accompanied with samples turned in for laboratory analysis. The chain of custody form should be retained by the laboratory. The Contract Coordinator should request a copy for record keeping and add the copy to the appropriate use assessment folder on Google Drive.

Access and Sharing

Blank field data and chain of custody sheets will be accessible on the Google Drive folder. Each planning committee member will have access to edit and add documents. The Google Drive link should not be shared widely beyond planning committee members and field sampling crews.

Storage and Backup

Google Drive will be utilized throughout the pilot project and beyond (for long-term management see "Designated Archive"). This storage mechanism actively saves any edits or updates made to pilot data. There are no data size limitations for using Google Drive through Iowa DNR, so there is no concern of data storage exceedance. The Access database will be routinely backed up on the server, and in addition by UMRBA.

UMRBA will conduct weekly backups of the Google Drive folder contents to ensure that the data are housed in a secondary location.

Data manipulation

The original data files will be maintained while the planning committee performs statistical analyses. This involves saving a new copy of the original data and renaming the document with the following naming convention: "Use assessment_ Date _ group member's initials". The designation from the original data will ensure that it is preserved.

3.2 Long-term data management (after pilot implementation)

Designated Archive

After the completion of the pilot, UMRBA will serve as the designated archive. State agencies will have an archive in their respective databases as well on USEPA's WQX.

Access and Sharing

The data are public and will be obtainable through UMRBA or USEPA's WQX. Any other external requests for the Reaches 8-9 pilot data can be directed to Lauren Salvato, lsalvato@umrba.org.

3.3 Metadata

Metadata is essential for capturing the content, quality, condition, and characteristics of all the data collected over the course of the pilot project. Metadata records will be maintained on the Access database. This research project's metadata will include data information represented in the following subsections: identification, constraints, data quality, maintenance, content, and distribution.

4. INDICATOR GROUP-SPECIFIC PROCEDURES

4.1 Water Chemistry and Other Indicators

Indicators

Chemistry parameters collected include field parameters, nutrients, bacteria (*E. coli*), cyanotoxins, miscellaneous, metals, and other parameters (Table 9). SOPs can be found in A-8.

Table 9: Water chemistry and other parameters, where X is sampled and — is not sampled

Indicator Group	**Indicators**	**Probabilistic Sites** 15 sites per reach 3 sampling events from July to September	**Fixed Sites** 1 site per reach Monthly sampling, unless noted otherwise
Field	Water temperature	X	X
	DO (concentration and saturation)	X	X
	pH	X	X
	Conductivity	X	X
	Turbidity	X	X
	Secchi and water depth	X	—
Nutrients	NO3+NO2	X	X
	TN	X	X
	NHx	X	X
	TP	X	X
	DP	X	X
	Chlorophyll α	X	X
Bacteria	*Escherichia coli*	X	X (April to October)
Cyanotoxins	Microcystin	X	X
	Cylindrospermopsin	X	X
Miscellaneous	BOD	X	X
	Chloride	X	X
	Sulfate	X	X
	TSS	X	X
	TOC	X	X
	Hardness (Ca and Mg)	X	X
	Alkalinity	X	X
Metals[&]	Aluminum (Al)	—	X
	Calcium (Ca)	—	X
	Cadmium (Cd)	—	X
	Chromium (Cr)	—	X
	Copper (Cu)	—	X
	Iron (Fe)	—	X
	Lead (Pb)	—	X
	Manganese (Mn)	—	X
	Magnesium (Mg)	—	X
	Potassium (K)	—	X
	Sodium (Na)	—	X
	Zinc (Zn)	—	X
Other[%]	Arsenic (As)	—	X
	Selenium (Se)	—	X
	VOCs	—	X
	Herbicides/Pesticides	—	X
	Carbamates	—	X

	Glyphosate	—	X

[&] All metals in the 200.7 method will be reported. Metals not listed are Antimony (Sb), Arsenic (As), Barium (Ba), Beryllium (Be), Boron (B), Cobalt (Co), Lithium (Li), Molybdenum (Mo), Nickel (Ni), Selenium (Se), Silver (Ag), Strontium (Sr), Thallium (Tl), Tin (Sn), and Vanadium (V)
% These parameters are collected as part of the drinking water use assessment

Site Selection

Fixed Sites: Fixed sample sites have been successfully sampled in the past, and because there is no biological sampling for fixed sites, there should be no site or bank selection issues. Samples will be collected from as near to the river's "x-point" centerline as possible, recognizing that these sites utilize fixed site infrastructure (e.g., lock and dam) that may dictate a specific sampling location.

Probabilistic Sites: Probabilistic sites are allocated along the river's centerline (defined by USACE navigation sailing line). Crews will sample at the centerline "x point" identified in the sample draw. Proposed sampling sites should be reviewed in the office (via the pilot project viewer) to identify in advance any potential sampling issues. Sampling transects are subject to change if an issue with biological sampling arises.

Frequency/Index Period

Fixed Sites: Water chemistry samples are collected monthly at fixed sites year-round. Bacteria (*E. coli*) samples are only collected during the months of April through October.

Probabilistic Sites: Water chemistry samples are collected three times during the probabilistic monitoring index period of July through September.

Crews should make an effort to intersperse sites among reaches and throughout the index period to achieve a representative mixture of conditions. However, cost effectiveness may dictate sampling a cluster of sites within an area over a short span of days. If unusual hydrological or weather conditions occur during a sampling event, they should be documented, at a minimum, and crew leaders will have discretion as to when sampling should be discontinued for unusual conditions.

Sample Collection

Field Parameters: Temperature, dissolved oxygen (concentration and saturation), pH, and conductivity are all measured by instruments on site at 0.2-meter depth and results recorded to lab sheet or electronic interface per sampling agency processes. Secchi depth is measured using a pole-mounted disk. Water depth may also be measured using the Secchi pole or with handheld sonar.

Habitat and site characteristics (e.g., depth, substrate, velocity) are not collected during chemistry sampling.

Nutrients, Miscellaneous, Metals and "Other" Parameters: All of these analytes are collected at a 0.2-meter depth using the equipment and sample bottles specified by the collecting agency. During grab

sampling, remove bottle cap and invert bottle lowering into the water until 0.2-meter depth is achieved, then turn bottle upright to begin filling, this will avoid collecting organic debris floating directly on the water surface. Preservation and analytical methods are done according to the protocols of the recipient laboratory (Table A-9 – Table A-11). Refer to data collection sheets if field filtration is required.

Bacteria (*E. coli*): Bacteria samples will be collected alongside the water chemistry parameters. Due to holding time limitations, crews will need to schedule their field days so that samples can be delivered to laboratories accordingly. Samples must also be held at 4°C until delivery to the lab. Note that samples received after the holding time may still be run and results flagged accordingly.

Cyanotoxins (*Microcystin and Cylindrospermopsin*): Cyanotoxins samples will be collected alongside the water chemistry parameters. Samples must be held below 6°C or kept frozen until delivery to the lab. Unfrozen samples must be delivered to the lab within 5 days. Frozen samples must be delivered to the lab within 14 days. Note that samples received after the holding time may still be run and results flagged accordingly.

4.2 Fish Assemblage

Fish sampling includes primarily collection of fish and associated site characteristic data (e.g., habitat). Fish data are collected to support calculation of Great River Fish Index (GRFIn) scores (Table A-12). Site characteristic data are collected in support of investigating outliers in catch data and to document any unique conditions at the time of sampling.

The Upper Mississippi River Restoration Long Term Resource Monitoring (LTRM) fish sampling methodology is integrated into the aquatic life use assessment. Instead of a 1 km EMAP-GRE transect, 5-200 meter transects will be randomly selected to sample and composited as one probabilistic site. Ten of the drawn subsites are eligible, 5 will be randomly selected, and the remaining 5 will be randomly ordered in the event that any of the initial sites are deemed unsampleable.

Site Selection

An initial determination should be made by fish crews on the site sampling status for electrofishing purposes prior to water chemistry sampling or artificial substrate sampler deployment to ensure all indicator crews monitor the same sites and maximize efficiencies. Fish crew leads must be in communication with other crew leads to share any issues regarding the ability to sample probabilistic sites. If sites are determined not to be sampleable, they will be replaced with the randomly determined list of subsites within the same assessment reach (Table A-4). Any deviations should be documented.

Cases may occur where the randomly selected bank cannot be utilized for macroinvertebrate sampling (due to velocity and/or depth issues) but is suitable for fish assemblage sampling. In such cases,

electrofishing will remain on the randomly selected subsite even if macroinvertebrate sampling is shifted to the next subsite (Table A-4).

Site Verification

The 5-200 m main channel shoreline (MCS) transect is established along a terrestrial shoreline interface and sampling is executed within the near-shore littoral zone. The MCS transect should be established and sampled along the predetermined random bank unless that bank is not representative of main channel border habitat or is unsafe to sample.

An assigned bank that is not representative of main channel border habitat conditions might include a backwater lake, riparian wetland, constructed marina, or other condition which prohibits sampling within the terrestrial shoreline interface adjacent to the main channel border. Impoundments are included within the study design and should be sampled unless unsafe conditions preclude a bank from being sampled. Unsafe conditions could include barge fleeting areas, dams, and lock channels.

Frequency/Index Period

Fish assemblage sampling is conducted one time during the July to September index period under normal summer baseflow conditions (discharge between the 25th and 75th percentile, preferably near the daily long-term median statistic).

Sample Collection

Fish assemblage data are collected by electrofishing with a three-person crew during the day. After electrofishing and processing fish, the crew records fish habitat data (i.e., site characteristics).

Electrofishing Transects: Upon arriving at the site location and completing the pre-sampling water quality data recording, the fish-sampling crew identifies and documents the upstream and downstream boundaries of the electrofishing run using GPS and shoreline features. When possible, the sampling run should be centered on the perpendicular intersection of a line through the x-site with shore, although sliding the boundaries of the reach to accommodate island configurations, man-made structures and other obstacles is acceptable. Upstream, downstream, midpoint, and any split transect coordinates are recorded, if different from those recorded in the office site verification process.

The shoreline electrofishing zone extends out from shore to a depth of 6 m (20 ft) or a distance of 30 m (100 ft), whichever is closer to the shore. Electrofishing is conducted for a minimum of 15 minutes (900 seconds) per 200 meters, for a total of 1 hour (3600 seconds) of total shock time to collect fish from the designated zone. Increased shock time may be necessary to fish shorelines with abundant cover.

Electrofishing: At a minimum, elapsed sampling time or "on-time" (electrical current applied to water in seconds) will be recorded. As available, standard ancillary electrofishing data will be recorded – volts, amps, frequency (Hz) and duty cycle (%).

The minimum electrofishing time for each 200-meter site is 15 minutes (900 seconds) of shock time. Along shorelines with swift current and/or little cover, it may be necessary to overlap passes along the shore to ensure coverage and achieve the required minimum shock time. There is no upper limit for electrofishing time, although all five sites should be able to be sampled within 3600-5400 seconds of shock time.

Sample Processing: Sample processing includes identifying fish to species, examining them for external anomalies, measuring and weighing, preserving small specimens for later processing, photographing voucher specimens, and selecting specimens to be retained for tissue contaminant analysis.

Fish are recorded by the UMRR-LTRM common codes. Abbreviated field data codes can be linked to scientific name later in the data entry. A total count of individuals for each species collected should be recorded in the data entry sheet. Crews may opt to process fish in batches by species and record a single count for each species on the Fish Sampling Form, or, if individual fish are recorded, their counts may be summed later, during data analysis. All fished are weighed (g), either as a batch weight, by species, or individually.

Each fish must be examined for DELTs (deformities, erosions, lesions, and tumors). Record the presence of DELTS on an individual fish or among fish in a batch using assigned codes. Although individual fish may have multiple DELTs, record only a single (most prevalent) DELT for each fish. Other abnormalities (e.g., blind eyes, pop-eye, fungus) can be recorded using flags.

Fish length data are optional, as the GRFIn does not require length information in its metrics. Crews may choose to record minimum and maximum lengths of each species, or individual lengths, or may choose certain species to measure, depending upon the standard practices of the collecting agencies.

Unknowns and voucher specimens: Specimens that cannot be identified with certainty in the field should be preserved in 10% formalin for later processing by the sampling crew. Preserved fish will be processed in the same way as field-processed fish. Crews must label preserved samples with site ID and sample date at a minimum, to identify where and when each sample was collected, and also fulfill any required hazard or biosecurity labeling requirements.

Each fish-sampling crew should collect or photograph voucher specimens for each different species encountered at a sampling site. Any known or suspected non-indigenous exotic or invasive fish species should be documented. State agencies should follow their respective protocols for reporting non-indigenous exotic or invasive fish species.

4.3 Fish Tissue Contaminants

Indicators

Fish contaminant concentrations are a co-indicator for the fishable-swimmable goals of the Clean Water Act. For the 2020 pilot monitoring, mercury and PCBs are the contaminants of concern that will be

used for 305(b)-type assessments. This information is intended to complement sport fish advisory efforts and is not intended to replace what each state has historically done or would plan to do in the future. Reaches with unusually high levels may indicate that there are still some active sources that can be investigated later.

Mercury and PCB tissue concentrations will be measured in fillets from target species groups and size classes. These species and sizes of fish will be analyzed individually by each state's sport fish advisory labs. Fish of the same species and approximate age have had a similar length of exposure to contaminants in the river (Table 10). This allows reaches to be compared to each other. The following fish are sought from each reach:

- Ten 15-17 in or 38.1-43.2 cm Black Basses: Smallmouth or Largemouth bass (mixed is ok)
- Ten 18-21 in or 45.7-53.3 cm Common Carp

The ranges listed above are preferred size ranges. The primary purpose of the size classes is to obtain fish of roughly the same age. However, if fish specifically in the size range cannot be collected, it is better to have some fish for a reach than none at all. Variation in size of up to 1" from the above guidelines is acceptable.

Table 10: Summary of reach-based probabilistic fish tissue sampling. Sampling is conducted once from July to September.

Parameter	Sample Type	Fish Group (Species)	Size Class	Fish Retained per Reach	Total Number of Samples per Reach	Number of Sites per Reach
Mercury PCBs	Skin-off fillet	Top Predator (Black Basses)	15-17" or 38.1-43.2 cm (4-6 yrs)	10	20	15
		Bottom-Feeder (Common Carp)	18-21" or 45.7-53.3 cm (4-6 yrs)	10		

Site Selection

Fish tissue samples are collected from probabilistic sites, as part of fish assemblage monitoring.

Frequency/Index Period

Fish tissue samples are collected one time during the July to September index period, as part of fish assemblage monitoring.

Sample Collection

Number of Sites/Number of Samples: Fish for tissue analysis will be collected as part of the random site fish electroshocking work. Under the probabilistic design, 15 sites will be sampled for a

community assessment in each reach. Across these fifteen sites, 10 fish per species group per reach will be retained for tissue analysis (i.e., 20 total fish per reach as there are two species groups).

Discretion will be given to samplers to spread these samples to the greatest extent possible across the reach and across pools in the reach. Samplers should try to spread samples across the whole reach while still getting a full sample of 10 specimens in each reach.

The availability of each species in these size classes is likely not equally distributed across the random sites. To address this issue, samplers should keep all fish meeting the size and species requirements as they start electroshocking in each reach until reaching the goal of 10 of each species. If the goal is not met in the whole reach, some limited targeted fishing is an elective of the sampling crew to complete the sample target. If more than one fish of each species is collected from any one site, substitute fish meeting the objectives as available in subsequent stations. In short, keep the first 10 fish of each species substituting in others as they are collected (Figure 7).

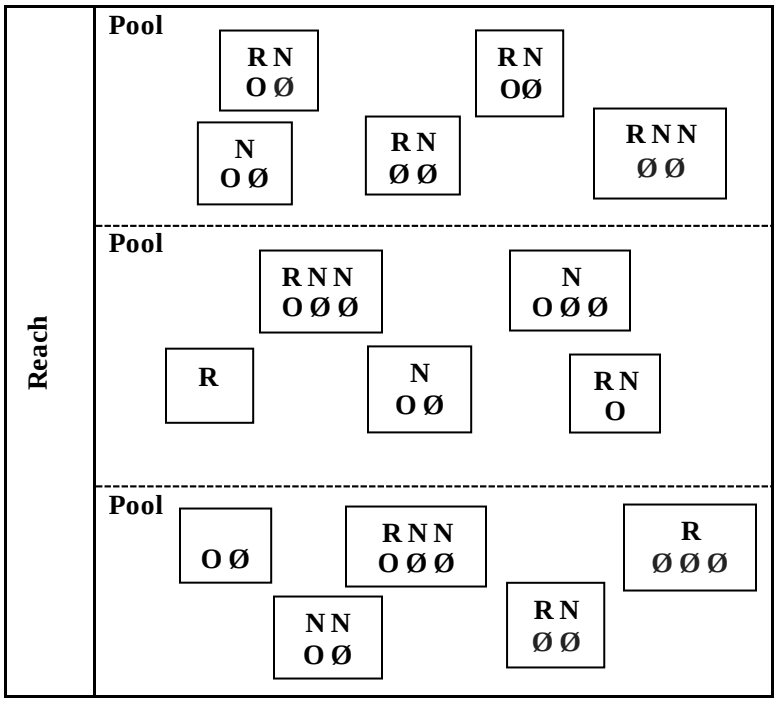

Figure 7: Example of fish tissue sampling/retention, where each box represents a sample site and R=retained top predator species fish, N = not retained top predator, O= retained bottom feeder species fish, and Ø = not retained bottom feeder species fish

In instances where there is known and significant variation in tissue concentrations between pools within a reach (e.g., between Pools 1 and 2, and between Pools 5 and 5A), a greater number of samples

may be collected if desired by the sampling entity. It is especially important to get 3-5 Common Carp in Pool 2 and in Pool 5A if possible, as previous data show levels lower than in surrounding pools.

Fish Species and Sizes Preferred: Fish will be sampled from a top predator group and a bottom-feeder group. In general, fish will be of a size that is representative of the "middle" of the age distribution for a particular species. The top predator species group to be utilized for purposes of the pilot is the Black Basses (Smallmouth and Largemouth Bass), in the size range of 15-17" (4-6 years old). It is possible that different predator species groups will need to be utilized in areas of the river beyond the pilot project, as Black Basses will not likely be available river-wide. For the bottom-feeder fish group, Common Carp will be sampled river-wide, with a size target of 18-21" (4-6 years old). Some variation from the size class (within 1") is acceptable if needed to meet sample number target.

Sample Preparation/Type**:** For the purposes of the pilot project, it is assumed that whole fish will be submitted for analysis, with skin-off fillets then prepared at the laboratory. Field crews should follow their own state's processes for specific sample preparation procedures. Generally, each specimen should be wrapped in aluminum foil shiny side out. They should be labeled with the date, station id, reach number, species and length. Specimens should be placed on ice and kept frozen until delivery to the laboratory for processing. Skin-on fillets from individual fish will then be prepared. Top predatory fish should be analyzed for mercury and bottom feeders for PCBs.

4.4 Macroinvertebrates

The deployment and collection of artificial substrate samplers for colonization by aquatic macroinvertebrate serves as the primary source of information regarding the health and composition of the macroinvertebrate community. Water quality and site characteristic (e.g., habitat) data are collected to supplement the biological data, and to document conditions at the time of sampling. Macroinvertebrate data are collected to support calculation of Wisconsin Large River Invertebrate Index scores (Table A-13).

Equipment

Invertebrate sampling equipment: The primary sampling gear to be used in the UMR pilot monitoring project for the collection of macroinvertebrates is the modified multi-plate artificial substrate sampler, also known as the Hester-Dendy sampler (Hester and Dendy 1962). Two floats are anchored in place using one or more cinder blocks to maintain the samplers in an area with sufficient flow (>0.09 m/s). Rope length equivalent to 4-5 times the depth at which the sampler is deployed should be used when tying the buoy to the anchor (Figure 8).

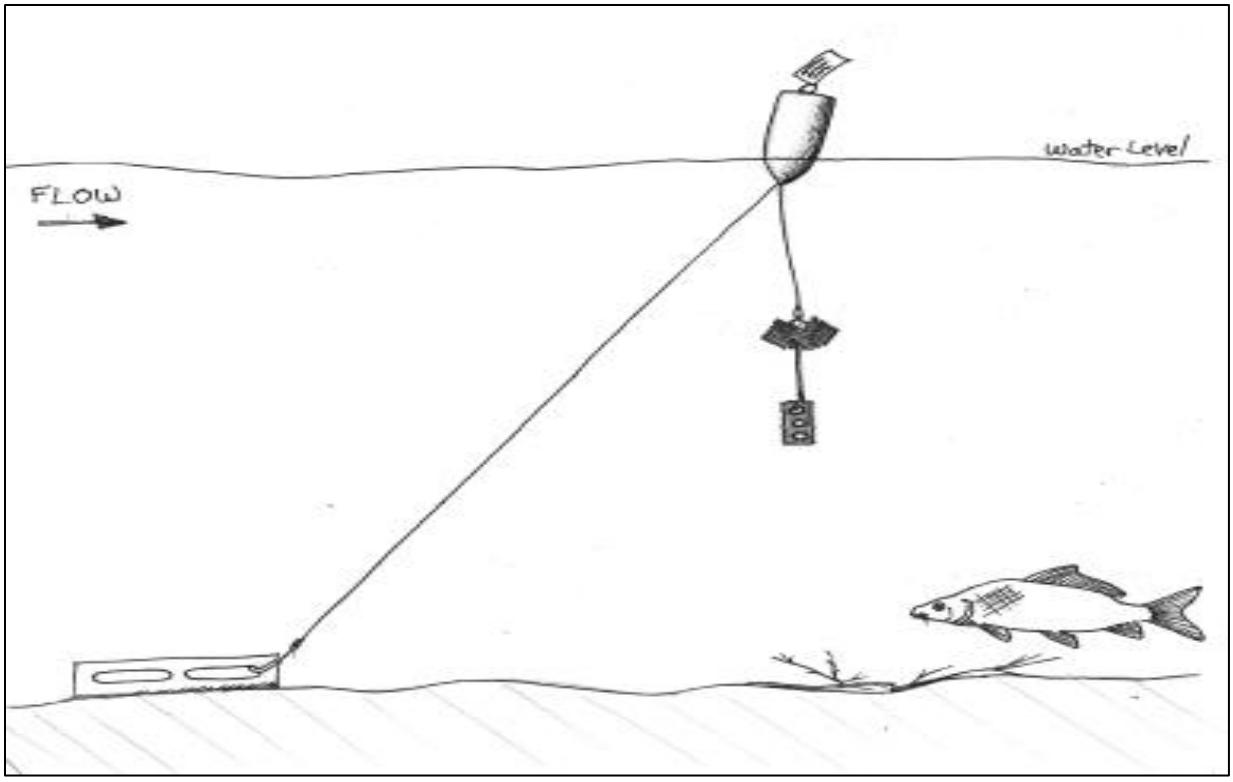

Figure 8: Sampling rig used for the collection of macroinvertebrates, including three Hester-Dendy multi-plate artificial substrate samplers, a float, and concrete block anchor. Image courtesy of Minnesota Pollution Control Agency.

Site Selection

The main-channel bank to be sampled has been randomly determined, however, invertebrate crews have the flexibility to sample another subsite if site conditions prevent a representative sample from being collected (e.g., due to dams, barge fleeting, inadequate flow, etc.). If the selected subsite cannot be sampled, the field crew has the discretion to replace the site.

Note that cases may occur where the randomly selected bank cannot be utilized for macroinvertebrate sampling (due to velocity and/or depth issues) but is suitable for fish assemblage sampling. In such cases, electrofishing will remain on the randomly selected bank even if macroinvertebrate sampling is shifted to another subsite.

Site Verification

Site verification and sampling status is determined by the presence of five factors:

1) The site is representative of main channel border habitat
2) The sampler can be safely deployed and retrieved,

3) The sampler, once deployed, will be clear of barge traffic and major recreational boat traffic

4) The location of sampler deployment has adequate depth and flow velocity to maintain minimum depth (1 m between sampler and bottom sediment) and flow requirements (0.09 m/s) throughout the six-week sampler deployment)

5) The location of sampler deployment does not exceed the maximum flow threshold (2 m/s) at the time it is deployed. It is anticipated that these requirements will be present at some point in the 200-meter reach and that sites can be verified in the office prior to sampling using GIS and staff experience.

The 200-meter MCS transect is established along a terrestrial shoreline interface and samplers are deployed within the near-shore zone, in water that has adequate depth and velocity to meet sampling requirements. Samplers are to be deployed along the predetermined random bank unless that bank is not representative of main channel border habitat or is unsafe to sample.

The placement of artificial substrate samplers should be reflective of the conditions of the 200-meter sampling reach, and not representative of highly localized influences. When selecting sample deployment locations, the following situations should be avoided if possible:

- Samplers should not be placed at or immediately downstream of the outlet of tributary streams. Tributary streams could potentially contribute significant quantities of invertebrates not reflective of large river systems. If possible, the samplers should be placed upstream of tributaries, at the furthest point downstream, or on the opposite bank if it is determined that the stream influence cannot be avoided on the randomly chosen bank.
- Samplers should not be placed at or immediately downstream of major point source discharges. If possible, the samplers should be located upstream of the outfall, at the furthest point downstream within the reach, or on the opposite bank if it is determined that the influence of the discharge cannot be avoided.

An assigned bank that is not representative of main channel border habitat conditions might also include a backwater lake, riparian wetland, constructed marina, or other condition which prohibits sampling within the terrestrial shoreline interface adjacent to the main channel border.

Frequency/Index Period

Invertebrate artificial substrate samplers are deployed for a six-week period during the summer and fall months, ideally in conditions representative of summer baseflow conditions (discharge between the 25th and 75th percentile, preferably near the daily long-term median statistic). Samplers should be deployed in the month of July, and retrieved in either August or September, depending on when the samplers where

deployed. The six-week deployment can be extended by two weeks to accommodate conditions that may be unfavorable for sample retrieval (e.g. high flows, extreme heat, storms).

Sample Collection

Hester-Dendy Deployment:

1) Navigate to the sampling reach and begin looking for artificial substrate deployment locations that meet the requirements described above in the site verification section.
2) Anchor the boat then measure and record velocity at 1m depth. Velocity should be more than 0.09 m/s and is likely to be maintained over the next 6 weeks.
3) Measure and record depth. Depth should be at least 2 m over the 6-week deployment period.
4) Complete invertebrate deployment visit form.
5) Determine the number of cinderblocks required to maintain the sampler rig in position given the flow at the site. Attach a length rope to the cinderblock(s) with sufficient length to maintain the float at the water's surface given the amount of flow at the site and possible increased in water depth over the deployment period.
6) Attach the samplers to the float so that they will be suspended 1 m below the float.
7) If necessary, attach flagging to tree or other landmark on shore.

Hester-Dendy Retrieval: There are two options for processing the HD samples: field processing or lab processing with preservative.

Field processing or laboratory processing with preservative:

1) Locate sampler and anchor boat just downstream of the rig without disturbing the sampler.
2) Measure and record field measurements at the deployment site.
3) Carefully lift the float from the water and using a 500-µm mesh kick net retrieve the Hester-Dendy rig.
4) Place the samplers in a bucket with river water being careful to remove organisms from the kick net bag.
5) Complete Hester Dendy retrieval form.
6) Return to the shore and disassemble the HDs in the bucket. Scrape each plate and place the clean plates in a bag. *If processing samples in the laboratory, conduct the following steps within 48 hours of collection.*
7) Pour the contents of the bucket through the #35 sieve (500 µm) or sieve bucket. Place organisms and detritus in 16-oz sample jar making sure that no debris or organisms remain in the pan or bucket. Preserve with 95% ETOH. Add an interior locality label and seal. Add an exterior locality label.

Shipping instructions: Before shipping the macroinvertebrates to Missouri DoC, preserve them in 95% ETOH for a minimum of three days. Drain the samples and place into a labelled sample bottle. Leave a small amount of 95% ETOH in the container to ensure the samples are moist.

5. REFERENCES

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6. APPENDICES

Table A-1: Field sampling bottle counts quantified per trip, organized by use assessments. The automated version can be found by accessing the following link here.

Table A-2: UMR-Based Community Public Water Systems in Reaches 8 and 9 (adapted from UMR Water Suppliers Coalition Summary, 2006). Note that Fort Madison, Iowa no longer draws from the Mississippi River as a drinking water source.

Community Public Water System	**State**	**Interstate Assessment Reach**	**Approximate River Mile**	**Est. Population Served***
Burlington Municipal Water Works	IA	8	405	35,000[1]
Keokuk Municipal Water Works			365	11,427[2]
Nauvoo Water Department	IL		376	1,063[2]
Hamilton Water Department			364	3,029[2]
Warsaw Water Department		9	360	1,793[2]
Quincy Water Department			327	40,366[2]
			Total:	1,646,471

1 – Water Utility
2 – 2000 US census
*Does not include populations of indirectly served systems

Table A-3: Personnel estimates for fixed and probabilistic sampling for the Reaches 0-3 field sampling crews.

Note: The personnel estimates and lesson learned from the Reaches 0-3 pilot were used to help the Reaches 8-9 planning committee organize staff and resources for pilot implementation.

Wisconsin DNR estimates:

Crews were divided into 1) water chemistry and macroinvertebrates 2) aquatic vegetation and 3) fish

1) Water chemistry
   - Sampling was divided by probabilistic and fixed sites
   - Crews consisted of two Wisconsin DNR staff
   - Roughly 10-15 probabilistic sites were completed per day
   - Wisconsin DNR sampled one of the four fixed sites during the Reaches 0-3 pilot. Minnesota PCA sampled two fixed sites and Metropolitan Council sampled one fixed site.
   - Macroinvertebrate deployment and collection was conducted separate of water chemistry. It took approximate 3 days for deployment and 3 days for pickup.

2) Aquatic vegetation
   - Crews consisted of two Wisconsin DNR staff
   - The crew averaged about 20 sites per day and worked 10-hour days to improve efficiency.

3) Fish
   - Sampling crews consisted of 3 Wisconsin DNR staff
   - Crews did not do overnight travel to complete sampling for the pilot
   - One probabilistic site took roughly 4-5 hours to sampled, depending on the distance from the field station
     - Electrofishing took roughly 60-90 minutes and was split into two-half kilometer segments
     - After the first segment was completed, fish were processed: counted, weighed, and measured. This took roughly 30 minutes
     - The second half of the 1-km transect was completed afterwards

[Note: Reaches 0-3 pilot conducted fish assemblage monitoring as a part of the aquatic life use assessment. Fish tissue sampling was not completed during this pilot.]

Minnesota PCA estimates:

Crews were divided into 1) water chemistry – probabilistic 2) water chemistry - fixed 3) fish and 4) macroinvertebrates

4) Water chemistry – probabilistic
   - Field sampling crews consisted of teams of two in one boat launching from one river access, as needed a third delivery person meeting at the access point to transport bacteria samples to avoid hold time issues
   - In one day, crews sampled one reach or 15 probabilistic sites in a 12-14 hour sampling day

5) Water chemistry – fixed

- Field sampling crews consisted of a one-person team
- Completed one fixed site per month and planning sampling with a different monitoring effort

6) Fish
   - Crews consisted of two staff
   - Two probabilistic sites were completed in approximately one 12-14-hour day. This is an average as travel time to sites varied drastically. Some metro area stations took 30 minutes of one-way, total travel time, while stations at the lower end of Lake Pepin could take over two hours of total one-way travel.

7) Macroinvertebrates
   - One team of two during HD deployment, and one team of two or three during HD retrieval. When a team of 3 was used for retrieval it was because we had extra help available to make the process go faster. A three-person team should not be considered necessary.
   - Ten sites/day for initial deployment in July, ten sites/day to retrieve in September. Six sites/day for second deployment in early August, and 6 sites/day for second retrieval in late September. A typical deployment/retrieval schedule would include more time for retrieval, something like a 2:3 ratio. The reason our ratio was 1:1 was because half of our sites were lost, both in the initial set of samples and the additional deployment. A visit to a site with a missing sampler takes a few minutes, versus an hour+ when retrieving a set of Hester-Dendys.
   - Approximately one 12-14-hour day to cover 10 sites at deployment, and a similar amount of time at retrieval. This is an average as travel time to sites varied drastically – some metro area stations took 30 minutes of one-way, total travel time, while stations at the lower end of Lake Pepin could take over two hours of total one-way travel. As mentioned above, the deployment: retrieval ratio would be different if all of the samplers had been available to retrieve.

[Note: aquatic vegetation was sampled by Minnesota DNR field crews].

Resources:

- UMR CWA Pilot Project Evaluation Report, FTE
- UMR CWA Monitoring Strategy 2013-2022, Part I: Options and Considerations (Yoder, 2013), Probabilistic Design A estimates
- Correspondence with Wisconsin DNR staff: Shawn Giblin, Andy Bartels, Deanne Drake and Minnesota PCA staff: Joel Chirhart and Pam Anderson

Table A-4: The randomized order for fish assemblage (aquatic life use) and fish consumption sampling, including geographical information. If sites are deemed unsampleable, then the alternative sites should be sampled.

Reach	Site ID	Subsite Geographic Information (Easting, Northing) (Top row are the sites in randomized order to sample and bottom row are alternate sites)				
8	UMR15-0182	B (666384.49, 4559433.48)	D (666942.59, 4559499.56)	J (668402.13, 4558753.90)	I (668009.07, 4558421.31)	F (667533.59, 4559377.60)
		E (667191.23, 4558755.60)	C (666977.74, 4558810.79)	A (666575.04, 4558852.32)	H (667964.57, 4559088.00)	G (667608.61, 4558576.27)
	UMR15-0186	E (671597.97, 4552273.91)	C (671396.47, 4552563.80)	A (671159.04, 4553030.54)	B (671648.70, 4553424.21)	G (671866.17, 4551901.39)
		F (672244.83, 4552585.18)	J (672662.23, 4551644.43)	I (672036.56, 4551478.05)	D (671956.08, 4553034.07)	H (672458.66, 4552119.37)
	UMR15-0190	J (672288.75, 4539530.06)	C (672361.84, 4541085.33)	I (671946.30, 4539674.80)	A (672480.72, 4541562.32)	B (672978.96, 4541429.88)
		F (672756.54, 4540451.62)	H (672675.34, 4539925.80)	G (672141.43, 4540124.51)	D (672846.23, 4540941.95)	E (672123.94, 4540626.97)
	UMR15-0194	F (671501.07, 4531698.08)	D (671729.16, 4532232.19)	J (670525.71, 4531293.10)	C (670942.63, 4532566.61)	B (671872.31, 4532738.68)
		A (671194.55, 4532829.00)	G (670558.76, 4532237.85)	H (670969.65, 4531525.14)	I (670214.44, 4531849.95)	E (670779.58, 4532495.66)
	UMR15-0193	E (664458.92, 4525847.64)	I (664115.06, 4524861.39)	D (665116.15, 4526022.15)	F (664851.66, 4525614.91)	H (664649.89, 4525179.75)
		A (664735.09, 4527015.20)	B (665415.87, 4526404.81)	C (664729.02, 4526307.23)	G (664264.90, 4525337.86)	J (664506.35, 4524696.04)
	UMR15-0184	D (661094.91, 4520394.82)	F (660988.34, 4519913.20)	H (660948.30, 4519571.12)	B (661305.76, 4520696.00)	E (660347.95, 4520085.17)
		J (661014.52, 4519087.26)	A (660778.39, 4521084.95)	I (660314.45, 4518976.48)	C (660417.76, 4520590.55)	G (660343.40. 4519493.53)
	UMR15-0195	B (659667.13, 4511613.63)	I (658852.98, 4509715.37)	D (659654.76, 4511218.32)	H (659249.95, 4510268.62)	E (658912.14, 4510815.76)
		C (659013.23, 4511298.92)	A (659117.07, 4511837.12)	G (658852.80, 4510304.11)	F (659332.09, 4510746.74)	J (659303.58, 4509854.06)
	UMR15-0192	E (658551.11,	F (659196.18,	B (659806.44,	G (658314.79,	H (658681.16,

		4504267.00)	4503915.58)	4504954.87)	4503944.79)	4503509.65)
		J (658269.94, 4503148.33)	A (658671.21, 4505175.43)	C (658500.04, 4504754.35	D (660040.63, 4504266.74)	I (657923.03, 4503696.79)
	UMR15-0188	G (654380.71, 4501617.88)	F (655668.74, 4500618.25)	B (656368.42,450 1246.20)	E (654821.54, 4501803.46)	J (654624.88, 4500071.69)
		C (655260.30, 4502056.49)	I (653807.70, 4501700.86)	A (655658.11, 4502382.70)	D (656065.56, 4500888.22)	H (655146.22, 4500316.79)
	UMR15-0183	I (635380.85, 4493404.11)	E (635345.20, 4494463.24)	F (637902.06, 4492867.08)	H (637591.01, 4492471.43)	C (635485.09, 4494965.42)
		J (637198.10, 4492098.75)	A (636537.59, 4494874.00)	G (635414.68, 4493831.84)	D (638184.76, 4493280.10)	B (638491.04, 4493687.88)
	UMR15-0187	A (635202.46, 4493311.81)	G (633656.58, 4491790.17)	D (636207.53, 4491260.83)	C (634322.72, 4493469.55)	I (633246.80, 4490809.86)
		J (635367.15, 4490206.06)	B (636574.31, 4491591.99	E (634089.84, 4492948.44)	F (635820.93, 4490945.99)	H (635579.87, 4490583.78)
	UMR15-0191	H (639325.60, 4482723.07)	I (637817.91, 4482395.98)	F (639390.15, 4483413.08)	A (637802.39, 4484556.51)	G (637927.86, 4482942.50)
		J (639253.17, 4482311.64)	D (639391.44, 4483977.35)	C (637903.52, 4483938.12)	B (639333.69, 4484599.50)	E (40.4892, -91.3722)
	UMR15-0181	H (638426.59, 4476778.10)	I (636889.74, 4476047.00)	D (638093.49, 4477698.66)	C (636578.61, 4477841.28)	E (637951.19, 4483325.42)
		F (638207.66, 4477230.20)	B (638060.25, 4478195.52)	J (638528.52, 4476472.97)	A (636594.49, 4478366.98)	G (636657.49, 4476705.62)
	UMR15-0185	D (639641.83, 4474123.53)	C (637832.08, 4474318.06)	I (637895.42, 4471694.64)	H (637791.29, 4472611.21)	B (639431.08, 4474645.56)
		E (637920.77, 4473829.40)	J (637470.23, 4472278.76)	F (639645.29, 4473563.14)	A (637643.12, 4474837.30)	G (638594.42, 4472334.85)
	UMR15-0189	I (635078.97, 4471690.20)	J (635144.35, 4470930.46)	C (636739.96, 4471202.34)	B (636983.48, 4472056.38)	D (636516.43, 4471929.35)
		H (635557.08, 4471834.60)	F (636055.82, 4471829.15)	A (637280.77, 4471350.47)	G (635666.19, 4470975.72)	E (636168.57, 4471109.16)
9	UMR15-0034	F (630689.35, 4466193.38)	B (631145.16, 4466961.29)	A (630496.55, 4467291.19)	G (629841.46, 4465868.59)	C (630268.77, 4466819.49)
		D (630810.07, 4466618.91)	H (630506.27, 4465710.15)	J (630496.31, 4465226.36)	E (630023.62, 4466328.26)	I (629592.43, 4465375.04)
	UMR15-0045	J (628494.45,	B (628795.59,	G (627716.74,	H (628483.66,	A (628139.80,

		4458958.92)	4460707.01)	4459409.64)	4459361.38)	4460889.375)
		C (628017.73, 4460413.69)	I (627713.88, 4458872.07)	E (627849.53, 4459935.54)	F (628559.24, 4459725.35)	D (628595.09, 4460217.08)
	UMR15-0042	C (628051.90, 4457975.61)	B (628630.98, 4458615.32)	A (627804.70, 4458449.91)	H (629012.45, 4457154.00)	E (628093.86, 4457462.25)
		D (628801.99, 4458247.78)	G (627981.78, 4456977.19)	I (628112.58, 4456572.09)	F (628940.23, 4457756.48)	J (628789.33, 4456554.75)
	UMR15-0038	J (628063.28, 4453691.40)	B (628684.26, 4455715.77)	E (627874.33, 4454948.89)	A (628028.83, 4455843.87)	G (627712.31, 4454498.84)
		C (628047.07, 4455386.64)	D (628535.69, 4455210.23)	H (628475.13, 4454075.39)	I (627430.17, 4454119.01)	F (628363.78, 4454727.11)
	UMR15-0037	A (626698.25, 4453058.21)	E (626688.22, 4452001.80)	H (627241.51, 4451594.28)	B (627446.42, 4452892.72)	F (627230.77, 4452104.18)
		D (627338.81, 4452547.16)	G (626808.66, 4451516.85)	C (626619.29, 4452521.71)	J (627700.74, 4451225.93)	I (626891.83, 4451011.55)
	UMR15-0033	D (627543.33, 4449959.50)	J (628264.19, 4448508.01)	C (627189.95, 4449845.29)	E (627349.56, 4449368.70)	I (627309.56, 4448432.71)
		B (627596.71, 4450469.28)	H (627891.49, 4449006.59)	A (626709.64, 4450260.04)	G (627359.75, 4448879.26)	F (627794.27 4449521.31)
	UMR15-0041	I (626537.23, 4446615.94)	C (627289.70, 4447728.53)	H (627564.41, 4446541.69)	B (628177.05, 4448048.37	G (40.1640, -91.5132)
		J (627529.76, 4445900.42)	D (627911.40, 4447519.22)	A (627343.33, 4448121.94)	E (627023.60, 4447317.21)	F (627672.31, 4447063.26)
	UMR15-0044	F (627085.07, 4444437.80)	G (626579.52, 4443730.90)	E (626489.85, 4444225.08)	D (627191.02, 4445182.44)	A (626420.24, 4445840.47)
		J (627385.24, 4443403.10)	H (627202.86, 4443932.84)	C (626376.32, 4445265.50)	I (626646.51, 4443264.83)	B (627310.11, 4445474.35)
	UMR15-0040	A (626686.20, 4442025.71)	G (627080.09, 4440596.20)	F (627579.20, 4441179.05)	I (627200.18, 4440094.45)	B (627382.10, 4442173.65)
		C (626845.61, 4441555.38)	D (627393.24, 4441657.97)	E (626989.37, 4441076.77)	J (628066.08, 4440265.26)	H (627567.90, 4440775.44
	UMR15-0043	H (628382.30, 4437681.32)	G (627721.87, 4437551.96)	F (628277.25, 4438180.94)	D (628053.22, 4438647.27)	I (627950.12, 4437067.04)
		B (628175.50, 4439184.86)	E (627581.51, 4438028.14)	J (628511.37, 4437284.68)	A (627442.66, 4439020.54)	C (627500.91, 4438519.98)
	UMR15-0032	J (628853.49, 4432334.58)	H (628629.03, 4432718.54)	B (628842.45, 4433993.75)	D (628763.98, 4433503.13)	E (628174.40, 4433015.71)

		I (628456.20, 4432123.38)	F (628666.58, 4433146.00)	G (628240.44, 4432610.39)	C (628264.54, 4433687.40)	A (628354.71, 4434198.96)
	UMR15-0035	C (629069.66, 4431007.16)	D (629574.30, 4431315.25)	A (628787.26, 4431423.32)	J (630303.19, 4429982.68)	H (629985.49, 4430383.71)
		I (629794.36, 4429701.58)	F (629786.73, 4430865.60)	B (629363.33, 4431764.86)	G (629536.42, 4430126.47)	E (629324.28, 4430573.22)
	UMR15-0031	H (631051.41, 4428070.47)	A (629964.90, 4429261.10)	I (630673.65, 4427417.85)	G (630583.93, 4427894.43)	C (630190.01, 4428813.49)
		E (630428.40, 4428365.29)	B (630633.10, 4429520.84)	J (631139.10, 4427540.42)	F (630817.55, 4428529.80)	D (630904.04, 4429085.27)
	UMR15-0039	E (632255.46, 4424263.53)	G (632510.04, 4423773.44)	D (632728.60, 4425126.67)	J (633547.63, 4423872.94)	A (632986.44, 4422692.26)
		B (632510.90, 4425601.62)	F (632999.15, 4424658.76)	C (632123.35, 4424629.38)	I (632744.65, 4423247.93)	H (633210.61, 4424225.03)
	UMR15-0036	E (633950.52, 4422151.02)	A (632986.44, 4422692.26)	D (634104.65, 4422942.50)	C (633516.17, 4422454.42)	F (634443.69, 4422576.21)
		H (634826.11, 4422246.07)	J (635115.58, 4421812.43)	B (633800.86, 4423337.35)	G (634237.66, 4421742.42)	I (634369.62, 4421339.67)

Table A-5: Probabilistic sites of reaches 8 and 9. Sites are listed in order from north to south

Reach	Site ID	Approx. River Mile	Latitude	Longitude	Easting	Northing
8	UMR15-0182	433	41.1669	-91.0041	667438.0810	4559203.8709
	UMR15-0186	428	41.1058	-90.9502	672119.0865	4552524.1912
	UMR15-0190	420	40.9976	-90.9489	672515.0163	4540518.3363
	UMR15-0194	415	40.9200	-90.9651	671348.1009	4531867.1467
	UMR15-0193	409	40.8657	-91.0453	664733.8212	4525685.1309
	UMR15-0184	404	40.8154	-91.0954	660627.2903	4520010.2396
	UMR15-0195	398	40.7326	-91.1157	659119.8135	4510781.6523
	UMR15-0192	394	40.6729	-91.1214	658775.9264	4504144.7155
	UMR15-0188	391	40.6505	-91.1668	654986.8270	4501571.3975
	UMR15-0183	377.5	40.5704	-91.3829	636880.9504	4492326.0337
	UMR15-0187	377	40.5651	-91.3879	636466.8440	4491727.1296
	UMR15-0191	371	40.4894	-91.3664	638446.4547	4483355.5688
	UMR15-0181	367	40.4345	-91.3778	637591.2863	4477243.7785
	UMR15-0185	364	40.4035	-91.5143	637962.1365	4473081.0963
	UMR15-0189	363	40.3842	-91.3967	636086.0853	4471636.4475
9	UMR15-0034	357.5	40.3368	-91.4657	630327.1708	4466266.6269
	UMR15-0045	353	40.2797	-91.4941	628017.6637	4459885.9551
	UMR15-0042	351.5	40.2541	-91.4896	628448.5290	4457057.0862
	UMR15-0038	350	40.2380	-91.4908	628380.2191	4455266.4373
	UMR15-0037	347	40.2003	-91.5073	627043.6568	4451052.0494
	UMR15-0033	346	40.1898	-91.5038	627363.5370	4449901.0310
	UMR15-0041	345.5	40.1734	-91.4990	627802.9309	4448081.2730
	UMR15-0044	343	40.1391	-91.3732	626468.7243	4444738.3428
	UMR15-0040	341	40.1107	-91.5073	627212.8403	4441115.1698
	UMR15-0043	339	40.0834	-91.5005	627847.5205	4438086.4440
	UMR15-0032	335	40.0344	-91.4950	628407.3555	4432656.6761
	UMR15-0035	333	40.0083	-91.4773	629961.4937	4429793.4399
	UMR15-0031	333	40.0043	-91.4748	630181.1965	4429345.2802
	UMR15-0039	329	39.9569	-91.4421	633070.2912	4424134.9489
	UMR15-0036	328.5	39.9491	-91.4346	633725.8692	4423277.6115

Table A-6: Fixed sites of reaches 8-9. Sites are listed in order from north to south

Site ID	Reach	River Mile	Location	Illinois EPA Site ID	HUC-8	Latitude, Longitude
Fixed Site Sampling						
UMR-437.7	7	437	Lock & Dam 17 at New Boston, IL	IL L-04	07080101	41.19029, -91.05629
UMR-365.8	8	364.6	Lock & Dam 19 at Keokuk, IA	IL K-22	07080104	40.39547, -91.37206
UMR-325.9	9	325	Lock & Dam 21, 0.75 miles SW of Quincy, IL	IL K-17	07110001	39.90391, -91.43064
Drinking Water Sampling						
UMR–364.8	8	364	Warsaw Water Department		07080104	
UMR-365.8	8	365	Keokuk Municipal Water Works		07080104	
UMR-327.9	9	327	Quincy Water Department		07110001	

Table A-7: Probabilistic sites within reaches 8-9 for replicate sampling. Two sites per reach (bold and underlined font) will be utilized for replicate sampling. If a site is eliminated due to sampleability, then another replicate site should be randomly selected.

Replicate Order (Within Reach)	Reach 8	Reach 9
1	UMR15-0181	UMR15-0031
2	UMR15-0182	UMR15-0032
3	UMR15-0183	UMR15-0033
4	UMR15-0184	UMR15-0034
5	UMR15-0185	UMR15-0035
6	**UMR15-0186**	UMR15-0036
7	**UMR15-0187**	UMR15-0037
8	UMR15-0188	UMR15-0038
9	UMR15-0189	UMR15-0039
10	UMR15-0190	UMR15-0040
11	UMR15-0191	UMR15-0041
12	UMR15-0192	**UMR15-0042**
13	UMR15-0193	UMR15-0043
14	UMR15-0194	UMR15-0044
15	UMR15-0195	**UMR15-0045**

Table A-8: Missouri DNR SOP's can be found on the Google Drive folder linked here.

Table A-9: Comparison of sampling and analyzing procedures related to nutrient parameters

Analyte Name (per plan)	Agency	Agency Analyte Name	Lab Method	Method Detection Limit	Reporting Limit	Units	Filtration (Y/N and size/type)*	Preservation	Hold time
NO_3+NO_2	Missouri DNR	Nitrite + Nitrate as Nitrogen	Lachat L10-107-04-1-C USEPA 353.2	0.008 0.005	0.01 0.050	mg/L	N	< 6 deg C H_2SO_4 to pH <2	28 days
NO_3+NO_2	Illinois EPA	Inorganic Nitrogen (Nitrate + Nitrite)	USEPA 353.2	0.0247	0.1	mg/L	N	< 6 deg C H_2SO_4 to pH <2	28 days
TKN	Missouri DNR	Total Kjeldahl Nitrogen	Calculation (TN-NO3+NO2)			mg/L	N	< 6 deg C H_2SO_4 to pH <2	28 days
	Illinois EPA	Total Kjeldahl Nitrogen	USEPA 351.2	0.37	0.5	mg/L	N	< 6 deg C	28 days
NHx	Missouri DNR	Ammonia Nitrogen, Total	Lachat L10-107-06-1-J	0.02	0.05	mg/L	N	< 6 deg C H_2SO_4 to pH <2	28 days
	Illinois EPA	Ammonia Nitrogen, Total	USEPA 350.1	0.05	0.1	mg/L	N	< 6 deg C H_2SO_4 to pH <2	28 days
TP	Missouri DNR	Total Phosphorus	L 10-115-01-4-C	0.005	0.005	mg/L	N	< 6 deg C H_2SO_4 to pH <2	28 days
	Illinois EPA	Total Phosphorus	USEPA 365.1	0.0042	0.005	mg/L	N	< 6 deg C H_2SO_4 to pH <2	28 days
DP	Missouri DNR	Orthophosphate, Dissolved as Phosphorus	Lachat L 10-115-01-1-A	0.05	0.05	mg/L	Y filter on-site	< 6 deg C	48 hours
	Illinois EPA	Orthophosphate, Dissolved as Phosphorus	USEPA 365.1	0.0042	0.005	mg/L	Y 0.45 µm opening filter	< 6 deg C	28 days
Chlorophyll-a	Missouri DNR	Chlorophyll-α (phytoplankton and periphyton)	Method 445.0 rev 1.2	0.1	0.1	mg/L	Y filter within 12 hours	Freeze filter in desiccant	60 days
	Illinois EPA	Chlorophyll-α (corrected for pheophytin)	SM 10200H		0.7	µg/L	Y filter within 24 hours	Foil wrapped filter, frozen	28 days
	Illinois EPA	Chlorophyll-α (uncorrected for pheophytin)	SM 10200H		0.5	µg/L	Y	Foil wrapped filter, frozen	28 days

Table 2: Miscellaneous Parameters									
Analyte (per plan)	**Agency**	**Agency Analyte Name**	**Lab Method**	**Method Detection Limit**	**Reporting Limit**	**Units**	**Filtration (Y/N and size/type) ***	**Preservation**	**Hold time**
BOD	Missouri DNR	Biochemical Oxygen Demand (grab or composite)	SM 5210-B	2	2	mg/L	N	< 6 deg C	48 hours
	Illinois EPA	Biochemical Oxygen Demand (grab or composite)	SM 5210B	2	2	mg/L	N	< 6 deg C	48 hours
Chloride	Missouri DNR	Chloride	L 10-117-07-1-A	1.5	5	mg/L	N	< 6 deg C	28 days
	Illinois EPA	Chloride	USEPA 300.0	0.02	1	mg/L	N	< 6 deg C	28 days
Sulfate	Missouri DNR	Sulfate	L 10-116-10-2-A	3.5	5	mg/L	N	< 6 deg C	28 days
	Illinois EPA	Sulfate	USEPA 300.0	0.02	10	mg/L	N	< 6 deg C	28 days
TSS	Missouri DNR	Total Suspended Solids	SM 2540-D	5	5	mg/L	N	< 6 deg C	7 days
	Illinois EPA	Total Suspended Solids	SM 2540-D	N/A	4	mg/L	N	< 6 deg C	7 days
TOC	Missouri DNR	Total Organic Carbon	SM 5310-C	0.3	0.5	mg/L	N	< 6 deg C H_3PO_4 to pH <2	28 days
	Illinois EPA	Total Organic Carbon	SM 5310C	0.17	0.4	mg/L	N	< 6 deg C	28 days
Hardness (Ca & Mg)	Missouri DNR	Hardness (Calculate using Ca and Mg)	Calculation	3.31	6.62	mg/L			
	Illinois EPA	Hardness (Calculate using Ca and Mg)	2340B (Calculation)			µg/L			
Alkalinity	Missouri DNR	Alkalinity (Total as $CACO_3$)	SM 2320-B	5	5	mg/L	N	< 6 deg C	14 days
	Illinois EPA	Alkalinity (Total as $CACO_3$)	USEPA 310.2	7.48	10	µg/L	N	< 6 deg C	14 days

Fluoride	Missouri DNR	Flouride	Lacht 10-109-12-2-A	0.004	0.05	mg/L	N	< 6 deg C	28 days
Phenols	Missouri DNR	Total Phenols	USEPA 420.1	5	50	µg/L	N	< 6 deg C H_2SO_4 to pH < 2	28 days
Herbicides/ Pesticides	Missouri DNR	Herbicides/Pesticides (includes multiple analytes)*	USEPA 507/508 or 525.2, and 515.4	Varies	Varies		N	4 deg C Na2S2O3	7 days
Glyphosate	Missouri DNR	Glyphosate	USEPA 547	6	10	µg/L	N	4 deg C Na2S2O3	14 days
Carbamates	Missouri DNR	Carbamates (includes multiple analytes)*	USEPA 531.1	Varies	1 or 2	µg/L	N	4 deg C C2H3O2Cl	28 days
Volatile Organic Compounds (VOCs)	Missouri DNR	VOCs (includes multiple analytes)*	USEPA 524.2	0.02-1.6	0.5 or 1	µg/L	N	< 4 deg C HCl	14 days

***For additional analyte descriptions, follow the link here.**

Table 3: Metals

Analytes	Agency	Agency Analyte Name	Lab Method	Method Detection Limit	Reporting Limit	Units	Filtration (Y/N and size/type)*	Preservation	Hold time
Al	Missouri DNR	Aluminum-Dissolved	USEPA 200.8	2	10	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Al	Missouri DNR	Aluminum-Total Recoverable	USEPA 200.8	2	10	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Al	Illinois EPA	Aluminum-Dissolved	USEPA 200.8	19.8	50	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Al	Illinois EPA	Aluminum-Total Recoverable	USEPA 200.8	47.5	50	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months

Sb	Missouri DNR	Antimony-Dissolved	USEPA 200.8	0.5	1	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Sb	Missouri DNR	Antimony-Total Recoverable	USEPA 200.8	0.5	1	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
As	Missouri DNR	Arsenic-Dissolved	USEPA 200.8	0.5	1	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
As	Missouri DNR	Arsenic-Total Recoverable	USEPA 200.8	0.5	1	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
As	Illinois EPA	Arsenic-Dissolved	USEPA 200.8	0.13	2	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
As	Illinois EPA	Arsenic-Total Recoverable	USEPA 200.8	0.1	2	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Ba	Missouri DNR	Barium-Dissolved	USEPA 200.8	0.5	1	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Ba	Missouri DNR	Barium-Total Recoverable	USEPA 200.8	0.5	1	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Ba	Illinois EPA	Barium-Dissolved	USEPA 200.8	0.2	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Ba	Illinois EPA	Barium-Total Recoverable	USEPA 200.8	0.15	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Be	Missouri DNR	Beryllium-Dissolved	USEPA 200.8	0.5	1	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Be	Missouri DNR	Beryllium-Total Recoverable	USEPA 200.8	0.5	1	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Be	Illinois EPA	Beryllium-Dissolved	USEPA 200.8	0.68	1	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Be	Illinois EPA	Beryllium-Total Recoverable	USEPA 200.8	0.62	1	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months

B	Missouri DNR	Boron-Dissolved	USEPA 200.7	25	100	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
B	Missouri DNR	Boron-Total Recoverable	USEPA 200.7	25	100	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
B	Illinois EPA	Boron-Dissolved	USEPA 200.8	2.27	10	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
B	Illinois EPA	Boron-Total Recoverable	USEPA 200.8	1.83	10	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Cd	Missouri DNR	Cadmium-Dissolved	USEPA 200.8	0.1	0.2	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Cd	Missouri DNR	Cadmium-Total Recoverable	USEPA 200.8	0.1	0.2	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Cd	Illinois EPA	Cadmium-Dissolved	USEPA 200.8	0.23	3	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Cd	Illinois EPA	Cadmium-Total Recoverable	USEPA 200.8	0.09	3	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Ca	Missouri DNR	Calcium-Dissolved	USEPA 200.7	0.6	1	mg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Ca	Missouri DNR	Calcium-Total Recoverable	USEPA 200.7	0.6	1	mg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Ca	Illinois EPA	Calcium-Dissolved	USEPA 200.8	57.2	300	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Ca	Illinois EPA	Calcium-Total Recoverable	USEPA 200.8	104	300	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Cr	Missouri DNR	Chromium-Dissolved	USEPA 200.8	0.5	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Cr	Missouri DNR	Chromium-Total Recoverable	USEPA 200.8	0.5	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months

Cr	Illinois EPA	Chromium-Dissolved	USEPA 200.8	0.21	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Cr	Illinois EPA	Chromium-Total Recoverable	USEPA 200.8	0.39	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Co	Missouri DNR	Cobalt-Dissolved	USEPA 200.8	1	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Co	Missouri DNR	Cobalt-Total Recoverable	USEPA 200.8	1	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Co	Illinois EPA	Cobalt-Dissolved	USEPA 200.8	0.16	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Co	Illinois EPA	Cobalt-Total Recoverable	USEPA 200.8	0.06	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Cu	Missouri DNR	Copper-Dissolved	USEPA 200.8	0.5	1	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Cu	Missouri DNR	Copper-Total Recoverable	USEPA 200.8	0.5	1	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Cu	Illinois EPA	Copper-Dissolved	USEPA 200.8	0.27	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Cu	Illinois EPA	Copper-Total Recoverable	USEPA 200.8	0.14	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Fe	Missouri DNR	Iron-Dissolved	USEPA 200.7	2.5	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Fe	Missouri DNR	Iron-Total Recoverable	USEPA 200.7	2.5	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Fe	Illinois EPA	Iron-Dissolved	USEPA 200.8	3.38	50	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Fe	Illinois EPA	Iron-Total Recoverable	USEPA 200.8	8.08	50	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months

Pb	Missouri DNR	Lead-Dissolved	USEPA 200.8	0.5	1	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Pb	Missouri DNR	Lead-Total Recoverable	USEPA 200.8	0.5	1	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Pb	Illinois EPA	Lead-Dissolved	USEPA 200.8	0.12	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Pb	Illinois EPA	Lead-Total Recoverable	USEPA 200.8	0.17	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Mg	Missouri DNR	Magnesium-Dissolved	USEPA 200.7	0.6	1	mg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Mg	Missouri DNR	Magnesium-Total Recoverable	USEPA 200.7	0.6	1	mg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Mg	Illinois EPA	Magnesium-Dissolved	USEPA 200.8	11	300	mg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Mg	Illinois EPA	Magnesium-Total Recoverable	USEPA 200.8	2	10	mg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Mn	Missouri DNR	Manganese-Dissolved	USEPA 200.8	0.5	1	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Mn	Missouri DNR	Manganese-Total Recoverable	USEPA 200.8	0.5	1	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Mn	Illinois EPA	Manganese-Dissolved	USEPA 200.8	0.13	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Mn	Illinois EPA	Manganese-Total Recoverable	USEPA 200.8	2.9	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Mo	Missouri DNR	Molybdenum-Dissolved	USEPA 200.8	2	10	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Mo	Missouri DNR	Molybdenum-Total Recoverable	USEPA 200.8	2	10	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months

Ni	Missouri DNR	Nickel -Dissolved	USEPA 200.8	0.5	1	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Ni	Missouri DNR	Nickel -Total Recoverable	USEPA 200.8	0.5	1	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Ni	Illinois EPA	Nickel -Dissolved	USEPA 200.8	0.56	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Ni	Illinois EPA	Nickel -Total Recoverable	USEPA 200.8	0.14	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
K	Missouri DNR	Potassium-Dissolved	USEPA 200.7	0.6	1	mg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
K	Missouri DNR	Potassium-Total Recoverable	USEPA 200.7	0.6	1	mg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
K	Illinois EPA	Potassium-Dissolved	USEPA 200.8	23.6	1400	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
K	Illinois EPA	Potassium-Total Recoverable	USEPA 200.8	18.2	1400	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Se	Missouri DNR	Selenium-Dissolved	USEPA 200.8	0.5	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Se	Missouri DNR	Selenium-Total Recoverable	USEPA 200.8	0.5	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Se	Illinois EPA	Selenium-Dissolved	USEPA 200.8	1.18	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Se	Illinois EPA	Selenium-Total Recoverable	USEPA 200.8	1.16	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Ag	Missouri DNR	Silver-Dissolved	USEPA 200.8	0.5	1	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Ag	Missouri DNR	Silver-Total Recoverable	USEPA 200.8	0.5	1	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months

Ag	Illinois EPA	Silver-Dissolved	USEPA 200.8	0.04	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Ag	Illinois EPA	Silver-Total Recoverable	USEPA 200.8	1.16	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Na	Missouri DNR	Sodium-Dissolved	USEPA 200.7	0.6	1	mg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Na	Missouri DNR	Sodium-Total Recoverable	USEPA 200.7	0.6	1	mg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Na	Illinois EPA	Sodium-Dissolved	USEPA 200.8	42.7	300	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Na	Illinois EPA	Sodium-Total Recoverable	USEPA 200.8	84.5	300	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Sr	Missouri DNR	Strontium-Dissolved	USEPA 200.7	2	10	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Sr	Missouri DNR	Strontium-Total Recoverable	USEPA 200.7	2	10	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Sr	Illinois EPA	Strontium-Dissolved	USEPA 200.8	0.21	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Sr	Illinois EPA	Strontium-Total Recoverable	USEPA 200.8	0.23	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Tl	Missouri DNR	Thallium-Dissolved	USEPA 200.8	0.5	1	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Tl	Missouri DNR	Thallium-Total Recoverable	USEPA 200.8	0.5	1	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Sn	Missouri DNR	Tin-Dissolved	USEPA 200.7	5	20	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Sn	Missouri DNR	Tin-Total Recoverable	USEPA 200.7	5	20	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months

Ti	Missouri DNR	Titanium-Dissolved	USEPA 200.7	1	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Ti	Missouri DNR	Titanium-Total Recoverable	USEPA 200.7	1	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
V	Missouri DNR	Vanadium-Dissolved	USEPA 200.7	1	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
V	Missouri DNR	Vanadium-Total Recoverable	USEPA 200.7	1	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
V	Illinois EPA	Vanadium-Dissolved	USEPA 200.8	0.17	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
V	Illinois EPA	Vanadium-Total Recoverable	USEPA 200.8	0.29	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Zn	Missouri DNR	Zinc-Dissolved	USEPA 200.8	0.5	1	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Zn	Missouri DNR	Zinc-Total Recoverable	USEPA 200.8	0.5	1	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months
Zn	Illinois EPA	Zinc-Dissolved	USEPA 200.8	4.33	5	µg/L	Y filter on-site	< 6 deg C HNO_3 to pH < 2	6 months
Zn	Illinois EPA	Zinc-Total Recoverable	USEPA 200.8	3.04	5	µg/L	N	< 6 deg C HNO_3 to pH < 2	6 months

Table A-10: Comparison of sampling and analyzing procedures related to Escherichia coli

Analyte (per plan)	Agency	Agency Analyte Name	Lab Method	Method Detection Limit	Reporting Limit	Units	Filtration (Y/N and size/type)*	Preservation	Hold time
Bacteria	Missouri DNR	*Escherichia coli*	IDEXX Quanti-Tray/2000	1	1	[MPN]/100mL	N	< 6 deg C	8 hours
	Iowa SHL	*Escherichia coli*	IDEXX Quanti-Tray/2000	10	10	[MPN]/100mL	N	Sodium thiosulfate powder, < 6 deg C	30 hours
	Illinois EPA	*Fecal Coliform*	IDEXX Coliert-18 / SM 9222D	1	1	[MPN]/100mL	N	< 6 deg C	8 hours

Table A-11: Comparison of sampling and analyzing procedures related to cyanotoxins

Analyte (per plan)	Agency	Lab Method	Method Detection Limit	Reporting Limit	Units	Filtration (Y/N and size/type) *	Preservation	Hold time
Microcystin	Iowa DNR	US EPA Method 546, Abraxis 520011OH	0.10	0.3	ug/L	N	< 6 deg C or frozen	5 Days < 6 deg C, 14 Days frozen
Cylindrospermopsin	Iowa DNR	Abraxis 522011	0.040	0.120	ug/L	N	< 6 deg C or frozen	5 Days < 6 deg C, 14 Days frozen

Table A-12: Great River Fish Index (GRFIn) metrics. Adapted from Pearson, et al. (2011)

Fish Assemblage Metric	**Metric Class**
Proportion of invertivore individuals	Trophic
Proportion of non-indigenous individuals	Composition
Proportion of individuals with DELTS	Fish Health
Proportion of detritivore Individuals	Trophic
Proportion of native individuals	Composition
Total deep-bodied sucker biomass (kg)	Biomass
Total number of fish species (exclusive)	Richness
Number of darter species	Richness
Catch per unit effort of native species	Relative Abundance
Number of minnow species	Richness

Table A-13: Wisconsin Large River Macroinvertebrate Index Metrics. Adapted from Weigel and Dimick (2011)

Metric Category	**Metric (Abbreviation)**
Taxon richness and composition	Number of insect taxa (Insect-T)
	% insect individuals (Insect-%I)
	Number of EPT taxa (EPT-T)
	% individuals in the top 3 taxa (Dom_3-%I)
Tolerance and composition	Mean pollution tolerance value (MPTV)
	% intolerant EPT individuals with maximum tolerance = 2 ($IntolEPT_2$-%I)
	% tolerant chironomid individuals with minimum tolerance value = 8 ($TolChir_8$-%I)
Ecology	Number of unique combinations of the 4 ecology trait niches (rheophily, thermal preference, habitat, and trophic status) (EcoFTN)
	% gathering insects (Gath-%I)
	% scraper insects (Scr-%I)