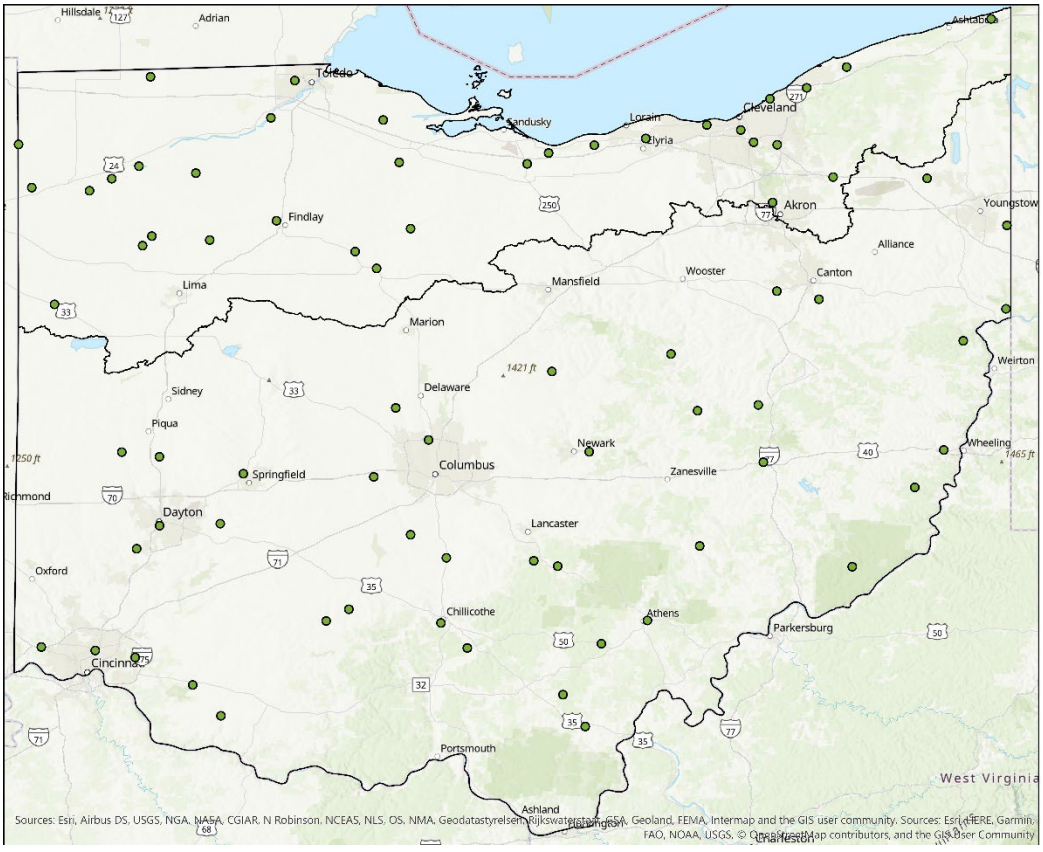
Environmental Protection Agency

Quality Assurance Project Plan (QAPP) for Statewide Ambient Water Quality Monitoring



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Division of Surface Water

November 2023

Quality Assurance Project Plan (QAPP) for Statewide Ambient Water Quality Monitoring

Version 1.2

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Section A

A1. Title and Approval

Quality Assurance Project Plan for Statewide Ambient Monitoring Program.

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List of Acronyms - (Glossary of Terms can be found ***here***)

AMLER	Abandoned Mine Land Economic Revitalization
BMP	Best Management Practices
CWA	Clean Water Act
DES	Division of Environmental Services
DQO	Data Quality Objective
DOC	Dissolved Organic Carbon
EA3	Ecological Assessment and Analysis Application
EPA	Environmental Protection Agency
FEG	Fish Evaluation Group
HUC	Hydrological Unit Code
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
ID	Identification
IJC	International Joint Commission
IR	Integrated Report
ITS	Information Technology Services
Mlwb	Modified Index of Well-being
NASQAN	National Stream Quality Accounting Network
NAWQMN	National Ambient Water Quality Monitoring Network
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
PCS	Permit Compliance System (US EPA)
OAC	Ohio Administrative Code
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QHEI	Qualitative Habitat Evaluation Index
pH	Potential Hydrogen
RL	Reporting Limit
SOP	Standard Operating Procedure
SOCC	State of Ohio Computer Center
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TSD	Technical Support Document
USGS	United States Geological Survey
WAU	Watershed Assessment Unit
WLA	Wasteload Allocation
WPCLF	Water Pollution Control Loan Fund
WQ	Water Quality
WQBELs	Water-Quality-Based Effluent Limits
WQMN	Water Quality Monitoring Network
WQS	Water Quality Standards
WRRSP	Water Resource Restoration Sponsor Program

WWTP	Wastewater Treatment Plant

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A3. Distribution List

This Quality Assurance Project Plan (QAPP) will be distributed to the following division management and staff, saved on the Division of Surface Water (DSW) collaboration site and posted on the DSW webpage.

Table 1 — Distribution List

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Kristin Sowards, Sample Receiving Coordinator	***kristin.sowards@epa.ohio.gov***	(614) 644-4243

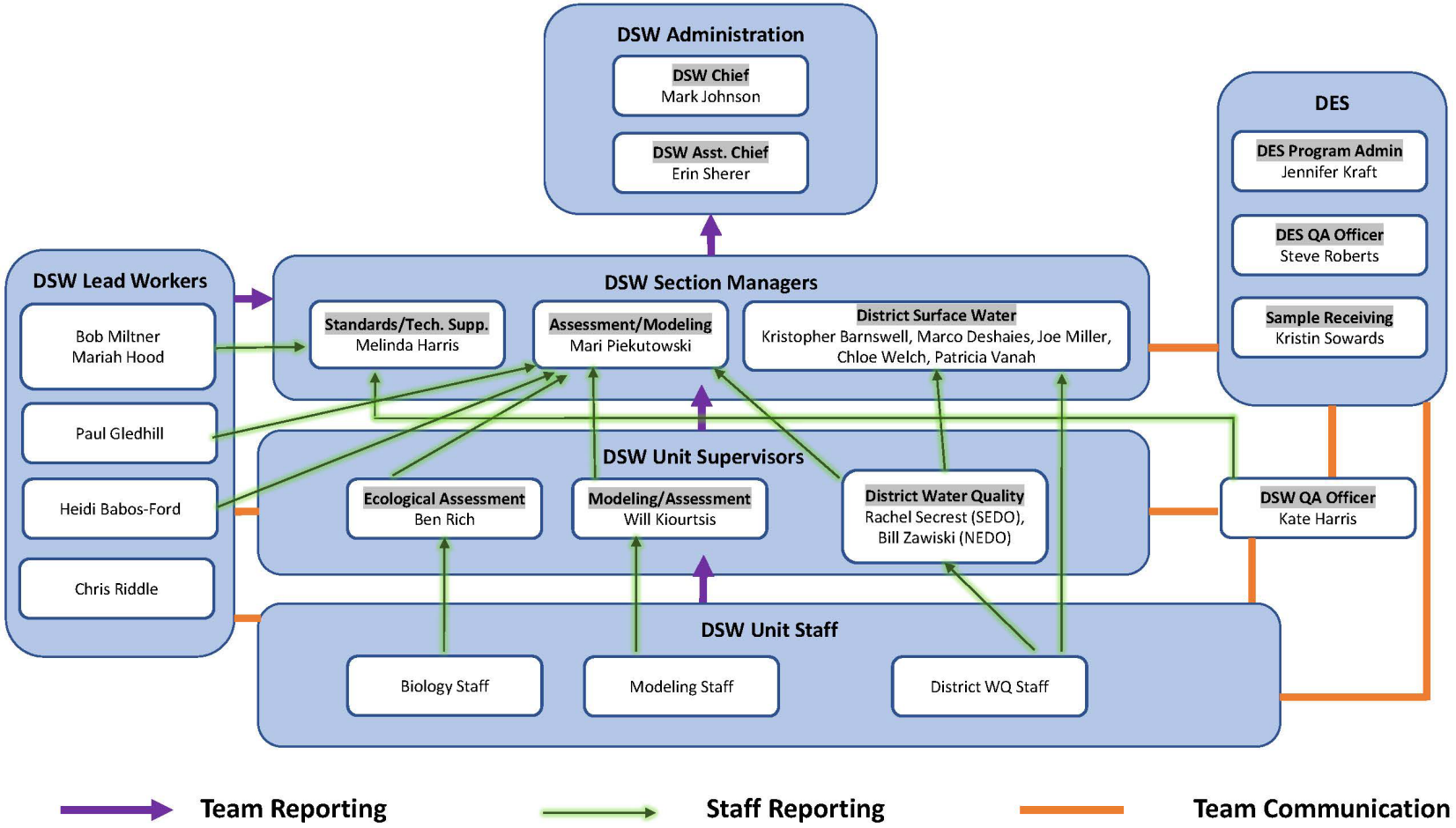
A4. Project Organization and Communication

Table 2 — Roles and Responsibilities.

Individual(s) Assigned:	Responsible for:	Authorized to:
Division of Surface Water		
Mark Johnson / Erin Sherer DSW Chief/Assistant Chief	Overall administration of division.	Confirm project existence; approve staff and capital resources; approve plans; edit reports.
Mari Piekutowski Assessment, Modeling & TMDL Section Manager	Overall management of monitoring section.	Assign staff; approve plans; edit reports.
Ruth Briland TMDL and IR Unit Supervisor	Coordination of biennial Integrated Report update; TMDL program development.	Assign and support staff; edit reports.
Melinda Harris Standards and Tech Support Section Manager	Quality management (QAPPs, SOPs); staff training; water quality standard rules.	Approve plans and edit reports.
Bob Miltner Standards and Tech Support Lead Worker	Water quality standard criteria development and rule updates.	Help plan study. Review project actions and documents in relation to listed responsibilities.
Kate Harris QA Officer	DSWs quality management program.	Develop and implement field QA/QC guidelines. Track field QA/QC and staff training.
Mariah Hood Standards and Tech Support Lead Worker	Water quality standard criteria development and rule updates.	Help plan study. Make recommended beneficial use changes.
Rich Budnik Standards and Tech Support Staff	Representing agency in fish and wildlife consumption and contact advisory matters.	Help plan study. Make waterbody specific consumption and contact advisory recommendations.
Ben Rich Ecological Assessment Unit Supervisor	Supporting biological field crews with supplies, equipment and training.	Obtain approvals and signatures; develop budgets; conduct field audits; edit reports.
Heidi Babos-Ford Ecological Assessment Unit Lead Worker	Assist with property access, track project progress, managing data and compiling information for Integrated Report.	Provide landowner information for access consent. Upload fish, bug and chemistry data into EA3. Review and comment on reports. Write assigned Integrated Report sections.
[Multiple Staff] Ecological Assessment Unit Fish Crew Leader	Fish population and stream habitat assessments.	Help plan study. Schedule and complete assigned field activities. Tabulate data and write discussion for technical report.
[Multiple Staff] Ecological Assessment Unit Bug Crew Leader	Macroinvertebrate population assessments.	Help plan study. Schedule and complete assigned field activities. Tabulate data and write discussion for technical report.

Individual(s) Assigned:	Responsible for:	Authorized to:
[Multiple Management Staff] District Surface Water Section Manager	Implementing division goals at the district level. Supporting water quality field crews with supplies, equipment, and training.	Review documents and reports; suggest changes and edits; obtain approvals and signatures; develop budgets; conduct field audits.
[Multiple Management Staff] District Water Quality Unit Supervisor	Supporting water quality field crews with supplies, equipment, and training.	Obtain approvals and signatures; develop budgets; conduct field audits; edit reports.
[Multiple Management Staff] District Water Quality Unit	Water and sediment data collection, validation, and management.	Help plan study. Schedule and complete assigned field activities. Tabulate data and write discussion for technical report.
Division of Environmental Services		
Jennifer Kraft Program Administrator	Overall administration of laboratory activities.	Help solve laboratory information management system problems. Develop analytical methods and SOPs.
Steve Roberts QA Officer	DES quality management program.	Oversee data completeness, validation, and delivery.
Kristin Sowards Sample Receiving Coord.	Intake of laboratory samples, coordination with field staff	Help solve daily sample scheduling and sample submission issues.

Figure 1 — Organization Chart.



A5. Problem Definition & Background

Ohio is a water-rich state, bordered on the south by the Ohio River and the north by Lake Erie. These water bodies, as well as thousands of miles of inland streams, rivers and thousands of acres of lakes and wetlands, are rich in biodiversity and contribute to the quality of life of Ohio's citizens. The Federal Clean Water Act (CWA) mandates that all states report on the overall condition of aquatic resources. Ohio Environmental Protection Agency's (EPA) DSW conducts comprehensive watershed surveys to characterize waters, identify trends over time, recognize emerging problems, determine effectiveness of water management programs, help direct remediation efforts where they are most needed and to respond to emergencies such as natural disasters and spills.

The goal of DSW's watershed assessment program is to assesses each watershed on a 12-year rotation. The program schedule includes specific projects aimed at large rivers, wadeable streams and rivers studies, and headwaters probabilistic surveys.

Each year, Ohio EPA collects data from 400 to 450 stream and river sites around the state to support watershed assessment. During these studies, Ohio EPA scientists collect chemical samples, examine and count fish and aquatic insects, and record measurements of the stream. There are three major objectives for these studies:

- To determine how the stream is doing compared to goals assigned in the Ohio Water Quality Standards (WQS);
- To determine if the goals assigned to the river or stream are appropriate and attainable; and
- To determine if the streams condition has changed since the last time the stream was studied.

The data gathered by a field survey is processed, evaluated, and synthesized in a biological and water quality report. The findings and conclusions of each biological and water quality study may factor into regulatory actions taken by Ohio EPA and are incorporated into Water Quality Permit Support Documents, Total Maximum Daily Loads (TMDLs), State Water Quality Management Plans, the Ohio Nonpoint Source Assessment and the Ohio Water Resource Inventory (305[b] report). This information also provides the basis for the list of impaired and threatened waters required by Section 303(d) of the Clean Water Act.

In total, state programs that adequately meet the CWA objectives should be able to answer the following questions:

- What is the overall quality of waters in the State?
- To what extent is water quality changing over time?
- What are the problem areas and areas needing protection?

- What level of protection is needed?
- How effective are clean water projects and programs?

While Ohio's watershed survey program addresses each of these items, continuous, monthly monitoring of a network of ambient stations will help develop a data set that can further inform our understanding of each of these issues.

Ohio's Ambient Stream Monitoring Program is designed to both supplement as well as compliment the work performed through the watershed assessment program. Simply put, a 12-year gap between visits to any given part of the state has the potential to limit our ability to meet our full suite of objectives. Biological sampling is conducted during a summer-fall period from June 15 to October 15. While the evaluation of biological indicators is the backbone of Ohio's program, stream chemistry data plays an important role in informing our understanding of impairments. The implementation of monthly chemistry sampling at a series of fixed locations, co-located with USGS stream gage stations, fills important data gaps, both seasonally as well as between watershed surveys. Biological sampling will be completed at ambient stations during watershed surveys.

With the implementation of this QAPP, Ohio EPA will end a three-year gap in our ambient monitoring program and resume an effort that provides benchmark information for long-term trend analyses at the main stems and selected tributaries of many of Ohio's major rivers. Individually, these sites will provide data that helps fill the gaps between scheduled watershed assessments. Collectively, they will allow for the analysis of greater trends across Ohio that are impacting the quality of our water resources.

These data may also help identify sources of nutrients that contribute to harmful algae blooms in Western Lake Erie and the Gulf of Mexico via the Ohio River and be used to evaluate the effectiveness of management actions.

Ambient Monitoring History

As part of Ohio's statewide monitoring strategy, biological and water quality assessments are completed on a 12-year rotation. Between these assessments, most waterways are not scheduled to be monitored by Ohio's water quality program. From 1991 through 2020, Ohio EPA maintained an ambient sampling program across the state. These stations, numbering greater than 100 sites on more than 60 waterways, provide the only source of long-term, year-round data on many of Ohio's major waterways. In other parts of the state, these data complement efforts by many of our partners at the federal and local level.

The United States Geological Survey (USGS) National Ambient Water Quality Monitoring Network (NAWQN) was established to facilitate national-scale understanding of surface-water quality conditions through the collection of comparable data in large rivers and small streams in different geographic and land-use settings. The NAWQN overlaps with International Joint

Commission (IJC) designated sites, which addresses data needs for assessing water quality conditions in Lake Erie and its major tributaries. The Water Quality Monitoring Network (WQMN) also overlaps with the USGS National Stream Quality Accounting Network (NASQAN), which is comprised of a network of gage stations and a limited number of four parameter continuous monitors. Ohio's ambient monitoring program will compliment these programs, utilizing data resources provided by USGS gage stations, while monitoring for a suite of parameters not covered by our federal partners.

A6. Project Description

Ohio's ambient sampling program includes sites in watersheds across the state. Watersheds with ambient stream sites are listed in Table 4.

Ambient sampling stations will be monitored monthly, year-round, except when frozen waterways prevent USGS stream gages from functioning properly. An effort will be made to collect water quality samples under a variety of streamflow conditions. Flow duration curves for each sampling station will be developed. Each sample collected will be plotted against the curve and a record of the distribution of samples will be maintained for each station by district staff. Staff will utilize real time streamflow data for Ohio published by USGS.

Stations will have "at point" field parameters measured with a calibrated water quality sonde such as a YSI® Pro Series meter or equivalent. The field data will be logged electronically or recorded in writing on a lab sample submission form. A summary of the field measurements is listed in Table 3.

Table 3 – Field Parameters Collected with Water Quality Sonde

Parameter	PCS	RL	Units
Temperature	00010	0.001	C
Dissolved Oxygen	00300	0.01	mg/L
Oxygen Saturation	00301	0.001	%
Specific Conductivity	00095	0.01	µS/cm
pH	00400	0.1	SU

Samples will be collected in accordance with Ohio EPA's *Division of Surface Water's Field Sampling Manual: for Water Quality Parameters and Flows, Version 9.0*. Staff will utilize Version 9.0, released in 2023, or more current version when available. This document will henceforth be referred to simply as the *Surface Water Field Sampling Manual* and is available at ***https://epa.ohio.gov/divisions-and-offices/surface-water/reports-data/technical-bulletins***.

At this time, biological sampling will only be completed at each station approximately once every 12 years as a part of Ohio EPA DSW's targeted watershed studies. All relevant guidance for biological sampling will be housed within each targeted study's individual QAPP. Future consideration will be given to additional biological sampling opportunities at ambient stations. Macroinvertebrate and fish community assessment will be collected and analyzed using standardized procedures available at ***https://epa.ohio.gov/static/Portals/35/documents/BioCrit15_Vol3.pdf***.

Table 4 – List of Watershed Assessment Units (WAU) in Study Area

HUC8 Name	HUC12	HUC Name
Ottawa-Stony	04100001 03 08	Sibley Creek-Ottawa River
St. Joseph	04100003 05 05	Willow Run-Saint Joseph River
St. Mary's	04100004 03 03	Yankee Run-Saint Mary's River
Upper Maumee	04100005 02 02	North Chaney Ditch-Maumee River
Tiffin	04100006 02 02	Deer Creek-Bean Creek
	04100006 05 03	Village of Stryker-Tiffin River
Blanchard	04100008 04 05	Lower Riley Creek
	04100008 03 04	Howard Run-Blanchard River
Auglaize	04100007 05 03	Village of Kalida-Ottawa River
	04100007 12 07	Little Flatrock Creek
	04100007 09 04	Big-Run Auglaize River
	04100007 12 09	Eagle Creek-Auglaize River
Lower Maumee	04100009 01 01	West Creek
	04100009 02 03	Wade Creek-Maumee River
	04100009 09 03	Crooked Creek-Maumee River
Cedar-Portage	04100010 05 02	Portage River
Sandusky	04100011 06 05	Lick Run-Tymochtee Creek
	04100011 08 06	Lower Honey Creek
	04100011 07 02	Town of Upper Sandusky-Sandusky River
	04100011 13 02	Indian Creek-Sandusky River
Huron-Vermilion	04100012 06 06	Mud Brook-Frontal Lake Erie
	04100012 03 04	Old Woman Creek
	04100012 02 04	Town of Vermilion-Vermilion River
Black Rocky	04110001 02 03	Rocky River
	04110001 06 02	Black River
Cuyahoga	04110002 02 03	Lake Rockwell-Cuyahoga River
	04110002 04 05	Boston Run-Cuyahoga River
	04110002 05 04	Town of Twinsburg-Tinkers Creek
	04110002 06 02	Village of Independence-Cuyahoga River
	04110002 06 05	City of Cleveland-Cuyahoga River
Ashtabula-Chagrin	04110003 04 03	Town of Willoughby-Chagrin River
	04110003 05 03	Euclid Creek
Grand	04110004 06 07	Red Creek-Grand River

Chautauqua-	04120101 06 05	Marsh Run-Conneaut Creek
Upper Ohio	05030101 06 10	Bieler Run-Little Beaver Creek
	05030101 08 04	Hollow Rock Run-Yellow Creek
Mahoning	05030103 06 03	City of Warren-Mahoning River
	05030103 08 09	Coffee Run-Mahoning River
Upper Ohio-Wheeling	05030106 03 04	Flat Run-Wheeling Creek
	05030106 09 05	Pea Vine Creek-Captina Creek
Little Muskingum-Middle Island	05030201 07 03	Wingett Run-Little Muskingum River
Hocking	05030204 03 02	Outlet Clear Creek
	05030204 06 05	Harper Run-Hocking River
	05030204 10 01	Willow Creek-Hocking River
Tuscarawas	05040001 05 06	Town of East Sparta-Nimishillen Creek
	05040001 12 02	Wetmore Creek-Tuscarawas River
	05040001 18 04	Blue Ridge Run-Tuscarawas River
Walhonding	05040003 03 02	Armstrong Run-Kokosing River
	05040003 08 04	Big Run-Killbuck Creek
Muskingum	05040004 03 01	Robinson Run-Muskingum River
	05040004 08 06	Oilspring Run-Muskingum River
Wills	05040005 05 04	Sarchet Run-Wills Creek
Licking	05040006 05 04	Bowling Green Run-Licking River
Upper Scioto	05060001 06 04	Lower Mill Creek
	05060001 11 02	Rush Run-Olentangy River
	05060001 20 06	Thomas Ditch-Little Darby Creek
	05060001 22 04	Lizard Run-Big Darby Creek
Lower Scioto	05060002 04 03	Lick Run-Scioto River
	05060002 10 05	Stony Creek-Scioto River
Paint	05060003 04 07	Big Branch-Rattlesnake Creek
	05060003 10 03	Outlet Paint Creek
	05060003 06 02	Farmers Run-Paint Creek
Upper Great Miami	05080001 13 03	Canyon Run-Stillwater River
	05080001 18 02	Pondy Creek-Mad River
Lower Great Miami	05080002 01 05	Town of Oakwood-Great Miami River
	05080002 04 04	Dry Run-Great Miami River
	05080002 09 06	Jordan Creek-Great Miami River
Raccoon-Symmes	05090101 03 04	Flat Run-Raccoon Creek

	05090101 04 03	Meadow Run-Little Raccoon Creek
	05090101 06 03	Mud Creek-Raccoon Creek
Ohio Brush-Whiteoak	05090201 10 02	Miranda Run-Whiteoak Creek
Little Miami	05090202 01 04	Yellow Springs Creek-Little Miami River
	05090202 11 02	Fivemile Creek-East Fork Little Miami River
	05090202 14 03	Horner Run-Little Miami River
Middle Ohio-Laughery	05090203 01 04	Congress Run-Mill Creek

Figure 2- NEDO Sample Locations Map

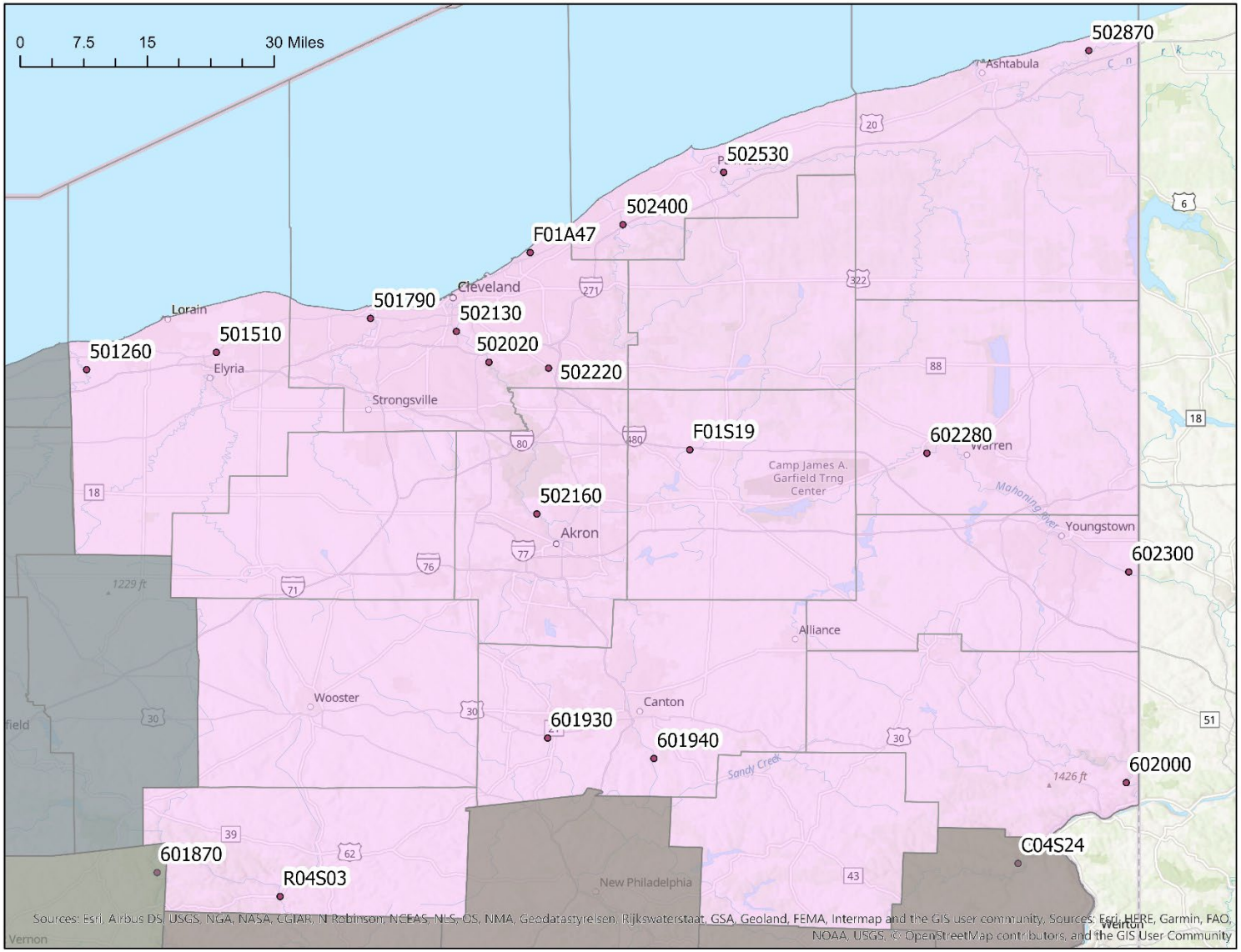


Figure 3- NWDO Sample Locations Map

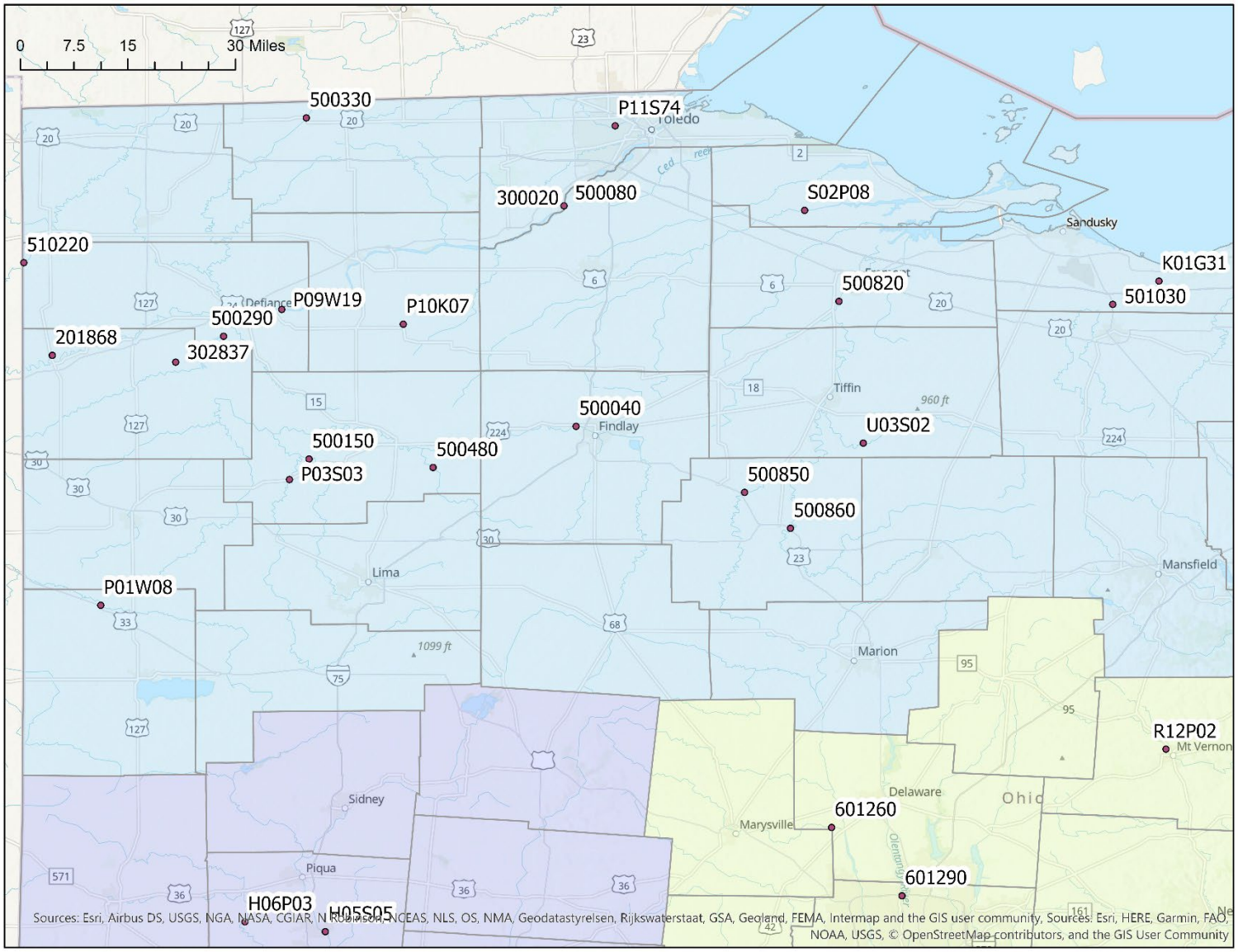


Figure 4 - CDO & SEDO Sample Locations Map

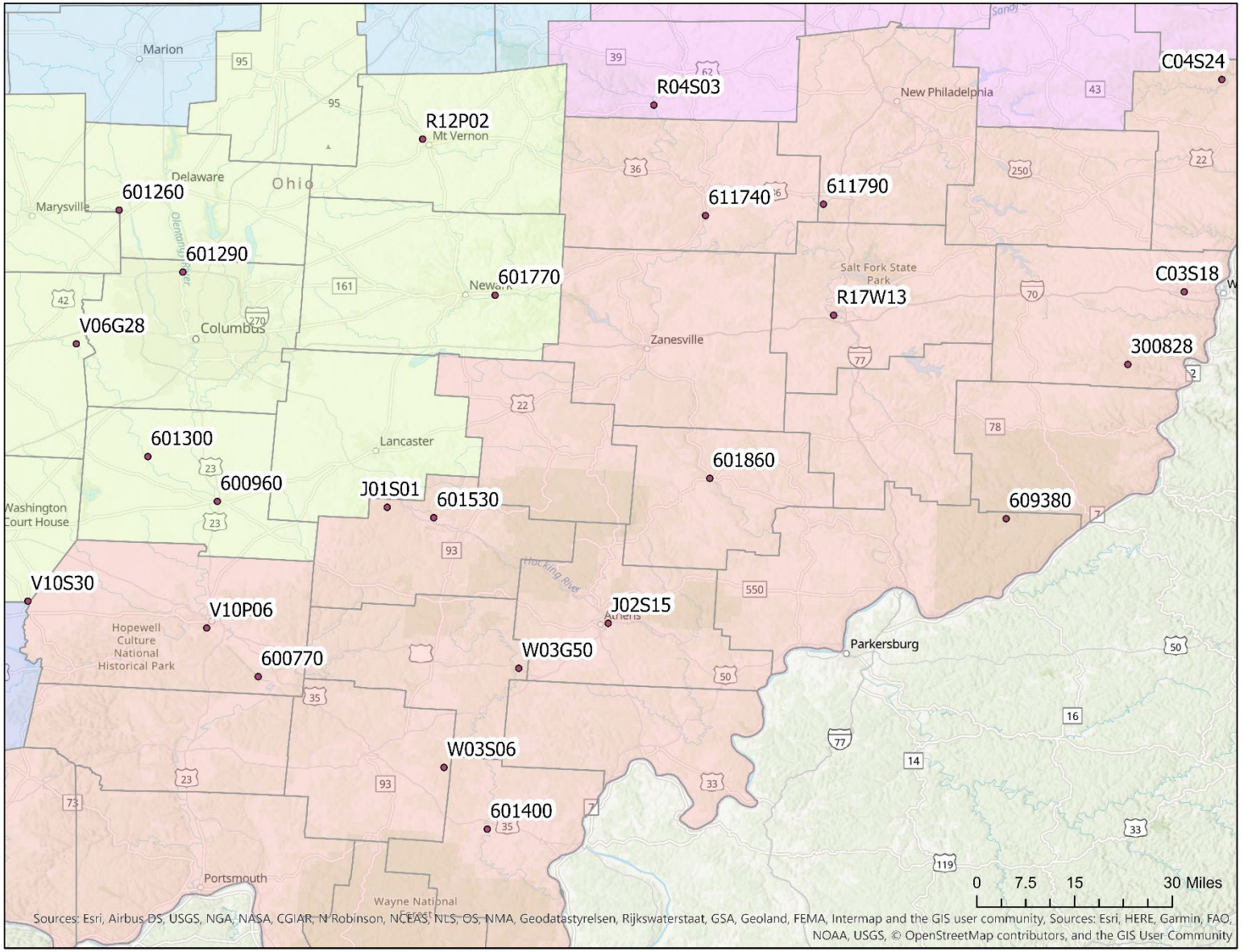
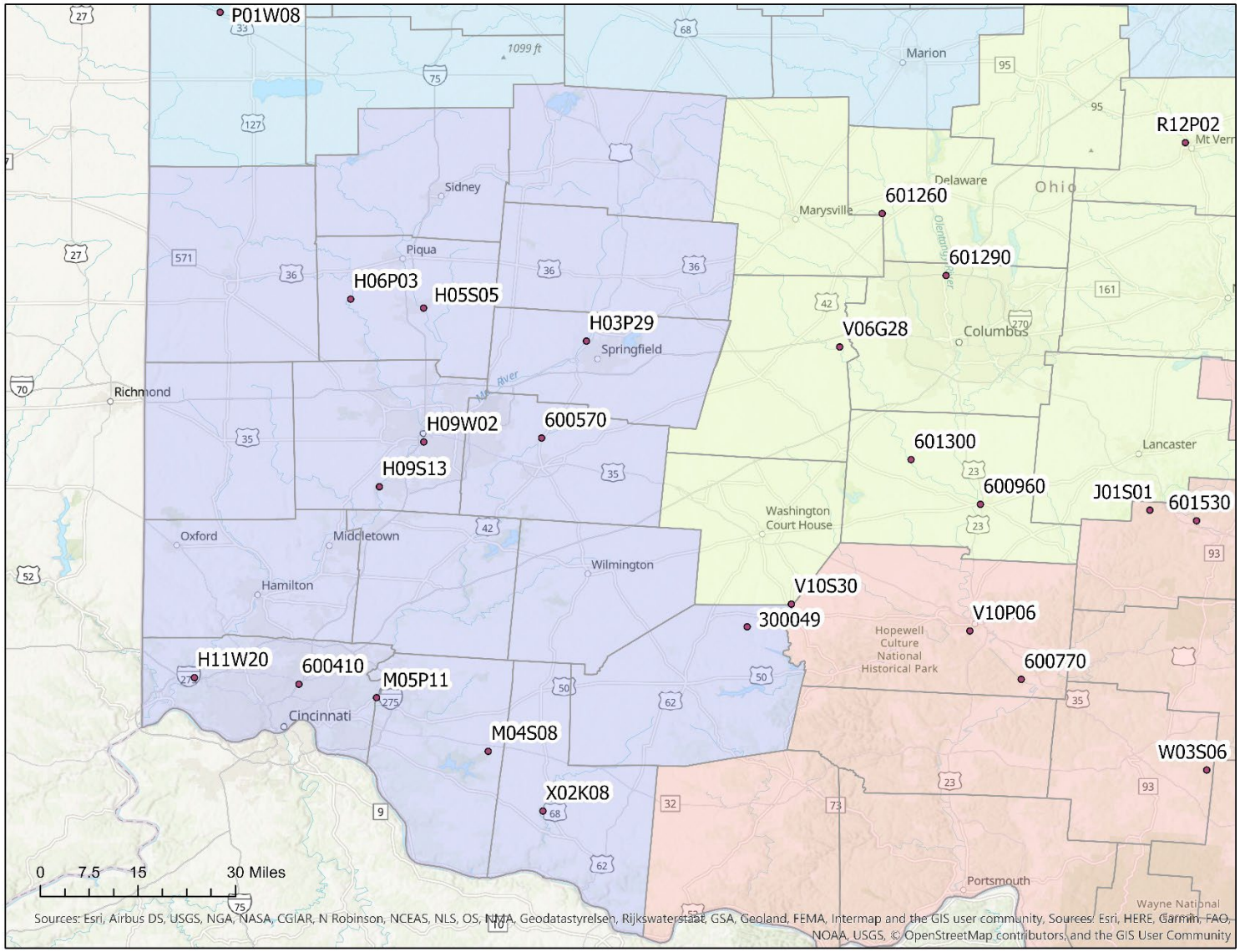


Figure 5- SWDO Sample Locations Map



A7. Data Quality Objectives

DSW's water quality group has been sampling ambient surface water stations throughout Ohio as a part of Ohio ambient stream monitoring program since 1991. The current Ohio EPA Ambient sampling objectives are to:

- provide year-round data, spanning the hydrograph,
- provide data useful for long-term biological and chemical trend analysis,
- monitor for emerging pollutants,
- support the National Pollutant Discharge Elimination System (NPDES) permitting program,
- provide data for Water Quality Standards (WQS) development and TMDL implementation, and
- provide timely, consistent, and unbiased information on the current condition of Ohio's streams.

Long-term Trend Analysis

While local and federal partners maintain sampling programs on waterways across Ohio, this program will complement and supplement those data sources, in terms of location, timing, and parameters sampled. All data will be submitted to U.S. EPA's Water Quality Exchange, where it will be available to the public.

Ambient data may further enhance our ability to provide guidance to implementation partners attempting to track water quality responses to Best Management Practices (BMPs) and related practices. Sampling program design can be more accurately tailored to a watershed with ambient data due to our increased understanding of long-term variability within those watersheds.

Monitor for Emerging Pollutants

Additional parameters may be added to the current suite with minimal lag time between an identified need and implementation of sampling. The ambient network of stations provides a readymade framework for implementing sampling for parameters not currently monitored, including a historical record of potentially related chemical parameters and biological data for analysis.

Support NPDES Permitting

A key component in Water Quality Based Effluent Limit (WQBEL) development is compiling appropriate background data for use in the associated waste load allocation. Permit staff use Ohio EPA stream monitoring data that is collected at a location upstream of the facility that is being evaluated for compliance. This data is gathered primarily during summer biological surveys, creating significant data gaps. A representative ambient monitoring station is valuable since sampling provides a source of background data.

When developing a wasteload allocation (WLA) for nitrogen-ammonia (summer and winter), staff also may use ambient monitoring data to represent background values. Since samples collected during the summer biological surveys are primarily collected June through October, winter ammonia background data cannot be evaluated using stream survey data sets. The ambient site data allows for evaluation of both seasons. This also holds true if there is a seasonal focus for other parameters of interest, for example the spring phosphorus load.

When industries determine the benchmarks for hardness-dependent parameter, they may use the ambient monitoring data to represent that background value. The ambient site data may provide an additional source of data for applicants to use.

TMDL Implementation

The TMDL program, established under Section 303(d) of the Clean Water Act, focuses on identifying and restoring polluted rivers, streams, lakes, and other surface water bodies. TMDLs are prepared for waters identified as impaired on the 303(d) list in the Integrated Report. A TMDL is a written, quantitative assessment of water quality problems in a water body and contributing sources of pollution. It specifies the amount a pollutant needs to be reduced to meet WQS, allocates pollutant load reductions, and provides the basis for taking actions needed to restore a water body. The objectives of the TMDL process are to estimate pollutant loads from the various sources within the basin, define or characterize allowable loads to support the various beneficial uses, and to allocate pollutant loads among different pollutant sources through appropriate controls (e.g., NPDES permitting, storm water management, 319 proposals, Non-Point Source [NPS] controls or other abatement strategies). The TMDL process will be further strengthened through use of ambient data during the identification of impaired waters, verification (and re-designation if necessary) of beneficial use designations, gathering ambient information that will factor into the wasteload allocation, and ascribing causes and sources of use impairment. Stream monitoring data are necessary precursors to the development of effective control or abatement strategies. This program will provide a source of long-term, monthly data in watersheds across Ohio. It will serve as a useful tool when evaluating stream chemistry data during stream surveys, helping staff contextualize the data collected during any given survey field season.

Current Conditions Data

Targeted watershed surveys are currently planned on a 12-year rotating basis across the state. The ambient program will provide the only consistent source of data in many watersheds between targeted surveys. These sites will allow DSW to maintain a presence in watersheds across the state.

Additional benefits of the ambient sampling sites are:

- assist with quantifying nutrient loadings to Lake Erie and the Ohio River,
- inform DSW's nutrient mass balance work,

- update the Background Water Quality Report (Ohio EPA, 2018), and
- provide monitoring data for restoration projects funded by Ohio EPA (319 program, WRRSP, WPCLF, Ohio DNR (H2Ohio, AMLER), Ohio Public Works (Clean Ohio).

A8. Special Training/Certification

All staff who conduct surface water sampling, whether from streams or lakes, receive initial training by experienced staff in the proper techniques required, usually a supervisor or veteran employee. Mandatory refresher training is completed on an annual basis for all surface water samplers. Initial boating safety certification and annual refresher training is required by internal safety policy SP10-12 for all employees who operate a watercraft.

A9. Documents and Records

Microsoft® SharePoint is used as a library for documents. Access is through Ohio EPA's Intranet collaboration site.

Examples of documents posted to this location include the following. Examples of documents posted to this location include the following.

Pre-sampling documents:

- Property access forms (as needed)
- Draft and final QAPP versions

Project documents:

- Stream flow curve and sampling records
- Changes to sites, staff, parameters
- Data summaries
- QAPP addendums

Changes in project leadership or major actions which might affect the Data Quality Objectives (DQOs) require an updated QAPP and signoff sheet. The study team leader shall retain copies of all management reports, memoranda, and all significant correspondence between team members.

The original chain of custody is delivered to Division of Environmental Services (DES) along with the samples and retained according to Agency retention policy. A copy of the form may be kept by the sample collector as well. After samples are analyzed and the results are approved by the DES QA Officer the data is released to Sample Master® and subsequently uploaded to DSW's Ecological Assessment and Analysis Application (EA3). The sample collector reviews laboratory sheets for completeness and accuracy, validates field QC, adds comments and completes edits if necessary and approves the sheet. All data approved in EA3 is sent to U.S. EPA's Water Quality Exchange.

Original fish and QHEI data sheets will be retained at the Groveport Field Office. Data from the field sheet is manually entered into the EA3 database using the appropriate data entry screen. The sheets are double entered to minimize mistakes.

Section B. Data Generation and Acquisition

B1. Sampling Process and Design

Water chemistry samples will be collected once per month at each site, twelve months per year. Sites will not be sampled if streams are frozen, or USGS stream flow data is unavailable. Biological samples will only be collected at ambient stations during watershed surveys at this time.

Criteria for locating ambient stations is as follows:

- must be located at or in conjunction with a USGS station,
- have flow year-round,
- be safely accessible,
- be non-duplicative,
- be at a logical site to achieve the objectives of this QAPP,
- and reflect locally normal background water quality chemistry (not skewed by a nearby upstream influence such as a point source discharge or other abnormal or unnatural influence).

B2. Sampling Methods

Surface Water

Inorganic surface water chemical parameters will be analyzed from surface grab samples collected at every site listed in Appendix 2. Physical water quality measurements will be taken with a multimeter probe each time a sample is collected. Analytical methods and laboratory reporting levels for chemical and physical parameters for samples collected within the study are listed in Appendix 3.

Surface water grab samples will be collected and preserved using appropriate methods as outlined in the *Surface Water Field Sampling Manual*. Samples are delivered by field staff or via courier to Ohio EPA's DES for analyses. Field measurements of dissolved oxygen, pH, temperature and conductivity will be made using a properly calibrated YSI® Pro Series meter or equivalent.

Laboratory reporting limits are adequate to evaluate most pollutants. Potential exceptions include nitrate-nitrite and ammonia. It is common for nitrogen to become depleted during the summer in aquatic environments. In instances where a value is needed to calculate a mean

concentration and the result is below reporting limit (RL), the reported "value" will be used in the calculation.

B3. Sample Handling and Custody

Sample Master® software is used by field staff to create sample orders and DES to manage laboratory information. A guidance manual for use of the software is in Appendix IV of the *Surface Water Field Sampling Manual.* The sample collector logs into the system and places an order by selecting the appropriate project, stations to be sampled, and test group(s) to be analyzed. The program creates a chain of custody form and container labels for each site.

B4. Analytical Methods

The analytical methods to be used in this study are provided in Appendix 3 along with the preservatives, holding times, and reporting limits. SOPs for the analytical methods are maintained by DES and are available upon request.

B5. Quality Control

Surface Water Chemistry

Ten percent of the annual total number of water samples will be submitted to the laboratory as field quality control samples. About five percent will be duplicates, including replicates if natural variability is a concern, and about five percent will be blanks, including field blanks and equipment blanks. Data will be validated based on the results of the field quality control samples as outlined in Appendix IV in the *Surface Water Field Sampling Manual.* The laboratory will validate data according to the requirements defined in the applicable analytical method (see Appendix 3). Field instruments will be calibrated according to manufacturer guidelines. Field instruments utilizing electrochemical sensors must be calibrated daily.

B6. Instrument/Equipment Testing, Inspection and Maintenance

All instruments/equipment will be inspected prior to each use. All field meters are serviced annually by a factory certified service provider to ensure they are operating within specifications. Parts are repaired or replaced at this time if necessary.

B7. Instrument Calibration and Frequency

The appropriate calibration procedure, as specified in the instrument's user manual, must be followed. All calibration solutions used will be checked for expiration dates before utilized. All equipment is assigned a logbook that will detail the equipment's calibration and maintenance history. For more details see Section D and Appendix II of the *Surface Water Field Sampling Manual*.

B8. Inspection/Acceptance of Supplies

Supplies and consumables will be inspected upon receipt by the field sampling teams. Nearly all supplies utilized for this project are maintained and used during Ohio EPA's normal business operations. The field team leaders will be responsible for ensuring that all sample containers and all needed supplies and consumables are available in advance of all field work. It will be their responsibility to maintain and replenish stock when needed. Consumable supplies include, but are not limited to: sample containers, acid preservatives, Lugol's iodine solution, ethyl alcohol, buffers, filters and miscellaneous supplies such as distilled water, disposable gloves, and towels. Field personnel will confirm that all reagents are within applicable shelf life.

B9. Data Acquisition Requirements for Non-Direct Measurements

Data collected for this project and other data previously collected by Ohio EPA will be used to develop data summaries for each site.

B10. Data Management

The data management process is shared by DSW and DES. DES uses Sample Master® software to manage laboratory information and DSW uses the EA3 to manage data. These programs are linked together to allow the transfer of information between the two systems. EA3 software is used to assign a permanent six-digit station ID number to each sampling location and to create a project name to associate locations so data can subsequently be exported and assessed in groups.

Field measurements are collected instantaneously using a multi-parameter meter and saved in an internal file storage system. These files are downloaded to the manufacturer's software, exported to Microsoft Excel® and then uploaded to Sample Master® so field data can be associated with chemistry data in the database. Sample collector(s) will access the USGS streamflow web page and record gage height and discharge readings closest to the actual sample collection time and add it to the sample metadata in Sample Master®.

Field and chemistry data tabulated in Sample Master® are eventually uploaded into EA3. Then, in EA3, the sample collector will review each data sheet for accuracy, validate field QC, add comments, and complete edits, if necessary, before approving the sheet. This data is then available for use. All agency files are ultimately backed up and housed in the SOCC.

The study team leader will maintain the project file in a dedicated folder on SharePoint. The expectation is to have a complete record of all decisions about modifications of data collection, validation, or interpretation between the QAPP signoff and data approval. To achieve this, the study team leader will need to be included on emails or otherwise receive summaries of all

actions that meet the above description. Project photos should all be filed in the Agency's Lynx photo management system.

Section C. Assessment and Oversight of Data Collection

C1. Assessment and Response Actions

Assessments

Periodic assessment of field sites, field equipment, and laboratory equipment is necessary to ensure that data obtained meets project needs. This is an ongoing process that continues every day during project implementation, as well as on larger scale assessments that take place less frequently (*e.g.*, annually). The assessments generally focus on readiness and consistency of implementation but also are looking for continual improvement opportunities.

Daily assessments (for each day of project activities, as applicable) include assessment of field equipment and supplies, laboratory equipment and supplies, completeness of the day's samples and associated field notes, future needs, etc.

Response Actions

Despite best preparations, assessments may find situations requiring corrective actions. Small day-to-day level assessment findings are often addressed by the individual doing the assessment in the field or in the laboratory and are common enough to the process to not necessitate a formal response.

When more significant situations arise, staff are aware that a more formal response may be necessary.

For issues that arise at DES, corrective actions may result in changes to the analytical reporting via data qualifiers and comments, for more information see Appendix IV of the *Surface Water Field Sampling Manual* if:

- QC data are outside the warning or acceptable windows for precision and accuracy,
- Blanks contain target analytes above acceptable levels,
- Undesirable trends are detected in spike recoveries or relative percent difference (RPD) between duplicates,
- There are unusual changes in detection limits,
- Deficiencies are detected by the laboratory and or project QA officers during any internal or external audits or from the results of performance evaluation samples, or
- Inquiries concerning data quality are received.

Corrective action implementation will be determined by the likelihood that the situation may

affect the quality of the data.

Field corrective actions will be brought to the attention of the study team for consideration as to their impact on the data, their potential interest to other sampling teams/subcontractors, any future considerations for process improvement, and for their potential inclusion in project related reports.

Laboratory corrective actions will follow regular laboratory procedures and SOPs. Any laboratory corrective action with the potential to affect data quality will be conveyed to the study team leader by the laboratory.

Reporting and Resolution of Issues

Any audits or other assessments that reveal findings of practice or procedure that do not conform to the written QAPP will be corrected as soon as possible. The study team and QA coordinator will be notified regarding deviations.

Data Completeness

Success of the project will be judged by the resulting data fulfilling the needs outlined in the data objectives. Potential data gaps will be monitored as the project progresses and the project schedule will be revised to fill these gaps where they are determined to be significant or to potentially impact the fulfillment of project objectives.

Reports to Management

The study team leader or district supervisor will receive regular updates from field staff throughout the sampling season and will report to division management during Senior Management Team meetings. Any problems that jeopardize completion of the project will lead to memorandum and consultation with program management and quality assurance staff.

Section D. Data Validation and Usability

D1. Data Review, Validation and Verification Requirements

Data verification will be conducted by the study team with assistance from other DSW staff. This process will confirm that sample results received are congruent with samples submitted and parameters requested from the laboratory. The process will also result in summaries of any differences between initial sampling and methods planned in the QAPP and results reported and available. Differences may result from samples not being collected (due to weather, scheduling, etc.), samples not being submitted (due to accidents like broken containers, or delays resulting in being past holding times, etc.), problems at the laboratory (methods changing, containers or equipment breaking), or other reasons. It is also possible that additional sampling would take place because of field observations/conditions.

Documenting deviations from the QAPP is the responsibility of the study team leader.

The DES laboratory does the initial validation on all data and may qualify data based on laboratory QA/QC alone or with feedback from the sampler (regarding specific sampling procedures, variable sampling matrix, conditions, blank contamination, duplicate agreement, matrix spike recovery, etc.). The data user can evaluate the data given their knowledge of sampling conditions, expected variability given location and matrix, data uses, etc.

Upon approval in EA3, field and laboratory data cannot be revised without intervention from database administrators in the Agency's Office of Information Technology Services (ITS).

D2. Validation and Verification Methods

In addition to verifying data completeness, the study team will oversee data validation for the project that will include confirmation of sample holding times, proper preservatives, sample containers, analysis methods, Quality Assurance/Quality Control (QA/QC) results (including assessment of results for blanks, spikes, and duplicates), etc. This will be an ongoing effort, with Quality Assurance (QA) reviews managed on a calendar year basis.

The study team will make final decisions regarding validity and usability and will evaluate the sample collection, analysis, and data reporting processes to determine if the data is of sufficient quality to meet the project objectives. Data validation involves all procedures used to accept or reject data after collection and prior to use. These include screening, editing, verifying, and reviewing. Data validation procedures ensure that objectives for data precision and bias will be met, that data will be generated in accordance with the QAPP and Standard Operating Procedures (SOPs), and that data are traceable and defensible. The process is both qualitative and quantitative and is used to evaluate the project.

The laboratory QA staff will conduct a systematic review of the analytical data for compliance with the established Quality Control (QC) criteria using batch and sample QA/QC information including spike, duplicate, and blank results. All technical holding times will be reviewed, the laboratory analytical instrument performance will be evaluated, and results of initial and continuing calibration will be reviewed and evaluated.

Field QC sample results will be evaluated using procedures available in Section I of the *Surface Water Field Sampling Manual*. Much of this work is facilitated by a centralized automated QC data evaluation Excel® file. Use of this file is explained in the document "QC Tracking and Data Qualification" available in SharePoint in DSW Quality Management/Documents/DSW Procedures.

For most DSW chemical water quality data, data validation is generally confined to evaluation of blank results, duplicate/replicate results, paired parameter results (defined below) and confirming that samples were properly preserved/prepared (including filtration, *etc*. - if indicated by the method). Standards for evaluation of analytical results of those QC sample types and general field samples are described in Appendix IV, Section A of the *Surface Water Field Sampling Manual*.

Table 5 – Paired Parameter Comparisons

Parameter 1	Parameter 2
TKN	Ammonia
Conductivity (Lab)	Conductivity (Field)
Total Phosphorus	Dissolved Phosphorus
Nitrate-Nitrite	Nitrite

D3. Reconciliation with Data Quality Objectives

For most situations, issues can be addressed with acknowledgement of factors captured in the sample metadata which can confirm, explain, and document the data quality concern. Significant, persistent, or unresolved issues will be brought to the attention of the project study team, division QC personnel, and Ecological Assessment Unit and/or DSW management for further evaluation. This combination of personnel will assess how to best label affected data for storage in the EA3 database and how to eliminate or limit any similar problems going forward. Consideration will also be given on how best to memorialize data limitations or anomalies as the data is transferred to other databases, including the US EPA WQ Portal, so that future users of the sampling data are aware of any data quality issues or limitations.

Appendix 1. Summary of Sampling Effort

Type of Sample	# of sites	passes/frequency
Biology (during watershed surveys)		
Fish*	75	1/ watershed survey cycle
Macroinvertebrate*	75	1/ watershed survey cycle
Fish Tissue (during watershed surveys)		
Fish Tissue*	75	TBD
Water Quality (monthly)		
Inorganic Samples	75	1/ month

*Fish and macroinvertebrate sampling will occur at ambient stations as a part of regular surveys in each watershed. Sampling frequencies and details will be outlined in relevant watershed study QAPPs. Fish tissue sites will be set by watershed study teams without preference to ambient stations.

Appendix 2. Streams, Sampling Locations, and Sampling Types

Station	Site Name	River Mile	Area (mi^2)	HUC12	County	Lat.	Lon.	Sampling
Central District Office								
601300	BIG DARBY CREEK AT DARBYVILLE	13.36	534.0	05060001 22 04	Pickaway	39.7008	-83.1097	F, MQ, C
R12P02	KOKOSING R. AT MT. VERNON @ TILDEN AVE. GAGE	28.61	202.0	05040003 03 02	Knox	40.4056	-82.4997	F, MQ, C
V06G28	L. DARBY CREEK AT WEST JEFFERSON @ MIDDLE PIKE	7.35	162.0	05060001 20 06	Madison	39.951162	- 83.2682	F, MQ, C
601770	LICKING R. NEAR NEWARK @ ST. RT. 16 (STADDEN BRIDGE)	26.75	537.0	05040006 05 04	Licking	40.059357	- 82.3386	F, MQ, C
601260	MILL CREEK UPST. BELLPOINT @ MILLS RD. U.S.G.S. GAGE	1.57	178.0	05060001 06 04	Delaware	40.2481	- 83.1736	F, MQ, C
601290	OLENTANGY R. NEAR	11.5	497.0	05060001 11 02	Franklin	40.1103	- 83.0319	F, MQ, C
V10S30	PAINT CREEK UPST. GREENFIELD @	52.54	249.0	05060003 06 02	Fayette	39.3797	- 83.3758	F, MQ, C
600960	SCIOTO R. AT CIRCLEVILLE @ U.S. RT. 22	99.82	3217.0	05060002 04 03	Pickaway	39.6014	- 82.9553	F, MQ, C
300049	RATTLESNAKE CREEK @	7.55	209.0	05060003 04 07	Highland	39.329	- 83.4741	F, MQ, C
Northeast District Office								
501510	BLACK R. DST. ELYRIA @ FORD RD.	8.9	412.0	04110001 06 02	Lorain	41.41148	- 82.0952	F, MQ, C
502400	CHAGRIN R. AT WILLOUGHBY @ RIDGE RD. (ST. RT. 84)	4.95	246.0	04110003 04 03	Lake	41.63	- 81.4003	F, MQ, C
502870	CONNEAUT CREEK AT CONNEAUT @	6.69	175.0	04120101 06 05	Ashtabula	41.9271	- 80.6043	F, MQ, C
502130	CUYAHOGA R. AT CLEVELAND @ LOWER HARVARD AVE.	7.1	786.0	04110002 06 05	Cuyahoga	41.447356	- 81.6847	F, MQ, C
502020	CUYAHOGA R. AT INDEPENDENCE @ OLD ROCKSIDE RD.	13.08	707.0	04110002 06 02	Cuyahoga	41.3946	- 81.6292	F, MQ, C

Station	Site Name	River Mile	Area (mi^2)	HUC12	County	Lat.	Lon.	Sampling
F01S19	CUYAHOGA R. AT SHALERSVILLE @	64.3	178.0	04110002 02 03	Portage	41.245	- 81.286	F, MQ, C
502160	CUYAHOGA R. UPST. AKRON WWTP @ OLD PORTAGE TRAIL	42.2	404.0	04110002 04 05	Summit	41.1353	- 81.5475	F, MQ, C
F01A47	EUCLID CREEK @ LAKE SHORE	0.66	23.0	04110003 05 03	Cuyahoga	41.5819	- 81.5589	F, MQ, C
502220	TINKERS CREEK AT BEDFORD @ ST.	6.32	84.0	04110002 05 04	Cuyahoga	41.3844	- 81.5275	F, MQ, C
502530	GRAND R. AT PAINESVILLE @ ST.	8.45	685.0	04110004 06 07	Lake	41.7192	- 81.2281	F, MQ, C
R04S03	KILLBUCK CREEK DST. KILLBUCK WWTP @ U.S. RT. 62	23.91	464.0	05040003 08 04	Holmes	40.4814	- 81.9861	F, MQ, C
602280	MAHONING R. AT LEAVITTSBURG @	45.51	575.0	05030103 06 03	Trumbull	41.2392	- 80.8808	F, MQ, C
602300	MAHONING R. AT LOWELLVILLE @	12.42	1074.0	05030103 08 09	Mahoning	41.0361	- 80.5361	F, MQ, C
601940	NIMISHILLEN CREEK DST N. INDUSTRY @ HOWENSTINE RD.	6.72	177.0	05040001 05 06	Stark	40.7172	- 81.3475	F, MQ, C
501790	ROCKY R. AT LAKEWOOD @ PARK	3.0	291.0	04110001 02 03	Cuyahoga	41.4694	- 81.8317	F, MQ, C
601930	TUSCARAWAS R. AT MASSILLON @ WARMINGTON ST.	87.37	520.0	05040001 12 02	Stark	40.7522	- 81.5292	F, MQ, C
602000	L. BEAVER CREEK NEAR EAST LIVERPOOL @ GRIMMS BRIDGE RD.	4.5	496.0	05030101 06 10	Columbiana	40.6760	- 80.5402	F, MQ, C
Northwest District Office								
P03S03	AUGLAIZE R. NE OF FORT JENNINGS @ U.S. 224	39.57	327.0	04100007 09 04	Putnam	40.9489	-84.2661	F, MQ, C
500290	AUGLAIZE R. UPST. DEFIANCE @ HARDING RD.	4.14	2330.0	04100007 12 09	Defiance	41.2375	-84.3991	F, MQ, C
500330	BEAN CREEK E OF POWERS @ U.S. RT. 20	7.55	206.0	04100006 02 02	Fulton	41.6775	-84.2322	F, MQ, C
500040	BLANCHARD R. DST. FINDLAY @ CO. RD. 140	55.26	345.0	04100008 03 04	Hancock	41.0562	-83.6885	F, MQ, C

Station	Site Name	River Mile	Area (mi^2)	HUC12	County	Lat.	Lon.	Sampling
U03S02	HONEY CREEK AT MELMORE @ ST. RT. 67/100	12.3	149.0	04100011 08 06	Seneca	41.0222	-83.1097	F, MQ, C
501030	HURON R. AT MILAN, DST U.S. RT. 250 @ GAGE	12.3	371.0	04100012 06 06	Erie	41.3017	-82.6069	F, MQ, C
302837	L. FLATROCK CREEK @ TR 139 NEAR JUNCTION	3.4	15.3	04100007 12 07	Paulding	41.1855	-84.4954	F, MQ, C
201868	MAUMEE R. AT ANTWERP @ ANTWERP CITY PARK	99.0	2129.0	04100005 02 02	Paulding	41.1835	-84.7322	F, MQ, C
500080	MAUMEE R. AT WATERVILLE @ ST.	20.68	6330.0	04100009 09 03	Maumee	41.5001	-83.7128	F, MQ, C
P09W19	MAUMEE R. UPST. INDEPENDENCE DAM (MID RIVER)	60.0	5544.0	04100009 02 03	Defiance	41.2914	-84.2819	F, MQ, C
K01G31	OLD WOMAN CREEK @ BERLIN RD.	3.69	21.6	04100012 03 04	Erie	41.3485	-82.5139	F, MQ, C
P11S74	OTTAWA R. AT TOLEDO @ UNIVERSITY OF TOLEDO	11.15	155.0	04100001 03 08	Lucas	41.6614	-83.6097	F, MQ, C
500150	OTTAWA R. NEAR KALIDA @ CO. RD. 19	0.96	351.0	04100007 05 03	Putnam	40.9901	-84.2267	F, MQ, C
S02P08	PORTAGE R. 4 MI. N OF LINDSEY @ ST. RT. 590	17.03	495.0	04100010 05 02	Ottawa	41.4911	-83.2281	F, MQ, C
500480	RILEY CREEK AT PANDORA @ CO. RD. 6	4.36	70.0	04100008 04 05	Putnam	40.9731	-83.9767	F, MQ, C
500860	SANDUSKY R. DST. UPPER SAND. @ TWP. RD. 121	78.09	295.5	04100011 07 02	Wyandot	40.8506	-83.2564	F, MQ, C
500820	SANDUSKY R. UPST. FREMONT @ RICE RD,	20.25	1251.0	04100011 13 02	Sandusky	41.3078	-83.1589	F, MQ, C

Station	Site Name	River Mile	Area (mi^2)	HUC12	County	Lat.	Lon.	Sampling
510220	ST. JOSEPH R. @ OH/IN STATE LINE @ ST. RT. 249	42.34	609.0	04100003 05 05	Defiance	41.3856	-84.8017	F, MQ, C
P01K02	ST. MARYS R. DST ROCKFORD @ TOWNLINE	52.13	303.0	04100004 03 03	Mercer	40.7178	-84.6894	F, MQ, C
300020	TIFFIN R. W OF STRYKER @ CO. RD. F (CURTIS ST.)	33.95	412.0	04100006 05 03	Williams	41.5001	-83.7128	F, MQ, C
500850	TYMOCHTEE CREEK AT CRAWFORD @ ST. RT. 199	8.06	231.8	04100011 06 05	Wyandot	40.9228	-83.3489	F, MQ, C
501260	VERMILION R. NEAR VERMILION @ MILL HOLLOW/N. RIDGE RD.	6.32	262.0	04100012 02 04	Lorain	41.3819	-82.3169	F, MQ, C
P10K07	WEST CREEK N OF HAMLER @ ST. RT. 109	1.0	15.4	04100009 01 01	Henry	41.2619	-84.0367	F, MQ, C
Southeast District Office								
300828	CAPTINA CREEK AT ARMSTRONG MILLS @ NEW GAGE OFF ST. RT. 148	16.1	127	05030106 09 05	Belmont	39.90521	-80.93397	F, MQ, C
600770	SCIOTO R. DST. CHILLICOTHE @ HIGBY BRIDGE	56.17	5131	05060002 10 05	Ross	39.2122	-82.8647	F, MQ, C
601400	RACCOON CREEK AT ADAMSVILLE @ U.S. RT. 35	29.2	586	05090101 06 03	Gallia	38.8736	-82.3561	F, MQ, C
601530	HOCKING R. NEAR ENTERPRISE @ CO. RD. 31	73.37	459	05030204 06 05	Hocking	39.565	-82.4747	F, MQ, C
601860	MUSKINGUM R. AT MCCONNELSVILLE @ ST. RT. 37/78	49.83	7420	05040004 08 06	Morgan	39.6525	-81.8620	F, MQ, C

Station	Site Name	River Mile	Area (mi^2)	HUC12	County	Lat.	Lon.	Sampling
609380	L. MUSKINGUM R. AT BLOOMFIELD @ ST. RT. 260	30.13	210	05030201 07 03	Washington	39.5631	-81.2039	F, MQ, C
611740	MUSKINGUM R. DST. COSHOCTON @ ST. RT. 83	108.28	4861	05040004 03 01	Coshocton	40.2361	-81.8717	F, MQ, C
611790	TUSCARAWAS R. AT NEWCOMERSTOWN @ RIVER ST.	21.17	2443	05040001 18 04	Tuscarawas	40.2611	-81.6097	F, MQ, C
C03S18	WHEELING CREEK AT BLAINE @ PEASE RD.	5.05	97.6	05030106 03 04	Belmont	40.0669	-80.8086	F, MQ, C
J01S01	CLEAR CREEK AT U.S.G.S. GAGE @ CAMP WYANDOT BRIDGE	2.03	89.0	05030204 03 02	Hocking	39.5883	-82.5783	F, MQ, C
J02S15	HOCKING R. AT ATHENS @ STIMSON AVE.	33.03	942	05030204 10 01	Athens	39.3308	-82.0875	F, MQ, C
R17W13	WILLS CREEK AT CAMBRIDGE @ CAMPBELL AVE. GAGE	64.1	406	05040005 05 04	Guernsey	40.0145	-81.5871	F, MQ, C
V10P06	PAINT CREEK AT CHILLICOTHE @ ST. RT. 772	3.8	1138	05060003 10 03	Ross	39.32	-82.9789	F, MQ, C
W03G50	RACCOON CREEK AT BOLINS MILLS @ ST. RT. 50	80.62	200.0	05090101 03 04	Hocking	39.2308	-82.286	F, MQ, C
W03S06	L. RACCOON CREEK UPST. DICKASON RUN @ KEYSTONE RD.	12.71	127	05090101 04 03	Jackson	39.0106	-82.4522	F, MQ, C
C04S24	YELLOW CREEK NEAR HAMMONDSVILLE @ GAGE	5.51	147	05030101 08 04	Jefferson	40.5379	-80.725	F, MQ, C
Southwest District Office								

Station	Site Name	River Mile	Area (mi^2)	HUC12	County	Lat.	Lon.	Sampling
600570	L. MIAMI R. NEAR OLDTOWN @ U.S. RT. 68	80.63	129.0	05090202 01 04	Greene	39.7488	- 83.9314	F, MQ, C
H03P29	MAD R. NEAR EAGLE CITY @ EAGLE CITY RD.	30.5	307.0	05080001 18 02	Clark	39.9764	- 83.8225	F, MQ, C
H06P03	STILLWATER R. NEAR PLEASANT HILL @ LAUVER RD.	27.86	503.0	05080001 13 03	Miami	40.0578	- 84.3558	F, MQ, C
H09S13	GREAT MIAMI R. AT MIAMISBURG @ LINDEN AVE.	66.9	2711.0	05080002 04 04	Montgomery	39.6406	- 84.2922	F, MQ, C
H05S05	GREAT MIAMI R. AT TROY @ ST. RT.	106.1	927.0	05080001 08 05	Miami	40.0306	-84.1875	F, MQ, C
H09W02	GREAT MIAMI R. AT DAYTON @ STEWART ST.	78.85	2587.0	05080002 01 05	Montgomery	39.74	- 84.1933	F, MQ, C
600410	MILL CREEK DST. WEST FORK @ ANTHONY WAYNE AVE.	10.5	115.0	05090203 01 04	Hamilton	39.2015	- 84.4708	F, MQ, C
H11W20	GREAT MIAMI R. AT MIAMITOWN @ HARRISON RD.	15.49	3838.0	05080002 09 06	Hamilton	39.2161	- 84.7035	F, MQ, C
M04S08	E. FK. L. MIAMI R. AT WILLIAMSBURG @ MAIN ST.	34.91	237.0	05090202 11 02	Clermont	39.0525	- 84.05	F, MQ, C
M05P11	L. MIAMI R. AT MILFORD @	13.07	1203.0	05090202 14 03	Hamilton	39.1717	- 84.2986	F, MQ, C
X02K08	WHITE OAK CREEK @ WHITE OAK	15.2	199.0	05090201 10 02	Brown	38.9195	- 83.9283	F, MQ, C

Code	Sample Type
F	Fish (approx. 12-year cycle)
MQ	Macroinvertebrate - Quantitative (HD) (approx. 12-year cycle)
C	Chemistry (monthly)

Appendix 3. List of Physical/Chemical Parameters and Reporting Limits

Parameter	Method	Reporting Limit
Oxygen Demand		
Chemical Oxygen Demand (COD)	SM 5220D	20 mg/L
Physical Properties		
Alkalinity	USEPA 310.1	5 mg/L
Hardness	USEPA 200.7	10 mg/L
Dissolved Oxygen (mg/l and % saturation)	Field Meter/Sonde	0 mg/L 0% sat
pH	Field Meter/Sonde	0 s.u.
Conductivity (Lab)	SM 2510B	1 µS/cm
Specific Conductance	Field Meter/Sonde	1 µS/cm
Temperature	Field Meter/Sonde	0 °C
Total Dissolved Solids	SM 2540C	10 mg/L
Total Suspended Solids	SM 2540D	5 mg/L
Nutrients		
Ammonia-N	USEPA 350.1	0.05 mg/L
Nitrate-Nitrite	USEPA 350.1	0.5 mg/L
Nitrite	USEPA 353.2	0.02 mg/L
Total Kjeldahl Nitrogen (TKN)	USEPA 351.2	0.2 mg/L
Total Phosphorus	USEPA 365.4	0.01 mg/L
Orthophosphate, Dissolved (as P)	USEPA 365.4	0.01 mg/L
Total Organic Carbon	SM 5310C	2 mg/L
Anions		
Bromide	USEPA 300.1	0.02 mg/L
Chloride	USEPA 325.1	5 mg/L
Sulfate	USEPA 375.2	10 mg/L
Cations		
Aluminum	USEPA 200.7	200 µg/L
Barium	USEPA 200.7	15 µg/L
Calcium	USEPA 200.7	2 mg/L

Parameter	Method	Reporting Limit
Iron	USEPA 200.7	50 µg/L
Magnesium	USEPA 200.7	1 mg/L
Manganese	USEPA 200.7	10 µg/L
Potassium	USEPA 200.7	2 mg/L
Sodium	USEPA 200.7	5 mg/L
Strontium	USEPA 200.7	30 µg/L
Metals		
Zinc	USEPA 200.7	10 µg/L
Arsenic	USEPA 200.8/SM 3113B	2 µg/L
Cadmium	USEPA 200.8/SM 3113B	0.2 µg/L
Chromium	USEPA 200.8	2 µg/L
Copper	USEPA 200.8	2 µg/L
Lead	USEPA 200.8/SM 3113B	2 µg/L
Nickel	USEPA 200.8	2 µg/L
Selenium	USEPA 200.8/SM 3113B	2 µg/L

Appendix 4 – Safety Contacts and Hospital Locations

Safety:	
County Wildlife Officers:	
Central District Office	
Delaware (614) 902-4221 Fayette (614) 565-2538 Franklin (614) 902-4212 Highland (937) 205-3020	Knox (614) 400-0731 Licking (614) 400-0744 Madison (614) 309-3465 Pickaway (614) 203-3406
Northeast District Office	
Ashtabula (330) 802-9171 Columbiana (330) 245-3039 Cuyahoga (330) 245-3033 Holmes (330) 245-3045 Lake (330) 245-3034 Lorain (330) 802-9172	Mahoning (330) 245-3038 Portage (330) 245-3040 Stark (330) 245-3041 Summit (330) 245-3042 Trumbull (330) 245-3037
Northwest District Office	
Defiance (419) 429-8381 Erie (419) 429-8382 Fulton (419) 429-8383 Hancock (419) 429-8384 Lorain (330) 802-9172 Lucas (419) 429-8388	Mercer (419) 236-8787 Paulding (419) 429-8390 Putnam (419) 429-8391 Sandusky (419) 429-8393 Seneca (419) 429-8394 Williams (419) 429-8396 Wyandot (419) 429-8398
Southeast District Office	
Athens (740) 541-8266 Belmont (614) 563-1680 Coshocton (740) 502-4586 Gallia (614) 563-1843 Guernsey (614) 563-2355 Hocking (614) 257-7792	Jackson (740) 589-9986 Jefferson (330) 245-3050 Morgan (614) 563-5338 Ross (614) 565-9754 Tuscarawas (614) 230-6347 Washington (740) 412-9184
Southwest District Office	
Brown (513) 646-4014 Clark (937) 206-9321 Clermont (513) 673-1566 Greene (937) 545-6327	Hamilton (513) 446-7028 Miami (937) 470-1917 Montgomery (937) 545-6768

County Sheriff:	
Central District Office	
Delaware (740) 833-2810 Fayette (740) 335-6170 Franklin (614) 525-3360 Highland (937) 393-1421	Knox (740) 397-3333 Licking (740) 670-5555 Madison (740) 852-1332 Pickaway (740) 472-6033
Northeast District Office	
Ashtabula (440) 576-0055 Columbiana (330) 424-7255 Cuyahoga (216) 443-6000 Holmes (330) 674-1936 Lake (440) 350-5517 Lorain (440) 329-3702	Mahoning (330) 480-5030 Portage (330) 297-3682 Stark (330) 430-3800 Summit (330) 643-2122 Trumbull (330) 675-2508
Northwest District Office	
Defiance (419) 784-1155 Erie (419) 625-7951 Fulton (419) 335-4010 Hancock (419) 424-7097 Lorain (440) 329-3702 Lucas (419) 213-4941	Mercer (419) 586-7724 Paulding (419) 399-3791 Putnam (419) 523-3208 Sandusky (419) 332-2613 Seneca (419) 447-3456 Williams (419) 636-3151 Wyandot (419) 294-2362
Southeast District Office	
Athens (740) 593-6633 Belmont (740) 695-7933 Coshocton (740) 622-2411 Gallia (740) 446-1205 Guernsey (740) 439-4455 Hocking (740) 385-2131	Jackson (740) 286-6464 Jefferson (740) 283-8600 Morgan (740) 962-4044 Ross (740) 773-1186 Tuscarawas (330) 339-2000 Washington (740) 373-6623
Southwest District Office	
Brown (937) 378-4435 Clark (937) 328-2560 Clermont (513) 732-7500 Greene (937) 562-4803	Hamilton (513) 946-6400 Miami (937) 332-6835 Montgomery (937) 225-4192

Ohio Emergency Management Agency	
Central District Office	
Delaware (740) 833-2180 Fayette (740) 335-8264 Franklin (614) 794-0213 Highland (937) 393-5880	Knox (740) 393-6772 Licking (740) 522-9031 Madison (740) 852-4200 Pickaway (740) 477-1165
Northeast District Office	
Ashtabula (440) 576-9148 Columbiana (330) 424-9725 Cuyahoga (216) 443-5683 Holmes (330) 674-0989 Lake (440) 350-5499 Lorain (440) 329-5117	Mahoning (330) 740-2200 Portage (330) 297-3607 Stark (330) 451-3900 Summit (330) 643-2558 Trumbull (330) 675-6601
Northwest District Office	
Defiance (419) 782-1130 Erie (419) 627-7617 Fulton (419) 337-9207 Hancock (419) 424-7092 Lorain (440) 329-5117 Lucas (419) 213-6531	Mercer (419) 586-6468 Paulding (419) 399-3500 Putnam (419) 538-7315 Sandusky (419) 334-8933 Seneca (419) 447-0266 Williams (419) 633-5002 Wyandot (419) 294-4916
Southeast District Office	
Athens (740) 594-2261 Belmont (740) 695-5984 Coshocton (740) 622-1984 Gallia (740) 441-2036 Guernsey (740) 432-9292 Hocking (740) 270-9018	Jackson (740) 286-5630 Jefferson (740) 264-4646 Morgan (740) 962-3900 Ross (740) 773-1700 Tuscarawas (330) 308-6671 Washington (740) 373-5613
Southwest District Office	
Brown (513) 748-7788 Clark (937) 521-2176 Clermont (513) 732-7661 Greene (937) 562-5994	Hamilton (513) 263-8200 Miami (937) 332-8560 Montgomery (937) 225-4885

State Highway Patrol:	
Central District Office	
Delaware Patrol Post 1500 Columbus Pike Delaware, OH (740) 548-6011	Granville Patrol Post 3855 Outville Road SW Granville, OH (740) 927-0065
Wilmington Patrol Post 950 Rombach Avenue Wilmington, OH (937) 382-2551	West Jefferson Patrol Post 1485 West Main Street West Jefferson, OH (614) 879-7626
Columbus District Headquarters 2855 West Dublin-Granville Road Columbus, OH (614) 799-9241	Circleville Patrol Post 16395 US Route 23 Ashville, OH (740) 983-2538
Wilmington Patrol Post 950 Rombach Avenue Wilmington, OH (937) 382-2551	
Northeast District Office	
Ashtabula Patrol Post 4860 North Ridge West Ashtabula, OH (440) 969-1155	Canfield Patrol Post 500 South Broad Street Canfield, OH (330) 533-6866
Lisbon Patrol Post 9423 State Route 45 Lisbon, OH (330) 424-7783	Hiram Patrol Post P.O. Box 149 Ravenna, OH (330) 984-0532
Brookpark Facility Patrol Post 5225 West 140th Street Brookpark, OH (216) 265-1677	Canton Patrol Post 4710 Shuffel Road North Canton, OH (330) 433-6200
Chardon Patrol Post 530 Center Street Chardon, OH (440) 286-6612	Akron Patrol Post 108 Fir Hill Street Akron, Ohio (330) 535-2783

Elyria Patrol Post 38000 Cletus Drive North Ridgeville, OH (440) 365-5045	Warren Patrol Post 3424 State Route 422 Southington, OH (330) 898-2311
Northwest District Office	
Bowling Green Post 12891 Middleton Pike Bowling Green, OH (419) 352-2481	Defiance Post 2350 Baltimore Street Defiance, OH (419) 636-7711
Marion Post 2284 Marion-Upper Sandusky Road Marion, OH (740) 383-2181	Sandusky Post 511 Fremont Avenue Sandusky, OH (419) 625-6565
Southeast District Office	
Athens Patrol Post 13600 Della Drive Athens, OH (740) 593-6611	Jackson Patrol Post 10179 Chillicothe Pike Jackson, OH (740) 286-4141
St. Clairsville Patrol Post 51400 National Road St. Clairsville, OH (740) 695-0915	Steubenville Patrol Post 1377 Cadiz Road Wintersville, OH (740) 264-1641
Zanesville Patrol Post 3760 East Pike Zanesville, OH (740) 453-0541	Marietta Patrol Post 27761 State Route 7 Marietta, OH (740) 374-6616
Gallipolis Patrol Post 396 Jackson Pike Gallipolis, OH (740) 446-2433	Chillicothe Patrol Post 201 Hospital Road Chillicothe, OH (740) 775-7770
Cambridge Patrol Post 7051 Glenn Highway Road Cambridge, OH (740) 439-1388	New Philadelphia Patrol Post 2454 East High Avenue New Philadelphia, OH (330) 339-1103
Athens Patrol Post 13600 Della Drive Athens, OH	Marietta Patrol Post 27761 State Route 7 Marietta, OH

(740) 593-6611	(740) 374-6616
Southwest District Office	
Georgetown Patrol Post 9240 US 68 Georgetown, OH (937) 378-6191	Springfield Patrol Post 4201 Gateway Blvd. Springfield, OH (937) 323-9781
Batavia Patrol Post 1000 Hospital Drive Batavia, OH (513) 732-1510	Xenia Patrol Post 517 Union Road Xenia, OH (937) 372-7671
Cincinnati Metro Post 5791 Creek Road, Cincinnati, OH (513) 777-0387	Piqua Patrol Post 401 West US Route 36 Piqua, OH (937) 773-1131
Dayton Patrol Post 400 Smith Drive Clayton, OH (937) 832-4794	
Hospitals:	
Central District Office	
OhioHealth Grady Memorial Hospital 561 W. Central Avenue Delaware, OH (740) 615-1000	Knox Community Hospital 1330 Coshocton Avenue Mt. Vernon, OH (740) 393-9000
Adena Fayette Medical Center 1430 Columbus Avenue Washington Court House, OH (740) 335-1210	Licking Memorial Hospital 1320 W. Main Street Newark, OH (220) 564-4000
OhioHealth Riverside Methodist Hospital 3535 Olentangy River Road Columbus, OH (614) 566-5000	Madison Health 210 N. Main Street London, OH (740) 845-7000

Highland District Hospital 1275 N. High Street Hillsboro, OH 937-393-6100	OhioHealth Berger Hospital 600 N. Pickaway Street Circleville, OH (740) 474-2126
Northeast District Office	
Ashtabula County Medical Center 2420 Lake Avenue Ashtabula, OH (440) 997-2262	Mercy Health St. Elizabeth Youngstown Hospital 1044 Belmont Avenue Youngstown, OH (330) 746-7211
Cleveland Clinic Lutheran Hospital 1730 W. 25th Street Cleveland, OH (216) 696-4300	Aultman Hospital 2600 6th Street SW Canton, OH (330) 452-9911
Pomerene Hospital 981 Wooster Road Millersburg, OH (330) 674-1015	Summa Health System – Akron Campus 141 N. Forge Street Akron, OH (330) 375-3000
Lake Health West Medical Center 36000 Euclid Avenue Willoughby, OH (440) 953-9600	Trumbull Regional Medical Center 1350 E. Market Street Warren, OH (330) 841-9011
University Hospital 9480 Rosemont Dr Streetsboro, OH 44241 (330) 626-5566	East Liverpool City Hospital 39901 Osbourne Rd Salineville, OH 43945 (330) 385-7200
Mercy Health 3700 Kolbe Rd Lorain, OH 44053 (440) 960-4000	
Northwest District Office	
ProMedica Toledo Hospital 2142 N Cove Blvd Toledo, OH (419) 291-4000	Bryan Hospital 433 W High St Bryan, OH (419) 636-1131

ProMedica Defiance Regional Hospital 1200 Ralston Ave Defiance, OH (419) 783-6955	Mercer County Community Hospital 800 W Main St Coldwater, OH (419) 678-2341
Blanchard Valley Hospital 1900 S Main St Findlay, OH (419) 423-4500	The Bellevue Hospital 1400 W Main St Bellevue, OH (419) 483-4040
Southeast District Office	
Ohio Health O'Bleness Hospital 55 Hospital Drive Athens, OH (740) 593-5551	Genesis Hospital 2951 Maple Avenue Zanesville, OH (740) 454-5880
Coshocton Regional Medical Center 1460 Orange Street Coshocton, OH (740) 622-6411	Adena Regional Medical Center 272 Hospital Road Chillicothe, OH (740) 779-7500
Holzer Emergency Medical Center 100 Jackson Pike Gallipolis, OH (855) 446-5937	WVU Medicine Barnesville Hospital 639 W Main St Barnsville, OH 43713 (740) 425-3941
Southeastern Ohio Regional Medical Center 1341 Clark Street Cambridge, OH (740) 439-8000	Marietta Memorial Hospital 401 Matthew Street Marietta, OH (740) 374-1400
Hocking Valley Community Hospital 601 State Route 664 N Logan, OH (740) 380-8000	Coshocton Regional Medical Center Arrowhead Clinic 6307 E State Rd, Newcomerstown, OH (740)498-5515
Southwest District Office	
Brown County General Hospital 425 Home St. Georgetown, Ohio (937)378-7500	TriHealth Bethesda North Hospital 10500 Montgomery Road Cincinnati, OH (513) 865-1111

Springfield Regional Medical Center 100 Medical Center Drive Springfield, OH (937) 523-1000	Upper Valley Medical Center 3130 N. County Road 25A Troy, OH (937) 440-4000
Mercy Health Clermont Hospital 3000 Hospital Drive Batavia, OH (513) 732-8200	Miami Valley Hospital 1 Wyoming Street Dayton, OH (937) 208-8000
Greene Memorial Hospital 1141 N. Monroe Drive Xenia, OH (937) 352-2000	

References & Resources

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 1987. *Biological Criteria for the Protection of Aquatic Life: Volume I: The Role of Biological Data in Water Quality Assessment*. Published at: ***https://epa.ohio.gov/divisions-and-offices/surface-water/reports-data/biological-criteria-for-the-protection-of-aquatic-life***

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 2006. *2006 Updates to Biological Criteria for the Protection of Aquatic Life: Volume II and Volume II Addendum: Users Manual for Biological Field Assessment of Ohio Surface Waters*. Published at:

https://epa.ohio.gov/divisions-and-offices/surface-water/reports-data/biological-criteria-for-the-protection-of-aquatic-life

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 2015. *Biological Criteria for the Protection of Aquatic Life: Volume III. Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities.* Published at: ***https://epa.ohio.gov/divisions-and-offices/surface-water/reports-data/biological-criteria-for-the-protection-of-aquatic-life***

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 2021. *Fish Tissue Collection Manual*. Published at: ***https://epa.ohio.gov/divisions-and-offices/surface-water/reports-data/biological-criteria-for-the-protection-of-aquatic-life***

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 2006. *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)*. Published at: ***https://epa.ohio.gov/divisions-and-offices/surface-water/reports-data/biological-criteria-for-the-protection-of-aquatic-life***

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 2023. *Surface Water Field Sampling Manual: for Water Quality Parameters and Flows, Version 9.0*. Published at: ***https://epa.ohio.gov/divisions-and-offices/surface-water/reports-data/technical-bulletins***

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 2023c. *Surface Water Field Sampling Manual - Appendix II: for Water Quality Parameters and Flows, Version 9.0*. Published at: ***https://epa.ohio.gov/divisions-and-offices/surface-water/reports-data/technical-bulletins***

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 2023d. *Surface Water Field Sampling Manual - Appendix III: Sediment Sampling*. Published at: ***https://epa.ohio.gov/divisions-and-offices/surface-water/reports-data/technical-bulletins***

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 2023e. *Surface Water Field Sampling Manual - Appendix IV: Data Management*. Published at: ***https://epa.ohio.gov/divisions-and-offices/surface-water/reports-data/technical-bulletins***

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 2023f. *Surface Water Field Sampling Manual - Appendix I: Inland Lakes Sampling Procedure Manual*. Published at: ***https://epa.ohio.gov/divisions-and-offices/surface-water/reports-data/technical-bulletins***

Omernik, J.M. 1987. Ecoregions of the Conterminous United States. Ann. Assoc. Amer. Geogr. 77(1): 118-125.

Omernik, J.M. and A.L. Gallant, 1988. Ecoregions of the upper Midwest states. EPA/600/3-88/037. U. S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Oregon. 56 pp.

Rankin, E.T. 1989. *The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application.* Division of Water Quality Planning and Assessment, Columbus, Ohio.

Rankin E.T., 1995. *Habitat Indices in Water Resource Quality Assessments, Davis W.S., T.P. Simon (Eds.), Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*. Lewis Press, Boca Raton, FL (1995), pp. 181-208.

US EPA (Environmental Protection Agency – Office of Water). 2022. *Metals CRADA Phase 1 Report*. https://www.epa.gov/wqc/metals-crada-phase-1-report