UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
GREAT LAKES NATIONAL PROGRAM OFFICE
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

Ms. Joy Mulinex
Executive Director
Ohio Lake Erie Commission
P. O. Box 1049
Columbus, Ohio 43216

Dear Ms. Mulinex:

Thank you for your April 8, 2021 request to remove the *Eutrophication or Undesirable Algae* Beneficial Use Impairment (BUI) at the Cuyahoga River Area of Concern (AOC). As you know, we share your desire to restore all the Great Lakes AOCs and to formally delist them. Based upon a review of your submittal and supporting data, the U.S. Environmental Protection Agency (EPA) hereby approves your request to remove this BUI from the Cuyahoga River AOC. EPA will notify the International Joint Commission of this significant positive environmental change at this AOC.

We congratulate you and your staff as well as the many federal, state, and local partners who have been instrumental in achieving this environmental improvement. Removal of this BUI will benefit not only the people who live and work in the AOC, but all the residents of Ohio and the Great Lakes basin as well.

We look forward to the continuation of this productive relationship with your agency, the Ohio Environmental Protection Agency, and the Cuyahoga River AOC Advisory Committee as we work together to delist this AOC in the years to come. If you have any further questions, please contact me at (312) 353-8320 or your staff can contact Leah Medley at (312) 886-1307.

Sincerely,

Chris Korleski, Director
Great Lakes National Program Office

cc: Tiffani Kavalec, OEPA
Lynn Garrity, OLEC
Raj Bejankiwar, IJC

Ohio Lake Erie Commission

Mike DeWine, *Governor*
Jon Husted, *Lt. Governor*
Joy Mulinex, *Executive Director*
Laurie A. Stevenson, *Director, Ohio EPA; Chairwoman*

April 8, 2021

Chris Korleski, Director
U.S. Environmental Protection Agency
Great Lakes National Program Office
77 W. Jackson Boulevard (G-17J)
Chicago, IL 60604-3511

RE: Cuyahoga River Area of Concern Eutrophication or Undesirable Algae Beneficial Use Impairment Removal Action

Dear Director Korleski,

The State of Ohio, through the Ohio Lake Erie Commission, Ohio EPA and many partners, have worked towards the restoration of the beneficial use impairments identified for the Cuyahoga River Area of Concern (AOC).

As a result of the partnerships and progress made over the past two decades, the Ohio Area of Concern program is submitting its BUI removal recommendation for Eutrophication or Undesirable Algae in the Cuyahoga River AOC. In partnership with Ohio EPA and with the support of the Cuyahoga River AOC Advisory Committee, I request concurrence with the enclosed recommendation to remove the Eutrophication or Undesirable Algae BUI in the Cuyahoga River AOC.

The Cuyahoga River continues to improve and has been a part of ongoing community revitalization which has produced remarkable results. The improvements in the Cuyahoga River AOC are the result of many efforts by local stakeholders and organizations as well as the state and federal AOC programs. I appreciate the hard work and dedication from all the participants and look forward to continuing work with U.S. EPA and the local AOC Advisory Committee to continue restoration progress in the Cuyahoga River Area of Concern.

Sincerely,

Joy Mulinex
Director, Ohio Lake Erie Commission

Enclosure
cc: Tiffani Kavalec, OEPA-DSW
Lynn Garrity, OLEC
Leah Medley, USEPA-GLNPO

Removal Recommendation for the Eutrophication or Undesirable Algae Beneficial Use Impairment in the Cuyahoga River Area of Concern

April 2021

Ohio Environmental Protection Agency

Ohio Lake Erie Commission

CUYAHOGA RIVER AOC
AREA OF CONCERN

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Purpose

The purpose of this document is to recommend the removal of the Eutrophication or Undesirable Algae beneficial use impairment from the Cuyahoga River Area of Concern (AOC) by demonstrating that applicable restoration targets are being met.

Background

The Cuyahoga River lies in northeast Ohio, flowing into Lake Erie's central basin at the City of Cleveland. Its drainage basin covers an area of 813 square miles (Ohio EPA 2004). For more than 100 years, the lower Cuyahoga River received discharges from many treatment systems (from both municipal and industrial facilities), sewer overflows and storm water runoff. The river had become so severely degraded with loose debris, oil, municipal and industrial wastes that it ignited several times. The last fire, which occurred in 1969, helped spark the first Earth Day Celebration and formation of the U.S. EPA, both in 1970, and galvanized support for the 1972 Clean Water Act.

The lower Cuyahoga River to the mouth at Lake Erie, a few neighboring Lake Erie tributary systems, and the associated Lake Erie shoreline (Figures 1 and 2) had become degraded that these areas were subsequently designated as a Great Lakes Area of Concern (AOC) in 1987 under the Great Lakes Water Quality Agreement (GLWQA). The GLWQA is a commitment between the U.S. and Canada to restore and protect the waters of the Great Lakes. In 2010, the AOC Boundary Expansion Request approved by USEPA (USEPA 2010) expanded the upper boundary of the Cuyahoga River AOC to River Mile 45.5 to include the Gorge Dam pool in the Fish Creek Hydrologic Unit Code (HUC).

Nine of the fourteen possible impaired beneficial uses were listed as impaired in the Cuyahoga River AOC in the Stage 1 Report. A locally driven beneficial use impairment (BUI), Recreational Access, was removed in 2018. Seven BUIs remain classified as impaired in the Cuyahoga River AOC.

- #1 Restrictions on Fish Consumption REMOVED 2019
- #10b Recreational Access REMOVED 2018
- #11 Degradation of Aesthetics REMOVED 2018

Remaining Impaired BUIs

- #3 Degradation of Fish Populations
- #4 Fish Tumors and other Deformities
- #6 Degradation of Benthos
- #7 Restrictions of Navigational Dredging Activities
- #8 Eutrophication or Undesirable Algae
- #10 Recreational Use (Beach Closings)
- #14 Loss of Fish Habitat

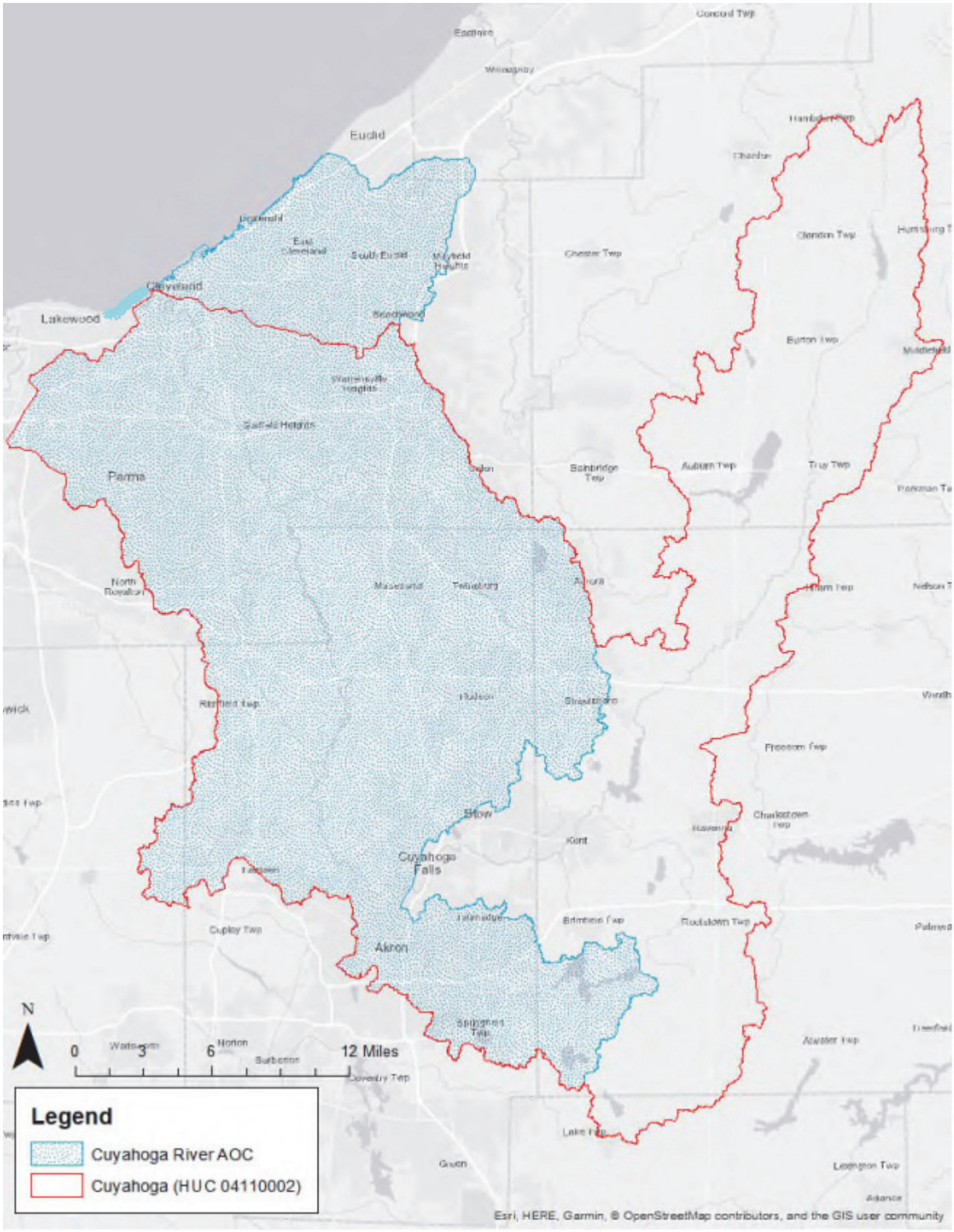


Figure 1. The Cuyahoga River AOC and the Cuyahoga River watershed

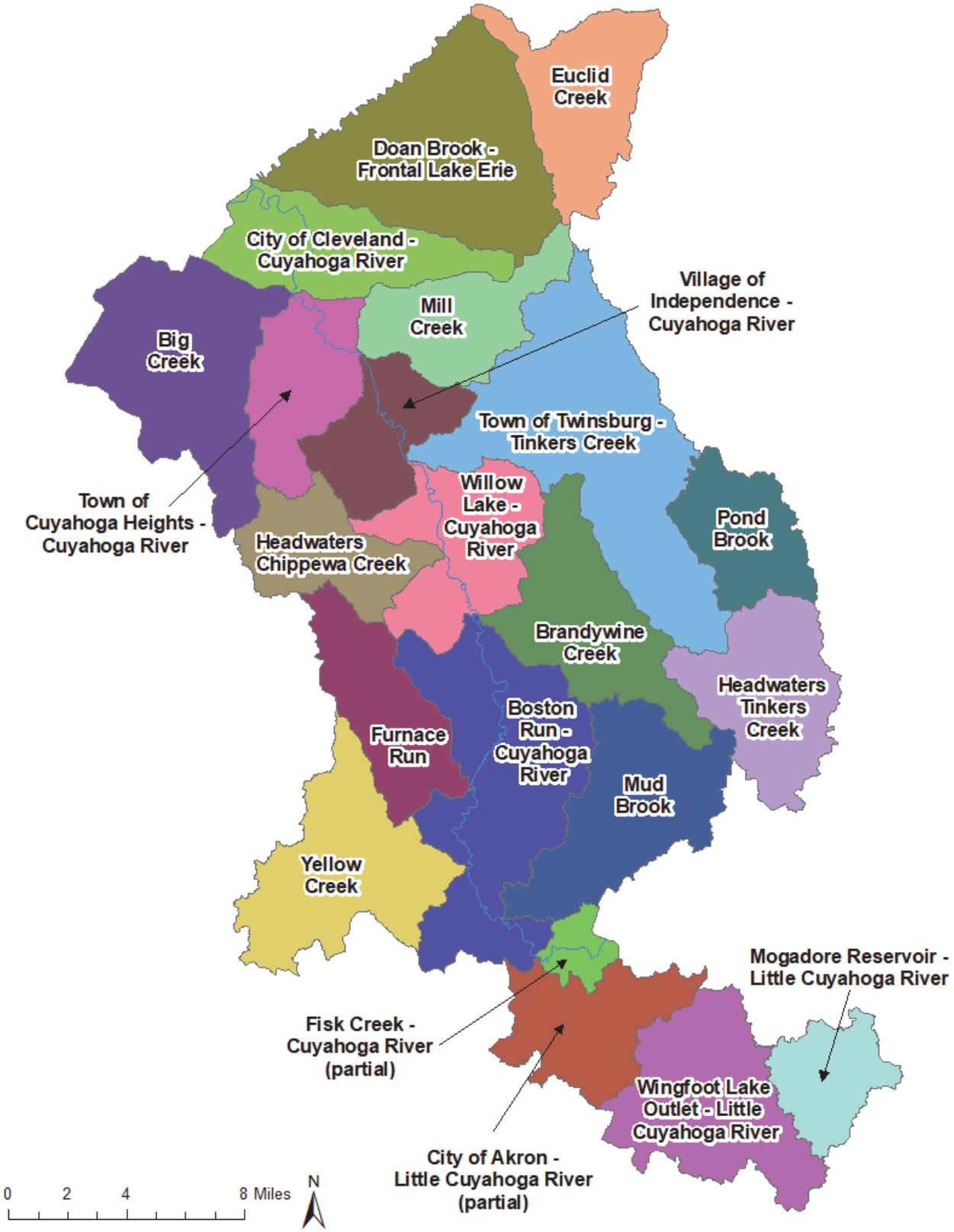


Figure 2. Cuyahoga AOC Hydrologic Units

The Eutrophication or Undesirable Algae BUI

The Eutrophication or Undesirable Algae beneficial use impairment is defined by persistent impairment of water quality relative to two conditions: low dissolved oxygen and nuisance growths of aquatic weeds or algae as a result of human activity. Problems with aquatic weeds or nuisance algae are components of this BUI if the problems are persistent and impact the public use of the water resource. Eutrophication typically occurs in warm, nutrient-enriched waters that are stagnant or under low flow conditions. Under these conditions, nuisance algal growth and other oxygen demanding substances can consume a substantial amount of oxygen, creating a hypoxic environment for other aquatic life. Oxygen concentrations set forth in Ohio's statewide Water Quality Standards (WQS) (https://epa.ohio.gov/Portals/35/rules/01-all.pdf) for protection of aquatic life and to prevent problems with aquatic weeds or nuisance algae are the basis for the targets used for removal of the eutrophication component of this BUI.

History of Eutrophication or Undesirable Algae BUI in the Cuyahoga River AOC

The Cuyahoga River Remedial Action Plan Coordinating Committee (CRCC) developed the Stage 1 report in 1992 and the Stage 2 report in 2012. Cuyahoga River Restoration (CRR) developed a draft update of the Stage 2 report in 2015. With regards to the *eutrophication or undesirable algae BUI*,

- The **Stage 1 Remedial Action Plan (RAP)** report found impairment in the nearshore area (of Lake Erie), while *possible* impairment was identified in the navigation channel (CRCC 1992). Impairment upstream of the Navigation Channel was declared as *unknown*.

- The **Stage 2 RAP** report concluded that the nearshore area of Lake Erie was impaired due to "nutrient inputs from CSOs and other sources" (CRCC 2012). The recommended management actions were the development and implementation of long-term control plans to address combined sewer overflows (CSOs) in the Northeast Ohio Regional Sewer District (NEORSD) and City of Akron.

- The **Stage 2 RAP Update** draft report described the status of the *Eutrophication or Undesirable Algae BUI* as "All of the subwatersheds have been verified as having no persistent nuisance growth of algae. Recent [outside mixing zone average] measurements are being collected in the federal designated ship channel." (CAC 2015).

Together, the Stage 1 and Stage 2 RAP reports indicated that elevated nutrient concentrations were detected in the nearshore Lake Erie, but the reports did not evaluate tributaries in the Cuyahoga River AOC. According to the Stage 1 Report, the nearshore is defined as the "10 miles of the Lake Erie shoreline, from Edgewater Beach on the west side of Cleveland to Wildwood Park roughly 9 miles to the east." The nearshore/shoreline areas are not evaluated under this BUI, but will be evaluated under BUI #10, Recreational Use (Beach Closings). Additional data indicate observations of isolated algal blooms in a few lakes and reservoirs; however, no persistent nuisance algae have been documented in the AOC.

Impairment Listing Criteria

The original listing guideline, used in the Cuyahoga River AOC Stage 1 Report, stated that the Eutrophication or Undesirable Algae beneficial use will be listed as impaired "when there are persistent water quality problems (e.g., dissolved oxygen depletion of bottom waters, nuisance algal blooms or accumulation, decreased water clarity, etc.) attributed to cultural eutrophication." The current State of Ohio AOC guidance document states that this beneficial use will be listed as impaired if:

- Dissolved oxygen levels do not meet minimum criteria established in Ohio Water Quality Standards, WQS, for the stream segment of concern, and the cause is due to excessive nutrient loading or excessive levels of oxygen demanding substances;

  AND/OR

- Nutrients entering the waters as a result of human activity create nuisance growths of aquatic weeds or algae.

The statewide water quality criteria for dissolved oxygen can be seen in Table 1. For the eutrophication component removal target for dissolved oxygen in AOC lacustrine waters, the seasonal average dissolved oxygen value within an assessment unit must meet the Outside Mixing Zone Average (OMZA) value.

The statewide water quality criteria for dissolved oxygen can be seen in Table 1. For the eutrophication component of the BUI restoration target for dissolved oxygen in AOC lacustrine waters, the seasonal average dissolved oxygen value within an assessment unit must meet the Outside Mixing Zone Average (OMZA) value.

Table 1. Dissolved Oxygen AOC Restoration Targets

Dissolved Oxygen Restoration Targets	
Designated Use	**OMZA[1] (mg/L)**
EWH	6.0
WWH	5.0
MWH	4.0
LRW	3.0
Federally Designated Shipping Channels	NA

[1] *OMZA = outside mixing zone average defined as the minimum twenty-four-hour average.*
EWH: Exceptional Warmwater Habitat
WWH: Warmwater Habitat
MWH: Modified Warmwater Habitat
LRW: Limited Resource Water

As shown in Table 1, under the AOC Delisting Guidance restoration target, no dissolved oxygen target is applicable in a federally designated shipping channel. Thus, the lacustrine dissolved oxygen targets only apply in the lacustuary section upstream of the federally designated ship channels. The Cuyahoga River lacustuary extends upstream about 7.65 river miles, while the federally designated shipping channel is composed of the lower 5.6 miles of the Cuyahoga River and the Old Channel. According to the Ohio Administrative Code Chapter 3745-1-26, the Cuyahoga River is designated warmwater habitat from river mile 5.6 upstream to Lake Rockwell (river mile 62.0). Therefore, the lacustrine BUI target only applies to the Cuyahoga River lacustuary from river mile 5.6 upstream to river mile 7.65; the warmwater habitat BUI restoration target is applicable to this segment.

Eutrophication and undesirable algae impairments due to nutrient loading originating from outside the AOC will not be considered a source of impairment for BUI #8. Nutrient loading from such sources is addressed by other programs.

Ohio's BUI restoration targets for both riverine and lacustrine segments also address the persistent, nuisance growth of algae. The Delisting Guidance and Restoration Targets for Ohio Areas of Concern (Ohio EPA 2020) use the terms persistent and nuisance in the State of Ohio restoration targets for the Eutrophication or Undesirable Algae BUI. For the purpose of this BUI removal document, we have defined these terms as follows:

Persistent: existing for a long or longer than usual time or continuously. While “persistent” algal growth can be a sign of human-induced eutrophication, algal blooms also occur naturally in Northeastern Ohio streams in the summer months. Because many variables affect the length of algal blooms – such as drought, water depth, and stream gradient – a general numerical value for a “usual” algal bloom residence time cannot be defined across the AOC.

Nuisance: one that is annoying, unpleasant, or obnoxious. “Nuisance” algae will be defined as algae growth and/or blooms that cause negative cultural perception or cause direct harm to aquatic life.

Algal growth that meets all three of the criteria below will be considered impairments.

- Growth is persistent and lasts for a longer than expected time.
- Growth is a nuisance and causes a negative cultural perception.
- Growth is a result of nutrient enrichment from sources within the AOC.

Several public uses are addressed by other BUIs. Thus, nuisance algal growth that affects certain public uses is addressed under different BUIs. Nuisance algal growth that affects public drinking water supplies is addressed under the *Restrictions on Drinking Water Consumption or Taste and Odor Problems* Harmful algal blooms that affect public beaches are addressed under *Beach Closings (Recreational Use)*

Dissolved Oxygen in the Cuyahoga River Lacustuary

Ohio EPA, the Northeast Ohio Regional Sewer District (NEORSD), and the Ohio Department of Natural Resources (ODNR) collected dissolved oxygen data from the Cuyahoga River lacustuary from 2009-2018. The lacustuary area in the Cuyahoga River is located between river mile 7.1 to the mouth of the river. Monitoring locations are shown in Figure 2. By rule, data collected by Ohio EPA and ODNR are credible. NEORSD water quality data were collected by level 3 qualified data collectors under level 3 study plans that were approved by Ohio EPA.

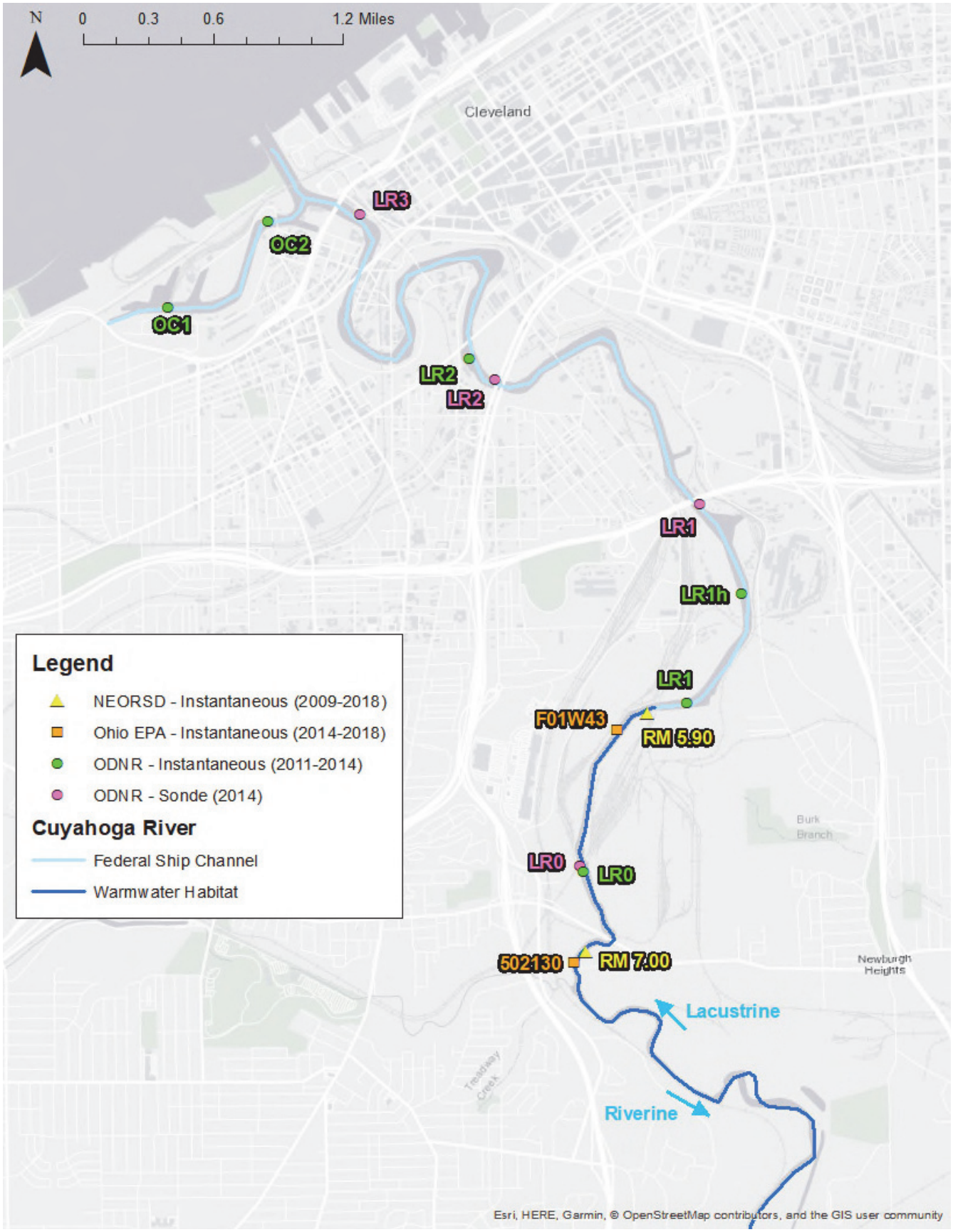


Figure 3. Dissolved oxygen monitoring stations in the Cuyahoga River lacustuary

NEORSD Monitoring (2009-2018)

NEORSD monitors locations throughout their service area for multiple purposes (e.g., stormwater management, permit compliance). NEORSD monitored dissolved oxygen at two locations in the Cuyahoga River lacustuary upstream of the federal designated shipping channel: river miles 5.90 and 7.00; these data are presented in Figures 3 and 4 below (data table in Appendix A). Instantaneous dissolved oxygen concentrations ranged from 6.1 to 13.4 mg/L.

Figure 4. NEORSD DO Monitoring 2009-2018 at River Mile 5.90. Red underlined segments indicate no data collected during these periods.

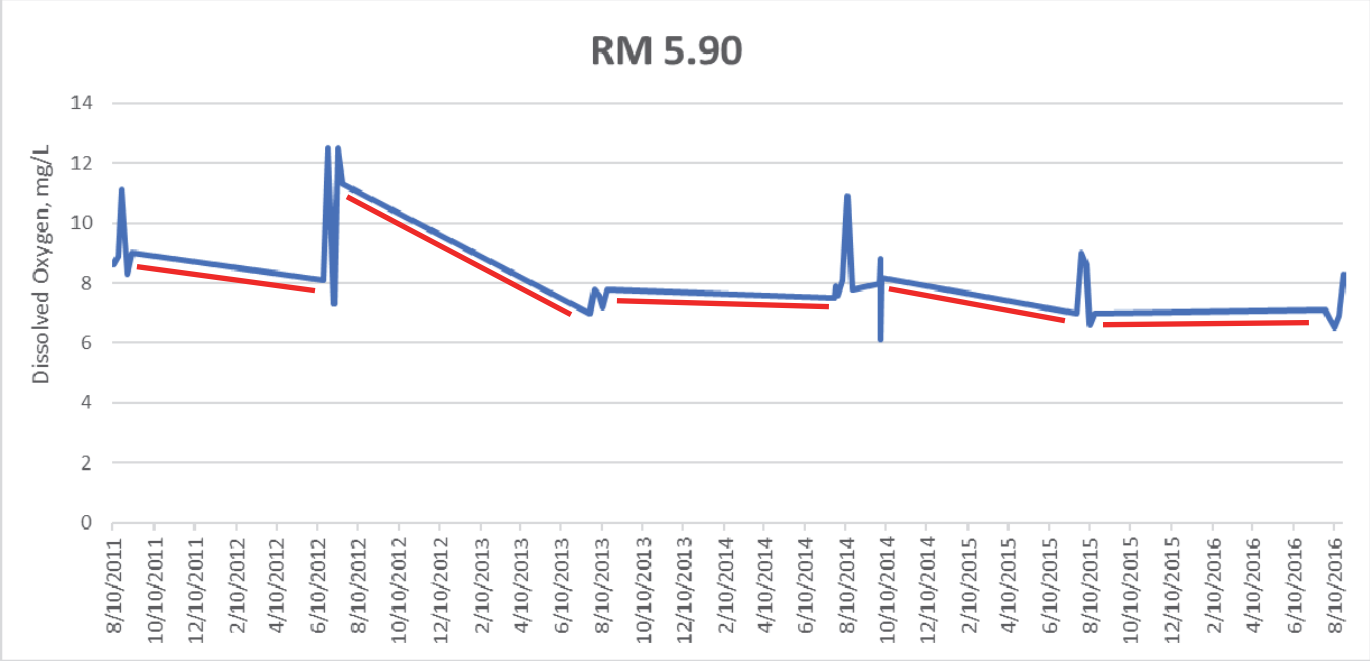
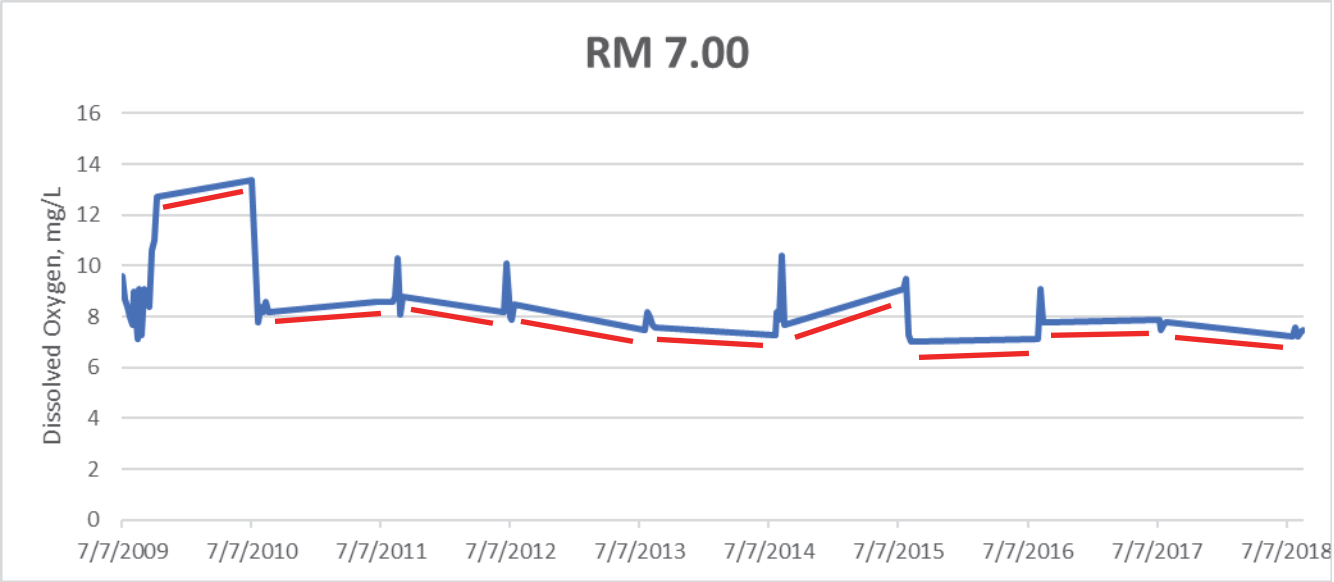


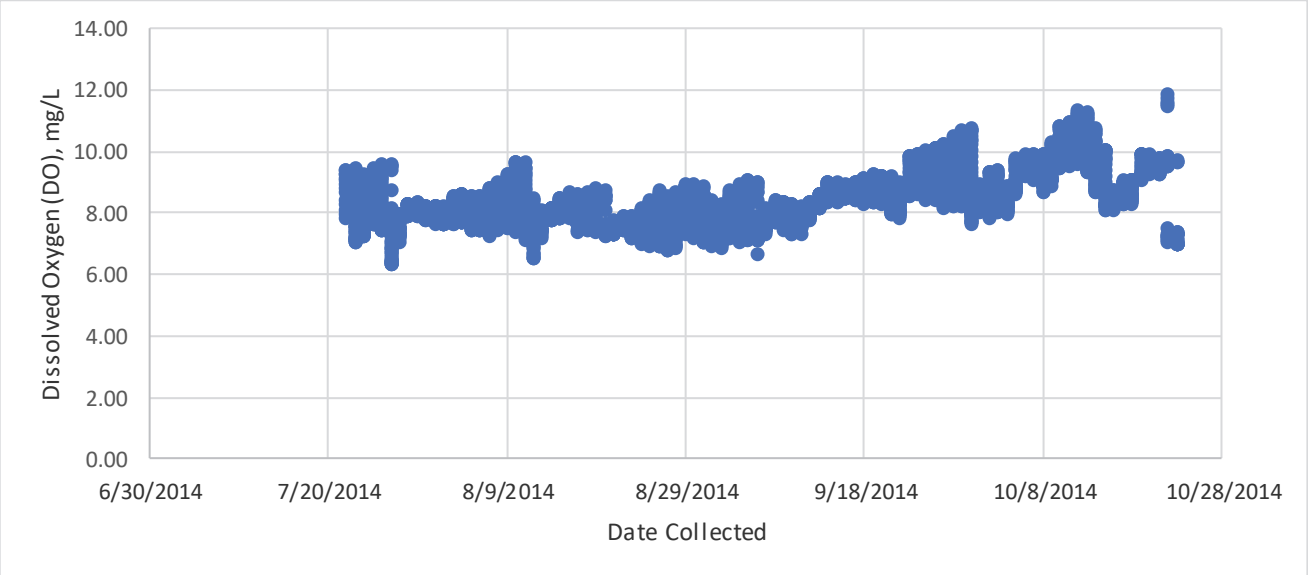
Figure 5. NEORSD DO Monitoring 2009-2018 at River Mile 7.00. Red underlined segments indicate no data collected during these periods.



ODNR Monitoring (2011-2015)

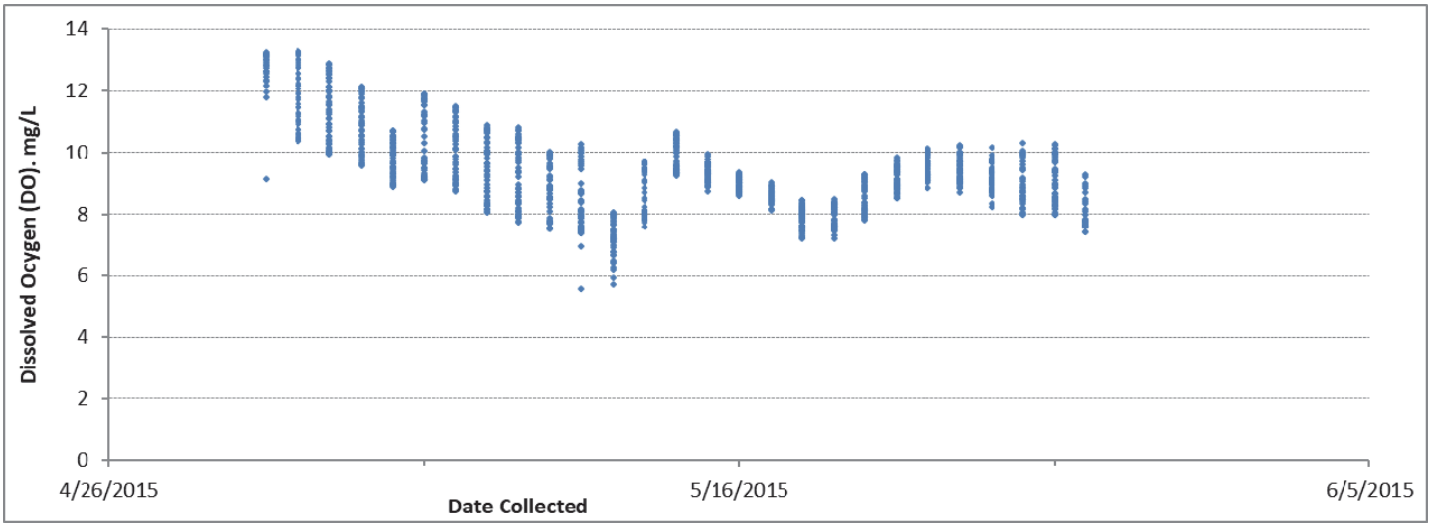
The Great Lakes Restoration Initiative funded the *Cuyahoga AOC Habitat and Fish Restoration Opportunities* project to evaluate water quality, fish habitat, and biota in the Cuyahoga River and Cleveland Harbor to set baseline conditions and evaluate existing and potential habitat and fish restoration activities. Water quality monitoring occurred from 2011 through 2014. During this time, dissolved oxygen monitoring occurred, including deployment of automated data loggers (commonly referred to as sondes) in 2014 and 2015. Sondes that continuously recorded dissolved oxygen were deployed at four sites in the Cuyahoga River lacustuary (LR0, LR1, LR2, and LR3). Note that site LR0 is upstream of the federal designated ship channel and the only site in the lacustuary. Sites LR1-LR3 are in the nonfederal designated ship channel of the mainstem, where the DO criteria are not applicable. The sonde data at site LR0 show that dissolved oxygen concentrations ranged from 6.30 to 11.85 mg/L from July 22 through October 22, 2014. The seasonal average was 8.40 mg/L.

Figure 6. Continuously recorded Dissolved Oxygen from data sonde from July 22 through October 22, 2014 at Station LR0 (See Figure 3 for location of Station LR0)



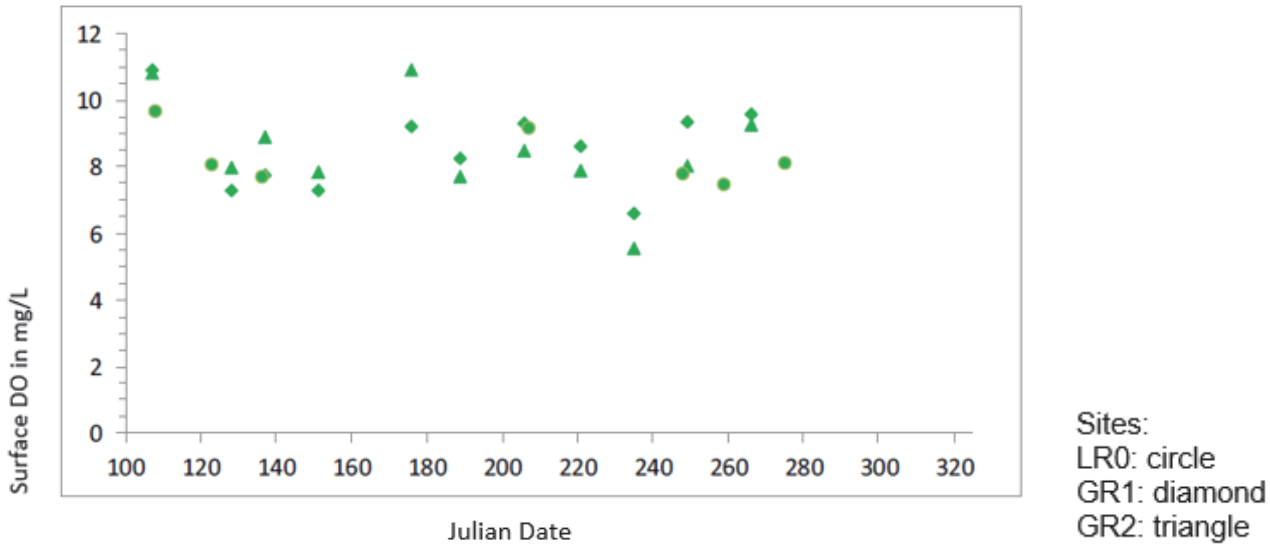
The sonde data at site LR0 show that dissolved oxygen concentrations ranged from 5.57 to 13.28 mg/L from May 1 through May 27, 2015. The seasonal average was 9.33 mg/L.

Figure 7. Continuously recorded Dissolved Oxygen from data sonde from May 1 through May 27, 2015 at Station LR0 (See Figure 3 for location of Station LR0)



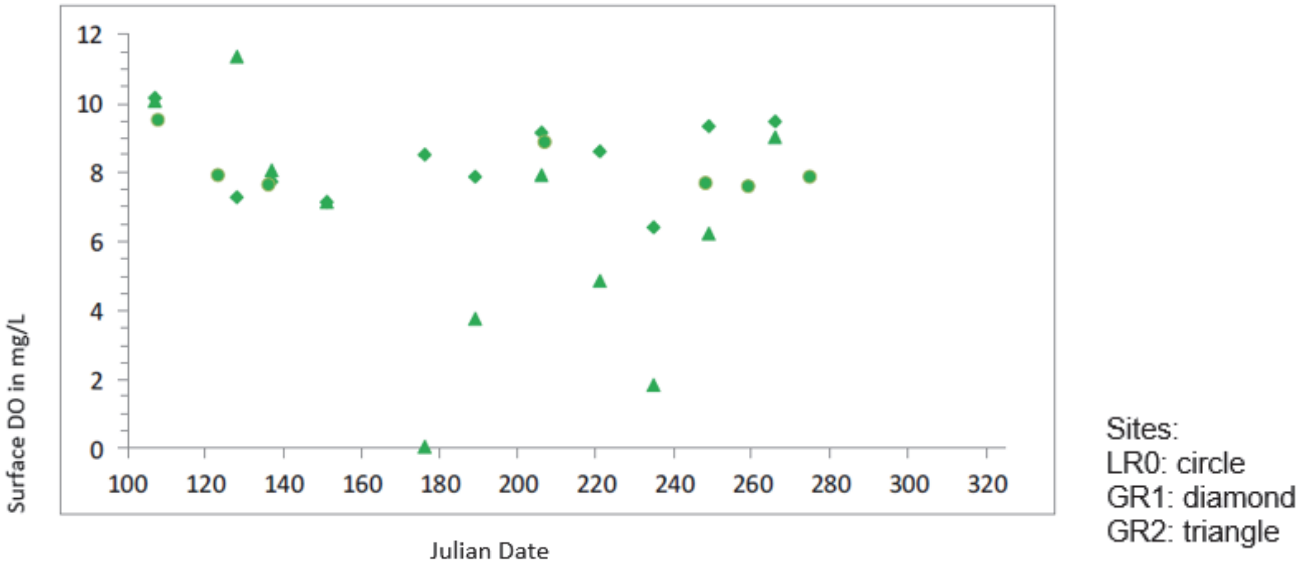
Instantaneous dissolved oxygen concentrations were collected both at the surface and in the bottom waters in 2011 thorough 2014. *The only lacustrine site upstream of the federal designated ship channel with instantaneous measurements of dissolved oxygen was site LR0*; this site was only monitored in 2013. Both surficial and bottom water dissolved oxygen concentrations ranged from 7 to 10 mg/L.

Figure 8. Instantaneous dissolved oxygen (DO) concentrations from 2013 at Station LR0 (circle) surface. Sites GR1 and GR2 are reference sites in the Grand River.



Julian Date reference: 100: Apr 10, 150: May 30
200: Jul 19, 250: Sep 7, 300: Oct 27

Figure 9. Instantaneous dissolved oxygen concentrations 2013 at Station LR0 (circle) bottom. Sites GR1 and GR2 are reference sites in the Grand River.



Julian Date reference: 100: Apr 10, 150: May 30
200: Jul 19, 250: Sep 7, 300: Oct 27

Ohio EPA Monitoring (2015-2018)

Ohio EPA sampled two monitoring sites within the Cuyahoga River lacustuary upstream of the federal designated ship channel:

- **F01W43**: Cuyahoga River at LTV footbridge (river mile 5.9)
- **502130**: Cuyahoga River at Lower Harvard Avenue (river mile 7.1)

Four samples were collected at site F01W43, and 13 samples were collected at site 502130 (See Figure 1 for sampling location). Instantaneous dissolved oxygen concentrations ranged from 5.35 to 13.50 mg/L. Both monitoring sites were sampled as part of the 2017 Cuyahoga River mainstem survey. Site 502130 was also sampled quarterly as part of Ohio's ambient monitoring program (site 502130 is a sentinel site).

Table 2. Ohio EPA lacustuary dissolved oxygen monitoring (2015-2018)

Date	F01W43 (RM 5.9) Dissolved oxygen (mg/L)	502130 (RM 7.1) Dissolved oxygen (mg/L)
6/15/2015	--	7.94
9/29/2015	--	7.23
6/20/2016	--	7.20
9/26/2016	--	7.73
5/17/2017	--	8.60
6/13/2017	5.35	7.20
7/12/2017	--	6.90
7/20/2017	5.51	6.24
8/7/2017	7.86	11.56
8/22/2017	13.17	13.50
6/4/2018	--	7.84
10/2/2018	--	9.07

Source: Ohio EPA 2019.

Note: Instantaneous dissolved oxygen monitoring from May through October in the Cuyahoga River lacustuary upstream of the federal shipping channel.

Summary of Findings of DO of data evaluation

As shown in the previous sections, the dissolved oxygen concentrations in the Cuyahoga River lacustuary upstream of the federal designated ship channel are greater than 5 milligrams per liter (mg/L) and achieve the lacustrine BUI restoration target of 5.0 mg/L for warmwater habitat. (See Table 3 below for representative data)

Table 3. Ohio EPA and NEORSD lacustuary instantaneous dissolved oxygen monitoring (2009-2018)

River mile	Monitoring site	Year	No. of instantaneous records	Seasonal average dissolved oxygen (mg/L)
5.9	RM 5.90	2011	5	9.2
		2012	5	10.3
		2013	5	7.5
		2014	10	8.1
		2015	5	7.6
		2016	5	7.1
5.9	F01W43	2017	4	8.0
7.0	RM 7.00	2009	16	9.3
		2010	6	9.1
		2011	7	8.8
		2012	5	8.5
		2013	5	7.8
		2014	5	8.3
		2015	5	8.0
		2016	5	7.8
		2017	5	7.7
		2018	5	7.4
7.1	502130	2015	2	7.6
		2016	2	7.5
		2017	6	9.0
		2018	2	8.5
All samples collected from 2009 through 2018			**115**	**8.4**

Note: Arithmetic means of instantaneous dissolved oxygen concentrations from monitoring during May through October in the Cuyahoga River lacustuary upstream of the federal shipping channel.

Nuisance Algae in the Cuyahoga AOC

Public entities regularly conduct surveys and monitor waterbodies in the Cuyahoga River AOC. In 2020, a survey was distributed by Ohio EPA to 31 public, private and community agencies and organizations who may have conducted work within the AOC in the past three years to determine the presence of nuisance algal growth within the AOC. The Ohio AOC Program received 13 completed surveys (survey results in Appendix B). Overall, 12 of the 13 surveys reported positive results of no persistent or nuisance algal blooms, only a few intermittent small blooms within the past 3 years. The only blooms regularly observed were by the City of Akron Water Supply on Mogadore Reservoir, which will be discussed in a later section.

Summary of Eutrophication Indicator Assessment and BUI Restoration Target

Ohio EPA Division of Surface Water Standards and Technical Support Section used five water chemistry parameters and chlorophyll to support an evaluation of the eutrophication status in the Cuyahoga AOC. The analysis took into consideration similar parameters to those used in the Stream Nutrient Assessment (SNAP) (Ohio EPA, 2015) metric proposed to measure eutrophication in large river systems of Ohio. Dissolved oxygen, pH, dissolved inorganic nitrogen (DIN), total phosphorus, benthic chlorophyll and total Kjeldahl nitrogen (TKN) were analyzed in each HUC 12 and the Large River Assessment Unit (LRAU) and compared against a eutrophication threshold. Data from the Ohio EPA 2017-2018 watershed survey was used in this assessment. A key to the HUC names is provided in Appendix C.

Out of the 21 Hydrological Units evaluated, 19 of them met the eutrophication threshold for each of the six parameters. The graphs and data for the evaluation are in Appendix C. The two HUCs that exceeded the thresholds and show signs of algae issues are Mogadore Reservoir and Tinkers Creek which are discussed below. Overall, the data evaluation supports that the Cuyahoga River AOC overall does not have a nuisance algae problem within the AOC program restoration targets.

Table 4. Eutrophication indicators arranged by 12-digit HUC for sites sampled in the Cuyahoga River Area of Concern. Values listed for DIN, TP, TKN, pH, and D.O. saturation are the percent of observations (n) exceeding the corresponding referenced cutoffs. Values for benthic chlorophyll are numbers of observations.

		Nutrients[1]		Organic and Trophic Stress[2]		Nuisance Indication[3]		Stress from Eutrophication[4]		
HUC NAME	HUC	DIN	TP	TKN		Benthic Chlorophyll		pH	D.O. Saturation	
		>3.6 mg/l	>0.13 mg/l	>1.0 mg/l	n	>320 mg/m2	n	>8.5	>150%	n
Mogadore Res-Little Cuyahoga River	04110002-03-02	0	60	100	5	0	2	0	0	5
Wingfoot Lake-Little Cuyahoga	04110002-03-03	0	0	19.5	41			0	0	42
Akron-Little Cuyahoga	04110002-03-04	0	5.5	3.6	55	0	10	0	0	58
Fish Creek-Cuyahoga	04110002-03-05	3	9.5	7.9	305	0	3	0.3	0.7	293
Mud Brook	04110002-04-01	0	10.5	57.9	19	0	4	0	0	19
Yellow Creek	04110002-04-02	0	0	9.1	33	0	8	2.9	0	35
Furnace Run	04110002-04-03	0	3.2	0	31	0	2	0	0	31
Brandywine Creek	04110002-04-04	0	0	55.6	18			0	0	18
Boston Run-Cuyahoga	04110002-04-05	9.1	10.9	10.9	110	0	18	0.9	0.9	110
Pond Brook	04110002-05-01	19.6	39.3	44.6	56			0	0	70
Tinkers Headwaters	04110002-05-02	11.9	4.8	26.2	42			16.7	0	46
Chippewa Headwaters	04110002-05-03	0	0	0	16	0	2	0	0	16
Twinsburg-Tinkers	04110002-05-04	35.7	24.3	43.3	263	2	12	9.6	3.7	300
Willow Lake-Cuyahoga	04110002-05-05	34.4	18.8	9.4	32	0	22	0	0	31
Mill Creek	04110002-06-01	0	17.9	28.2	39	0	4	0	0	37
Independence-Cuyahoga	04110002-06-02	22	33.9	23.7	59	0	18	1.7	3.3	60

[1] The percentages are based on all individual observations within the HUC, not geometric means from individual sampling locations.

[2] TKN is an overall indicator of organic and nutrient enrichment. TKN can reflect exogenous inputs of organic matter, endogenous sources from either autotrophic or heterotrophic pathways, and refractory nitrogen in treated effluent.

[3] The 320 mg/m2 threshold indicating nuisance conditions in Ohio.

[4] pH and dissolved oxygen percent saturation indicate the potential stress imparted on a system due to over-enrichment from eutrophication. The co-occurrence of high benthic chlorophyll levels along with relatively frequent observations of elevated pH and dissolved oxygen supersaturation in the Twinsburg-Tinkers HUC evidence unacceptable conditions due to nutrient over-enrichment.

		Nutrients[1]		Organic and Trophic Stress[2]		Nuisance Indication[3]		Stress from Eutrophication[4]		
HUC NAME	HUC	DIN	TP	TKN		Benthic Chlorophyll		pH	D.O. Saturation	
		>3.6 mg/l	>0.13 mg/l	>1.0 mg/l	n	>320 mg/m2	n	>8.5	>150%	n
Big Creek	04110002-06-03	1.8	10.5	5.3	57	0	8	6.4	0	51
Cuyahoga Heights-Cuyahoga	04110002-06-04	30.3	34.2	19.7	76	0	2	6.9	2.9	69
Cleveland-Cuyahoga	04110002-06-05	59.7	42	26.9	119	0	6	0.9	3.2	93
Euclid Creek	04110003-05-03	0	2.9	1.5	68	0	11	9.4	1.2	84
Doan Brook	04110003-05-04	0	44.8	10.3	29	0	6	0	0	44

Mogadore Reservoir (HUC 04110002-03-02)

Analysis of available data for Mogadore Reservoir indicate that the reservoir is and has historically been eutrophic and the algal community has been dominated by blue-green algae (cyanobacteria). Non-AOC State of Ohio programs continue to monitor and manage these conditions in respect to local and natural features of the reservoir. The available data are briefly summarized below and in the indicator assessment in Appendix C.

- Remedial Action Plans: The Stage 1 (1992) and Stage 2 (2012) remedial action plans did not identify Mogadore Reservoir as impaired for the BUI.
- The Remedial Action Plan Stage 2 (2015) *draft* identifies Mogadore Reservoir as a HUC12 of concern in the Cuyahoga AOC primarily due to this BUI.
- Mogadore is not a natural made reservoir but was formed in the early 1900's by damming the Little Cuyahoga River in a large wetland area to create an industrial water supply. Therefore, the natural state of water flow and quality are impeded (OEPA 1998).
- Lake management practice of releasing water only from the hypolimnion in the summer may help contribute to the seasonal problems with blooms of algae. City personnel indicated that about 4.0 MGD is released from the bottom waters of the lake, while no water flows over the surface of the dam for most of the summer. Although this lake management practice does have the ability to release bottom water nutrients from anoxic water in the summer months, it also has the potential to accumulate algae in the upper waters of the lake if no water flows over the lake dam (OEPA 1998).
- Mixing of high nutrient anoxic bottom water into the surface water during the summer could be a cause of the excessive blooms of surface water algae observed in the reservoir. Diversion of inflow water also has the potential to limit the flushing of surface water algae out of Mogadore Reservoir. Thus, it appears that the wide seasonal variation in algal production in Mogadore Reservoir may be related to a combination of causes including lack of flow over the dam during the summer, nutrient regeneration, and/or high nutrient loadings (OEPA 1998).
- The upper watershed inflow for Mogadore Reservoir has been diverted into the feeder canal for Lake Hodgson, the primary drinking water supply for the city of Ravenna. Thus, Mogadore Reservoir does not receive natural water inflow volume during low inflow periods.
- Ohio's Clean Water Act Programs: Ohio EPA and U.S. Geological Survey monitored Mogadore Reservoir in 1976 and 1996. Ohio EPA monitored downstream and nearby streams and rivers in 1986, 1991, and 1996. Published reports from these two agencies indicate that Mogadore Reservoir was historically eutrophic and that downstream tributaries were impaired by eutrophication. While collecting a fecal bacteria sample on 8-28-1996 at the swimming beach, an extensive bloom of blue green algae was observed, with a strong odor.
- Local Monitoring Programs: Northeast Ohio Four County Regional Planning and Development Organization and Kent State University collected samples from Mogadore Reservoir between 1989 and 1995. They determined that Mogadore Reservoir is hypereutrophic.
- National Lake Assessments: The U.S. Environmental Protection Agency studied Mogadore Reservoir in 2007 and 2012. Based upon a few water-quality samples, U.S. EPA determined that Mogadore Reservoir is eutrophic, and cyanobacteria dominate the phytoplankton community.
- Algal Bloom Reporting: Staff at the City of Akron Water Supply observed a HAB in Mogadore Reservoir in 2014. Staff at the Portage County Health Department observed an algae bloom in Mogadore Reservoir and nearby lakes and reservoirs in 2015.
- Satellite Imagery Analysis: Ohio EPA's HAB Program visually assesses a data product (based upon satellite imagery) to determine cyanobacteria spatial coverage and density for Ohio's inland lakes. High densities of cyanobacteria were identified on several dates in the summers of 2017 and 2018. No water quality samples were collected to field-verify that cyanobacteria densities were actually high during or after when satellite imagery were collected.

- Periodicals: Newspaper articles about Mogadore Reservoir from the Akron Beacon Journal (1997-2016) and Cleveland Plain Dealer (1845-2018) never discuss eutrophication or algae in the reservoir. Most articles discussed the fishery and fishing tournaments in Mogadore Reservoir.
- One survey response by the local public entity, City of Akron Water Supply, stated they observe cyanobacteria blooms every year. They observe the same issues with their other Reservoirs in the upper Cuyahoga River (outside of the AOC boundary) except for Lake Rockwell, which is actively managed for algae.
- The Mogadore Reservoir HUC contains many failing Household Septic Treatment Systems (HSTS) in the area that are being addressed under local jurisdictions.
- Conditions will continue to be monitored and managed under the Ohio EPA Inland Lakes Program. If it is considered impaired by State Water Quality Standards, it will be addressed by other state Water Quality programs.

Tinkers Creek (HUC 04110002-05-04)

The indicator assessment (Appendix C) outlines some parameters in the Tinkers Creek HUC that may include eutrophic conditions. Text below outlines, current conditions, and strategies underway within non-AOC State of Ohio programs to continue to monitor and manage these conditions in respect to local and natural features of this particular HUC.

- Tinkers Creek is a part of the approved Lower Cuyahoga River TMDL (Total Maximum Daily Load). Under this program at Ohio EPA, a process known as adaptive management will be used to gather data, identify stressors, and implement appropriate controls needed to restore water quality in Tinkers Creek.
- Six major wastewater treatment plants (over 1 million gallons per day) discharge to Tinkers Creek: Bedford, Bedford Heights, Streetsboro, Twinsburg, Aurora Westerly and Solon. The approved TMDL assigned a total phosphorus load to the major municipal wastewater treatment plants in the Tinkers Creek watershed. The WWTP permits also include language requiring the establishment of a nutrient trading program pursuant to Ohio's Water Quality Trading rules, OAC 3745-5. The intent of the trading program will be to further reduce phosphorus loading from non-point sources to the watershed.
- At River Mile 5.7, there is a 15 ft waterfall that impedes overall water quality as well as biological life in the creek.

Conclusions and Recommendation

The Cuyahoga River AOC has long been an urban and industrialized area with a history of environmental degradation, and therefore, its inclusion in the Great Lakes Area of Concern program and the impaired listing for the Eutrophication or Undesirable Algae BUI were warranted, given the listing criteria at the time. The river and watershed area are expected to remain urban and industrialized so its restoration to a pristine water resource is impracticable. Since the onset of the AOC process in the Cuyahoga River however, improvements have been seen and well documented.

While it is recognized that there are nutrient issues across the Lake Erie basin, this does not impede the removal of the BUI in the AOC. There are many other local, state and federal programs in place that will continue to address nutrient issues across Lake Erie such as H2Ohio, Ohio EPA Nutrient Trading Program, Water Quality Monitoring, TMDLs, Binational Lakewide Action and Management Plan, Ohio Phosphorus Task Force, Ohio Domestic Action Plan, and millions of dollars spent on eliminating Combined Sewer Overflows (CSOs) across the state.

Ohio EPA, Ohio Lake Erie Commission, and the Cuyahoga River AOC Advisory Committee have determined, based on data from 2012-2020, that all components of the removal criteria for the Eutrophication or Undesirable Algae BUI have been met:

- There have been no documented persistent problems with nuisance aquatic weeds or undesirable algae in any riverine or lacustuary areas of the Cuyahoga River AOC within the past 3 years (2017-2019). Two riverine watersheds may have localized conditions, and other State Water Quality Programs have been identified to administer and monitor any potential actions for these areas.
- There have been no documented persistent problems with nuisance aquatic weeds or undesirable algae in any lacustrine areas of the Cuyahoga River AOC and;
- The 2012-2018 seasonal average dissolved oxygen levels in lacustrine reaches of the Cuyahoga River mainstem meet the eutrophication dissolved oxygen target for warmwater habitat streams (5.0 mg/L),

A 21-day public review period was issued by Ohio EPA and Ohio Lake Erie Commission on March 4, 2021. A summary of the comment received and the state response is provided in Appendix E.

Removal Statement

Ohio EPA, Ohio Lake Erie Commission, and the Cuyahoga River AOC Advisory Committee recommend the removal of the Eutrophication or Undesirable Algae BUI from the Cuyahoga River AOC. This recommendation to remove the Eutrophication or Undesirable Algae BUI is made in accordance with the process and criteria set forth in the Delisting Targets for Ohio Areas of Concern (Ohio EPA, 2020).

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Appendix A: NEORSD lacustuary dissolved oxygen monitoring (2009-2018)

Date	RM 5.90 dissolved oxygen (mg/L)	RM 7.00 dissolved oxygen (mg/L)
7/7/2009	--	9.6
7/14/2009	--	8.7
7/21/2009	--	8.4
7/28/2009	--	8.0
8/4/2009	--	7.7
8/10/2009	--	9.0
8/19/2009	--	7.1
8/24/2009	--	9.1
8/31/2009	--	7.3
9/9/2009	--	9.1
9/14/2009	--	8.7
9/21/2009	--	8.4
9/28/2009	--	10.6
10/6/2009	--	11.0
10/12/2009	--	12.7
7/7/2010	--	13.4
7/27/2010	--	7.8
8/3/2010	--	8.4
8/10/2010	--	8.2
8/17/2010	--	8.6
8/24/2010	--	8.2
6/22/2011	--	8.6
8/10/2011	8.6	8.6
8/17/2011	8.9	8.8
8/23/2011	11.1	10.3
8/31/2011	8.3	8.1
9/7/2011	9.0	8.8
6/20/2012	8.1	8.2
6/27/2012	12.5	10.1
7/5/2012	7.3	8.0
7/11/2012	12.5	7.9
7/18/2012	11.3	8.5
7/22/2013	7.0	7.5
7/29/2013	7.8	8.2

8/5/2013	7.6	8.0
8/12/2013	7.2	7.7
8/19/2013	7.8	7.6
7/23/2014	7.5	7.3
7/25/2014	7.9	--
7/29/2014	7.6	8.2
8/5/2014	8.1	7.9
8/12/2014	10.9	10.4
8/19/2014	7.8	7.7
9/30/2014	8.0	--
10/1/2014	8.8	--
10/2/2014	6.1	--
10/3/2014	8.2	--
7/21/2015	7.0	9.1
7/28/2015	9.0	9.5
8/4/2015	8.6	7.3
8/11/2015	6.6	7.0
8/18/2015	7.0	7.0
7/27/2016	7.1	7.1
8/3/2016	6.8	7.1
8/10/2016	6.5	9.1
8/17/2016	6.9	7.8
8/24/2016	8.3	7.8
7/11/2017	--	7.9
7/18/2017	--	7.5
7/25/2017	--	7.7
8/1/2017	--	7.8
8/8/2017	--	7.8
7/24/2018	--	7.2
7/31/2018	--	7.6
8/7/2018	--	7.2
8/14/2018	--	7.4
8/21/2018	--	7.5

Appendix B: Persistent Nuisance Algae Growth Survey in the Cuyahoga AOC

A survey administered by Ohio EPA in 2020 from April 6, 2020 to April 30, 2020 was distributed to 84 contacts in the Cuyahoga AOC that monitor, manage and participate in Cuyahoga AOC activities or are engaged in contact with the River. Ohio EPA received 13 responses from various entities or contacts. 8 of the entities completed the full survey (results below). The remaining 5 responded via email stating that they have not observed any persistent nuisance algae blooms in the past 3 years in the Cuyahoga AOC.

Survey Questions and Summary of Responses (13 responses)

1. How often do you work and/or recreate in the Cuyahoga River on average during the field season, May through October? (daily, weekly, etc)

Survey Response: It depends on the workload of that year. For the last three years, I have been on the River three-four days a week. Other years, it may only be once every three months.

Survey Response: Maybe once per week at most – Possibly once every other week.

Survey Response: I work in the Cuyahoga River drainage weekly.

Survey Response: weekly / bi-weekly

Survey Response: NEORSD conducts biweekly sampling on the Cuyahoga River at two locations (river miles [RM] 10.95 and 9.78) throughout the field season as part of its NPDES permit requirements. In addition, seven locations on the river between RMs 16.20 and 7.00 have been monitored yearly to determine their designated use attainment status. This monitoring has included weekly sampling for a period of five weeks, usually during July and August.

Survey Response. It depends on the workload of that year. I may be out several days per week (evaluating habitat and biological communities, and/or taking water/sediment samples). I also live within the watershed, and recreate (i.e. kayak, fish, etc.) in the river. I may go out a few times per month.

Survey Response: I work downtown with an office that overlooks the Navigation Channel. I also park in a lot directly adjacent to the river. I therefore can observe this part of the watershed approximately daily.

Survey Response: Weekly.

2. **Are there specific subwatersheds or sections of the river that you normally work or recreate in? If so, which ones? **Note* Please use the attached map to identify subwatersheds in the AOC. The mainstem of the Cuyahoga River from the Gorge Dam pool at River Mile 45.1 to the mouth at Lake Erie is included in the AOC boundary. If you are referring to the mainstem, please (at minimum) identify if it is between the Gorge dam and River Mile 7.0 (Harvard Ave bridge) or if it is between River Mile 7.0 and the mouth at Lake Erie.***

Survey Response: I work the mainstem and tributaries throughout the AOC.

Survey Response: Work: Scranton Flats, Rivergate, Fed Shipping Channel
Recreate: from Station Rd north & south, Peninsula (between Gorge dam & RM7.0)

Survey Response: Anything up to headwater stream size within the drainage on Cleveland Metroparks property. I have a crew that also covers stream to primary headwater size.

Survey Response: Doan Brook, main stem of shipping channel.

Survey Response: Within the last five years, NEORSD has conducted attainment status assessments on Euclid Creek, Doan Brook, Big Creek, Mill Creek, West Creek, Tinkers Creek, Sagamore Creek, Chippewa Creek, Brandywine Creek, Furnace Run, and the Cuyahoga River mainstem between RM 20.75 and the mouth at Lake Erie. Sampling is also conducted at Edgewater, Euclid, and Villa Angela Beaches.

Survey Response: I work and recreate the mainstem and tributaries throughout the AOC. The main tributary that I recreate in is Tinkers Creek.

Survey Response: Navigation Channel.

Survey Response: Little Cuyahoga to Mogadore Dam

3. **What types of work or activities do you normally perform in or near the river?**

Survey Response: Collect water quality data.

Survey Response: Habitat management & monitoring at Scranton Flats. Occasional boat & walking tours throughout Fed Ship Channel.

Survey Response: Surveying streams via OEPA protocol (biology and habitat) and interacting with angling community.

Survey Response: Depends on the season. I walk over Doan Brook every day on my way to work. Some of my work takes place on the main stem around the shipping channel. My role with Ohio Sea Grant is an extension educator, so I give tours of the Cuyahoga and research/educate about critical issues facing the river and Lake Erie.

Survey Response: NEORSD's work includes water chemistry/bacteriological sampling, habitat assessments, and fish and benthic macroinvertebrate surveys.

Survey Response: I collect water quality data (i.e. habitat evaluation, evaluate biological community condition, sample water and sediment chemistry).

Survey Response: I park next to the river and walk next to it for several minutes each

weekday morning.

Survey Response: We manage Mogadore reservoir and the surrounding watershed for water quality

4. **In the past 3 years (2017-2019), have you ever observed any persistent nuisance growth (see definitions on next page) of blue-green algae or filamentous *Cladophora* blooms in the Cuyahoga River AOC? If so, please provide more information such as location, did you report or document it, what was the severity or size of the bloom, frequency (annually)? I have attached two resource/photo guides for visual identification of blue green and other nuisance algae for your reference. Please be as specific as possible.**

Survey Response: No (4)

Survey Response: I have been reported by staff what appeared to be a mild cyanobacteria bloom near the former Coast Guard Station at the mouthy of the river about two years ago in mid to late summer.

Survey Response: Starting on June 29, 2018, blue-green algae blooms were observed at Edgewater, Euclid and Villa Angela Beaches. These blooms persisted for several days, but total microcystin levels were only elevated on the first day. *Anabaena* was identified in the samples collected. The highest total microcystin concentration that was measured was 11.55 ug/L at Edgewater Beach. Subsequent daily monitoring for the next week showed concentrations below 1ug/L.

Survey Response: On July 10, 2019, an algal bloom was observed at Edgewater Beach that consisted of mostly *Dolichospermum*, but also *Anabaena* and *Microcystis*. A faint fluorescent-green color was also observed at Euclid and Villa Angela Beaches on the same day but did not appear to be thick enough to be considered a “bloom”. Total microcystin concentrations in the sample from Edgewater Beach were below the Recreational Public Health Advisory level.

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The results for both of these bloom events were reported to Ohio EPA by completing the Algal Bloom Report Form and submitting to HABMailbox@epa.ohio.gov.

Survey Response: No, I've never observed blue-green algae or filamentous *Cladophora* blooms.

Survey Response: We see cyanobacterial blooms every year. Have had antidotal reports of sick dogs after swimming in this no contact lake (Mogadore Reservoir). We do not identify these algae because recreation at the reservoir is monitored and administered by the ODNR.

5. **Has your entity received any other reports of persistent nuisance growth of algae or blooms within the Cuyahoga AOC? If so, please provide as many details as possible.**

Survey Response: Not that I am aware of. (2)

Survey Response: By any other, do you mean further in the past? I detected and reported a HAB at Hudson Springs Park in Sept 2016. They had water tested and confirmed presence of HAB in the Tinker's Creek watershed.

Survey Response: We have had reports of a couple HABs at Edgewater beach.

Survey Response: Not that I recall (natural gizzard shad kills, on the other hand, are reported to me annually in late winter into spring- so people will communicate concerns they see to me).

Survey Response: Not in the AOC, but periodically in Lake Erie close to Cleveland.

Survey Response: No. (2)

Survey Response: Residents and boaters do occasionally call to report green water at Mogadore.

6. **How would you say nuisance algae/eutrophication in the Cuyahoga AOC compares to other communities outside of the AOC?**

Survey Response: I would make the statement that it is comparable to other local watersheds.

Survey Response: Compared to Chagrin watershed, probably worse. Compared to Chippewa

Lake, tons better. There are definitely Great Lakes watersheds that are not listed as an AOC that have worse nuisance algae/eutrophication issues.

Survey Response: I have limited information to make that call- but in general similar to comparable sites elsewhere.

Survey Response: Better than in some other major rivers in Ohio that have more agricultural land use in their watersheds.

Survey Response: NEORSD has conducted monitoring of nutrients and other indicators of eutrophication throughout both the Cuyahoga River and Rocky River watersheds. Using the Ohio EPA Stream Nutrient Assessment Protocol and draft nutrient water quality standards for large rivers, the degree of eutrophication within the Cuyahoga AOC seems comparable to that in the Rocky River watershed.

Survey Response: Based on the limited number of occurrences of HABs at beaches within the AOC and reports of HABs elsewhere along Lake Erie indicate that nuisance algae/eutrophication is not worse within the AOC.

Survey Response: I do not know how nuisance algae/eutrophication in the Cuyahoga AOC compares to other communities outside the AOC, I have not seen/evaluated any data regarding this.

Survey Response: Conditions are better than in other large rivers in Ohio, such as the Maumee River and the Ohio River. It's probably similar to rivers like the Black and Rocky River.

Survey Response: We see the same thing with our other Reservoirs in the upper Cuyahoga except for Rockwell, which is actively managed.

7. **Does your entity/organization monitor the status and/or address persistent nuisance growth of algae within the Cuyahoga AOC? If so, please provide as many details as possible such as locations, time and type of monitoring/actions, etc.**

Survey Response: My agency would respond and monitor, if an algal bloom was reported to us. Currently, we have not received any reports of incidents needing a response.

Survey Response: Not in any organized fashion. We have staff that conduct various biological surveys on Metroparks property throughout the AOC. They are aware of HABs and would report one, if noticed.

Survey Response: Only when an issue is reported to us, and we typically notify NEORSD for follow-up since they routinely work in that area already.

Survey Response: Not directly. We focus more of our attention to HABS in the western basin.

Survey Response: As part of daily beach monitoring at Edgewater, Euclid and Villa Angela Beaches, observations about algal growth are noted by the samplers. In the event of potential harmful algal blooms, additional sampling is conducted based on the *State of Ohio Harmful Algal Bloom Response Strategy for Recreational Waters*.

Survey Response: Yes, the agency that I work for monitors and addresses persistent nuisance growth of algae within the Cuyahoga AOC. No actions have occurred in the past few years to the best of my knowledge.

Survey Response: No.

Survey Response: We observe blooms on the lake, but we do not quantify or identify. Observations are weekly during the summer, every other week in the winter unless we are doing work there.

Appendix C: Eutrophication Indicator Data in the Cuyahoga AOC

Hydrologic Units comprising the Cuyahoga Area of Concern

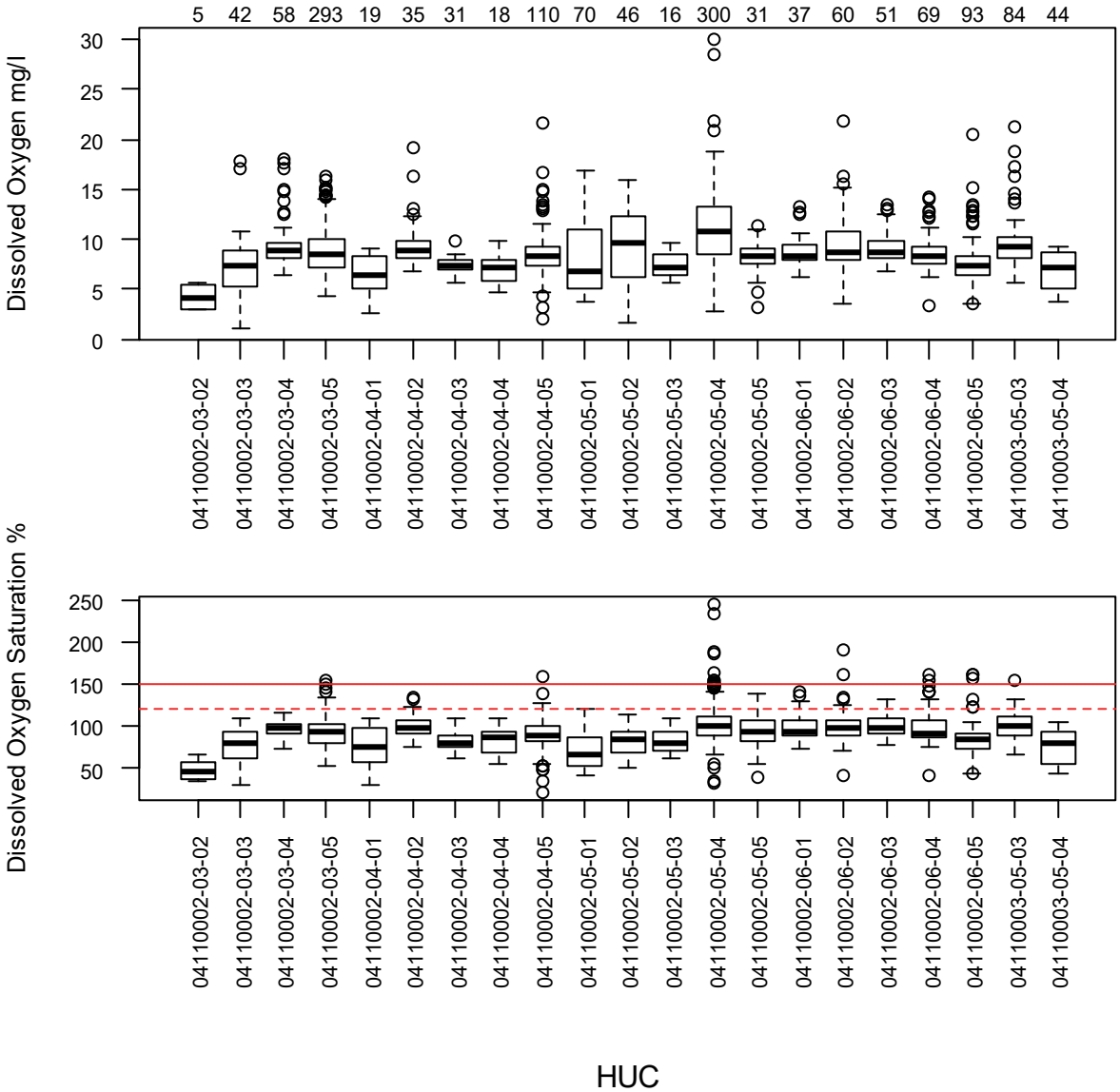
HUC Key			
04110002-03-02	Mogadore Reservoir-Little Cuyahoga	04110002-05-02	Tinkers Headwaters
04110002-03-03	Wingfoot Lake-Little Cuyahoga	04110002-05-03	Chippewa Headwaters
04110002-03-04	Akron-Little Cuyahoga	04110002-05-04	Twinsburg-Tinkers
04110002-03-05	Fish Creek-Cuyahoga	04110002-05-05	Willow Lake-Cuyahoga
04110002-04-01	Mud Brook	04110002-06-01	Mill Creek
04110002-04-02	Yellow Creek	04110002-06-02	Independence-Cuyahoga
04110002-04-03	Furnace Run	04110002-06-03	Big Creek
04110002-04-04	Brandywine Creek	04110002-06-04	Cuyahoga Heights-Cuyahoga
04110002-04-05	Boston Run-Cuyahoga	04110002-06-05	Cleveland-Cuyahoga
04110002-05-01	Pond Brook	04110003-05-03	Euclid Creek
		04110003-05-04	Doan Brook

Box Plot Legend

Thick line inside of box: median
Outline of box: upper 75% and lower 25% quartiles
Whiskers: 10th and 90th percentiles
- : outliers

Dissolved Oxygen

Dissolved oxygen (DO) concentrations in rivers and streams are strongly influenced by photosynthesis and respiration, and as such, can be diagnostic of over-enrichment. DO concentrations typically fluctuate by 3 to 6 mg/l over a 24-hour cycle; however, photosynthesis from prolific growths of algae can drive DO concentrations to supersaturation, and respiration overnight can result in hypoxia. Thus, daily DO ranges greater than 7 mg/l, and especially those greater than 9 mg/l, are atypical and diagnostic of over-enrichment. In the absence of daily ranges, frequent observations of DO saturation in excess of 120% is a good indication of over-enrichment, and saturation > 150% is atypical. When observed in daytime spot samples, the low DO concentrations are an indication of organic enrichment being the most proximal stressor, and largely irrelevant as an indication of nutrient enrichment (Miltner 2018).



Figures 1 & 2. Distributions of dissolved oxygen and percent saturation by HUC (data taken June 15-October 15, 2013-2019)

Red lines in the % saturation plot are drawn at 120 & 150% and correspond to levels of risk; moderate and high, respectively.

pH

The pH of a waterbody is similarly influenced by photosynthesis and respiration due to the uptake and effusion of CO2. Dissolved CO2 forms a weak acid when dissolved in water, so the uptake of CO2 during photosynthesis tends to raise pH, and respiration tends to lower pH. Because most waters are naturally buffered, pH tends to remain stable. It is also worth noting that pH is important for maintaining homeostasis, as it plays a role in ion exchange across gill membranes, and governs the equilibria of dissolved ions, ammonia being one prime example. Consequently, water quality standards have been established for pH. Although the water quality standard for pH is 9, pH levels greater than 8.5 appear stressful to aquatic life, and thus these endpoints conveniently communicate stress associated with over-enrichment. The determination of which HUCs appeared to have elevated pH levels was based on visual inspection of the box plots along with inspection of the data from individual sites within the respective HUCs (Miltner 2018).

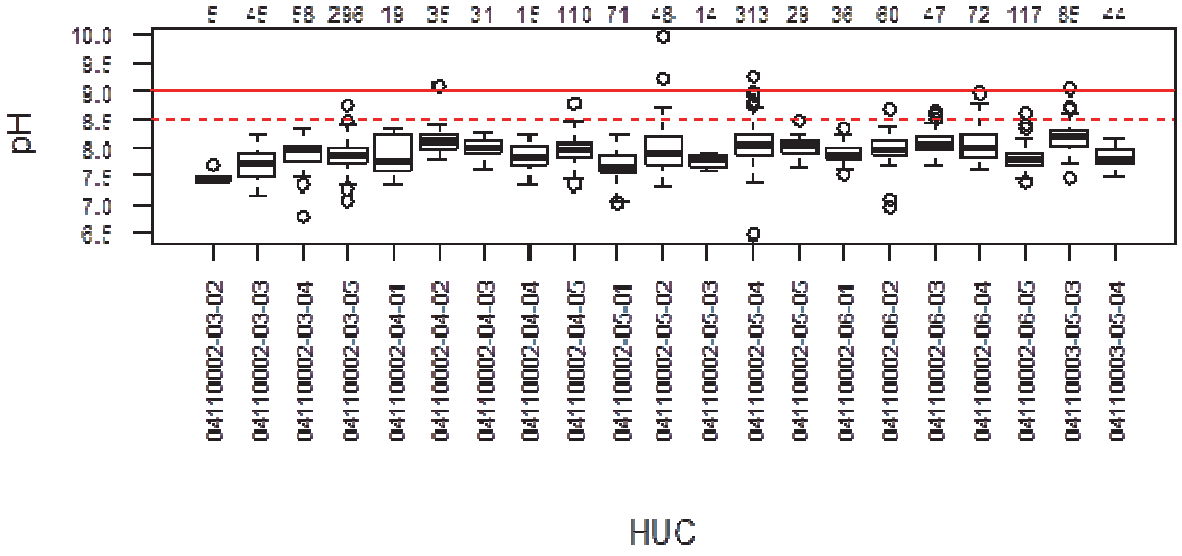
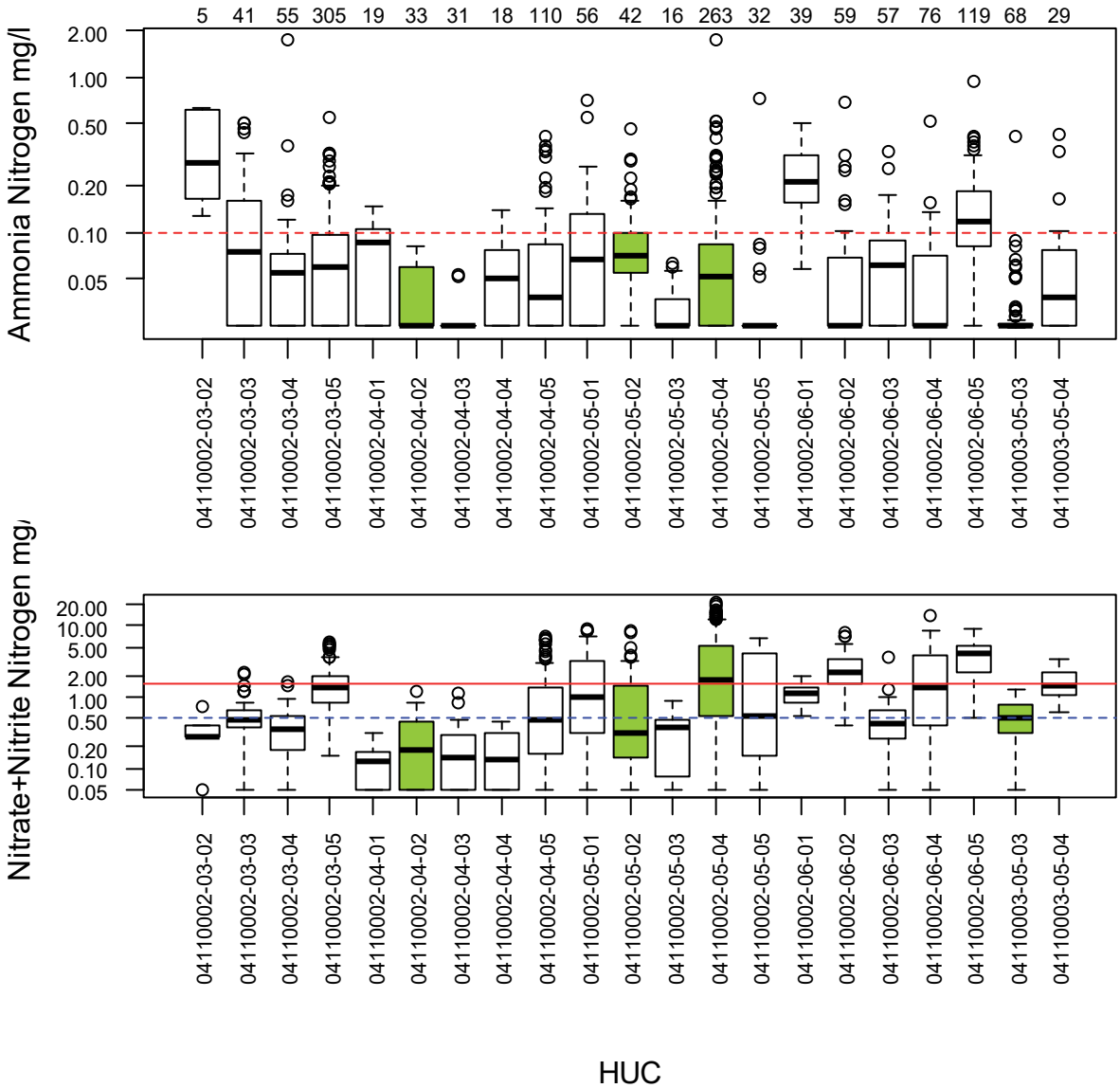


Figure 3. Distributions of pH by HUC
Red lines in the % saturation plot are drawn at 120 & 150% and correspond to levels of risk; moderate and high, respectively.

Dissolved Inorganic Nitrogen

Dissolved inorganic nitrogen (DIN) is comprised by nitrates and nitrites (NOx), and ammonia (NH3). Nitrogen is an essential plant nutrient, and when present in excess can contribute to algae blooms or noxious growths of periphyton. Algae preferentially uptake ammonia, as oxidized forms of nitrogen have to be reduced prior to being assimilated; however, oxidized forms are readily used. Therefore, both forms need to be considered when evaluating the potential for over-enrichment. Generally, DIN concentrations greater than 1.5 mg/l are essentially ad libitum for algal growth, and potentially rate limiting when less than ~0.5 mg/l. Clearly, nitrogen is not in short supply in most of the AOC HUCs. The HUCs where pH levels were atypically high are colored in the above plots for reference.



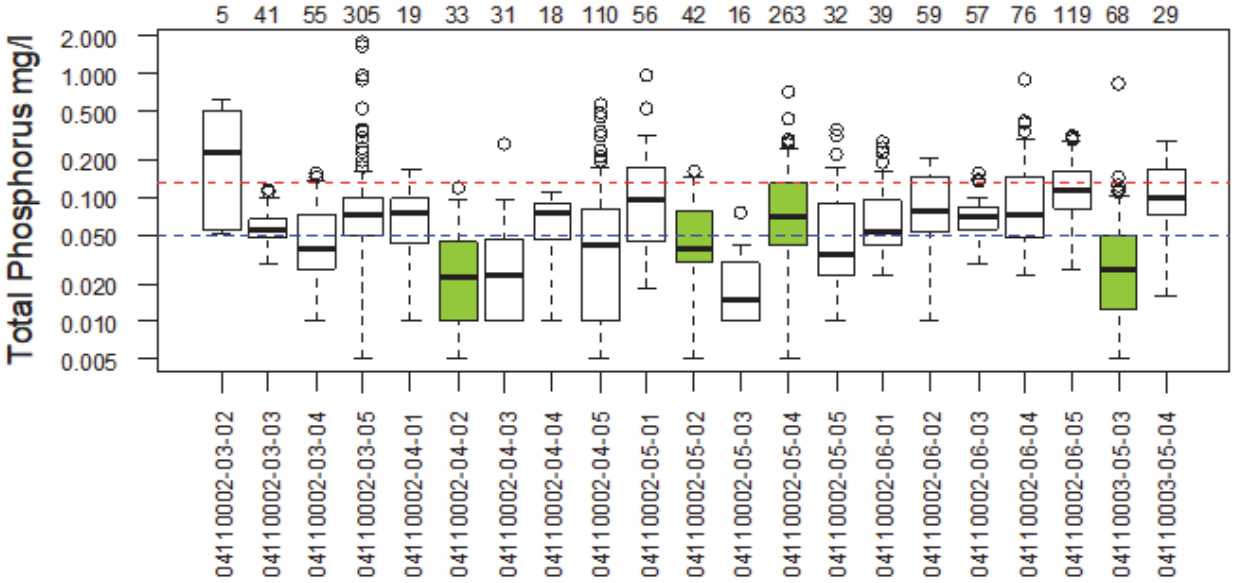
Figures 4 & 5. Distributions of ammonia and oxidized nitrogen by HUC

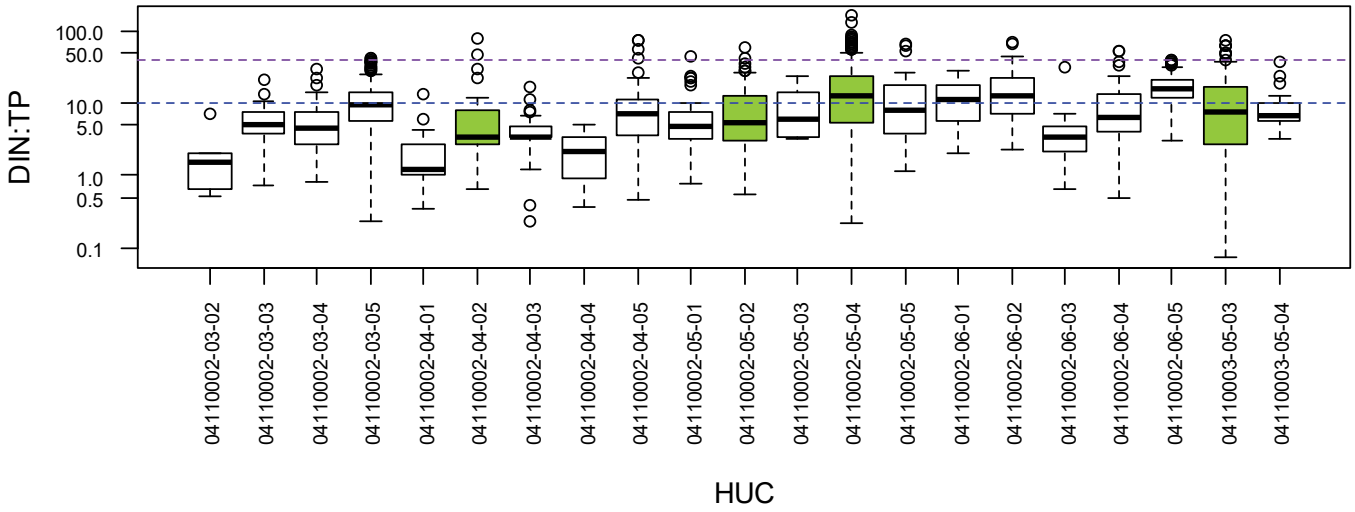
The dashed red line in the ammonia plot corresponds to an increased risk of impairment (moderate)

The blue line in the NOx plot is the upper range of background levels the red line denotes excessive levels (the link to aquatic life is not as direct)

Phosphorus

Phosphorus is also an essential element necessary for plant growth but can provoke nuisance growths when present in excess. Phosphorus concentration greater than 0.13 mg/l can be considered ad libitum, especially when measured as a seasonal average. However, concentrations have to be less than ~0.05 mg/l to be considered rate limiting. Although fairly low phosphorus concentrations can be theoretically saturating, factors such as grazing, scouring, and habitat quality can increase the apparent assimilative capacity of a waterbody. Also, the balance and ratio between nitrogen and phosphorus is an important consideration. Systems with relatively high concentrations of both nitrogen and phosphorus are at greatest risk of algal blooms, especially when the ratio of nitrogen to phosphorus falls within the range of about 10:1 and 40:1, as ratios within that range are optimal for growth.





Figures 6 & 7. Distributions of total phosphorus and ratios of inorganic nitrogen to total phosphorus by HUC

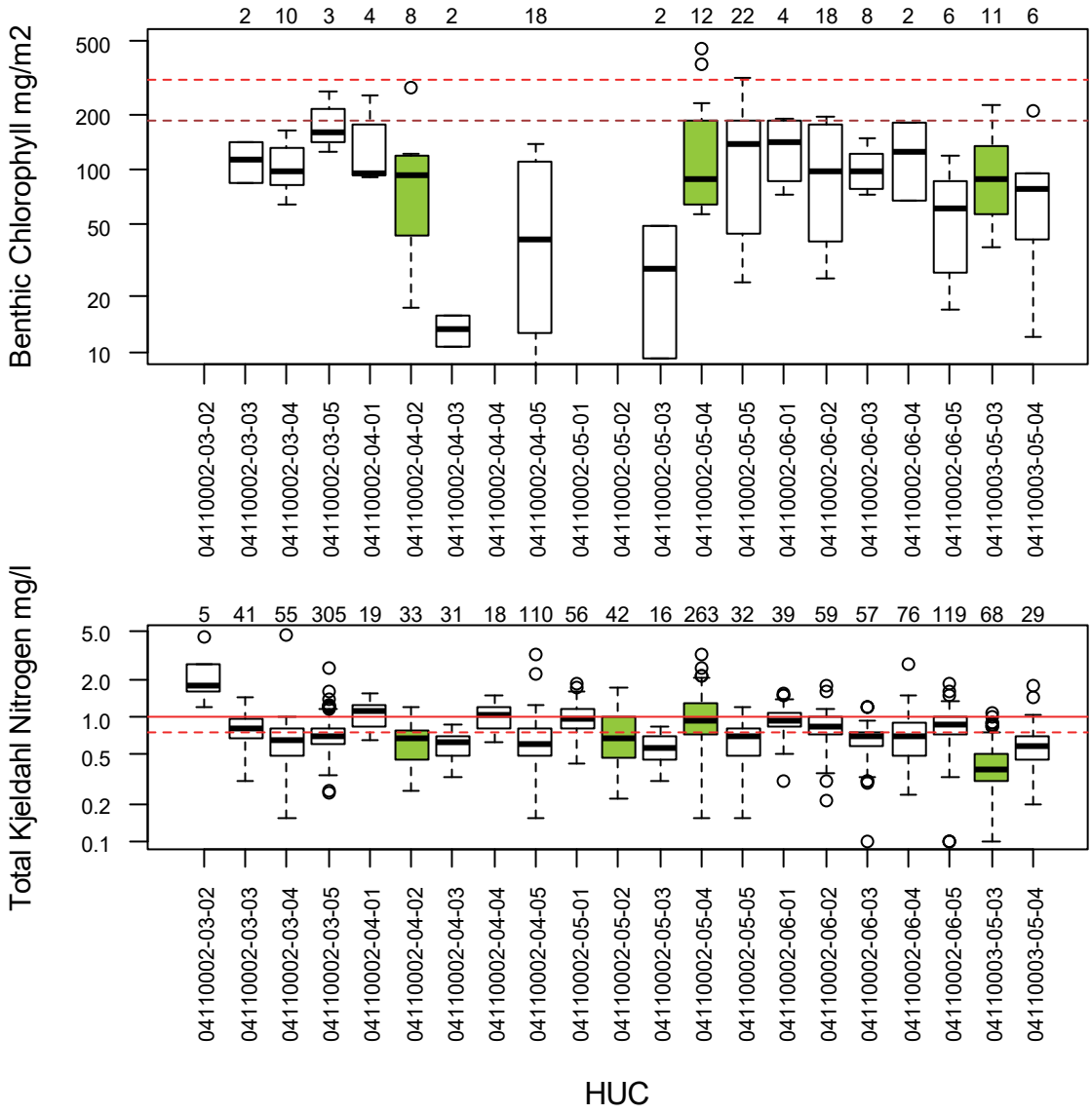
Blue and red lines in phosphorus plot correspond to background and excessive.

The lines in the N:P plot bracket the range of co-limitation. Values above the red line are clearly P-limited; values below the blue line are either nitrogen limited or suggest the inorganic nitrogen pool has been taken up give the high levels of available phosphorus.

Chlorophyll and TKN

Benthic chlorophyll is measured as a proxy for periphytic biomass and productivity. Several factors control how much periphytic biomass is likely to accrue, notably, canopy shading, the time since the last scouring event, grazing, and nutrient concentrations. Given the developed state of the Cuyahoga watershed, and its parent geology and glacial history, most streams in the catchment can be expected to be at least moderately productive. Benthic chlorophyll levels in modestly enriched streams typical of working landscapes fall within the range of 100-200 mg/m2. Concentrations less than 100 mg/m2 are more typical of forested headwaters (assuming the mat was not recently scoured), and concentrations exceeding 300 mg/m2 indicate either high productivity (when biomass is low) or the result of a nuisance bloom.

Total Kjeldahl nitrogen (TKN) can act as a response variable to indicate eutrophication. TKN is the sum of organic nitrogen and ammonia and is therefore also used as an indicator of organic enrichment from wastewater. When the ammonia fraction of TKN is relatively high, that tends to indicate organic enrichment. High levels of TKN can result from refractory humic compounds released from wetlands (or former wetlands). Knowing the environmental setting is obviously the key to distinguishing these cases.



Figures 8 & 9. Distributions of benthic chlorophyll and total Kjeldahl nitrogen by HUC

The red lines in the chlorophyll plot are straight from the SNAP - 180 and 300 (rounded to the nearest 10). Those in the TKN plot are moderate and high risk of impairment (when the TKN is not from organic enrichment, not from refractory nitrogen compounds).

Appendix D: Cuyahoga Advisory Committee Letter of Support

April 5, 2021

Ms. Joy Mulinex, Executive Director
Ohio Lake Erie Commission
P.O. Box 1049
Columbus, OH 43216-1049

Re: ***Removal of Beneficial Use Impairment #8 (Eutrophication & Undesirable Algae) from the Cuyahoga River Area of Concern***

Dear Director Mulinex:

The Cuyahoga River Area of Concern (AOC) Advisory Committee has reviewed available data, materials and documents for the removal, in the Cuyahoga River AOC, of the following beneficial use impairment (BUI):

- BUI #8: Eutrophication and Undesirable Algae

The Advisory Committee has determined that all applicable data meets or exceeds the State of Ohio removal criteria for this BUI and has voted to support its removal.

Therefore, the Advisory Council requests that the Ohio EPA proceed with the process of approving the removal of this Beneficial Use Impairment from the Cuyahoga River AOC and forward the necessary request for removal documents to U.S. EPA's Great Lakes National Program Office (GLNPO) for their approval.

With the removal of this BUI, the following impairments will remain in the Cuyahoga River AOC.

- BUI #3: Degradation of Fish Populations
- BUI #4: Fish Tumors or Other Deformities
- BUI #6: Degradation of Benthos
- BUI #7: Restrictions on Navigational Dredging
- BUI #10a: Beach Closings (Recreational Contact)
- BUI #14: Loss of Fish Habitat

We are pleased to count this as the fourth BUI removed to date and expect to see more removals in the near future. We appreciate the effort and expertise that the Ohio EPA has contributed to move our Area of Concern forward and facilitating these essential steps toward delisting.

Meanwhile, the Cuyahoga River AOC Advisory Committee will continue its efforts to remove the remaining impairments leading to the delisting and complete restoration of the Cuyahoga River Area of Concern.

Sincerely,

Jennifer M. Grieser
Chair, Cuyahoga River AOC Advisory Committee

Cuyahoga River Area of Concern Advisory Committee • 3311 Perkins Ave., Suite 100 • Cleveland, OH 44114 • info@cuyahogaaoc.org

Appendix E. Public Comments

Public Comments	Response
There is a lack of preventative protection of the many watersheds affecting the Cuyahoga River/Lake Erie with reference to particular new planned development in the watershed in the Akron region along the Cuyahoga River. Why would we jeopardize progress in the AOC with more development that impacts the health of the watersheds. With 21 sub-watersheds, protecting each with engaged citizens collectively rather than each of them would be helpful.	The Eutrophication & Undesirable Algae BUI has distinct restoration target criteria that needs to be met for BUI removal. The criteria for this BUI was met or further explained on conditions that will be addressed or monitored within other state programs for its removal outlined in the removal recommendation. Eutrophication and algae are typically products of nutrient pollution and development within the watershed is not found to be a source of nutrient pollution. The Cuyahoga Area of Concern Community Advisory Committee provides an entity of which community representatives from the sub-watersheds can participate and convene to discuss goals and activities for the Cuyahoga Area of Concern. More information on the Cuyahoga AOC Advisory Committee can be found at https://cuyahogaaoc.org/. There are watershed-wide organizations that work throughout the Cuyahoga River watershed including Cuyahoga River Restoration http://www.cuyahogariver.org/ and Friends of the Crooked River http://cuyahogariver.net/

Medley, Leah

From: Buszka, Paul M <pmbuszka@usgs.gov>
Sent: Sunday, April 11, 2021 2:49 PM
To: Medley, Leah
Subject: Re: [EXTERNAL] FW: Cuyahoga River AOC BUI Removal Recommendation

Technical review of "Removal Recommendation for the Eutrophication or Undesirable Algae Beneficial Use Impairment in the Cuyahoga River Area of Concern, April 2021" by Ohio Environmental Protection Agency and Lake Erie Commission

This email documents results of my technical reviews of the report Removal Recommendation for the Eutrophication or Undesirable Algae Beneficial Use Impairment in the Cuyahoga River Area of Concern, April 2021" submitted by the Ohio Environmental Protection Agency and Lake Erie Commission. Detailed comments were provided by me to the authors on two dates: on November 12, 2020 for the report version dated October 2020 and on January 25, 2021 for the report drafts provided to me on January 15, 2021. The authors have appropriately addressed my technical and editorial comments as revisions to the report or provided appropriate logic as to why a comment was not addressed. The final report dated April 2021 reflects those revisions.

The background, data and logic presented in this report provide a technically accurate case that support improved water quality conditions in the Cuyahoga River Area of Concern lacustuary and compliance with the Eutrophication or Undesirable Algae Beneficial Use Impairment (BUI 8) criteria. Dissolved oxygen data presented in the report indicate that the lacustuary of the Cuyahoga River mainstem meets the State of Ohio dissolved oxygen criteria for warmwater habitat streams (5.0 mg/L). The report further presents sufficient information to indicate a lack of persistent problems with nuisance aquatic weeds or undesirable algae within the AOC program targets in riverine or lacustuary areas of the Cuyahoga River AOC.

The report also outlines specific State of Ohio programs and actions targeted to address indications of recurring algal stresses in two localized watersheds in the Cuyahoga River AOC, Tinkers Creek and Mogadore Reservoir. For the Tinkers Creek watershed, the report documents actions to decrease nutrient and phosphorus loads to the watershed through the State of Ohio approved Lower Cuyahoga River TMDL (Total Maximum Daily Load) process. These actions include (1) an adaptive management process to gather data, identify stressors, and implement appropriate controls needed to restore water quality in Tinkers Creek and (2) a State of Ohio permit-based establishment of a nutrient trading program pursuant to State water quality trading rules. For the Mogadore Reservoir, the report presents and references sufficient information, data, and logic to support future monitoring, and if needed, management of episodic eutrophic conditions through other appropriate State water quality programs.

Thank you for the opportunity to provide this review.

Regards,

Paul M. Buszka, U.S. Geological Survey
Technical Review Lead, BUI 8 (Eutrophication or Undesirable Algae),
Cuyahoga River Area of Concern