



# Loading Analysis Plan and Supporting Data Acquisition Needed for the Lower Auglaize River Tributaries Basin

**Total Maximum Daily Load Development**



*Flatrock Creek River Mile (RM) 23.72*

Ohio EPA Technical Report AMS/2014-LAUGL-3

Division of Surface Water  
Assessment and Modeling Section  
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## Introduction

This document provides an overview of the information considered in proposing analytical methods to address water quality impairments in the Lower Auglaize River tributary watersheds. These recommendations are based on data collected as part of a biological and water quality study in 2014. A description of the project area, sites, data types and methods can be found in the Lower Auglaize River tributaries study plan document at ([https://epa.ohio.gov/static/Portals/35/tmdl/LowerAuglaize\\_StudyPlan\\_041114.pdf](https://epa.ohio.gov/static/Portals/35/tmdl/LowerAuglaize_StudyPlan_041114.pdf)). A summary of the study results can be found in the biological and water quality report at (<https://epa.ohio.gov/static/Portals/35/documents/2014%20Lower%20Auglaize%20River%20Tributaries%20TSD.pdf>).

Sites in the Lower Auglaize River tributaries watersheds were assessed for aquatic life use, recreation use and water supply use. The attainment of aquatic life and recreation use is based on specific restoration targets. This document examines those targets and lays out proposals for addressing each impairment. Where appropriate, methods are outlined to develop total maximum daily loads (TMDL) for specific pollutants.

The federal Clean Water Act (CWA) requires that states identify waters not meeting water quality goals and then prioritize them for action to restore their beneficial uses. The resulting list of prioritized impaired waters is known as the 303(d) list. The process of listing involves assigning a condition status (a category) for each of four beneficial uses (aquatic life, human health, recreation, and public water supply) for each assessment unit. For more information on impaired water listings and categories, please Ohio's Integrated Water Quality Monitoring and Assessment Report at: [epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/surface-water/reports-data/ohio-integrated-water-quality-monitoring-and-assessment-report](http://epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/surface-water/reports-data/ohio-integrated-water-quality-monitoring-and-assessment-report).

## Aquatic Life Use

### *Evaluation of Biocriteria*

Attainment of Ohio EPA's biocriteria are based on fish and macroinvertebrate scores, as measured by the Index of Biotic Integrity (IBI), Modified Index of well-being (MIwb) and Invertebrate Community Index (ICI). Further explanations of Ohio EPA's biocriteria can be found in Ohio Administrative Code (OAC) Chapter 3745-1-07 and additionally at [epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/surface-water/reports-data/statewide-biological-and-water-quality-monitoring-and-assessment](http://epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/surface-water/reports-data/statewide-biological-and-water-quality-monitoring-and-assessment). Goals for those indices in the Lower Auglaize River tributaries watershed are shown in

Table 1. The attainment status for each site is shown in

Figure 1 — *Map summarizing ALU attainment status in the Lower Auglaize River tributaries watershed in 2014.* and the scores for impaired sites are shown in Table 2.

**Table 1 – Biological criteria applicable in the lower Auglaize River tributaries watershed for aquatic life use designations.**

Ecoregion	Biological Index	Assessment Method <sup>2,3</sup>	Biological Criteria for the Applicable Aquatic Life Use Designations <sup>1</sup>		
			WWH	EWH	MWH <sup>4</sup>
Huron-Erie Lake Plains (HELP)	IBI	Headwater	28	50	20
		Wading	32	50	22
		Boat	34	48	20
	MIwb	Wading	7.3	9.4	5.6
		Boat	8.6	9.6	5.7
	ICI	All <sup>5</sup>	34	46	22

<sup>1</sup> Aquatic Life Use (ALU) designations: warmwater habitat (WWH); modified warmwater habitat (MWH) exceptional warmwater habitat (EWH)

<sup>2</sup> The assessment method used at a site is determined by its drainage area (DA) according to the following:  
Headwater: DA ≤ 20 mi<sup>2</sup>; wading: DA >20 mi<sup>2</sup> and ≤ 500 mi<sup>2</sup>; boat: DA > 500 mi<sup>2</sup>.

<sup>3</sup> MIwb not applicable to drainage areas less than 20 mi<sup>2</sup> (headwater sites).

<sup>4</sup> Biocriteria depend on type of MWH. MWH-C (due to channelization) is the only type found in the watershed.

<sup>5</sup> Limited to sites with appropriate conditions for artificial substrate placement.

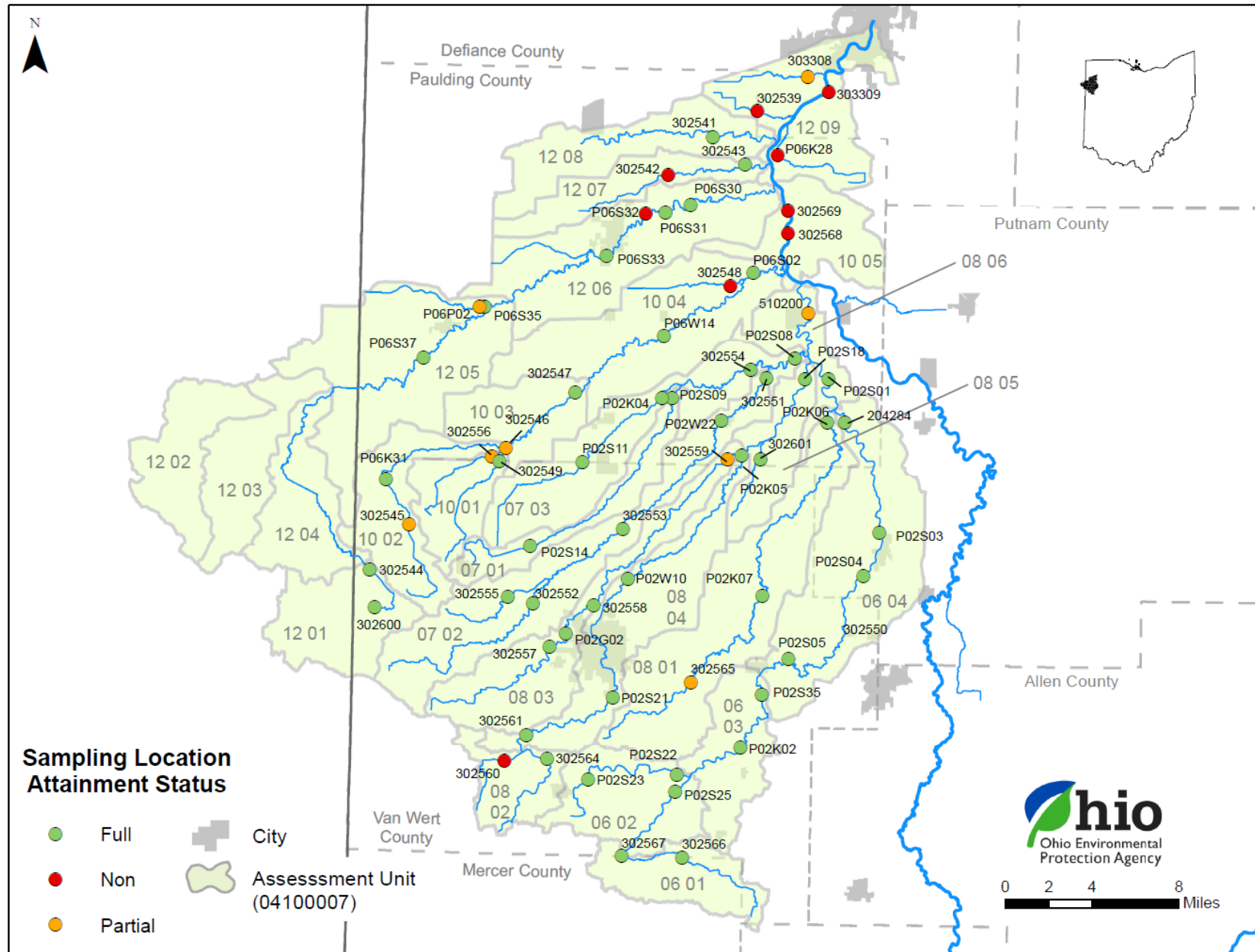


Figure 1 — Map summarizing ALU attainment status in the Lower Auglaize River tributaries watershed in 2014.

Table 2 – Aquatic life use attainment information for impaired sampling locations in the Lower Auglaize River tributaries watershed, 2014.

Station	Location	Ecoregion <sup>1</sup> / ALU <sup>2</sup>	River Mile <sup>a</sup>	Drain. Area (mi <sup>2</sup> )	IBI	Mlwb <sup>b</sup>	ICI <sup>c</sup>	QHEI	Attain. Status	Causes	Sources
04100007 08 01 – Dog Creek											
302565	DOG CREEK @ GAMBLE RD.	HELP/WWH	22.10 <sup>H</sup>	13.5	30	-	F*	45.3	<b>PARTIAL</b>	Sedimentation/siltation Direct habitat alterations Other flow regime alterations	Agriculture Crop production with subsurface drainage
04100007 08 02 – Upper Town Creek											
302560	TOWN RUN AT DULL ROBINSON RD.	HELP/MWH	27.45 <sup>H</sup>	3.8	30	-	P*	31.0	<b>NON</b>	Sedimentation/siltation Other flow regime alterations	Agriculture Crop production with subsurface drainage
05090201 08 03 – Maddox Creek											
302559	MADDOX CREEK @ ST. RT. 637	HELP/WWH	0.90 <sup>W</sup>	32.7	31 <sup>ns</sup>	6.76*	38	57.5	<b>PARTIAL</b>	Sedimentation/siltation Direct habitat alterations Other flow regime alterations	Agriculture Crop production with subsurface drainage
04100007 08 06 – Burt Lake – Little Auglaize River											
510200	L. AUGLAIZE R. E OF MELROSE @ ST. RT. 613	HELP/WWH	2.02 <sup>W</sup>	401.0	34	8.93	F*	52.8	<b>PARTIAL</b>	Direct habitat alterations Other flow regime alterations	Dam or Impoundment
04100007 10 01 – Upper Prairie Creek											
302556	MIDDLE CREEK @ PARKER RD.	HELP/MWH	0.50 <sup>H</sup>	5.0	34	-	LF*	20.0	<b>PARTIAL</b>	Sedimentation/siltation Other flow regime alterations	Agriculture Crop production with subsurface drainage
04100007 10 02 – Upper Blue Creek											
302545	BLUE CREEK @ DIXON CAVETT RD.	HELP/WWH	31.95 <sup>H</sup>	7.4	34	-	F*	24.8	<b>PARTIAL</b>	Sedimentation/siltation Direct habitat alterations Other flow regime alterations	Agriculture Crop production with subsurface drainage

Station	Location	Ecoregion <sup>1</sup> / ALU <sup>2</sup>	River Mile <sup>a</sup>	Drain. Area (mi <sup>2</sup> )	IBI	MIwb <sup>b</sup>	ICI <sup>c</sup>	QHEI	Attain. Status	Causes	Sources
04100007 08 01 – Dog Creek											
302565	DOG CREEK @ GAMBLE RD.	HELP/WWH	22.10 <sup>H</sup>	13.5	30	-	F*	45.3	<b>PARTIAL</b>	Sedimentation/siltation Direct habitat alterations Other flow regime alterations	Agriculture Crop production with subsurface drainage
04100007 10 03 – Middle Blue Creek											
302546	BLUE CREEK @ YOAKUM RD.	HELP/WWH	22.00 <sup>W</sup>	41.0	35	8.72	F*	56.5	<b>PARTIAL</b>	Sedimentation/siltation Direct habitat alterations Other flow regime alterations	Agriculture Crop production with subsurface drainage
04100007 10 04 – Lower Blue Creek											
302548	BARCER RUN AT ST. RT. 637	HELP/WWH	0.75 <sup>H</sup>	6.9	28	-	<u>P</u> *	41.5	<b>NON</b>	Sedimentation/siltation Direct habitat alterations Other flow regime alterations	Agriculture Crop production with subsurface drainage
04100007 10 05 – Town of Charloe-Auglaize River											
302568	BOBENMYER DITCH AT STOUFFER RD.	HELP/WWH	0.70 <sup>H</sup>	6.1	28	-	<u>P</u> *	47	<b>NON</b>	Sedimentation/siltation Other flow regime alterations	Agriculture Crop production with subsurface drainage
302569	SNYDER DITCH AT STOUFFER RD.	HELP/WWH	0.30 <sup>H</sup>	5.2	<u>20</u> *	-	LF*	42.5	<b>NON</b>	Sedimentation/siltation Other flow regime alterations	Agriculture Crop production with subsurface drainage
04100007 12 05 – Wildcat Creek-Flatrock Creek											
P06P02	WILDCAT CREEK NE OF PAYNE AT ST. RT. 500	HELP/WWH	0.27 <sup>H</sup>	7.9	36	-	F*	37.3	<b>PARTIAL</b>	Sedimentation/siltation Direct habitat alterations Other flow regime alterations	Agriculture Crop production with subsurface drainage
04100007 12 06 – Big Run-Flatrock Creek											

Station	Location	Ecoregion <sup>1</sup> / ALU <sup>2</sup>	River Mile <sup>a</sup>	Drain. Area (mi <sup>2</sup> )	IBI	MIwb <sup>b</sup>	ICI <sup>c</sup>	QHEI	Attain. Status	Causes	Sources
04100007 08 01 – Dog Creek											
302565	DOG CREEK @ GAMBLE RD.	HELP/WWH	22.10 <sup>H</sup>	13.5	30	-	F*	45.3	<b>PARTIAL</b>	Sedimentation/siltation Direct habitat alterations	Agriculture
										Other flow regime alterations	Crop production with subsurface drainage
P06S32	FLATROCK CREEK UPST. PAULDING WWTP LAGOONS	HELP/WWH	9.70 <sup>W</sup>	183.0	<u>27</u> *	7.92	F*	69.0	<b>NON</b>	Sedimentation/siltation	Agriculture
04100007 12 07 – Little Flatrock Creek											
302542	LITTLE FLATROCK CREEK AT BROUGHTON RD.	HELP/MWH	1.53 <sup>H</sup>	7.6	20	-	LF*	21.0	<b>PARTIAL</b>	Sedimentation/siltation Direct habitat alterations	Agriculture
										Other flow regime alterations	Crop production with subsurface drainage
04100007 12 09 – Eagle Creek-Auglaize River											
303308	THREEMILE CREEK AT CANAL RD.	HELP/WWH	0.87 <sup>H</sup>	4.9	30	-	LF*	67.5	<b>PARTIAL</b>	Sedimentation/siltation Other flow regime alterations	Agriculture Crop production with subsurface drainage
303309	JACKSON DITCH AT POWER DAM RD.	HELP/WWH	0.05 <sup>H</sup>	4.8	26 <sup>ns</sup>	-	<u>P</u> *	51.0	<b>NON</b>	Sedimentation/siltation	Dam or impoundment Agriculture
										Other flow regime alterations	Crop production with subsurface drainage
302539	FIVEMILE CREEK AT DEFIANCE/PAULDING COUNTY LINE	HELP/WWH	1.7 <sup>H</sup>	2.9	<u>20</u> *	-	<u>P</u> *	33.3	<b>NON</b>	Sedimentation/siltation Other flow regime alterations	Agriculture Crop production with subsurface drainage
P06K28	EAGLE CREEK WNW OF JUNCTION AT RIVER RD.	HELP/WWH	1.57 <sup>H</sup>	3.70	<u>20</u> *	-	LF*	49.5	<b>NON</b>	Sedimentation/siltation Other flow regime alterations	Agriculture Crop production with subsurface drainage

- a River Mile (RM) represents the Point of Record (POR) for the station and may not be the actual sampling RM.
- b MIwb is not applicable to headwater streams with drainage areas  $\leq 20$  miles<sup>2</sup>.
- c A narrative evaluation of the qualitative sample based on attributes such as EPT taxa richness, number of sensitive taxa, and community composition was used when quantitative data was not available or considered unreliable. VP=Very Poor; P=Poor; LF=Low Fair; F=Fair; MG=Marginally Good; G=Good; VG=Very Good; E=Exceptional
- ns Nonsignificant departure from biocriteria ( $\leq 4$  IBI or ICI units, or  $\leq 0.5$  MIwb units).
- \* Indicates significant departure from applicable biocriteria ( $>4$  IBI or ICI units, or  $>0.5$  MIwb units). Underlined scores are in the Poor or Very Poor range.
- H Headwater site (draining  $\leq 20$  miles<sup>2</sup>).
- W Wading site (non-boat site draining  $>20$  miles<sup>2</sup>).

### Proposed Actions

Ohio EPA considers many factors when deciding how to address impairments. For some projects, no TMDL is required. The watershed may be in attainment, or the impairment is being addressed by another program/entity so no further action by the Division of Surface Water is necessary. Additionally, the cause of impairment may be natural (i.e., flow or habitat), in which case no action is required. For those needing a TMDL, the complexity of each impairment—including the primary origin of the pollutant, its delivery mechanisms and the waterbody kinetics involved—will determine the complexity needed in a model. Additionally, Ohio EPA must take into consideration ongoing efforts in the watershed, previous TMDL analyses, the questions to be answered by a model and the amount of effort required to complete the model. Depending on the method selected, the Agency may be required to return to the watershed and collect additional data, and it is possible the modeling approach may change. A summary of Ohio EPA's preliminary modeling approaches is presented in Table 3.

**Table 3 – Summary of Aquatic Life Use impairments and potential modeling approaches**

Station	Stream Name	River Mile	HUC 12 (04100007)	Cause(s) of Impairment	Source(s) of Impairment	IR Cat. <sup>1</sup>	Action <sup>2</sup>	Method <sup>3</sup>	Parameter
302565	Dog Creek	22.10 <sup>H</sup>	08 01	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment
				Direct habitat alterations		4C	Other	Restoration Plan	Habitat
				Other flow regime alterations		4C	N/A	-	-
302560	Town Creek	27.45	08 02	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment
				Other flow regime alterations		4C	N/A	-	-
302599	Maddox Creek	0.90 <sup>W</sup>	08 03	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment
				Direct habitat alterations		4C	Other	Restoration Plan	Habitat
				Other flow regime alterations		4C	N/A	-	-

Station	Stream Name	River Mile	HUC 12 (0410007)	Cause(s) of Impairment	Source(s) of Impairment	IR Cat. <sup>1</sup>	Action <sup>2</sup>	Method <sup>3</sup>	Parameter		
510200	Lower Auglaize River	2.02 <sup>W</sup>	08 06	Direct habitat alterations	Dam or Impoundment	4C	Other	Restoration Plan	Habitat		
				Other flow regime alterations		4C					
302566	Middle Creek	0.50 <sup>H</sup>	10 01	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment		
				Other flow regime alterations		4C			N/A	-	-
302545	Blue Creek	31.95 <sup>H</sup>	10 02	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment		
				Direct habitat alterations		4C			Other	Restoration Plan	Habitat
				Other flow regime alterations		4C			N/A	-	-
302546	Blue Creek	22.00 <sup>W</sup>	10 03	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment		
				Direct habitat alterations		4C			Other	Restoration Plan	Habitat
				Other flow regime alterations		4C			N/A	-	-
302548	Barcer Run	0.75	10 04	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment		
				Direct habitat alterations		4C			Other	Restoration Plan	Habitat
				Other flow regime alterations		4C			N/A	-	-
302568	Bobenmyer Ditch	0.70	10 05	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment		
				Other flow regime alterations		4C			N/A	-	-
302569	Snyder Ditch	0.30	10 05	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment		
				Other flow regime alterations		4C			N/A	-	-
P06P02	Wildcat Creek	0.27	12 05	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment		
				Direct habitat alterations		4C			Other	Restoration Plan	Habitat
				Other flow regime alterations		4C			N/A	-	-
P06S32	Flatrock Creek	9.70	12 06	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment		

Station	Stream Name	River Mile	HUC 12 (04100007)	Cause(s) of Impairment	Source(s) of Impairment	IR Cat. <sup>1</sup>	Action <sup>2</sup>	Method <sup>3</sup>	Parameter
302542	Little Flatrock Creek	1.53	12 07	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment
				Direct habitat alterations		4C	Other	Restoration Plan	Habitat
				Other flow regime alterations	Crop production with subsurface drainage	4C	N/A	-	-
303308	Threemile Creek	0.87	12 09	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment
				Other flow regime alterations	Crop production with subsurface drainage	4C	N/A	-	-
303309	Jackson Ditch	0.05	12 09	Sedimentation/siltation	Dam or impoundment	4C	TMDL	QHEI-sed	-
					Agriculture	5			Sediment
				Other flow regime alterations	Crop production with subsurface drainage	4C	N/A	-	-
302539	Fivemile Creek	0.87	12 09	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment
				Other flow regime alterations	Crop production with subsurface drainage	5	N/A	-	-
P06K28	Eagle Creek	1.57	12 09	Sedimentation/siltation	Agriculture	5	TMDL	QHEI-sed	Sediment
				Other flow regime alterations	Crop production with subsurface drainage	4C	N/A	-	-

1. IR Cat. (Integrated Report Category)

Category	Definition/interpretation
4C	Water body is impaired for this parameter, but the parameter is not considered a pollutant and therefore a TMDL is not required
5	Water body is impaired for this parameter, and it needs to be addressed by additional actions

2. Action

Abbreviation	Definition/interpretation
N/A	Not applicable, no action needed
Other	Action will be taken outside of a new TMDL
TMDL	A Total Maximum Daily Load (TMDL) will be developed

3. Method

<b>Abbreviation</b>	<b>Definition/interpretation</b>
QHEI-sed	Sub-metrics of the QHEI (Qualitative habitat evaluation index) will be used to address sedimentation and embeddedness.
Restoration Plan	A restoration plan will be developed to address a 4C impairment outside of the TMDL process.

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### *TMDL to address sediment impairments required: IR Cat: 5 - Action: TMDL*

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The cause of impairment at 16 sites within 12 HUC-12 subwatersheds was due to impacts from sedimentation and/or siltation. The assessed watersheds are largely rural areas dominated by row crop production with active stream channel maintenance, and most of the impairment stems from the impact of these activities on the landscape. A sediment TMDL calculated using QHEI sub-metrics will appropriately address this cause of impairment.

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### *Restoration plan for habitat required: IR Cat: 4C - Action: Other*

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Several of the assessment sites impacted by sedimentation are also co-listed with direct habitat alterations. These impairments are routine for agricultural watersheds in northwest Ohio and QHEI data collected during the survey can support TMDL calculations for both sedimentation and habitat. While a dam or impoundment was the only source of impairment causing habitat alterations at one location in the watershed, the QHEI metrics will still be appropriate to set restoration goals, so the same TMDL methods will be used.

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### *No action required due to cause of impairment not considered a pollutant: IR Cat: 4C - Action: N/A*

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Flow regime alterations are also co-listed as a cause of impairment at most of the sites with sedimentation impacts. With few exceptions, the streams in this study were historically channelized to facilitate drainage. Production and promotion of subsurface drainage through tile infrastructure was a common practice in this watershed. The result of these drainage modifications is more water exported during high flow events and less available to sustain baseflows. Although flow alteration negatively impacts aquatic life, it is not a pollutant, therefore it is not appropriate to address via a TMDL.

## ***Aquatic Life Use Proposed Targets***

### *Habitat*

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Since its development, the Qualitative Habitat Evaluation Index (QHEI) has been used to evaluate habitat at most biological sampling sites and there is an extensive database that includes QHEI scores and other water quality variables. Strong correlations exist between QHEI scores and the biological indices used in Ohio's water quality standards such as the Index of Biotic Integrity (IBI). Through statistical analyses of data for the QHEI and the biological indices, target values have been established for QHEI scores with respect to the various aquatic life use designations (Ohio EPA 1999). These targets are shown in Table 4.

One of the strongest correlations found through the statistical analyses described above is the negative relationship between the number of modified attributes and the IBI scores. Modified attributes are features or conditions of the stream that have poor habitat quality and therefore are assigned relatively fewer points or negative points in the QHEI scoring. A sub-group of the modified attributes shows a stronger impact on biological performance; these are termed high influence modified attributes (Table 5).

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For example, in order to meet the targets, streams designated as WWH cannot have more than four modified attributes, of which no more than one can be a high influence modified attribute. For simplicity, a pass/fail distinction is made indicating whether or not each of the three targets is being met. Targets are set for: 1) the total QHEI score; 2) the maximum number of all modified attributes; and 3) the maximum number of high influence modified attributes. If the minimum target is satisfied, then that category is assigned a

“1,” if not, it is assigned a “0.” To satisfy the habitat TMDL, the stream segment in question should achieve a score of three.

**Table 4 – QHEI targets for habitat TMDLs**

Habitat TMDL Targets			
QHEI Category	Target		Score
	WWH/ MWH	EWB	
QHEI Score	≥ 60	≥ 75	+ 1
High Influence #	≤ 1	0	+ 1
Total # Modified	≤ 4	≤ 2	+ 1
Habitat TMDL ►			+ 3

**Table 5 – Itemization of modified attributes for computing habitat TMDLs**

High Influence Modified Attributes	Moderate Influence Modified Attributes
<ul style="list-style-type: none"> <li>Recent channelization or no recovery</li> <li>Silt/muck substrate</li> <li>Low or no sinuosity (drainage area ≤ 20 mi<sup>2</sup>)</li> <li>Sparse/no cover</li> <li>Maximum pool depth &lt; 40 cm (wadable or headwater sites)</li> </ul>	<ul style="list-style-type: none"> <li>Recovering channelization</li> <li>Heavy/moderate silt cover</li> <li>Sand substrate (boat sites)</li> <li>Hardpan substrate origin</li> <li>Fair/poor development</li> <li>Low or no sinuosity (drainage area &gt; 20 mi<sup>2</sup>)</li> <li>Only 1-2 cover types</li> <li>Intermittent pools and max pool depth &lt; 40 cm</li> <li>No fast current</li> <li>High/moderate substrate embeddedness</li> <li>High/moderate riffle embeddedness</li> <li>No riffle</li> </ul>

### Sediment

Numeric targets for sediment are based on three sub-metrics of the QHEI. Although the QHEI evaluates the overall quality of stream habitat, some of its component sub-metrics consider particular aspects of stream habitat that are closely related to and/or impacted by the sediment delivery and transport processes occurring in the system. The QHEI sub-metrics used in the sediment TMDL are the substrate, channel morphology, and bank erosion/riparian zone. Table 66 lists targets for each of these metrics.

**Table 6 – QHEI targets for sediment TMDLs**

Sediment TMDL Targets		
QHEI Category	WWH/M WH	EWB
Substrate	≥ 13	≥ 15
Channel	≥ 14	≥ 15
Riparian	≥ 5	≥ 5
Sediment TMDL ►	≥ 32	≥ 35

The substrate sub-metric evaluates predominant substrate types, the amount and origin of these types and the degree of embeddedness and silt cover. This is a qualitative evaluation of the amount of excess fine material in the system and the ability of the channel to assimilate or sort the sediment load.

The channel morphology sub-metric considers sinuosity, riffle and pool development, channelization and channel stability. Except for stability, each of these aspects is directly related to channel form, sediment transport, erosion, and deposition within the channel. Stability reflects the degree of channel erosion, which indicates the potential of the stream to be a significant sediment source.

The bank erosion and riparian zone sub-metric also reflects the likely degree of in-stream sediment sources. The evaluation of floodplain quality is included in this sub-metric, which relates to the capacity of the system to assimilate sediment loads.

## Recreation Use

### *Evaluation of Criteria*

Attainment of recreation use goals is based on numeric criteria for *Escherichia coli* (*E. coli*) as an indicator bacterium. These criteria, shown in Table 7, are also the targets used for TMDLs.

Table lists attainment of recreation use based on criteria at the time of assessment, which were different than the current standards. However, any TMDLs created for those assessment units will use the updated values in Table 7.

**Table 7 – Water quality criteria for recreation use**

Recreation Use	<i>Escherichia coli</i> (colony forming units per 100 mL)	
	90-day geometric mean	Statistical threshold value <sup>1</sup>
Bathing water	126	410 <sup>a</sup>
Primary contact recreation	126	410
Secondary contact recreation	1030	1030

<sup>1</sup> These criteria shall not be exceeded in more than 10 percent of the samples taken during any 90-day period.

<sup>a</sup> A beach action value of 235 *E. coli* colony forming units per 100 mL shall be used for the purpose of issuing beach and bathing water advisories.

**Table 8 – Recreation use attainment information for impaired sampling locations in the Lower Auglaize River Tributaries watershed, 2014.**

Station	Stream Name	River Mile	# Samples	Geometric Mean	Attainment Status	Possible Source(s)
302567	Kyle Prairie Ck	0.20	5	1250	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02S25	Little Auglaize R	47.20	5	475	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02S23	Long Prairie Ck	6.79	5	640	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02P04	Evans Ditch	0.29	5	1126	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02S35	Little Auglaize R	38.26	5	405	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02S05	Little Auglaize R	34.75	5	502	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02S03	Little Auglaize R	22.51	5	386	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
204284	Little Auglaize R	12.65	5	412	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02K04	Hagerman Creek	0.86	5	379	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02S14	Hagerman Creek	12.22	5	1784	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
302553	Hoaglin Creek	13.10	5	1213	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
302554	W. Br. Prairie Ck	0.60	5	365	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02S09	Prairie Creek	12.50	5	201	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02S08	Prairie Creek	1.50	5	377	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02K07	Dog Creek	14.06	5	1260	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02K06	Dog Creek	0.97	5	365	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
302564	Roller Creek	1.35	5	1176	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
302559	Maddox Creek	0.90	5	660	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02G02	Maddox Creek	14.75	5	2196	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
302561	Town Creek	25.35	5	841	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02W10	Town Creek	11.32	5	2973	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P02S18	Middle Creek	1.32	5	322	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
510220	Little Auglaize R	2.02	5	280	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
302556	Middle Creek	0.50	5	381	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
302549	Upper Prairie Ck	0.90	5	395	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P06K31	Blue Creek	29.43	5	478	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
302547	Blue Creek	17.15	5	214	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P06S02	Blue Creek	3.43	5	193	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
302568	Bobenmyer Dit.	0.70	5	180	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
302569	Snyder Ditch	0.30	5	711	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
302544	Flatrock Creek	48.30	5	505	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P06S35	Flatrock Creek	23.72	5	617	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P06S37	Flatrock Creek	28.84	5	528	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P06S31	Flatrock Creek	8.13	5	499	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P06S30	Flatrock Creek	6.02	5	564	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
500250	Flatrock Creek	14.11	5	322	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
302543	Little Flatrock Ck	1.50	5	579	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
302541	Sixmile Creek	3.90	5	235	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
P06K28	Eagle Creek	1.57	5	2859	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife
302539	Fivemile Creek	1.70	5	2248	<b>NON</b>	Failing HSTS, Livestock Runoff, Wildlife

### Recreation Use Proposed Actions

Concentrations of *E. coli* exceeding the water quality standard are due to both pervasive and direct sources. Two predominant pathways exist for pathogen delivery to water bodies. The first pathway is pathogen-rich discharge, including material such as poorly treated or untreated effluent from wastewater treatment plants, combined sewer overflows, sanitary sewer overflows, household sewage treatment systems and livestock access to streams. This is delivered to the stream by direct discharge. The second pathway is pathogen-rich runoff/drainage from nonpoint sources. The associated delivery mechanism is precipitation-driven wash-off. This type of transport involves the delivery of pathogen-rich material by overland flow during precipitation and runoff events (e.g., summer storms, snowmelt, etc.).

Due to these mechanisms of delivery, the sources of pathogens in surface waters can be determined to a certain extent via the level of stream flow observed. Therefore, Ohio EPA proposes using the load duration curve (LDC) framework for recreation use TMDLs. LDCs are an empirical method for determining TMDL pollutant loading and needed reductions. The main advantage of the use of LDCs is in this method’s ability to differentiate loads from various types of sources based on stream flow regime. This is a fairly simple modeling method and the relationships between bacteria source contributions and flow regimes are straight forward. In-stream processes and interactions between sources are simplified, mitigating the major weaknesses of the technique. *Figure 2* shows an example LDC with corresponding TMDL calculations represented in Table 9.

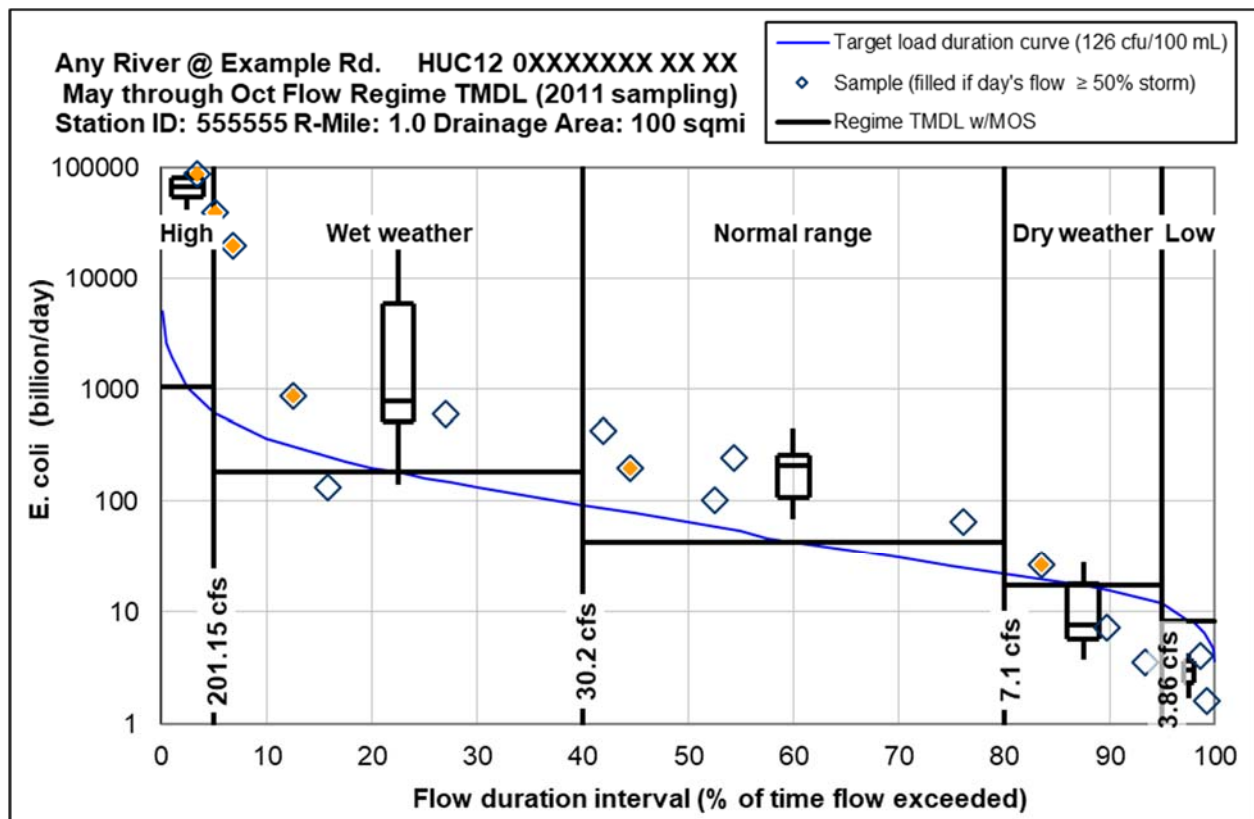


Figure 2 – Example load duration curve.

**Table 9 – Example TMDL table calculations (from above load duration curve).**

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
<b>Samples Per Regime</b>	2	4	5	3	2
<b>Median Sample load</b>	66807	781	209.25	7.72	2.99
<b>Total Load Reduction Required</b>	98.9%	82.8%	84.7%	NA	NA
<b>Total Maximum Daily Load</b>	1036.68	182.09	43.25	17.26	8.35
<b>Margin of Safety: 20%</b>	207.34	36.42	8.65	3.45	1.67
<b>Allowance for Future Growth</b>	62.20	10.93	2.60	1.04	0.50
<b>Load Allocation</b>	740.71	127.29	27.63	8.98	2.58
<b>Wasteload Allocation Total</b>	26.43	7.46	4.37	3.80	3.60
<b>MS4</b>	23.01	4.04	0.96	0.38	0.19
<b>Example Town WWTP XPX00XXX</b>	3.41	3.41	3.41	3.41	3.41

### Recreation Use Proposed Targets

The primary contact recreation geometric mean criterion of 126 *E. coli* colony forming units per 100 mL will be used as the target concentration for the recreation use TMDL. As shown as the blue curve in the example load duration curve in Figure 2, this target concentration is converted into a load throughout the calculated flow regime. The black horizontal lines in Figure 2 and the “Total Maximum Daily Load” row in Table 9 show the TMDL values for five flow regime categories. This TMDL is the median of the curve load within each flow regime category.

## Water Supply Use

### Evaluation of Criteria

The public drinking water supply use includes surface waters from which public drinking water is supplied. Attainment determination associated with this use designation is shown in Table **Error! Not a valid bookmark self-reference.**

**Table 4 – Water quality criteria for public drinking water supply use**

Indicator	Full attainment conditions	“Watch List” conditions	Impaired Conditions
Algae: Cyanotoxins <sup>a</sup>	No more than one excursion <sup>b</sup> above the state drinking water thresholds (microcystins = 1.6 µg/L, cylindrospermopsin = 3.0 µg/L, and saxitoxins = 1.6 µg/L) within the 5-year period	Maximum instantaneous value ≥ 50% of the state drinking water thresholds	Two or more excursions <sup>b</sup> above the state drinking water thresholds (microcystins = 1.6 µg/L) within the 5-year period
Nitrate	No more than one excursion <sup>b</sup> above 10.0 mg/L within the 5-year period	Maximum instantaneous value > 8.0 mg/L	Two or more excursions <sup>b</sup> above 10.0 mg/L within the 5-year period
Pesticides	Annual average for atrazine does not exceed 3.0 µg/L	Running quarterly average > WQ criteria OR Maximum instantaneous value > 4x WQ criteria	Annual average exceeds WQ criteria (atrazine = 3.0 µg/L)

<sup>a</sup> Impaired conditions based on source water detections at inland public water supply systems and detections at public water system intakes for Lake Erie source waters. Cyanotoxins include: microcystins, saxitoxins, anatoxin-a and cylindrospermopsin.

<sup>b</sup> Excursions must be at least 30 days apart in order to capture separate or extended source water quality events.

**Table 11 – Public drinking water use attainment information for impaired watershed assessment units in the Lower Auglaize River Tributaries watershed.**

Public Drinking Water System	Pollutant	Attainment Status
04100007 06-04 Dry Fork-L. Auglaize R.		
Delphos	Algae	Impaired
	Nitrate	Impaired

### Public Water Supply Proposed Actions

As mentioned in the Aquatic Life Use Proposed Action section above, Ohio EPA considers many factors when determining an action to address a water quality impairment. Source water for the City of Delphos public water system had microcystins and nitrate concentrations exceeding the state thresholds. An in-depth overview of the City of Delphos public water supply as well as a summary of the impairments can be found in [Appendix A](#).

The Drinking Water Source Assessment for the City of Delphos was first produced by Ohio EPA’s Source Water Assessment and Protection Program in 2002; the report documented the drinking water source protection areas for both the City’s sources of drinking water – its intake on the Little Auglaize River and a wellfield north of the city. The report was updated in 2007 and 2021, which document changes to water sources for the City of Delphos Public Water System, specifically discontinued use of the wellfield and reliance on surface water sources, the intake on the Little Auglaize River and the associated underground reservoir. All surface waters are considered to be susceptible to contamination; by their nature surface waters are accessible and can be easily contaminated by chemicals and pathogens. After the City of Delphos accepts the revised report, Ohio EPA will provide assistance to the City of Delphos Public Water System in developing a drinking water source protection plan.

Proposed actions for public drinking water use impairments are listed on Table 12.

**Table 12 – Summary of public drinking water use impairments and potential TMDL modeling approaches**

HUC-12	Portion of HUC-12	Cause(s) of	Action	Method
06 04	Dry Fork-L. Auglaize R.	Algae	Other	Follow-up <sup>1</sup>
		Nitrate	TMDL	SWAT

Abbreviation	Definition/interpretation
<sup>1</sup> Follow-up	Follow-up assessment is required to determine if the attainment status has changed or to clarify/verify the listed cause of impairment.

The raw water detections of microcystins triggered the City of Delphos water system to submit a Treatment Optimization Protocol (short-term actions) and General Plan (long-term actions) for addressing Harmful Algal Bloom (HAB) events. The water system’s HAB General Plan was approved by Ohio EPA on 8/14/2019 and includes reservoir management actions to monitor and mitigate HAB events as well as evaluating treatment processes to remove microcystins. At this time, follow-up sampling is recommended for the public water supply impairment to

determine if the approved HAB General Plan is effective in reducing algal toxins in the source water. Follow-up sampling will occur during our targeted study and will include upground reservoir sampling. **Ohio EPA will not be developing a TMDL for algae, this impairment will be addressed through the HAB General Plan.**

**Nitrate impairments will be addressed through the development of a TMDL.** The Soil and Water Assessment Tool (SWAT) model, developed by The Ohio State University (OSU), will be utilized in this effort. OSU's Maumee River Basin SWAT model covers the Delphos drinking water supply watershed and includes nitrate. A recent version of this model simulates manure fertilization application in addition to all other relevant agricultural activities. In OSU's SWAT model, the hydrologic response units, the smallest spatial unit of the model, are detailed enough to allow for field-level analysis. This will allow for model scenarios to be run that provide nutrient reduction best management practice options that meet the TMDL. The results of this TMDL will provide for more effective implementation strategies to be included within the TMDL. These could be tied to Agricultural Conservation Planning Framework toolbox providing local stakeholders with detailed geographic options for meeting nitrate reduction goals.

### ***Public Water Supply Proposed Targets***

The drinking water maximum contaminant level for nitrate of 10 mg/L will be used as the target concentration for the nitrate public water supply use TMDL. A significant, explicit margin of safety will be applied to this TMDL calculation to protect from calculation and monitoring uncertainties.

## References

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 1999. *Association between nutrients, habitat, and the aquatic biota of Ohio's rivers and streams*. Published at:

[epa.ohio.gov/static/Portals/35/documents/assoc\\_load.pdf](http://epa.ohio.gov/static/Portals/35/documents/assoc_load.pdf)

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 2014. 2014 Study Plan for the Lower Auglaize River Tributaries, Defiance, Mercer, Paulding, and Van Wert Counties, Ohio. Division of Surface Water. Ecological Assessment Section. Columbus, Ohio. Published at:

[epa.ohio.gov/static/Portals/35/tmdl/LowerAuglaize\\_StudyPlan\\_041114.pdf](http://epa.ohio.gov/static/Portals/35/tmdl/LowerAuglaize_StudyPlan_041114.pdf)

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 2015. Biological and Water Quality Study of the Lower Auglaize River Tributaries, Defiance, Mercer, Paulding, and Van Wert Counties, Ohio.

Division of Surface Water. Ecological Assessment Section. Columbus, Ohio. Published

at: [epa.ohio.gov/static/Portals/35/documents/2014 Lower Auglaize River Tributaries TSD.pdf](http://epa.ohio.gov/static/Portals/35/documents/2014_Lower_Auglaize_River_Tributaries_TSD.pdf)

## Appendix A

### Summary of Impairments at Delphos PWS (OH0200412)

Ohio EPA has developed an assessment methodology for public water supply beneficial use which focuses on source water contaminants not effectively removed through conventional treatment methods. Source water quality is assessed through comparison of water quality data to numeric chemical water quality criteria for three core indicators: nitrate; pesticides (atrazine); and cyanotoxins. The *Integrated Water Quality Monitoring and Assessment Report* (Ohio IR) describes this methodology and is available at [epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/surface-water/reports-data/ohio-integrated-water-quality-monitoring-and-assessment-report](http://epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/surface-water/reports-data/ohio-integrated-water-quality-monitoring-and-assessment-report). The Ohio IR is updated on a two-year cycle, and the current report at the time of this study was the 2020 Ohio IR. To assess the PWS beneficial use for each indicator, samples were collected at representative sites and analyzed for nitrate, atrazine and cyanotoxins (microcystins, saxitoxins and cylindrospermopsin). Additionally, all surface water PWSs must conduct routine microcystins monitoring and cyanobacteria screening as specified in Ohio Administrative Code (OAC) 3745-90-03. Detections of total microcystins in raw and finished water samples trigger treatment technique requirements detailed in OAC 3745-90-05 that require written protocols for addressing cyanotoxins. All cyanotoxin (microcystins, saxitoxins and cylindrospermopsin) results are available on Ohio EPA's website at [http://wwwapp.epa.ohio.gov/dsw/hab/HAB\\_Sampling\\_Results.xlsx](http://wwwapp.epa.ohio.gov/dsw/hab/HAB_Sampling_Results.xlsx).

The City of Delphos Water Treatment Plant (DWTP) serves a population of approximately 7,101 in Allen County (Ohio). Water is supplied through approximately 2,840 metered service connections, and DWTP has an approved capacity of 3.75 million gallons per day. The water treatment system obtains its water from a combination of surface and groundwater sources, though the majority is surface water taken from Little Auglaize River and pumped to an upground reservoir, Delphos Reservoir, with capacity of 450 million gallons. The water plant uses a conventional surface water treatment process that consists of pre-oxidation and rapid-mix, flocculation, sedimentation, up-flow clarification, softening, recarbonation, gravity filtration, granulated activated carbon adsorption, ultra-violet reactor dosing, filtration, and disinfection.

The Drinking Water Source Assessment for the City of Delphos was first produced by Ohio EPA's Source Water Assessment and Protection Program in 2002; the report documented the drinking water source protection areas for both of the City's sources of drinking water – its intake on the Little Auglaize River and a wellfield north of the city. The report was updated in 2007. The DWTP has since discontinued the use of its wellfield and Ohio EPA is in the process of updating the Drinking Water Source Assessment for the intake on the Little Auglaize River and the associated upground reservoir. All surface waters are considered to be susceptible to contamination; by their nature surface waters are accessible and can be easily contaminated by chemicals and pathogens. After the City of Delphos accepts the revised report Ohio EPA will provide assistance to the City of Delphos Public Water System in developing a drinking water source protection plan.

In the 2020 Ohio IR, the drinking water use support for the watershed assessment unit (Dry Fork – Little Auglaize River) that includes intakes for City of Delphos is listed as impaired for nitrate and algae (cyanotoxins). Nitrate samples collected from the source water for DWTP exceeded the water quality criterion (10 mg/L) in 2015 and 2017 (maximum concentration 16.5 mg/L). The City of Delphos also monitors nitrate concentrations at their intake on the Little Auglaize River, and this data provides additional support for the nitrate impairment with nitrate concentrations exceeding 10 mg/L routinely during recent years (see table below). For the algae (cyanotoxin) impairment, raw water monitoring at the treatment plant had microcystins exceeding the water quality threshold during 2017, 2018, and 2019 (maximum concentration 19.2 µg/L). Microcystins occurred during

November through April months, and additional sampling for phytoplankton identification found a cold-tolerant cyanobacteria (*Planktothrix rubescens*).

The raw water detections of microcystins triggered the DWTP to submit a Treatment Optimization Protocol (short-term actions) and General Plan (long-term actions) for addressing HAB events. The water system's HAB General Plan was approved by Ohio EPA on 8/14/2019 and includes reservoir management actions to monitor and mitigate HAB events as well as evaluating in-plant treatment processes to remove microcystins. The water plant staff are implementing reservoir management actions to monitor the reservoir with a multiparameter sonde for early indicators of cyanobacteria and when necessary treating the reservoir with algaecide to limit cyanobacteria growth. The staff note that cyanobacteria can occur at depth and have adapted algaecide application to target the depth of the cyanobacteria. Additionally, the water system uses selective pumping from the river intake to avoid high nutrient (nitrate and phosphorus) concentrations, when possible, though water capacity needs are principal. When high nitrate levels occur, water system staff have taken additional steps to sample upstream of their intake to document potential areas of concern and have reported concerns to local and state agencies.

**Table A1 – Summary of nitrate sampled at Delphos PWS intake on Little Auglaize River (data provided by public water system).**

Year	Maximum Nitrate (mg/L)	Count of events (days) exceeding 10.0 mg/L
<b>2016</b>	16.5	21
<b>2017</b>	19.7	27
<b>2018</b>	16.4	2
<b>2019</b>	11.3	1
<b>2020</b>	15.0	9