



**Environmental
Protection
Agency**

Loading Analysis Plan and Supporting Data Acquisition Needed for the **Mohican River Watershed**

Total Maximum Daily Load Development



Clear Fork of the Mohican River at Benedict Road bridge outside of the Village of Butler.

Ohio EPA Technical Report AMS/2007-MOHIC-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 the strategy to address water quality impairments in the Mohican watershed. These recommendations are based on data collected as part of a biological and water quality study in 2007. A description of the project area, sites, data types and methods can be found in the *2007 Study Plan for the Walhonding Watershed* (Ohio EPA, 2007). A summary of the study results can be found in *Biological and Water Quality Study of the Mohican River and Selected Tributaries* (Ohio EPA, 2009).

Sites in the Mohican watershed were assessed for aquatic life use, recreation use, and public drinking water supply use. The attainment of aquatic life and recreation use is based on specific criteria. The attainment of the public drinking water supply use is detailed in the current cycle of Ohio's Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2022). The purpose of this loading analysis plan is to examine the water quality criteria and lay 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 see Ohio's Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2022).

Aquatic Life Use

Evaluation of Biocriteria

Aquatic Life Use (ALU) attainment details are documented in the biological and water quality report (Ohio EPA, 2009). The attainment status for the impaired sites is shown in Figure 1. A list of the assessment sites that did not meet their aquatic life use designation is in Table 1. This table also contains the causes and sources of impairment for each site.

In 2007, Ohio EPA completed an assessment for ALU at 81 sites in this watershed. Of the 81 sites sampled for ALU, 60 locations (74.1%) were in full attainment, 11 locations were in partial attainment (13.6%) and 10 locations (12.3%) were in non-attainment.

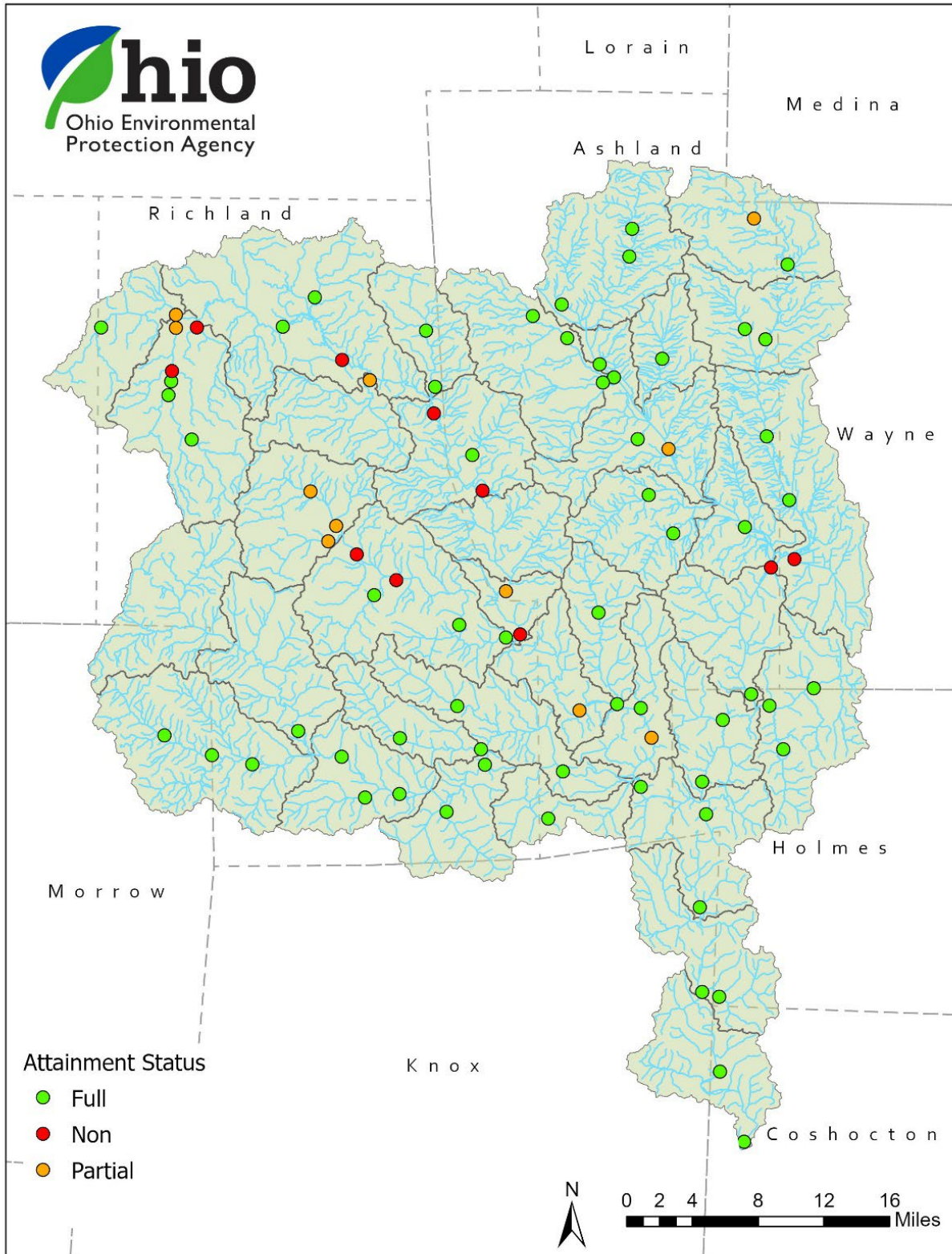


Figure 1 — Map summarizing ALU attainment status in the Mohican watershed in 2007.

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Table 1 – Aquatic life use attainment information for impaired sampling locations in the Mohican watershed, 2007.

Station	Location	ALU	River Mile ^a	Drain. Area (mi. ²)	QHEI	Attain. Status	Causes	Sources
R01W34	MARSH RUN N OF SHELBY @ SR 61	WWH	0.17 ^W	20.8	27.0	Partial	Sedimentation/Siltation	Dam or Impoundment, Non-irrigated Crop Production, Channelization
R01W33	BLACK FK. MOHICAN R. N OF SHELBY @ LONDON WEST RD.	WWH	51.32 ^W	30.8	64.5	Partial	Direct Habitat Alterations	Channelization
							Other flow regime alterations	Channelization, urban runoff/storm sewers
300220	BEAR RUN @ LONDON WEST RD. (CR 58)	WWH	0.48 ^H	8.6	26.0	Non	Direct Habitat Alterations	Non-irrigated Crop Production, channelization
							Dissolved oxygen	Manure runoff, unrestricted cattle access
							Organic Enrichment (Sewage) Biological Indicators	Manure runoff, unrestricted cattle access
R01S24	TUBY RUN AT SHELBY @ FOOTBRIDGE NEAR MOUTH	WWH	0.10 ^H	4.5	53.5	Non	Total Dissolved Solids	Industrial Point Source Discharge
300224	BRUBAKER CREEK @ EBY RD. (TWP. RD. 230)	WWH	0.30 ^W	22.7	66.0	Partial	Nutrient/Eutrophication Biological Indicators	Non-irrigated Crop Production
							Direct Habitat Alterations	Channelization
200657	BLACK FK. MOHICAN R. SE OF GANGES @ SR 13	WWH	36.60 ^B	108.0	35.5	Non	Turbidity	Sediment resuspension (clean sediment)
							Other flow regime alterations	Channelization

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Station	Location	ALU	River Mile ^a	Drain. Area (mi. ²)	QHEI	Attain. Status	Causes	Sources
R01G01	BLACK FK. MOHICAN R. @ CHARLES RD. (WELLER TWP. RD. 89)	WWH	29.67 ^B	166.0	57.5	Non	Nutrient/Eutrophication Biological Indicators	Crop Production with Subsurface Drainage
							Sedimentation/siltation	Channelization
300231	BLACK FK. MOHICAN R. AT CRIDER RD. (RICHLAND CR 92)	WWH	23.31 ^B	190.0	56.0	Non	Turbidity	Dam or Impoundment, Channelization
							Other flow regime alterations	Dam or Impoundment, Channelization
							Dissolved oxygen	Dam or Impoundment, Non-irrigated Crop Production
							Direct habitat alterations	Dam or Impoundment, Channelization
R01W16	ROCKY FK. MOHICAN R. N OF MANSFIELD @ BOWMAN RD (CR 215)	WWH	16.43 ^H	11.2	66.5	Partial	Natural Conditions (Flow or Habitat)	Natural sources
R01P22	ROCKY FK. MOHICAN R. AT MANSFIELD @ LONGVIEW AVE.	WWH	14.23 ^H	19.3	45.0	Partial	Metals	Sediment Resuspension (Contaminated Sediment)
							Nutrient/eutrophication biological indicators	Unspecified urban storm water
300238	TOUBY RUN AT MANSFIELD @ BOWMAN ST.	WWH	1.00 ^H	9.2	48.5	Partial	High Flow Regime	Unspecified Urban Storm water
							Unknown	
611900	ROCKY FK. MOHICAN R. AT MANSFIELD @ SR 39 (PARK AVE. E)	WWH	12.49 ^W	30.3	50.5	Non	Nutrient/Eutrophication Biological Indicators	Unspecified Urban Storm water
601800	ROCKY FK. MOHICAN R. DST MANSFIELD @ SR 39	WWH	10.13 ^W	51.0	88.5	Non	Organic Enrichment (Sewage) Biological Indicators	Municipal Point Source Discharges, Unspecified Urban Storm water

Watershed

Station	Location	ALU	River Mile ^a	Drain. Area (mi. ²)	QHEI	Attain. Status	Causes	Sources
							Nutrient/Eutrophication Biological Indicators	Municipal Point Source Discharges, Unspecified Urban Storm water
R01P19	BLACK FK. MOHICAN R. @ TWP. RD. 1265	WWH	17.81 ^W	218.0	68.0	Partial	Other flow regime alterations	Dam or Impoundment
							Nutrient/Eutrophication Biological Indicators	Dam or Impoundment
							Suspended algae	Dam or Impoundment
R01P29	BLACK FK. MOHICAN R. NW OF PERRYSVILLE @ SR 39	WWH	14.65 ^B	224.0	60.5	Non	Dissolved oxygen	Dam or Impoundment
							Nutrient/eutrophication biological indicators	Dam or Impoundment
300256	MUDDY FK. MOHICAN R. @ JACKSON TWP. RD. 101	WWH	23.29 ^H	9.3	73.5	Partial	Other flow regime alterations	Dam or Impoundment
							High Flow Regime	Dam or Impoundment, channelization
300261	KISER DITCH @ SR 95	MWH-C	0.38 ^H	19.4	32.5	Non	Dissolved oxygen	Dam or Impoundment, channelization
							Biochemical oxygen demand	Dam or Impoundment, channelization
							Sedimentation/siltation	Dam or Impoundment, channelization
R02W17	JEROME FORK NW OF JEROMESVILLE @ TWP. RD. 1600	WWH	7.90 ^W	114.0	56.5	Partial	Nutrient/Eutrophication Biological Indicators	Municipal point source discharges
							Sedimentation/siltation	Channelization
							Sedimentation/Siltation	Dam or Impoundment, Non-irrigated Crop Production, Channelization
300272	LAKE FORK MOHICAN R. @ SR 95	WWH	14.04 ^W	271.0	47.5	Non	Direct Habitat Alterations	Dam or Impoundment, channelization
							Nutrient/Eutrophication Biological Indicators	Dam or Impoundment, Non-irrigated Crop Production

Watershed

Station	Location	ALU	River Mile ^a	Drain. Area (mi. ²)	QHEI	Attain. Status	Causes	Sources
							Dissolved oxygen	Dam or Impoundment, Non-irrigated Crop Production
							Other flow regime alterations	Dam or Impoundment, channelization
200642	BLACK FK. MOHICAN R. AT PERRYSVILLE, DST. SR 39	WWH	7.00 ^B	316.0	83.0	Partial	Natural Conditions (Flow or Habitat)	Freshets or Major Flooding
R99Q08	BLACK FK. MOHICAN R. DST. LOUDONVILLE @ SR 39	WWH	2.53 ^B	349.0	80.5	Partial	Natural Conditions (Flow or Habitat)	Freshets or Major Flooding

¹ Aquatic Life Use (ALU) designations: warmwater habitat (WWH); exceptional warmwater habitat (EWH); modified warmwater habitat (MWH); modified warmwater habitat – channelized (MWH-C); coldwater habitat (CWH), limited resource waters (LRW) and seasonal salmonid habitat (SSH) do not have associated biological criteria.

^a River Mile (RM) represents the Point of Record (POR) for the station and may not be the actual sampling RM.

² In general, the assessment method used at a site is determined by its drainage area (DA) according to the following:

Headwater: DA ≤ 20 mi²; wading: DA >20 mi² and ≤ 500 mi²; boat: DA > 500 mi².

H Headwater site (draining ≤20 miles²).

W Wading site (non-boat site draining >20 miles²).

B Boat site (large or deep waters, necessitating the use of boat sampling methods)

Aquatic Life Use Proposed Actions

Ohio EPA considers many factors when deciding how to address impairments. For some projects, no TMDL is required. The sites within 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. Ohio EPA must also 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 2.

Table 2 – Summary of ALU impairments and potential modeling approaches.

Station	Stream Name	River Mile	Assessment Unit (05040002)	Cause(s) of Impairment	Source(s) of Impairment	IR Cat. ¹	Action ²	Method ³	Parameter ⁴
R01W34	Marsh Run	0.17	01 01	Sedimentation/Siltation	Dam or Impoundment, Non-irrigated Crop Production, Channelization	5	TMDL	QHEI-sed	Sediment
R01W33	Black Fork of Mohican	51.32	01 02	Direct Habitat Alterations	Channelization	4C	Other	Restoration Plan	Habitat
				Other flow regime alterations	Channelization, urban runoff/storm sewers	5	Other	Follow-up	-
				Direct Habitat Alterations	Non-irrigated Crop Production, channelization	4C	Other	Restoration Plan	Habitat
300220	Bear Run	0.48	01 02	Dissolved oxygen	Manure runoff, unrestricted cattle access	5	Other	Follow-up	-
				Organic Enrichment (Sewage) Biological Indicators	Manure runoff, unrestricted cattle access	5	Other	Follow-up	-
R01S24	Tuby Run	0.10	01 02	Total Dissolved Solids	Industrial Point Source Discharge	5	Other	Follow-up	-

Watershed

Station	Stream Name	River Mile	Assessment Unit (05040002)	Cause(s) of Impairment	Source(s) of Impairment	IR Cat. ¹	Action ²	Method ³	Parameter ⁴
300224	Brubaker Creek	0.30	01 03	Nutrient/Eutrophication Biological Indicators	Non-irrigated Crop Production	5	Other	Follow-up	-
				Direct Habitat Alterations	Channelization	4C	Other	Restoration Plan	Habitat
200657	Black Fork of Mohican	36.60	01 05	Turbidity	Sediment resuspension (clean sediment)	5	Other	Follow-up	-
				Other flow regime alterations	Channelization	5	Other	Follow-up	-
R01G01	Black Fork of Mohican	29.67	02 01	Nutrient/Eutrophication Biological Indicators	Crop Production with Subsurface Drainage	5	Other	Follow-up	-
				Sedimentation/siltation	Channelization	5	TMDL	QHEI-sed	Sediment
300231	Black Fork of Mohican	23.31	02 01	Turbidity	Dam or Impoundment, Channelization	5	Other	Follow-up	-
				Other flow regime alterations	Dam or Impoundment, Channelization	5	Other	Follow-up	-
				Dissolved oxygen	Dam or Impoundment, Non-irrigated Crop Production	5	Other	Follow-up	-
				Direct habitat alterations	Dam or Impoundment, Channelization	4C	Other	Restoration Plan	Habitat
R01W16	Rocky Fork of Mohican	16.43	02 03	Natural Conditions (Flow or Habitat)	Natural sources	4C	N/A	-	-
R01P22	Rocky Fork of Mohican	14.23	02 03	Metals	Sediment Resuspension (Contaminated Sediment)	5	Other	Follow-up	-

Watershed

Station	Stream Name	River Mile	Assessment Unit (05040002)	Cause(s) of Impairment	Source(s) of Impairment	IR Cat. ¹	Action ²	Method ³	Parameter ⁴
				Nutrient/eutrophication biological indicators	Unspecified urban storm water	5	Other	Follow-up	-
300238	Touby Run	1.00	02 03	High Flow Regime	Unspecified Urban Storm water	5	Other	Follow-up	-
				Unknown		5	Other	Follow-up	-
611900	Rocky Fork of Mohican	12.49	02 04	Nutrient/Eutrophication Biological Indicators	Unspecified Urban Storm water	5	Other	Follow-up	-
601800	Rocky Fork of Mohican	10.13	02 04	Organic Enrichment (Sewage) Biological Indicators	Municipal Point Source Discharges, Unspecified Urban Storm water	5	Other	Follow-up	-
				Nutrient/Eutrophication Biological Indicators	Municipal Point Source Discharges, Unspecified Urban Storm water	5	Other	Follow-up	-
R01P19	Black Fork of Mohican	17.81	02 05	Other flow regime alterations	Dam or Impoundment	5	Other	Follow-up	-
				Nutrient/Eutrophication Biological Indicators	Dam or Impoundment	5	Other	Follow-up	-
				Suspended algae	Dam or Impoundment	5	Other	Follow-up	-
R01P29	Black Fork of Mohican	14.65	02 05	Dissolved oxygen	Dam or Impoundment	5	Other	Follow-up	-
				Nutrient/eutrophication biological indicators	Dam or Impoundment	5	Other	Follow-up	-
300256	Muddy Fork of Mohican	23.29	05 01	Other flow regime alterations	Dam or Impoundment	5	Other	Follow-up	-
300261	Kiser Ditch	0.38	05 03	High Flow Regime	Dam or Impoundment, channelization	5	Other	Follow-up	-
				Dissolved oxygen	Dam or Impoundment, channelization	5	Other	Follow-up	-
				Biochemical oxygen demand	Dam or Impoundment, channelization	5	Other	Follow-up	-

Watershed

Station	Stream Name	River Mile	Assessment Unit (05040002)	Cause(s) of Impairment	Source(s) of Impairment	IR Cat. ¹	Action ²	Method ³	Parameter ⁴
				Sedimentation/siltation	Dam or Impoundment, channelization	5	Other	Follow-up	-
R02W17	Jerome Fork of Mohican	7.90	06 05	Nutrient/Eutrophication Biological Indicators	Municipal point source discharges	5	Other	Follow-up	-
				Sedimentation/siltation	Channelization	5	TMDL	QHEI-sed	Sediment
				Sedimentation/Siltation	Dam or Impoundment, Non-irrigated Crop Production, Channelization	5	Other	Follow-up	-
				Direct Habitat Alterations	Dam or Impoundment, channelization	5	Other	Follow-up	-
300272	Lake Fork of Mohican	14.04	07 02	Nutrient/Eutrophication Biological Indicators	Dam or Impoundment, Non-irrigated Crop Production	5	Other	Follow-up	-
				Dissolved oxygen	Dam or Impoundment, Non-irrigated Crop Production	5	Other	Follow-up	-
				Other flow regime alterations	Dam or Impoundment, channelization	5	Other	Follow-up	-
200642	Black Fork of Mohican	7.00	08 02	Natural Conditions (Flow or Habitat)	Freshets or Major Flooding	4C	N/A	-	-
R99Q08	Black Fork of Mohican	2.53	08 03	Natural Conditions (Flow or Habitat)	Freshets or Major Flooding	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

Abbreviation	Definition/interpretation
Follow-up	Follow-up sampling is required to determine if the attainment status has changed after ongoing implementation has occurred or to clarify/verify the listed cause of impairment.
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.

- ⁴ Parameter – For TMDL or Other actions, the parameter listed in this field will be the pollutant or non-pollutant stressor used to address impairment. This parameter will match a heading in the Proposed Targets section.

The following subsections are organized to explain the various methods being used to address the proposed actions outlined in Table 2 above.

No action required due to natural causes of impairment: IR Cat: 4C - Action: N/A

For several sites outlined in Table 2, the source of impairment is classified as natural. At the Rocky Fork of the Mohican River Mile (RM) 16.32, the Black Fork of the Mohican RM 7.00, and the Black Fork of the Mohican RM 2.53, the sources of the impairments are natural sources or major flooding. Impairments due to natural causes are exempt from TMDL requirements. For these sites, where no other sources of impairment have been documented, no further action is required to address these impairments.

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

The cause of impairment for several sites outlined on Table 2 for the Mohican River watershed was direct habitat alterations, specifically at the Black Fork of the Mohican at River Miles 23.31, 36.6 and 51.32 and Bear Run at RM 0.48. At all these assessment sites the impacts were from non-natural sources, e.g., channelization and agriculture, and a restoration plan will be developed. This plan uses an empirical method providing benchmarks for certain sub-metrics of each impaired sites' Qualitative Habitat Evaluation Index (QHEI). The QHEI is measured at every aquatic life use assessment site by Ohio EPA. The restoration plan for this watershed will be developed in a separate report that will include several other watersheds. Updates to the restoration plan will be posted to [*Ohio EPA's multi-watershed TMDL webpage*](#).

Follow-up monitoring is recommended prior to TMDL development to address some causes: IR Cat: 5 - Action: Other

Several causes of impairment outlined in Table 2 for the Mohican River watershed are from impacts that may not persist. Since the most recent assessment performed in 2007, several actions in the watershed may have ameliorated these causes.

Total dissolved solids is listed as the cause of the impairment at Tuby Run RM 0.10. The source is identified as an industrial point source discharge, namely NPDES permit 2ID00002 - ArcelorMittal Tubular Products. In July 2022 this facility stopped regularly discharging and is routing wastewater to the Shelby wastewater treatment plant. The facility continues to have a permit for storm water discharge and to discharge process water in emergency situations. The reduction in the discharge of process water may improve conditions downstream.

The two causes of the impairment are listed for Rocky Fork RM 10.13 are organic enrichment and nutrient /eutrophication biological indicators. The source is identified as the Mansfield wastewater treatment plant. Since the survey in 2007, several improvements have been made to the Mansfield wastewater treatment plant, including enhancements to the equalization basin, the addition of phosphorus removal by chemical treatment, the addition of chemical flocculant, and inflow and infiltration reduction.

At Jerome Fork RM 7.90, the partial impairment was attributed to nutrient /eutrophication biological indicators from the Ashland wastewater treatment plant. Since the survey in 2007, no substantial improvements have been made to the Ashland wastewater treatment plant. The plant is planning some future work to address the plant bypass.

Six sites have dam or dam impoundment listed as the sources of the impairment: Black Fork of Mohican at River Miles 23.31, 17.81 and 14.65; Muddy Fork of Mohican at RM 23.29; Kiser Ditch at RM 0.38; and Lake Fork of the Mohican at RM 14.04. Since these dams are for recreational lakes or flood control, dam removal is not being considered. Management of the dam, including water release methods and timing can alter downstream conditions.

At the Rocky Fork of the Mohican RM 14.23, metals were identified at the cause of impairment. The source of the metals is contaminated sediment attributed to general urban runoff within the Mansfield city limits. Results from sediment sample collected at this site did exceed several guidance values. However, sediment contaminant concentrations did improve compared to a sample collected in the same general area in 1993 (except for several metals). Conditions may have continued to improve since the most recent sampling in 2007.

The source of impairment for several site is related to agriculture. At the Black Fork of the Mohican RM 29.67, the source was identified as crop production with subsurface drainage. At Bear Run 0.48, the source was identified as manure runoff and unrestricted cattle access. At Brubaker RM 0.30, the source was identified as non-irrigated crop production. Conditions at these the surrounding agricultural operation may have changed since the survey in 2007.

Similarly, several sites have urban runoff or urban stormwater identified as the source of the impairment, including Black Fork of the Mohican RM 51.31, Touby Rub RM 1.00, Rocky Fork of the Mohican RM 14.23, and RM 12.49. Conditions in these urban areas could have changed substantially since the survey in 2007.

Because of these factors, follow-up monitoring is recommended prior to TMDL development. When this follow-up monitoring occurs another study plan, water quality results, and Loading Analysis Plan will be published prior to any new TMDL development. All three of those future documents will include public comment periods before they are considered final.

[TMDL to address sediment impairments required: IR Cat: 5 - Action: TMDL](#)

The cause of impairment for three sites outlined on Table 2 for Mohican watershed was sedimentation and/or siltation, specifically Marsh Run RM 0.17, Black Fork of the Mohican RM 29.67, and Jerome Fork of the Mohican RM 7.90. The sedimentation is largely due to channelization. A sediment TMDL calculated using QHEI sub-metrics will appropriately address this cause of impairment. Sediment impairments for this watershed will be developed in a separate report that will include several other watersheds. Updates to this separate sediment TMDL report will be posted to [Ohio EPA's multi-watershed TMDL webpage](#).

Aquatic Life Use Proposed Targets

[Habitat](#)

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 3.

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 4).

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For example, 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 if 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 3 – QHEI targets for habitat TMDLs

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

Table 4 – Itemization of modified attributes for computing habitat TMDLs

High Influence Modified Attributes	Moderate Influence Modified Attributes	
<ul style="list-style-type: none"> Recent channelization or no recovery Silt/muck substrate Low or no sinuosity (drainage area ≤ 20 mi²) Sparse/no cover Maximum pool depth < 40 cm (wadable or headwater sites) 	<ul style="list-style-type: none"> Recovering channelization Heavy/moderate silt cover Sand substrate (boat sites) Hardpan substrate origin Fair/poor development Low or no sinuosity (drainage area > 20 mi²) Only 1-2 cover types 	<ul style="list-style-type: none"> Intermittent pools and max pool depth < 40 cm No fast current High/moderate substrate embeddedness High/moderate riffle embeddedness No riffle

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 5 lists targets for each of these metrics.

Table 5 – QHEI targets for sediment TMDLs

Sediment TMDL Targets		
QHEI Category	WWH/ MWH	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 6, are also the targets used for TMDLs. Table 7 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 6.

Table 6 – 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 ¹
Bathing water	126	410 ^a
Primary contact recreation	126	410
Secondary contact recreation	1030	1030

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

^a 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 7 – Recreation use attainment information for impaired sampling locations in the Mohican River watershed, 2007.

Station	Stream Name	HUC-12 (05040004)	RM	# Samples	Geo. Mean
R01P29	Black Fork Mohican River	02 05	14.65	4	107
R01G02	Black Fork Mohican River	02 05	18.3	10	173
R99Q16	Clear Fork Mohican River	03 03	23.35	5	767
R01S30	Clear Fork Mohican River	03 03	29.57	10	700
R01W07	Clear Fork Mohican River	04 01	16.17	5	400
R01G03	Clear Fork Mohican River	04 01	19.83	13	631
300240	Clear Fork Mohican River	04 03	10.55	9	238
300270	Lake Fork Mohican River	07 02	7.33	10	1126
300160	Lake Fork Mohican River	07 03	1	6	529
200642	Black Fork Mohican River	08 02	7.09	4	604
R99Q08	Black Fork Mohican River	08 03	2.5	9	1302
601870	Mohican River	08 04	16.92	10	272
300285	Mohican River	08 04	22.54	5	295
300286	Mohican River	08 04	27	5	506
200636	Mohican River	08 05	11.66	4	174
200634	Mohican River	08 06	0.5	9	87
300284	Mohican River	08 06	6.53	9	257

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 of 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. While this is a basic modeling method, relationships between bacteria source contributions and flow regimes are straight forward. In-stream processes and interactions between pathogen sources are assumed conservative (i.e., not occurring) in this method. Figure 2 shows an example LDC with corresponding TMDL calculations represented in Table 8.

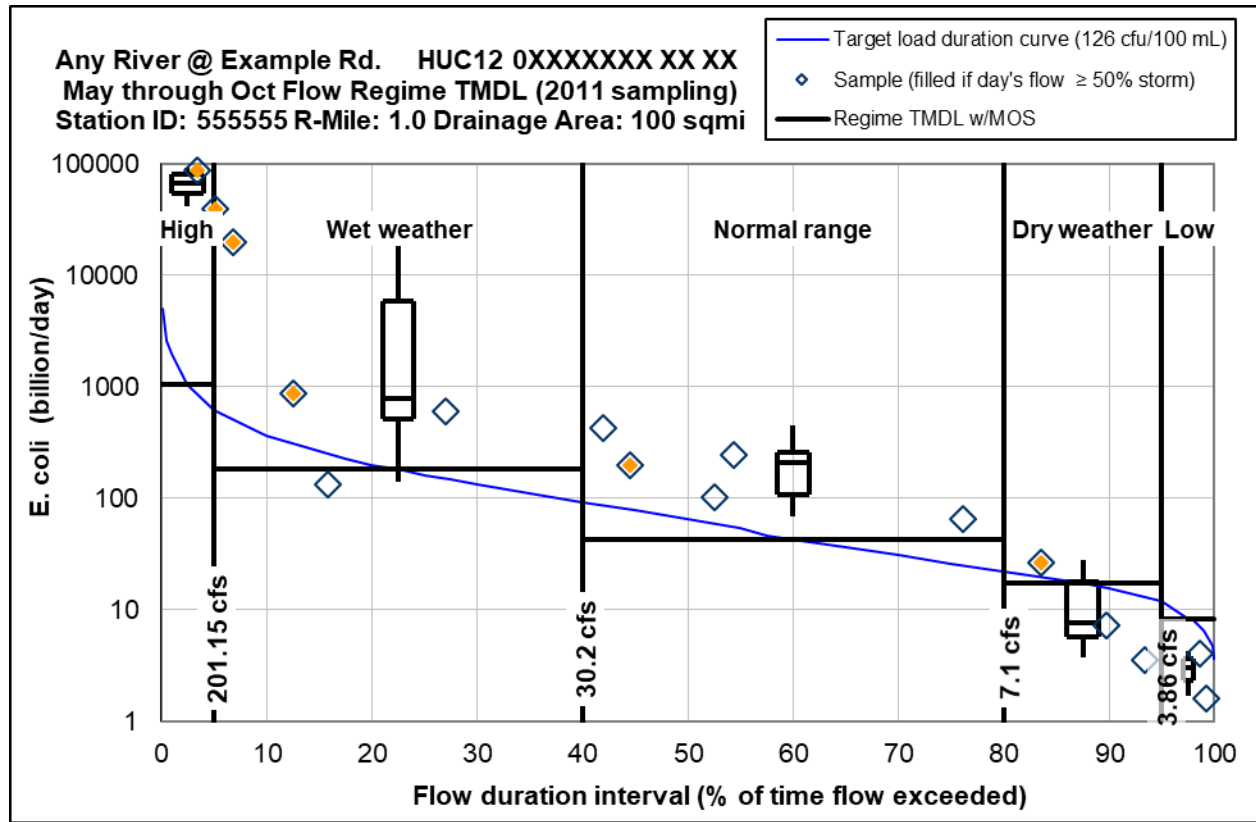


Figure 2 – Example load duration curve.

Table 8 – 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%
Samples Per Regime	2	4	5	3	2
Median Sample load	66807	781	209.25	7.72	2.99
Total Load Reduction Required	98.9%	82.8%	84.7%	NA	NA
Total Maximum Daily Load	1036.68	182.09	43.25	17.26	8.35
Margin of Safety: 20%	207.34	36.42	8.65	3.45	1.67
Allowance for Future Growth	62.20	10.93	2.60	1.04	0.50
Load Allocation	740.71	127.29	27.63	8.98	2.58
Wasteload Allocation Total	26.43	7.46	4.37	3.80	3.60
MS4	23.01	4.04	0.96	0.38	0.19
Example Town WWTP XPX00XXX	3.41	3.41	3.41	3.41	3.41

Recreation Use Proposed Targets

The primary contact recreation geometric mean criterion of 126 colony forming units per 100 mL *E. coli* will be used as the target concentration for the recreation use TMDL. As shown as the blue curve in the example load

duration curve of Figure 2, above, 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 8 show the TMDL values for five flow regime categories. This TMDL is the median of the curve load within each flow regime category.

Public Drinking Water Supply Use

Evaluation of Criteria

The public drinking water supply (PDWS) beneficial use in the WQS (OAC 3745-1-33) currently applies within 500 yards of drinking water intakes and for all publicly owned lakes. Ohio EPA has developed an assessment methodology for this 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 (Table 9).

The Integrated Water Quality Monitoring and Assessment Report (Ohio IR) describes this methodology (Ohio EPA, 2022). The Ohio IR is updated on a two-year cycle, and the current report was published in 2022.

Table 10 lists assessment units not meeting their public drinking water supply use designation and the impaired indicator(s) in Mohican River watershed.

Table 9 - Water quality criteria for public drinking water supply use

Indicator	Impaired Conditions
Algae: Cyanotoxins ^a	Two or more excursions ^b above the state drinking water thresholds (microcystins = 1.6 µg/L) within the 5-year period
Nitrate	Two or more excursions ^b above 10.0 mg/L within the 5-year period.
Pesticides	Annual average exceeds WQ criteria (atrazine = 3.0 µg/L)

^a Cyanotoxins include: microcystins, saxitoxins, anatoxin-a and cylindrospermopsin.

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

Table 10 – Public drinking water use attainment information for impaired watershed assessment units in the Mohican River Watershed.

Assessment Unit (05040004)	Assessment Unit Name	Public Drinking Water System	Impaired Pollutant
03 01	Headwaters Clear Fork Mohican River (Clear Fork Reservoir)	Mansfield	Algae

Public Water Supply Proposed Actions

Ohio EPA considers many factors when determining an action to address a water quality impairment. Source water for the Mansfield public water system had microcystins exceeding the state threshold. In response the city of Mansfield Public Water System (OH7002914) developed a Harmful Algal Bloom General Plan. Ohio EPA Division of

Drinking and Ground Waters approved this Harmful Algal Bloom General Plan in 2018. In addition, the city of Mansfield Public Water System has a Source Water Protection Plan that was endorsed by Ohio EPA in 2013.

At this time, follow-up sampling is recommended for the public water supply impairment to determine if the approved Harmful Algal Bloom General Plan is effective in reducing algal toxins in the source water. Follow up sampling will also provide additional information on the sources of nutrients in the source water that contribute to the formation of the harmful algal blooms and resulting toxins. Ohio EPA will not be developing a TMDL for algae, this impairment will be addressed through the HAB General Plan.

Table 11 - Summary of public drinking water use impairments and potential TMDL modeling approaches

HUC-12 (05040004)	Portion of HUC-12 (TMDL Assessment Area)	Cause(s) of Impairment	Action	Method
03 01	Headwaters Clear Fork Mohican River (Clear Fork Reservoir)	Algae, microcystins	Other	Follow-up ¹
Abbreviation	Definition/interpretation			
¹ Follow-up	Follow-up assessment is required to determine if the attainment status has changed or to clarify/verify the listed cause of impairment.			

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: https://epa.ohio.gov/static/Portals/35/documents/assoc_load.pdf
- Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 2000. *Legal and Technical Basis for Nutrient Target Values Used in TMDL Projects, Water Quality Standard Guidance 4*. Published at: epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/surface-water/guides-manuals/dsw-guidance-documents
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