



Loading Analysis Plan and Supporting Data Acquisition Needed for the Walhonding and Muskingum River Tributaries Basin

Includes Walhonding River, 2007
Total Maximum Daily Load Development



Ohio EPA Technical Report AMS/2010-WALMU-3

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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 Walhonding/Muskingum River tributaries watershed and Walhonding River mainstem. These recommendations are based on data collected as part of a biological and water quality study in 2007 and 2010. A description of the project area, sites, data types, and methods can be found in the Walhonding/Muskingum River tributaries watershed 2010 study plan document at epa.ohio.gov/static/Portals/35/tmdl/monitoring_WalMuskStudyPlan2010.pdf. A summary of the study results can be found in the biological and water quality report at epa.ohio.gov/static/Portals/35/documents/WalMusk2010_TSD.pdf.

Sites in the Walhonding/Muskingum River tributaries watershed and Walhonding River mainstem were assessed for aquatic life use and recreation use. The public water supply use was not assessed since no surface waters are used as a public water supply in this study area. 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.

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-assessmen. Goals for those indices in the Walhonding/Muskingum River tributaries watershed are shown in Table 1. The attainment status for each site is shown in Figure 1 and the scores for impaired sites are shown in Table 2. Aquatic life use (ALU) was assessed at 35 sites in the Walhonding River mainstem and Walhonding/Muskingum River tributaries watershed in 2007 and 2010. The study encompassed 13 HUC 12 watersheds in Coshocton and Muskingum counties. Out of 34 sites listed in the TSD in Table 2 with an attainment status, 13 were documented as having partial or non-attainment.

Table 1 – Biological criteria applicable in the Walhonding/Muskingum River tributaries watershed for aquatic life use designations.

Ecoregion	Biological Index	Assessment Method ^{2, 3}	Biological Criteria for the Applicable Aquatic Life Use Designations ¹	
			WWH	EWH
Western Allegheny Plateau (WAP)	IBI	Headwater	44	50
		Wading	44	50
		Boat	40	48
	MIwb	Wading	8.4	9.4
		Boat	8.6	9.6
	ICI	All ⁴	36	46

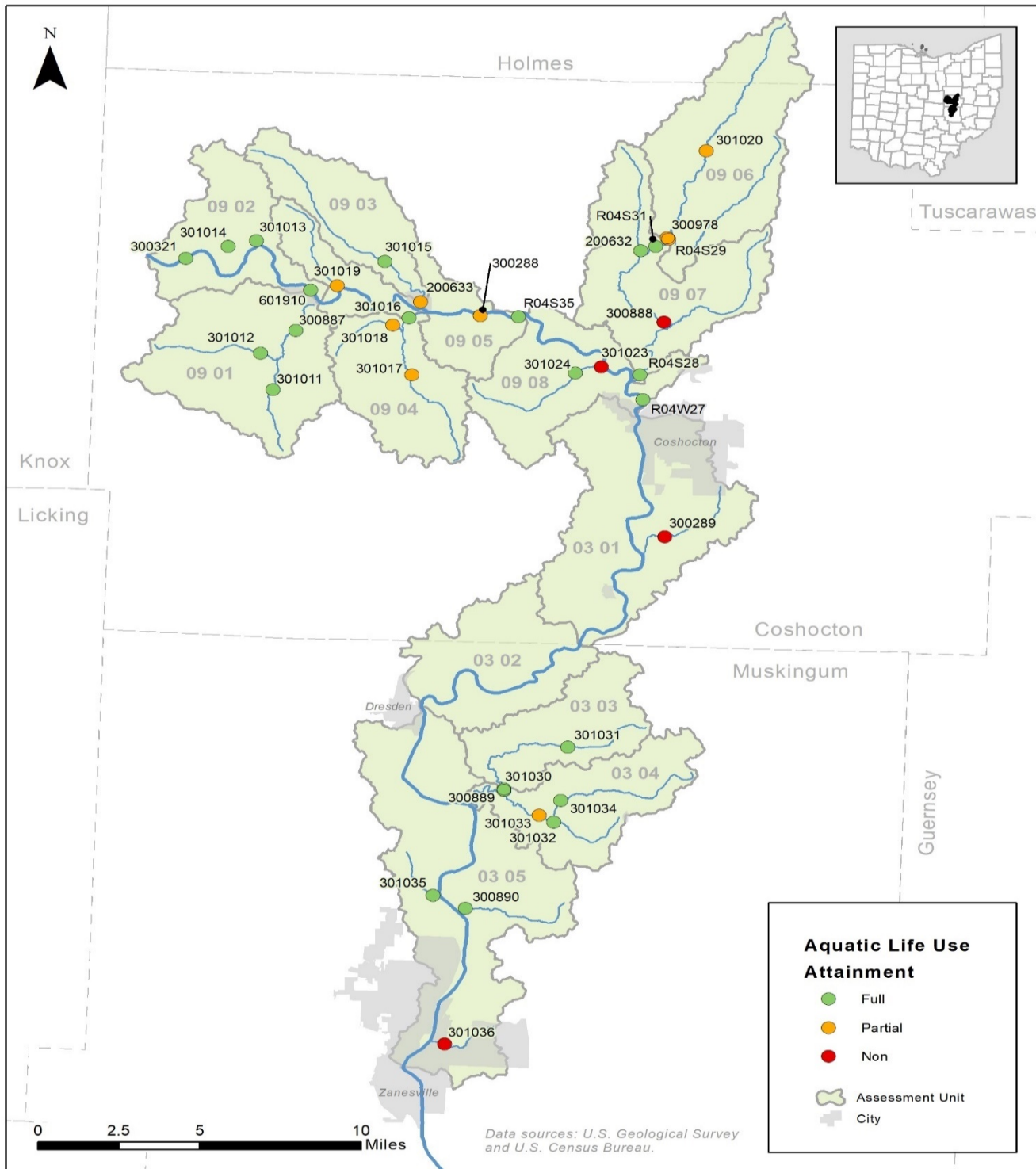
¹ Aquatic Life Use (ALU) designations: warmwater habitat (WWH); exceptional warmwater habitat (EWH); coldwater habitat (CWH) does not have associated biological criteria.

² 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.

³ MIwb not applicable to drainage areas less than 20 mi² (headwater sites).

⁴ Limited to sites with appropriate conditions for artificial substrate placement.

Figure1 - Map summarizing ALU attainment status in the Walhonding River mainstem in 2007 and Walhonding/Muskingum River



tributaries watershed in 2010.

Table 2 – Aquatic life use attainment information for impaired sampling locations in the Walhonding/Muskingum River tributaries watershed, 2007 and 2010

Station	Location	ALU	River Mile ^a	Drain. Area (mi ²)	IBI	MIwb ^b	ICI ^c	QHEI	Attain. Status	Causes	Sources
05040003 09 03 - Beaver Run											
200633	Beaver Run @ SR 36 at Warsaw	CWH	0.17 ^H	14.10	54	-	G*	60.3	Partial	Sedimentation/siltation Particle distribution (embeddedness)	Crop production (crop land or dry land)
05040003 09 04 – Simmons Run											
301016	Simmons Run @ TR 78	WWH	2.97 ^H	9.29	52	-	F*	64.5	Partial	Sedimentation / siltation	Channelization Stream bank destabilization/ modification
301018	Flint Run @ SR 60	WWH	0.40 ^H	2.25	50	-	F*	56.5	Partial	Natural conditions (flow or habitat)	Natural sources
05040003 09 05 – Darling Run – Walhonding River											
300288	Walhonding River UPST Six Mile Dam	EWH	8.81 ^B	1572.0	45*	8.53*	F*	64.0	Non	Direct habitat alterations Other flow regime alterations	Dam or impoundment
301019	Darling Run @ TR 340	WWH	0.10 ^H	3.82	44	-	F*	59.8	Partial	Natural conditions (flow or habitat)	Natural sources
05040003 09 06 – Headwaters Mill Creek											
301020	Mill Creek @ TR 215	EWH	12.50 ^H	8.84	52	-	G*	68.0	Partial	Nutrient/eutrophication biological indicators	Livestock (grazing or feeding operation)
R04S29	Mill Creek @ TR 206	EWH	8.50 ^H	18.50	44*	-	VG ^{NS}	64.3	Partial	Sedimentation/siltation Organic enrichment (sewage) biological indicators	Unrestricted cattle access
200632	Little Mill Creek @ Driveway off TR 206	EWH	0.10 ^H	8.40	54	-	G*	63.8	Partial	Sedimentation/siltation	Livestock (grazing or feeding operation) Stream bank destabilization/ modification

Station	Location	ALU	River Mile ^a	Drain. Area (mi ²)	IBI	MIwb ^b	ICI ^c	QHEI	Attain. Status	Causes	Sources
05040003 09 07 – Spoon Creek – Mill Creek											
300888	Mill Creek @ TR 322	EWB	3.54 ^W	39.90	44*	8.7*	36*	59.8	Non	Sedimentation/siltation	Crop production (crop land or dry land) Livestock (grazing or feeding operation) Sediment resuspension (contaminated sediment)
										Organic enrichment (sewage) biological indicators	Onsite treatment systems (septic systems)
05040003 09 08 – Crooked Creek – Walhonding River											
301023	Crooked Run @ TR 495	WWH	0.06 ^H	8.97	36*	-	F*	42.8	Non	Natural conditions (flow or habitat)	Natural sources
05040004 03 01 – Robinson Run – Muskingum River											
300289	Robinson Run @ CR 271	WWH	1.35 ^H	3.81	<u>20</u> *	-	<u>VP</u> *	79.5	Non	Sedimentation/siltation Particle distribution (embeddedness) Bottom deposits Total dissolved solids	Acid Mine Drainage impacts from abandon mine lands (inactive)
05040004 03 04 – South Branch Symmes Creek – Symmes Creek											
301033	Symmes Creek @ Mutton Ridge Road	WWH	4.35 ^H	15.30	34*	-	VG	58.0	Partial	Natural conditions (flow or habitat)	Natural sources
05040004 03 05 – Blount Run – Muskingum River											
301036	Mill Run @ Coal Run Rd	WWH	0.45 ^H	3.38	36*	-	F*	52.5	Non	Sedimentation/siltation Particle distribution (embeddedness) Bottom deposits	Acid Mine Drainage impacts from abandon mine lands (inactive)

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 ≤ 20 mi².

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; F=Fair; G=Good; VG=Very Good

ns Nonsignificant departure from biocriteria (≤4 IBI or ICI units, or ≤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 ≤ 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)

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 ALU impairments and potential modeling approaches

Station	Stream Name	River Mile	HUC 12 (050400)	Cause(s) of Impairment	Source(s) of Impairment	IR Cat. ¹	Action ²	Method ³	Target
200633	Beaver Run	0.17	03 09 03	Sedimentation/ siltation	Crop production (crop land or dry land)	5	TMDL	QHEI-sed	Sediment
				Particle distribution (embeddedness)					
301016	Simmons Run	2.97	03 09 04	Sedimentation/siltation	Channelization	5	TMDL	QHEI-sed	Sediment
					Stream bank destabilization/modification				
301018	Flint Run	0.40	03 09 04	Natural conditions (flow or habitat)	Natural sources	4C	N/A	-	-
300288	Walhonding River	8.81	03 09 05	Direct habitat alterations	Dam or impoundment	4C	N/A	Follow-up	-
				Other flow regime alteration					
301019	Darling Run	0.10	03 09 05	Natural conditions (flow or habitat)	Natural sources	4C	N/A	-	-
301020	Mill Creek	12.50	03 09 06	Nutrient/ eutrophication biological indicators	Livestock (grazing or feeding operation)	5	Other	Follow-up	-
R04S29	Mill Creek	8.50	03 09 06	Sedimentation/siltation	Unrestricted cattle access	5	TMDL	QHEI-sed	Sediment

Station	Stream Name	River Mile	HUC 12 (050400)	Cause(s) of Impairment	Source(s) of Impairment	IR Cat. ¹	Action ²	Method ³	Target
				Organic enrichment (sewage) biological indicators		5	Other	Follow-up	-
200632	Little Mill Creek	0.10	03 09 06	Sedimentation/siltation	Livestock (grazing or feeding operation) Streambank destabilization/modification	5	TMDL	QHEI-sed	Sediment
300888	Mill Creek	3.54	03 09 07	Sedimentation/siltation	Crop production (crop land or dry land) Livestock (grazing or feeding operations) Sediment resuspension (contaminated sediment)	5	TMDL	QHEI-sed	Sediment
301023	Crooked Run	0.06	03 09 08	Organic enrichment (sewage) biological indicators	Onsite treatment systems (septic systems)	5	Other	Follow-up	-
301023	Crooked Run	0.06	03 09 08	Natural conditions (flow or habitat)	Natural sources	4C	N/A	-	-
300289	Robinson Run	1.35	04 03 01	Sedimentation/siltation Particle distribution (embeddedness) Bottom deposit	Acid Mine Drainage impacts from abandoned mine lands (Inactive)	5	TMDL	QHEI-sed	Sediment
				Total dissolved solids	Acid Mine Drainage impacts from abandoned mine lands (Inactive)	5	TMDL	TDS LDC	TDS
301033	Symmes Creek	4.35	04 03 04	Natural conditions (flow or habitat)	Natural sources	4C	N/A	-	-
301036	Mill Run	0.45	04 03 05	Sedimentation/siltation Particle distribution (embeddedness) Bottom deposits	Acid Mine Drainage impacts from abandoned mine lands (Inactive)	5	TMDL	QHEI-sed	Sediment
				Total dissolved solids		5	TMDL	TDS LDC	TDS

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.
5-alt	Category 5-alternative restoration plan will be developed to outline restoration approaches more immediately beneficial or practicable than a TMDL.
LDC	"Load duration curve" method will be used to address 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.

Flint Run at river mile (RM) 0.4, Darling Run at RM 0.1, Crooked Run at RM 0.06, and Symmes Creek at RM 4.35 are listed as impaired due to natural causes and natural sources. No TMDL is required at these sites.

The Walhonding River at RM 8.81 is impaired from habitat and flow regime alterations due to the Six Mile Dam downstream. Flow alteration and habitat alteration are not pollutants and therefore they will not be addressed with a TMDL. However, the Six Mile Dam was removed in 2020 and natural channel designs were installed to enhance habitat for aquatic life. These alterations should bring this site back into attainment.

Sedimentation/siltation, particle distribution (embeddedness), or bottom deposits are listed as the causes of impairment at seven sites across the watershed. These causes are related to either current (agricultural), bank erosion, livestock access, channelization or historic (mining) land use practices. The impairments will be addressed using sub-metrics of the QHEI that relate to sediment delivery and transport.

Eutrophication has been listed as a cause of impairment for Mill Creek at RM 12.5. Since the 2010 study, Ohio EPA has developed different methods to evaluate nutrient enrichment in streams. Ohio EPA now uses a weight-of-evidence approach that considers diurnal swings in dissolved oxygen, chlorophyll-*a* concentrations in the water column and benthos, and water column nutrient concentrations to support causal determination. Continuous monitoring data for DO collected in Mill Creek shows a minimum and maximum DO of 5.97 mg/L and 7.41 mg/L. A DO fluctuation of 1.43 mg/L (7.41 – 5.97 = 1.43) does not support nutrient enrichment, in addition no chlorophyll-*a* samples were collected at this site. Ohio EPA will revisit and use the new methods to determine if nutrients/eutrophication is still an appropriate cause of impairment before deciding if a TMDL is necessary.

Mill Creek is listed as impaired for organic enrichment at two sites (RM 8.5 and RM 3.54). While Ohio EPA does not measure organic enrichment directly, dissolved oxygen (DO) concentrations are used to estimate the ecological impact of decomposing organic material in streams. Continuous monitoring data for DO collected in Mill Creek is summarized in Table 4. Minimum measurements of 6.48 mg/L and 6.7 mg/L are well above Ohio EPA's minimum water quality criteria and do not clearly indicate organic enrichment. Ohio EPA recommends follow-up monitoring at these sites to clarify if organic enrichment was the appropriate cause of impairment.

Table 4 – Dissolved oxygen minimum and average for Mill Creek.

Site	RM	Minimum DO (mg/L)	Average DO (mg/L)
Mill Creek (300289)	8.5	6.7	7.15
Mill Creek (301036)	3.54	6.48	7.96

Robinson Run and Mill Run are influenced by acid mine drainage and is listed as impaired for total dissolved (TDS). TDS impairment will be addressed using Load Duration Curve (LDC) empirical method. Table 5 shows the target for TDS. An example of LDC method with corresponding TMDL graph and calculations can be found in Figure 2 and Table 9.

The following subsections are organized to explain the various methods being used to address the proposed actions outlined in Table 3 above.

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

The cause of impairment for several sites outlined on Table 3 for Walhonding and Muskingum River tributaries watershed was due to natural causes.

Four sites were impaired due to natural conditions relating to physical habitat and flow limitations. Some headwaters had very steep bedrock waterfalls while others became completely desiccated during the summer which made fish passage and establishment very difficult. The rise and fall of the Walhonding River frequently scoured the mouths of Darling and Crooked runs. These natural phenomena reduced EPT¹ and sensitive taxa numbers. Natural conditions are not considered a pollutant and therefore were removed from TMDL considerations.

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

The cause of impairment for several sites outlined on Table 3 for Walhonding and Muskingum River tributaries watershed was due to causes not considered a pollutant.

The Walhonding River mainstem, sampled in 2007, was in full attainment of the Exceptional Warmwater Habitat (EWH) aquatic life use except for the site at river mile (RM) 8.81 near Warsaw, which was impounded by the Six Mile Dam. The Six Mile Dam was removed in 2020. Following complete removal, habitat features using natural channel design were installed to enhance habitat for aquatic life and enhance sportfishing opportunities for anglers. A follow-up is the appropriate method to assess/verify the attainment of this site.

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

Three sites have been listed as impaired for organic enrichment and nutrient eutrophication. While Ohio EPA does not measure organic enrichment directly, dissolved oxygen (DO) concentrations are used to estimate the ecological impact of decomposing organic material in streams. Continuous monitoring data for DO do not clearly indicate organic enrichment. Ohio EPA recommends follow-up monitoring at these sites to clarify if organic enrichment and nutrient eutrophication were the appropriate causes of impairment.

Because of these factors, follow-up monitoring is recommended prior to a TMDL being developed. 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 several sites outlined on Table 3 for Walhonding and Muskingum River tributaries watershed was due to impacts from sedimentation and/or siltation. Sedimentation is seen widely throughout the watershed and is listed as the cause of impairment for 7 of the 16 impaired sites. The sedimentation is largely due

¹ EPT stands for Ephemeroptera-Plecoptera-Trichoptera, the orders of invertebrates commonly known as mayflies, stoneflies, and caddisflies, respectively. Their collective presence and abundance in the benthos is generally considered an indicator of high resource quality.

to various sources such as bank erosion, livestock access, channelization and Acid Mine Drainage (AMD). A sediment TMDL calculated using QHEI sub-metrics will appropriately address this cause of impairment.

Proposed Targets

Total Dissolved Solids

Ohio has adopted a statewide numeric water quality criterion for total dissolved solids (TDS) for the protection of aquatic life, as detailed in OAC 3745-1-35, Table 35-1.

Table 5 – Water quality criteria for total dissolved solids.

Chemical	OMZA
Dissolved Solids	1500 mg/L ^a

^a Equivalent 25°C specific conductance value is 2400 micromhos/cm.

Concentrations of TDS at levels harmful to aquatic life can be due to both pervasive and direct sources. Two predominant pathways exist for TDS delivery to water bodies: via direct discharge (point source) or precipitation-driven wash-off (nonpoint source). Due to these mechanisms of delivery, the sources of dissolved solids 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 TDS TMDLs. LDCs are an empirical method of determining TMDL pollutant loading and needed reductions. More details on the LDC method are presented in the Recreation Use section.

Sediment

Since its development, the 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).

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 6 lists targets for each of these metrics.

Table 6 – QHEI targets for sediment TMDLs.

Sediment TMDL Targets		
QHEI Category	WWH	EWH
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 8, are also the targets used for TMDLs. Table 8 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 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 ninety-day period.

^a A beach action value of 235 *E. coli* colony counts 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 Walhonding/Muskingum River tributaries watershed, 2010.

Station	Stream Name	HUC-12 (050400)	RM	# Samples	Geo. Mean	Max. Value	Attain. Status	Possible Source(s)	Action	Method
300887	Mohawk Creek	03 09 01	1.48	14	340	2200	NON	Agriculture, Livestock	TMDL	LDC
301013	Dutch Run	03 09 02	0.15	4	389	730	NON	Agriculture, Livestock	TMDL	LDC
200633	Beaver Run	03 09 03	0.17	14	475	3100	NON	On-lot sewage systems	TMDL	LDC
301017	Simmons Run	03 09 04	0.60	4	447	1600	NON	Agriculture, Livestock	TMDL	LDC
301019	Darling Run	03 09 05	0.10	5	499	740	NON	Agriculture, Livestock	TMDL	LDC

Station	Stream Name	HUC-12 (050400)	RM	# Samples	Geo. Mean	Max. Value	Attain. Status	Possible Source(s)	Action	Method
R04S29	Mill Creek	03 09 06	8.5	10	556	2200	NON	Agriculture, Livestock	TMDL	LDC
300978	Mill Creek	03 09 07	7.9	14	746	3700	NON	Agriculture, Livestock	TMDL	LDC
300888	Mill Creek	03 09 07	3.54	7	718	2400	NON	Agriculture, Livestock	TMDL	LDC
301024	Crooked Run up. Edgewood	03 09 08	0.98	5	869	1700	NON	On-lot sewage systems	TMDL	LDC
301023	Crooked Run	03 09 08	0.06	4	985	2700	NON	On-lot sewage systems	TMDL	LDC
301029	Monroe Basin Creek	04 03 02	1.80	5	1095	24000	NON	Agriculture, Livestock	TMDL	LDC
301030	North Branch Symmes Creek	04 03 03	0.10	10	409	6100	NON	Agriculture, Livestock	TMDL	LDC
300889	Symmes Creek	04 03 04	2.35	14	313	5100	NON	Agriculture, Livestock	TMDL	LDC
300890	Blount Run	04 03 05	0.31	13	269	2800	NON	Unknown	TMDL	LDC

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 fairly 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 9.

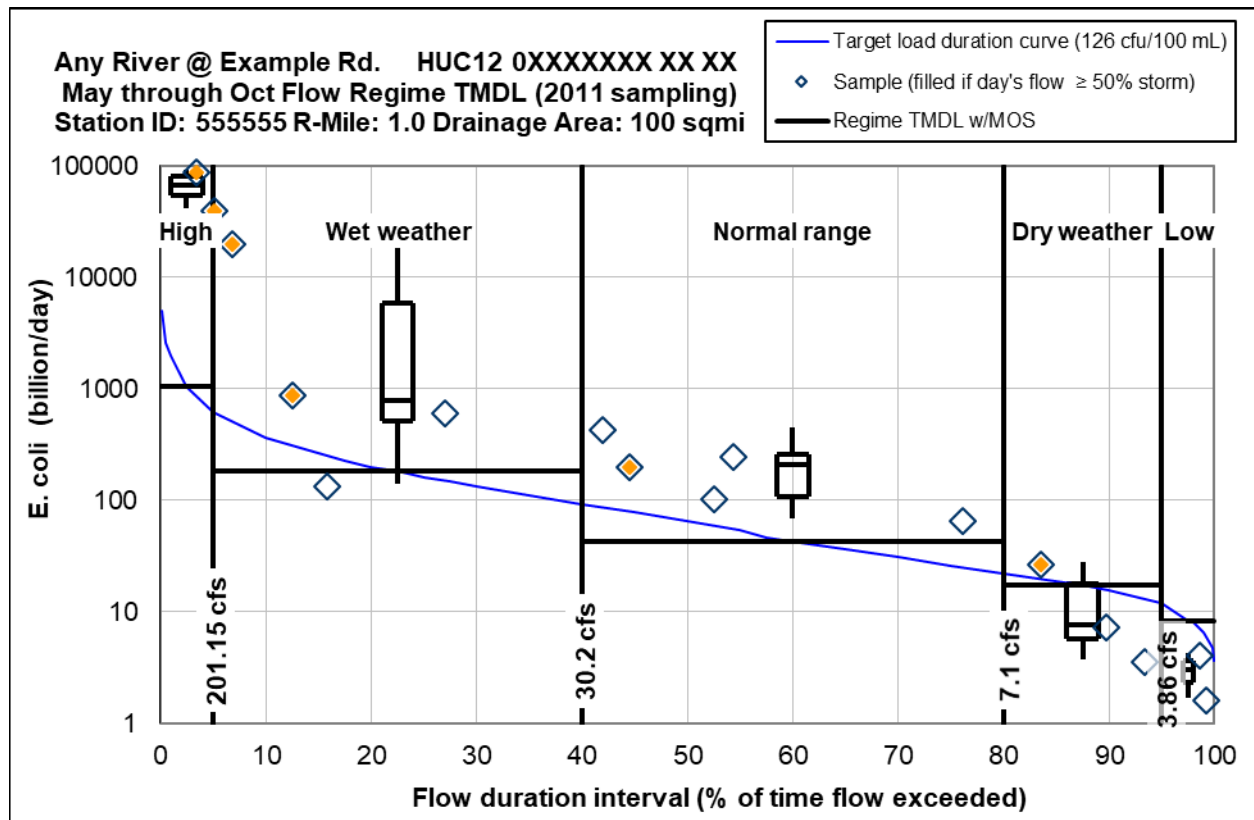


Figure 2 – Example load duration curve

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%
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 9 show the TMDL values for five flow regime categories. This TMDL is the median of the curve load within each flow regime category.

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/wps/portal/gov/epa/divisions-and-offices/surface-water/reports-data/technical-bulletins