Ohio Environmental Protection Agency

Loading Analysis Plan and Supporting Data Acquisition Needed for the

Northern Central Ohio River Tributaries Basin

Total Maximum Daily Load Development

Wheeling Creek.

Ohio EPA Technical Report AMS/2010-CORTN-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 central Ohio River tributaries watershed. These recommendations are based on data collected as part of a biological and water quality study in 2010 (Ohio EPA, 2010). A description of the project area, sites, data types and methods can be found in the central Ohio River tributaries study plan document (Ohio EPA, 2010). A summary of the study results can be found in the Wheeling, Short, and Cross Creek's water quality report(Ohio EPA, 2013).

Sites in the central Ohio River tributaries watershed were assessed for aquatic life use and recreation 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, see Ohio's Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2022).

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 (Ohio EPA, 2017). Goals for those indices in the central Ohio 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.

Assessments were completed at 74 sites to determine aquatic life use in the Northern Central Ohio River tributaries in 2010-2011. The study area includes all or portions of 15 HUC-12 watershed assessment units. Of the 74 sites sampled, 36 were documented as having partial or non-attainment.

Table 1 – Biological criteria applicable in the central Ohio 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]		
			EWH	WWH	MWH[4]
Western Allegheny Plateau (WAP)	IBI	Headwater	50	44	24 / - / 24
		Wading	50	44	24 / - / 24
		Boat	48	40	24 / 30 / 24
	MIwb	Wading	9.4	8.4	6.2 / - / 5.5
		Boat	9.6	8.6	5.8 / 6.6 / 5.4
	ICI	All[5]	46	36	22 / - / 30

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

[2] In general, the assessment method used at a site is determined by its drainage area (DA) according to the following: Headwater: DA ≤ 20 mi^2; wading: DA >20 mi^2 and ≤ 500 mi^2; boat: DA > 500 mi^2.

[3] MIwb not applicable to drainage areas less than 20 mi^2 (headwater sites).
[4] Biocriteria depend on type of MWH. MWH-C (due to channelization) is listed first, MWH-I (due to impoundment) is listed second, and MWH-A (mine affected) is listed third (only applicable in the WAP).
[5] Limited to sites with appropriate conditions for artificial substrate placement.

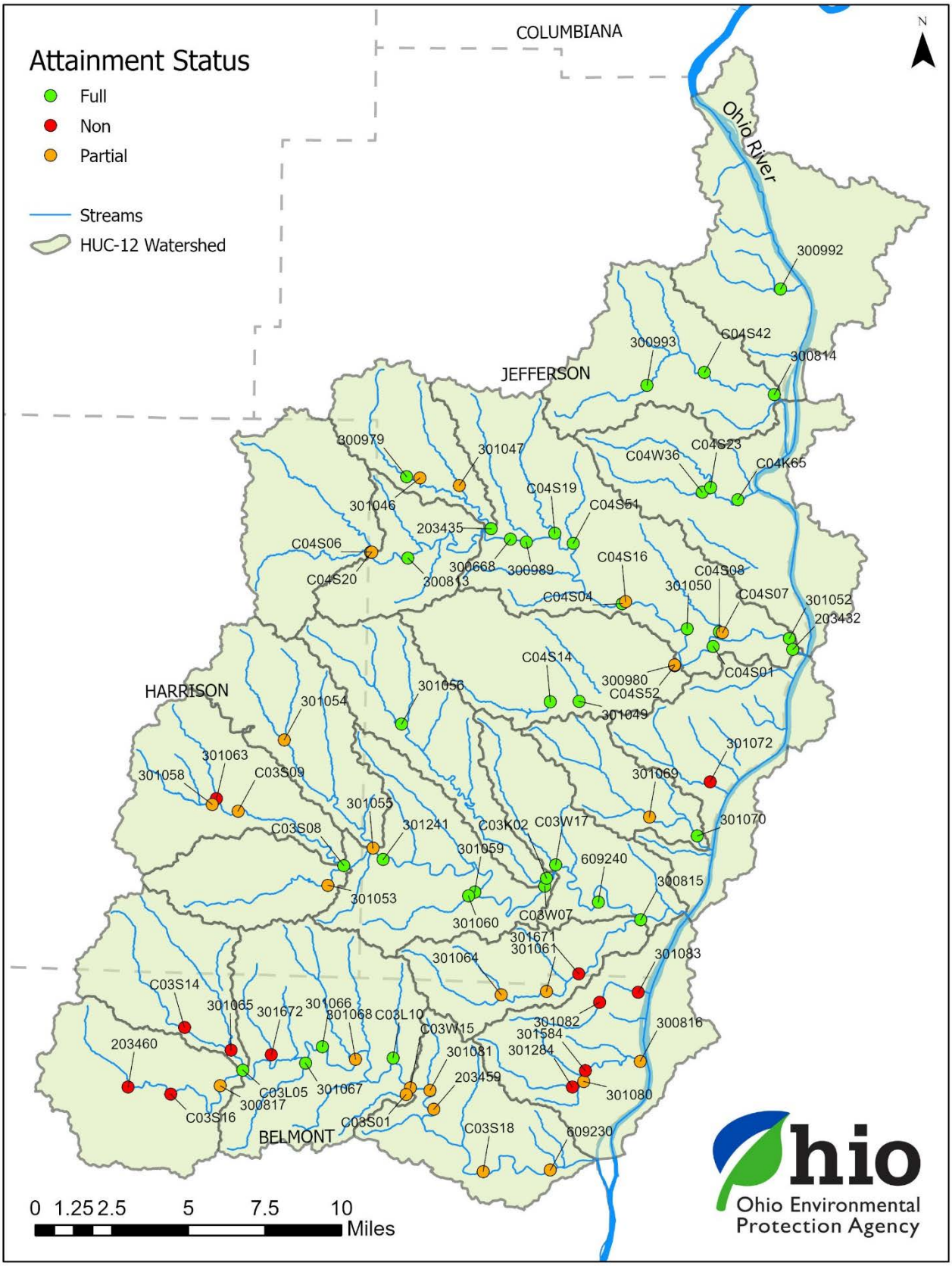

*Figure **1** — Map summarizing ALU attainment status in the central Ohio River tributaries watershed, 2010.*

Table 2 – Aquatic life use attainment information for impaired sampling locations in the central Ohio River tributaries watershed, 2010.

Station	Location	ALU	River Mile[a]	Drain. Area (mi^2)	IBI	MIwb[b]	ICI[c]	QHEI	Attain. Status	Causes	Sources
05030101 10 01 – Upper Cross Creek											
C04S20	N. BR. CROSS CREEK AT MOUTH, ADJ. TWP. RD. 309	WWH	0.1	11.3	42^{ns}	NA	F*	77.5	PARTIAL	TDS	Mine drainage
05030101 10 02 – Salem Creek											
301046	LEAS BRANCH @ TWP. RD. 136	CWH	0.15	2.70	46	NA	F*	59	PARTIAL	TDS	Mine drainage
301047	GRASSY RUN UPST. SEMINARY POND @ TWP. RD. 205	WWH	0.68	4.20	34*	NA	VG	52.5	PARTIAL	Siltation	Mine drainage
05030101 10 04 – McIntyre Creek											
300980	LONG RUN @ CO. RD. 74 (MINGO JUNCTION-GOULDS RD.)	WWH	0.03	3.04	56	NA	F*	82	PARTIAL	TDS	Mine drainage
05030101 10 05 – Lower Cross Creek											
C04S16	BARBERS HOLLOW TRIB. (9.60) NEAR MOUTH @ CO. RD. 26	WWH	0.06	3.2	40^{ns}	NA	F*	79	PARTIAL	Organic enrichment	Municipal WWTP
C04S07	DRY FORK AT GOULD @ DRIVEWAY BRIDGE NEAR MOUTH	CWH	0.28	6.6	58	NA	F*	66.5	PARTIAL	TDS	Mine drainage
05030106 02 01 – South Fork Short Creek											
301053	S. FK. SHORT CREEK @ TWP. RD. 83 (GREAVES RD.)	WWH	1.13	14.01	44	NA	F*	80	PARTIAL	TDS	Abandoned mine drainage
05030106 02 02 – Middle Fork Short Creek											
301063	LIMING CREEK @ TWP. RD. 76 (JACKSON RD.)	WWH	0.15	4.71	38*	NA	F*	75	NON	TDS, Organic Enrichment	Abandoned mine drainage, Unrestricted livestock
301058	SALLY BUFFALO CREEK JUST UPST. CADIZ WWTP	WWH	0.17	9.92	40^{ns}	NA	F*	68.8	PARTIAL	TDS	Abandoned mine drainage
C03S09	M. FK. SHORT CREEK @ 2ND CO. RD. 15 BRIDGE DST. CADIZ WWTP	WWH	5.35	15.8	42^{ns}	NA	F*	69.5	PARTIAL	TDS, Organic Enrichment	Abandoned mine drainage, Municipal WWTP
05030106 02 03 – North Fork Short Creek											
301055	N. FK. SHORT CREEK AT ADENA @ NAGY LANE OFF CO. RD. 10	WWH	0.09	18.01	44	NA	F*	68.5	PARTIAL	TDS	Abandoned mine drainage

301054	N. FK. SHORT CREEK DST HARMON CR @ C.R. 12 (UNIONVILLE RD.)	WWH	6.21	11	44	NA	F*	76	PARTIAL	TDS, Metals	Abandoned mine drainage
05030106 02 06 – Little Short Creek											
301064	COAL RUN AT MOUTH @ ST. RT. 647/TWP. RD. 475	WWH	0.15	2	34*	NA	G	62.8	PARTIAL	Metals	Abandoned mine drainage
301671**	L SHORT CREEK AT GLEN ROBBINS, ADJ YORKVILLE-GLEN ROBBINS RD	WWH	3.5	14	26	NA		52.8	NON	Metals	Abandoned mine drainage
301061	L. SHORT CREEK UPST PARKERS @ TR 472 (S CK GLENN ROBBINS RD)	WWH	4.99	11	34*	NA	G	85.8	PARTIAL	Metals	Abandoned mine drainage
05030106 03 01 – Crabapple Creek											
301065	CAMPBELL RUN AT MOUTH @ ABANDONED TWP. RD. 414	WWH	0.03	7.3	32*	NA	VP*	70.8	NON	Dissolved solids, metals	Mine drainage
C03S14	CRABAPPLE CREEK N OF UNIONTOWN @ CO. RD. 66	WWH	2.88	10	36*	NA	F*	59.5	NON	Dissolved solids	Mine drainage
05030106 03 02 – Headwaters Wheeling Creek											
300817	WHEELING CREEK UPST. CRABAPPLE CREEK @ LEE RD. (TWP RD 337)	LWH/WWH	22.73	24.2	32*	NA	42	81.3	PARTIAL	Dissolved solids	Mine drainage
C03S16	WHEELING CREEK E OF LAFFERTY @ CO. RD. 78	LWH/WWH	25.97	13.4	34*	NA	F*	64.5	NON	Dissolved solids	Mine drainage
203460	WHEELING CREEK ON WEST EDGE OF LAFFERTY @ MT. HOPE RD.	LWH/WWH	27.9	4.4	38*	NA	F*	60.3	NON	Dissolved solids	Mine drainage
05030106 03 03 – Cox Run - Wheeling Creek											
301068	COX RUN @ TWP. RD. 432 (STONEHOUSE-PURSEGLOVE RD.)	WWH	0.03	7.3	46	NA	F*	61.5	PARTIAL	Dissolved solids	Mine drainage
301672	MCCRACKEN RUN NEAR MOUTH AT FAIRPOINT @ ST. RT. 9	WWH	0.23	4.7	38*	NA	NA	54	NON	Dissolved solids	Mine drainage
C03S01	TOWN RUN W OF BARTON @ HELLS KITCHEN RD.	WWH	0.28	2.4	46	NA	F*	58.8	PARTIAL	Organic enrichment	Municipal WWTP
C03W15	WHEELING CREEK NEAR BARTON, JUST UPST. TOWN RUN	LWH/WWH	10.99	82.1	39*	7.84^{ns}	38	78.5	PARTIAL	Dissolved solids	Mine drainage
05030106 03 04 – Flat Run - Wheeling Creek											
301081	STEEP RUN AT BARTON, NEAR MOUTH, DST. CO. RD. 10	WWH/MWH	0.03	2.3	26	NA	P*	30.5	PARTIAL	Dissolved solids, metals, ammonia	Mine drainage, septic tanks
609230	WHEELING CREEK NEAR BRIDGEPORT @ CO. RD. 24	LWH/WWH	1.64	103	44	9	26*	67	PARTIAL	Dissolved solids	Mine drainage
C03S18	WHEELING CREEK AT BLAINE @ PEASE RD.	LWH/WWH	5.05	96	42^{ns}	8.1^{ns}	30*	84	PARTIAL	Dissolved solids	Mine drainage

203459	WHEELING CREEK @ FIRST BRIDGE S OF BARTON	LWH/WWH	9.4	86	41^{ns}	7.8*	40	70.5	PARTIAL	Dissolved solids	Mine drainage
05030106 12 01 – Rush Run											
301069	RUSH RUN @ CO. RD. 17 (RUSH RUN RD.) NEAR TWP. RD. 159	WWH	2.71	8.45	30*	NA	G	64.5	PARTIAL	TDS, Organic Enrichment	Abandoned mine drainage, Septic tanks
05030106 12 02 – Salt Run - Ohio River											
301072	SALT RUN ADJ. TWP. RD. 157 (CHURCH BRIDGE CROSSING)	WWH	0.6	4.02	32*	NA	F*	40.5	NON	TDS, Siltation	Surface mining
05030106 12 04 – Glenns Run - Ohio River											
300816	GLENNS RUN @ CO. RD. 4 (GLENNS RUN RD.)	WWH	0.1	10.7	52	NA	F*	58.3	PARTIAL	TDS, Metals	Abandoned mine drainage
301083	DEEP RUN AT DEEP RUN RD. @ RR BRIDGE	WWH	0.25	4.11	34*	NA	P*	47	NON	TDS, Metals	Abandoned mine drainage
301082	DEEP RUN ADJ. DEEP RUN RD, UPST MINING IMPACTS	WWH	2.4	2.48	22*	NA	MG^{ns}	50.8	NON	TDS, Metals	Abandoned mine drainage
301584**	GLENNS RUN DST. AMD SEEP, ADJ. GLENNS RUN RD.	WWH	2.5	7.6	24	NA		68.8	NON	Metals	Abandoned mine drainage
301080	GLENNS RUN UPST. PATTON RUN, ON CO. RD. 4	WWH	2.9	6.17	30*	NA	MG^{ns}	66.5	PARTIAL	Metals	Abandoned mine drainage
301284**	GLENNS RUN UPST. BUCKEYE RUN, ADJ. ST. RT. 647	WWH	3.32	4.7	24	NA		71	NON	Metals	Abandoned mine 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 ≤ 20 mi^2.

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 (≤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.

**These sites were not listed in the corresponding TSDs but are considered by OEPA as impaired and are included in the Ohio EPA Integrated Report (2022).

H Headwater site (draining ≤20 miles^2).

W Wading site (non-boat site draining >20 miles^2).

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 3.

Table 3 – Summary of ALU impairments and potential modeling approaches.

Station	Stream Name	River Mile	Assessment Unit (05030101)	Cause(s) of Impairment	Source(s) of Impairment	IR Cat.[1]	Action[2]	Method[3]	Parameter[4]
C04S20	N. Br. Cross Creek	0.1	10 01	Metals	Mine drainage	5	TMDL	LDC	TDS
301046	Leas Branch	0.15	10 02	TDS	Mine drainage	5	TMDL	LDC	TDS
301047	Grassy Run	0.68	10 02	Siltation	Mine drainage	5	TMDL	QHEI-Sed	Siltation
300980	Long Run	0.03	10 04	TDS	Mine drainage	5	TMDL	LDC	TDS
C04S16	Barbers Hollow	0.06	10 05	Organic enrichment	Municipal WWTP	5	Other	Follow-up	Organic enrichment
C04S07	Dry Fork	0.28	10 05	TDS	Mine drainage	5	TMDL	LDC	TDS
Station	**Stream Name**	**River Mile**	**Assessment Unit (05030106)**	**Cause(s) of Impairment**	**Source(s) of Impairment**	**IR Cat.[1]**	**Action[2]**	**Method[3]**	**Parameter[4]**
301053	S. Fk. Short Creek	1.13	02 01	TDS	Abandoned mine drainage	5	TMDL	LDC	TDS
301063	Liming Creek	0.15	02 02	TDS	Abandoned mine drainage	5	TMDL	LDC	TDS
				Organic Enrichment	Unrestricted livestock	5	Other	Follow-up	Organic enrichment

Station	Stream Name	River Mile	Assessment Unit (05030106)	Cause(s) of Impairment	Source(s) of Impairment	IR Cat.[1]	Action[2]	Method[3]	Parameter[4]
301058	Sally Buffalo Creek	0.17	02 02	TDS	Abandoned mine drainage	5	TMDL	LDC	TDS
C03S09	M. Fk. Short Creek	5.35	02 02	TDS	Abandoned mine drainage	5	TMDL	LDC	TDS
				Organic Enrichment	Municipal WWTP	5	Other	Follow-up	Organic enrichment
301055	N. Fk. Short Creek	0.09	02 03	TDS	Abandoned mine drainage	5	TMDL	LDC	TDS
301054	N. Fk. Short Creek	0.21	02 03	TDS	Abandoned mine drainage	5	TMDL	LDC	TDS
				Metals	Abandoned mine drainage	5	TMDL	LDC	Metals
301064	Coal Run	0.15	02 06	Metals	Abandoned mine drainage	5	TMDL	LDC	Metals
301061	Little Short Creek	4.99	02 06	Metals	Abandoned mine drainage	5	TMDL	LDC	Metals
301065	Campbell Run	0.03	03 01	Dissolved solids	Mine drainage	5	TMDL	LDC	Dissolved solids
				Metals	Mine drainage	5	TMDL	LDC	Metals
C03S14	Crabapple Creek	2.88	03 01	Dissolved solids	Mine drainage	5	TMDL	LDC	Dissolved solids
300817	Wheeling Creek	22.73	03 02	Dissolved solids	Mine drainage	5	TMDL	LDC	Dissolved solids
C03S16	Wheeling Creek	25.97	03 02	Dissolved solids	Mine drainage	5	TMDL	LDC	Dissolved solids
203460	Wheeling Creek	27.9	03 02	Dissolved solids	Mine drainage	5	TMDL	LDC	Dissolved solids
301068	Cox Run	0.03	03 03	Dissolved solids	Mine drainage	5	TMDL	LDC	Dissolved solids
301672	McCracken Run	0.23	03 03	Dissolved solids	Mine drainage	5	TMDL	LDC	Dissolved solids

C03S01	Town Run	0.28	03 03	Organic enrichment	Municipal WWTP	5	Other	Follow-up	Organic enrichment
C03W15	Wheeling Creek	10.99	03 03	Dissolved solids	Mine drainage	5	TMDL	LDC	Dissolved solids
301081	Steep Run	0.03	03 04	Dissolved solids	Mine drainage	5	TMDL	LDC	Dissolved solids
				Metals	Mine drainage	5	TMDL	LDC	Metals
				Ammonia	Septic tanks	5	Other	Follow-up	Ammonia
609230	Wheeling Creek	1.64	03 04	Dissolved solids	Mine drainage	5	TMDL	LDC	Dissolved solids
C03S18	Wheeling Creek	5.05	03 04	Dissolved solids	Mine drainage	5	TMDL	LDC	Dissolved solids
203459	Wheeling Creek	9.4	03 04	Dissolved solids	Mine drainage	5	TMDL	LDC	Dissolved solids
301069	Rush Run	2.71	12 01	TDS	Abandoned mine drainage	5	TMDL	LDC	TDS
				Organic Enrichment	Septic tanks	5	Other	Follow-up	Organic Enrichment
301072	Salt Run	0.6	12 02	TDS	Surface mining	5	TMDL	LDC	TDS
				Siltation	Surface mining	5	TMDL	QHEI-sed	Siltation
300816	Glenns Run	0.1	12 04	TDS	Abandoned mine drainage	5	TMDL	LDC	TDS
				Metals	Abandoned mine drainage	5	TMDL	LDC	Metals
301083	Deep Run	0.25	12 04	TDS	Abandoned mine drainage	5	TMDL	LDC	TDS
				Metals	Abandoned mine drainage	5	TMDL	LDC	Metals
301082	Deep Run	2.4	12 04	TDS	Abandoned mine drainage	5	TMDL	LDC	TDS
				Metals	Abandoned mine drainage	5	TMDL	LDC	Metals
301584	Glenns Run	2.5	12 04	Metals	Abandoned mine drainage	5	TMDL	LDC	Metals
301080	Glenns Run	2.9	12 04	Metals	Abandoned mine drainage	5	TMDL	LDC	Metals

301284	Glenns Run	3.32	12 04	Metals	Abandoned mine drainage	5	TMDL	LDC	Metals
301671	Little Short Creek	3.5	12 06	Metals	Abandoned mine drainage	5	TMDL	LDC	Metals

[1] IR Cat. (Integrated Report Category)

Category	Definition/interpretation
4A	Water body is impaired for this parameter, and it has already been addressed by an approved TMDL
4B	Water body is impaired for this parameter, and it has already been addressed by an approved 4B plan
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.
4B Plan	Category 4B plan will be developed to demonstrate that other pollution control requirements (outside of a TMDL) are stringent enough to address impairment.
5-alt	Category 5-alternative restoration plan will be developed to outline restoration approaches more immediately beneficial or practicable than a TMDL.
GWLF	"Generalized Watershed Loading Function" model will be used to approximate existing conditions.
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.
QUAL2K	One-dimensional steady state model (modernized version of QUAL2E) will used to address the listed cause of impairment.
Restoration Plan	A restoration plan will be developed to address a 4C impairment outside of the TMDL process.
Review TMDL Implementation	This impairment is addressed by an existing TMDL, but Ohio EPA will evaluate whether the implementation plan needs to be updated based on new data.

[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 3 above.

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

One site is impaired due to ammonia, and five are impaired due to organic enrichment. These two causes of impairment, outlined in Table 3, for Northern Central Ohio River tributaries basin may not persist. This is because actions in the watershed may have ameliorated these causes since the most recent 2010 assessment. Because of this factor, follow-up monitoring is recommended prior to a developed TMDL. 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.

Three of the sites impaired for organic enrichment were attributed to local WWTPs. Since the 2010 study, the Cadiz WWTP has completed several improvements to their system, including a new auger screen and improvements to one of the clarifiers.

One site impaired by organic enrichment and the only site impaired by ammonia were attributed to septic tanks in the area. Since the 2010 study, 102, 88, and five septic systems were repaired or replaced in Short Creek, Cross Creek, and the Crabapple Creek-Wheeling Creek Watersheds respectively.

TMDL to address siltation impairments required: IR Cat: 5 - Action: TMDL

The cause of impairment for two sites outlined in Table 3 was due to impacts from siltation, resulting from ongoing surface mining in the Salt Run watershed. A sediment TMDL calculated using QHEI sub-metrics will appropriately determine needed reduction of siltation.

TMDL to address TDS and metal impairments required: IR Cat: 5 - Action: TMDL

The cause of impairment for 39 sites outlined in Table 3 is high concentrations of total dissolved solids (TDS) and/or metals. As TDS includes metals, TMDLs developed for TDS should also result in the needed reduction of metals in the watershed. Because Ohio EPA has a water quality criterion for TDS, these impairments will be handled directly with a TDS TMDL using load duration curves. Figure 2, in the Recreation Use Proposed Actions section, shows an example LDC with corresponding TMDL calculations represented in Table 10.

Aquatic Life Use Proposed Targets

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 7 lists targets for each of these metrics.

Table 4 – QHEI targets for sediment TMDLs

Sediment TMDL Targets		
QHEI Category	WWH/ MWH	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.

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 exceeding the water quality criterion 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. 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 simple modeling method, relationships between TDS source contributions and flow regimes are straight forward. In-stream processes and interactions between sources are simplified, mitigating the major weaknesses of the technique. More details on the LDC method are presented in the Recreation Use section.

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 9 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 8.

Table 6 – Water quality criteria for recreation use

Recreation Use	*Escherichia coli* (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 Northern Central Ohio tributaries basin. Only the most downstream impaired station per HUC 12 is listed because TMDLs are done for the entire HUC 12. The full list of impaired sites can be found in the corresponding TSDs.

Station	Stream Name	HUC-12 (0503010)	RM	# Samples	Geo. Mean	Max value	Attain. Status	Possible Source(s)
C04S06	Cross Creek	1 10 01	24.87	6	361	670	NON	Failing HSTS, Livestock Runoff
203435	Salem Creek	1 10 02	0.1	6	232	950	NON	Failing HSTS, Livestock Runoff
300813	Cross Creek	1 10 03	22.9	12	1112	4000	NON	Failing HSTS, Livestock Runoff
C04S52	McIntyre Creek	1 10 04	0.18	12	232	1200	NON	Failing HSTS, Livestock Runoff
C04S01	Cross Creek	1 10 05	4.15	12	166	2200	NON	Failing HSTS, Livestock Runoff
C03S08	M. Fk. Short Creek	6 02 02	0.23	6	441	2700	NON	Failing HSTS, Livestock Runoff
301055	N. Fk. Short Creek	6 02 03	0.09	6	462	640	NON	Failing HSTS, Livestock Runoff
C03K02	Piney Fork	6 02 04	0.35	6	466	2300	NON	Failing HSTS, Livestock Runoff
C03S07	Short Creek	6 02 05	19.37	10	530	2700	NON	Failing HSTS, Livestock Runoff
C03W07	Short Creek	6 02 05	8.84	6	287	1100	NON	Failing HSTS, Livestock Runoff
609240	Short Creek	6 02 07	4.96	11	240	970	NON	Failing HSTS, Livestock Runoff
C03L05	Crabapple Creek	6 03 01	0.16	10	241	520	NON	Failing HSTS, Livestock Runoff
300817	Wheeling Creek	6 03 02	22.73	11	478	5800	NON	Failing HSTS, Livestock Runoff

C03W15	Wheeling Creek	6 03 03	10.99	5	620	8800	NON	Failing HSTS, Livestock Runoff
C03S18	Wheeling Creek	6 03 04	5.05	11	207	1800	NON	Failing HSTS, Livestock Runoff
301197	Wheeling Creek	6 03 04	10.5	5	588	8000	NON	Failing HSTS, Livestock Runoff
C03L02	Steep Run	6 03 04	0.98	5	424	2400	NON	Failing HSTS, Livestock Runoff
301081	Steep Run	6 03 04	0.1	5	1597	20000	NON	Failing HSTS, Livestock Runoff
301081	Steep Run	6 03 04	0.03	5	1541	7600	NON	Failing HSTS, Livestock Runoff
301070	Rush Run	6 12 01	0.65	6	660	4000	NON	Failing HSTS, Livestock Runoff
301072	Salt Run	6 12 02	0.6	6	237	490	NON	Failing HSTS, Livestock Runoff
300816	Glenns Run	6 12 04	0.1	11	279	2100	NON	Failing HSTS, Livestock Runoff

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 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 10.

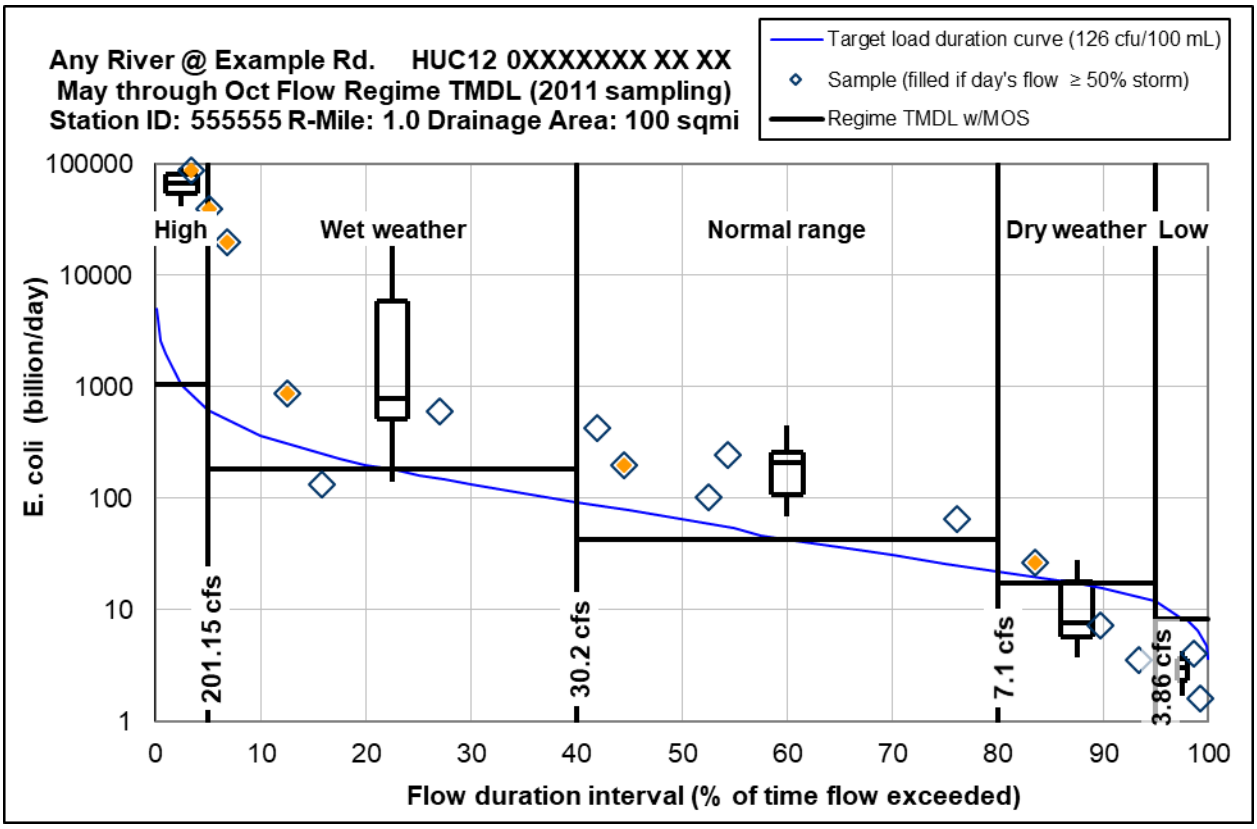

Figure 2 – Example load duration curve.

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

References

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