Ohio Environmental Protection Agency

Loading Analysis Plan and Supporting Data Acquisition Needed for the

Lower Scioto River and Selected Tributaries

Total Maximum Daily Load Development

Walnut Creek

Ohio EPA Technical Report AMS/2011-LSCIO-3

Division of Surface Water
Assessment and Modeling Section
March 2020

Introduction

This document provides an overview of the information considered in proposing the strategy to address water quality impairments in the Lower Scioto River watershed. These recommendations are based on data collected as part of a biological and water quality study in 2011. A description of the project area, sites and data types and methods can be found in the Lower Scioto River watershed study plan document at ***epa.ohio.gov/portals/35/tmdl/LowerScioto_Study_Plan_Final_2011.pdf***. A summary of the study results can be found in the biological and water quality report at ***epa.ohio.gov/Portals/35/tmdl/TSD/Lower%20Scioto/2011-LSCIO-2_Final_03252019.pdf***.

Sites in the Lower Scioto River watershed were assessed for aquatic life and recreation uses. 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 each use is based on specific restoration targets. This document examines those targets and lays out proposals for addressing each impairment via a TMDL. Where appropriate, methods are outlined to develop total maximum daily loads 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/dsw/bioassess/BioCriteriaProtAqLife***. Goals for those indices in the Lower Scioto River 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) assessment was completed at 101 sites in the Lower Scioto River watershed in 2011. These 101 sites include 78 tributary sites and 23 mainstem Scioto sites. The study encompassed 16 HUC-12 watersheds in Pickaway, Ross, Pike, Fairfield, and Scioto Counties. Out of the 101 sites 14 sites were documented as having partial or non-attainment.

Table 1 – Biological criteria applicable in the Lower Scioto River watershed for aquatic life use designations.

Ecoregion	Biological Index	Assessment Method[2]	Biological Criteria for the Applicable Aquatic Life Use Designations[1]	
			EWH	WWH
Eastern Cornbelt Plains (ECBP)	IBI	Headwater	50	40
		Wading	50	40
		Boat	48	42
	MIwb[3]	Wading	9.4	8.3
		Boat	9.6	8.5
	ICI	All[4]	46	36
Western Allegheny Plateau (WAP)	IBI	Headwater	50	44
		Wading	50	44
		Boat	48	40
	MIwb	Wading	9.4	8.4
		Boat	9.6	8.6
	ICI	All	46	36

[1] Aquatic Life Use (ALU) designations: warmwater habitat (WWH); exceptional warmwater habitat (EWH).
[2] 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] Limited to sites with appropriate conditions for artificial substrate placement.

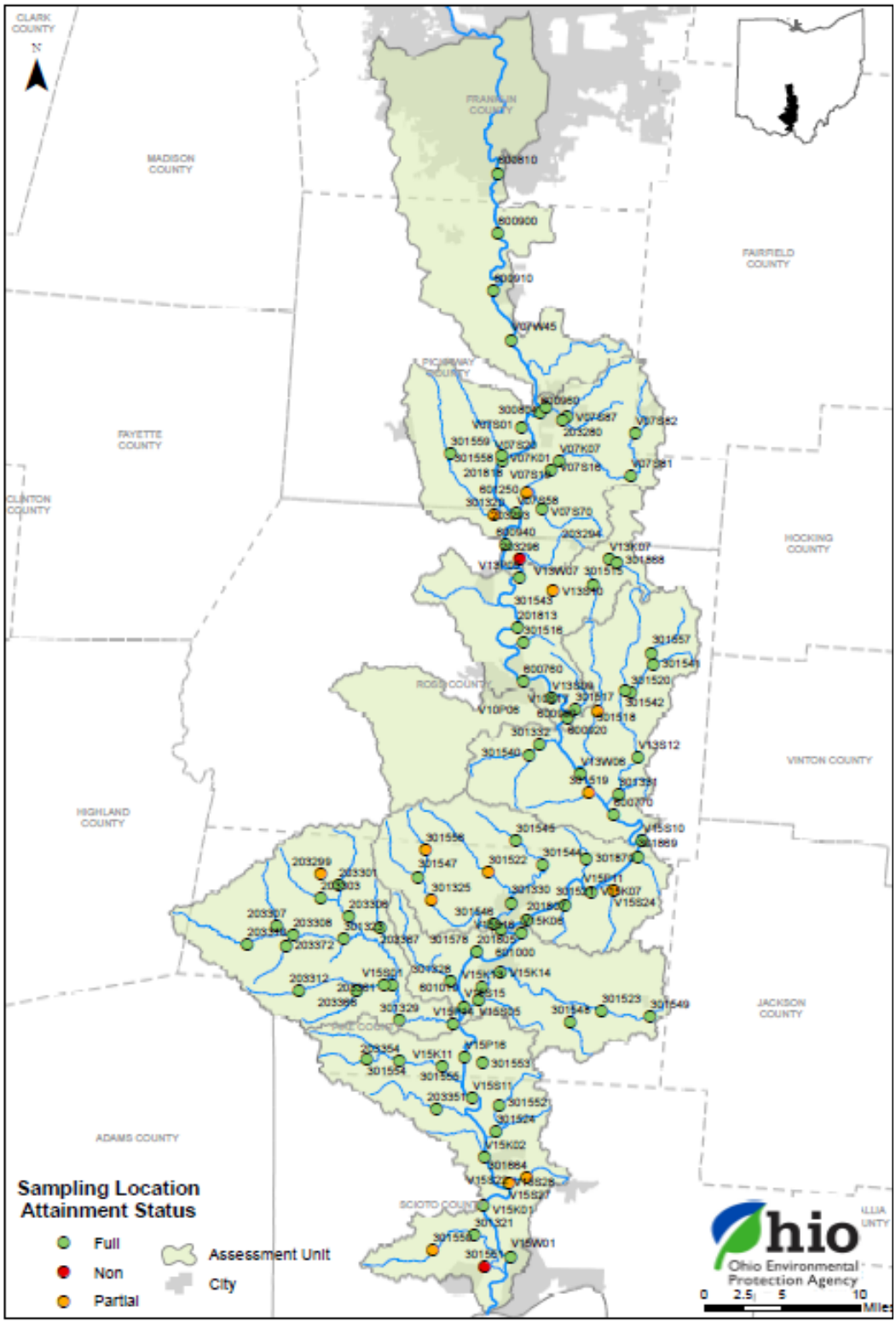

Figure 1 — Map summarizing ALU attainment status in the Lower Scioto River watershed in 2011.

Table 2 – Aquatic life use attainment information for impaired sampling locations in the Lower Scioto River watershed, 2011.

Station	Location	Ecoregion[1]/ ALU[2]	River Mile[a]	Drain. Area (mi^2)	IBI	MIwb[b]	ICI[c]	QHEI	Attain. Status	Causes	Sources
05060002 04 02 – Yellowbud Creek											
301320	Yellowbud Creek South of Circleville, near mouth	ECBP/EWH	1.1(W)	36.2	57	9.6	38*	79.3	**PARTIAL**	Sedimentation	Channel modification
											Agriculture
05060002 04 05 – Scippo Creek											
601250	Scippo Creek south of Circleville at River Rd	ECBP/EWH	1.6(W)	50.40	49ns	8.5*	E	73	**PARTIAL**	Unknown	Unknown
05060002 04 06 – Blackwater Creek											
203296	Blackwater Creek west of Kensington at Orr Rd.	ECBP/WWH	0.7(H)	8.1	34*	NA	F*	58	**NON**	Direct habitat alteration	Channel modification
05060002 05 01 – Kinnikinnick Creek											
V13S10	Kinnikinnick Creek east of Kinnikinnick at RR bridge	ECBP/EWH	2.9(W)	31.6	43*	8.9ns	58	75.8	**PARTIAL**	Unknown	Unknown
05060002 10 02 – Dry Run											
301624	Dry Run at Miller Rd	WAP/WWH	5.4(H)	10.6	28*	NA	G	62.3	**PARTIAL**	Natural conditions (low flow)	Natural sources
05060002 10 05 – Stony Creek-Scioto River											
301519	Stony Creek at 3 Locks Rd	WAP/WWH	0.2/0.6(H)	10.6	30*	NA	G	70.8	**PARTIAL**	Natural conditions (flow or habitat)	Natural sources
05060002 11 01 – Carrs Run											
V15S24	Carrs Run SW of Richmond Dale at North River Rd	WAP/WWH	1.5(H)	12.7	52	NA	F*	64.5	**PARTIAL**	Sedimentation (sand)	Sand/ gravel mining
05060002 11 02 – Left Fork Crooked Creek											
301522	Left Fork Crooked Creek at Co Rd 47	WAP/WWH	2.6(H)	13.2	38*	NA	VG	68.8	**PARTIAL**	Natural conditions (low flow)	Natural sources
05060002 11 04 – Pee Pee Creek											
301556	Pee Pee Creek at Nipgen Rd	WAP/WWH	11.5(H)	4.1	22*	NA	VG	49	**PARTIAL**	Natural conditions (low flow)	Natural sources
301325	Pee Pee Creek E of Buchanon, upstream of Long Beach at Co	WAP/WWH	7.6(W)	21.1	40ns	7.0*	E	63.8	**PARTIAL**	Natural conditions (low flow)	Natural sources

05060002 12 02 – Headwaters Morgan Fork											
203299	Middle Fork Morgan Fork 0.5mi downstream of Pike Lake, adj. to Pike Lake Rd	WAP/WWH	1.5/1.4(H)	4.7	34*	NA	G	78	**PARTIAL**	Flow alteration	Impoundment (downstream effects)
05060002 16 03 – Bear Creek-Scioto River											
301664	Candy Run at Lintz Hollow Rd	WAP/WWH	2.6(H)	5.20	52	NA	F*	73.3	**PARTIAL**	Organic enrichment	HSTS (home septic)
V15S27	Candy Run downstream of Lucasville WWTP at US Rt 23	WAP/WWH	0.9(H)	8	56	NA	F*	71	**PARTIAL**	Organic enrichment	POTW (Lucasville WWTP)
05060002 16 04 – Pond Creek											
301551	Dry Run upstream of St Rt 104, adj. to Co Rd 57	WAP/WWH	1.3(H)	4.5	32*	NA	NA	39.3	**(NON)**	Natural conditions (low flow)	Natural sources

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

b- MIwb is not applicable to headwater streams with drainage areas $\leq$ 20 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. F=Fair, G=Good, VG=Very Good, E=Exceptional

ns- Nonsignificant departure from biocriteria ($\leq$4 IBI or ICI units, or $\leq$0.5 MIwb units).

*- Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

H- Headwater site (draining ≤20 $miles^2$)

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

1- Level III Ecoregions: Eastern Corn Belt Plains (ECBP), Western Allegheny Plateau (WAP)

2- Aquatic Life Use (ALU) designations: Exceptional Warmwater Habitat (EWH), Warmwater Habitat (WWH).

Proposed TMDL Actions

Ohio EPA considers many factors when deciding how to address impairments in TMDLs. 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 TMDL approaches

Station	Stream Name	River Mile	HUC 12 (05060002)	Cause(s) of Impairment	Source(s) of Impairment	Action	Method[1]
301320	Yellowbud Creek	1.1	04 02	Sedimentation	Channel modification Agriculture	TMDL	QHEI-sed
601250	Scippo Creek	1.6	04 05	Unknown	Unknown	N/A	Follow up
203296	Blackwater Creek	0.7	04 06	Direct habitat alteration	Channel modification	TMDL	QHEI
V13S10	Kinnikinnick Creek	2.9	05 01	Unknown	Unknown	N/A	Follow up
301624	Dry Run	5.4	10 02	Natural conditions (low flow)	Natural sources	N/A	
301519	Stony Creek	0.2	10 05	Natural conditions (flow or habitat)	Natural sources	N/A	
V15S24	Carrs Run	1.5	11 01	Sedimentation (sand)	Sand/ gravel mining	TMDL	QHEI-sed NPDES
301522	Left Fork Crooked Creek	2.6	11 02	Natural conditions (low flow)	Natural sources	N/A	
301556	Pee Pee Creek	11.5	11 04	Natural conditions (low flow)	Natural sources	N/A	
301325	Pee Pee Creek	7.6	11 04	Natural conditions (low flow)	Natural sources	N/A	
203299	Middle Fork Morgan Fork	1.5	12 02	Flow alteration	Impoundment (downstream	N/A	
301664	Candy Run	2.6	16 03	Organic enrichment	HSTS (home septic)	Other	Follow up
V15S27	Candy Run	0.9	16 03	Organic enrichment	POTW (Lucasville WWTP)	Other	Follow up
301551	Dry Run	1.3	16 04	Natural conditions (low flow)	Natural sources	N/A	

[1] Due to space limitations there are several abbreviations used to describe the analysis or remediation method. Some abbreviations are compounded when the analysis method indirectly addresses the listed cause of impairment through use of a surrogate parameter. Those abbreviations are defined as follows:

Abbreviation	Definition/interpretation
Follow-up	Follow-up assessment is required to determine if attainment status has changed or to clarify/verify the listed cause of impairment.
QHEI	"Qualitative habitat evaluation index" is used as means to address impairment due to inadequate habitat quality.
QHEI-sed	Sub-metrics of the QHEI used to evaluate aspects of habitat quality as a surrogate for addressing impairment due to excess sediment.
NPDES	The impairment will be addressed through Ohio EPA's permitting and compliance programs.

Natural causes/sources

Stony Creek (RM 0.2), Left Fork Crooked Creek (RM 2.6), Pee Pee Creek (RM 7.6 and RM 11.5), and two different Dry Run sites, one at RM 1.3 and the other at RM 5.4, are impaired by low flow which is a natural cause of impairment and do not require TMDLs.

Unknown causes/sources

Scippo Creek (RM 1.6) and Kinnikinnick Creek (RM 2.9) are impaired due to unknown causes and sources. No TMDLs can be done at either of these sites and more data is needed to clarify the causes and sources of the impairment.

Sedimentation

Sedimentation is listed as the cause of impairment at Yellowbud Creek and Carrs Run. The impairment in Yellowbud Creek is due to channel modification and agricultural activities. The impairment in Carrs Run is associated with stormwater runoff from piles of sand from past sand and gravel mining operations at Ohio Basic Minerals (OBM) which is adjacent to Carrs Run. The Ohio Basic Minerals, Scioto Plant, Pike County: NPDES permit # 0IJ00053*CD, expires May 21, 2021. OBM is a defunct industrial mineral mining (sand) company which owned three sites in Ohio. Resilience Capital financed or backed OBM and once OBM went out-of-business, Resilience Capital retained ownership of all assets. Since mid-2019, Resilience Capital has taken responsibility of three OBM sites by:

- Selling the Jackson Plant, Jackson County to another industrial mining company for continued operations. This site is an active sand processing facility.
- Selling all useable assets to generate some return on investment with the understanding of their environmental responsibilities.
- Reclaimed the Barbee Facility in Ross County.
- As of January 22, 2020, Resilience Capital has communicated to Ohio EPA of their intent to reclaim the Scioto Plant, Pike County. The Scioto Plant site is the site impacting Carrs Run. Currently they are accepting bids for the work and once bids are reviewed a plan will be shared with Ohio EPA.
- Resilience Capital needs to transfer the Jackson Permit to the new owner.
- Resilience Capital needs to terminate the Barbee Plant NPDES permit.
- Resilience Capital needs to reclaim and then terminate the NPDES permit for the Scioto Plant.

Ohio EPA is utilizing its regulatory and enforcement abilities to require reclamation of the Scioto Plant site. At this time, the responsible party is cooperating and progressing in a reasonable timeframe. A deadline has not been determined for the completion of the work. As long as the work continues at a reasonable timeframe and weather cooperates, Ohio EPA does not expect escalated enforcement.

Flow alteration

Middle Fork Morgan Fork has been listed as impaired due to flow alterations from impoundment. Flow alterations are not a pollutant (a category 4c in the integrated report), and no TMDL is required at this site.

Direct habitat alteration

Habitat alterations resulting from channel modification to facilitate agricultural activity is the main cause of non-attainment at Blackwater Creek. Impairment caused by habitat alteration in this site is straightforward and does not require additional data or in-depth modeling. A habitat TMDL can be calculated using QHEI habitat analysis.

Organic Enrichment impairment

Candy Run has been listed as impaired for organic enrichment at two sites, upstream of Lucasville WWTP (RM 2.6) and downstream of Lucasville WWTP (RM 0.9). Currently, Ohio doesn't have any Water Quality Standards (WQS) to address organic enrichment, but dissolved oxygen (D.O.) can be used as an end point to address organic enrichment. To verify organic enrichment in Candy Run, a second survey was done. Two datasondes were deployed in Candy Run upstream and downstream of Lucasville WWTP. Minimum and average D.O. readings are shown in Table 4. The minimum recorded D.O. and average D.O. are well above WWH water quality standard minimum D.O. of 4 mg/L and average D.O. of 5 mg/L. The recorded minimum and calculated average D.O. do not support organic enrichment as a cause; therefore, more data is needed to confirm organic enrichment as the cause of impairment or to show that organic enrichment is not a cause of impairment.

Table 4 – Candy Run minimum and average D.O.

Name	Location	River mile	Minimum D.O. (mg/L)	Average D.O. (mg/L)
Candy Run	@ US 23 (dnst. Of Lucasville WWTP)	0.87	5.77	6.73
Candy Run	Upst Lucasville WWTP	1.04	4.81	5.87

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 5.

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 6).

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For example, in order to meet the targets, streams designated as WWH cannot have more than four modified attributes, of which no more than one can be a high influence modified attribute. For simplicity, a pass/fail distinction is made indicating whether or not each of the three targets is being met. Targets are set for: 1) the total QHEI score; 2) the maximum number of all modified attributes; and 3) the maximum number of high influence modified attributes. If the minimum target is satisfied, then that category is assigned a "1", if not, it is assigned a "0". To satisfy the habitat TMDL, the stream segment in question should achieve a score of three.

Table 5 – QHEI targets for habitat TMDLs

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

Table 6 – Itemization of modified attributes for computing habitat TMDLs

High Influence Modified Attributes	Moderate Influence Modified Attributes	
• Recent channelization or no recovery • Silt/muck substrate • Low or no sinuosity (drainage area ≤ 20 mi^2) • Sparse/no cover • Maximum pool depth < 40 cm (wadable or headwater sites)	• Recovering channelization • Heavy/moderate silt cover • Sand substrate (boat sites) • Hardpan substrate origin • Fair/poor development • Low or no sinuosity (drainage area > 20 mi^2) • Only 1-2 cover types	• 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 lists targets for each of these metrics.

Table 7 – 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 , 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 – 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 ten per cent 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 9 – Recreation use attainment information for impaired sampling locations in the Lower Scioto watershed, 2011.

Station	Stream Name	River Mile	# of Samples	Geometric Mean	Maximum Value	Attainment Status	Possible Source(s)
05060002 04 01 - Hargus Creek							
300804	Hargus Creek	0.4	8	1149	8500	NON	Urban, HSTS, ILLD
05060002 04 02 - Yellowbud Creek							
301320	Yellowbud Creek	1.1	9	283	770	NON	Ag, HSTS, unsewered areas
05060002 04 03 - Lick Run-Scioto River							
600960	Scioto River	100.0	8	363	1100	NON	Agriculture
V07S62	Scioto River	96.5	5	279	690	NON	Agriculture, WWTP
V07K01	Scioto River	94.6	5	253	670	NON	Agriculture, WWTP
301558	Lick Run	0.2	5	425	720	NON	Ag, livestock, HSTS
05060002 04 04 - Congo Creek							
V07S70	Congo Creek	2.2	5	443	590	NON	Ag, livestock, HSTS
05060002 04 05 - Scippo Creek							
601250	Scippo Creek	1.6	9	493	3100	NON	Ag, livestock, HSTS, WWTP

Station	Stream Name	River Mile	# of Samples	Geometric Mean	Maximum Value	Attainment Status	Possible Source(s)
05060002 04 06 - Blackwater Creek-Scioto River							
V07S58	Scioto River	89.5	5	321	2200	NON	Agriculture, WWTP
203296	Blackwater Creek	0.7	12	778	2000	NON	Ag, livestock, HSTS
05060002 05 01 - Kinnikinnick Creek							
V13S10	Kinnikinnick Creek	2.95	8	230	470	NON	Ag, livestock
301515	South Fork Kinnikinnick Creek	0.8	8	300	730	NON	Ag, livestock
05060002 05 02 - Dry Run-Scioto River							
301516	Dry Run	0.6	8	381	980	NON	Unsewered area
05060002 05 03 - Lick Run-Scioto River							
600920	Scioto River	64.2	10	139	930	NON	undetermined
301517	Lick Run	0.64	8	1494	5400	NON	Ag, HSTS
05060002 10 01 - Indian Creek							
301332	Indian Creek	1.2	8	181	860	NON	Unsewered area
05060002 10 02 - Dry Run							
301518	Dry Run	5.36	4	1724	9500	NON	Agriculture, pooled area
05060002 10 03 – Headwaters-Walnut Creek							
301520	Walnut Creek	11.3	8	230	490	NON	undetermined
05060002 10 04 – Lick Run-Walnut Creek							
301331	Walnut Creek	1.3	8	192	620	NON	undetermined
05060002 11 01 - Carrs Run							
V15S24	Carrs Run	1.52	8	232	530	NON	undetermined
05060002 11 02 - Left Fork Crooked Creek							
301522	Left Fork Crooked Creek	2.65	8	235	530	NON	undetermined
05060002 11 03 - Crooked Creek							
301330	Crooked Creek	2.37	8	199	26,000	NON	undetermined
05060002 11 05 - Meadow Run-Scioto River							
301521	Meadow Run	0.26	8	262	690	NON	undetermined
05060002 12 01 – Headwaters Sunfish Creek							
203310	Sunfish Creek	23.3	8	173	470	NON	undetermined
05060002 12 04 – Grassy Fork-Sunfish Creek							
301323	Sunfish Creek	16.2	8	175	570	NON	undetermined
05060002 12 05 - Chenoweth Fork							
203361	Chenoweth Fork	1.7	7	184	350	NON	undetermined
05060002 12 06 – Leeth Creek-Sunfish Creek							
301329	Sunfish Creek	4.85	8	356	2900	NON	undetermined
05060002 13 02 – Headwaters Big Beaver Creek							
301523	Big Beaver Creek	16.01	8	367	3000	NON	undetermined
05060002 13 03 – Little Beaver Creek-Big Beaver Creek							
V15K13	Big Beaver Creek	3.15	8	165	380	NON	undetermined
05060002 16 01 - Camp Creek							
203354	Camp Creek	5.2	8	244	32,000	NON	undetermined
05060002 16 03 – Bear Creek-Scioto River							
301524	Miller Run	0.93	8	1045	7300	NON	undetermined

Station	Stream Name	River Mile	# of Samples	Geometric Mean	Maximum Value	Attainment Status	Possible Source(s)
05060002 16 04 - Pond Creek							
301321	Pond Creek	4.8	8	313	2400	NON	undetermined

1 – At the time of this survey, recreation uses included three primary contact recreation classes (A, B, or C); bathing waters (BW); or secondary contact recreation (SCR).
2 – Per assessment procedures in place at the time of this survey, attainment status was determined based on the seasonal geometric mean. The status was not determined at locations where fewer than two samples were collected during the recreation season.
3 - Possible Sources:
AG-Agriculture
CAFO-Concentrated Animal Feeding Operation
HSTS-Home Sewage Treatment Systems
ILLD-Illicit Discharges
WWTP-Wastewater Treatment Plants

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.

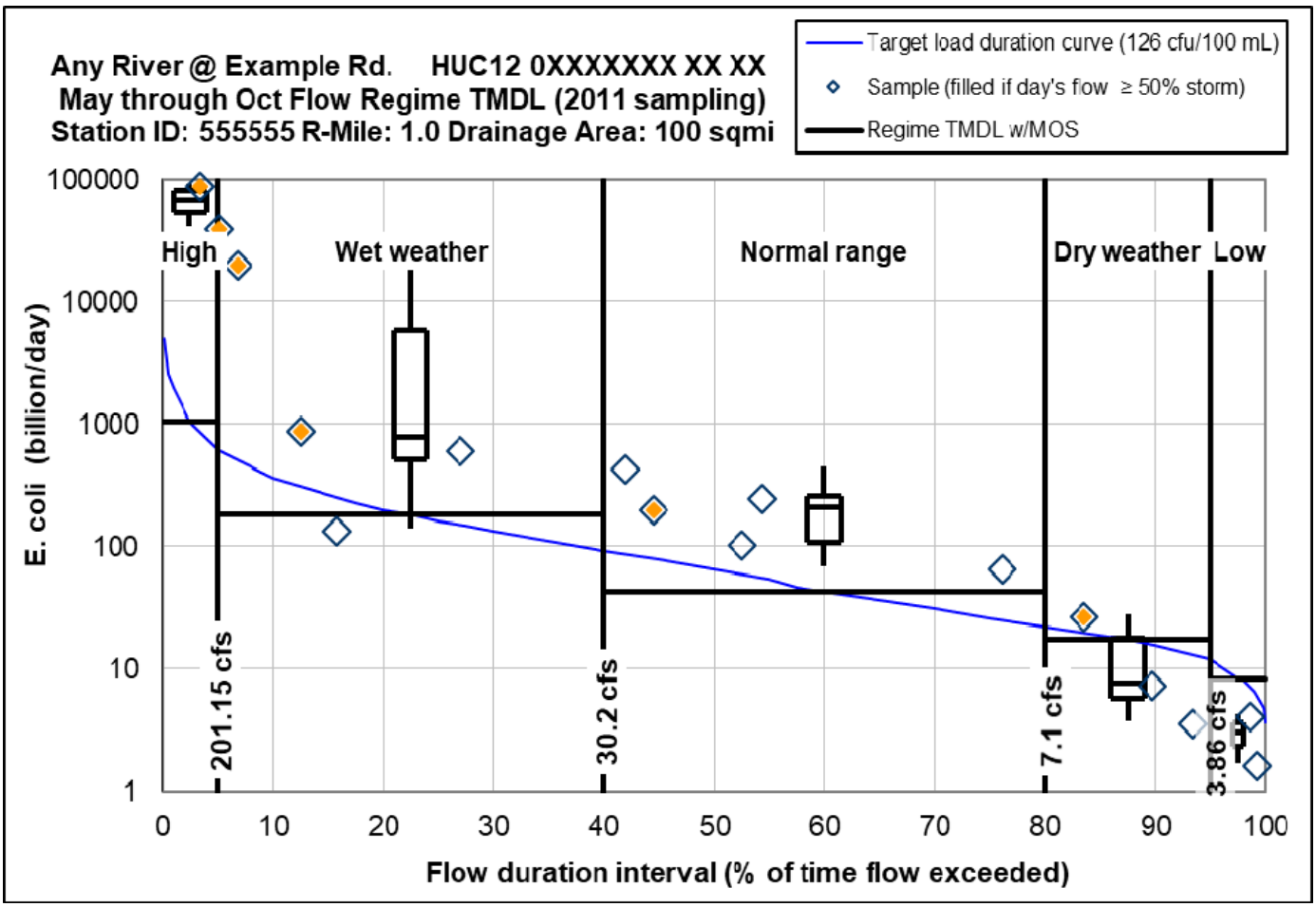

Figure 2 – Example load duration curve.

Table 10 – 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

Reference

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/portals/35/guidance/assoc_load.pdf***