State of Ohio
Environmental Protection Agency

Division of Surface Water

Total Maximum Daily Loads for the Hocking River Watershed

Hocking River near Route 33 crossing, Fairfield County

Final Report
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Ted Strickland, Governor
Chris Korleski, Director

TABLE OF CONTENTS

Appendices

List of Tables

List of Figures

List of Acronyms and Abbreviations

BIT	Bacteria Indicator Tool
BMP	best management practice
cm	centimeter
CNMP	Comprehensive Nutrient Management Plan
cnt/seas	counts per season
CO	consent agreement
Corps	U.S. Army Corps of Engineers
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CSO	combined sewer overflow
CSS	combined sewer system
CWA	Clean Water Act
CWH	Cold Water Habitat
DA	drainage area
DEFA	Division of Environmental and Financial Assistance
DFFOs	Directors Final Findings and Orders
DNAP	Division of Natural Areas and Preserves
DSW	Division of Surface Water
DSWC	Division of Soil and Water Conservation
ECBP	Eastern Corn Belt Plains
EQIP	Environmental Quality Incentives Program
EWH	Exceptional Warmwater Habitat
FC	Fecal Coliform
FSA	Farm Service Agency
gpd	gallons per day
GPS	geographic positioning system
GW	groundwater
HSTS	household sewage treatment system
HUC	hydrologic unit code
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
LA	load allocations
lb/yr	pounds per year
LEAP	Livestock Environmental Assurance Program
LID	low impact development
LTCP	Long term Control Plan
mg/L	milligrams per liter
MGD	million gallons per day
MHP	Mobile Home Park
MIWB	Modified Index of Well-Being
mi^2	square mile
ml	milliliter
MOR	monthly operating reports
MORPC	Mid-Ohio Regional Planning Commission
MOS	margin of safety
MS4	municipal separate storm sewer system
MWH	Modified Warmwater Habitat
NACD	National Association of Conservation Districts
NEMO	Nonpoint Education for Municipal Official

NLCD	National Land Cover Dataset
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NRCS	Natural Resource Conservation Service
OAC	Ohio Administrative Code
OAEA	Ohio Agricultural Environmental Assurance
ODNR	Ohio Department of Natural Resources
ODOT	Ohio Department of Transportation
OFAER	On Farm Assessment and Environmental Review
OFBF	Ohio Farm Bureau Federation
OLC	Ohio Livestock Coalition
ORC	Ohio Revised Code
PCR	Primary Contact Recreation
PIR	Pollution Investigation Report
PTI	Permit to Install
QHEI	Qualitative Habitat Evaluative Index
RC&D	Resource Conservation and Development
RI	return interval
RM	river mile
SCR	Secondary Contact Recreation
SCS	Soil Conservation Service
SSO	sanitary sewer overflow
SSO	separate sewer overflow
SSS	sanitary sewer system
SWCD	Soil and Water Conservation District
TMDL	total maximum daily load
tn/yr	tons per year
TP	total phosphorus
TSS	total suspended solids
U.S. EPA	U.S. Environmental Protection Agency
USDA-ARS	United States Department of Agriculture-Agricultural Research Service
USGS	U.S. Geologic Survey
WHC	Wildlife Habitat Council
WLA	wasteload allocations
WPCLF	Water Pollution Control Loan Fund
WQC	Water Quality Certification
WQMP	Water Quality Management Plan
WQS	water quality standards
WRP	Wetland Reserve Program
WRRSP	Water Resource Restoration Sponsor Program
WTP	water treatment plant
WWH	Warmwater Habitat
WWTP	wastewater treatment plant

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1.0 INTRODUCTION

Ohio EPA conducted a comprehensive physical, chemical and biological survey in portions of the Hocking River watershed from 2003 to 2005. The water quality survey included monitoring of the Hocking River and several streams within tributary subwatersheds as described in Section 2.1. Several stream segments not meeting the Ohio water quality standards were identified during the survey. These findings and other information regarding water quality and habitat conditions are summarized in this report.

Total Maximum Daily Loads (TMDL) have been developed for pollutants and stressors which have impaired water uses and precluded attainment of applicable water quality standards. This report summarizes the approach taken and results for these TMDL analyses. This report also includes a discussion about actions and land management that can abate the identified water resource problems.

Specific TMDLs that have been developed and are described in this report include:

- Nutrients (using total phosphorus as the sole indicator nutrient enrichment)
- Sediment (using a qualitative index to assess the degree of in-stream sedimentation)
- Habitat (using a qualitative index to assess the quality of habitat features)
- Pathogens (using fecal coliform as indicator of contamination)

1.1 The Clean Water Act Requirement to Address Impaired Waters

The Clean Water Act (CWA) Section 303(d) requires States, Territories, and authorized Tribes to list and prioritize waters for which technology-based limits alone do not ensure attainment of water quality standards. Lists of these impaired waters (the Section 303(d) lists) are made available to the public for comment, then submitted to the U.S. Environmental Protection Agency (U.S. EPA) for approval in even-numbered years. Further, the CWA and U.S. EPA regulations require that Total Maximum Daily Loads (TMDLs) be developed for all waters on the Section 303(d) lists. The Ohio EPA identified several assessment units in the Hocking River watershed as impaired on the 2008 303(d) list (available at http://www.epa.state.oh.us/dsw/tmdl/2008IntReport/2008OhioIntegratedReport.aspx.

The 303(d) list includes the waterbodies that are not meeting water quality standards, the environmental stressors that are responsible for the substandard water quality and the sources of these stressors. Stressors are typically a specific pollutant or suite of pollutants. However, the physical condition of the stream systems (e.g., poor habitat quality) may also be putting stress on the system. These listed parameters are then addressed accordingly through the TMDL development process.

In the simplest terms, a TMDL can be thought of as a cleanup plan for a watershed that is not meeting water quality standards. A TMDL is defined as a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards and an allocation of that quantity among the sources of the pollutant. Ultimately, the goal of Ohio's TMDL process is full attainment of Water Quality Standards (WQS), which would subsequently lead to the removal of the waterbodies from the 303(d) list. Table 1.1 summarizes how the impairments identified in the Hocking River watershed are addressed in this TMDL report.

Table 1.1 A summary of the 2008 303(d) listed impairments in the Hocking River TMDL study area.

Assessment Unit 05030204 -	Drainage area (sq mi)	Aquatic Life Use Impairment	Recreational Use Impairment	Drinking Water Use Impairment	Human Health Impairment	Priority Points
010	132.0	Yes	Yes	Unknown	Yes	10
020	98.9	Yes	No	None	Yes	1
030	136.0	Yes	Yes	None	Yes	5
040	91.8	No	No	None	Unknown	-
050	126.3	Yes	No	None	Unknown	6
080	102.4	Yes	Yes	None	Unknown	7
090	144.6	Yes	Yes	None	Unknown	5
100	109.7	Yes	No	None	Unknown	4

Table 1.2 Summary of causes of impairment to aquatic life and recreational uses for the Hocking River watershed and actions taken to address them. (Blank spaces indicate that the listed cause of impairment does not apply in that assessment unit.)

Causes of Impairment	Assessment Units (05030204 -)							
	010	020	030	040	050	080	090	100
Aquatic Life Uses								
Siltation	S	S	S		S	S	S	S
Direct Habitat Alteration	S	S	S		S			
Flow alteration						N	N	N
Nutrients	N	S	S		S	N	N	N
Organic Enrichment (DO)	O	O	O		O	O	O	N
pH		N			N	N		
Salinity/TDS/chloride		N						N
Aluminum		N					N	
Natural					na		na	
Unknown					na			
Recreational Uses								
Pathogens	T	T*	T		T*	T	T	

"T" means TMDL developed using WQS numeric criteria.
"T" means TMDL developed using WQS numeric criteria to address some other cause of impairment (e.g., pathogens used to address organic enrichment).*
"S" means a surrogate measure is used to calculate a TMDL.
"O" means that other causes being addressed will adequately deal with this cause.
"N" means TMDL <u>not</u> developed.
"na" means a TMDL cannot be developed for this.

1.2 Public Involvement

Public involvement is key to the success of water restoration projects, including TMDL efforts. From the beginning, Ohio EPA has invited participation in all aspects of the TMDL program. The Ohio EPA convened an external advisory group in 1998 to assist the Agency with the development of the TMDL program in Ohio. The advisory group issued a report in July 2000 to the Director of Ohio EPA on their findings and recommendations. The Hocking River watershed TMDL project has been completed using the process endorsed by the advisory group.

Consistent with Ohio's current Continuous Planning Process (CPP), the draft TMDL report was available for public review from July 2, 2009 through August 3, 2009. A copy of the draft report was posted on Ohio EPA's web page (http://www.epa.state.oh.us/dsw/Home.aspx). No comments were received.

Ohio EPA has been in communication with representatives from local agencies and organizations regarding the findings of the watershed assessments and preliminary TMDL results. These include regional planning, soil and water conservation districts, county Natural Resource Conservation Service offices, Resource Conservation and Development offices, Ohio State University Extension, Ohio Farm Bureau Federation, and watershed groups. Meetings were held in which results of the watershed assessment and preliminary TMDL analyses were shared and approaches towards water quality restoration were discussed.

Continued public involvement is critical to the success of any TMDL project. Ohio EPA will continue to support the implementation process and will facilitate, to the fullest extent possible, restoration actions that are acceptable to the communities and stakeholders in the study area and to Ohio EPA. Ohio EPA is reluctant to rely solely on regulatory actions and strongly advocates voluntary actions facilitated by the local stakeholders, watershed organization, and agency partners to restore the Hocking River watershed.

2.0 DESCRIPTION OF THE PROJECT AREA

The Hocking River is over 102 miles long and its watershed spans from central Ohio to southeast Ohio. This watershed drains 1,197 square miles of land and covers parts of Fairfield, Perry, Hocking, Athens, Washington, and Meigs counties. The largest municipalities in the watershed are found near the mainstem of the Hocking River which include Lancaster, Logan, Nelsonville, and Athens. Somewhat smaller municipalities situated near major tributary streams include New Lexington and Bremen along Rush Creek, Somerset along the headwaters of Somerset Creek, Amanda near Clear Creek, Albany near Margaret Creek, and Amesville near Federal Creek. Chauncey, the Plains and Coolville are small communities located along the Hocking River in the southern portion of the watershed.

2.1 Project Delineation

This section of the report explains how data for the many different streams and land areas of the watershed is organized. Initial water quality surveys and the subsequent TMDLs that are developed are based on assessment units (AUs).

For this report, the assessment units correspond to 11-digit Hydrologic Unit Codes (HUCs) established by the Natural Resource Conservation Service (NRCS) to delineate watershed areas. If possible, an 11-digit HUC captures the entire drainage area for a significant stream and its tributaries. For example, Clear Creek, a tributary to the Hocking River, and all of its tributaries occupy an area delineated by an 11-digit HUC. HUCs average approximately 100 to 120 square miles in size.

Each 11-digit HUC is identified with both a name and a numeric code (i.e., 11-digits in length). These HUCs are subunits of larger watersheds. For example, the entire Hocking River watershed is represented by an eight digit HUC (05030204) which contains ten 11-digit HUCs. Likewise, 11-digit HUCs can be further sub-divided into smaller 14-digit HUCs which typically correspond to small tributary streams with an approximate drainage area of 20 to 25 square miles. The 14-digit HUCs are also presented in this report to more specifically identify and describe areas within the overall project area.

The TMDL project area encompasses the entire Hocking River watershed with the exception of the Monday and Sunday Creek watersheds, for which TMDLs were completed and approved by U.S. EPA in 2005 and 2006, respectively. The remainder of the Hocking River watershed is 941.6 square miles and is comprised of eight HUC11 assessment units. Figure 2.1 is a map of the project area that shows the boundaries of the AU watersheds with the respective 11-digit code displayed. Monday and Sunday Creek watersheds are outlined in red and crosshatched. The ecoregions (see Section 2.2) that overlay the Hocking River TMDL project area are also included on the map. Table 2.1 lists the HUC11 and HUC14 subwatersheds and provides a narrative description of their locations within the river system. Only AUs that were sampled during the 2003-2005 Hocking River survey are included in Table 2.1.

Although not included in this TMDL, the Sunday and Monday Creek watersheds have had severe aquatic life use impairments documented. For both watersheds acid mine drainage causing elevated metals and sediment loading as well as low pH and altered stream flow. The impact of these tributaries on the mainstem of the Hocking is believed to be minimal due to the

attainment of aquatic life uses downstream from these confluences. Nonetheless, abatement of the acid mine drainage problems in these watersheds will improve the overall health of the larger Hocking River watershed. More information regarding these areas can be found on the TMDL websites for the Sunday Creek project http://www.epa.state.oh.us/dsw/tmdl/SundayCreekTMDL.aspx) and the Monday Creek project (http://www.epa.state.oh.us/dsw/tmdl/MondayCreekTMDL.aspx).

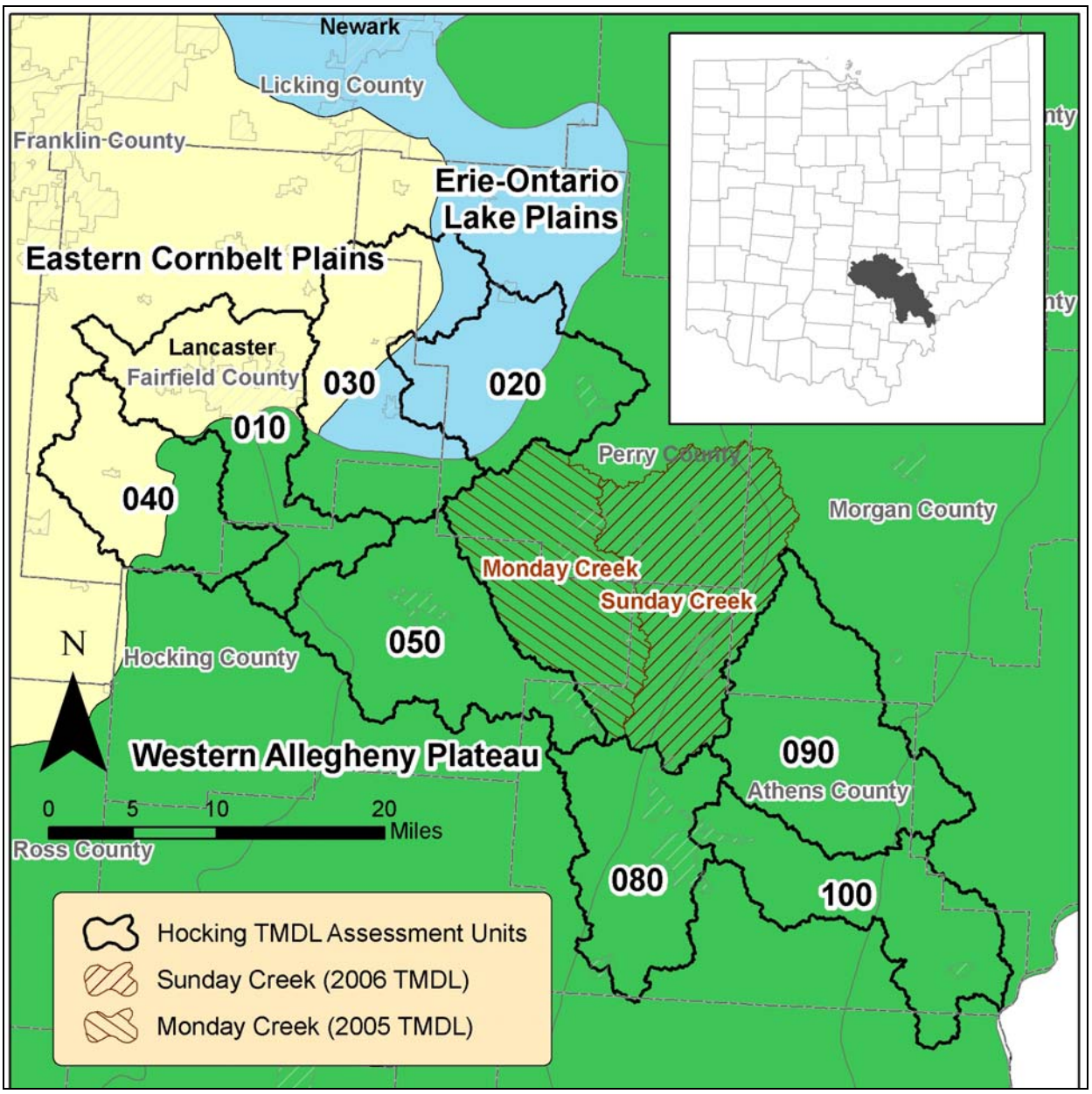

Figure 2.1. Assessment units and ecoregions in the Hocking River watershed. The three digit numbers representing each assessment unit are the last three digits of the 11-digit Hydrologic Unit Code (HUC).

Table 2.1. Watersheds and subwatersheds used as assessment units for the Hocking River TMDL project area.

05030204-		Narrative Description	Drainage Area (square miles)
010	***Hocking River (headwaters to Enterprise [except Rush and Clear Creeks])***		***132.0***
	010-010	Hocking River headwaters to above Hunters Run	36.6
	010-020	Hunters Run	11.1
	010-030	Baldwin Run	12.6
	010-040	Pleasant Run	17.5
	010-050	Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]	20.8
	010-060	Buck Run	10.9
	010-070	Hocking River below Rush Cr. to Enterprise [except Clear Cr. and Buck Run]	22.5
020	***Rush Creek (headwaters to above Little Rush Creek)***		***98.9***
	020-010	Rush Creek headwaters to above Center Branch	45.5
	020-020	Center Branch	24.8
	020-030	Rush Creek below Center Branch to above L. Rush Cr.	28.5
030	***Rush Creek (above Little Rush Creek to Hocking River)***		***136.0***
	030-010	Little Rush Cr. headwaters to near Rushville	30.1
	030-020	Little Rush Cr. near Rushville to Rush Cr.	31.2
	030-030	Raccoon Run	27.5
	030-040	Rush Creek below L. Rush Cr. to Hocking R. [except Raccoon Run]	47.2
040	***Clear Creek***		***91.8***
	040-010	Clear Creek headwaters to above Muddy Prairie Run	48.2
	040-020	Muddy Prairie Run	11.0
	040-030	Arney Run	11.2
	040-040	Clear Creek below Muddy Prairie Run to Hocking R. [except Arney Run]	21.4
050	***Hocking River (below Enterprise to above Monday Creek)***		***126.3***
	050-010	Hocking River at Enterprise to above Fivemile Cr. [except Scott Cr. and Oldtown Cr.]	16.5
	050-020	Scott Creek [except Clear Fk.]	23.7
	050-030	Clear Fork	16.1
	050-040	Oldtown Creek	13.7
	050-050	Fivemile Creek	14.4
	050-060	Hocking River below Fivemile Cr. to above Monday Cr.	42.0
080	***Hocking River (below Monday Creek to Athens/RM33.1 (except Sunday Creek)***		***102.4***
	080-010	Hocking River below Monday Cr. to above Sunday Cr.	22.1
	080-020	Hocking River below Sunday Cr. to Athens [except Margaret Cr.]	20.3
	080-030	Margaret Creek headwaters to above W. Branch	33.1
	080-040	Margaret Creek above W. Branch to above Factory Cr.	14.2
	080-050	Margaret Creek above Factory Cr. to Hocking R.	12.6
090	***Federal Creek***		***144.6***
	090-010	Federal Creek headwaters to below Hyde Fk. and Miners Fk. confluence	16.5
	090-020	Federal Creek below Miners Fk. to above McDougall Branch	15.5
	090-030	McDougall Branch above Mush Run	14.0
	090-040	Mush Run	13.2
	090-050	McDougall Branch below Mush Run to Federal Cr.	10.4
	090-060	Sharps Fork	35.7
	090-070	Marietta Run	10.2
	090-080	Big Run	11.9
	090-090	Federal Creek below McDougall Branch to Hocking R. [except Sharps Fk., Marietta Run, & Big Run]	17.3

05030204-		Narrative Description	Drainage Area (square miles)
100	***Hocking River below Athens/RM33.1 to Ohio River [except Federal Creek]***		***109.7***
	100-010	Hocking River from Athens to above Willow Cr.	18.3
	100-030	Hocking River below Willow Cr. to above Federal Cr.	20.6
	100-020	Willow Creek	12.7
	100-040	Hocking River below Federal Cr. to Ohio R. [except Fourmile Cr.]	41.9
	100-050	Fourmile Creek	16.2

2.2 Ecoregion

Ecoregions are areas delineated based on natural characteristics, such as topography, general soil types, climate, dominant vegetation, and land use related to human activity. These factors have controlling impacts on river and stream systems in terms of hydrology, aquatic biological communities, chemical water quality, and physical stream attributes. Generally speaking, there is less stream-to-stream variation within an ecoregion than there is for streams of differing ecoregions. For this reason some of Ohio's water quality standards are ecoregion-specific.

The Hocking River watershed is located within parts of the three different ecoregions: the Eastern Corn Belt Plains (ECBP), the Erie-Ontario Lake Plains (EOLP), and the Western Allegheny Plateau (WAP). Figure 2.1 shows the boundaries of these three ecoregions within the Hocking River watershed.

Eastern Corn Belt Plains (ECBP)
This ecoregion consists primarily of rolling till plains with local end moraines. The soils developed from loamy, limy, glacial deposits of Wisconsinan age. Historically, beech forests, oak-sugar maple forests, and elm-ash swamp forests grew on the nearly level terrain; however, today corn, soybean, and livestock production is widespread.

Erie-Ontario Lake Plains (EOLP)
This ecoregion is characterized by low lime drift overlying rolling to level terrain with scattered end moraines and kettles. The soils are usually less naturally fertile than the high lime till plains of other glaciated ecoregions. Lakes, wetlands, and swampy streams occur where the drainage pattern is deranged or where the land is flat and clayey. Groundwater fed headwater streams may be present where there are moraines or where bedrock has become exposed through erosion of the till.

Western Allegheny Plateau (WAP)
The WAP has a more rugged, unglaciated terrain with local relief up to 500 feet. The underlying strata are made of sandstone, siltstone, shale, and limestone. Soils are from these same materials with some isolated loess soils. Coal, oil and gas deposits are found in much of this region. Extraction of coal, oil, and gas has had and continues to have a major effect on the ecology and culture of the region. Steep slopes in the region limit crop and cattle production to valley floors that reduces riparian corridors and concentrates animal wastes near the stream. Cattle often have free access to streams resulting in increased sedimentation and direct nutrient loading.

2.3 Land Cover

Land cover is a way to express what is on the surface of the landscape. Land covers are primarily distinguished based on the types of vegetation (e.g., forest, grassland, row crops), surfaces associated with developed areas (e.g., high density housing, low density housing), surface water features, and barren land.

Land cover affects the hydrology and water quality of a watershed. For example, runoff from urban land covers reaches streams faster and in larger quantities than from forested or crop land cover. This has consequences in terms of flood frequency and severity, which also impacts the quality of the system. In terms of pollutants, crop land and urban land typically yield higher pollutant loading than forested land due to more land applied chemicals and residues associated with human activities.

In the Hocking River watershed forest is the dominant cover accounting for over 60% while developed land accounts for less than 10%. The cropland areas are primarily located in the northern, upper portions of the watershed. Developed land is primarily spread between three urban area in the upper (Lancaster), middle, (Nelsonville), and lower (Athens) portions of watershed. See Figure 2.3 for a map of the various land covers in the Hocking River watershed.

Table 2.2. Types of land cover in the Hocking River watershed.

Land cover type	Percent of total land area	Area in square miles
Forest	62.2%	745
Pasture/Hay	13.9%	167
Cultivated Crop	12.9%	154
Developed	8.8%	106
All Other cover Types	6.7%	81
TOTAL		1,197

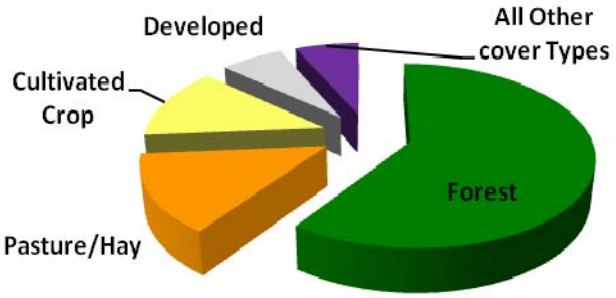

Figure 2.2. Land cover within the Hocking River watershed.

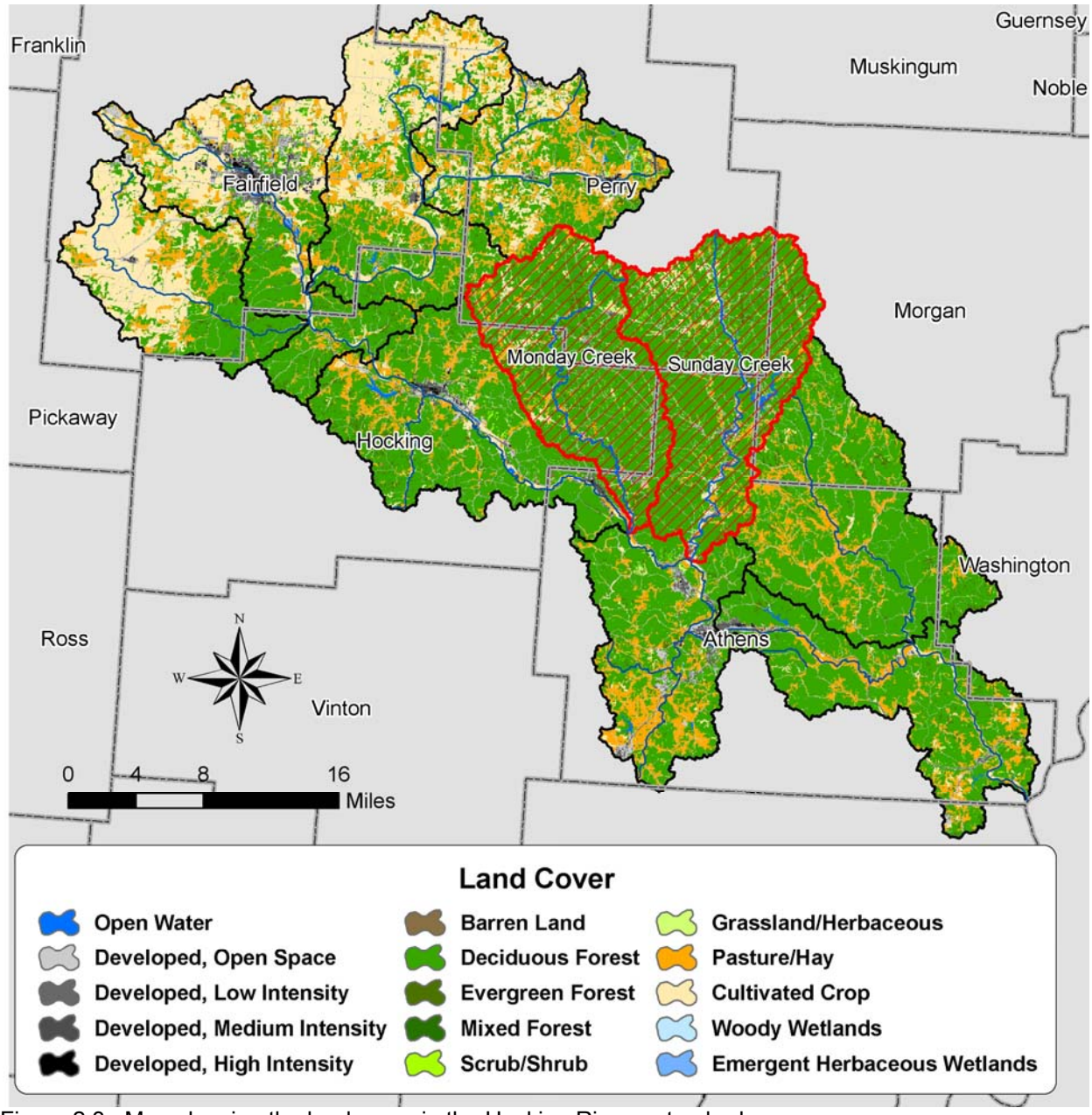

Figure 2.3. Map showing the land cover in the Hocking River watershed.

2.4 Population

The population and growth pattern of a watershed can have a substantial impact on water quality. Densely populated areas are associated with more impervious cover and the associated land management and land uses result in relatively high pollution loading to surface waters (see Section 2.3). Likewise the volume of wastewater that is generated is higher which results in larger pollutant loading.

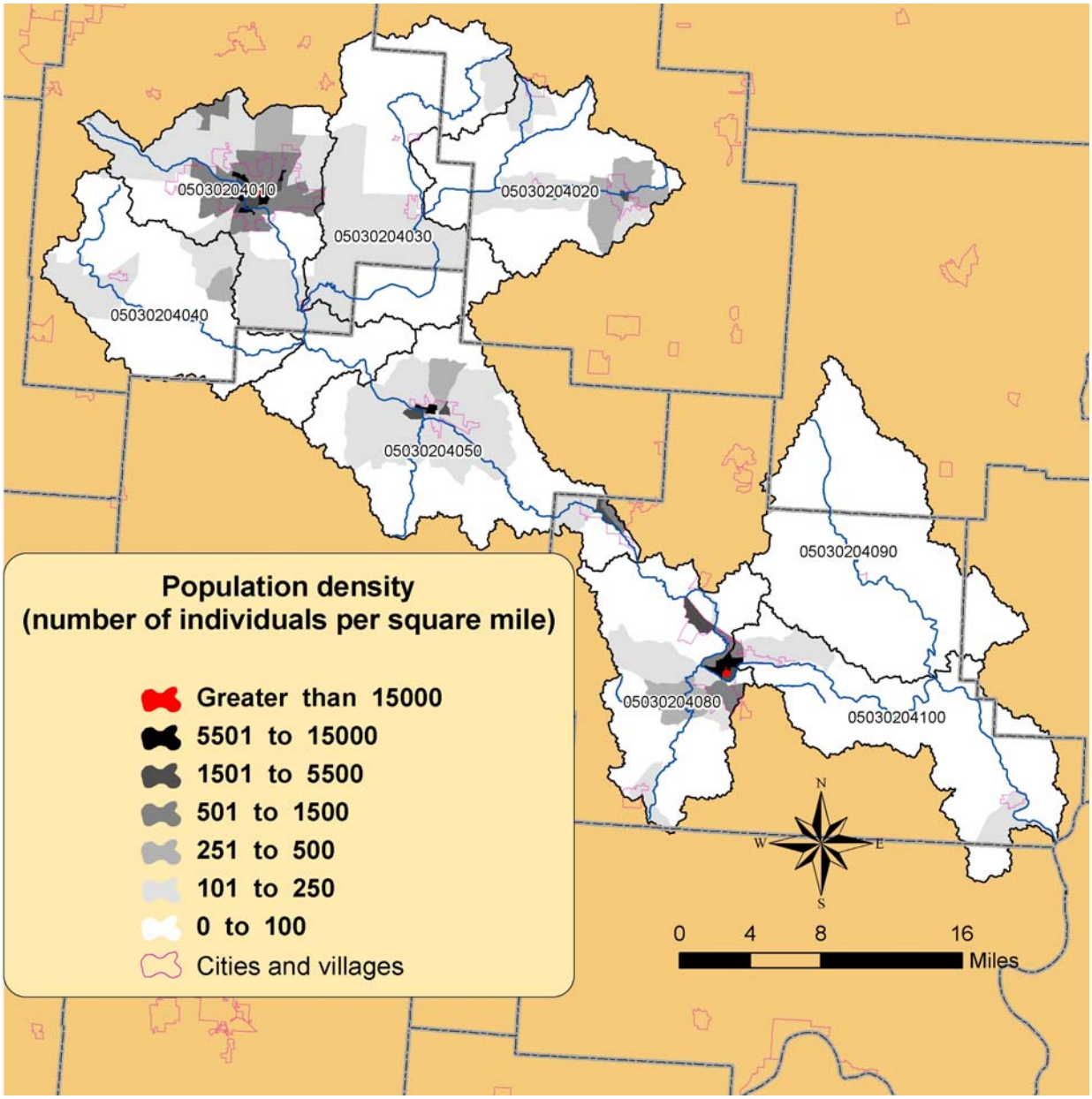

Figure 2.4. Map showing population density within the Hocking River watershed.

Population growth projections based on the Department of Development's Office of Strategic Research suggest that Fairfield County will continue to see significant growth. Increases of twenty to thirty thousand people per decade is expected to occur between now and the year 2030. However, projections for the other counties in the Hocking River watershed are that modest to stagnant population growth will occur. Fairfield County is currently the most populous in the basin with a total of 122,759 people as of the 2000 census. In 2030 that number is expected to be just over 200,000.

Figure 2.4 shows the TMDL project area with population density indicated by the color or shading of the various census blocks shown. Three urban areas have the highest population densities and are associated with the Cities of Lancaster (Fairfield County), Logan (Hocking County), and Athens (Athens County). Nelsonville, The Plains, and New Lexington are other

areas with relatively high population densities. The remainder of the watershed and the large majority of the land area have a population density of less than one hundred people per square mile.

For the TMDL analyses, an allowance for future growth is not included because the area with the most growth is not impaired for the aquatic life use and, for the recreation use, permit limits are equal to water quality criteria. In addition, significant reduction in loadings is anticipated as combined sewer overflows are eliminated in this area over the next several years.

3.0 WATER QUALITY STANDARDS

TMDLs are required when a waterbody fails to meet water quality standards (WQS). Every state must adopt WQS to protect, maintain, and improve the quality of the nation's surface waters. WQS represent a level of water quality that will support the Clean Water Act goal of swimmable and fishable waters. Ohio's WQS, set forth in Chapter 3745-1 of the Ohio Administrative Code (OAC), include four major components: beneficial use designations, narrative criteria, numeric criteria, and anti-degradation provisions.

Beneficial use designations describe the existing or potential uses of a waterbody. They consider the use and value of a waterbody for public water supply; protection and propagation of aquatic life; recreation in and on the water; and agricultural, industrial or other purposes. Ohio EPA assigns beneficial use designations to each waterbody in the state. Use designations are defined in paragraph (B) of rule 3745-1-07 of the OAC and are assigned in rules 3745-1-08 to 3745-1-32. Attainment of uses is based on specific numeric and narrative criteria.

Numeric criteria are estimations of chemical concentrations, degree of aquatic life toxicity, and physical conditions allowable in a waterbody without adversely impacting its beneficial uses. Narrative criteria, located in rule 3745-1-04 of the OAC, describe general water quality goals that apply to all surface waters. These criteria state that all waters shall be free from sludge, floating debris, oil, scum, color and odor-producing materials; substances that are harmful to human or animal health; and nutrients in concentrations that may cause excessive algal growth.

Antidegradation provisions describe the conditions under which water quality may be lowered in surface waters. Under such conditions water quality may not be lowered below criteria protective of existing beneficial uses unless lower quality is deemed necessary to allow important economic or social development. Antidegradation provisions are in Sections 3745-1-05 and 3745-1-54 of the OAC.

3.1 Recreational Use

3.1.1 Recreational Use Designations

Two recreational use designations are applicable to stream and river segments in the Hocking River watershed: Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR). PCR is applied to waters suitable for full-body contact such as swimming and canoeing. SCR is applied to waters suitable for partial-body contact recreation such as wading. Recreational use designations are in effect for only the recreation season. The recreation season is defined as May 1st through October 15th. Recreational use designations are further described in Section 3745-1-7 of the OAC.

Almost all of the stream segments within the TMDL project area are designated as primary contact recreation. The only exception is an unnamed tributary to Rush Creek that is designated as secondary contact recreation. This designation is given due to extreme acid mine pollution.

3.1.2 Recreational Use Criteria

Attainment of recreational use designation is evaluated by comparison to bacteriological numeric and narrative criteria. Ohio currently has bacteriological criteria for two parameters: fecal coliform and *Escherichia coli* (*E. coli*). Narrative criteria state that only one of the two criteria must be met to result in attainment. Bacteriological criteria apply outside the mixing zone of permitted discharges.

The numeric criteria for PCR state the geometric-mean fecal coliform content shall not exceed 1,000 per 100 ml, and fecal coliform content shall not exceed 2,000 per 100 ml in more than ten percent of samples. The numeric criteria for PCR also state that the geometric-mean *E. coli* content shall not exceed 126 per 100 ml, and *E. coli* content shall not exceed 298 per 100 ml in more than ten percent of samples takes. The numeric criteria for SCR state fecal coliform and *E. coli* content shall not exceed 4,000 per 100 ml and 576 per 100 ml, respectively, in more than ten percent of samples taken. Fecal coliform and *E. coli* content is to be evaluated on no less than 5 samples collected within a 30-day period for both PCR and SCR.

3.2 Aquatic Life Use

3.2.1 Aquatic Life Use Designations

Five aquatic life use designations are applicable in this TMDL project area: Warmwater Habitat, Exceptional Warmwater Habitat, Cold Water Habitat, Modified Warmwater Habitat and Limited Resource Waters.

Warmwater Habitat (WWH) is characterized by the typical assemblage of aquatic organisms in Ohio rivers and streams. WWH represents the principal restoration target for the majority of water resource management efforts in Ohio, and is in line with the Clean Water Act goal of fishable waters.

Exceptional Warmwater Habitat (EWH) is applied to waters that support unusual and exceptional assemblages of aquatic organisms. These assemblages are characterized by a high diversity of species, particularly those that are highly intolerant, threatened, endangered, or of special status (i.e., declining species). EWH represents a protection goal for the management of Ohio's best water resources.

Cold Water Habitat (CWH) is applied to waters that support native communities of cold-water organisms, and/or those that support trout stocking and management under the auspices of the Ohio Department of Natural Resources.

Modified Warmwater Habitat (MWH) is applied to waters that have been subject to maintained and essentially permanent modification. The MWH designation is appropriate if the modification is such that WWH criteria are unattainable. Additionally, the modification must be sanctioned by state or federal law. MWH aquatic communities are generally composed of species that are tolerant to low dissolved oxygen, silt, nutrient enrichment and poor quality habitat. Where this use designation is applied, the allowable conditions in the MWH-designated stream may be driven by the need to protect a higher downstream aquatic life use designation (e.g., WWH, EWH).

Limited Resource Waters (LRW) is applied to water bodies that are incapable of supporting biological communities that resemble any of the other aquatic life use habitats, even the lower expectations associated with modified warmwater habitat. Limited resource waters have persistent and irretrievable conditions that are intolerable to most aquatic life. Such conditions may be from a natural background or are human-induced. In the Hocking River drainage acid mine drainage is listed as the causative factor resulting in the limited resource waters use designation.

Most of the aquatic life uses in this TMDL project area are warmwater habitats. Only one segment is designated exceptional, and three are designated as coldwater habitat. One segment of the Hocking River mainstem is designated as modified warmwater habitat due to the urban influences of the City of Lancaster and three tributary streams are designated as limited resource waters due to severe acid mine drainage in the upper Rush Creek watershed. Table 3.1 lists the number of stream segments receiving each of the aquatic life use designations within this project area. These segments are further separated by ecoregion because this determines the biocriteria that are applicable (Section 3.1.2).

Table 3.1. Distribution of aquatic life use designations throughout the Hocking River TMDL project area.

ALU	Stream length (mi)	Relative %
WWH	625	87.4%
EWH	43	6.0%
LRW	28	4.0%
CWH	9	1.2%
MWH	7	1.0%
LWH	3	0.5%
GRANDTOTAL	**716**	

3.2.2 Aquatic Life Use Criteria

Aquatic life use attainment is dependent upon numeric biological criteria (biocriteria). Biocriteria are based on aquatic community characteristics that are measured both structurally and functionally. The rationale for using biocriteria have been extensively discussed elsewhere (Karr, 1991; Ohio EPA, 1987a,b; Yoder, 1989; Miner and Borton, 1991; Yoder, 1991; Yoder and Rankin, 1995).

Ohio's biocriteria are based upon three evaluation tools: the Index of Biotic Integrity (IBI), the Modified Index of Well-Being (MIwb) and the Invertebrate Community Index (ICI). These three indices are based on species richness, trophic composition, diversity, presence of pollution-tolerant individuals or species, abundance of biomass and the presence of diseased or abnormal organisms. The IBI and the MIwb apply to fish; the ICI applies to macroinvertebrates. Details regarding IBI, MIwb and ICI sampling procedures are described in the *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (Ohio EPA, 1987c). Provisions addressing biocriteria are in paragraph (A)(6) of Section 3745-1-07 of the OAC.

Ohio EPA uses IBI, MIwb, and ICI assessment results of reference-site sampling to establish biocriteria. Least-impacted reference sites are periodically evaluated to determine minimum-expected index scores associated with various stream sizes, designations, and ecoregions.

Attainment of aquatic life use designation is determined by comparison of biological assessment results to biocriteria. If an assessment site meets all applicable biocriteria for the IBI, MIwb and ICI, then it is in full attainment. If it achieves none of the applicable biocriteria, then it is in non-attainment. If it achieves some, but not all, then it is in partial attainment. Table 3.2 presents biocriteria applicable in this TMDL project area. Biocriteria do not currently exist for CWH; attainment is determined on a case-by-case basis.

Table 3.2. Biocriteria for all ecoregions within the Hocking River TMDL project area.

Biological Index	Assessment method[2, 3]	Applicable aquatic life use designations[1]		
		WWH	EWH	MWH
Eastern Cornbelt Plains (ECBP)				
IBI	Headwater	40	50	24
IBI	Wading	40	50	24
IBI	Boat	42	48	24
MIwb	Wading	8.3	9.4	4.0
MIwb	Boat	8.5	9.6	4.0
ICI	All[4]	36	46	22
Erie-Ontario Lake Plains (EOLP)				
IBI	Headwater	40	50	24
IBI	Wading	38	50	24
IBI	Boat	40	48	24
MIwb	Wading	7.9	9.4	6.2
MIwb	Boat	8.7	9.6	5.8
ICI	All[4]	34	46	22
Western Allegheny Plateau (WAP)				
IBI	Headwater	44	50	24
IBI	Wading	44	50	24
IBI	Boat	40	48	24
MIwb	Wading	8.4	9.4	6.2 / 5.5[5]
MIwb	Boat	8.6	9.6	5.8 / 5.4[5]
ICI	All[4]	36	46	22 / 30[5]

1. Limited resource waters (LRW) and cold water habitats (CWH) are found within the project area but do 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 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.
4. Limited to sites with appropriate conditions for artificial-substrate placement.
5. Biocriteria depend on type of MWH. MWH-C (due to channelization) is listed first and MWH-A (mine affected) is listed second

4.0 WATERSHED ASSESSMENT RESULTS

Water quality monitoring is conducted throughout Ohio to evaluate whether or not minimum quality standards are being met which also indicates if designated uses are being attained (see Chapter 3). The following sub-sections discuss the results of the watershed-wide water quality survey which was conducted by the Ohio EPA between June and October of 2004. Over one hundred sixty sites were monitored across a 942 square mile area to assess the overall water quality (see Figure 2.1 and Table 2.1). The data collected were water chemistry and bacteria concentrations, sediment chemistry, fish and macroinvertebrate populations, and the quality of stream habitat.

4.1 Recreation Uses

Based on the criteria described in Section 3.1.2, recreational use impairment was found to be scattered throughout much of the TMDL project area. The Clear Creek (040) and the Lower Hocking (100) watersheds are the only two of the eight assessment units to fully attain their recreational uses.

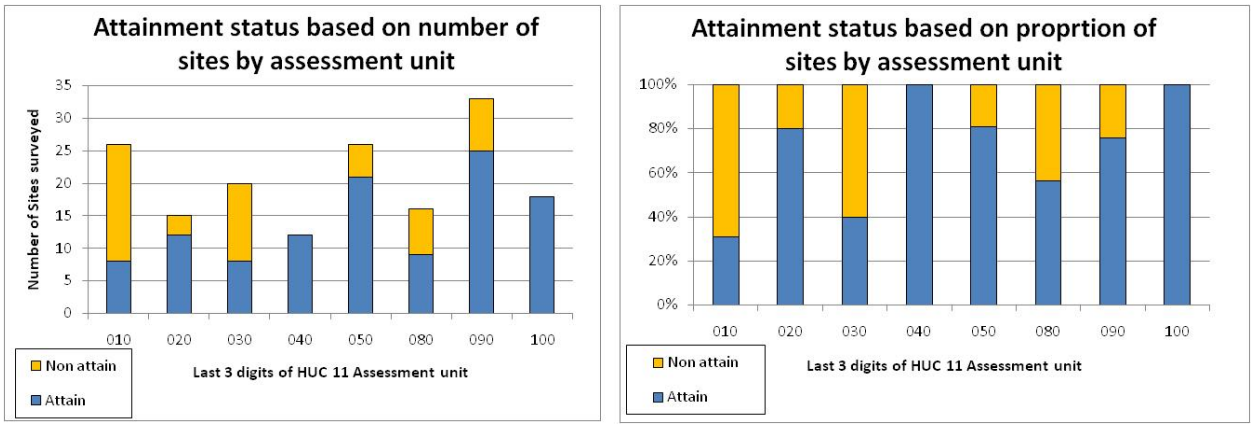

Figure 4.1. Recreational use attainment status per subwatershed

A total of 53 of the166 sites (32%) sampled exceeded the WQS for fecal coliform bacteria. Of those, 32 sites (19%) failed to meet the 90th percentile criterion (see Section 3.1 regarding WQS). This indicates acute problems typically related to storm flows where sources of FC on the landscape are transported to streams or untreated sewerage is discharged from combined sewer systems, sanitary sewer overflows or by-passes at treatment plants. Twenty sites (12%) failed to meet both the geometric mean and the 90th percentile criteria, which indicate that sources are significant under most stream flows. Failure to meet the geometric mean reflects elevated bacteria concentrations under flow conditions that are not exclusively related to storm events. Such situations indicate a persistent source such as a discharge (e.g, illicit) or manure being directly deposited into a stream. Only one site failed to meet the geometric mean while meeting the 90th percentile criterion.

Table 4.1 summarizes water quality data collected throughout the entire project area. Data for geometric mean and 90th percentile are given for each unique stream found within the respective AU and the accompanying subwatersheds. The number of sampling sites for each stream or stream segment ranges from 1 to 5. The minimum and maximum values among the sites are shown and bold values indicate failure to meet the water quality standard.

Table 4.1. Summary of the results of the bacteria sampling on streams within the TMDL project area.

05030204-	Stream name	Number of sample locations	Range of the geometric mean		Range of the 90th percentile	
			Max	Min	Max	Min
Upper Hocking River -010						
010-010	Hocking River	3	**1546**[1]	534	**17900**	**7950**
	Claypool Run	1	870	870	1115	1115
010-020	Hunters Run	2	819	816	**3190**	**2344**
010-030	Fetters Run	1	**1405**	**1405**	**3440**	**3440**
	Baldwin / Ewing Run	1	45	45	252	252
010-040	Pleasant Run	3	**1293**	**1293**	**2520**	**2520**
010-050	Hocking River	5	**1985**	995	**32000**	**3700**
	Trib to Hocking R @ RM 84.38	1	**3697**	**3697**	**5060**	**5060**
	Trib to Hocking R @ RM 82.57	1	**1816**	**1816**	**2740**	**2740**
010-060	East Fork Buck Run	1	189	189	252	252
	Buck Run	2	981	359	**3140**	1416
010-070	Hocking River	3	831	393	**2250**	1500
	Brushy Fork	1	924	924	1408	1408
	Trib to Hocking R @ RM 74.82	1	177	177	310	310
Upper Rush Creek -020						
020-010	Rush Creek	3	69	20	124	104
	Trib to Rush C @ 30.32	1	10	10	10	10
	Trib to Rush C @ 28.46	1	897	897	1840	1840
	Trib to Rush C @ 27.40	1	**1816**	**1816**	**37800**	**37800**
	Turkey Run	1	47	47	112	112
	Dry Run	1	352	352	726	726
020-020	Center Branch Rush Cr	3	586	407	**2700**	1540
	Somerset Creek	1	670	670	**2980**	**2980**
020-030	Trib to Rush C @ 19.40	1	252	252	634	634
	Trib to Rush C @ 17.89	1	307	307	624	624
	Rush Creek	1	65	65	450	450
Lower Rush Creek -030						
030-010	Little Rush Creek	3	335	120	1376	688
	Trib to Little Rush C @ 17.51	1	497	497	**6044**	**6044**
030-020	Little Rush Creek	1	229	229	910	910
	Indian Creek	2	398	66	**10500**	194
030-030	Raccoon Run	3	533	71	**13820**	438
	Trib to Raccoon R @ 3.62	2	561	390	**2180**	1096
030-040	Rush Creek	5	359	237	**8280**	**2040**
	Turkey Run	1	660	660	**19040**	**19040**
	Durbin Run	1	261	261	**4040**	**4040**
	Trib to Rush C @ 2.06	1	813	813	**4620**	**4620**

[1] Data presented in bold indicates that the water quality criteria is exceeded.

05030204-	Stream name	Number of sample locations	Range of the geometric mean		Range of the 90th percentile	
			Max	Min	Max	Min
Clear Creek -040						
040-010	Clear Creek	4	881	285	1860	1016
	Cattail Creek	1	283	283	504	504
040-020	Muddy Prairie Run	2	587	287	1335	814
040-030	Arney Run	2	477	362	1006	542
040-040	Clear Creek	1	251	251	1147	1147
	Trib to Clear C @ RM 4.93	1	193	193	354	354
	Trib to Clear C @ RM 6.8	1	375	375	584	584
Middle Hocking River I -050						
050-010	Hocking River	3	659	369	**20335**	880
	Harper Run	1	549	549	684	684
050-020	Scott Creek	4	539	43	**2220**	136
	Trib to Scott C @ RM 0.2	1	0	0	1800	1800
	Dry Run	1	160	160	506	506
	Trib to Dry Run @ RM 1.48	1	131	131	312	312
050-030	Clear Fork	2	640	76	860	292
	Duck Creek	1	661	661	1480	1480
050-040	Oldtown Creek	2	325	279	1436	420
	Trib to Oldtown C @ SR 93 RM 0.1	1	473	473	640	640
050-050	Fivemile Creek	2	504	146	1020	382
	Trib to Fivemile C@ RM 3.44	1	**1093**	**1093**	**5480**	**5480**
050-060	Hocking River	2	257	245	1550	925
	Trib to Hocking R @ SR 595	1	**2656**	**2656**	**16320**	**16320**
	Threemile Creek	2	538	405	**3714**	1740
	Minkers Run	1	68	68	264	264
Middle Hocking River II -080						
080-010	Hocking River	1	249	249	610	610
	Hamley Run	2	**15525**	235	**41600**	507
	Trib to Hocking R @ RM 48.7	1	20	20	44	44
080-020	Sugar Creek	1	313	313	438	438
	Hocking River	1	171	171	440	440
080-030	Margaret Creek	3	**1072**	327	**5820**	**2932**
	Biddle Creek	1	691	691	935	935
080-040	Magaret Creek	1	842	842	**8036**	**8036**
	W Branch Maraget Creek	2	682	108	1360	612
080-050	Margaret Creek	1	364	364	**2640**	**2640**
	Factory Creek	2	281	240	**2251**	703
Federal Creek -090						
090-010	Miners Fork	2	302	252	470	426
	Hyde Fork	1	116	116	252	252

05030204-	Stream name	Number of sample locations	Range of the geometric mean		Range of the 90th percentile	
			Max	Min	Max	Min
090-020	Federal Creek	3	856	438	1984	526
	Kasler Creek	1	193	193	1272	1272
	Linscott run	1	307	307	768	768
	Zarley Run	1	**5160**	**5160**	**12300**	**12300**
090-030	McDougall Branch	3	272	236	890	346
	Bryson Branch	1	308	308	842	842
090-040	Mush Run	2	273	211	504	372
	Dutch Creek	1	192	192	312	312
090-050	McDougall Branch	2	515	394	**4376**	692
	Wyatt Run	1	**1079**	**1079**	**6340**	**6340**
090-060	Sharps Fork	4	328	199	1528	353
	Oppossum Run	2	**1185**	186	**36232**	382
090-070	Marrietta Run	1	96	96	136	136
090-080	Big Run	1	268	268	2000	2000
090-090	Federal Creek	5	**1536**	366	**13514**	1696
Lower Hocking River -100						
100-010	Hocking River	3	204	128	925	350
	Strouds Run	1	34	34	68	68
100-020	Willow Creek	3	403	117	878	255
	Scotts Creek	1	265	265	1104	1104
100-030	Hocking River	1	166	166	670	670
	Hocking River	2	182	77	395	225
100-040	Frost Run	1	159	159	204	204
	Jordan Run	2	342	229	948	756
	Skunk Run	1	171	171	254	254
100-050	Fourmile Creek	2	197	84	1676	230
	East Fourmile Creek	1	153	153	383	383

4.2 Aquatic Life Uses

Aquatic life uses are in attainment if the minimum scores for the three biological community indices are met. Two of these indices measure attributes of the fish community, while the other measures attributes of the macroinvertebrate community (see Section 3.2).

Aquatic life uses were fully met at nearly 70% of sampling sites throughout the watershed. Just over 20% of the sites sampled were found to be in partial attainment where one or two of the three biological indices were met. About 10% of the sites failed to meet any of the biological indices. The individual assessment units ranged from 27% to 100% in terms of full attainment. The Upper Rush Creek assessment unit (020) is severely impacted by acid mine drainage (AMD) along the mainstem of Rush Creek and some of its small tributaries. These streams are essentially devoid of fish and macroinvertebrates. Due to the overwhelming impact from the

AMD, some streams and stream segments are designated as limited resource waters (LRW). In contrast, Clear Creek showed excellent stream quality and all survey sites fully met the minimum standards for its aquatic life use designations.

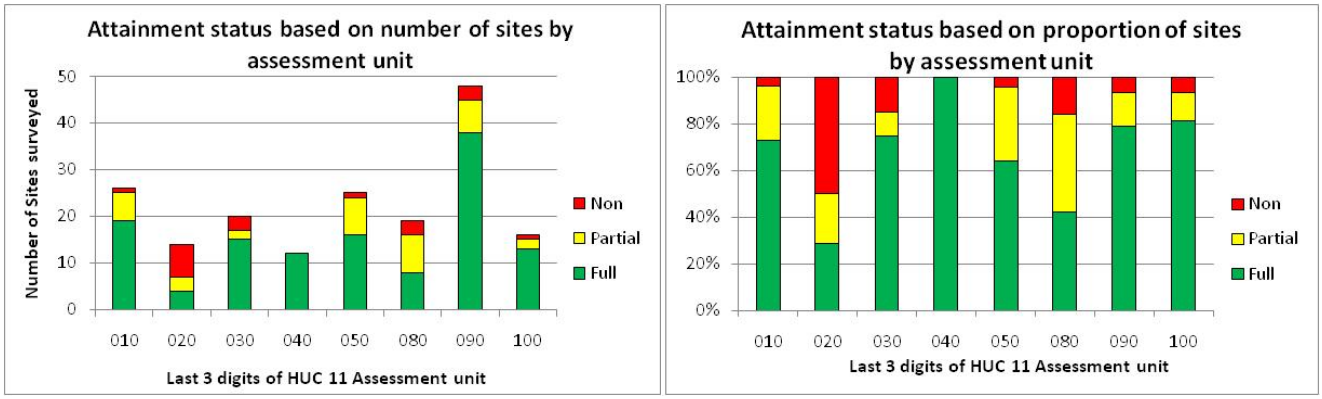

Figure 4.2. Aquatic life use attainment status per subwatershed

Table 4.2 shows the aquatic life use attainment status for each stream that was surveyed in this TMDL project area. The number of sites surveyed on that stream within the given assessment unit is listed with the accompanying attainment status. A summary of each assessment unit as well as the entire project area is also given.

Table 4.2. Summary of the attainment status of aquatic life uses in streams within the TMDL project area.

Stream	Number of sites surveyed	Aquatic life use attainment status		
		Full	Partial	Non
Upper Hocking River -010				
Hocking River	10	8	1	1
Claypool Run	1	1		
Hunters Run	2	2		
Baldwin Run	1	1		
Fetters Run	1	1		
Pleasant Run	3	3		
Hocking River Tributary@RM 84.38	2	1	1	
Hocking R. Tributary@RM 82.57	1		1	
Brushy Fork	1		1	
Buck Run	2	1	1	
East Fork Buck Run	1		1	
Hocking R. Tributary@RM 74.82	1	1		
ENTIRE ASSESSMENT UNIT	**26**	**19**	**6**	**1**
		73.1%	***23.1%***	***3.8%***
Upper Rush Creek -020				
Rush Creek	4			4
Rush Creek Tributary@RM 30.32	1			1
Yeager Creek	1			1
Rush Creek Tributary@RM 27.40	1			1
Turkey Run	1	1		
Dry Run	1		1	
Center Branch	3	1	2	
Somerset Creek	1	1		
Rush Creek Tributary@RM 19.40	1	1		
ENTIRE ASSESSMENT UNIT	**14**	**4**	**3**	**7**
		29.0%	***21.0%***	***50.0%***
Lower Rush Creek -030				
Rush Creek	5	5		
Little Rush Creek	4	4		
Indian Creek	2	1	1	
L. Rush Creek Tributary@ RM 17.51	1	1		
Raccoon Run	3	2	1	
Raccoon Run Tributary@RM 3.62	2			2
Turkey Run	1	1		
Durbin Run	1	1		
Rush Creek Tributary@RM 2.06	1			1

Stream	Number of sites surveyed	Aquatic life use attainment status		
		Full	Partial	Non
ENTIRE ASSESSMENT UNIT	**20**	**15**	**2**	**3**
		75.0%	***10.0%***	***15.0%***
Clear Creek -040				
Clear Creek	5	5		
Cattail Creek	1	1		
Muddy Prairie Run	2	2		
Arney Run	2	2		
Clear Creek Tributary@RM 6.80	1	1		
Clear Creek Tributary @RM 4.93	1	1		
ENTIRE ASSESSMENT UNIT	**12**	**12**	**0**	**0**
		100.0%	***0.0%***	***0.0%***
Middle Hocking River I -050				
Hocking River	5	5		
Harper Run	1	1		
Scott Creek	4	1	3	
Clear Fork	2	1	1	
Duck Creek	1	1		
Dry Run	1	1		
Dry Run Tributary@RM 1.48	1		1	
Oldtown Creek	2	2		
Oldtown Tributary@RM 4.25	1	1		
Threemile Creek	2		2	
Fivemile Creek	2	1	1	
Fivemile Cr. Tributary@RM 3.44	1	1		
Hocking R. Tributary@RM 62.18	1	1		
Minkers Run	1			1
ENTIRE ASSESSMENT UNIT	**25**	**16**	**8**	**1**
		64.0%	***32.0%***	***4.0%***
Middle Hocking River II -080				
Hocking River	4	4		
Hocking R. Tributary@RM 48.70	1			1
Hamley Run	2		1	1
Sugar Creek	1	1		
Margaret Creek	6	3	2	1
Factory Creek	2		2	
W. Br. Margaret Cr.	2		2	
Biddle Creek	1		1	
ENTIRE ASSESSMENT UNIT	**19**	**8**	**8**	**3**

Stream	Number of sites surveyed	Aquatic life use attainment status		
		Full	Partial	Non
		42.1%	***42.1%***	***15.8%***
Federal Creek -090				
Federal Creek	12	12		
Hyde Fork	1	1		
Miners Fork	2	2		
Kasler Creek	2	1		1
Linscott Run	2	1	1	
McDougall Branch	4	4		
Wyatt Run	1	1		
Mush Run	2	2		
Dutch Creek	1	1		
Bryson Branch	1	1		
Sharps Fork	8	8		
Opossum Run	4	3		1
Sulfur Run	2		1	1
Marietta Run	3	3		
Big Run	2	1	1	
Sharps Run	1	1		
ENTIRE ASSESSMENT UNIT	**48**	**42**	**3**	**3**
		87.5%	***6.3%***	***6.3%***
Lower Hocking River -100				
Hocking River	4	4		
Strouds Run	1			1
Willow Creek	3	2	1	
Scott Creek	1	1		
Jordan Run	2	2		
Frost Run	1		1	
Skunk Run	1	1		
Fourmile Creek	2	2		
East Fourmile Creek	1	1		
ENTIRE ASSESSMENT UNIT	**16**	**13**	**2**	**1**
		81.3%	***12.5%***	***6.3%***
ENTIRE TMDL PROJECT AREA	**181**	**129**	**33**	**19**
		71.3%	**18.2%**	**10.5%**

4.3 Causes of Impairment

In addition to identifying areas that are not meeting WQS, the watershed assessment also identifies what is causing the impairment to the designated water uses. Recreational uses in this TMDL study area are impaired due to bacterial contamination. Aquatic life uses are impaired by a number of stressors which vary from stream to stream. Table 4.3 lists the stressors causing impairment for each of the streams assessed. The relative contribution to aquatic life use impairment for any one of the stressors is expressed as its percentage of the total stressor occurrences in a given assessment unit (i.e., HUC 11 watershed).

Table 1.2 lists the causes of impairment and provides an explanation of how they are addressed in terms of TMDL development. Sections 5.1 through 5.3 establish what the target conditions are for the subset of stressors that have TMDLs developed. Section 5.4 discusses targets for acid mine drainage pollutants although, TMDL loadings and allocation ultimately are not developed. Section 5.5 illustrates how the field data deviate from these target conditions. Chapter 6 discusses discharges and land management activities that are sources of the stressors as well as the methods used to estimate this stressor loading and the contributions made by the respective sources. Chapter 7 provides the results of the TMDL analyses organized by assessment units which include TMDL values and allocations to the applicable sources.

Table 4.3. Stressors causing aquatic life use impairments in the Hocking River watershed.

05030204	Stream name	Causes of aquatic life use impairments									
		Nutrients	DO/Organic Enrichment	Siltation	Direct Habitat alteration	Flow Alteration	Low pH	Aluminum	Total Dissolved Solids	Natural	Unknown
Upper Hocking River -010											
010 & 050	Hocking River	x	x	x	x						
050	UN Hocking Trib.@ RM 84.38	x		x	x						
050	UN Hocking Trib @ RM 82.57			x	x						
070	Brushy Fork			x	x						
060	Buck Run			x	x						
060	E. Frk. Buck Run			x							
ENTIRE ASSESSMENT UNIT		2	1	6	5	0	0	0	0	0	0
		14.3%	7.1%	42.9%	35.7%	0%	0%	0%	0%	0%	0%
Upper Rush Creek -020											
010 & 030	Rush Creek	x	x				x	x			
010	UN Rush Cr. Trib. @ RM 30.32						x		x		
010	Yeager Creek	x	x				x				
010	UN Rush Cr. Trib.@RM 27.4	x	x	x			x				
010	Dry Run	x		x			x				
020	Center Branch	x		x							
030	UN Rush Cr Trib @ RM 19.4	x		x							
ENTIRE ASSESSMENT UNIT		6	3	4	0	0	5	1	1	0	0
		30.0%	15.0%	20.0%	0%	0%	25.0%	5.0%	5.0%	0%	0%
Lower Rush Creek -030											
020	Indian Creek	x	x								
030	Raccoon Run	x		x	x						
030	UN Raccoon R. Trib @ RM 3.62	x	x	x							
040	UN Rush Cr Trib @ RM 2.06	x		x							
ENTIRE ASSESSMENT UNIT		4	2	3	1	0	0	0	0	0	0
		40.0%	20.0%	30.0%	10.0%	0%	0%	0%	0%	0%	0%
Clear Creek -040											
	No sites impaired										
Middle Hocking River I -050											
020	Scott Creek						x		x	x	x
030	Clear Fork	x			x						
020	UN Dry Run Trib. @ RM 1.48			x							
060	Threemile Cr.			x	x						
050	Fivemile Cr.		x	x							
060	Minkers Run				x		x		x		
ENTIRE ASSESSMENT UNIT		1	1	3	3	0	2	0	2	1	1
		7.1%	7.1%	21.4%	21.4%	0%	14.3%	0%	14.3%	7.1%	7.1%
Middle Hocking River II -080											
010	UN Hocking Trib. @ RM 48.7						x				

05030204	Stream name	Causes of aquatic life use impairments									
		Nutrients	DO/Organic Enrichment	Siltation	Direct Habitat alteration	Flow Alteration	Low pH	Aluminum	Total Dissolved Solids	Natural	Unknown
010	Hamley Run	x	x	x							
050	Factory Creek			x							
030 & 040	Margaret Cr.			x							
040	West Branch Margaret Creek		x	x	x	x					
030	Biddle Creek	x	x	x							
ENTIRE ASSESSMENT UNIT		2	3	5	1	1	1	0	0	0	0
		15.4%	23.1%	38.5%	7.7%	7.7%	7.7%	0%	0%	0%	0%
Federal Creek -090											
020	Kasler Creek		x			x					
020	Linscott Run									x	
060	Opossum Run									x	
060	Sulfur Run			x					x		
080	Big Run		x	x		x					
ENTIRE ASSESSMENT UNIT		0	2	2	0	2	0	0	1	2	0
		0%	22.2%	22.2%	0%	22.2%	0%	0%	11.1%	22.2%	0%
Lower Hocking River -100											
010	Strouds Run	x				x					
020	Willow Creek					x					
040	Frost Run		x	x		x					
ENTIRE ASSESSMENT UNIT		1	1	1	0	3	0	0	0	0	0
		16.7%	16.7%	16.7%	0%	50.0%	0%	0%	0%	0%	0%
ENTIRE TMDL PROJECT AREA		**16**	**13**	**24**	**10**	**6**	**8**	**1**	**4**	**4**	**1**
		18%	**15%**	**28%**	**11%**	**7%**	**9%**	**1%**	**5%**	**5%**	**1%**

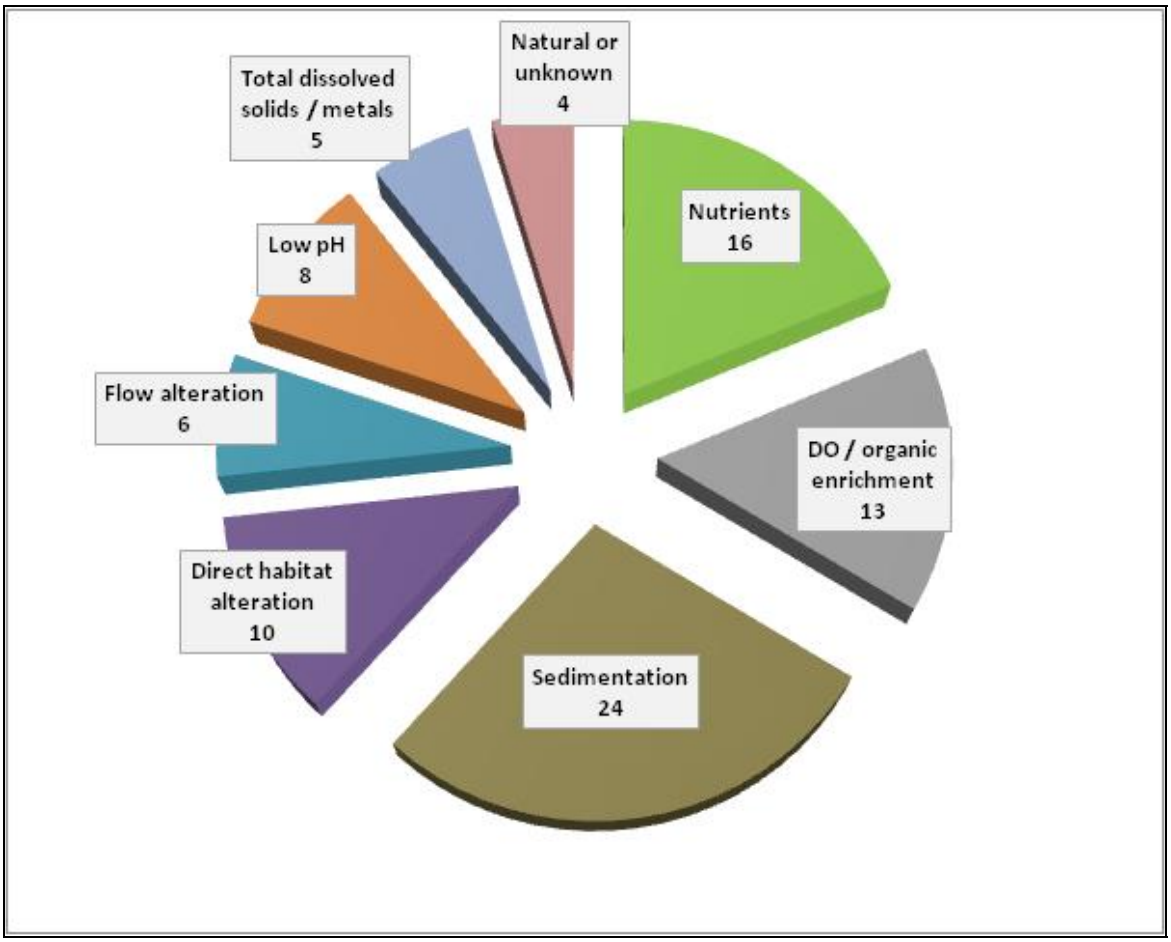

Figure 4.3. Proportion each aquatic life stressor makes to the total ALU impairments in the Hocking TMDL area. The number below the each stressor label indicates the number of assessment sites that evidenced this stressor. Many sites had more than one stressor listed.

5.0 PROBLEM STATEMENT AND NUMERIC TARGETS

The primary causes of impairment are siltation, nutrient enrichment, habitat alteration, flow alteration, contamination by pathogens, and acid mine drainage. Sections 5.1 through 5.4 discuss target conditions for these factors which would result in achieving the WQS. Section 5.5 discusses how much the measured conditions deviate from these targets. The following are brief definitions of these stressors.

Siltation is the deposition of fine soil particles on the bottom of stream and river channels. Deposition typically follows high-flow events that erode and entrain soil particles. As the flow subsequently decreases, the entrained soil particles fall from suspension to the stream bottom. This reduces the diversity of stream habitat available to aquatic organisms.

Nutrient Enrichment is the contribution of organic and inorganic substances necessary for plant growth. High nutrient concentrations do not typically have toxic effects, but rather have indirect lethal effects through excessive algae production resulting in very low dissolved-oxygen concentrations. Excess nutrients also cause a trophic shift of the aquatic community to species tolerant to harsh conditions and that outperform other species in an enriched condition.

Habitat Alteration results from the straightening, widening, or deepening a stream's natural channel. Habitat alteration can also include the degradation or complete removal of vegetated riparian areas that are important to a healthy stream. Habitat alteration can reduce the stream's capacity to assimilate sediments by disconnecting the system from the flood plain, an area available for export of sediment from the stream channel. In addition, it may disrupt the natural mechanisms that process nutrients in small streams, thereby further reducing the assimilative capacity for nutrients.

Flow Alteration is disruption to the natural flow regime of streams due to impoundment, increased peak flow associated with the urbanization of watersheds, and water table regulation through sub-surface drainage. This affects habitat quality when more severe peak flows scour streambed substrates and stream banks. Also, the dewatering of the soil profile and groundwater through impervious covers or artificial drainage leads to temporary periods with insufficient water flow to sustain healthy aquatic communities.

Contamination by Pathogens occurs when human or animal waste reaches the stream. Pathogenic organisms include bacteria, viruses, and protozoan. Contamination by pathogens is a human health issue, as skin contact or accidental ingestion can lead to various conditions such as skin irritation, gastroenteritis, or other more serious illnesses.

Acid Mine Drainage (AMD) is the outflow or runoff of acidic water from underground mines, surface mines, or mine wastes. AMD is usually associated with abandoned mines and characterized by low pH, high metal

concentrations, and low dissolved oxygen (DO). AMD can have a devastating effect upon the aquatic life of a stream or river due to toxic effects and habitat degradation.

Numeric targets allow for comparison between observed conditions and those expected to restore the designated uses of the waterbody. Targets are based either directly on the WQS or based on the best available data and scientific understanding.

The following sections describe the numeric targets used to develop TMDLs for each cause of impairment. Section 5.4 discusses stressors related to AMD, but TMDLs are not developed. Instead only the deviation from the AMD targets are calculated based on concentration data. No existing loads, TMDLs, or allocations are determined.

5.1 Nutrient Enrichment

Total phosphorus (TP) is a measure of the organic and inorganic elemental phosphorus in the water column. For the purpose of this report, TP is used as an indicator of the degree of nutrient enrichment. TP is selected because phosphorus is typically the limiting nutrient to primary production in freshwaters.

The Ohio EPA does not currently have statewide numeric criteria for TP; however, narrative criteria related to the effects of nutrient enrichment exist. These criteria are:

- Waters of the state shall be free from suspended solids resulting from human activities that will settle to form putrescent or otherwise objectionable sludge deposits, or that will adversely affect aquatic life (OAC 3745-1-04 A); and,

- Waters of the state shall be free from nutrients resulting from human activity in concentrations that create nuisance growths of aquatic weeds and algae (OAC 3745-1-04 E).

The Ohio EPA has identified potential targets for TP in the report titled *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999). This document provides the results of a study analyzing the effects of nutrients and other parameters on aquatic biological communities in Ohio streams and rivers. TP target concentrations are identified based on observed concentrations associated with acceptable ranges of biological community performance within each ecoregion. TP targets applicable in the Hocking Watershed are presented in Table 5.1. It is important to note that these targets are not codified in Ohio's WQS; therefore, there is a certain degree of flexibility as to how they can be used in a TMDL setting.

Table 5.1. TP numeric targets

Stream Type[1]	Ecoregion[2]	WWH
Headwater	EOLP	0.05[3]
Wadeable	EOLP	0.07
Headwater	WAP	0.05
Wadeable	WAP	0.07

[1]Headwater is < 20 mi^2. Wadeable is 20 - 200 mi^2.
[2] EOLP - Erie Ontario Lake Plain; WAP - Western Allegheny Plateau
[3]TP concentrations given in mg/l.

5.2 Fecal Coliform

Fecal Coliform (FC) is a measure of the number of organisms in the water column within the fecal coliform sub-group of bacteria. FC bacteria are largely non-pathogenic organisms naturally found in the intestinal tracts of warm-blooded animals. FC is used as an indicator of pathogen contamination because most pathogenic organisms are found in the ambient environment in numbers too small and variable to directly quantify.

The numeric targets for fecal coliform are derived directly from WQS. The PCR fecal-coliform geometric-mean criterion of 1,000 counts per 100 ml is the target for the average condition. The PCR ten-percent exceedance criterion of 2,000 counts per 100 ml is the target for the acute condition. These targets are also applied to SCR waters to protect for downstream use.

5.3 QHEI Targets for Sediment and Habitat TMDLs

The Qualitative Habitat Evaluation Index (QHEI) is a tool developed and used by the Ohio EPA to assess stream habitat quality. The QHEI evaluates six general aspects of physical habitat that include channel substrate, in-streamcover, riparian characteristics, channel condition, pool/riffle quality, and gradient. Within each of these categories or metrics, points are assigned based on the ecological utility of specific stream features as well as their relative abundance in the system. Demerits (i.e., negative points) are also assigned if certain features or conditions are present which reduce the overall utility of the habitat (e.g., heavy siltation and embedded substrate). These points are summed within each of the six metrics to give a score for that particular aspect of stream habitat. The overall QHEI score is the sum of all of the metric scores.

Strong correlations exist between QHEI scores and some its component metrics and metrics and the biological indices 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). For the aquatic life use designation of warm water habitat (WWH) an overall QHEI score of 60 has been shown to provide reasonable certainty that habitat is not deficient to the point of precluding attainment of the biocriteria. An overall score of 75 is targeted for streams designated as exceptional warm water habitat (EWH) and a minimum score of 45 for modified warm water habitat (MWH) streams.

Strong negative correlations exist between the number of “modified attributes” and the IBI scores. Modified attributes are features or conditions that have low or negative value in terms of 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 negative impact on biological performance; these are termed “high influence modified attributes”.

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For streams designated as WWH, there should no more than four modified attributes of which no more than one should be a high influence modified attribute. Table 5.2 lists modified and high influence modified attributes and provides the QHEI targets used for this habitat TMDL. For simplicity, a pass/fail distinction is made telling whether each of the three targets are being met. Targets are set for: 1) the total QHEI score, 2) maximum number of all modified attributes, and 3) maximum number of high influence modified attributes only. 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 5.2. QHEI targets for the habitat TMDL.

	Overall QHEI Score	**All Modified Attributes**	
		High Influence Modified Attributes	**All Other Modified Attributes**
Range of Possibilities	12 to 100 points	- Channelized or No Recovery - Silt/Muck Substrate - Low Sinuosity - Sparse/No Cover - Max Pool Depth < 40 cm (wadeable streams only)	- Recovering Channel - Sand Substrate (boat sites) - Hardpan Substrate Origin - Fair/Poor Development - Only 1-2 Cover Types - No Fast Current - High/Moderate Embeddedness - Ext/Mod Riffle Embeddedness - No Riffle
Target	Overall score $\geq$ 60	Total number < 2	Total number < 5[a]
TMDL Points Assigned if Target is Satisfied	+ 1	+ 1	+ 1

[a] Total number of modified attributes includes those counted towards the high influence modified attributes.

Sediment TMDL targets and the qualitative habitat evaluation index (QHEI)

The QHEI is also used in developing the sediment TMDL for this project. Numeric targets for sediment are based upon metrics of the QHEI. Although the QHEI evaluates the overall quality of stream habitat, some of its component 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 metrics used in the sediment TMDL are the substrate, channel morphology, and bank erosion and riparian zone. Table 5.3 lists targets for each of these metrics.

- The substrate metric evaluates the dominant substrate materials (i.e., based on texture size and origin) and the functionality of coarser substrate materials in light of the amount of silt cover and degree of embeddedness. This is a qualitative evaluation of the amount of excess fine material in the system and the degree to which the channel has assimilated (i.e., sorts) the loading.
- The channel morphology metric considers sinuosity, riffle, and pool development, channelization, and channel stability. Except for stability each of these aspects are directly related to channel form and consequently how sediment is transported, eroded, and deposited within the channel itself (i.e., this is related to both the system's assimilative capacity and loading rate). Stability reflects the degree of channel erosion which indicates the potential of the stream as being a significant source for the sediment loading.
- The bank erosion and riparian zone metric also reflects the likely degree of in-streamsediment sources. The evaluation of floodplain quality is included in this metric which is related to the capacity of the system to assimilate sediment loads.

Table 5.3. QHEI targets for the sediment TMDL.

Sediment TMDL =	Substrate	+	Channel Morphology	+	Riparian Zone/Bank Erosion	
For WWH >=	13	+	14	+	5	>= 32

5.4 Acid Mine Drainage

Indicators of AMD used in this analysis are acidity, total aluminum, total iron, total manganese, and total sulfate as these parameters are commonly associated with AMD. The Ohio EPA does not currently have statewide numeric criteria for any of these parameters; however, narrative criteria related to the effects of acid mine drainage exist. These criteria are:

- Waters of the state shall be free from materials entering the waters as a result of human activity producing color, odor or other conditions in such a degree as to create a nuisance (OAC 3745-1-04 C); and,

- Waters of the state shall be free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life and/or are rapidly lethal in the mixing zone (OAC 3745-1-04 E).

Numeric targets for these parameters were developed using the water-chemistry sample results collected by the Ohio EPA for this TMDL project. Only non-impacted sites in the Western Alleghany Plateau ecoregion of the watershed were used to develop the targets as the vast majority of mining operations exist in this ecoregion. Impacted sites are defined as those immediately downstream a major point source or those in a known AMD receiving stream. High TSS in a sample can be a confounding factor when evaluating AMD impacts. Samples with TSS in the fourth quartile were removed to avoid this bias.

This edited database was analyzed to determine the median and 90th percentiles for each of the target parameters. The median statistic is used as the target to represent the desirable average condition. The 90th percentile is used as the target to represent the allowable instantaneous maximum. Results of the water-chemistry dataset are presented in Table 5.4.

Table 5.4 Target Values for AMD Indicators

Parameter	Units	Sample Size	Average Target	Maximum Target
Headwater sites (DA < 20 mi^2)				
Acidity	mg/l	392	5	5
Aluminum, Total	ug/l	391	200	200
Iron, Total	ug/l	391	254	641
Manganese, Total	ug/l	391	100	336
Sulfate, Total	mg/l	392	38	99
Wadeable sites (20 mi2 < DA < 200 mi^2)				
Acidity	mg/l	105	5	5
Aluminum, Total	ug/l	105	200	347
Iron, Total	ug/l	105	404	949
Manganese, Total	ug/l	105	101	275
Sulfate, Total	mg/l	105	42	126

5.5 Deviation from Targets

This section compares the target values versus the observed values for parameters that are addressed to abate aquatic life use impairments. Since the criteria for fecal coliform bacteria are used to both determine recreational use attainment status as well as provide a target for TMDL development it is not necessary to display the deviation from target in this section as it has already been presented in Section 4.1 for the result of the recreational use evaluation. Additionally, deviations from target QHEI and QHEI metric scores are presented only in Section 7.2 since the TMDLs are in fact the deviation from targets (i.e., these are not load based parameters). Therefore deviations from the target conditions for total phosphorus and chlorophyll a (used as an indicator of lake eutrophication) are the only parameters presented since they neither have promulgated water quality standards not do they represent the calculated existing loading.

Fecal coliform results and deviations are summarized in Table 4.1. Geometric-mean values are generally representative of the average condition, while 90th percentile values are typically representative of high-flow storm events. The deviations from targets for nutrient impaired subwatersheds or lakes are presented in Table 5.4. Table 5.5 gives the deviations from the targets for AMD-impacted sites, and the deviations from the bedload and habitat targets per site are presented in Table 7.10.

Table 5.5. Deviation from Target of Nutrient-Related Impairments

Observed Total Phosphorus (mg/l)				
Subwatershed	Average In-Stream Concentration	In-Stream Target	Deviation from Target	
			mg/l	%
Rush Creek headwaters to above Center Branch	0.130	0.07	0.060	86
Center Branch	0.137	0.07	0.067	96
Little Rush Creek near Rushville to Rush Creek	0.091	0.05	0.041	82
Raccoon Run	0.111	0.07	0.041	59
Predicted Seasonal Chlorophyll a (µg/l)				
Lake	Average In-Lake Concentration	In-Lake Target	Deviation from Target	
			µg/l	%
Oakthorpe Lake	50	20	30	150
Lake Logan	24	20	4	20

Table 5.6. Deviation from Target for Acid Mine Drainage Impacted Sites.

05030204	Stream Name	RM	Use	Attain-ment	Parameter	Sample Results		Deviation	
						Median	90th	Average	Max
020-010	Rush Creek	30.9	NA	NA	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	200	0%	0%
					Fe (ug/l)	1098	1825	**332%**	**185%**
					Mn (ug/l)	932	1210	**832%**	**260%**
					Sulfate (mg/l)	503	567	**1224%**	**473%**
		27.1	LRW	NON	Acidity (mg/l)	119	136	**2270%**	**2620%**
					Al (ug/l)	10695	13200	**5248%**	**3704%**
					Fe (ug/l)	9945	14300	**2362%**	**1407%**
					Mn (ug/l)	11850	14600	**11633%**	**5209%**
					Sulfate (mg/l)	678	787	**1514%**	**525%**
		21.1	LRW	NON	Acidity (mg/l)	78	83.8	**1460%**	**1576%**
					Al (ug/l)	5290	9656	**2545%**	**2683%**
					Fe (ug/l)	1230	2000	**204%**	**111%**
					Mn (ug/l)	7360	10992	**7187%**	**3897%**
					Sulfate (mg/l)	550	674.2	**1210%**	**435%**
	UT to Rush Ck @ 27.40	0.2	WWH	NON	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	200	0%	0%
					Fe (ug/l)	536	596.5	**111%**	-7%
					Mn (ug/l)	752	1325	**652%**	**294%**
					Sulfate (mg/l)	181	217	**376%**	**119%**
	UT to Rush Ck @ 28.46	0.2	WWH	NON	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	200	0%	0%
					Fe (ug/l)	432	627.9	**70%**	-2%
					Mn (ug/l)	666	944.4	**566%**	**181%**
					Sulfate (mg/l)	148	182.2	**289%**	**84%**
	UT to Rush Ck @ 30.32	0.3	LRW	NON	Acidity (mg/l)	298	390	**5850%**	**7700%**
					Al (ug/l)	20650	24800	**10225%**	**12300%**
					Fe (ug/l)	35100	46950	**13719%**	**7224%**
					Mn (ug/l)	17400	20450	**17300%**	**5986%**
					Sulfate (mg/l)	1140	1370	**2900%**	**1284%**
020-020	Center Branch Rush Ck	0.1	WWH	Partial	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	6630	0%	**1811%**
					Fe (ug/l)	657	1966.4	**63%**	**107%**
					Mn (ug/l)	133	7743.6	**32%**	**2716%**
					Sulfate (mg/l)	38	39	-10%	-69%

Table 5.6. Deviation from Target for Acid Mine Drainage Impacted Sites (continued)

0503020	Stream Name	RM	Use	Attain-ment	Parameter	Sample Results		Deviation	
						Median	90th	Average	Max
020-030	Rush Creek	17.4	LRW	NON	Acidity (mg/l)	8	32	**60%**	**540%**
					Al (ug/l)	2700	4915	**1250%**	**1316%**
					Fe (ug/l)	639	1285.5	**58%**	**35%**
					Mn (ug/l)	5460	10075	**5306%**	**3564%**
					Sulfate (mg/l)	359	460.5	**755%**	**265%**
050-020	Scott Creek	9.1	WWH	Partial	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	200	0%	0%
					Fe (ug/l)	130	216.4	-49%	-66%
					Mn (ug/l)	142	274	**42%**	-18%
					Sulfate (mg/l)	144	176.2	**279%**	**78%**
		5.7	WWH	Partial	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	200	0%	0%
					Fe (ug/l)	461	619.4	**81%**	-3%
					Mn (ug/l)	284	441.4	**184%**	**31%**
					Sulfate (mg/l)	77	105.4	**103%**	**6%**
		2.1	WWH	Partial	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	200	0%	0%
					Fe (ug/l)	542	711.2	**113%**	**11%**
					Mn (ug/l)	156	209.6	**56%**	-38%
					Sulfate (mg/l)	44	52.6	**16%**	-47%
050-050	Fivemile Creek	3.97	WWH	Partial	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	200	0%	0%
					Fe (ug/l)	430	745.5	**69%**	**16%**
					Mn (ug/l)	156	279.5	**56%**	-17%
					Sulfate (mg/l)	40	42.5	**5%**	-57%
080-010	Hamley Run	2.1	WWH	NON	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	301.5	0%	**51%**
					Fe (ug/l)	467	735.9	**84%**	**15%**
					Mn (ug/l)	101	115.8	**1%**	-66%
					Sulfate (mg/l)	56	67.3	**47%**	-32%
		0.01	WWH	Partial	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	200	0%	0%
					Fe (ug/l)	574	627.6	**126%**	-2%
					Mn (ug/l)	367	373.4	**267%**	**11%**
					Sulfate (mg/l)	40	40.8	**5%**	-59%

Table 5.6. Deviation from Target for Acid Mine Drainage Impacted Sites (continued)

0503020	Stream Name	RM	Use	Attain-ment	Parameter	Sample Results		Deviation	
						Median	90th	Average	Max
080-010	UT to Hocking R @ 48.7	0.1	LRW	NON	Acidity (mg/l)	71	79	**1320%**	**1480%**
					Al (ug/l)	10100	12420	**4950%**	**6110%**
					Fe (ug/l)	3160	12632	**1144%**	**1871%**
					Mn (ug/l)	2980	3420	**2880%**	**918%**
					Sulfate (mg/l)	404	451.2	**963%**	**356%**
080-030	Biddle Creek	2	WWH	Partial	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	444	0%	**122%**
					Fe (ug/l)	369	806.6	**45%**	**26%**
					Mn (ug/l)	281	701.8	**181%**	**109%**
					Sulfate (mg/l)	64	64.8	**68%**	-35%
	Margaret Creek	11.3	EWH	NON	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	200	0%	0%
					Fe (ug/l)	253	390.6	0%	-39%
					Mn (ug/l)	285	405.2	**185%**	21%
					Sulfate (mg/l)	54	75.2	**42%**	-24%
		6	WWH	Partial	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	218	281.5	**9%**	-19%
					Fe (ug/l)	932	975.5	**131%**	**3%**
					Mn (ug/l)	383	468.5	**279%**	**70%**
					Sulfate (mg/l)	39	43	-8%	-66%
090-080	Big Run	1.6	WWH	Partial	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	200	0%	0%
					Fe (ug/l)	286	380.4	**13%**	-41%
					Mn (ug/l)	276	396.6	**176%**	**18%**
					Sulfate (mg/l)	32	32.6	-16%	-67%
090-090	Federal Creek	10.4	EWH	Partial	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	499.2	0%	**44%**
					Fe (ug/l)	586	886.4	**45%**	-7%
					Mn (ug/l)	103	112.4	**2%**	-59%
					Sulfate (mg/l)	60	68.4	**43%**	-46%
		3.9	EWH	NA	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	577.2	0%	**66%**
					Fe (ug/l)	463	1038.4	**15%**	**9%**
					Mn (ug/l)	102	207.6	**1%**	-25%
					Sulfate (mg/l)	91	110.8	**117%**	-12%

Table 5.6. Deviation from Target for Acid Mine Drainage Impacted Sites (continued)

0503020	**Stream Name**	**RM**	**Use**	**Attain-ment**	**Parameter**	**Sample Results**		**Deviation**	
						Median	**90th**	**Average**	**Max**
090-090	Federal Creek	0.9	EWH	Partial	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	209	547.2	**5%**	**58%**
					Fe (ug/l)	472	970.4	**17%**	**2%**
					Mn (ug/l)	83	112.4	-18%	-59%
					Sulfate (mg/l)	90	112.8	**114%**	-10%
100-040	Frost Run	0.5	WWH	Partial	Acidity (mg/l)	5	5	0%	0%
					Al (ug/l)	200	230	0%	**15%**
					Fe (ug/l)	637	849.2	**151%**	**32%**
					Mn (ug/l)	587	888.6	**487%**	**164%**
					Sulfate (mg/l)	27	52.6	-29%	-47%

Deviations from targets in **red** are over 100% of the target value. **Bold** indicates a positive deviation less than 100%.

6.0 SOURCES OF IMPAIRMENT

Sources of impairment generate pollutant loads or poor physical conditions, which adversely impact water quality and the aquatic community. TMDL analyses quantify how much each source contributes to the overall loading. This information is used to make recommendations for load reductions or alternative management practices, to mitigate the effect of the source.

Two important terms concerning sources of impairment are load and wasteload. Load is a term used frequently in this report, but has specific meaning in this context. When describing the pollutant contribution of a source, *load* is applied to sources that are not regulated by permit. Pollutant runoff from agricultural fields is an example of a load. *Wasteload* is applied to the pollutant contribution of sources regulated by permit. A municipal wastewater treatment plant is an example of a source that contributes to the total wasteload. This distinction becomes important during the allocation process described in Chapter 8. For the time being, suffice it to say pollutant sources contribute to either the total load or wasteload.

6.1 Definition of Sources

Sources of impairment to the Hocking River Watershed include nonpoint, regulated point (NPDES dischargers), household sewage treatment systems, livestock with stream access, combined and sanitary sewer overflow, channel maintenance, stream impoundments, and abandoned mines with acid mine drainage. These sources are defined in following sections. Each section provides information concerning pollutant delivery pathways and the primary environmental condition affected by the source.

6.1.1 Nonpoint Sources

Nonpoint source (NPS) pollution consists of contaminants contributed by diffuse sources. In the context of this TMDL, NPS pollution refers to sediment, phosphorus, and fecal coliform delivered to the stream system via surface runoff, ground water, and sub-surface tile drainage.

NPS pollution is intermittent by nature because it is primarily driven by rainfall or snowmelt. It is most apparent during high stream flow as increased pollutant concentrations, but its effects extend to average and low flow conditions. Settling sediment contributes to siltation, while phosphorus and bacteria adsorbed to the sediment influence water chemistry even as the flow recedes.

This TMDL divides NPS pollution into two-classes based upon source area. NPS pollution originating from land areas regulated by the Municipal Separate Storm Sewer System (MS4) Program are differentiated from areas that are not. NPS pollution from MS4 areas contributes to the total watershed *wasteload*. NPS pollution from non-MS4 areas contributes to the total *load*.

6.1.2 Point Sources

Point sources of pollution enter waterways through pipes or other distinct entry points. Under the Clean Water Act, point sources are required to possess a permit through the National Pollutant Discharge Elimination System (NPDES). NPDES permits limit the quantity of

pollutants discharged and impose monitoring requirements. NPDES permits are designed to protect public health and the aquatic environment by helping to ensure compliance with state and federal regulations.

NPDES entities typically discharge wastewater continuously. They primarily affect water quality under average to low flow conditions, when the potential for dilution is lower. NPDES dischargers located near the origin of a stream or on a small tributary are more likely to cause water quality problems, because their effluent can dominate the natural stream flow at the extreme lows of its hydrologic regime.

This TMDL classifies NPDES dischargers as major, minor, or miscellaneous. Majors are those identified as such by their NPDES permit, and discharge more than one-million gallons per day (MGD). Minors are smaller industries or waste water treatment plants (WWTPs) that serve small municipalities, schools, private businesses, and developments. Miscellaneous facilities are those discharging process, cooling, or storm water, such as industrial complexes, water treatment plants (WTPs), and quarries. The Hocking River watershed TMDL includes wasteload calculations for three major, 46 minor, and 28 miscellaneous NPDES dischargers for a total of 77 NPDES dischargers discharging approximately 54 MGD.

6.1.3 Household Sewage Treatment Systems

Household Sewage Treatment Systems (HSTS) are small wastewater treatment units serving individual homes or businesses. HSTS are typically located on the property of the home or business from which they treat waste. HSTS are often referred to as onsite wastewater treatment systems (OWTSs) or on-lot systems. These terms are approximately synonymous.

There are many types of HSTS, but those most common in the Hocking River watershed are septic tanks with leach fields, septic tanks with sand filters, and aeration systems. The efficacy with which each system treats waste is dependent upon its age, the manner in which it is maintained, and characteristics of the site where it is located. Important site characteristics include soil drainage, water table depth, bedrock depth, land slope, and parcel lot size.

HSTS affect water quality under multiple conditions. HSTS discharging directly to a stream or river, such as many aeration or illicit systems, behave similarly to a point source. These types of systems primarily affect water quality under dry, low flow conditions. HSTS discharging indirectly to a stream via a tile drain or intermittent ditch may exhibit effects akin to a nonpoint source. Wastewater discharged to a dry tile or ditch may be of insufficient volume to sustain flow to the stream, but pollutants can accumulate and eventually be flushed by rainfall. These types of systems primarily affect water quality under wet-weather, high-flow conditions. Additional pollutant delivery pathways associated with HSTS exist, but those discussed above are the most significant in the Hocking River watershed.

HSTS are regulated by general permits issued by local health authorities. Pollution from direct HSTS discharges contributes to the total *wasteload*. Indirect pollution from HSTS contributes to the total nonpoint *load*.

6.1.4 Livestock with Stream Access

Some operators allow livestock access to streams for watering or to allow movement to pasture. Either of these situations can result in the contribution of large pollutant loads to the stream system. Of particular concern is bacterial contamination, because unrestricted livestock can

deposit waste directly into the stream. This results in very high local bacteria concentrations, nutrient and organic enrichment, and can potentially affect downstream uses as well.

Grazing livestock with stream access can also contribute to habitat and channel degradation. Livestock often graze to the stream edge, eliminating beneficial riparian vegetation. Further, livestock trample, collapse, and destabilize stream banks. This can result in elevated instream TSS concentrations and downstream siltation.

The pollution from livestock with stream access is not regulated by permit; therefore, it contributes to the total watershed load.

6.1.5 Combined and Sanitary Sewer Overflow

Combined sewer overflow (CSO) is discharge from a wastewater collection system designed to transport both sanitary and storm flow. This type of collection system is called a combined sewer system (CSS). In the absence of rainfall, a CSS conveys sanitary waste from its origin to a WWTP. During wet-weather events, the capacity of a CSS may be exceeded by the inflow of storm water. In these situations sewage and storm water can overflow the system and be discharged at an engineered relief point to a stream or river.

Sanitary sewer overflow (SSO) is discharge from a wastewater collection designed to transport only sanitary flow. This type of collection system is called a sanitary sewer system (SSS). Infiltration of ground water and inflow of storm water can cause the capacity of an SSS to be exceeded. Ground water infiltration results when the integrity of underground sewer pipes is compromised. Inflow of storm water results from the improper connection of roof downspouts or from poorly-sealed man holes. When the capacity of an SSS is exceeded, it will overflow and discharge to a storm sewer or city street. The overflow often drains to a stream or river.

The impact of CSO and SSO on water quality is most apparent as high bacteria concentrations during high-flow. However, pollutants contributed to the stream by CSO and SSO can also affect water quality during average to low flow conditions. CSO and SSO contain organic solids that can settle to the stream bottom downstream of the overflow outfall. The resulting sludge beds contribute to the enrichment of the stream, degrade habitat quality, and can act as a source of bacterial contamination.

CSO outfalls are often permitted through the NPDES program. SSOs are considered an illicit discharge and are not permitted. Therefore, pollutants from CSO contribute the total watershed wasteload, and pollutants from SSO contribute to the total watershed load.

6.1.6 Channel Construction and Maintenance

Channel construction and maintenance often entails modification to the natural course of a stream or river. Examples include widening, deepening, straightening, or changing the location of any waterway and removal of obstructions such as silt bars, log jams, debris, or drift from any river, creek, or waterbody.

Channel maintenance provides benefits such as enhanced land drainage and flood control in the immediate vicinity of a waterway. These benefits are contingent upon the channel being deep enough (i.e., relative to the surrounding land elevation) and conveying water fast enough to prevent substantial rise in water levels. Land drainage and channel maintenance also helps establish suitable building conditions and reduces the prevalence of standing water which

sometimes represents a health concern. One drawback, however, to increased conveyance at the upstream locale is increased flooding at downstream locations.

In terms of water quality, channel modifications have a primarily negative impact. Straighter and/or deeper, obstruction-free channels convey water faster which diminishes the stream's capacity to remove pollutants, ultimately allowing pollution to concentrate in downstream waters. In contrast, natural streams have longer processing times because they hold water longer due to longer flow paths afforded by meanders in the stream. Stream structure such as rock and woody material not only further slows water but also provides a medium for the bacteria and other naturally occurring biological agents that are responsible for removing pollutants.

Habitat is lost when channels are reconstructed and riparian areas are heavily managed. Refuge from predators and intense flow conditions are eliminated with the removal of rock and woody material. Additionally pools and riffles which are also destroyed through channel reconstruction and maintenance effectively eliminate species that require those habitats.

Streams, rivers, and ditches subject to routine channel maintenance are often designated MWH. The MWH designation represents lower expectations for the abundance and diversity of aquatic life than the EWH or WWH designations (OAC 3745-1-07). Modified segments are considered to be in attainment if they can achieve these lower expectations. Regardless of their local attainment status, modified segments may be affecting downstream uses for those reasons discussed above.

6.1.7 Stream Impoundment

Stream impoundment deals with flow control structures that restrict the downstream movement of water. Stream impoundment results in an area of pooled water behind the flow control structure. The pooled area is characterized by greater depth and slower velocity than what would be expected if the flow was unrestricted.

Streams are impounded for downstream flood control, to create a public water supply reservoir, to simplify sewer or utility crossing, to enhance recreational opportunities, or for aesthetic purposes. The extent of the impoundment depends upon the intended use.

Stream impoundment is a severe flow alteration that has multiple effects on the health of the stream system. Stream impoundment alters the natural channel such that pool-riffle-run complexes are inundated, thereby reducing the diversity of habitat available to aquatic organisms. Stream impoundment increases the settling of solids, which can result in very poor substrate. Finally, stream impoundment increases the residence time of water behind the flow control structure, which has various impacts upon chemical and physical water properties.

6.1.8 Abandoned Mines and AMD

Active subsurface coal and metal mines are generally kept from flooding by pumps. After these mines are abandoned, pumping ceases and the mines fill with water. The drainage from a flooded mine is acidic due to the oxidation of the metal sulfides present in these mines which ultimately produces sulfuric acid. Runoff from strip mine operations and tailing piles is also acidic for the same reason.

The effect of this acidic drainage on a receiving stream is variable and will depend upon the volume, frequency, and chemistry of the drainage, as well as the size, hydrologic condition, and

chemistry of the receiving stream. In Ohio, streams impacted by AMD typically exhibit one or more of the following signatures: low pH, low DO, elevated concentrations of metals, sulfates, hardness and conductivity. Metal precipitates may be observed on the stream bed below the point of discharge. This is a result of dissolved metals in the drainage reacting with water to form various hydroxides. One such precipitate, ferric hydroxide, is responsible for the reddish-orange color commonly associated with AMD impacted streams. Ferric hydroxide is often called “yellow boy”. Precipitation of aluminum typically forms grayish-white solids; manganese precipitate is bluish-black.

The primary effect of AMD on aquatic life is related to the toxic effects of low pH and elevated concentrations of dissolved metals. Depressed DO, osmotic disturbance due to high dissolved solids, and habitat degradation due to metal precipitation can also severely impact aquatic life. Several natural characteristics of a stream can help to mitigate the effect of AMD upon aquatic life. These include the potential for dilution, buffering capacity, hardness, and dissolved organic matter.

6.2 Summary of Methods to Quantify Source Loading

The following sections briefly describe the tools and methods used to quantify the magnitude of the pollution contribution from each source of impairment.

6.2.1 Generalized Watershed Loading Function

The Generalized Watershed Loading Function (GWLF) model was used to simulate the hydrology and predict the NPS loading of sediment and nutrients to the nutrient impaired subwatersheds in the Hocking River Watershed. It is a continuous simulation model which uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment and nutrient loads, based on the daily water balance accumulated to monthly values. GWLF is a watershed-scale model developed originally at Cornell University. NOAA added a Windows-based desktop interface to the GWLF model (referred to as BasinSim); this version of GWLF was utilized for the Hocking TMDL.

The primary goal of applying GWLF to the Hocking River watershed was to determine the impact of various management activities on water quality. To do so, representative management scenarios are developed using statistical data on agriculture, sources of literature applicable to the Hocking region and/or Ohio, and the best professional judgment of experts, extension personnel, local agencies, and producers.

6.2.2 BATHTUB Lake Model

BATHTUB is a U.S. Army Corps of Engineers steady-state lake response model used to simulate lake water quality. The model incorporates several empirical equations of nutrient settling and algal growth to predict in-lake nutrient and chlorophyll *a* concentrations based on waterbody characteristics, hydraulic characteristics, and nutrient loadings. BATHTUB has three primary input interfaces: global inputs (atmospheric contributions of precipitation, evaporation, and atmospheric phosphorus), lake morphology, and watershed loading. Input data includes atmospheric loads of nutrients, tributary flows and concentrations, and global parameters such as evaporation rates and annual average precipitation. Appendix H describes the BATHTUB model inputs and results.

BATHTUB and GWLF were integrated to simulate lake water quality conditions for two nutrient impaired eutrophic reservoirs that are contributing to impairment downstream of their dams. The integrated model simulates lake response to changes in watershed land use and management and was used to develop implementation strategies to address the impairments.

6.2.3 QUAL2K Stream Model

The Enhanced Stream Water Quality Model version K (QUAL2K) predicts the in-stream chemical concentration response of several parameters including dissolved oxygen and ammonia to various inputs and stream conditions under steady, non-varying flows. QUAL2K represents the stream as a series of computational elements grouped together within a specified stream reach. It calculates the output from one element based on the input from the previous element and on reactions that occur within the element itself.

QUAL2K was used in this project to predict the in-stream concentration of dissolved oxygen and nitrogen compounds during low flow summer conditions for the Hocking River downstream of the Lancaster WWTP. The simulated in-stream concentrations were compared to water quality criteria to evaluate if violations had the potential to occur, to determine the water quality impact of the dam downstream of this facility, and to calculate appropriate effluent limitations for dissolved oxygen demanding substances at the Lancaster WWTP.

6.2.4 Bacteria Indicator Tool

The U.S. EPA's Bacteria Indicator Tool (BIT) is used to estimate the fecal coliform loads accumulated on the land surface and contributed by livestock with stream access. BIT operates by creating an accounting of all manure sources within a subwatershed. BIT distributes the total quantity of manure among various methods of disposal. BIT accounts for the waste contribution of livestock and wildlife through direct deposition to cropland, pasture, or forest; barn or feedlot deposition and subsequent field application; or direct deposition in the stream or river. BIT outputs the daily accumulation rate of fecal coliform bacteria on each land-use type (counts/acre/day), and the fecal coliform load contributed to the stream by livestock with direct access (counts/hour).

6.2.5 Spreadsheet Methods

Spreadsheet methods are used to estimate the pollutant loads from bacteria washoff, NPDES dischargers, HSTS, CSO and SSO. These methods use combination of empirical data and literature or default values in each calculation. The following points briefly discuss each method.

- Bacteria washoff is estimated using the daily land-surface accumulation-rate generated by BIT, and a washoff equation common to SWMM, HSPF, and GWLF. In addition to the daily accumulation rate, the washoff equation requires daily runoff and a washoff coefficient as inputs. Daily runoff is estimated using the SCS curve-number method.

- The method used to calculate pollutant loads from NPDES dischargers is dependent upon the type of discharger. The loads from major dischargers and several significant minors are calculated individually for each facility based upon self-monitoring data. Pollutant loads from other minors are estimated as the product of each facility's design flow and representative water quality information from a pooled dataset of self-

monitoring data. Miscellaneous point source loads are calculated based upon observed wastewater flow-rates and representative wastewater quality values.

- HSTS pollutant loads are estimated as the product of the number persons served by failing systems in each subwatershed, a per capita wastewater flow-rate, and representative wastewater quality information.

- CSO and SSO pollutant loads are estimated as the product of measured or modeled flow volumes and representative water quality information. CSO and SSO load calculations pertaining to the City of Lancaster's collection system are benefited by the city's Wet Weather Management Plan which contains information regarding the water quality of sewer overflow from their system.

7.0 TOTAL MAXIMUM DAILY LOADS

TMDLs establish allowable loadings or other quantifiable parameters for a waterbody, and thereby provide the basis for states to establish water quality based controls. These controls should provide the pollution reduction necessary for a waterbody to meet water quality standards.

A TMDL is the sum of its load allocations, wasteload allocations, and a margin of safety. Load allocations (LA) are the portion of the TMDL reserved for nonpoint sources of pollution. Wasteload allocations are the portion reserved for point sources. The margin of safety (MOS) is a portion of the TMDL reserved for uncertainty in the method of calculation. MOS may be included explicitly or implicitly. TMDLs are required to consider both critical condition and seasonality for each parameter of concern.

TMDL development requires the definition of the existing load, calculation of the loading capacity, and allocation of the TMDL. The existing load is the quantity of a pollutant that is contributed to a waterbody prior to TMDL implementation. The loading capacity is the quantity of a pollutant that a waterbody can receive and still maintain water quality standards. Allocation of the TMDL involves the distribution of the loading capacity to all known sources.

The following sections present the method of calculation and TMDL values for the Hocking River watershed. Section 7.1 presents load-based TMDLs. Section 7.2 presents non-load-based, or environmental condition based, TMDLs.

7.1 Load-Based TMDLs

Load based TMDLs refer to those developed for parameters or substances that are quantified in terms of their mass, volume, or number (i.e., count) as they occur in the stream systems per some defined period of time. Non-load based TMDLs are not quantified in terms of a mass, volume, or count. For this TMDL project, the load based parameters are total phosphorus and fecal coliform bacteria.

7.1.1 Method of TMDL Calculation

The TMDL value for a watershed is the assimilative capacity of that watershed. The assimilative capacity of a watershed equals the product of the applicable flow volume for the calculation period and the in-stream concentration target for the parameter of concern. The flow volumes used were simulated using GWLF for nutrient impairments, BIT for pathogens, or calculated from USGS gages.

7.1.2 Method of Allocation

The allocation method used for each parameter varied slightly depending on the model used and the inputs and outputs for each model. Table 7.1 summarizes the calculation method used for the pathogen TMDLs. Table 7.2 summarizes the methods used for total phosphorus stream TMDL development and the GWLF model, while Table 7.3 summarizes the methods used for total phosphorus lake TMDL development and the BATHTUB model.

7.1.3 Critical Condition and Seasonality

The critical condition for aquatic organisms is the summer low flow periods when plant biomass production is at its highest levels and the problem of excessive algal growth most often occurs. The summer period exhibits the highest temperatures combined with the lowest stream flow leading to the lowest annual dissolved oxygen concentrations. Ohio EPA's biocriteria (e.g., IBI) and targets for habitat (i.e., QHEI) and nutrient concentrations are protective of the critical period because they are based on data collected only during the summer months. Further, assessing the biology during the summer months evaluates the biological performance during the most critical time of the year.

The critical condition for nutrient enrichment likewise is the summer warm season, when the potential for primary production is highest. The summer concentration of phosphorus in the water column, however, is dependent upon more than summer phosphorus load contributed to the stream. As phosphorus readily attaches to sediment, detachment of adsorbed phosphorus in bottom sediments can lead to elevated in-stream concentrations regardless of the magnitude of short term loads. As a result, it is the long term, or chronic, phosphorus load and sediment load that is more directly related to the degradation of water quality. For this reason TMDLs were developed for loading occurring throughout the year.

The critical condition for pathogens is a "first flush" situation during the summer when pre-storm flows are the lowest and build-up of bacteria is at its highest. Summer is also the period when the probability of recreational contact is the greatest. For these reasons recreational use designations are only applicable in the period from May 1 to October 15. Pathogen TMDLs were developed for the same May to October time-period in consideration of the critical condition and for agreement with Ohio WQS.

Table 7.1. Summary of pathogen TMDL development

Development step	Source		Method
Existing load	Point source		Product of discharger design flow and the fecal coliform average standard currently in place.
	Surface runoff		BIT tool with spreadsheet washoff model.
	HSTS		Population served by failing HSTS estimated via GIS and county health departments. Fecal coliform load based upon population estimate and a per capita loading rate.
	Upstream load		No upstream load is included
Calculation of loading capacity	-		Product of the daily discharge volume during the recreational season averaged over a 10-year period from each sub-basin and the fecal coliform geometric mean target concentration.
Allocation	Margin of safety		An explicit 10% margin of safety is allocated.
	WLA	Point sources	Product of discharger design flow and the fecal coliform average permit limit currently in place.
		MS4	MS4s are allocated a portion of the total LA. MS4s allocations are the product of the percentage of the sub-basin area occupied by MS4s and the sub-basin surface runoff allocation.
	LA	Surface washoff	The portion of the TMDL remaining after the WLA, the HSTS LA, and the MOS are removed.
		HSTS	Direct discharge home sewage treatment systems are allocated a fecal coliform load of zero. If this brings the estimated failure rate of all HSTSs to below 5% then indirect HSTS loads are allocated with no reduction. If not, an allocation for the indirect HSTS load is set to a point that reduces total HSTS load to meet a 5% failure rate.

Table 7.2. Summary of TMDL for total phosphorus in streams

Development step	Source		Method
Existing load	Point source		Product of discharger average design flow and the total phosphorus average effluent concentration if available or an assumed 3 mg/l concentration if not.
	Surface runoff		GWLF model using existing land uses and practices
	HSTS		Population served by failing and direct HSTS estimated via GIS and county health departments. TP load based upon population estimate and a per capita loading rate.
	Natural load		GWLF model using native, unmanaged lands.
Calculation of loading capacity	-		Product of the average daily discharge volume over a 10 year period and the total phosphorus target applicable for the subwatershed.
Allocation	Natural load		Same as for the existing natural load.
	Margin of safety		A 10% explicit margin of safety is allocated.
	WLA	HSTS	Direct HSTS load allocation is zero.
		Point Source	The total percent reduction needed after removing the existing direct HSTS load was calculated. This percent reduction was applied in equal proportions to point sources and nonpoint sources to determine the allowable load.
		MS4 or CSO	No nutrient impaired areas had these sources.
	LA	Surface runoff	The total percent reduction needed after removing the existing direct HSTS load was calculated. This percent reduction was applied in equal proportions to point sources and nonpoint sources to determine the allowable load.

7.1.4 Margin of Safety

TMDLs for the Hocking River watershed include an implicit margin of safety that is incorporated into the process for listing impaired waters, the selection of TP targets, and the method of calculation for the FC TMDL as well as an explicit 10% margin of safety set aside. The explicit margin of safety is based on the variability of the bacteria data results and the limited amount of nutrient data available for both the stream and lake total phosphorus models.

Table 7.3. Summary of TMDL for total phosphorus in lakes.

Development step	Source		Method
Existing load	Point source		Product of discharger design flow and the total phosphorus permit concentration currently in place.
	Surface runoff		GWLF model using existing land uses and practices
	HSTS		Population served by failing and direct HSTS estimated via GIS and county health departments. TP load based upon population estimate and a per capita loading rate.
	Atmospheric deposition		Surface area of lake multiplied by literature loading rate value for TP.
Calculation of loading capacity	-		Product of the average daily discharge volume over a 10 year period and the total phosphorus target applicable for the subwatershed.
Allocation	Margin of safety		A 10% explicit margin of safety is allocated.
	WLA	Point sources	Product of discharger design flow and 1 mg/l TP.
		MS4/CSO	None in lake areas.
		HSTS	Direct HSTS load allocation is zero.
	LA	Surface runoff	The portion of the TMDL remaining after all other allocated loads are removed.
		Atmospheric Deposition	Equal to the existing atmospheric load.

The List of Impaired Waters (the 303(d) List)

Ohio uses biological criteria in determining the status of aquatic life uses. In order for a waterbody to be removed from an impaired status in the 303(d) reporting it must demonstrate an appropriate level of biological integrity as determined through biological sampling. This approach provides a high level of certainty that aquatic life uses are met, which far exceeds reliance on surrogate measures such as chemical or other physical parameters to indicate the attainment status of aquatic life uses. For example, relying solely on chemical data does not account for factors for which no criteria exist but do in fact impact stream biology. Additionally such an approach does not account for multiple stressor situations. Therefore, the chemical specific approach misses many biologically impaired streams and may not detect a problem until it is severe.

Total Phosphorus

A margin of safety was incorporated implicitly into the TP TMDLs through the target development process. A conservative assumption implicit in target development lies in the selection of the median statistic used to represent the phosphorus targets for the WWH streams and the 75th percentile for EWH streams that corresponds to an unimpaired biological community. Since Ohio EPA's evaluation of data for generating target values is based on measured performance of aquatic life and since full attainment can be observed at concentrations above these targets (reinforcing the concept that habitat and other factors play an important role in supporting fully functioning biological communities), water quality attainment can occur at levels higher than the targets. The difference between the actual level where attainment can be achieved and the selected target is an implicit margin of safety.

Pathogens
A margin of safety was implicitly incorporated into the pathogen TMDL. The fecal coliform load to the streams in each subwatershed was quantified, as was the fecal coliform loading capacity at the outlet of each subwatershed. Loading capacity was calculated as the product of the seasonal flow volume and the fecal coliform target concentration. However, bacteria die off is not accounted for when determining the downstream loading rates when in fact a considerable amount of die off occurs. This conservative approach provides an implicit margin of safety.

7.1.5 Results of the TMDL Analyses

This section presents all of the results from the load based TMDL analyses. These results include the estimates of the total existing loads for point sources and nonpoint sources as well as the overall assimilative capacity of the system, the TMDL. Allocations to the point sources (wasteloads) and nonpoint sources (loads) and their corresponding percent reductions are also presented along with the loads associated with the margins of safety (MOS).

The results for total phosphorus are presented first followed by those for fecal coliform bacteria. A map showing the watershed areas for which the TMDLs were developed precedes the results (Figure 7.1 for total phosphorus and Figure 7.2 for fecal coliform bacteria). Tables 7.4 and 7.7 provide a gross overview of the above stated values based on each area that the stream system that was analyzed (i.e., 14-digit HUC or some smaller subdivision). Tables 7.5 and 7.8 show detailed wasteload allocations to individual dischargers located in the area of interest and Tables 7.6 and 7.10 show details of the load allocations based on the relevant land use and other nonpoint sources for total phosphorus and fecal coliform bacteria, respectively.

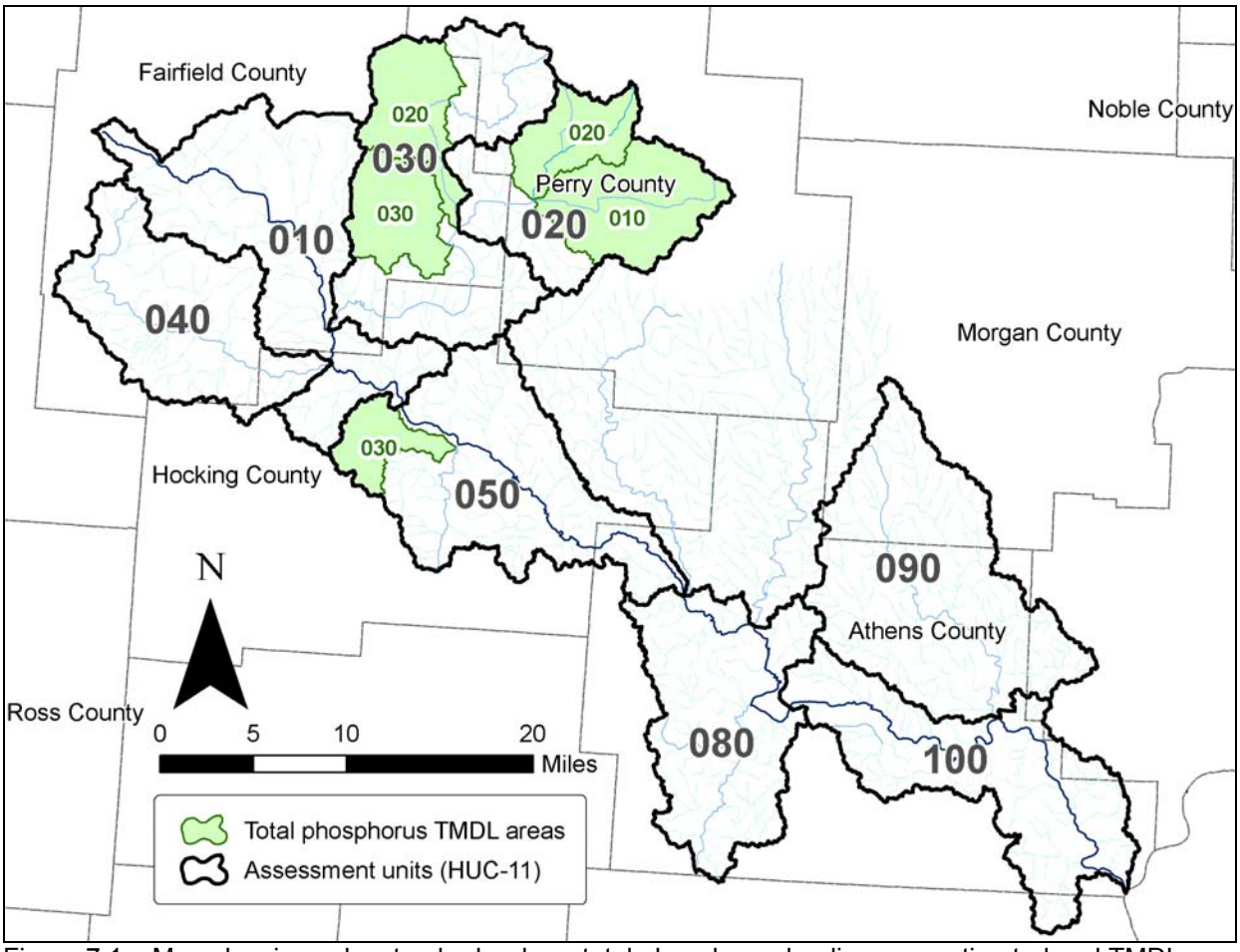

Figure 7.1. Map showing subwatersheds where total phosphorus loading was estimated and TMDLs developed.

Table 7.4. Overview of existing conditions, allocations, TMDLs, and calculated reductions for total phosphorus within the entire TMDL project area.

05030204		Existing loads (lb/day)		Margin of safety (lb/day)	Allowable (lb/day)					
		Point Sources	Nonpoint source		Total WLA	Percent reduction	Total LA	Percent reduction	TMDL	Percent reduction
020	010	Rush Creek headwaters to above Center Branch								
		28	*119*	*8*	*11*	*60%*	*60*	*50%*	*79*	*46%*
	020	Center Branch								
		8.7	*105*	*6*	*2.8*	*68%*	*48*	*54%*	*58*	*49%*
030	020	Headwaters to Oakthorpe Lake								
		1.2	*19*	*0.5*	*0*	*100%*	*4*	*77%*	*5*	*76%*
	020	Rushville to Rush Creek								
		1	*22*	*1*	*0*	*100%*	*12*	*48%*	*13*	*45%*
	030	Racoon Run								
		6.4	*45*	*3*	*0.46*	*93%*	*29*	*36%*	*33*	*37%*
050	030	Clear Fork / headwaters to Lake Logan								
		1.5	*17*	*1.3*	*0.2*	*83%*	*10*	*37%*	*12*	*34%*

Table 7.5. Total phosphorus waste load allocations by assessment unit.

05030204		Sources	Total Phosphorus Load (lb/day) Existing	Allowable	Reduction Required	Comments
020	010	Rush Creek headwaters to above Center Branch				A total phosphorus permit limit of 1.4 mg/l and monitoring is required for those facilities that discharge total phosphorus.
		BP Amoco Oil Corp Bulk Plant	0.003	0.001	54%	
		New Lexington STP	22	10	54%	
		Roof Tile Acquisition Corp	0.013	0.006	54%	
		Junction City STP	3	1	54%	
		No CSO or MS4 areas	-	-	-	
		Direct HSTS	4	0	100%	
		Total Point Source (Wasteloads)	*28*	*11*	*60%*	
	020	Center Branch				Somerset STP NPDES permit will need to have a 1.3 mg/l total phosphorus limit and monitoring requirements.
		Somerset STP	6.3	2.8	55%	
		No CSO or MS4 areas	-	-	-	
		Direct HSTS	2.4	0	100%	
		Total Point Source (Wasteloads)	*8.7*	*2.8*	*68%*	
030	020	Headwaters to Oakthorpe Lake				Oakthorpe Lake is highly eutrophic. Upstream nutrient reductions are needed to reduce and eliminate the over-abundance of algae in the lake. The major source of concern is nonpoint source runoff.
		No NPDES facilities	-	-	-	
		No CSO or MS4 areas	-	-	-	
		Direct HSTS	1.2	0	100%	
		Total Point Source (Wasteloads)	*1.2*	*0*	*100%*	
	020	Rushville to Rush Creek				
		No NPDES facilities	-	-	-	
		No CSO or MS4s	-	-	-	
		Direct HSTS	1	0	100%	
		Total Point Source (Wasteloads)	*1*	*0*	*100%*	
	030	Racoon Run				A permit limit of 1.6 mg/l & monitoring is required for facilities that have TP.
		Cyril-Scott	0.1	0.05	46%	
		Fairfield-Union High School	0.75	0.41	46%	Ralston Purina is a facility in this subwatershed which sends its industrial waste to Lancaster WWTP; however, contaminated storm water associated with this facility has been an issue in the past. This issue appears to have been resolved, but continued vigilance on the part of the company and others should be maintained to ensure the issue does not re-occur.
		No CSO or MS4 areas	-	-	-	
		Direct HSTS	5.5	0	100%	
		Total Point Source (Wasteloads)	*6.4*	*0.46*	*93%*	
050	030	Clear Fork / headwaters to Lake Logan				Lake Logan is a eutrophic lake. The lake waters are enriched and contributing to downstream impairment.
		Lake Moor Estates Subdivision	0.2	0.2	0%	
		No CSO or MS4 areas	-	-	-	
		Direct HSTS	1.2	0	100%	
		Total Point Source (Wasteloads)	*1.5*	*0.2*	*83%*	

Table 7.6. Total phosphorus load allocations by assessment unit.

05030204		Sources	Total Phosphorus Load (lb/day) Existing	Allowable	Reduction Required	Comments
020	010	Rush Creek headwaters to above Center Branch				
		Natural	4	4	0%	
		Other Runoff	115	54	53%	
		Total Nonpoint Source	*119*	*60*	*50%*	
	020	Center Branch				Direct HSTS and livestock in the streams are the major sources of fecal coliform in this subwatershed. Fencing pastures to limit domestic animal access to the streams and eliminating direct HSTS are areas to focus on in this subwatershed. The Somerset STP NPDES permit will need to have a 1.3 mg/l total phosphorus limit and monitoring requirements.
		Indirect HSTS	-	-		
		Built Up	-	-		
		Forest / Natural	2	2		
		Pasture	-	-		
		Crop	-	-		
		Total Nonpoint Source	*105*	*48*	*54%*	
030	020	Headwaters to Oakthorpe Lake				Oakthorpe Lake is highly eutrophic. Upstream nutrient reductions are needed to reduce and eliminate the over-abundance of algae in the lake. The major source of concern is nonpoint source runoff.
		Atmospheric Deposition	0.03	0.03		
		Runoff	19	4		
		Total Nonpoint Source	*19*	*4*	*77%*	
	020	Rushville to Rush Creek				Nonpoint source runoff upstream of Oakthorpe Lake is the major source of nutrients in this watershed.
		Natural	0.4	0.4	0%	
		Other Runoff	22	11	48%	
		Total Nonpoint Source	*22*	*12*	*48%*	
	030	Racoon Run				
		Natural	1.4	1.4	0%	
		Other Runoff	44	27	38%	
		Total Nonpoint Source	*45*	*29*	*36%*	
050	030	Clear Fork / headwaters to Lake Logan				Lake Logan is a eutrophic lake. The lake waters are enriched and contributing to downstream impairment. The season for lake loading is May through September.
		Atmospheric Deposition	0.2	0.2	0%	
		Runoff	17	10	38%	
		Total Nonpoint Source	*17*	*10*	*37%*	

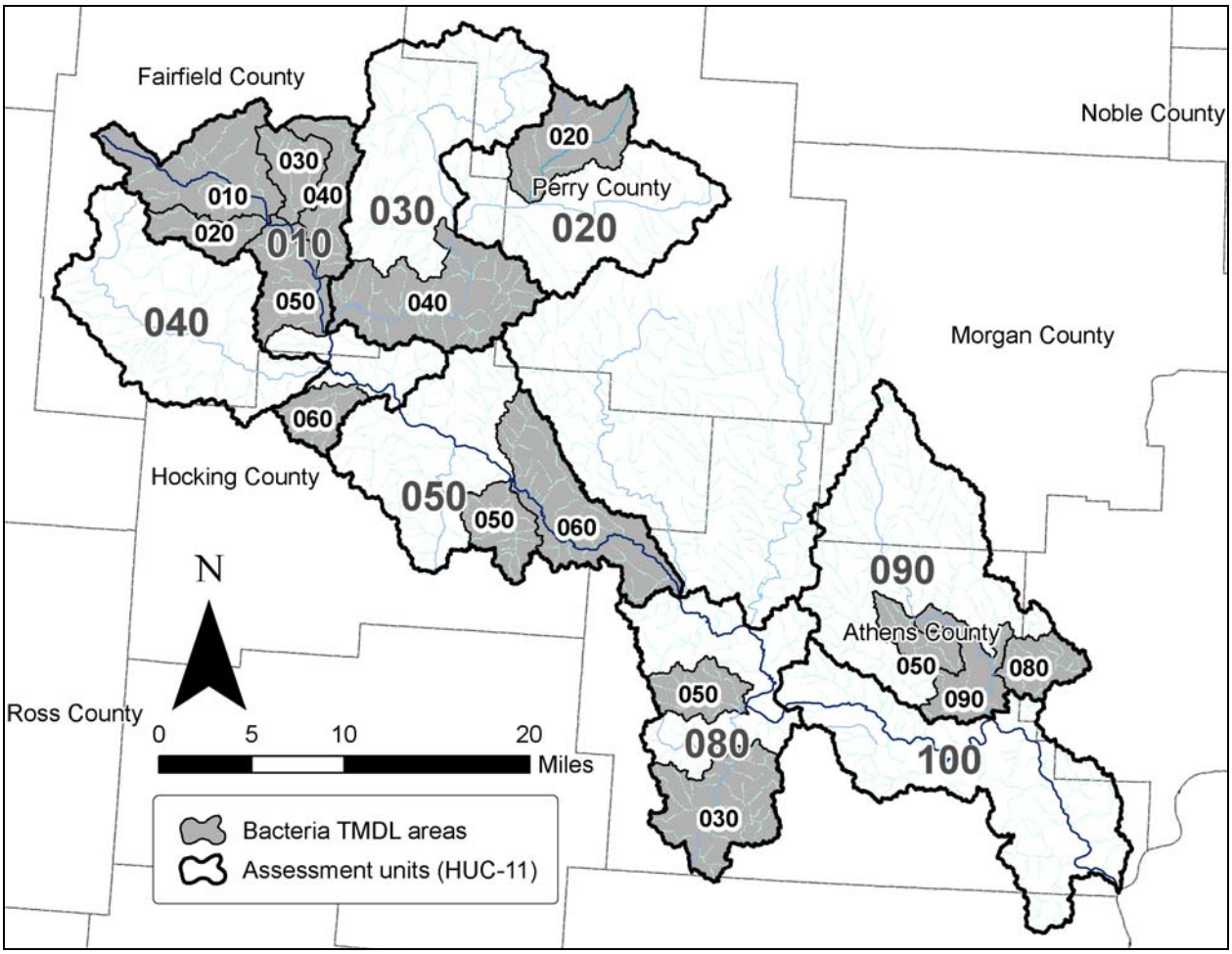

Figure 7.2. Map showing subwatersheds where bacteria loading was estimated and TMDLs developed.

Table 7.7. Overview of existing conditions, allocations, TMDLs, and calculated reductions for fecal coliform bacteria within the entire TMDL project area.

05030204		Existing loads (cfu*10^{7})/day)		Margin of safety (lb/day)	Allowable (cfu*10^{7})/day)					
		Point Sources	Nonpoint source		Total WLA	Percent reduction	Total LA	Percent reduction	TMDL	Percent reduction
010	010	**Hocking River from headwaters to Rock Mill Dam**								
		24,888	*1,904*	1,008	-	*100%*	*1,904*	*0%*	*2,912*	*89%*
	010	**Hocking River from Rock Mill Dam to below the Ohio and Erie Canal**								
		14,210	*3,216*	329	-	*100%*	*2,965*	*8%*	*3,295*	*81%*
	010 & 050	**Hocking River from Rock Mill Recreation Area to Ety Road**								
		34,108	*6,019*	760	4,814	*86%*	*2,029*	*66%*	*7,604*	*81%*
	020	**Hunter's Run**								
		26,276	*3,676*	185	3	*100%*	*1,658*	*55%*	*1,846*	*94%*
	030	**Baldwin Run**								
		55,882	*1,336*	1,565	31	*100%*	*1,336*	*0%*	*2,932*	*95%*
	040	**Pleasant Run**								
		20,366	*2,964*	1,100	61	*100%*	*2,964*	*0%*	*4,124*	*82%*
	050	**Hocking River from Pleasant Run to above Rush Creek**								
		17,283	*2,001*	174	207	*99%*	*1,359*	*32%*	1,740	*91%*
	060	**Buck Run**								
		1,073	*1,666*	136	-	*100%*	*1,227*	*26%*	1,363	*50%*
020	020	**Center Branch**								
		9,892	*11,720*	335	95	*99%*	*2,925*	*75%*	3,365	*84%*
030	040	**Rush Creek below Little Rush Creek to mouth (except Raccoon Run)**								
		29,823	*5,264*	570	127	*100%*	*4,980*	*5%*	5,704	*84%*
050	050	**Fivemile Creek**								
		9,875	*1,746*	141	1	*100%*	*1,274*	*27%*	1,417	*88%*
	060	**Hocking River below Fivemile Creek to above Monday Creek**								
		63,043	*5,680*	599	218	*100%*	*4,639*	*18%*	5,455	*92%*
080	030	**Margaret Creek Headwaters to above West Branch**								
		50,513	*7,635*	469	82	*100%*	*4,139*	*46%*	4,690	*92%*
	050	**Margaret Creek above Factory Creek to Hocking River**								
		19,890	*993*	986	-	*100%*	*547*	*45%*	1,533	*93%*
090	050	**McDougall Branch below Mush Run to Federal Creek**								
		2,463	*327*	660	-	*100%*	*327*	*0%*	988	*65%*
	080	**Big Run**								
		3,832	*273*	843	-	*100%*	*273*	*0%*	1,115	*73%*
	090	**Federal Creek below McDougall Branch to Hocking River (except Sharps Fork, Marietta Run, and Big Run)**								
		5,754	*1,259*	417	-	*100%*	*1,259*	*0%*	1,676	*76%*

Table 7.8. Bacteria waste load allocations by assessment unit.

05030204		Sources	Fecal Coliform Load (count/day*10^7) Existing	Allowable	Reduction Required	Comments
010	010	Hocking River from headwaters to Rock Mill Dam				Direct HSTS connections are illegal and the only known sources of significance in this subwatershed, and need to be eliminated.
		No NPDES facilities	-	-	-	
		No CSO or MS4s	-	-	-	
		Direct HSTS	24888	0	100%	Elimination of illegal direct HSTS reduce the load below the TMDL. The difference between this load reduction and the TMDL is the MOS.
		Total Point Source (Wasteloads)	*24888*	*0*	*100%*	
	010	Hocking River from Rock Mill Dam to below the Ohio and Erie Canal				Failing and direct HSTS pose the major sources of concern in this area.
		Air Products & Chemicals	-	-	-	
		Lancaster MS4	0.228	0.224	2%	
		Direct HSTS	14210	0	100%	Air Products & Chemicals does not discharge fecal coliform
		Total Point Source (Wasteloads)	*14210*	*0*	*100%*	
	010 & 050	Hocking River from Rock Mill Recreation Area to Ety Road				The Lancaster Long Term CSO Control Plan should achieve a 95% reduction in fecal coliform load once it is fully implemented.
		Lancaster WPCF	3785	3785	0%	
		CSO	20264	1013	95%	A new WWTP is proposed for Lancaster which would tie in many of the direct and failing HSTS.
		Lancaster MS4	46	15	66%	
		Direct HSTS	10013	0	100%	
		Total Point Source (Wasteloads)	*34108*	*4814*	*86%*	Manure management and limiting livestock access are areas that need attention in this subwatershed.
010						
	020	Hunter's Run				The Lancaster Long Term CSO Control Plan should achieve this reduction in fecal coliform load once it is fully implemented.
		Stonewall Landfill	-	-	-	
		CSO	20264	0	100%	
		Lancaster MS4	7	3	55%	A new WWTP is proposed for Lancaster which would tie in many of the direct and failing HSTS.
		Direct HSTS	6005	0	100%	
		Total Point Source (Wasteloads)	*26276*	*3*	*100%*	
						Manure management and limiting livestock access are areas that need attention in this subwatershed.
						Stonewall Landfill does not discharge fecal coliform
	030	Baldwin Run				The Lancaster Long Term CSO Control Plan should achieve this reduction in fecal coliform load once it is fully implemented.
		No NPDES facilities	-	-	-	
		CSO	45085	0	100%	
		MS4	31	31	0%	A new WWTP for Lancaster will eliminate some of the direct HSTS.
		Direct HSTS	10766	0	100%	
		Total Point Source (Wasteloads)	*55882*	*31*	*100%*	The elimination of the CSOs through the Lancaster LTCP and the elimination of direct HSTS will reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.

05030204		Sources	Fecal Coliform Load (count/day*10^7) Existing	Allowable	Reduction Required	Comments
	040	Pleasant Run				Colony Village MHP will need to have a fecal coliform permit limit of 1000 counts/100ml.
		Bay Packing Co.	0.07	0.07	0%	
		Venture Industries	-	-	-	
		Diamond Power	-	-	-	Direct HSTS are the major source of fecal coliform in this subwatershed. These illegal sources need to be eliminated.
		Lakeside Estates	3	3	0%	
		Fairfield County Subdivision	15	15	0%	
		South Central Power Co.	1	1	0%	The elimination of illegal direct HSTS will reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.
		Colony Village MHP	38	4	90%	
		MS4	38	38	0%	
		Direct HSTS	20271	0	100%	
		Total Point Source (Wasteloads)	*20366*	*61*	*100%*	
	050	Hocking River from Pleasant Run to above Rush Creek				Failing and direct HSTS pose the major sources of concern in this area.
		Hillview MHP	8	8	0%	
		Rustic Ridge MHP	189	189	0%	
		Brookdale MHP	8	8	0%	
		Presbytery of Scioto	3	3	0%	
		No CSO or MS4 areas	-	-	-	
		Direct HSTS	17076	0	100%	
		Total Point Source (Wasteloads)	*17283*	*207*	*99%*	
	060	Buck Run				Failing and direct HSTS pose the major sources of concern in this area.
		No NPDES facilities	-	-		
		No CSO or MS4 areas	-	-		
		Direct HSTS	1073	0	100%	
		Total Point Source (Wasteloads)	*1073*	*0*	*100%*	
020	020	Center Branch				**Implementation Focus**: Direct HSTS and livestock in the streams are the major sources of fecal coliform in this subwatershed. Fencing pastures to limit domestic animal access to the streams and eliminating direct HSTS are areas to focus on in this subwatershed. The Somerset STP NPDES permit will need to have a 1.3 mg/l total phosphorus limit and monitoring requirements.
		Somerset STP	95	95	0%	
		No CSO or MS4 areas	-	-	-	
		Direct HSTS	9797	0	100%	
		Total Point Source (Wasteloads)	*9892*	*95*	*99%*	
030	040	Rush Creek below Little Rush Creek to mouth (except Raccoon Run)				Direct HSTS and livestock in the streams are the major sources of fecal coliform in this subwatershed.
		Sugar Grove STP	26	26	0%	
		Bremen STP	127	127	0%	
		No CSO or MS4 areas	-	-	-	Fencing pastures to limit domestic animal access to the streams and eliminating direct HSTS are areas to focus on in this subwatershed.
		Direct HSTS	29696	0	100%	
		Total Point Source (Wasteloads)	*29823*	*127*	*100%*	
050	050	Fivemile Creek				Direct HSTS pose the major source of concern in this area.
		Union Furnace Elementary	1.1	1.1	0%	
		No CSO or MS4 areas	-	-	-	

05030204		Sources	Fecal Coliform Load (count/day*10^7) Existing	Allowable	Reduction Required	Comments
		Direct HSTS	9874	0	100%	
		Total Point Source (Wasteloads)	*9875*	*1.1*	*100%*	
	060	Hocking River below Fivemile Creek to above Monday Creek				Direct HSTS pose the major source of concern in this area. There are also cows present in the streams; these animals need to be restricted from stream access.
		Nelsonville STP	208	208	0%	
		Hadenville WWTP	9	9	0%	
		Logan Hocking School District	0.9	0.9	0%	
		No CSO or MS4s	-	-	-	The elimination of direct HSTS and cattle in the stream reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.
		Direct HSTS	62826	0	100%	
		Total Point Source (Wasteloads)	*63043*	*218*	*100%*	
080	030	Margaret Creek Headwaters to above West Branch				Direct HSTS pose the major source of concern in this area. There are also cows present in the streams; these animals need to be restricted from stream access.
		Albany WWTP	49	49	0%	
		ODOT 34 Rest Area	4	4	0%	
		Knoll Wood MHP	11	11	0%	
		Capstone Village 001	6	6	0%	
		Capstone Village 002	9	9	0%	
		Bassett House	2	2	0%	
		Health Recovery Sv	0.9	0.9	0%	
		No CSO or MS4s	-	-	-	
		Direct HSTS	50432	0	100%	
		Total Point Source (Wasteloads)	*50513*	*82*	*99.80%*	
	050	Margaret Creek above Factory Creek to Hocking River				Direct HSTS pose the major source of concern in this area. There are also cows present in the streams; these animals need to be restricted from stream access.
		No NPDES facilities	-	-	-	
		No CSO or MS4 areas	-	-	-	
		Direct HSTS	19890	0	100%	
		Total Point Source (Wasteloads)	*19890*	*0*	*100%*	The elimination of direct HSTS and cattle in the stream reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.
090	050	McDougall Branch below Mush Run to Federal Creek				Direct HSTS pose the major source of concern in this area.
		No NPDES facilities	-	-	-	
		No CSO or MS4s	-	-	-	The elimination of illegal direct HSTS reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.
		Direct HSTS	2463	0	100%	
		Total Point Source (Wasteloads)	*2463*	*0*	*100%*	
	080	Big Run				
		No NPDES facilities	-	-		Direct HSTS pose the major source of concern in this area.
		No CSO or MS4 areas	-	-		The elimination of illegal direct HSTS reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.
		Direct HSTS	3832	0	100%	
		Total Point Source (Wasteloads)	*3832*	*0*	*100%*	

05030204	Sources	Fecal Coliform Load (count/day*10^7) Existing	Allowable	Reduction Required	Comments
090	Federal Creek below McDougall Branch to Hocking River (except Sharps Fork, Marietta Run, and Big Run)				Direct HSTS pose the major source of concern in this area.
	No NPDES facilities	-	-		
	No CSO or MS4 areas	-	-		The elimination of illegal direct HSTS reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.
	Direct HSTS	5754	0	100%	
	Total Point Source (Wasteloads)	*5754*	*0*	*100%*	

Table 7.9. Bacteria load allocations by assessment unit. Note that the margin of safety for these bacteria TMDLs is displayed only in this table and not in Table 7.6 where wasteload allocations are presented.

05030204		Sources	Fecal Coliform Load (count/day*10^7) Existing	Allowable	Reduction Required	Comments
010	010	Hocking River from headwaters to Rock Mill Dam				Direct HSTS connections are illegal and the only known sources of significance in this subwatershed, and need to be eliminated.
		Indirect HSTS	932	932	0%	
		Built Up	14	14	0%	
		Forest	4	4	0%	Elimination of illegal direct HSTS reduce the load below the TMDL. The difference between this load reduction and the TMDL is the MOS.
		Pasture	674	674	0%	
		Crop	280	280	0%	
		Total Nonpoint	*1904*	*1904*	*0%*	
	010	Hocking River from Rock Mill Dam to below the Ohio and Erie Canal				Failing and direct HSTS pose the major sources of concern in this area.
		Indirect HSTS	305	101	67%	
		Built Up	1	1	2%	
		Forest	8	8	0%	Air Products & Chemicals does not discharge fecal coliform
		Pasture	2102	2068	2%	
		Crop	800	788	2%	
		Total Nonpoint	*3216*	*2965*	*8%*	
	010 & 050	Hocking River from Rock Mill Recreation Area to Ety Road				The Lancaster Long Term CSO Control Plan should achieve a 95% reduction in fecal coliform load once it is fully implemented.
		Indirect HSTS	867	286	67%	
		Built Up	3	1	66%	A new WWTP is proposed for Lancaster which would tie in many of the direct and failing HSTS.
		Forest	26	26	0%	
		Pasture	2952	989	66%	
		Crop	2171	727	66%	Manure management and limiting livestock access are areas that need attention in this subwatershed.
		Total Nonpoint	*6019*	*2029*	*66%*	
	020	Hunter's Run				The Lancaster Long Term CSO Control Plan should achieve this reduction in fecal coliform load once it is fully implemented.
		Indirect HSTS	111	39	65%	
		Built Up	0	0	55%	
		Forest	16	16	0%	A new WWTP is proposed for Lancaster which would tie in many of the direct and failing HSTS.
		Pasture	2523	1140	55%	
		Crop	1025	463	55%	
		Total Nonpoint	*3676*	*1658*	*55%*	Manure management and limiting livestock access are areas that need attention in this subwatershed.
						Stonewall Landfill does not discharge fecal coliform
	030	Baldwin Run				The Lancaster Long Term CSO Control Plan should achieve this reduction in fecal coliform load once it is fully implemented.
		Indirect HSTS	235	235	0%	
		Built Up	1	1	0%	
		Forest	7	7	0%	A new WWTP for Lancaster will eliminate some of the direct HSTS.
		Pasture	588	588	0%	

05030204		Sources	Fecal Coliform Load (count/day*10^7) Existing	Allowable	Reduction Required	Comments
		Crop	504	504	0%	The elimination of the CSOs through the Lancaster LTCP and the elimination of direct HSTS will reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.
		Total Nonpoint	*1336*	*1336*	*0%*	
	040	Pleasant Run				Colony Village MHP will need to have a fecal coliform permit limit of 1000 counts/100ml.
		Indirect HSTS	1001	1001	0%	
		Built Up	11	11	0%	
		Forest	10	10	0%	Direct HSTS are the major source of fecal coliform in this subwatershed. These illegal sources need to be eliminated.
		Pasture	1476	1476	0%	
		Crop	466	466	0%	
		Total Nonpoint	*2964*	*2964*	*0%*	The elimination of illegal direct HSTS will reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.
	050	Hocking River from Pleasant Run to above Rush Creek				Failing and direct HSTS pose the major sources of concern in this area.
		Indirect HSTS	1494	851	43%	
		Built Up	2	2	0%	
		Forest	17	17	0%	
		Pasture	263	263	0%	
		Crop	226	226	0%	
		Total Nonpoint	*2001*	*1359*	*32%*	
	060	Buck Run				Failing and direct HSTS pose the major sources of concern in this area.
		Indirect HSTS	442	128	71%	
		Built Up	1	1	10%	
		Forest	10	10	0%	
		Pasture	1016	912	10%	
		Crop	197	177	10%	
		Total Nonpoint	*1666*	*1227*	*26%*	
020	**020**	Center Branch				**Implementation Focus**: Direct HSTS and livestock in the streams are the major sources of fecal coliform in this subwatershed. Fencing pastures to limit domestic animal access to the streams and eliminating direct HSTS are areas to focus on in this subwatershed. The Somerset STP NPDES permit will need to have a 1.3 mg/l total phosphorus limit and monitoring requirements.
		Indirect HSTS	733	733	0%	
		Built Up	2	1	69%	
		Forest / Natural	20	20	0%	
		Pasture	7219	1008	86%	
		Crop	3746	1163	69%	
		Total Nonpoint	*11720*	*2925*	*75%*	
030	**040**	Rush Creek below Little Rush Creek to mouth (except Raccoon Run)				Direct HSTS and livestock in the streams are the major sources of fecal coliform in this subwatershed.
		Indirect HSTS	1631	1631	0%	
		Built Up	4	4	0%	

05030204		Sources	Fecal Coliform Load (count/day*10^7) Existing	Allowable	Reduction Required	Comments
		Forest	41	41	0%	Fencing pastures to limit domestic animal access to the streams and eliminating direct HSTS are areas to focus on in this subwatershed.
		Pasture	2904	2621	10%	
		Crop	684	684	0%	
		Total Nonpoint	*5264*	*4980*	*5%*	
050	**050**	Fivemile Creek				Direct HSTS pose the major source of concern in this area.
		Indirect HSTS	321	321	0%	
		Built Up	0.9	0.6	28%	
		Forest	13	13	0%	
		Pasture	623	386	38%	
		Crop	789	553	30%	
		Total Nonpoint	*1746*	*1274*	*27%*	
	060	Hocking River below Fivemile Creek to above Monday Creek				Direct HSTS pose the major source of concern in this area. There are also cows present in the streams; these animals need to be restricted from stream access.
		Indirect HSTS	2044	2044	0%	
		Built Up	16.7	16.7	0%	
		Forest	38	38	0%	
		Pasture	2054	1013	51%	The elimination of direct HSTS and cattle in the stream reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.
		Crop	1527	1527	0%	
		Total Nonpoint	*5680*	*4639*	*18%*	
080	**030**	Margaret Creek Headwaters to above West Branch				Direct HSTS pose the major source of concern in this area. There are also cows present in the streams; these animals need to be restricted from stream access.
		Indirect HSTS	1392	1392	0%	
		Built Up	8.8	7.8	11%	
		Forest	13	13	0%	
		Pasture	4532	1216	73%	
		Crop	1689	1509	11%	
		Total Nonpoint	*7635*	*4139*	*46%*	
	050	Margaret Creek above Factory Creek to Hocking River				Direct HSTS pose the major source of concern in this area. There are also cows present in the streams; these animals need to be restricted from stream access.
		Indirect HSTS	137	137	0%	
		Built Up	0.6	0.6	0%	
		Forest	13	13	0%	
		Pasture	654	208	68%	The elimination of direct HSTS and cattle in the stream reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.
		Crop	188	188	0%	
		Total Nonpoint	*993*	*547*	*45%*	
090	**050**	McDougall Branch below Mush Run to Federal Creek				Direct HSTS pose the major source of concern in this area.
		Indirect HSTS	65	65	0%	
		Built Up	0.04	0.04	0%	The elimination of illegal direct HSTS reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.
		Forest	7	7	0%	
		Pasture	144	144	0%	
		Crop	111	111	0%	

05030204		Sources	Fecal Coliform Load (count/day*10^7) Existing	Allowable	Reduction Required	Comments
		Total Nonpoint	*327*	*327*	*0%*	
	080	Big Run				Direct HSTS pose the major source of concern in this area.
		Indirect HSTS	101	101	0%	
		Built Up	0.06	0.06	0%	
		Forest	12	12	0%	The elimination of illegal direct HSTS reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.
		Pasture	89	89	0%	
		Crop	71	71	0%	
		Total Nonpoint	*273*	*273*	*0%*	
	090	Federal Creek below McDougall Branch to Hocking River (except Sharps Fork, Marietta Run, and Big Run)				Direct HSTS pose the major source of concern in this area.
		Indirect HSTS	151	151	0%	
		Built Up	0.35	0.35	0%	The elimination of illegal direct HSTS reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.
		Forest	17	17	0%	
		Pasture	731	731	0%	
		Crop	360	360	0%	
		Total Nonpoint	*1259*	*1259*	*0%*	

7.2 Condition Based TMDLs

Condition based TMDLs represent some measurable threshold value of the stream system (although not in terms of mass or other quantity) which is considered necessary for meeting water quality standards. In this case the measureable thresholds come from scores of a habitat evaluation index (i.e., QHEI) which are based on personal observation of the presence or absence and/or relative abundance of unambiguous habitat features. Due to the impracticality of making quantified measurements of these features (such as enumerating substrate particles of various texture size classes) and the enormous complexity in the various factors and their interactions which are responsible for shaping the habitat quality (e.g., hydrologic regime, types of soils and bedrock, geomorphology) the general or average condition of the habitat is evaluated and used as the basis for setting restoration goals. This general condition is captured well by the QHEI as evidenced through strong its correlation with the IBI (Ohio EPA, 1999).

The condition based TMDLs in this report are for habitat and sediment bedload. Habitat TMDL targets are primarily designed to address the issues of habitat and flow alteration, which are critical factors in shaping the aquatic biological community. Bedload TMDL targets are designed to address the issue of siltation. Achievement of the targets provides the secondary benefit of increased assimilative capacity, which will increase the likelihood of achieving the in-streamtargets for total phosphorus and fecal coliform bacteria.

7.2.1 Method of Development

The habitat and bedload TMDLs are based upon the QHEI. Since no processes are being simulated and source and transport mechanisms are not applicable, the TMDLs are generated strictly based comparison of observed conditions (i.e., QHEI scores) to target conditions. (Section 5.3 lists the target values and provides information regarding the QHEI). For the bedload TMDLs, the target is based on the sum total of the substrate, channel, and riparian

metric scores, and the deviation is calculated as the proportion of the difference between actual and target values to the target value. No percent deviation is calculated for the results of the habitat analysis and only the composite score which ranges from zero and three is used to convey the degree of habitat improvement needed. Specifically, the score shows how many of the aspects related to habitat quality are in need of improvement.

7.2.2 Habitat and Bedload TMDL Results

Table 7.10 presents results of the bedload and habitat TMDL analysis. Habitat and bedload targets are included for the 170 sites assessed in 2005. **Appendix E** presents the full QHEI analysis, and the habitat and bedload deficits per subwatershed are shown graphically.

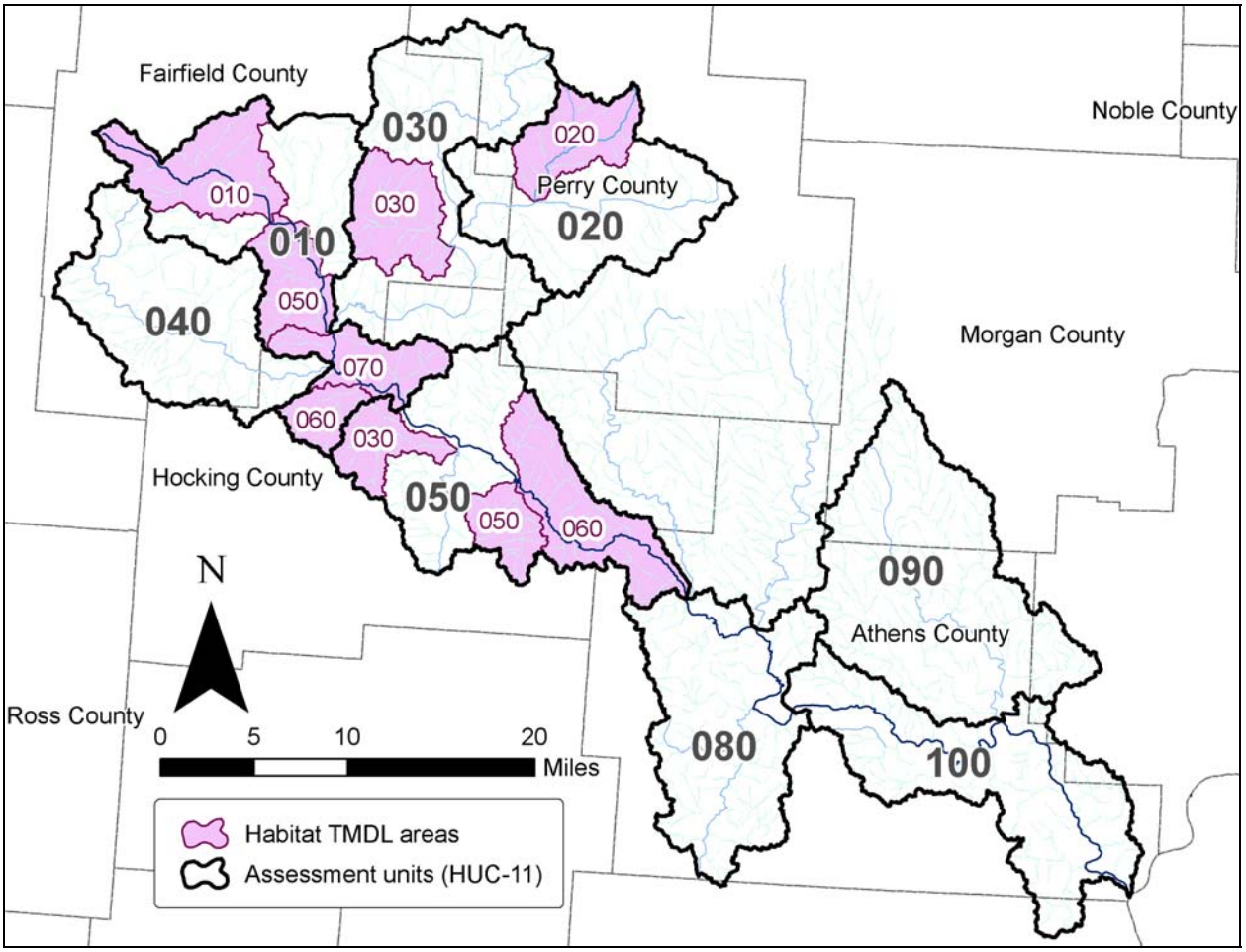

Figure 7.3. Map showing subwatersheds where habitat TMDLs were developed.

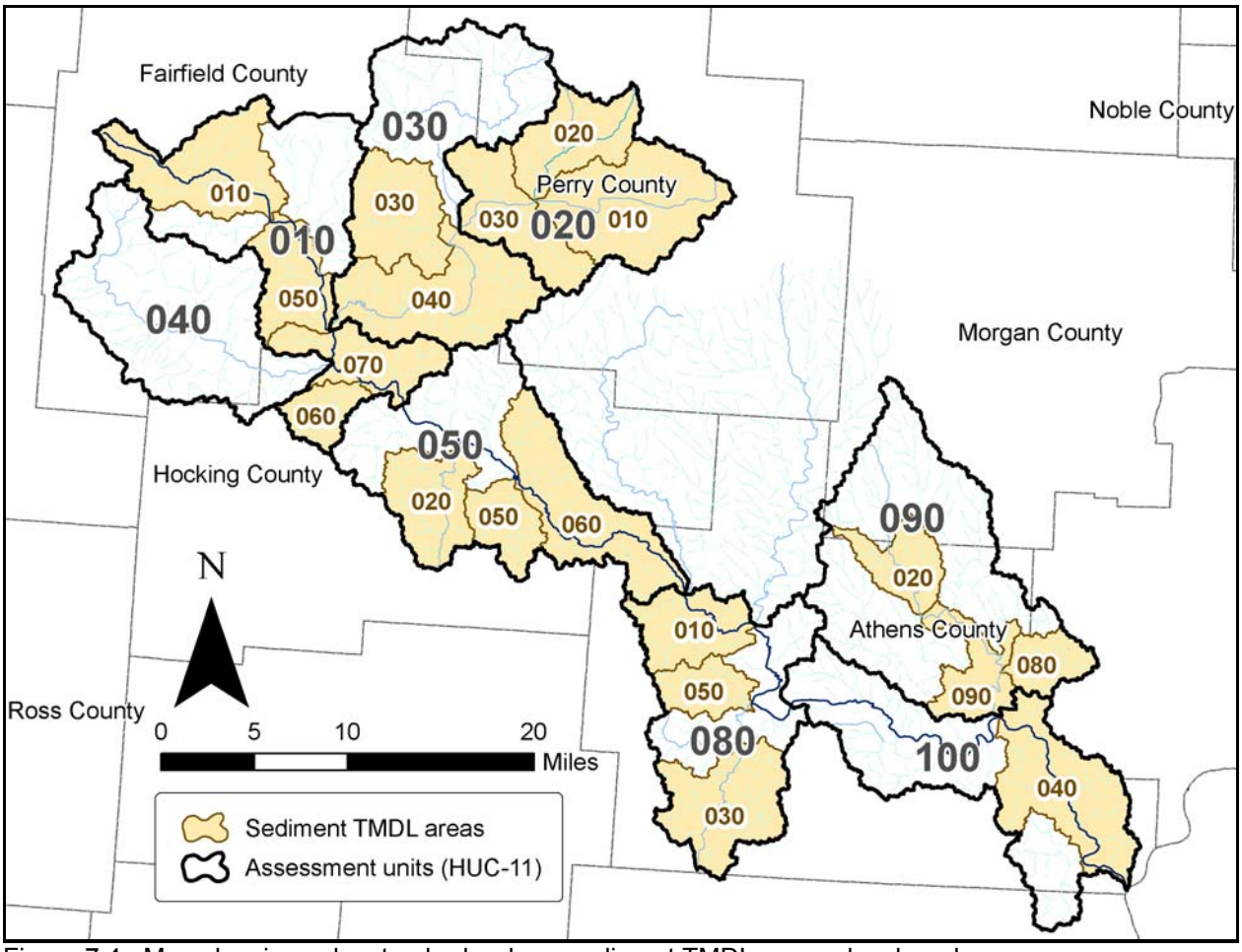

Figure 7.4. Map showing subwatersheds where sediment TMDLs were developed.

Table 7.10. Overview of existing conditions, allocations, TMDLs, and calculated reductions for habitat and bedload within the entire TMDL project area.

Stream name (aquatic life use)	River mile	BEDLOAD TMDL						HABITAT TMDL						
		QHEI Categories			Total Bedload Score	% Deviation from Target	Main Impaired Category	QHEI Score	# High influence Attributes	Total # Modified Attributes	Subscore			Total Habitat Score
		Substrate	Channel	Riparian							QHEI	High Influence	# Modified Attributes	
05030204-010-010 - Hocking River headwaters to above Hunters Run														
Hocking River (WWH)	100.2	6	7	4	17	47%	substrate	41	4	10	0	0	0	0
	96.8	17.5	10	9.5	37	—	channel	72.5	2	6	1	0	0	1
Hocking River (MWH)	91.9	15.5	7	5	27.5	n/a	n/a	52	2	7	n/a	n/a	n/a	n/a
Claypool Run (WWH)	0.4	9.5	5.5	4.5	19.5	39%	channel	38.5	3	8	0	0	0	0
05030204-010-020 - Hunters Run														
Hunters Run (WWH)	4.9	15.5	10	2.5	28	13%	riparian	53	3	7	0	0	0	0
	2.5	15	13	4.5	32.5	—	riparian	60.5	1	5	1	1	0	2
05030204-010-030 - Baldwin Run														
Baldwin Run (WWH)	2.7	7	15	4.5	26.5	17%	substrate	65.5	0	5	1	1	0	2
Fetters Run (WWH)	2.2	16	14.5	6.5	37	—	—	70	1	5	1	1	0	2
05030204-010-040 - Pleasant Run														
Pleasant Run (WWH)	8.4	14.5	9	4.5	28	13%	channel	60	1	6	1	1	0	2
	5.6	11	16	7	34	—	substrate	67.5	0	3	1	1	1	3
	0.6	15.5	10.5	5	31	3%	channel	65	1	4	1	1	1	3
05030204-010-050 - Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]														
Hocking River (MWH)	89.4	15.5	9.5	6	31	n/a	n/a	69	1	5	n/a	n/a	n/a	n/a
Hocking River (WWH)	88.9	13.5	7	5	25.5	20%	channel	55.5	2	9	0	0	0	0
	87.3	14.5	10.5	4	29	9%	channel	65	1	7	1	1	0	2
	81.9	15.5	14.5	6	36	—	—	77	0	1	1	1	1	3
Trib. to Hocking R. (RM 84.38) (WWH)	0.2	9.5	9.5	3	22	31%	riparian	47	3	8	0	0	0	0
Trib. to Hocking R. (RM 82.57) (WWH)	1.1	12	11	6	29	9%	channel	54	2	4	0	0	1	1
05030204-010-060 - Buck Run														
Buck Run (WWH)	2.8	11.5	9	7	27.5	14%	channel	57.5	2	7	0	0	0	0
	0.9	10.5	11.5	4	26	19%	riparian	61.5	0	5	1	1	0	2
East Branch Buck Run (WWH)	0.1	11	16	6	33	—	substrate	56	1	6	0	1	0	1

Stream name (aquatic life use)	River mile	BEDLOAD TMDL						HABITAT TMDL						
		QHEI Categories			Total Bedload Score	% Deviation from Target	Main Impaired Category	QHEI Score	# High influence Attributes	Total # Modified Attributes	Subscore			Total Habitat Score
		Substrate	Channel	Riparian							QHEI	High Influence	# Modified Attributes	
05030204-010-070 - Hocking River below Rush Cr. to Enterprise [except Clear Cr. and Buck Run]														
Hocking River (WWH)	81.3	14.5	15	6.5	36	—	—	78.5	0	4	1	1	1	3
	77.2	15.5	15	5.5	36	—	—	81.5	0	3	1	1	1	3
	73.6	14.5	10.5	5.5	30.5	5%	channel	73	0	7	1	1	0	2
Brushy Fork (WWH)	0.9	13.5	6	4.5	24	25%	channel	44	4	9	0	0	0	0
Trib. to Hocking R. (RM 74.82) (WWH)	0.4	12	15	6	33	—	substrate	66	1	6	1	1	0	2
05030204-020-010 - Rush Creek headwaters to above Center Branch														
Rush Creek (LRW)	29.7	16.5	11	8	35.5	n/a	n/a	74.5	1	3	n/a	n/a	n/a	n/a
	27.1	16	13	5.5	34.5	n/a	n/a	67.5	0	4	n/a	n/a	n/a	n/a
	21.1	9	13.5	7	29.5	n/a	n/a	52	1	7	n/a	n/a	n/a	n/a
Dry Run (WWH)	0.4	5	14.5	9	28.5	11%	substrate	57.5	2	7	0	0	0	0
Trib. to Rush Creek (RM 28.46) (WWH)	0.2	13.5	8	3.5	25	22%	channel	65	2	7	1	0	0	1
Trib. to Rush Creek (RM 27.40) (WWH)	0.2	11.5	14	7	32.5	—	substrate	60	1	6	1	1	0	2
Turkey Run (LRW)	0.9	13.5	10	5.5	29	n/a	n/a	58	2	7	n/a	n/a	n/a	n/a
05030204-020-020 - Center Branch														
Center Branch (WWH)	6.4	14	15	5	34	—	—	74	0	2	1	1	1	3
	3	11	5	8.5	24.5	23%	channel	46.5	3	8	0	0	0	0
	0.1	7.5	16	6	29.5	8%	substrate	60	0	4	1	1	1	3
Somerset Creek (WWH)	0.6	14.5	11	5.5	31	3%	channel	63	0	6	1	1	0	2
05030204-020-030 - Rush Creek below Center Branch to above L. Rush Cr.														
Rush Creek (LRW)	17.4	11	12.5	5.5	29	n/a	n/a	59.5	1	7	n/a	n/a	n/a	n/a
Trib. to Rush Creek (RM 19.40) (WWH)	1.8	13	14.5	5	32.5	—	—	60.5	1	6	1	1	0	2
Trib. to Rush Creek (RM 17.89) (WWH)	0.1	13.5	14	6.5	34	—	—	61	3	9	1	0	0	1
05030204-030-010 - Little Rush Cr. headwaters to near Rushville														
Little Rush Creek (WWH)	18.7	14	8	5	27	16%	channel	53	2	7	0	0	0	0
	7.2	13	16	5	34	—	—	64.5	0	4	1	1	1	3
Trib. to L. Rush Creek (RM 17.51) (WWH)	0.7	3	11	5	19	41%	substrate	46.5	2	8	0	0	0	0

Stream name (aquatic life use)	River mile	BEDLOAD TMDL						HABITAT TMDL						
		QHEI Categories			Total Bedload Score	% Deviation from Target	Main Impaired Category	QHEI Score	# High influence Attributes	Total # Modified Attributes	Subscore			Total Habitat Score
		Substrate	Channel	Riparian							QHEI	High Influence	# Modified Attributes	
05030204-030-020 - Little Rush Cr. near Rushville to Rush Cr.														
Little Rush Creek (WWH)	1.7	16.5	12	5	33.5	—	channel	70	1	6	1	1	0	2
Indian Creek (WWH)	2.5	8.5	9	5	22.5	30%	channel	52.5	2	8	0	0	0	0
	0.6	13.5	14	8	35.5	—	—	71	0	5	1	1	0	2
05030204-030-030 - Raccoon Run														
Raccoon Run (WWH)	4.8	13	14.5	5.5	33	—	—	68.5	0	3	1	1	1	3
	3.3	9.5	10	3	22.5	30%	riparian	54.5	1	7	0	1	0	1
	0.4	11.5	8.5	4.5	24.5	23%	channel	56	2	8	0	0	0	0
Trib. to Raccoon Run (RM 3.62) (WWH)	2.5	7	15	5	27	16%	substrate	56	0	6	0	1	0	1
	0.1	3	8	8	19	41%	substrate	41	3	10	0	0	0	0
05030204-030-040 - Rush Creek below L. Rush Cr. to Hocking R. [except Raccoon Run]														
Rush Creek (MWH)	15.4	9	7.5	5	21.5	n/a	n/a	46.5	2	8	n/a	n/a	n/a	n/a
	14.4	12	6	5.5	23.5	n/a	n/a	46.5	3	8	n/a	n/a	n/a	n/a
Rush Creek (WWH)	12.7	4.5	6	4.5	15	53%	substrate	44	2	9	0	0	0	0
	9.1	14	14.5	7	35.5	—	—	74	0	4	1	1	1	3
	2.1	9	9.5	6	24.5	23%	channel	51.5	1	8	0	1	0	1
Durbin Run (WWH)	0.4	0	4	4	8	75%	substrate	23	5	11	0	0	0	0
Trib. to Rush Creek (RM 2.06) (WWH)	0.1	10	13	9	32	—	substrate	53	2	6	0	0	0	0
Turkey Run (WWH)	1.4	8.5	15	4.5	28	13%	substrate	54.5	2	7	0	0	0	0
05030204-040-010 - Clear Creek headwaters to above Muddy Prairie Run														
Clear Creek (WWH)	21.5	15	10.5	4	29.5	8%	channel	67.5	2	7	1	0	0	1
	19.6	9.5	7	2	18.5	42%	riparian	50	3	9	0	0	0	0
	14.1	14.5	7	3	24.5	23%	channel	58	2	8	0	0	0	0
	9.5	15.5	12	3	30.5	5%	riparian	74	0	3	1	1	1	3
Cattail Creek, Trib. To Clear Creek (RM 9.52) (WWH)	0.1	12.5	10	3	25.5	20%	riparian	58.5	2	7	0	0	0	0
05030204-040-020 - Muddy Prairie Run														
Muddy Prairie Run (WWH)	3.8	14.5	12	3	29.5	8%	riparian	58.5	2	5	0	0	0	0

Stream name (aquatic life use)	River mile	BEDLOAD TMDL						HABITAT TMDL						
		QHEI Categories			Total Bedload Score	% Deviation from Target	Main Impaired Category	QHEI Score	# High influence Attributes	Total # Modified Attributes	Subscore			Total Habitat Score
		Substrate	Channel	Riparian							QHEI	High Influence	# Modified Attributes	
	0.5	15	15.5	4	34.5	—	riparian	75.5	0	1	1	1	1	3
05030204-040-030 - Arney Run														
Arney Run (WWH)	4.3	12.5	10	4	26.5	17%	channel	52	2	6	0	0	0	0
	0.1	16.5	18	5	39.5	—	—	82.5	0	0	1	1	1	3
05030204-040-040 - Clear Creek below Muddy Prairie Run to Hocking R. [except Arney Run]														
Clear Creek (WWH)	2	12	15	8.5	35.5	—	substrate	77.5	0	3	1	1	1	3
Trib. to Clear Creek (RM 6.80) (CWH)	0.6	15.5	14.5	6.5	36.5	n/a	n/a	69.5	1	3	1	1	1	3
Trib. to Clear Creek (RM 4.93) (CWH)	0.1	13.5	14.5	8	36	n/a	n/a	66	1	4	1	1	1	3
05030204-050-010 - Hocking River at Enterprise to above Fivemile Cr. [except Scott Cr. and Oldtown Cr.]														
Hocking River (WWH)	69.6	15	13.5	6	34.5	—	channel	79	0	4	1	1	1	3
	67.6	12	9.5	6.5	28	13%	channel	66.5	1	9	1	1	0	2
	67.4	14.5	16.5	7.5	38.5	—	—	84	0	3	1	1	1	3
05030204-050-020 - Scott Creek [except Clear Fk.]														
Scott Creek (WWH)	8.9	17	17	10	44	—	—	66.5	1	2	1	1	1	3
	5.6	10	10	5.7	25.7	20%	channel	54.7	2	8	0	0	0	0
	2.1	13	15	4.5	32.5	—	riparian	74	0	1	1	1	1	3
	0.1	14.5	17	6	37.5	—	—	74.5	1	4	1	1	1	3
	0.1	13.5	11.5	6	31	3%	channel	63.5	1	7	1	1	0	2
Dry Run (WWH)	0.2	6	16.5	8.5	31	3%	substrate	63	0	5	1	1	0	2
Trib. to Dry Run (RM 1.48) (WWH)	0.4	10.5	14	5	29.5	8%	substrate	57.5	0	6	0	1	0	1
05030204-050-030 - Clear Fork														
Clear Fork, Scott Cr. Trib. (WWH)	4.8	6.5	6	4	16.5	48%	channel	45.5	3	7	0	0	0	0
	0.1	19	11	7	37	—	channel	66	1	7	1	1	0	2
Duck Creek (WWH)	2	10.5	11	7	28.5	11%	channel	52.5	1	7	0	1	0	1
05030204-050-040 - Oldtown Creek														
Oldtown Creek (WWH)	4.1	10	14	4	28	13%	substrate	62	0	5	1	1	0	2
	0.6	9	13.5	6	28.5	11%	substrate	58.5	1	7	0	1	0	1
Trib. to Oldtown Creek (RM 4.25)	0.1	10.5	10	4	24.5	23%	channel	59	1	7	0	1	0	1

Stream name (aquatic life use)	River mile	BEDLOAD TMDL						HABITAT TMDL						
		QHEI Categories			Total Bedload Score	% Deviation from Target	Main Impaired Category	QHEI Score	# High influence Attributes	Total # Modified Attributes	Subscore			Total Habitat Score
		Substrate	Channel	Riparian							QHEI	High Influence	# Modified Attributes	
(WWH)														
05030204-050-050 - Fivemile Creek														
Fivemile Creek (WWH)	3.5	4	12	1.5	17.5	45%	riparian	46.5	2	8	0	0	0	0
	1	10	14	6.5	30.5	5%	substrate	62.5	0	3	1	1	1	3
Trib. to Fivemile Creek (RM 3.44) (WWH)	0.1	6	14	2	22	31%	riparian	52	0	6	0	1	0	1
05030204-050-060 - Hocking River below Fivemile Cr. to above Monday Cr.														
Hocking River (WWH)	60.8	15	16	7.5	38.5	—	—	84	0	2	1	1	1	3
	51.4	15.5	15.5	6	37	—	—	81.5	0	3	1	1	1	3
Threemile Creek (WWH)	3.9	9	15	4.5	28.5	11%	substrate	54.5	0	5	0	1	0	1
	1.9	7	12.5	5.5	25	22%	substrate	46	2	8	0	0	0	0
Trib. to Hocking R. (RM 62.18) (WWH)	1.1	13	12	5.5	30.5	5%	channel	60	1	6	1	1	0	2
Minkers Run (WWH)	0.8	11	12.5	5	28.5	11%	substrate	58.5	1	5	0	1	0	1
05030204-080-010 - Hocking River below Monday Cr. to above Sunday Cr.														
Hocking River (WWH)	48	15	10.5	7	32.5	—	channel	64.5	1	8	1	1	0	2
Trib. to Hocking R. (RM 48.70) (LRW)	0.1	0.5	10	9	19.5	n/a	n/a	46.5	3	7	n/a	n/a	n/a	n/a
Hamley Run (WWH)	2.1	15	16	6	37	—	—	66	1	3	1	1	1	3
	0.4	12	13	7	32	—	substrate	63	0	6	1	1	0	2
05030204-080-020 - Hocking River below Sunday Cr. to Athens [except Margaret Cr.]														
Hocking River (WWH)	36.3	8	10	3.5	21.5	33%	substrate	57.5	1	9	0	1	0	1
Sugar Creek (WWH)	2.2	12	13	5	30	6%	substrate	63	2	4	1	0	1	2
05030204-080-030 - Margaret Creek headwaters to above W. Branch														
Margaret Creek (WWH)	11.3	12.5	13	5	30.5	5%	channel	53.5	1	7	0	1	0	1
	8.5	6	12.5	3.5	22	31%	substrate	48	3	8	0	0	0	0
	6.1	0.5	11.5	4	16	50%	substrate	40.5	2	8	0	0	0	0
Biddle Creek (WWH)	2	11	12.5	6	29.5	8%	substrate	53.5	2	7	0	0	0	0
05030204-080-040 - Margaret Creek above W. Branch to above Factory Cr.														
Margaret Creek (WWH)	3.3	7.5	13	6.5	27	16%	substrate	58	2	8	0	0	0	0

Stream name (aquatic life use)	River mile	BEDLOAD TMDL						HABITAT TMDL						
		QHEI Categories			Total Bedload Score	% Deviation from Target	Main Impaired Category	QHEI Score	# High influence Attributes	Total # Modified Attributes	Subscore			Total Habitat Score
		Substrate	Channel	Riparian							QHEI	High Influence	# Modified Attributes	
	1.4	13	16	6.3	35.3	—	—	64.3	0	3	1	1	1	3
West Branch Margaret Creek (WWH)	2.3	1	11.5	6.5	19	41%	substrate	35	3	9	0	0	0	0
	1.2	1	10	2.5	13.5	58%	substrate	29.5	3	9	0	0	0	0
05030204-080-050 - Margaret Creek above Factory Cr. to Hocking R.														
Factory Creek (WWH)	3.8	15	14.5	9.5	39	—	—	70.5	0	3	1	1	1	3
	0.7	13	13	6	32	—	channel	59.5	1	3	0	1	1	2
05030204-090-010 - Federal Creek headwaters to below Hyde Fk. and Miners Fk. confluence														
Hyde Fork (WWH)	1.8	16	16	5	37	—	—	67	0	3	1	1	1	3
Miners Fork (WWH)	2.3	13	14	5.5	32.5	—	—	55.5	1	3	0	1	1	2
	0.1	13	15	5.5	33.5	—	—	63	2	3	1	0	1	2
05030204-090-020 - Federal Creek below Miners Fk. to above McDougall Branch														
Federal Creek (EWH)	16.2	14.5	12.5	5.5	32.5	7%	channel	62.5	2	7	0	0	0	0
	11.7	11.5	12.5	4	28	20%	substrate	51.5	1	7	0	0	0	0
	11.3	12	12.5	5.5	30	14%	substrate	59	1	4	0	0	0	0
Kasler Creek (WWH)	1.8	17	17	9.5	43.5	—	—	78	0	1	1	1	1	3
Linscott Run (WWH)	3.8	14	16.5	4	34.5	—	riparian	66	1	1	1	1	1	3
	0.8	17.5	17	5	39.5	—	—	71.5	1	2	1	1	1	3
05030204-090-030 - McDougall Branch above Mush Run														
McDougall Branch (WWH)	5	14	13.5	5	32.5	—	channel	55.5	1	5	0	1	0	1
	4.5	14	12	5	31	3%	channel	61.5	2	4	1	0	1	2
Bryson Branch (WWH)	1.2	13	15.5	6.5	35	—	—	67	0	1	1	1	1	3
05030204-090-040 - Mush Run														
Mush Run (WWH)	1.8	13	14	5.5	32.5	—	—	58.5	0	4	0	1	1	2
	1	13.5	13	7	33.5	—	channel	64.5	0	5	1	1	0	2
Dutch Creek (WWH)	1.7	16	16.5	7.5	40	—	—	75.5	0	1	1	1	1	3
05030204-090-050 - McDougall Branch below Mush Run to Federal Cr.														
McDougall Branch (WWH)	2.9	13	15	6	34	—	—	70	0	0	1	1	1	3
	0.5	6	16	4	26	19%	substrate	62	0	4	1	1	1	3

Stream name (aquatic life use)	River mile	BEDLOAD TMDL						HABITAT TMDL						
		QHEI Categories			Total Bedload Score	% Deviation from Target	Main Impaired Category	QHEI Score	# High influence Attributes	Total # Modified Attributes	Subscore			Total Habitat Score
		Substrate	Channel	Riparian							QHEI	High Influence	# Modified Attributes	
Wyatt Run (WWH)	0.4	14	12.5	7.5	34	—	channel	61.5	2	6	1	0	0	1
05030204-090-060 - Sharps Fork														
Opossum Run (WWH)	4.1	20	16.5	9.5	46	—	—	66	3	5	1	0	0	1
	2.6	12	12.5	5.5	30	6%	channel	67.5	1	4	1	1	1	3
	0.8	11	11	5	27	16%	channel	54	1	7	0	1	0	1
	0.2	11.5	15.5	5	32	—	substrate	61	1	5	1	1	0	2
05030204-090-060 - Sharps Fork (con't)														
Sharps Fork (WWH)	10.7	16	16	8.5	40.5	—	—	79	0	1	1	1	1	3
	9.1	14	13	7.5	34.5	—	channel	66.5	2	6	1	0	0	1
	8.1	15	15	6	36	—	—	65	0	6	1	1	0	2
	5.3	13	16	7.5	36.5	—	—	66.5	1	2	1	1	1	3
	1.7	11.5	12.5	5.5	29.5	8%	substrate	65.5	1	6	1	1	0	2
	1.6	8	10	5.5	23.5	27%	substrate	53.5	1	8	0	1	0	1
Sulphur Run (WWH)	0.8	9	14.5	6	29.5	8%	substrate	53	1	5	0	1	0	1
	0	5	14.5	5	24.5	23%	substrate	43.5	3	7	0	0	0	0
05030204-090-070 - Marietta Run														
Marietta Run (WWH)	3.2	14.5	19.5	9.5	43.5	—	—	81	0	0	1	1	1	3
	1.6	13.5	17	9	39.5	—	—	74.5	0	4	1	1	1	3
	0.1	10	14	9	33	—	substrate	60.5	0	5	1	1	0	2
05030204-090-080 - Big Run														
Big Run (WWH)	3.9	14	16	8	38	—	—	71.5	1	2	1	1	1	3
	1.7	12	11.5	5	28.5	11%	channel	58	2	6	0	0	0	0
05030204-090-090 - Federal Creek below McDougall Branch to Hocking R. [except Sharps Fk., Marietta Run, and Big Run]														
Federal Creek (EWH)	9.3	13	16	6.5	35.5	—	substrate	66	1	1	0	0	1	1
	9.1	10.5	10.5	7	28	20%	channel	58	1	5	0	0	0	0
	4.9	13	12	8	33	6%	channel	64	0	4	0	1	0	1
	0.9	9	11	7.5	27.5	21%	substrate	53.5	1	7	0	0	0	0
Sharps Run (WWH)	0	10	13	5.5	28.5	11%	substrate	56	1	5	0	1	0	1

Stream name (aquatic life use)	River mile	BEDLOAD TMDL						HABITAT TMDL						
		QHEI Categories			Total Bedload Score	% Deviation from Target	Main Impaired Category	QHEI Score	# High influence Attributes	Total # Modified Attributes	Subscore			Total Habitat Score
		Substrate	Channel	Riparian							QHEI	High Influence	# Modified Attributes	
05030204-100-010 - Hocking River from Athens to above Willow Cr.														
Hocking River (WWH)	33.1	10.5	6.5	3.5	20.5	36%	channel	47.5	2	10	0	0	0	0
	32	9	5.5	3.5	18	44%	channel	44	2	9	0	0	0	0
	27.8	13.5	12.5	3	29	9%	riparian	78.5	0	5	1	1	0	2
Strouds Run (WWH)	0.3	13.5	12.5	8	34	—	channel	67.5	1	6	1	1	0	2
05030204-100-020 - Willow Creek														
Willow Creek (WWH)	2.2	15.5	15	7	37.5	—	—	71.5	0	2	1	1	1	3
	1.4	13	15	6.5	34.5	—	—	66.5	0	4	1	1	1	3
	0.2	11.5	14.5	4.5	30.5	5%	substrate	64.5	2	5	1	0	0	1
Scott Creek (WWH)	0.1	16	15.5	7	38.5	—	—	73	0	1	1	1	1	3
05030204-100-030 - Hocking River below Willow Cr. to above Federal Cr.														
Hocking River (WWH)	19.7	14.5	14	4.5	33	—	riparian	82	0	4	1	1	1	3
05030204-100-040 - Hocking River below Federal Cr. to Ohio R. [except Fourmile Cr.]														
Hocking River (WWH)	13.6	14	13.5	4.5	32	—	riparian	72	0	7	1	1	0	2
	5.4	0	13	7	20	38%	substrate	47	2	8	0	0	0	0
Jordan Run (WWH)	2.8	16	16	7.2	39.2	—	—	65.2	1	3	1	1	1	3
	0.1	10	10.5	6.2	26.7	17%	channel	52.7	2	8	0	0	0	0
Frost Run (WWH)	0.4	9	13	8.5	30.5	5%	substrate	57.5	1	6	0	1	0	1
Skunk Run (WWH)	1.3	14	13.5	6.5	34	—	channel	64	1	6	1	1	0	2
05030204-100-050 - Fourmile Creek														
Fourmile Creek (WWH)	2.5	13	14	7	34	—	—	64.5	2	7	1	0	0	1
	1.8	15	14	8	37	—	—	67	1	3	1	1	1	3
East Fourmile Creek (WWH)	1.8	12	12	3.5	27.5	14%	riparian	50.5	2	7	0	0	0	0

7.2.3 Critical Condition

The critical condition for the habitat and bedload TMDLs is the summer when environmental stress upon aquatic organisms is greatest. It is during this period that the presence of high-quality habitat features, such as deep pools and un-embedded substrate, is essential to provide refuge for aquatic life. QHEI scores, the basis of the habitat TMDLs, are assessed during the summer field season. The habitat and bedload TMDLs are therefore reflective of the critical condition.

7.2.4 Margin of Safety

A MOS was implicitly incorporated into the habitat and bedload TMDLs through the use of conservative target values. The target values were developed though comparison of paired IBI and QHEI evaluations. Using an IBI score of 40 as representative of the attainment of WWH, individual components of the QHEI were analyzed to determine their magnitude at which WWH attainment is probable (OEPA, 1999). Attainment does, however, occur at levels lower than the established targets. The difference between the habitat and bedload targets and the levels at which attainment actually occurs is an implicit margin of safety.

8.0 WATER QUALITY IMPROVEMENT STRATEGY

This section of the report discusses options for abating the water quality problems in the Hocking River watershed and achieving the goals established earlier in this report. Namely, what will be discussed are options for meeting the pollutant reductions as well as making improvements to the stream system such as habitat improvements and increasing capacity to assimilate pollutant loads.

A series of tables list actions appropriate for abating the water quality stressors at specific locations in the basin. The recommended actions are well established practices with proven effectiveness. Details regarding these practices are included in Appendix E of this report. Additionally, Appendix E compiles various programs and organizations that can be sources for assistance in carrying out the recommended actions.

The actions recommended herein; however, are not the only means for making the needed water quality improvements but instead highlight the more common approaches. Additionally, there is some level of redundancy in these recommendations because certain stressors can be abated through a variety of approaches (e.g., both naturalizing watershed hydrology and stream restoration improve habitat quality). The abatement options that are selected have been done so with both the effectiveness of the action coupled with efficiency. This is to say that other actions that are more complex and costly may produce a similar or greater level of improvement; however, this may go beyond the minimum necessary improvements for addressing the stressors causing impairments.

Table 8.1 lists the actions that are to be taken through regulatory controls and authority. These are relegated to the Ohio EPA, and deal with NPDES permitting and compliance. This table is used separately and placed first in this section because these actions have the highest assurances of being implemented. Table 8.2 provides a basin-wide perspective on the general types of practices needed for each of the assessments areas (including the regulatory actions discussed in the first table). The subsequent tables provide more detail of the recommendations for each assessment area. A map of the assessment area with the subwatersheds delineated and a table of the names of the subwatersheds comes before the table of recommendations.

8.1 Regulatory Measures for Abatement

This section summarizes recommendations from this TMDL that can be implemented using regulatory authority. This differs from other recommendations found in this plan regarding land management or other measures that currently have no associated regulations. The National Pollution Discharge Elimination System (NPDES) is the primary regulatory means for making improvements to restore water quality. Table 8.1 shows the recommendations for NPDES permit holders.

Table 8.1. NPDES permit limits for facilities in the Hocking River watershed.

Area of Assessment (last six HUC 14 digits)	**Facility name / *Ohio EPA permit number***	**Permit expiration date**	**Recommendation**
010 -040	Colony Village MHP / ***4PY00004***	6/30/2012	Fecal coliform limit of 1000 counts/ 100ml
020 - 010	BP Amoco Oil Corp bulk Plant / ***0IN00228***	6/30/2007	Total phosphorus limit of 1.4 mg/l and monitoring required
020 - 010	New Lexington STP / ***0PC00008***	7/31/2007	Total phosphorus limit of 1.4 mg/l and monitoring required
020 - 010	Roof Tile Acquisition Corp / ***0IN00055***	10/31/2011	Total phosphorus limit of 1.4 mg/l and monitoring required
020 - 010	Junction City STP / ***0PA00074***	7/31/2013	Total phosphorus limit of 1.4 mg/l and monitoring required
030 - 030	Cyril-Scott /		Total phosphorus limit of 1.6 mg/l and monitoring required
030 - 030	Fairfield-Union High School / ***4PT00003***	7/31/2011	Total phosphorus limit of 1.6 mg/l and monitoring required

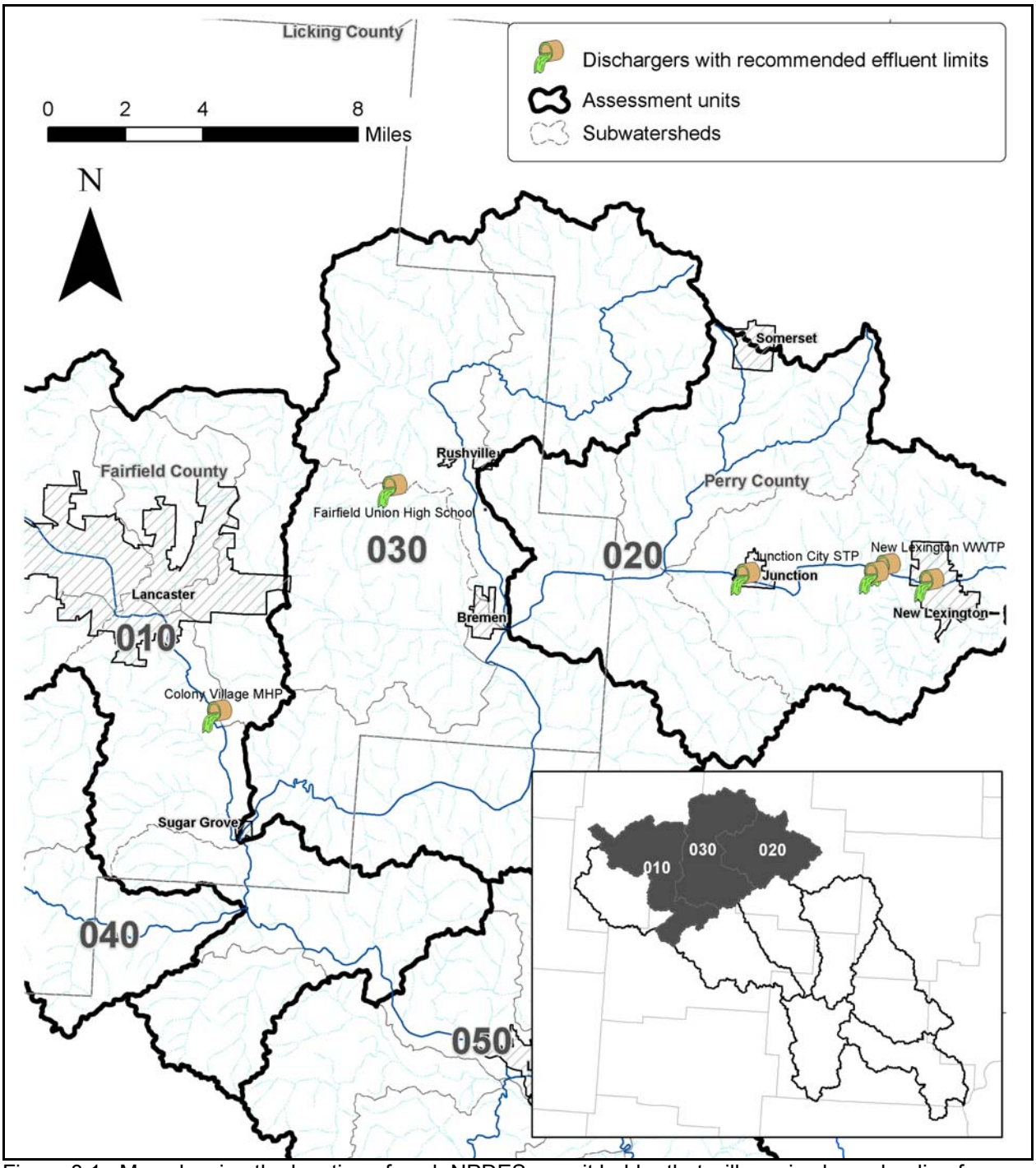

Figure 8.1. Map showing the location of each NPDES permit holder that will receive lower loading for one of more discharge parameters.

8.2 Recommended Abatement Actions

Table 8.2 in this section lists each impaired assessment unit and its constituent subwatersheds. The major cause/sources associations are listed (sources are listed with causes in parentheses) and an associated suite of potential abatement actions are marked. These abatement actions

are grouped in general categories which are later described in more detail in the later subsections that deal with each of the assessment units. It should also be noted that although there is aquatic life use impairments in the 100 assessment unit, the sources of impairments are believed to be exclusively natural limitations and an impoundment and therefore abatement recommendations are not provided.

Table 8.2. Overview of the types of restoration actions that are recommended throughout the entire TMDL project area.

Watershed	Sources of impairment (causes of impairment associated with the source)	Bank & riparian restoration	Stream restoration	Wetland restoration	Conservation easements	Home sewage planning & improvement	Education & outreach	Point source controls (regulatory programs)	Agricultural best management practices	Mine drainage abatement
05030204 010 - Hocking River (headwaters to Enterprise [except Rush and Clear Creeks)										
010 - Hocking River headwaters to above Hunter's Run										
	row crop (sediment, nutrients)				x				x	
	channelization (poor habitat)		x							
	riparian disturbance (sediment, DO)	x								
	HSTS (bacteria)					x				
	natural conditions (sediment)									
020 - Hunters Run										
	failed HSTS (bacteria)					x				
030 - Baldwin Run										
	failed HSTS (bacteria)					x				
040 - Pleasant Run										
	failed HSTS (bacteria)					x				
050 - Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]										
	channelization (poor habitat, sediment, DO)		x							
	row crop production (nutrients, organic enrichment)								x	
	riparian disturbance (sediment, DO)	x								
	failed HSTS (bacteria, nutrients)					x				
	natural conditions (poor habitat)									
060 - Buck Run										
	channelization (poor habitat)		x							
	failed HSTS (bacteria)					x				
	natural conditions (sedimentation)									
070 - Hocking River below Rush Cr. to Enterprise [except Clear Cr. and Buck Run]										
	channelization (poor habitat)		x							
	natural conditions (sedimentation)									

Watershed	Sources of impairment (causes of impairment associated with the source)	Bank & riparian restoration	Stream restoration	Wetland restoration	Conservation easements	Home sewage planning & improvement	Education & outreach	Point source controls (regulatory programs)	Agricultural best management practices	Mine drainage abatement
05030204 020 - Rush Creek (headwaters to above Little Rush Creek)										
010 - Rush Creek headwaters to above Center Branch										
	AMD (low pH, TDS and Al, sedimentation)									x
	urban runoff (nutrients)							x		
	impoundments (nutrients)									
	minor WWTP / New Lexington (nutrients)							x		
020 - Center Branch										
	row crop production (sedimentation, nutrients)								x	
	natural conditions (sedimentation)									
	riparian disturbance (sedimentation)	x								
	pastureland (bacteria)								x	
	failed HSTS (bacteria)					x				
030 - Rush Creek below Center Branch to above L. Rush Cr.										
	pastureland (sedimentation)								x	
	impoundment (nutrients)									
05030204 030 - Rush Creek (above Little Rush Creek to Hocking River)										
020 - Little Rush Cr. near Rushville to Rush Cr.										
	upstream impoundment / OakThorpe Lake (DO, nutrients)									
030 - Raccoon Run										
	channelization (poor habitat, sedimentation)		x							
	row crop production (nutrients, sedimentation)								x	
	riparian disturbance (poor habitat)	x								
	point source / Cyril-Scot (nutrients)							x		
	industrial storm water / Ralston							x		

Watershed	Sources of impairment (causes of impairment associated with the source)	Bank & riparian restoration	Stream restoration	Wetland restoration	Conservation easements	Home sewage planning & improvement	Education & outreach	Point source controls (regulatory programs)	Agricultural best management practices	Mine drainage abatement
	(organic enrichment)									
	upstream impoundment (nutrients)									
040 - Rush Creek below L. Rush Cr. to Hocking R. [except Raccoon Run]										
	row crop production (nutrients, sedimentation)								x	
	failed HSTS (bacteria)					x				
	upstream impoundment (nutrients)									
	natural conditions (sedimentation)									
05030204 050 - Hocking River (below Enterprise to above Monday Creek)										
020 - Scott Creek [except Clear Fk.]										
	riparian disturbance (sedimentation)	x								
	naturalconditions / isolation (impeded colonization)									
	AMD (low pH)									
030 - Clear Fork										
	row crop production (nutrients)								x	
	channelization (poor habitat)		x							
	riparian disturbance (poor habitat)	x								
	upstream impoundment / Lake Logan (nutrients)									
050 - Fivemile Creek										
	failed HSTS (bacteria)					x				
	livestock (siltation, organic enrichmement)								x	
	riparian disturbance (sedimentation, poor habitat)	x								
060 - Hocking River below Fivemile Cr. to above Monday Cr.										
	channelization (poor habitat)		x							
	riparian disturbance (poor habitat, sedimentation)	x								
	unstable stream banks	x								

Watershed	Sources of impairment (causes of impairment associated with the source)	Bank & riparian restoration	Stream restoration	Wetland restoration	Conservation easements	Home sewage planning & improvement	Education & outreach	Point source controls (regulatory programs)	Agricultural best management practices	Mine drainage abatement
	(sedimentation)									
	failed HSTS (bacteria)					x				
	AMD									x
	pastureland								x	
	natural conditions (beaver dams)									
05030204 080 - Hocking River (below Monday Creek to Athens/RM33.1 (except Sunday Creek)										
010 - Hocking River below Monday Cr. to above Sunday Cr.										
	riparian disturbance (sedimentation)	x								
	unstable stream banks (sedimentation)	x								
	failed HSTS (nutrients)					x				
	pastureland (nutrients)								x	
	AMD (low pH)									x
030 - Margaret Creek headwaters to above W. Branch										
	pastureland (nutrients)								x	
	riparian disturbance (DO)	x								
	unstable stream banks (sedimentation)	x	x							
	failed HSTS (bacteria)					x				
	golf course (nutrients)								x	
	AMD (elevated Al and Mn)									
040 - Margaret Creek above W. Branch to above Factory Cr.										
	riparian disturbance (DO)	x								
	unstable stream banks (sedimentation)	x	x							
	upstream impoundment / Fox Lake (low flow)									
050 - Margaret Creek above Factory Cr. to Hocking R.										
	unstable stream banks (sedimentation)	x								

Watershed	Sources of impairment (causes of impairment associated with the source)	Bank & riparian restoration	Stream restoration	Wetland restoration	Conservation easements	Home sewage planning & improvement	Education & outreach	Point source controls (regulatory programs)	Agricultural best management practices	Mine drainage abatement
	natural conditions (sedimentation)									
	failed HSTS (bacteria)					x				
05030204 090 - Federal Creek										
010 - Federal Creek headwaters to below Hyde Fk. and Miners Fk. Confluence										
	natural conditions / losing stream (low flow, DO)									
020 - Federal Creek below Miners Fk. to above McDougall Branch										
	riparian disturbance (sedimentation)	x								
	unstable stream banks (sedimentation)	x								
	natural conditions (sedimentation)									
050 - McDougall Branch below Mush Run to Federal Cr.										
	failed HSTS (bacteria)					x				
060 - Sharps Fork										
	riparian disturbance (sedimentation)	x								
	AMD (TDS)									x
	natural conditions (sedimentation)									
080 - Big Run										
	riparian disturbance (DO, sedimentation)	x								
	failed HSTS (bacteria)					x				
	natural conditions (low flow)									
090 - Federal Creek below McDougall Branch to Hocking R. [except Sharps Fk., Marietta Run, and Big Run]										
	unstable stream banks	x								
	riparian disturbance	x								
	failed HSTS (bacteria, nutrients)					x				
	natural conditions (sedimentation)									

Watershed	Sources of impairment (causes of impairment associated with the source)	Bank & riparian restoration	Stream restoration	Wetland restoration	Conservation easements	Home sewage planning & improvement	Education & outreach	Point source controls (regulatory programs)	Agricultural best management practices	Mine drainage abatement
05030204 100 - Hocking River below Athens/RM33.1 to Ohio River [except Federal Creek]										
010 - Hocking River from Athens to above Willow Cr.										
	upstream impoundment / Dow Lake (flow, nutrients)									
020 - Hocking River below Willow Cr. to above Federal Cr.										
	natural / losing stream (low flow)									
040 - Hocking River below Federal Cr. to Ohio R. [except Fourmile Cr.]										
	natural / losing stream (low flow, DO, sedimentation)									

8.2.1. Hocking River (headwaters to Enterprise [except Rush and Clear Creeks]) - 010

The most widely recommended abatement actions for this assessment unit deal with controlling pollution and/or stressors from row crop production, drainage improvements, home sewage systems, and point sources (primarily combined sewer overflows). Nutrients derived from cropland runoff are causing problems in the 010 and 050 HUC -14 subwatersheds and cropping, tillage and nutrient application (including manure management) oriented conservation practices are recommended. Alternatives to typical channel maintenance for drainage are recommended to foster some level of floodplain function (two-stage channel shape or stream restoration) in HUCs 010, 060 and 070.

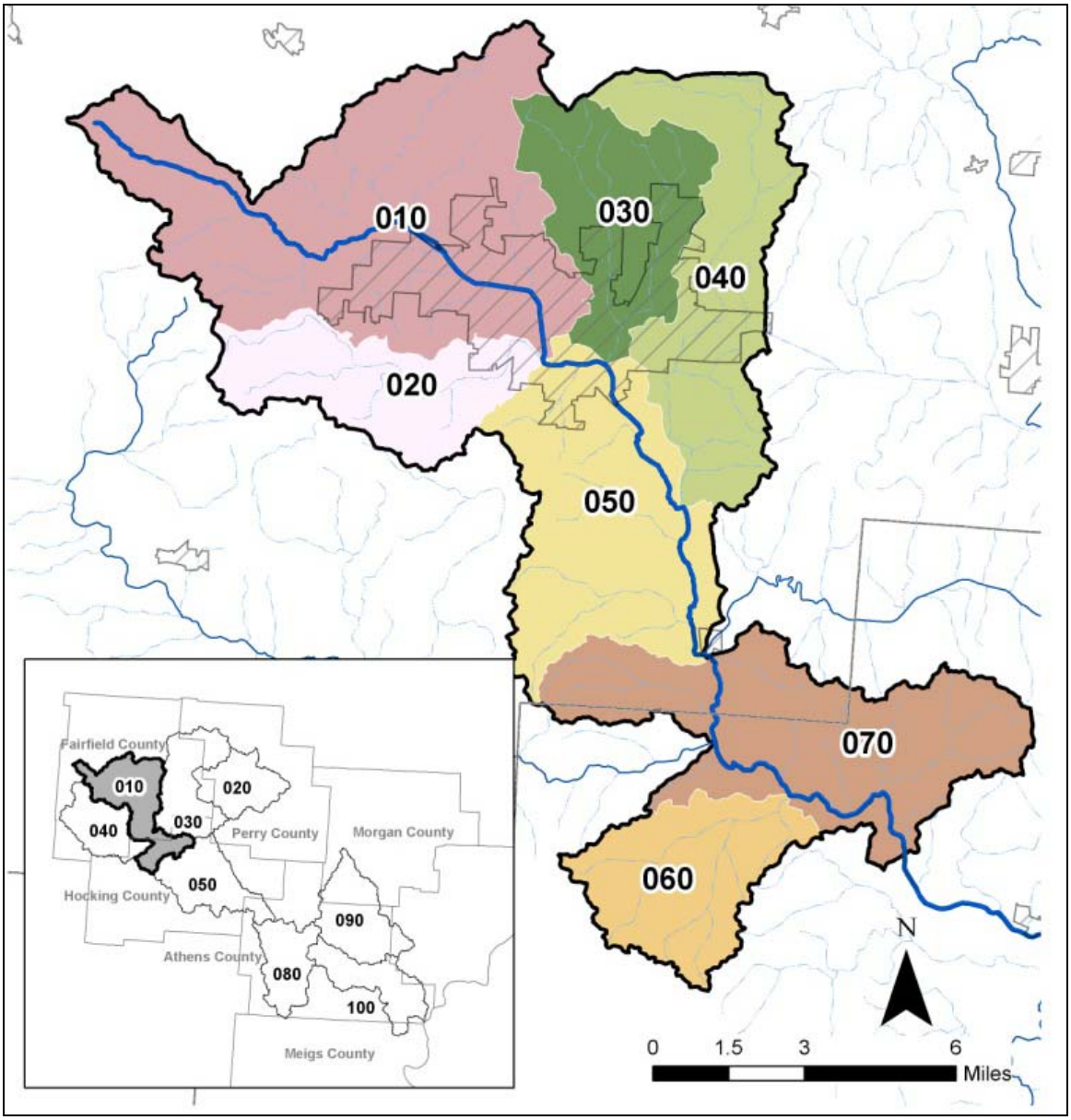

Figure 8.2. Map of the 010 assessment unit and its subwatersheds.

Table 8.3. Narrative descriptions of each of the subwatersheds in the 010 assessment unit.

14-digit HUC	Narrative Description
05030204-010- Hocking River (headwaters to Enterprise [except Rush and Clear Creeks])	
010	Hocking River headwaters to above Hunters Run
020	Hunters Run
030	Baldwin Run
040	Pleasant Run
050	Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]
060	Buck Run
070	Hocking River below Rush Cr. to Enterprise [except Clear Cr. and Buck Run]

Table 8.4. Restoration and abatement actions that are recommended for the 010 assessment unit.

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering							
		Restore streambank by recontouring or regrading							
	planted	Plant grasses in riparian areas							
		Plant prairie grasses in riparian areas	x					x	x
		Remove/treat invasive species							
		Plant trees or shrubs in riparian areas	x					x	x
Stream Restoration		Restore flood plain	x					x	x
		Restore stream channel	x					x	x
		Install in-stream habitat structures							
		Install grade structures							
		Construct 2-stage channel	x					x	x
		Restore natural flow	x					x	x
Wetland Restoration		Reconnect wetland to stream							
		Reconstruct & restore wetlands							
		Plant wetland species							
Conservation Easements		Acquire agriculture conservation easements	x						
		Acquire non-agriculture conservation easements							
Home Sewage Planning and Improvement		Develop HSTS plan	x	x	x	x	x	x	
		Inspect HSTS	x	x	x	x	x	x	
		Repair or replace traditional HSTS	x	x	x	x	x	x	
		Repair or replace alternative HSTS	x	x	x	x	x	x	
Education and Outreach		Distribute educational materials							
		Host meetings, workshops and/or other events							
Storm Water Best Mgt Practices	quantity controls	Post-construction BMPs: innovative BMPs							
		Post-construction BMPs: infiltration							
		Post-construction BMPs:							

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
		retention/detention							
	quality controls	Post-construction BMPs: filtration							
		Construction BMPs: erosion control							
		Construction BMPs: runoff control							
		Construction BMPs: sediment control							
Point Source Controls (Regulatory Programs)	collection and new treatment	Install sewer systems in communities							
		Develop and/or implement long term control plan (CSOs)	x	x	x	x	x		
		Eliminate SSOs/CSOs/by-passes	x	x	x		x		
	storm water	Implement an MS4 permit	x	x	x	x	x		
		Implement an industrial permit							
		Implement a construction permit	x	x	x	x	x		
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)							
		Improve quality of effluent							
	monitoring	Establish ambient monitoring program							
		Increase effluent monitoring							
	alternatives	Establish water quality trading							
Agricultural Best Mgt Practices	farmland	Plant cover/manure crops	x				x		
		Implement conservation tillage practices	x				x		
		Implement grass/legume rotations	x				x		
		Convert to permanent hayland							
		Install grassed waterways	x				x		
		Install vegetated buffer strips	x				x		
		Install / restore wetlands	x				x		
	nutrients / agro-chemicals	Conduct soil testing	x				x		
		Install nitrogen reduction practices	x				x		
		Develop nutrient management plans	x				x		
	drainage	Install sinkhole stabilization structures							
		Install controlled drainage system	x				x		
		Implement drainage water management	x				x		
		Construct overwide ditch	x				x		
		Construct 2-stage channel	x				x		
	livestock	Implement prescribed & conservation grazing practices							
		Install livestock exclusion fencing							
		Install livestock crossings							
		Install alternative water supplies							
		Install livestock access lanes							
	manure	Implement manure management practices	x				x		
		Construct animal waste storage structures							
		Implement manure transfer practices							
		Install grass manure spreading strips							

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
	misc. infra-structure and mgt	Install chemical mixing pads							
		Install heavy use feeding pads							
		Install erosion & sediment control structures							
		Install roof water management practices							
		Install milkhouse waste treatment practices							
		Develop whole farm management plans							

8.2.2 Rush Creek (headwaters to above Little Rush Creek) & Rush Creek (above Little Rush Creek to Hocking River) – 020 & 030

The most widely recommended abatement actions for these assessment units deal with controlling pollution and/or stressors from home sewage systems, row crop production, and acid mine drainage. Streamside protection is also widely recommended. Reestablishment of floodplain connection is also recommended in some areas to abate the disturbed hydrology due to upland drainage efficiencies. The need for continued vigilance regarding compliance with storm water permits is pointed out in the recommendations, which is in reference to industrial storm water that formerly had a high concentration of biological oxygen demand in its discharge. Additionally, Ohio EPA staff is aware of a discrete storm water issue within a separate storm sewer area in New Lexington. These issues are to be handled though inspection and compliance work on the part of Ohio EPA staff.

Acid mine drainage is particularly problematic in the upper portion of Rush Creek and a number of its small tributary streams. The U.S. Geological Survey has conducted a study to better understand the geographic scope and severity of the mine drainage problems. An acid mine drainage abatement and treatment plan (AMDAT) is in development. Once complete, this document will culminate the most recent water chemistry and other data and expert analyses of the problems and possible abatement strategies. Cost effectiveness and benefit-cost analysis is a large part of the abatement planning. Based on the expertise of the developers of the AMDAT and communications that Ohio EPA has had with them, it is likely that this document will be endorsed by Ohio EPA as the best plan for achieving water quality standards in this part of the Hocking River watershed.

To view the USGS report visit : http://pubs.er.usgs.gov/usgspubs/sir/sir20055196. For more information about the development of the AMDAT visit: http://www.dnr.state.oh.us/mineral/acid/tabid/10421/Default.aspx.

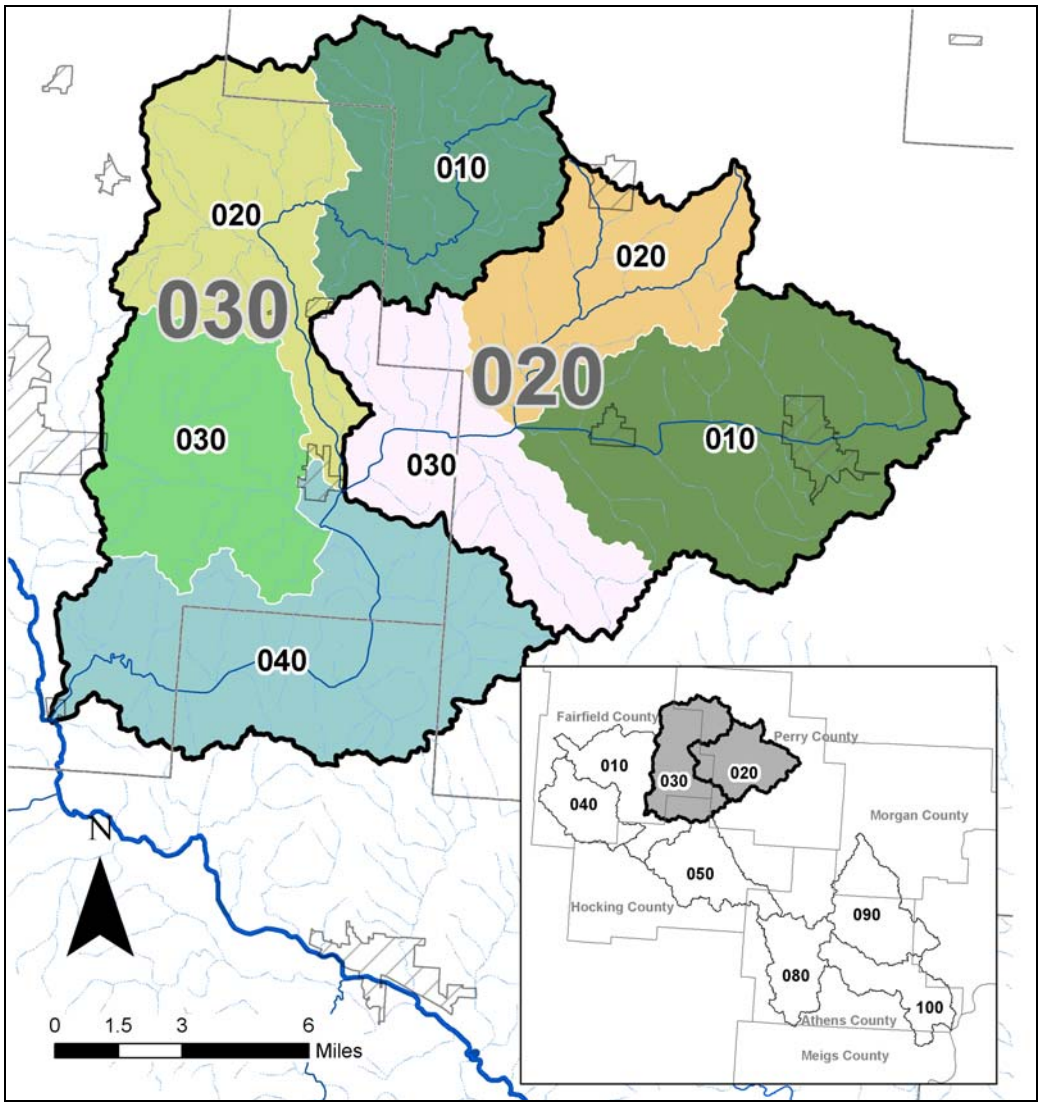

Figure 8.3. Map of the 020 and 030 assessment units and their subwatersheds.

Table 8.5. Narrative descriptions of each of the subwatersheds in the 020 and 030 assessment units.

14-digit HUC	Narrative Description
05030204-020- Rush Creek (headwaters to above Little Rush Creek)	
010	Rush Creek headwaters to above Center Branch
020	Center Branch
030	Rush Creek below Center Branch to above L. Rush Cr.
05030204-030- Rush Creek (above Little Rush Creek to Hocking River)	
010	Little Rush Cr. headwaters to near Rushville
020	Little Rush Cr. near Rushville to Rush Cr.
030	Raccoon Run
040	Rush Creek below L. Rush Cr. to Hocking R. [except Raccoon Run]

Table 8.6. Restoration and abatement actions that are recommended for the 020 and 030 assessment units.

Restoration Categories		Specific Restoration Actions	05030204 - 020			05030204 - 030		
			010	020	030	020	030	040
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering					x	
		Restore streambank by recontouring or regrading					x	
	planted	Plant grasses in riparian areas		x		x	x	
		Plant prairie grasses in riparian areas		x		x	x	
		Remove/treat invasive species						
		Plant trees or shrubs in riparian areas		x		x	x	
Stream Restoration		Restore flood plain		x			x	
		Restore stream channel						
		Install in-stream habitat structures						
		Install grade structures						
		Construct 2-stage channel					x	
		Restore natural flow					x	
Wetland Restoration		Reconnect wetland to stream						
		Reconstruct & restore wetlands						
		Plant wetland species						
Conservation Easements		Acquire agriculture conservation easements						
		Acquire non-agriculture conservation easements						
Home Sewage Planning and Improvement		Develop HSTS plan		x				x
		Inspect HSTS		x				x
		Repair or replace traditional HSTS		x				x
		Repair or replace alternative HSTS		x				x
Education and Outreach		Distribute educational materials						
		Host meetings, workshops and/or other events						
Storm Water Best Mgt Practices	quantity controls	Post-construction BMPs: innovative BMPs						
		Post-construction BMPs: infiltration						
		Post-construction BMPs: retention/detention						
	quality controls	Post-construction BMPs: filtration	x					
		Construction BMPs: erosion control						
		Construction BMPs: runoff control						
		Construction BMPs: sediment control						
Point Source Controls (Regulatory Programs)	collection and new treatment	Install sewer systems in communities						
		Develop and/or implement long term control plan (CSOs)						
		Eliminate SSOs/CSOs/by-passes						
	storm water	Implement an MS4 permit	x					
		Implement an industrial permit					x	
		Implement a construction permit						
	enhanced	Issue permit(s) and/or modify permit	x				x	

Restoration Categories		Specific Restoration Actions	05030204 - 020			05030204 - 030		
			010	020	030	020	030	040
	treatment	limit(s)						
		Improve quality of effluent	x				x	
	monitoring	Establish ambient monitoring program						
		Increase effluent monitoring						
	alternatives	Establish water quality trading						
Agricultural Best Mgt Practices	farmland	Plant cover/manure crops		x		X	x	x
		Implement conservation tillage practices		x		x	x	x
		Implement grass/legume rotations		x		X	x	x
		Convert to permanent hayland		x		X	x	x
		Install grassed waterways		x				
		Install vegetated buffer strips		x		X	x	x
		Install / restore wetlands		x		X	x	x
	nutrients / agro-chemicals	Conduct soil testing		x		X	x	x
		Install nitrogen reduction practices		x		X	x	x
		Develop nutrient management plans		x		X	x	x
	drainage	Install sinkhole stabilization structures						
		Install controlled drainage system		x			x	x
		Implement drainage water management		x			x	x
		Construct overwide ditch						
		Construct 2-stage channel						
	livestock	Implement prescribed & conservation grazing practices		x	x			
		Install livestock exclusion fencing		x				
		Install livestock crossings		x				
		Install alternative water supplies		x				
		Install livestock access lanes						
	manure	Implement manure management practices		x	x			
		Construct animal waste storage structures						
		Implement manure transfer practices						
		Install grass manure spreading strips		x	x			
	misc. infra-structure and mgt	Install chemical mixing pads						
		Install heavy use feeding pads						
		Install erosion & sediment control structures						
		Install roof water management practices						
		Install milkhouse waste treatment practices						
		Develop whole farm management plans						
Abandoned Mine Land Reclamation	treatment	Construct lime dosers	x					
		Install slag leach beds	x					
		Install limestone leach beds	x					
		Install limestone channels	x					
		Install successive alkalinity producing systems	x					

Restoration Categories		Specific Restoration Actions	05030204 - 020			05030204 - 030		
			010	020	030	020	030	040
		Install settling ponds	x					
		Construct acid mine drainage wetland	x					
	flow diversion	Repair subsidence sites						
		Reclaim pit impoundments						
		Reclaim abandoned mine land	x					
		Eliminate stream captures						
		Restore positive drainage	x					
		Cover toxic mine spoils	x					

8.2.3 Hocking River (below Enterprise to above Monday Creek)– 050

The most widely recommended abatement actions for this assessment unit deal with controlling pollution and/or stressors from home sewage systems and row crop production. Streamside protection is also widely recommended and three streams would benefit from channel and riparian habitat improvements.

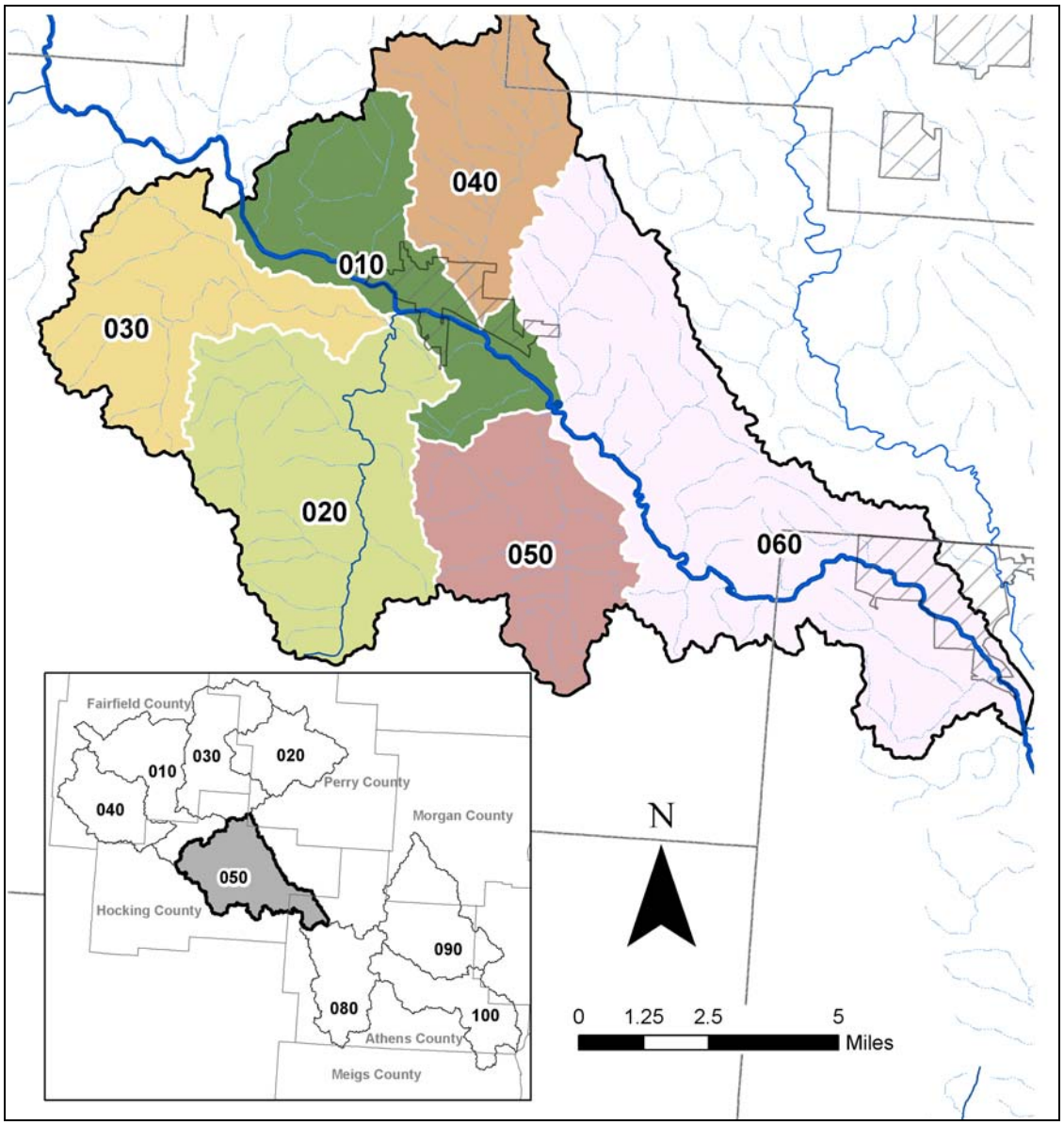

Figure 8.4. Map of the 050 assessment unit and its subwatersheds.

Table 8.7. Narrative descriptions of each of the subwatersheds in the 050 assessment unit.

14-digit HUC	Narrative Description
05030204-050- *Hocking River (below Enterprise to above Monday Creek)*	
010	Hocking River at Enterprise to above Fivemile Cr. [except Scott Cr. and Oldtown Cr.]
020	Scott Creek [except Clear Fk.]
030	Clear Fork
040	Oldtown Creek
050	Fivemile Creek
060	Hocking River below Fivemile Cr. to above Monday Cr.

Table 8.8. Restoration and abatement actions that are recommended for the 050 assessment unit.

Restoration Categories		Specific Restoration Actions	05030204 - 050			
			020	030	050	060
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering				
		Restore streambank by recontouring or regrading			x	
	planted	Plant grasses in riparian areas	x	x	x	x
		Plant prairie grasses in riparian areas	x	x	x	x
		Remove/treat invasive species				
		Plant trees or shrubs in riparian areas	x	x	x	x
Stream Restoration		Restore flood plain		x		x
		Restore stream channel		x		x
		Install in-stream habitat structures		x		x
		Install grade structures				
		Construct 2-stage channel		x		x
		Restore natural flow		x		x
Wetland Restoration		Reconnect wetland to stream				
		Reconstruct & restore wetlands				
		Plant wetland species				
Conservation Easements		Acquire agriculture conservation easements				
Home Sewage Planning and Improvement		Develop HSTS plan			x	x
		Inspect HSTS			x	x
		Repair or replace traditional HSTS			x	x
		Repair or replace alternative HSTS			x	x
Education and Outreach		Distribute educational materials				
		Host meetings, workshops and/or other events				
Storm Water Best Mgt Practices	quantity controls	Post-construction BMPs: innovative BMPs				
		Post-construction BMPs: infiltration				
		Post-construction BMPs: retention/detention				
	quality controls	Post-construction BMPs: filtration				
		Construction BMPs: erosion control				
		Construction BMPs: runoff control				
		Construction BMPs: sediment control				
Point Source Controls (Regulatory Programs)	collection and new treatment	Install sewer systems in communities				
		Develop and/or implement long term control plan (CSOs)				
		Eliminate SSOs/CSOs/by-passes				
	storm water	Implement an MS4 permit				
		Implement an industrial permit				
		Implement a construction permit				
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)				
		Improve quality of effluent				
	monitoring	Establish ambient monitoring program				
		Increase effluent monitoring				

Restoration Categories		Specific Restoration Actions	05030204 - 050			
			020	030	050	060
	alternatives	Establish water quality trading				
Agricultural Best Mgt Practices	farmland	Plant cover/manure crops		x		
		Implement conservation tillage practices				
		Implement grass/legume rotations		x		
		Convert to permanent hayland				
		Install grassed waterways				
		Install vegetated buffer strips		x		
		Install / restore wetlands		x		
	nutrients / agro-chemicals	Conduct soil testing		x		
		Install nitrogen reduction practices		x		
		Develop nutrient management plans		x		
	drainage	Install sinkhole stabilization structures				
		Install controlled drainage system				
		Implement drainage water management				
		Construct overwide ditch				
		Construct 2-stage channel				
	livestock	Implement prescribed & conservation grazing practices			x	x
		Install livestock exclusion fencing			x	
		Install livestock crossings				
		Install alternative water supplies				
		Install livestock access lanes				
	manure	Implement manure management practices			x	x
		Construct animal waste storage structures				
		Implement manure transfer practices				
		Install grass manure spreading strips			x	x
	misc. infra-structure and mgt	Install chemical mixing pads				
		Install heavy use feeding pads				
		Install erosion & sediment control structures				
		Install roof water management practices				
		Install milkhouse waste treatment practices				
		Develop whole farm management plans				
Abandoned Mine Land Reclamation	treatment	Construct lime dosers				
		Install slag leach beds				
		Install limestone leach beds				
		Install limestone channels				
		Install successive alkalinity producing systems				
		Install settling ponds				
		Construct acid mine drainage wetland				
	flow diversion	Repair subsidence sites				
		Reclaim pit impoundments				

Restoration Categories		Specific Restoration Actions	05030204 - 050			
			020	030	050	060
		Reclaim abandoned mine land				
		Eliminate stream captures				
		Restore positive drainage				
		Cover toxic mine spoils				

8.2.4 Hocking River (below Monday Creek to Athens/RM33.1 (except Sunday Creek)– 080

The most widely recommended abatement actions for this assessment unit deal with controlling pollution and/or stressors from home sewage systems, row crop production, and acid mine drainage. Streamside protection is also widely recommended as is stream habitat improvements within the West Branch of Margaret Creek. A break in a sewer line had a negative impact on the macroinvertebrate community in Hamley Run; however, this source of impact is addressed.

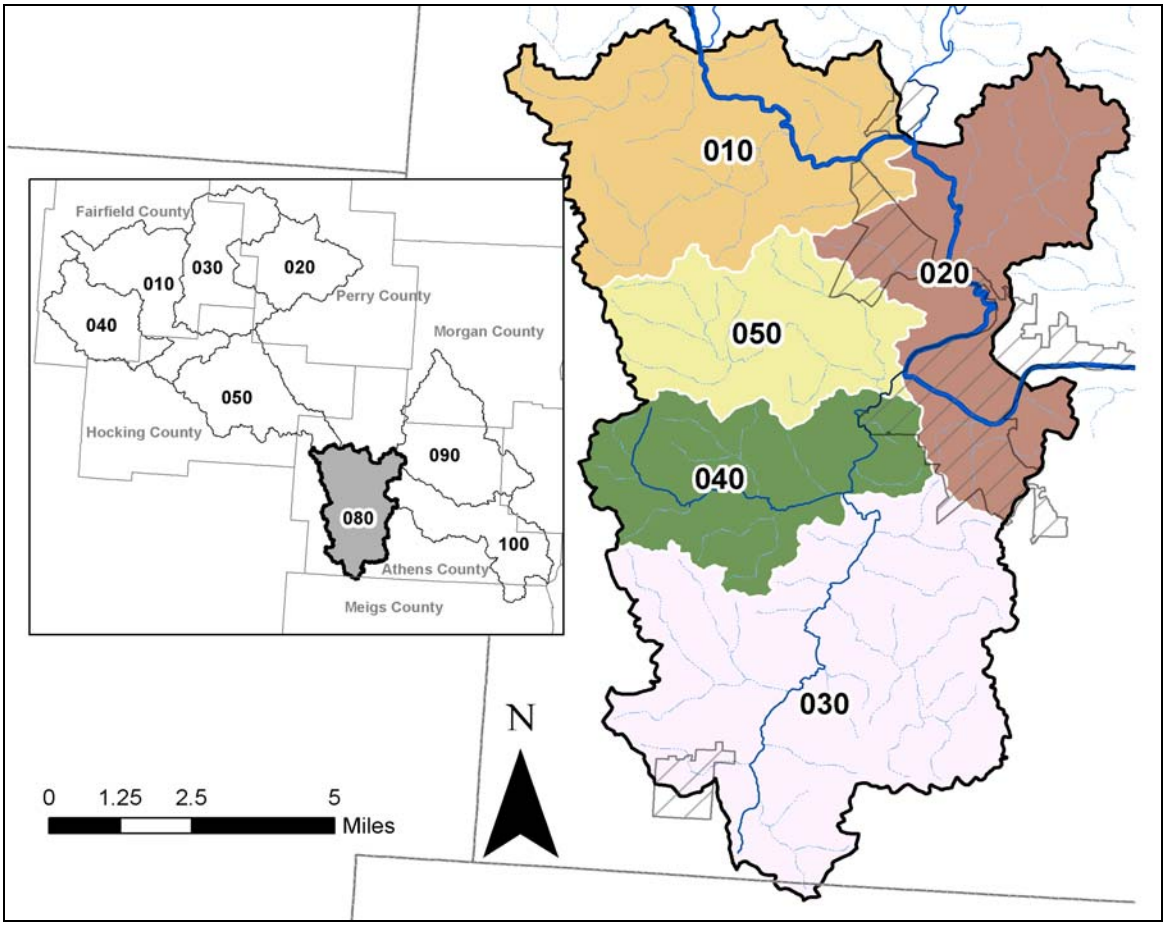

Figure 8.5. Map of the 080 assessment unit and its subwatersheds.

Table 8.9. Narrative descriptions of each of the subwatersheds in the 080 assessment unit.

14-digit HUC	Narrative Description
05030204-080- *Hocking River (below Monday Creek to Athens/RM33.1 (except Sunday Creek)*	
010	Hocking River below Monday Cr. to above Sunday Cr.
020	Hocking River below Sunday Cr. to Athens [except Margaret Cr.]
030	Margaret Creek headwaters to above W. Branch
040	Margaret Creek above W. Branch to above Factory Cr.
050	Margaret Creek above Factory Cr. to Hocking R.

Table 8.10. Restoration and abatement actions that are recommended for the 080 assessment unit.

Restoration Categories		Specific Restoration Actions	05030204 - 080			
			010	030	040	050
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering		x	x	x
		Restore streambank by recontouring or regrading		x	x	x
	planted	Plant grasses in riparian areas	x	x	x	
		Plant prairie grasses in riparian areas	x	x	x	
		Remove/treat invasive species				
		Plant trees or shrubs in riparian areas	x	x	x	
Stream Restoration		Restore flood plain		x	x	
		Restore stream channel				
		Install in-stream habitat structures				
		Install grade structures				
		Construct 2-stage channel				
		Restore natural flow				
Wetland Restoration		Reconnect wetland to stream				
		Reconstruct & restore wetlands				
		Plant wetland species				
Conservation Easements		Acquire agriculture conservation easements				
		Acquire non-agriculture conservation easements				
Home Sewage Planning and Improvement		Develop HSTS plan	x	x		x
		Inspect HSTS	x	x		x
		Repair or replace traditional HSTS	x	x		x
		Repair or replace alternative HSTS	x	x		x
Education and Outreach		Distribute educational materials				
		Host meetings, workshops and/or other events				
Storm Water Best Mgt Practices	quantity controls	Post-construction BMPs: innovative BMPs				
		Post-construction BMPs: infiltration				
		Post-construction BMPs: retention/detention				
	quality controls	Post-construction BMPs: filtration				
		Construction BMPs: erosion control				

Restoration Categories		Specific Restoration Actions	05030204 - 080			
			010	030	040	050
		Construction BMPs: runoff control				
		Construction BMPs: sediment control				
Point Source Controls (Regulatory Programs)	collection and new treatment	Install sewer systems in communities				
		Develop and/or implement long term control plan (CSOs)				
		Eliminate SSOs/CSOs/by-passes				
	storm water	Implement an MS4 permit				
		Implement an industrial permit				
		Implement a construction permit				
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)				
		Improve quality of effluent				
	monitoring	Establish ambient monitoring program				
		Increase effluent monitoring				
	alternatives	Establish water quality trading				
Agricultural Best Mgt Practices	farmland	Plant cover/manure crops				
		Implement conservation tillage practices				
		Implement grass/legume rotations				
		Convert to permanent hayland				
		Install grassed waterways				
		Install vegetated buffer strips				
		Install / restore wetlands				
	nutrients / agro-chemicals	Conduct soil testing		x		
		Install nitrogen reduction practices		x		
		Develop nutrient management plans		x		
	drainage	Install sinkhole stabilization structures				
		Install controlled drainage system				
		Implement drainage water management				
		Construct overwide ditch				
		Construct 2-stage channel				
	livestock	Implement prescribed & conservation grazing practices	x	x		
		Install livestock exclusion fencing		x		
		Install livestock crossings		x		
		Install alternative water supplies		x		
		Install livestock access lanes		x		
	manure	Implement manure management practices	x	x		
		Construct animal waste storage structures				
		Implement manure transfer practices				
		Install grass manure spreading strips	x	x		
	misc. infra-structure and mgt	Install chemical mixing pads				
		Install heavy use feeding pads				
		Install erosion & sediment control structures				
		Install roof water management practices				
		Install milkhouse waste treatment practices				

Restoration Categories		Specific Restoration Actions	05030204 - 080			
			010	030	040	050
		Develop whole farm management plans				
Abandoned Mine Land Reclamation	treatment	Construct lime dosers	x			
		Install slag leach beds	x			
		Install limestone leach beds	x			
		Install limestone channels	x			
		Install successive alkalinity producing systems	x			
		Install settling ponds	x			
		Construct acid mine drainage wetland	x			
	flow diversion	Repair subsidence sites				
		Reclaim pit impoundments				
		Reclaim abandoned mine land				
		Eliminate stream captures				
		Restore positive drainage				
		Cover toxic mine spoils				

8.2.5 Federal Creek – 090

The most widely recommended abatement actions for this assessment unit deal with controlling pollution and/or stressors from home sewage systems, row crop production, and acid mine drainage. Streamside protection is also widely recommended.

A detailed assessment of acid mine drainage impacts in the Federal Creek watershed was finalized in 2006. The report documents that the problems associated with acid mine drainage are primarily confined to a small area surrounding the Sulphur Run tributary. Recommendations for abating these issues are put forth in this AMDAT report.

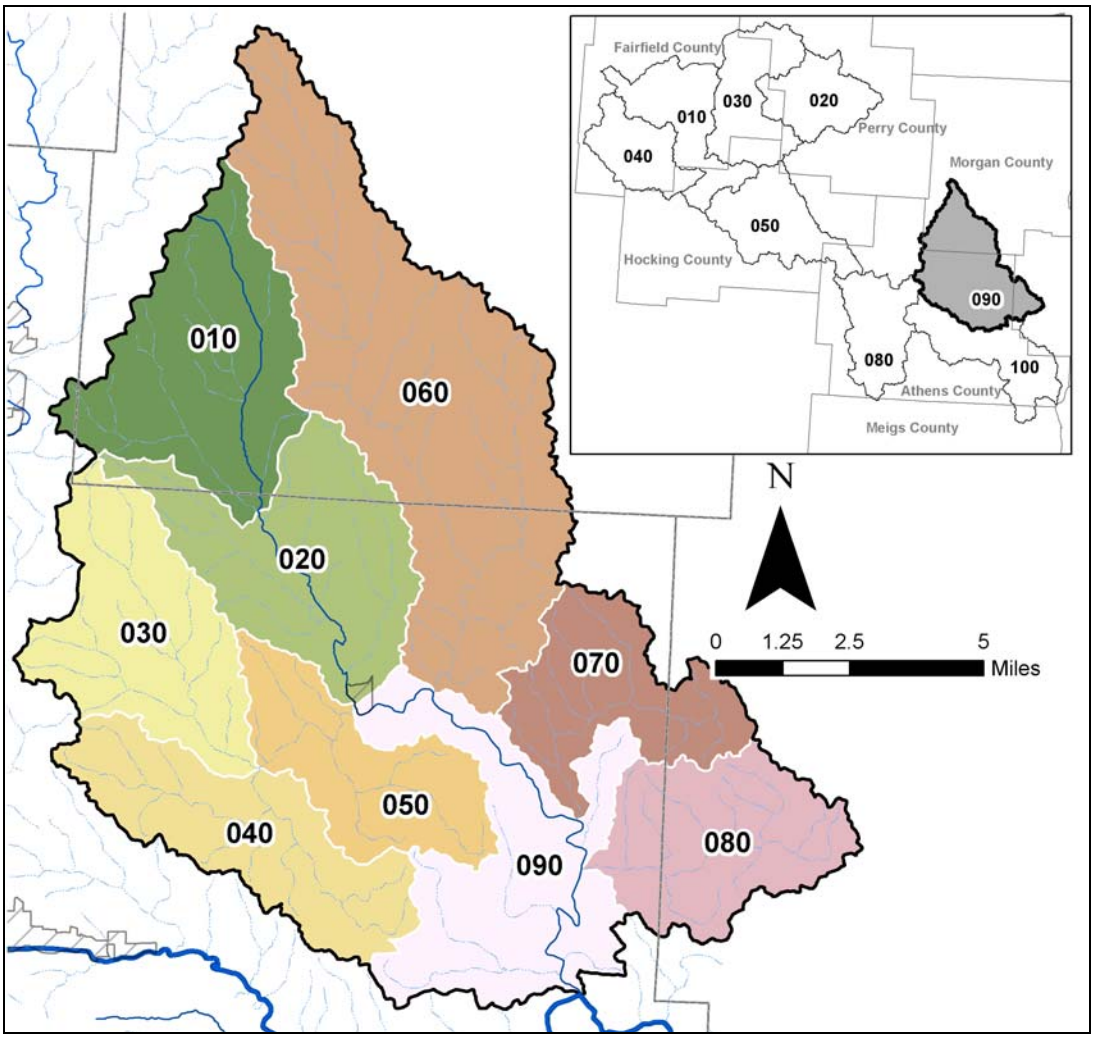

Figure 8.6. Map of the 090 assessment unit and its subwatersheds.

Table 8.11. Narrative descriptions of each of the subwatersheds in the 090 assessment unit.

14-digit HUC	Narrative Description
05030204-090- *Federal Creek*	
010	Federal Creek headwaters to below Hyde Fk. and Miners Fk. confluence
020	Federal Creek below Miners Fk. to above McDougall Branch
030	McDougall Branch above Mush Run
040	Mush Run
050	McDougall Branch below Mush Run to Federal Cr.
060	Sharps Fork
070	Marietta Run
080	Big Run
090	Federal Creek below McDougall Branch to Hocking R. [except Sharps Fk., Marietta Run, and Big Run]

Table 8.12. Restoration and abatement actions that are recommended for the 090 assessment unit.

Restoration Categories		Specific Restoration Actions	05030204 - 090					
			010	020	050	060	080	090
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering		x				x
		Restore streambank by recontouring or regrading		x				x
	planted	Plant grasses in riparian areas		x		x	x	x
		Plant prairie grasses in riparian areas		x		x	x	x
		Remove/treat invasive species						
		Plant trees or shrubs in riparian areas		x		x	x	x
Stream Restoration		Restore flood plain						
		Restore stream channel						
		Install in-stream habitat structures						
		Install grade structures						
		Construct 2-stage channel						
		Restore natural flow						
Wetland Restoration		Reconnect wetland to stream						
		Reconstruct & restore wetlands						
		Plant wetland species						
Conservation Easements		Acquire agriculture conservation easements						
		Acquire non-agriculture conservation easements						
Home Sewage Planning and Improvement		Develop HSTS plan			x		x	x
		Inspect HSTS			x		x	x
		Repair or replace traditional HSTS			x		x	x
		Repair or replace alternative HSTS			x		x	x
Education and Outreach		Distribute educational materials						
		Host meetings, workshops and/or other events						
Storm Water Best Mgt Practices	quantity controls	Post-construction BMPs: innovative BMPs						
		Post-construction BMPs: infiltration						
		Post-construction BMPs: retention/detention						
	quality controls	Post-construction BMPs: filtration						
		Construction BMPs: erosion control						
		Construction BMPs: runoff control						
		Construction BMPs: sediment control						
Point Source Controls (Regulatory Programs)	collection and new treatment	Install sewer systems in communities						
		Develop and/or implement long term control plan (CSOs)						
		Eliminate SSOs/CSOs/by-passes						
	storm water	Implement an MS4 permit						
		Implement an industrial permit						
		Implement a construction permit						
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)						
		Improve quality of effluent						

Restoration Categories		Specific Restoration Actions	05030204 - 090					
			010	020	050	060	080	090
	monitoring	Establish ambient monitoring program						
		Increase effluent monitoring						
	alternatives	Establish water quality trading						
Agricultural Best Mgt Practices	farmland	Plant cover/manure crops						
		Implement conservation tillage practices						
		Implement grass/legume rotations						
		Convert to permanent hayland						
		Install grassed waterways						
		Install vegetated buffer strips						
		Install / restore wetlands						
	nutrients / agro-chemicals	Conduct soil testing						
		Install nitrogen reduction practices						
		Develop nutrient management plans						
	drainage	Install sinkhole stabilization structures						
		Install controlled drainage system						
		Implement drainage water management						
		Construct overwide ditch						
		Construct 2-stage channel						
	livestock	Implement prescribed & conservation grazing practices						
		Install livestock exclusion fencing						
		Install livestock crossings						
		Install alternative water supplies						
		Install livestock access lanes						
	manure	Implement manure management practices						
		Construct animal waste storage structures						
		Implement manure transfer practices						
		Install grass manure spreading strips						
	misc. infra-structure and mgt	Install chemical mixing pads						
		Install heavy use feeding pads						
		Install erosion & sediment control structures						
		Install roof water management practices						
		Install milkhouse waste treatment practices						
		Develop whole farm management plans						
Abandoned Mine Land Reclamation	treatment	Construct lime dosers						
		Install slag leach beds						
		Install limestone leach beds						
		Install limestone channels						
		Install successive alkalinity producing systems						
		Install settling ponds				x		
		Construct acid mine drainage wetland				x		

Restoration Categories		Specific Restoration Actions	05030204 - 090					
			010	020	050	060	080	090
	flow diversion	Repair subsidence sites						
		Reclaim pit impoundments						
		Reclaim abandoned mine land						
		Eliminate stream captures						
		Restore positive drainage						
		Cover toxic mine spoils						

8.3 Process for Evaluation and Revision

The effectiveness of actions implemented based on the TMDL recommendations should be validated through ongoing monitoring and evaluation. Information derived from water quality analyses can guide changes to the implementation strategy to more effectively reach the TMDL goals. Additionally, monitoring is required to determine if and when formerly impaired segments meet applicable water quality standards (WQS).

This section of the report provides a general strategy for continued monitoring and evaluation and lists parties who can potentially carry out such work. It highlights past efforts and those planned to be carried out in the future by the Ohio EPA and others. It also outlines a process by which changes to the implementation strategy can be made if needed.

8.3.1 Evaluation and Analyses

Aquatic life and recreational uses are impaired in the watershed, so monitoring that evaluates the river system with respect to these uses is a priority to the Ohio EPA. The degree of impairment of aquatic life use is exclusively determined through the analysis of biological monitoring data. Recreational use impairment is determined through bacteria counts from water quality samples. Ambient conditions causing impairment include sediment, nutrients, bacteria, and organic substances. This report sets targets values for these parameters (Chapter 7), which should also be measured through ongoing monitoring.

A serious effort should be made to determine if and to what degree the recommended implementation actions have been carried out. This should occur within an appropriate timeframe following the completion of this TMDL report and occur prior to measuring the biological community, water quality or habitat.

Past and Ongoing Water Resource Evaluation
The Ohio EPA has conducted water quality surveys within all or parts of the Hocking River watershed in 2004 and 2003, as well as 1995, 1990, and 1982. The Ohio EPA is scheduled to re-assess the watershed through biological, water quality, habitat, and sediment chemistry monitoring in the eight HUC-11 assessment units of this project area along with Sunday and Monday Creeks in 2019 (Ohio EPA, 2008).

Acid mine drainage issues have been studied in the Rush Creek watershed by the U.S. Geological Survey (USGS) in 2005 and in the Federal Creek watershed by the Institute for Local Governments Administration and Rural Development (ILGARD) in 2002. The Midwest

Biodiversity Institute (MBI) conducted field studies in 2004 in support of Ohio EPA's assessment of this TMDL project area.

Effluent quality is monitored by several of the municipal or commercial WWTPs in the watershed. These data are included in the monthly operating reports (MORs) that are submitted to the Ohio EPA by these facilities.

The City of Lancaster has recently begun a storm water sampling program to support its Phase 2 Storm Water Pollution Prevention Program. Institutions that have actively monitored water resources in the Hocking River watershed for either research-based initiatives or educational purposes are Ohio University and Hocking College. The USGS also maintains flow gaging stations in Athens and Enterprise on the mainstem of the Hocking River and on the Clear Creek tributary near Rockbridge.

Recommended Approach for Gathering and Using Available Data
Early communications should take place between the Ohio EPA and any potential collaborators to discuss research interests and objectives. Through this, areas of overlap should be identified and ways to make all parties research efforts more efficient should be discussed. Ultimately important questions can be addressed by working collectively and through pooling resources, knowledge, and data.

8.3.2 Revision to the Implementation Approach

An adaptive management approach will be taken in the Hocking River watershed. Adaptive management is recognized as a viable strategy for managing natural resources (Baydack et al., 1999) and this approach is applied on federally-owned lands. An adaptive management approach allows for changes in the management strategy if environmental indicators suggest that the current strategy is inadequate or ineffective. The recommendations put forth for the Hocking River watershed largely center on abating home septic system failure and polluted runoff from crop and livestock production areas, and creating stream setbacks and buffer areas next to streams. If chemical water quality does not show improvement and/or water bodies are still not attaining water quality standards after the implementation plan has been carried out, then a TMDL revision would be initiated. The Ohio EPA would initiate the revision if no other parties wish to do so.

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