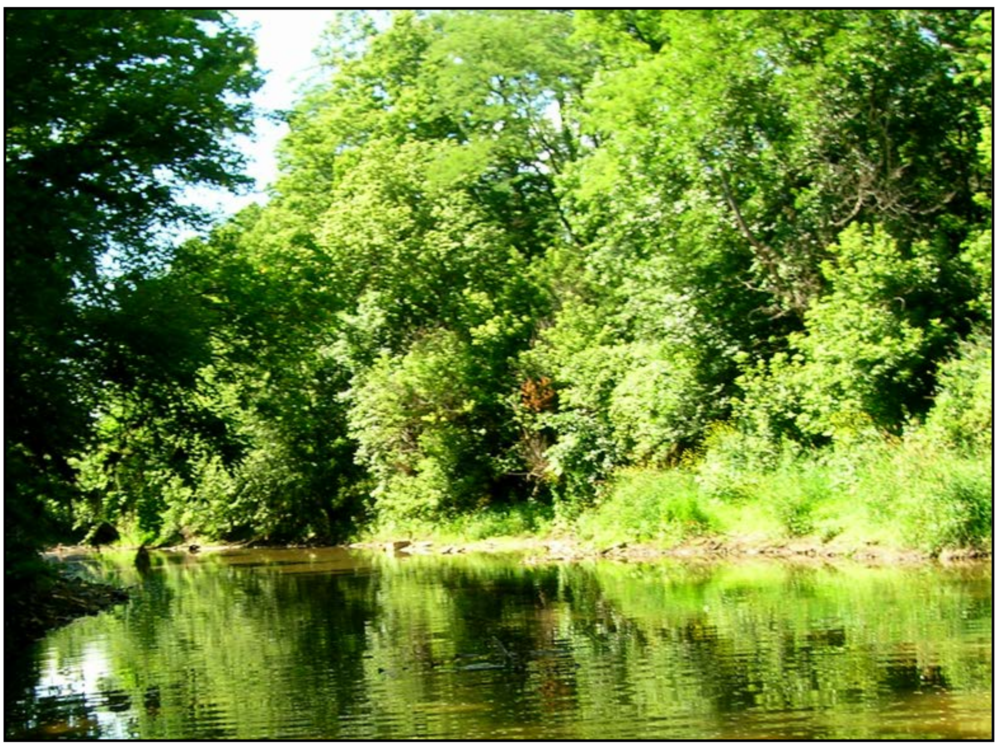
Total Maximum Daily Loads for the Scioto River (upper) Watershed



Division of Surface Water
Draft Report
July 1, 2014

Cover photo: Scioto River at river mile 211.5, just downstream of Kenton, in Hardin County, Ohio.

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Acronyms and Abbreviations

AFG	allowance for future growth
ALU	aquatic life use
AU	assessment unit
AWS	agricultural water supply
BMP	best management practices
BNA	base neutral and acid extractable compounds
BW	bathing water
CAFO	confined animal feeding operation
CFR	Code of Federal Regulations
cfs	cubic feet per second
Corps	United States Army Corps of Engineers
CREP	Conservation Reserve Enhancement Program (USDA program)
CRP	Conservation Reserve Program (USDA program)
CSO	combined sewer overflow
CSP	Conservation Security Program (USDA program)
CWA	Clean Water Act
CWH	coldwater habitat
D.O.	dissolved oxygen
DA	drainage area
DMR	discharge monitoring report
DNAP	Division of Natural Areas and Preserves (part of ODNR)
DOW	Division of Wildlife (part of ODNR)
DSW	Division of Surface Water (part of Ohio EPA)
DSWR	Division of Soil and Water Resources (part of ODNR)
ECBP	Eastern Corn Belt Plains (ecoregion)
EPA	Environmental Protection Agency, see U.S. EPA
EQIP	Environmental Quality Incentive Plan (USDA program)
EWH	exceptional warmwater habitat
FCA	fish consumption advisory
FFY	federal fiscal year (October 1 to September 30)
FSA	Farm Service Agency
FWPCA	Federal Water Pollution Control Act
gpd	gallons per day
GRP	Grassland Reserve Program (USDA program)
HELP	Huron Erie Lake Plain (ecoregion)
HSTS	home sewage treatment system
HU	hydrologic unit
HUC	hydrologic unit code
I/I	infiltration and inflow
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
IR	Integrated Report
IWS	industrial water supply
kg	kilogram
L	liter
LA	load allocation
LaMP	Lakewide Management Plan
LEC	(Ohio) Lake Erie Commission

LEL	lowest effect level
LEPF	Lake Erie Protection Fund (LEC program)
LRAU	large river assessment unit
LRW	limited resource water
LTCP	long-term control plan
mg	milligram
MGD	million gallons per day
MHP	mobile home park
MIwb	Modified Index of well being
mi^2	square miles
ml	milliliter
MOS	margin of safety
MPN	most probable number
MS4	municipal separate storm sewer system
MWH	modified warmwater habitat
n	number (of data points in a grouping)
NHD	National Hydrography Dataset
NOI	notice of intent
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NRCS	Natural Resource Conservation Service
OAC	Ohio Administrative Code
ODA	Ohio Department of Agriculture
ODH	Ohio Department of Health
ODNR	Ohio Department of Natural Resources
ODOT	Ohio Department of Transportation
OEPA	Ohio Environmental Protection Agency
Ohio EPA	Ohio Environmental Protection Agency (preferred nomenclature)
ORC	Ohio Revised Code
ORSANCO	Ohio River Valley Water Sanitation Commission
OSC	on-site coordinator
OSUE	Ohio State University Extension
OWDA	Ohio Water Development Authority
OWRC	Ohio Water Resources Council
PAHs	polyaromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCR	primary contact recreation
PEC	probable effect concentration
PDWS	public drinking water supply
PEC	probable effect concentration
ppb	parts per billion
PS	point source
PTI	permit to install
PTO	permit to operate
PWS	public water supply
QA	quality assurance
QC	quality control
QHEI	qualitative habitat evaluation index
RM	river mile
SCR	secondary contact recreation
SDWA	Safe Drinking Water Act

SEL	severe effect level
SFY	state fiscal year (July 1 to June 30)
SMP	sludge management plan
sq mi	square miles
SRW	state resource water
SSH	seasonal salmonid habitat
SSM	single-sample maximum
SSO	sanitary sewer overflow
STORET	STOrage and RETrieval (a U.S. EPA water quality database)
SWIMS	Surface Water Information Management System
SWCD	Soil and Water Conservation District
TEC	threshold effect concentration
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TOC	total organic carbon
TSS	total suspended solids
ug	microgram
µg	microgram
U.S. EPA	United States Environmental Protection Agency
UAA	use attainability analysis
USACOE	United States Army Corps of Engineers
USC	United States Code
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOC	volatile organic compound
WAU	watershed assessment unit
WHIP	Wildlife Habitat Incentives Program (USDA program)
WLA	wasteload allocation
WPCLF	Water Pollution Control Loan Fund
WQ	water quality
WQS	water quality standards
WRP	Wetland Reserve Program (USDA program)
WRRSP	Water Resource Restoration Sponsor Program (Ohio EPA program)
WTP	water treatment plant
WWH	warmwater habitat
WWTP	wastewater treatment plant

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Project leader and loading analysis	Paul Gledhill
Biological monitoring	Ben Rich, Jack Freda
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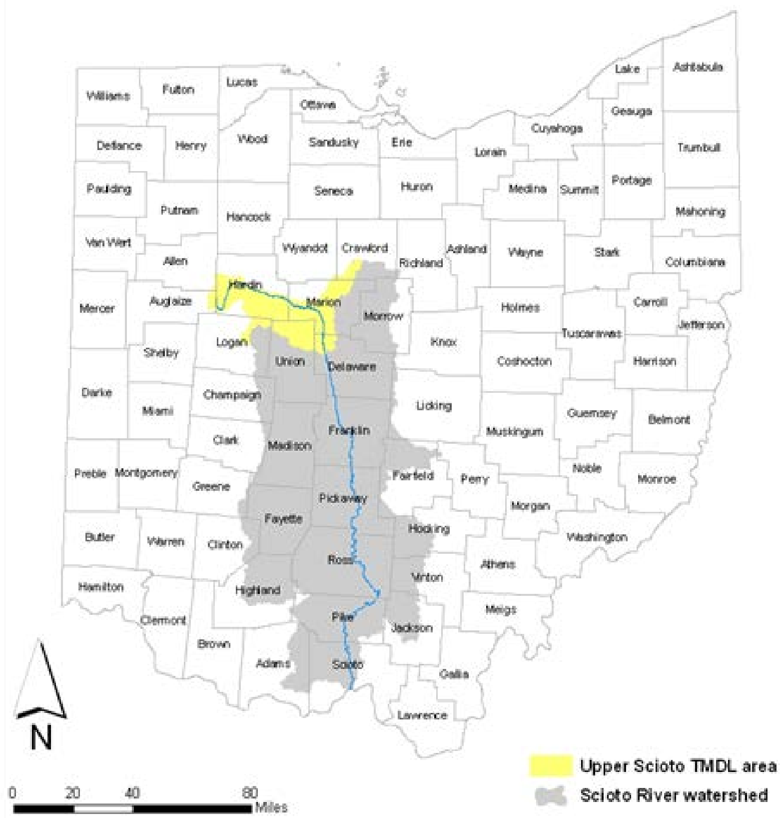
The Ohio EPA appreciates the cooperation of the property owners who allowed Ohio EPA personnel access to the project area.

Executive Summary

The upper Scioto River watershed is located in north central Ohio extending from the eastern edges of Allen and Auglaize counties in the west to the northwest corner of Delaware County at the most downstream area of the basin. This 661 square mile watershed area is home to more than 83,000 people and encompasses all or part of 13 municipalities in Hardin, Marion, Logan, Union, Delaware, Crawford, Allen and Auglaize counties. The watershed is primarily cropland with about eight percent being developed.

In 2009, Ohio EPA sampled 62 sites on streams in this watershed. Data collected related to water and sediment quality, aquatic biological communities, and habitat. Ohio's water quality standards were compared with these data to determine if quality criteria for various designated beneficial uses are being met.



The upper Scioto River watershed TMDL project area.

Overall the watershed met criteria for the recreation use at about 7 percent, 42 percent for aquatic life uses, 100 percent for the human health use, and there was not enough data to assess public drinking water supply use. The causes of impairments included *E. coli*, poor habitat, excessive fine sediment, nutrient enrichment, and organic enrichment and dissolved oxygen issues. Sources of these stressors include cropland for sediment, nutrients and *E. coli*, channelization for poor habitat and sediment, and combined sewer overflows for *E. coli*, organic enrichment and nutrients.

Total maximum daily loads (TMDL) have been developed for pollutants and stressors that impair beneficial uses and preclude attainment of applicable water quality standards. Specific TMDLs have been developed for *E. coli,* total phosphorus, and sediment and habitat.

The needed load reductions ranged from two to 99 % for *E. coli*, 44 to 86 % for nonpoint sources of total phosphorus, and for point sources from no reduction to 90% for total phosphorus. Sources of the pollutants that have been allocated the most significant reductions include point sources and cropland.

Recommendations for regulatory action resulting from this TMDL analysis include lower effluent limits for total phosphorus. Nonpoint sources of total phosphorus should be addressed by nutrient management, cover cropping, and better tillage practices, while practices that reduce soil export to streams are likely to also reduce loading of *E. coli*.

1 INTRODUCTION

The upper Scioto River watershed is located in north central Ohio. The 661 square mile watershed area is home to more than 83,000 people and encompasses all or part of 13 municipalities in Hardin, Marion, Logan, Union, Delaware, Crawford, Allen and Auglaize counties.

In 2009, Ohio EPA sampled 62 sites on streams in this watershed. Overall the watershed met criteria for the recreation use at about seven percent of the site, at 42 percent for aquatic life uses, at 100 percent for the human health use. There was not enough data to assess public drinking water supply use. The causes of impairments included *E. coli*, poor habitat, excessive fine sediment, nutrient enrichment, and organic enrichment and dissolved oxygen issues. Sources of these stressors include cropland for sediment, nutrients and *E. coli*, channelization for poor habitat and sediment, and combined sewer overflows for *E. coli*, organic enrichment and nutrients.

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 drafted and made available to the public for comment, then a final list is 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 the upper Scioto River watershed (assessment units 05060001 01 01 through 01 04; 02 01 through 02 03; 03 01 through 03 04; 04 01 through 04 06; 05 01 through 05 05) as impaired on the 2012 303(d) list (Ohio EPA, 2012; available at http://www.epa.state.oh.us/dsw/tmdl/OhioIntegratedReport.aspx).

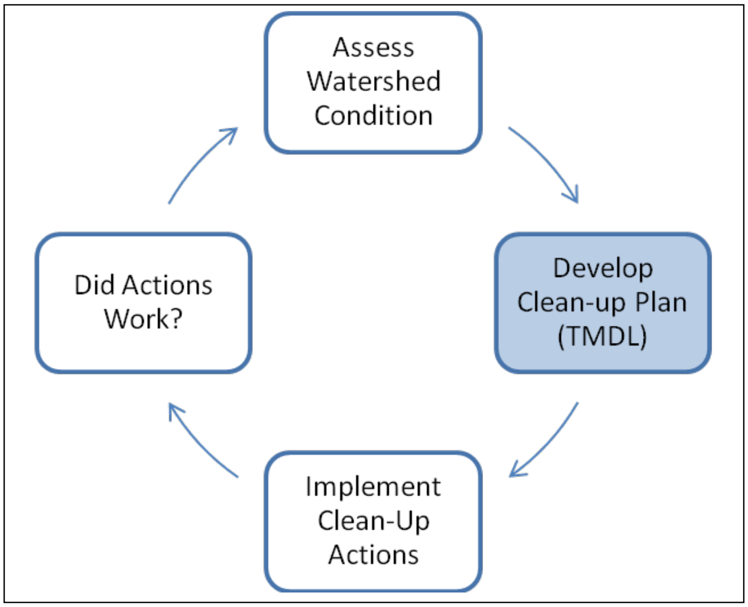


Figure 1-1. Overview of the TMDL project process.

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 Section 303(d) list. Figure 1-1 shows the phases of TMDL development in Ohio.

Table 1-1 summarizes how the aquatic life and recreation use impairments identified in the upper Scioto River watershed are addressed in this TMDL report.

Table 1-1. Summary of impairments in the upper Scioto River watershed and methods used to address impairments.

Assessment Unit	Narrative Description	Causes of Impairment[1]	Method to Address
05060001 01 01 *Priority points 3*	Cottonwood Ditch	Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 01 02 *Priority points: 6*	Headwaters Scioto River	Sedimentation/siltation	TMDL: QHEI Analysis
		Direct habitat alterations	
		Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 01 03 *Priority points: 4*	Taylor Creek	Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 01 04 *Priority points: 6*	Silver Creek- Scioto River	Natural conditions (flow or habitat)	No action
		Organic enrichment, McCoy	TMDL: GWLF nutrient
		Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 02 01 *Priority points: 7*	Headwaters Rush Creek	Sedimentation/siltation	TMDL: QHEI Analysis
		Dissolved oxygen from natural source	No action
		Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 02 02 *Priority points: 5*	McDonald Creek	Nutrient/eutrophication biological indicators	TMDL: GWLF nutrient
		Organic enrichment	
		Dissolved oxygen	
		Direct habitat alterations	TMDL: QHEI Analysis
		Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 02 03 *Priority points: 5*	Dudley Run- Rush Creek	Other flow regime alterations	TMDL: QHEI Analysis
		Direct habitat alterations	
		Natural conditions (flow or habitat)	No action
		Bacteria (recreation use)	TMDL: *E. coli* LDC

Assessment Unit	Narrative Description	Causes of Impairment[1]	Method to Address
05060001 03 01 *Priority points: 7*	Rock Fork	Direct habitat alterations	TMDL: QHEI Analysis
		Fish kills	No action. (Fish kill resulted from a 2008 manure spill; not expected to recur.)
		Nutrient/eutrophication biological indicators	TMDL: GWLF nutrient
		Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 03 02 *Priority points: 6*	Headwaters Little Scioto River	Direct habitat alterations	TMDL: QHEI Analysis
		Sedimentation/siltation	
		Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 03 03 *Priority points: 7*	City of Marion – Little Scioto River	Sedimentation/siltation	TMDL: QHEI Analysis
		Direct habitat alterations	
		Dissolved oxygen	4B: City of Marion Combined Sewer Overflow
		Organic enrichment (sewage) biological indicators	
		Metals	
		Abnormal fish deformities	
		PAHs	
		Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 03 04 *Priority points: 8*	Honey Creek – Little Scioto River	Creosote	US EPA Cleanup project
		Ammonia (from CSOs)	4B: City of Marion Combined Sewer Overflow
		Metals	
		Abnormal fish deformities	
		PAHs	
		Organic enrichment	
		Direct habitat alterations	TMDL: QHEI Analysis
		Nutrient/eutrophication biological indicators (Honey Creek only)	TMDL: GWLF nutrient
		Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 04 01 *Priority points: 6*	Gander Run – Scioto River	Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 04 02 *Priority points: 3*	Panther Creek	Nutrient/eutrophication biological indicators	TMDL: GWLF nutrient
05060001 04 03	Wolf Creek-Scioto	Fish kills	Reassessed

Assessment Unit	Narrative Description	Causes of Impairment[1]	Method to Address
Priority points: 6	River	Natural Conditions (Flow or Habitat)	No action
		Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 04 04 *Priority points: 4*	Wildcat Creek	Nutrient/eutrophication biological indicators	TMDL: GWLF nutrient
		Dissolved oxygen	
		Direct habitat alterations	TMDL: QHEI Analysis
		Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 04 05 *Priority points: 6*	Town of La Rue – Scioto River	Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 04 06 *Priority points: 12*	Glade Run – Scioto River	Sedimentation/siltation	TMDL: QHEI Analysis
		Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 05 01 *Priority points: 4*	Patton Run	Sedimentation/siltation	TMDL: QHEI Analysis
		Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 05 02 *Priority points: n/a*	Davids Run-Scioto River	***Insufficient data***	
05060001 05 03 *Priority points: 4*	Kebler Run	Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 05 04 *Priority points: 5*	Fulton Creek	Direct habitat alterations	TMDL: QHEI Analysis
		Total phosphorus	TMDL: GWLF nutrient
		Nutrient/eutrophication biological indicators	
		Dissolved oxygen	
		Organic enrichment	
		Bacteria (recreation use)	TMDL: *E. coli* LDC
05060001 05 05 *Priority points: n/a*	Ottawa Creek-Scioto River	***No impairment***	

[1] Cause of impairment relates to aquatic life uses unless otherwise indicated via parentheses.

1.2 Public Involvement

Public involvement is fundamental 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 upper Scioto River watershed TMDL project has been completed using the process endorsed by the advisory group.

The draft TMDL report is available for public comment from July 3 through August 4, 2014. A copy of the draft report is posted on Ohio EPA's web page (http://www.epa.ohio.gov/dsw/tmdl/index.aspx).

Continued public involvement is essential 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 upholds the need for voluntary actions facilitated by the local stakeholders, watershed organization, and agency partners to restore the upper Scioto River watershed.

1.3 Organization of Report

Chapter 2 is an overview of water quality standards applicable in the watershed. Chapter 3 gives an overview of the water quality conditions in the watershed. Chapter 4 briefly discusses the methods used to calculate load reductions. Chapter 5 provides the load reduction results. Chapter 6 discusses suggested restoration methods to improve water quality.

More detailed information on selected topics is contained in appendices. Appendix A lists the permitted facilities in the watershed. Appendix B summarizes the findings of the watershed survey. Appendix C is a primer on Ohio's water quality standards. Appendix D contains details of the loading analysis. Appendix E discusses programs and actions available to improve water quality.

2 Characteristics and Expectations of the Watershed

The upper Scioto River watershed lies just northwest of the geometric center of Ohio and occupies parts of (from west to east) Auglaize, Allen, Hardin, Logan, Union, Marion, Delaware, and Crawford counties. This 661 square mile area is the uppermost portion of one of the largest watersheds within Ohio's boundaries and lies at the divide between the Lake Erie and Ohio River drainages.

There are thirteen municipalities partially or entirely located within the watershed with Marion, Kenton, and Bucyrus being the urban areas of greatest significance. The primary land use is crop production; however, there are 41 individual wastewater permittees for municipal and industrial discharges with a combined design discharge capacity exceeding 25 million gallons per day. The topography is generally flat with nearly two-thirds of the area with soil slopes of one percent or less and 96 percent of the area with soils that do not exceed four percent slopes. The soils are also generally poorly drained with one third very poorly drained and 82 percent ranging from somewhat poorly drained through very poorly drained. Subsurface drainage infrastructure is believed to be widely used in the upper Scioto River watershed.

2.1 Watershed Characteristics

The following subsections provide an overview of the characteristics of the upper Scioto River watershed.

2.1.1 Population and Distribution

Approximately 83,000 people live within the boundaries of the upper Scioto River watershed. The overall density of this 661 square mile area is just over 125 individuals per square mile, which shows the generally rural nature of this watershed. For context, the statewide average for Ohio is just over 277 individuals per square mile with averages for the top six counties ranging from just over 1,200 to just over 3,000 (see http://www.development.ohio.gov/files/research/P2092.pdf).

Figure 2-1 shows the patterns for the population distribution across the watershed using population density within census blocks as the indicator. Although this map uses an imperfect measure of the population distribution, it illustrates that Marion is the most significant population center followed by Kenton and then Bucyrus, each occupying a relatively small portion of the overall watershed. Figure 2-2 shows the population distribution based on hydrologic units (i.e., 12-digit HUCs) for overall population and population density. Figure 2-3 provides perspective for the data presented in Figure 2-2 by showing that the 0303 12-digit HUC constitutes over one third of the total population, while the combination of the next four largest 12-digit HUCs likewise contribute one third of the overall population leaving the rest of the watershed population to be distributed across the remaining seventeen 12-digit HUCs. Alone, these seventeen 12-digit HUCs (531 square miles) have a population density of just over 50 individuals per square mile.

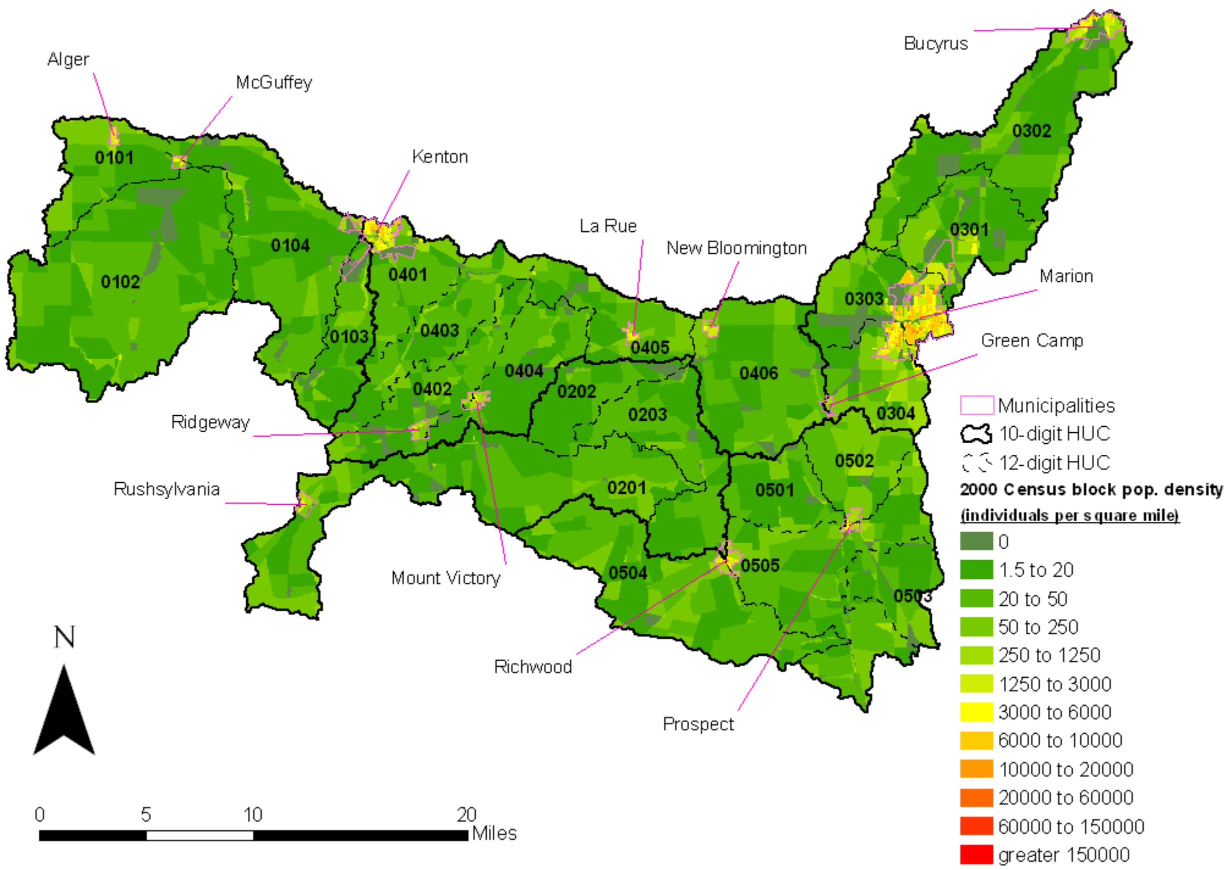


Figure 2-1. Population density per census block for the upper Scioto River watershed (source: 2000 U.S. Census).

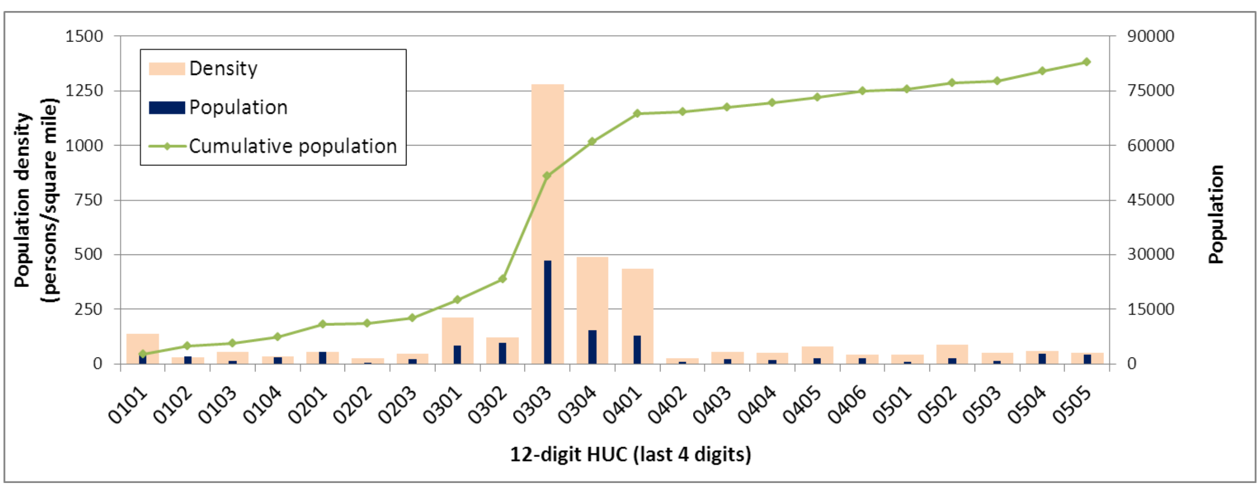


Figure 2-2. Population distribution across the 12-digit HUCs in the upper Scioto River watershed (source: 2000 U.S. Census).

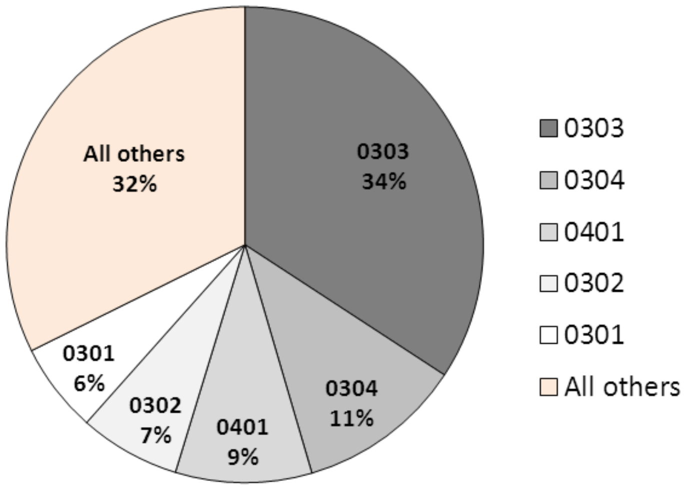


Figure 2-3. Percentage of the overall population across the top five 12-digit HUCs in the upper Scioto River watershed.

2.1.2 Land Use

The upper Scioto River watershed is dominated with cropland agriculture with over 80 percent of the area used for that purpose. There are no 12-digit HUC assessment units that are not dominated by cropland. Developed land is, overall, the second most significant land use (about eight percent) but is generally restricted to the areas around Marion and Bucyrus in the Little Scioto River watershed (03 HUC10), as well as Kenton near the headwaters of the Scioto River (0103 and 0401 HUC12s). Forest cover only occupies about seven percent of the watershed and has its highest proportions in the Taylor Creek (0103) and upper Rush Creek (0201) subwatersheds at 13 and 12 percent of those areas, respectively. Pasture has a very similar pattern of distribution as forest and occupies four percent of the total watershed with Wolf Creek (0403), upper Rush Creek (0201), Taylor Creek (0103) and the headwaters of the Scioto River (0102) with the highest proportions. Other land uses are insignificant by comparison and none exceed much more than one percent of the total watershed area and do not occupy more than three percent of any given 12-digit HUC area. Figure 2-4 is a map of the watershed showing land cover interpretations of satellite imagery (NLCD, 2001). Figure 2-5 is a bar graph of the land use distribution per 10-digit HUCs, where the dominance of cropland is clearly shown.

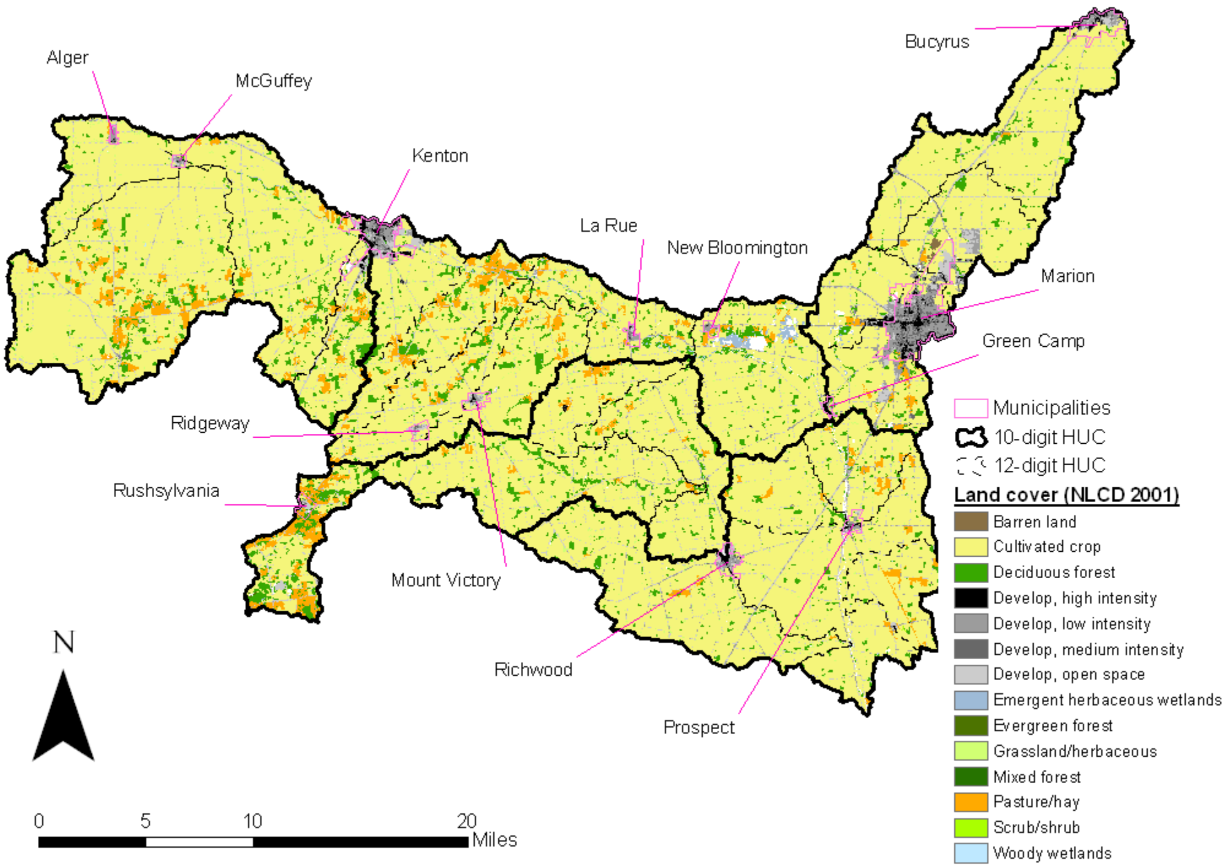


Figure 2-4. Distribution of land cover in the upper Scioto River watershed (source: NLCD 2001).

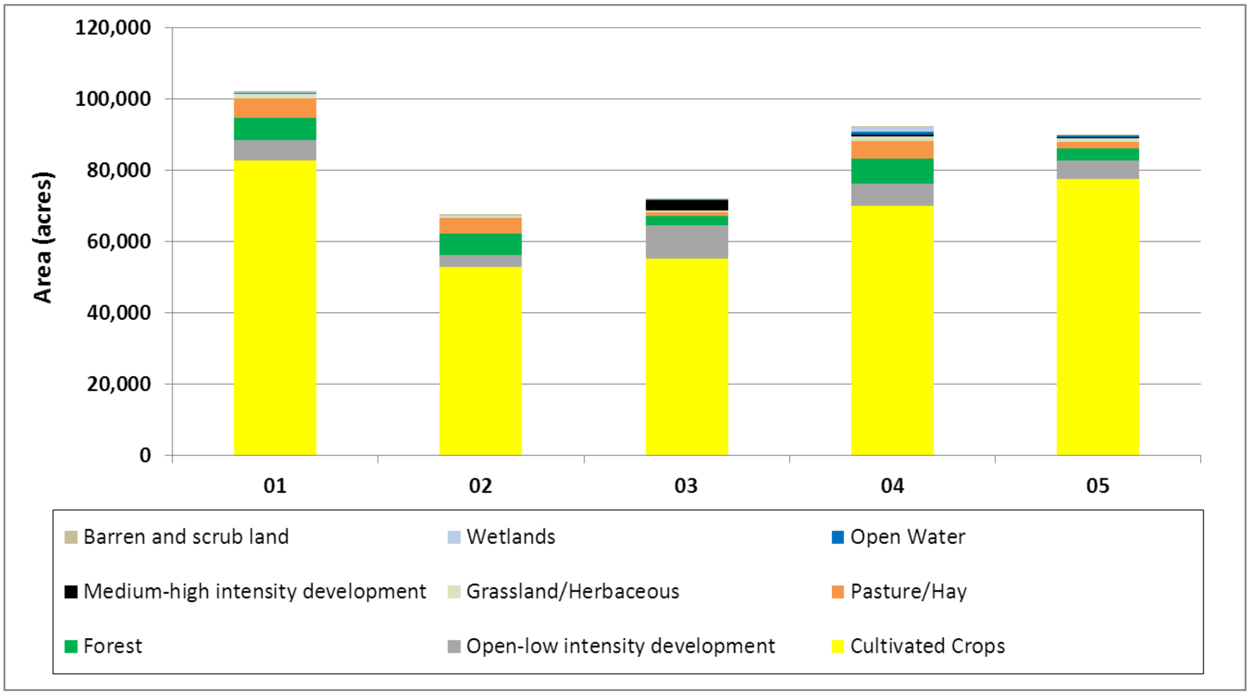


Figure 2-5. Distribution of land cover across the 10-digit HUCs (source: NLCD 2001).

2.1.3 Point Source Discharges

Industrial and municipal point sources include wastewater treatment plants and factories. Wastewater treatment plants can contribute to bacteria, nutrient enrichment, siltation, and flow alteration problems. Industrial point sources, such as factories, sometimes discharge water that is excessively warm or cold, changing the temperature of the stream. Point sources may contain other pollutants such as chemicals and metals.

NPDES dischargers are entities that 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 generally discharge wastewater continuously. They primarily affect water quality under average- to low-flow conditions because 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 severe water quality problems because their effluent can dominate the natural stream flow. Appendix A lists the NPDES permittees in the upper Scioto River watershed.

In the watershed there are 41 facilities with individual NPDES permits and one with a general NPDES permit for small sanitary wastes with discharges of less than 25,000 gallons per day (see http://www.epa.state.oh.us/dsw/permits/GP_SmallSanitaryDischargersNotBADCT.aspx). The combination of these facilities totals to a design wastewater discharge of over 25 million gallons per day (MGD). The distribution of the wastewater among the 12-digit HUCs is highly skewed to just four of the twenty-two 12-digit HUCs in the watershed with these accounting for over 90 percent of the design discharge capacity (23.4 MGD). Of these four 12-digit HUCs, 0303 stands out with 44 percent of the total and it receives effluent from the largest discharger in the watershed, Marion WPC (2PD00011). The two National Lime & Stone Co industrial facilities are the second and third largest dischargers and the 12-digit HUCs in which they discharge likewise rank second and third. Figures 2-6 and 2-7 are bar graphs showing the distribution of average effluent design discharge rates across the 12-digit HUCs and some of the individual facilities in the upper Scioto River watershed.

The top three streams receiving direct effluent discharges are the Little Scioto River (Marion WPC and others), Harvey Ditch (National Lime & Stone), and the Scioto River (Kenton WWTP, Prospect WWTP, New Bloomington WWTP, LaRue WWTP, and others). The three account for 91 percent of the wastewater discharges based on design discharge capacity.

Untreated sewage can enter streams through combined sewer systems as well as compromised sanitary sewer systems and are termed combined sewer overflows and sanitary sewer overflows, respectively. In the project area there are two combined sewer outfalls for the City of Marion's combined system (2PD00011). These two outfalls, 003 and 004, discharge to North Rock Swale Ditch and Columbia Ditch, respectively, and their annual discharge volumes from 2003 through 2012 are shown in Figure 2-7. Sanitary overflows have been documented in thirteen wastewater systems throughout the watershed and are listed in Table 2-1.

There are three confined animal feeding operations (CAFOs) within the watershed. CAFOs are not directly discharging systems, but instead typically land-apply the manure and wastes generated through the animal production in accordance to permit and/or other regulatory specifications. Table 2-2 lists the CAFOs in the watershed.

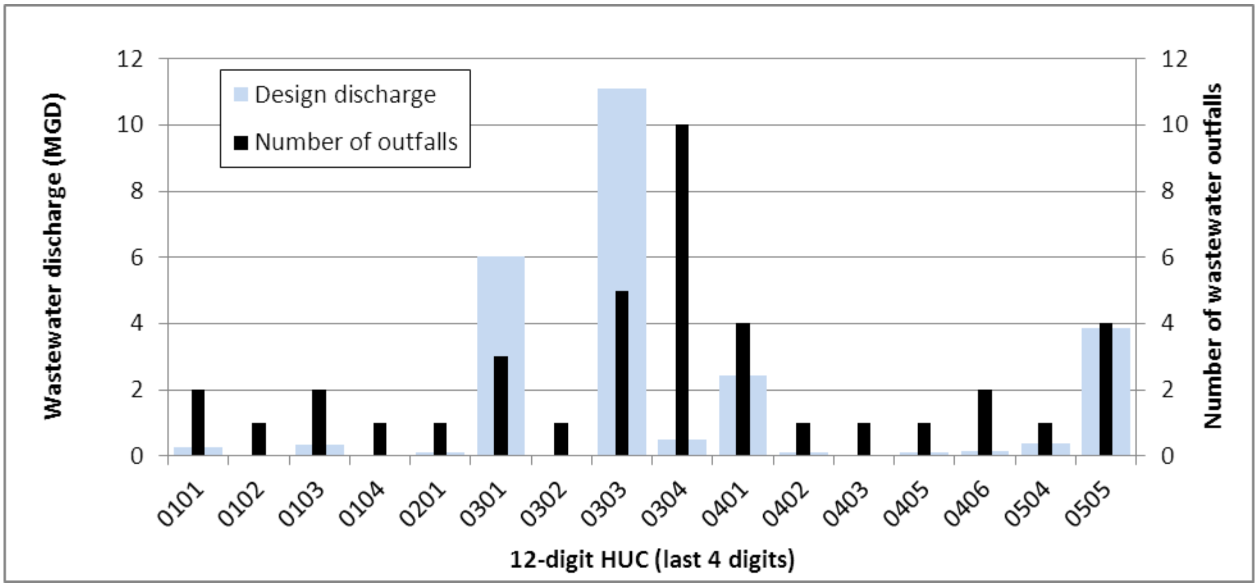


Figure 2-6. Distribution of designed wastewater discharge capacity across the 12-digit HUCs.

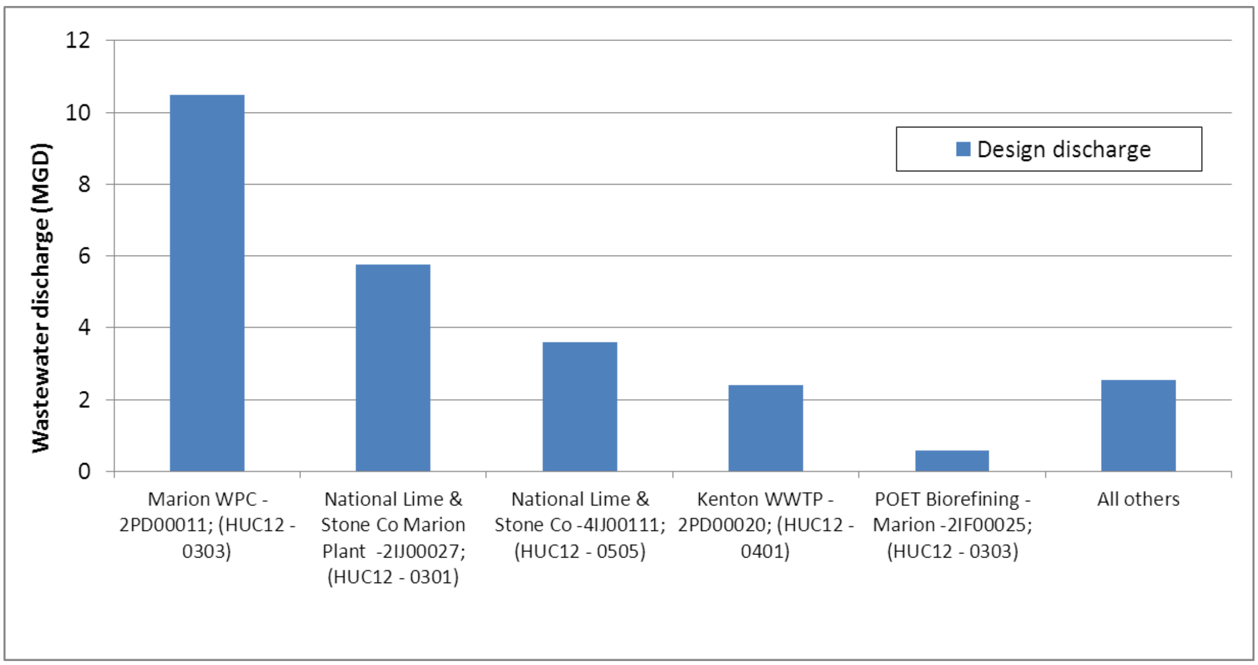


Figure 2-7. Distribution of designed wastewater discharge capacity across the largest dischargers.

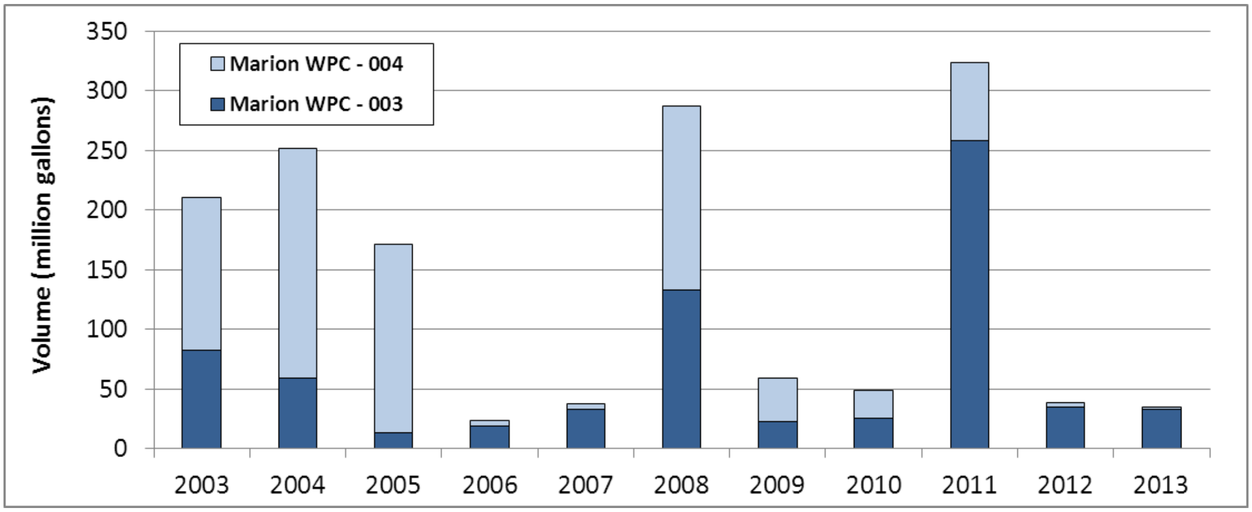


Figure 2-8. Annual discharge volume from combined sewer outfalls in the upper Scioto River watershed.

Table 2-1. List of wastewater systems with documented sanitary sewer system overflows.

12-digit HUC	Permit number	Facility name	Facility design discharge
05060001 01 01	2PB00064	Alger WWTP	0.150
05060001 01 01	2PA00006	McGuffey STP	0.120
05060001 01 02	2PG00004	Reed Road WWTP	0.007
05060001 02 01	1PB00025	Rushsylvania WWTP	0.100
05060001 03 03	2PD00011	Marion WPC	10.500
05060001 04 01	2PG00012	Roots Fairwayview STP	0.033
05060001 04 01	2PD00020	Kenton WWTP	2.400
05060001 04 02	2PA00046	Mt Victory WWTP	0.090
05060001 04 03	2PG00005	Eldridge Station Hills WWTP	0.008
05060001 04 06	2PA00065	New Bloomington WWTP	0.125
05060001 05 04	4PB00018	Richwood WWTP	0.380
05060001 05 05	2PA00041	Prospect WWTP	0.240
05060001 05 05	4PG00009	Tawa Estates WWTP	0.008

Table 2-2. List confined animal feeding operations.

12-digit HUC	Facility	Livestock type	Units	Permitting agency
05060001 02 03	DeVries Dairy LLC	Dairy	2,500	ODA/OEPA
05060001 02 02	OFE - Mt. Victory Egg Farm	Poultry	2,416,638	ODA
05060001 01 02	Van Deurzen Dairy LLC	Dairy	6,995	ODA

2.1.4 Public Drinking Water Supplies

Some communities supply public drinking water from ground water (underground aquifers). Other communities supply public drinking water by withdrawing water from surface waters, including lakes and streams. Surface water public drinking water supplies for the City of Marion are located in the upper Scioto River watershed. More details are available in Appendix B.

2.2 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 three major components: beneficial use designations, numeric and narrative criteria and antidegradation provisions. Where criteria have not been developed, the State can develop project-specific targets.

Beneficial use designations describe the existing or potential uses of a waterbody, such as public water supply; protection and propagation of aquatic life; and recreation in and on the water. 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 and scum, color and odor producing materials, substances that are harmful to human, animal or aquatic life, and nutrients in concentrations that may cause algal blooms. Much of Ohio EPA's present strategy regarding water quality based permitting is based upon the narrative free from of "no toxics in toxic amounts." Ohio EPA developed its strategy based on an evaluation of the potential for significant toxic impacts within the receiving waters. Very important components of this evaluation are the biological survey program and the biological criteria used to judge aquatic life use attainment.

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.

The following sub-sections describe the applicable water quality standards for the upper Scioto River watershed. Further details can be found in Appendix C.

2.2.1 Aquatic Life Use

Ohio's WQS have seven subcategories of aquatic life uses (see http://www.epa.ohio.gov/portals/35/rules/01-07.pdf). The WQS rule contains a narrative for each aquatic life use and the three most commonly assigned aquatic life uses have quantitative, numeric biological criteria that express the minimum acceptable level of biological performance based on three separate biological indices. The indices measure the health of aquatic communities of both fish and insects.

There are three different aquatic life use designations in the upper Scioto River watershed (Figure 2-9). Warmwater habitat (WWH) is the primary designation used and constitutes the highest percentage of designated stream miles (i.e., 92 percent). Modified warmwater habitat (MWH) is used to establish lower goals for streams that have experienced substantial and long-lasting degradation in quality and therefore essentially incapable of supporting aquatic communities that are diverse and healthy enough to achieve the goals associated with WWH. MWH constitutes four percent of the designated stream miles. Likewise, four percent of the designated stream miles are limited resource waters (LRW) which do not have associated biocriteria standards due to extreme and irretrievable water quality degradation. Figure 2-10 shows the distribution of stream miles per aquatic life use designation per 12-digit HUC. Table 2-3 shows the specific biological index scores used as the bio-criteria for the respective use designations and assessment methods.

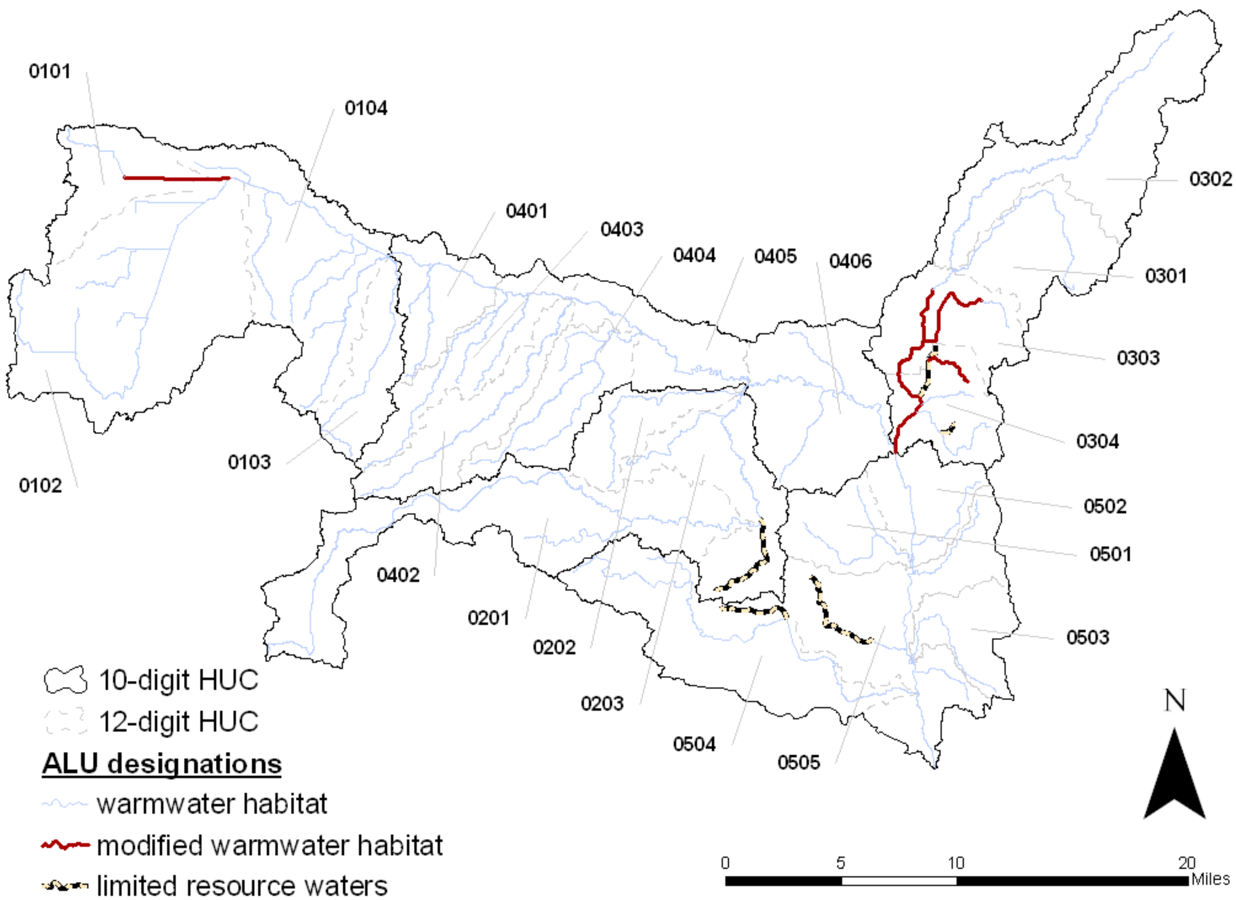


Figure 2-9. Distribution of aquatic life use designations across the upper Scioto River watershed.

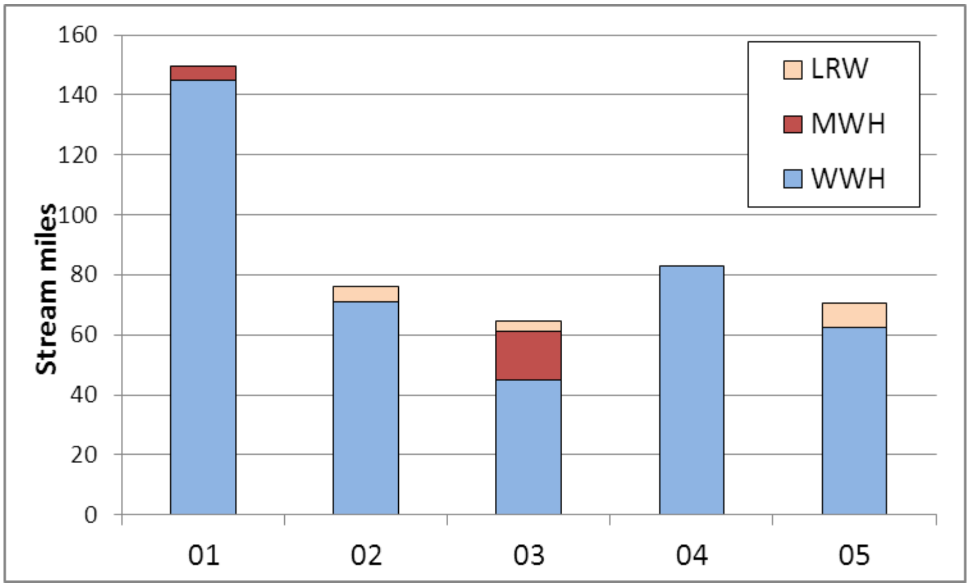


Figure 2-10. Distribution of aquatic life use designations per stream miles per 10-digit HUC.

Table 2-3. Biological criteria applicable to rivers and streams in the upper Scioto River watershed for three aquatic life use designations.

Ecoregion	Biological Index	Assessment Method[2, 3]	Biological Criteria for the Applicable Aquatic Life Use Designations[1]		
			WWH	EWH	MWH[4]
Eastern Cornbelt Plains (ECBP)	IBI	Headwater	40	50	24
		Wading	40	50	24
		Boat	42	48	24 / 30
	MIwb	Wading	8.3	9.4	6.2
		Boat	8.5	9.6	5.8 / 6.6
	ICI	All[5]	36	46	22

1 Coldwater habitats (CWH), limited warmwater habitat (LWH), resource waters (LRW) and seasonal salmonid habitat (SSH) 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 Biocriteria depend on type of MWH. MWH-C (due to channelization) is listed first, MWH-I (due to impoundment) is listed second, and MWH-A (mine affected) is listed third (only applicable in the WAP).
5 Limited to sites with appropriate conditions for artificial substrate placement.

2.2.2 Recreation Use

Ohio's WQS have three subcategories of recreation uses (bathing waters, primary contact and secondary contact). Within primary contact there are three classes of streams (A, B and C) that describe the general frequency with which the stream is used for recreation. The WQS rule contains a description of each recreation use and all primary contact recreation classes have numeric criteria that are associated with a statistically-based risk level. Table 2-4 shows the *E. coli* concentration statistics used as criteria for the respective use designations, while Figure 2-11 is a map that indicates the recreation use designations for the streams in the project area.

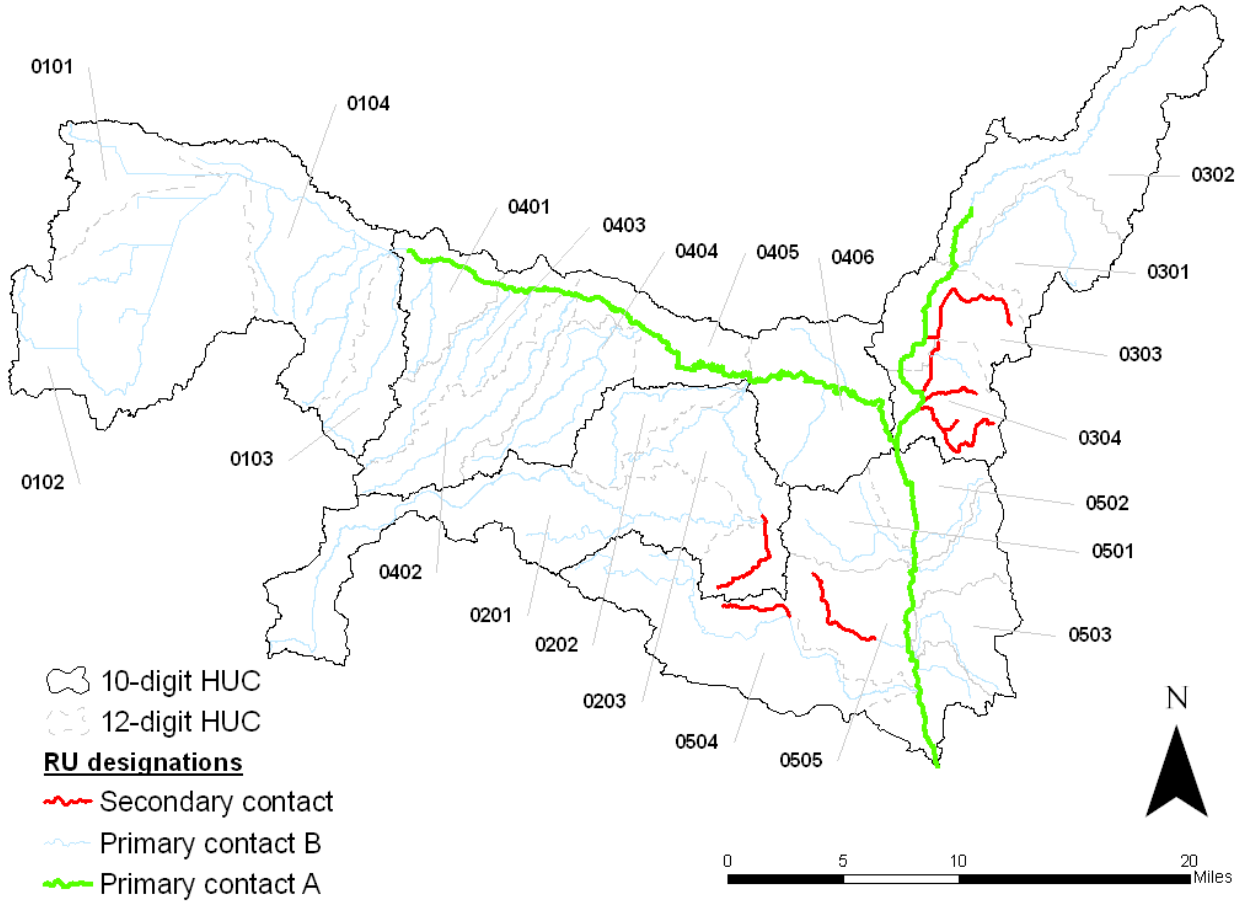


Figure 2-11. Distribution of recreation use designations across the upper Scioto River watershed.

Table 2-4. Water quality criteria established for recreation uses within water bodies throughout Ohio.

Recreation Use	*E. coli* (colony forming units per 100 ml)	
	Seasonal Geometric Mean	Single Sample Maximum[1]
Bathing water	126	235[a]
Class A primary contact recreation	126	298
Class B primary contact recreation	161	523
Class C primary contact recreation	206	940
Secondary contact recreation	1030	1030

[1] Except as noted in footnote *a*, these criteria shall not be exceeded in more than ten per cent of the samples taken during any thirty-day period.

[a] This criterion shall be used for the issuance of beach and bathing water advisories.

2.2.3 Public Drinking Water Supply Use

The public drinking water supply use includes surface waters from which public drinking water is supplied. This beneficial use provides an opportunity to strengthen the connection between Clean Water Act and Safe Drinking Water Act (SDWA) activities by employing the authority of the CWA to meet SDWA objectives of source water protection and reduced risk to human health. Criteria associated with this use designation apply within five hundred yards of surface water intakes.

2.2.4 Human Health (Fish Contaminants) Use

Ohio has adopted human health WQS criteria to protect the public from adverse impacts, both carcinogenic and non-carcinogenic, caused by exposure via drinking water (applicable at public water supply intakes) and by exposure in the contaminated flesh of sport fish (applicable in all surface waters). The latter criterion, called the non-drinking water human health criterion, ensures that levels of a chemical in water do not bioaccumulate in fish to levels harmful to people who catch and eat the fish. Ohio measures contaminants in fish tissue and uses the data in two comparisons: (1) to determine if the human health criteria are being violated, thus identifying the water for restoration through a TMDL or other action, or (2) to determine the quantity of sport fish that may be safely consumed. The first comparison can result in the water being identified as impaired on the 303(d) list; the second can result in the issuance of a sport fish consumption advisory.

Two common contaminants in fish tissue are polychlorinated biphenyls (PCBs) and mercury. PCBs are currently banned from use in the U.S. and are expected to decrease in streams over time. Therefore, despite being listed as causing human health impairments in the Ottawa Creek-Scioto River (0505) sub-watershed, no further action other than continued monitoring for PCBs in fish in will be taken.

The upper Scioto River watershed is included in the statewide fish advisory for mercury. There are additional advisories specific to the upper Scioto River watershed against eating fish or swimming in the Little Scioto River from State Route 739, near Marion to Holland Road, near Marion (Marion County) due to elevated poly-aromatic hydrocarbons (PAHs). Information regarding fish consumption advisories can be found at: http://www.epa.ohio.gov/dsw/fishadvisory/index.aspx.

3 WATER QUALITY CONDITIONS IN THE WATERSHED

Ohio uses the fish and aquatic insects that live in streams to assess the health of Ohio's flowing waters. Aquatic animals are generally the most sensitive indicators of pollution because they inhabit the water all of the time. A healthy stream community is also associated with high quality recreational opportunities (e.g., fishing and boating).

In addition to biological data, Ohio EPA collects information on the chemical quality of the water, sediment, and wastewater discharges; data on the contaminants in fish flesh; and physical information about streams. Taken together, this information identifies the factors that limit the health of aquatic life and that constitute threats to human health.

Ohio EPA performed a comprehensive water quality study in the upper Scioto River watershed in 2009. Sixty-two sites were studied for biological health, 67 sites for water chemistry, 29 sites for recreation use, and 18 sites for human health (fish contaminants) use. Sites were scattered throughout the watershed. Refer to Appendix B for more information.

Overall, less than half of the sites (42 percent) evaluated for aquatic life uses fully met the bio-criteria. About one-fourth failed to meet even one of the three bio-criteria and therefore is in non-attainment, while 32 percent is in partial attainment. The Little Scioto River watershed showed the worst performance from the aquatic communities as none of the eleven sites surveyed there fully attained their bio-criteria; nine of which were in non attainment (which is over half of the non attaining sites in the entire upper Scioto River watershed). McDonald Creek (0202) and Fulton Creek (0504) likewise stood out in terms of poor aquatic life performances and high level of non attaining sites. The remaining 12-digit HUCs generally had a high percentage of fully and/or partially attaining sites (Figure 3-1).

The degraded aquatic communities in Little Scioto River are primarily impacted by stressors emanating from crop and animal agriculture and associated land drainage practices. Excessive fine sediment and poor habitat quality are the top causes of aquatic life use impairment; however, nutrients and organic enrichment and associated impacts on dissolved oxygen concentrations are also significant problems. Low dissolved oxygen is not noted with elevated nutrients but instead in association with organic enrichment, where loading occurs through combined sewer systems. Legacy creosote pollution is still having an impact on the Little Scioto River near its mouth and is likely entering the water column from loading from combined sewers as well as re-suspension of contaminated sediment from the streambed. Manure laden run off is also a source of nutrients and, on occasions, has led to fish kills.

Recreation use was impaired at 27 of the 29 sites. Over half of the impaired sites exceeded the geometric mean criteria by a factor of at least two times greater. Twenty-five percent of the impaired sites exceeded the criteria by at least three times. All ten of the sites evaluated on the Scioto River failed to meet the criteria; however, seven of these failed by less than a factor of two times the geometric mean criteria. Run off from agricultural areas is suspected as the most common source of bacteria in the Scioto River and its tributaries (i.e., land applied manures and other residues that are sources of *E. coli* bacteria). Bacteria loading from septic systems, urban areas, and combined sewer overflows are also significant.

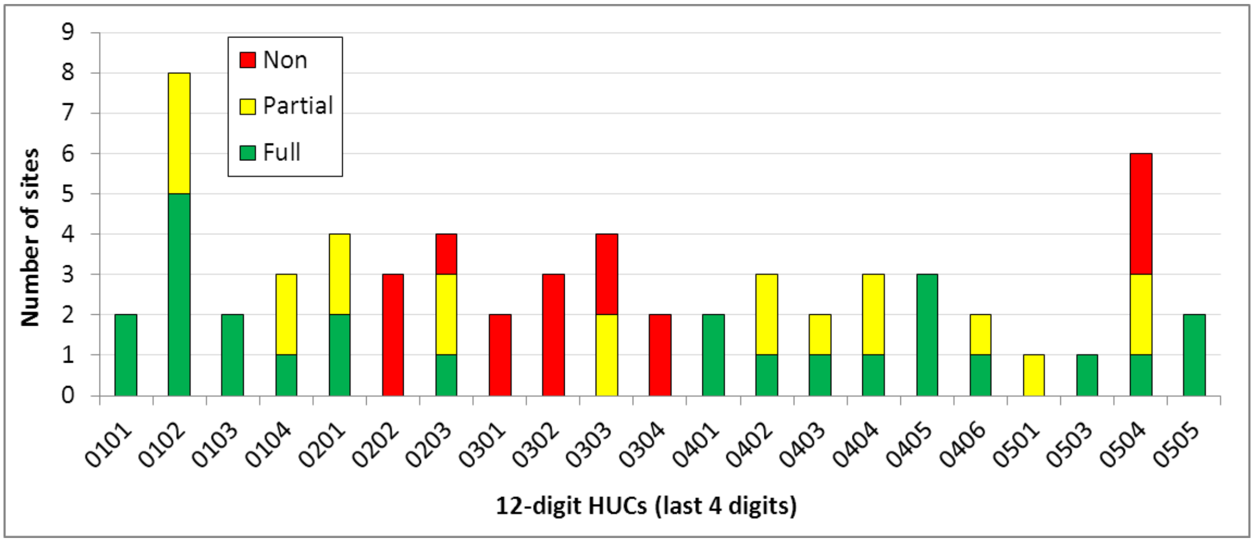


Figure 3-1. Distribution of site results per 12-digit HUC for aquatic life use attainment.

The upper Scioto River watershed TMDL includes five subwatersheds (Figure 3-2). Within each of the five subwatersheds, smaller watersheds are nested (12-digit assessment units). This chapter discusses conditions in each of the subwatersheds with detail added in unique nested subwatersheds. To report on the health of large rivers, Ohio EPA developed a special definition for the area beginning at the point where a river drains more than approximately 500 square miles and extending to the mouth. At this size, rivers generally are impacted more by the character of and activity in the accumulated drainage area and less by what is happening adjacent to the channel (i.e., on the stream bank). Three sites on the Scioto River, downstream of its confluence with the Little Scioto River, fall within the 05060001-9001 large river assessment unit (LRAU). These sites are within the 05-02 and 05-05 twelve-digit HUCs. However, the Middle Scioto River watershed was assessed in 2010, and it includes two LRAUs in its evaluation, including the lower portion of the 9001 LRAU. For this reason the three sites that fall within the geographic confines of the upper Scioto River watershed project will be considered with the remaining LRAU sites that are associated with the middle Scioto River TMDL project.

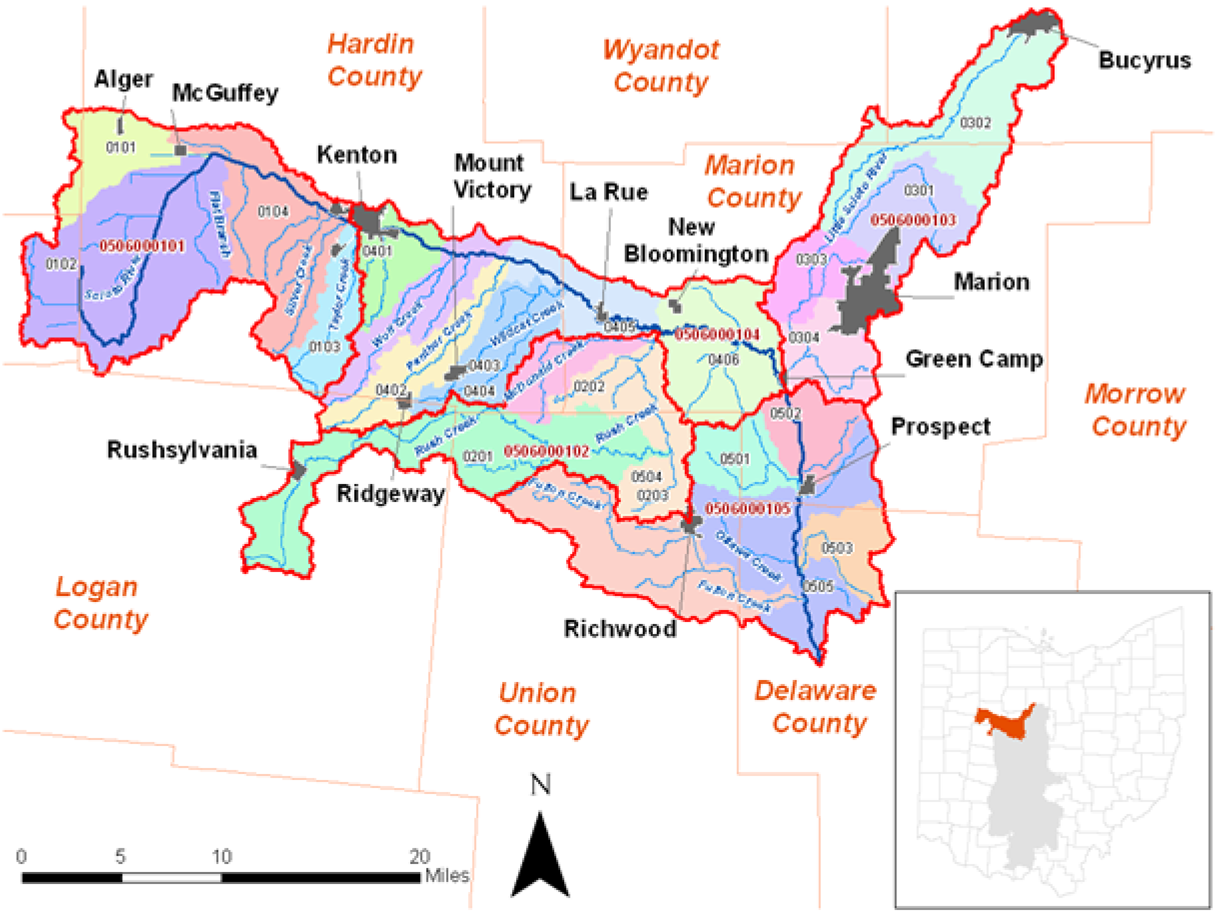


Figure 3-2. Map of the upper Scioto River watershed.

3.1 Headwaters Scioto River (05060001 01)

The Headwaters Scioto River subwatershed drains 159 square miles in the northwestern portion of the watershed (see Figure 3-3). It consists of four nested subwatersheds. The main tributaries to Scioto River include Cottonwood Ditch, Silver Creek and Taylor Creek. Major causes of impairment include poor habitat, sedimentation and altered flow. Those causes are primarily associated with channelization, land clearance and naturally occurring conditions. Figure 3-4 shows land use within the Headwaters Scioto River subwatershed which can provide context for the water quality observations.

Figure 3-5 shows water chemistry results in the subwatershed. Figure 3-6 shows relative occurrence of causes of aquatic life use impairment in the Headwaters Scioto River subwatershed. Figure 3-7 shows the relative occurrence of sources of aquatic life use impairment in the Headwaters Scioto River subwatershed.

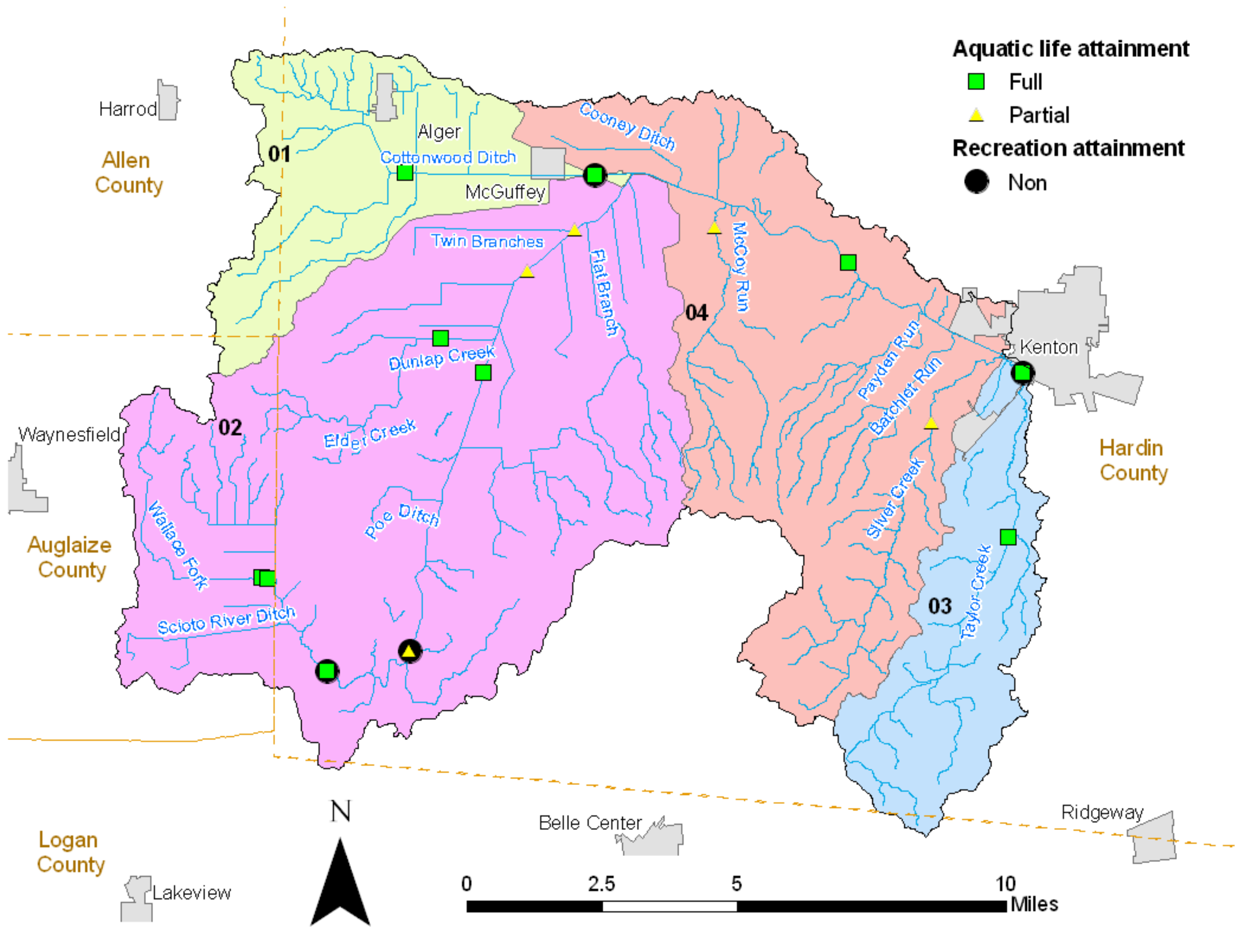


Figure 3-3. Attainment results for the Headwaters Scioto River subwatershed.

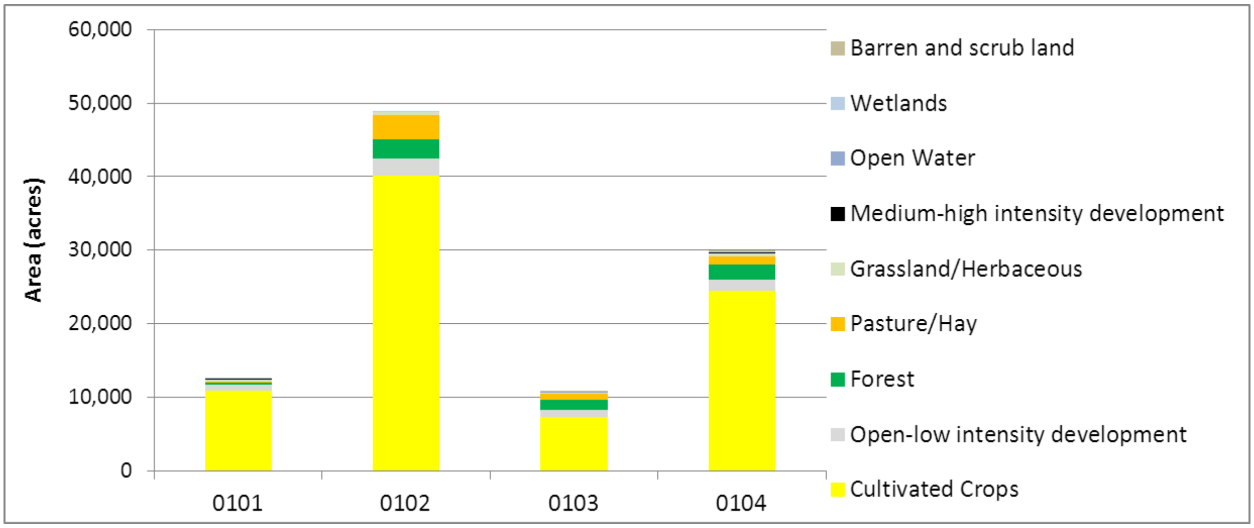


Figure 3-4. Land use in the Headwaters Scioto River subwatershed.

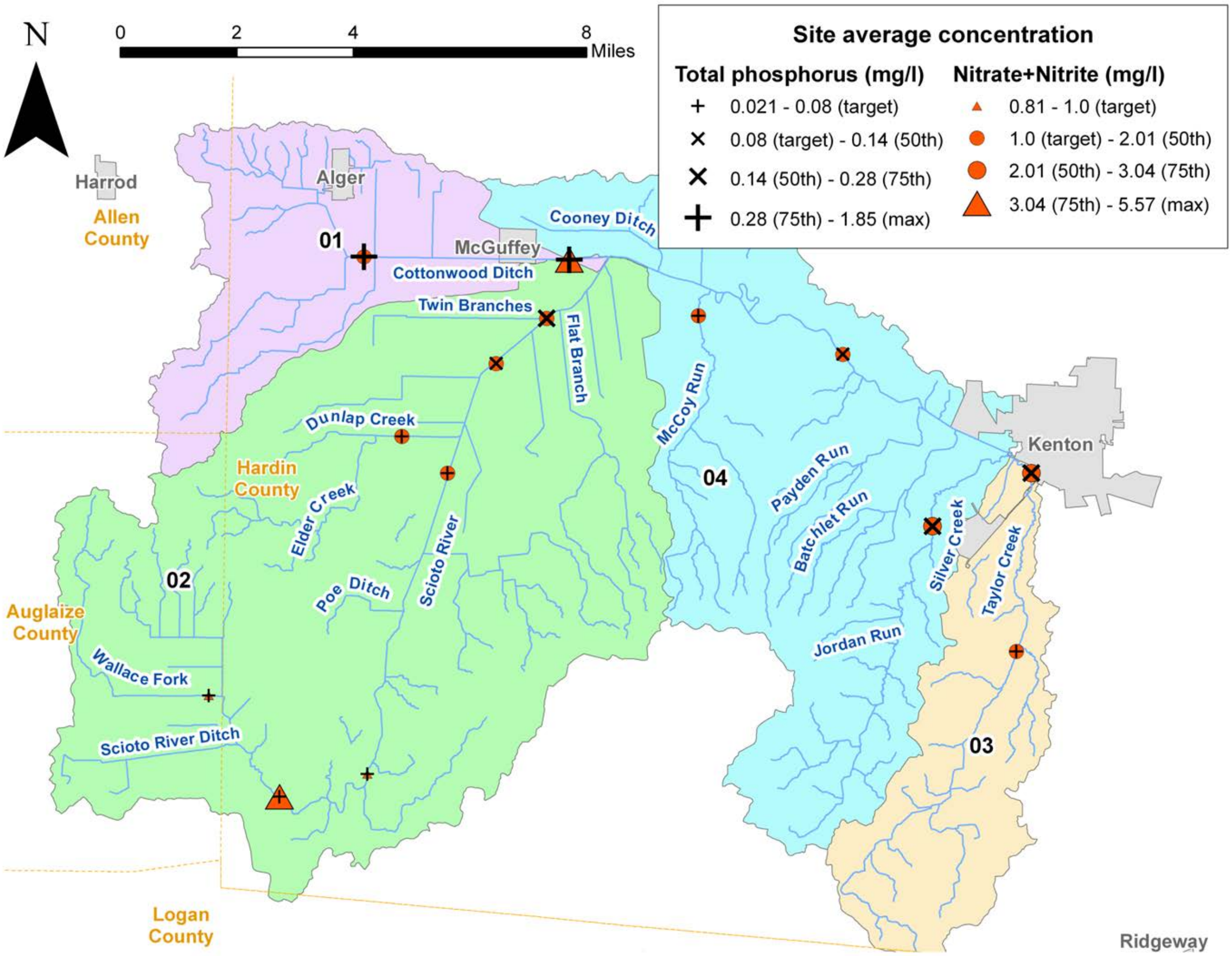


Figure 3-5. Water chemistry results for the Headwaters Scioto River subwatershed. Breakpoints in the concentration intervals are based on percentile statistics and water quality targets.

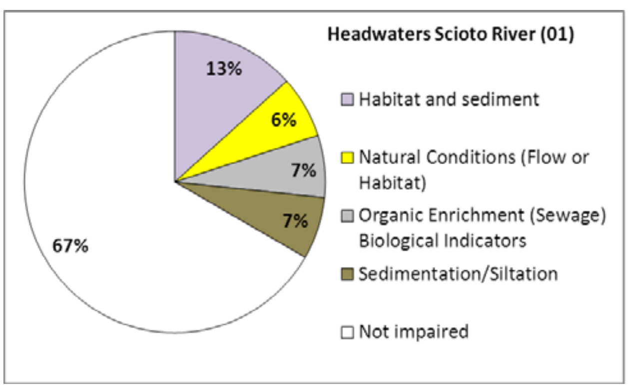


Figure 3-6. Causes of aquatic life use impairment in the Headwaters Scioto River subwatershed.

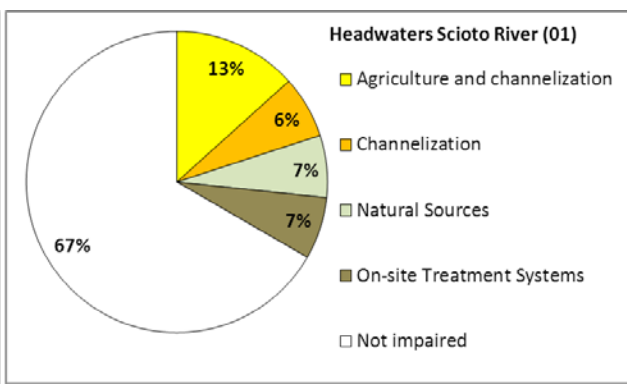


Figure 3-7. Sources of aquatic life use impairment in the Headwaters Scioto River subwatershed.

Table 3-1 shows the site-by-site results for each designated beneficial use organized by nested subwatersheds. For more specific information regarding individual site assessment results and supporting chemistry results, see Appendix B.

Table 3-2. Number of impaired sites, organized by use and nested subwatershed, in the Headwaters Scioto River subwatershed.

Nested Subwatershed (05060001 01)		Aquatic Life Use	Recreation Use	Public Drinking Water Supply Use	Human Health Use[1]
01 01	# impaired sites (non/partial)	0	1		
	Index score[2]	100.0	50.0	N/A	N/A
01 02	# impaired sites (non/partial)	3 (0/3)	2		
	Index score	37.5	50.0	N/A	N/A
01 03	# impaired sites (non/partial)	0	1		
	Index score	100.0	75.0	N/A	N/A
01 04	# impaired sites (non/partial)	2 (0/2)	1		
	Index score	50.0	50.0	N/A	N/A

[1] Impairments to the human health use are not being addressed in this TMDL.
[2] The index score (between 0 and 100) indicates the relative support of the aquatic life or recreation use in the nested subwatershed. A score of 100 indicates full support of the use.

Habitat quality in the headwaters of the Scioto River was lower than the target conditions, with some sites above target, but a slight majority was far below the target. Scores from the qualitative habitat evaluation index (QHEI) provide a means to use numeric representations of habitat quality and therefore have a quasi-quantification of how exceptional or deficient the habitat quality is. For warm water habitats (WWH designations) a score of 60 out of a possible 100 points is considered the lower boundary before adverse impacts to biota can be reasonably expected. For the 15 sites evaluated in the headwaters of Scioto River (13 are within WWH reaches and two in MWH reaches), the average QHEI score is 49.8 (median = 46.0) with a range in scores from 18 to 80. Three sites on the Scioto River from river miles 236.7 to 231.86 showed good to exceptional habitat quality, while the remaining sites on the river (from river mile 226.3 to 216.67) showed very poor habitat quality. The tributaries had scores that were either very poor (Cottonwood Ditch, Dunlap Creek, and Wallace Fork) or good to exceptional (Taylor and Silver Creeks).

3.2 Rush Creek (05060001 02)

The Rush Creek subwatershed drains 105 square miles in the central portion of the watershed (see Figure 3-8). It consists of three nested subwatersheds. The main tributaries to Rush Creek include McDonald Creek, Dudley Run and Rocky Fork. Major causes of impairment include poor habitat, low dissolved oxygen and low flow conditions. Those causes are primarily associated with channelization, agricultural practices and naturally occurring conditions. McDonald Creek was especially impacted by its poor habitat quality due to its maintenance as an agricultural drainage conduit. Poor habitat (mean QHEI score = 41.8; n = 3) also was likely to exacerbate eutrophic conditions that further degraded the aquatic community (e.g., by limiting assimilative capacity and re-aeration of the water column and/or facilitating massive algae growth). Figure 3-9 shows land use within the Rush Creek subwatershed which can provide context for the water quality observations.

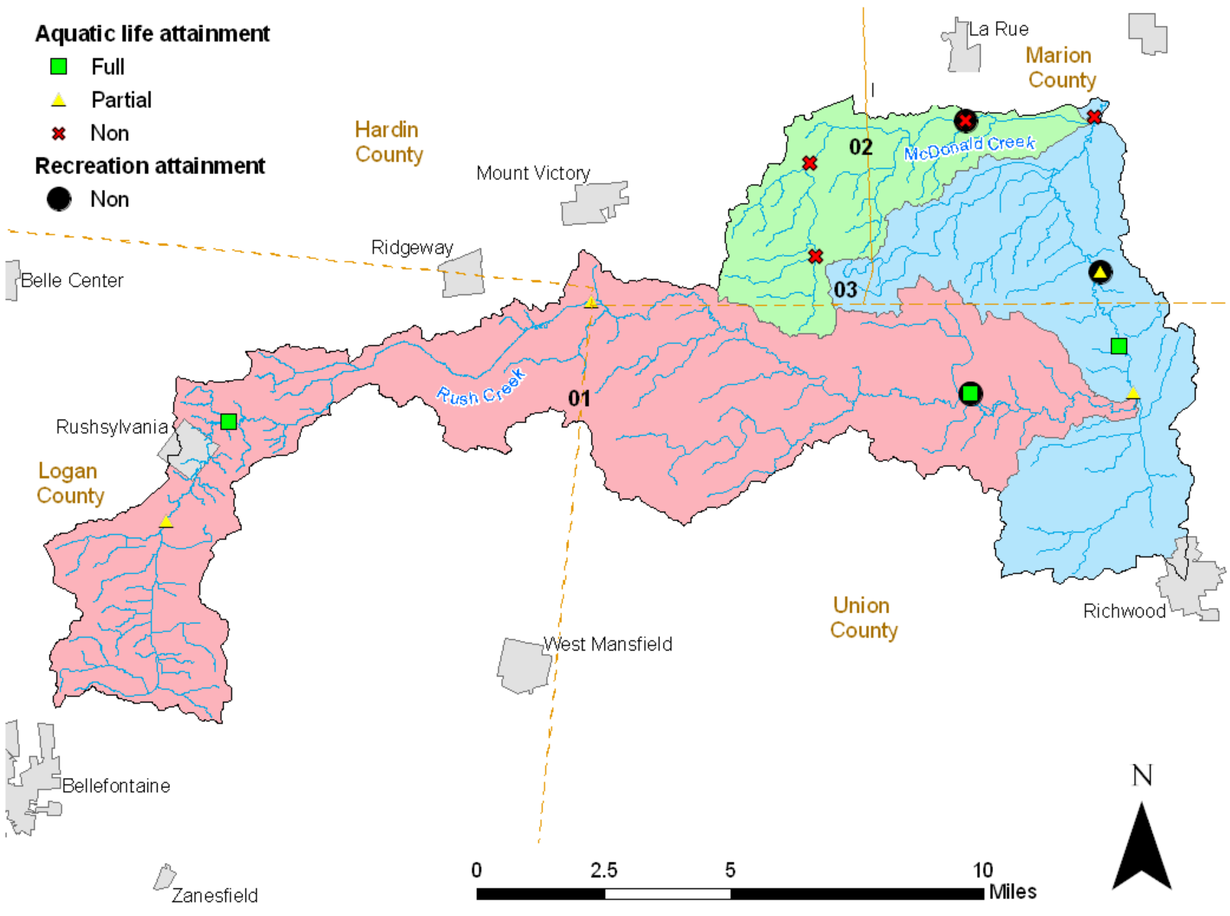


Figure 3-8. Attainment results for the Rush Creek subwatershed.

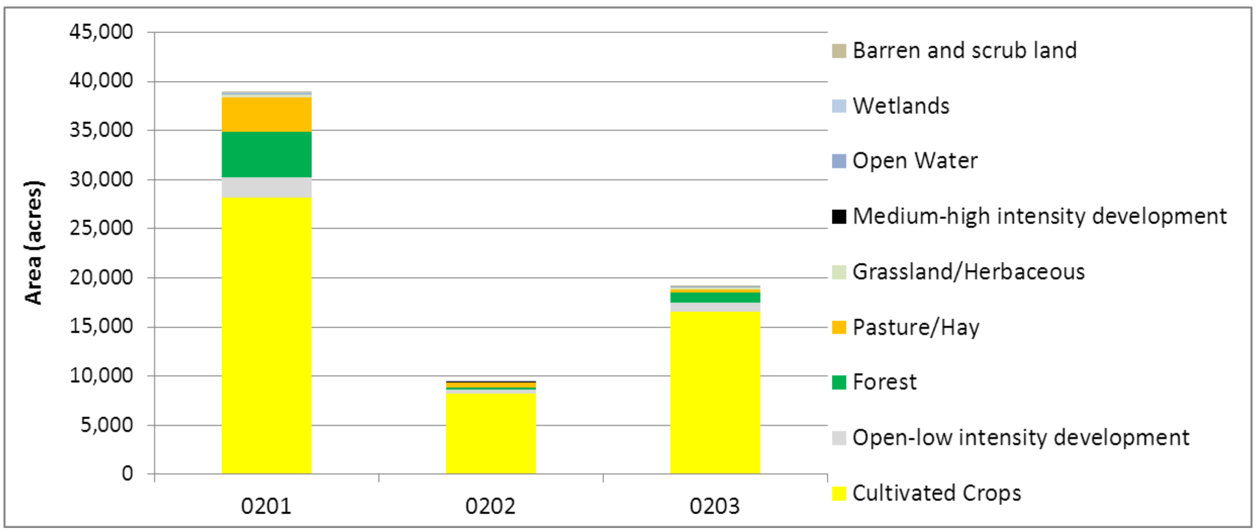


Figure 3-9. Land use in the Rush Creek subwatershed.

Figure 3-10 shows water chemistry results in the subwatershed. Some of these results aided in identifying causes of aquatic life use impairment. Figure 3-11 shows relative occurrence of causes of aquatic life use impairment in the Rush Creek subwatershed. Figure 3-12 shows the relative occurrence of sources of aquatic life use impairment in the Rush Creek subwatershed.

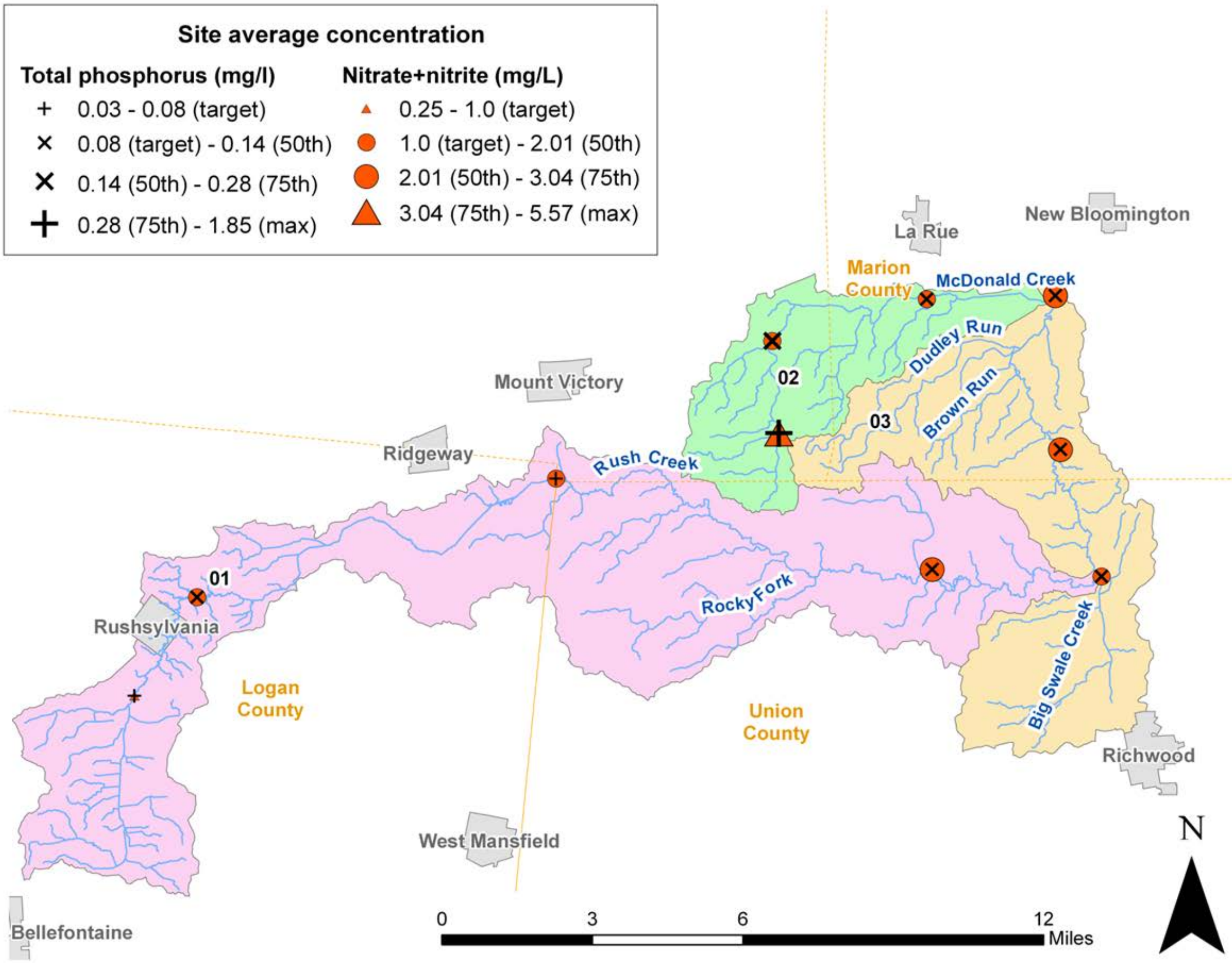


Figure 3-10. Water chemistry results for the Rush Creek subwatershed. Breakpoints in the concentration intervals are based on percentile statistics and water quality targets.

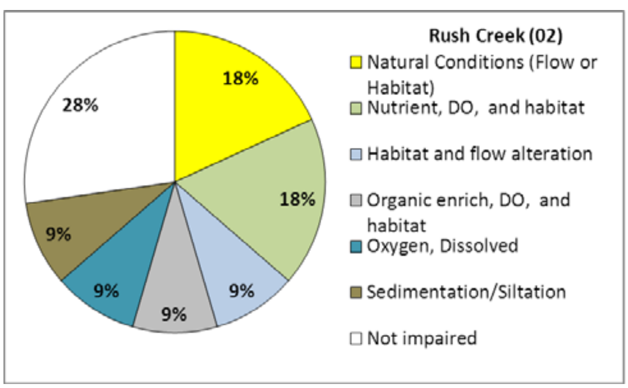


Figure 3-11. Causes of aquatic life use impairment in the Rush Creek subwatershed.

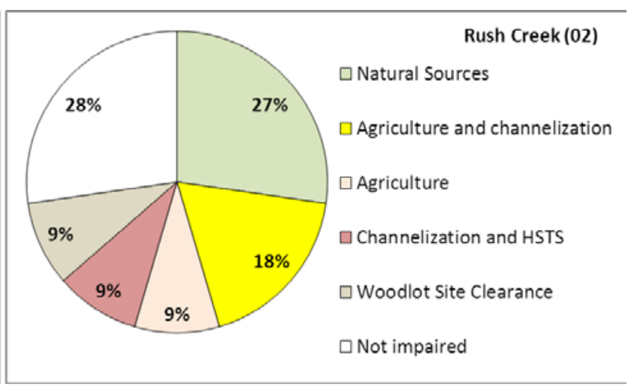


Figure 3-12. Sources of aquatic life use impairment in the Rush Creek subwatershed.

Table 3-2 shows the site-by-site results for each designated beneficial use organized by nested subwatersheds. For more specific information regarding individual site assessment results and supporting chemistry results, please see Appendix B.

Table 3-2. Number of impaired sites, organized by use and nested subwatershed, in the Rush Creek subwatershed.

Nested Subwatershed (05060001 01)		Aquatic Life Use	Recreation Use	Public Drinking Water Supply Use	Human Health Use[1]
02 01	# impaired sites (non/partial)	2 (0/2)	1		
	Index score[2]	62.5	50.0	N/A	N/A
02 02	# impaired sites (non/partial)	3 (3/0)	1		
	Index score	0.0	75.0	N/A	N/A
02 03	# impaired sites (non/partial)	3 (1/2)	1		
	Index score	25.0	75.0	N/A	N/A

[1] Impairments to the human health use are not being addressed in this TMDL.
[2] The index score (between 0 and 100) indicates the relative support of the aquatic life or recreation use in the nested subwatershed. A score of 100 indicates full support of the use.

Habitat quality in the two streams evaluated in the Rush Creek watershed differed considerably from one another. Rush Creek showed good to exceptional habitat quality (especially in the headwaters) and none of the QHEI scores fell below the WWH target of 60. Average QHEI scores in Rush Creek was 69.1 with scores as high as 82.5. McDonald Creek; however, showed poor habitat quality with a maximum score from the three sites of 44.5.

3.3 Little Scioto River (05060001 03)

The Little Scioto River subwatershed drains 113 square miles in the northeastern portion of the watershed (see Figure 3-13). It consists of four nested subwatersheds. The main tributaries to the Little Scioto River include Rock Fork, Rock Swale and Honey Creek. Major causes of impairment include poor habitat, nutrients and organic enrichment. Those causes are primarily associated with channelization, agricultural practices, and combined sewer overflows. Figure 3-14 shows land use within the Little Scioto River subwatershed which can provide context for the water quality observations.

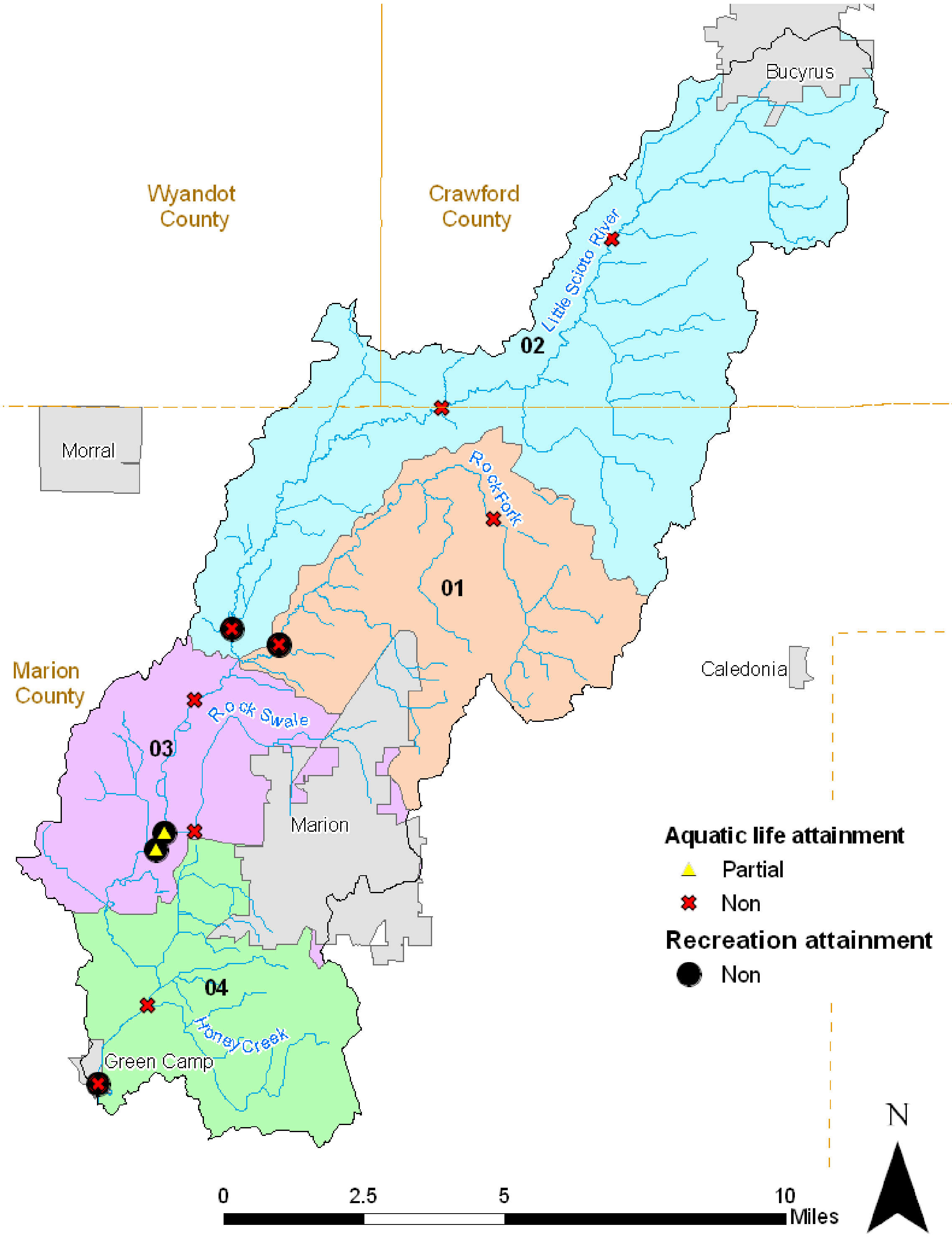


Figure 3-13. Attainment results for the Little Scioto River subwatershed.

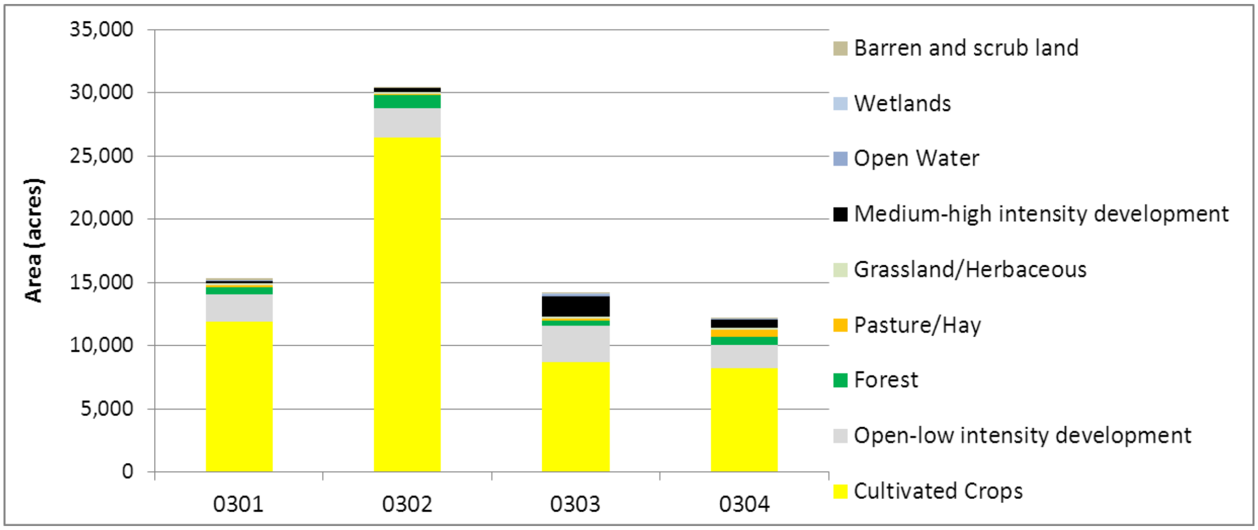


Figure 3-14. Land use in the Little Scioto River subwatershed.

Figure 3-15 shows water chemistry results in the subwatershed. Some of these results aided in identifying causes of aquatic life use impairment. Figure 3-16 shows relative occurrence of causes of aquatic life use impairment in the Little Scioto River subwatershed. Figure 3-17 shows the relative occurrence of sources of aquatic life use impairment in the Little Scioto River subwatershed.

Table 3-3 shows the site-by-site results for each designated beneficial use organized by nested subwatersheds. For more specific information regarding individual site assessment results and supporting chemistry results, please see Appendix B.

Habitat quality in the Little Scioto River was generally somewhat lower than the target conditions, with some sites above target, but a slight majority was below the target. For the eleven sites evaluated in the Little Scioto River (seven are within WWH reaches and four in MWH reaches), the average QHEI score is 51.0 (median = 49.0) with a range in scores from 31 to 74. Five of the seven sites on the Little Scioto River showed habitat quality below the target QHEI score of 60. Honey Creek nearly achieved the target (QHEI = 58.5); however, Rock Fork was far below target at an upstream site (river mile 8.13) and considerably above target near its mouth (river mile 1.10).

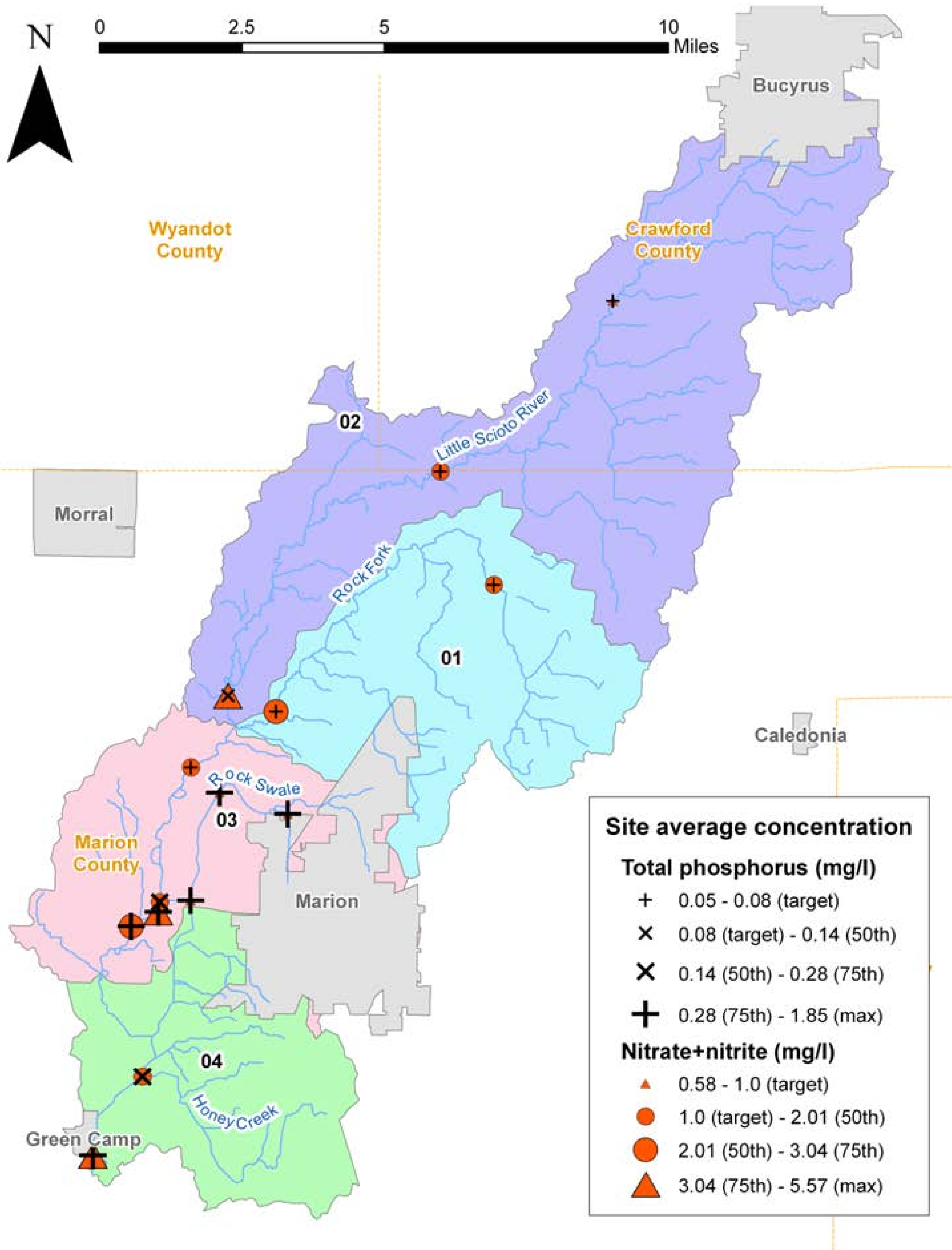


Figure 3-15. Water chemistry results for the Little Scioto River subwatershed. Breakpoints in the concentration intervals are based on percentile statistics and water quality targets.

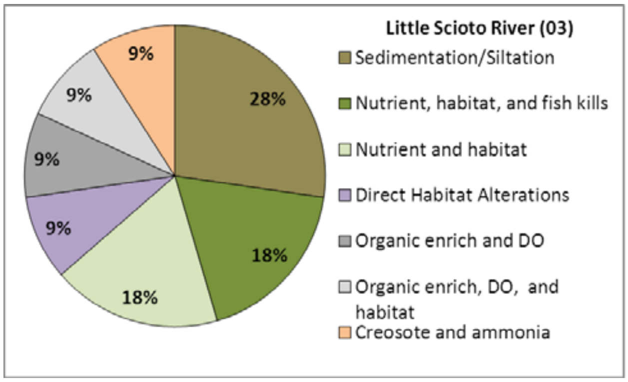


Figure 3-16. Causes of aquatic life use impairment in the Little Scioto River subwatershed.

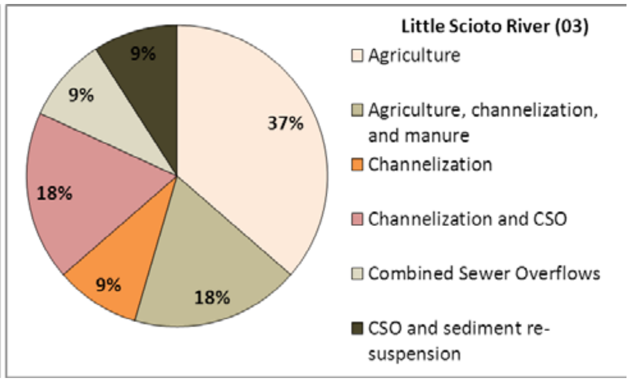


Figure 3-17. Sources of aquatic life use impairment in the Little Scioto River subwatershed.

Table 3-3. Number of impaired sites, organized by use and nested subwatershed, in the Little Scioto River subwatershed.

Nested Subwatershed (05060001 01)		Aquatic Life Use	Recreation Use	Public Drinking Water Supply Use	Human Health Use[1]
03 01	# impaired sites (non/partial)	2 (2/0)	1		
	Index score[2]	0.0	75.0	N/A	N/A
03 02	# impaired sites (non/partial)	3 (3/0)	1		
	Index score	0.0	50.0	N/A	N/A
03 03	# impaired sites (non/partial)	4 (2/2)	4		
	Index score	0.0	31.3	N/A	N/A
03 04	# impaired sites (non/partial)	2 (2/0)	1		
	Index score	25.0	50.0	N/A	N/A

[1] Impairments to the human health use are not being addressed in this TMDL.
[2] The index score (between 0 and 100) indicates the relative support of the aquatic life or recreation use in the nested subwatershed. A score of 100 indicates full support of the use.

3.3.1 Honey Creek-Little Scioto River (050600010304)

The Little Scioto River had been severely impacted by creosote contamination from industry in the City of Marion via loading from North Rock Swale Ditch. A considerable portion of the impacted area has been cleaned over the past ten years, namely one half mile of North Rock Swale Ditch, as well as the Little Scioto River from its confluence with Rock Swale down to the crossing at State Route 95. See the following web link for more information: http://www.epa.gov/region05/cleanup/littlescioto/index.htm.

3.4 Panther Creek-Scioto River (05060001 04)

The Panther Creek-Scioto River subwatershed drains 144 square miles in the central portion of the watershed (see Figure 3-18). It consists of six nested subwatersheds. The main tributaries to Scioto River include Wolf Creek, Panther Creek, and Wildcat Creek. Major causes of impairment include nutrients, excessive fine sediment and poor habitat. Those causes are primarily associated with agricultural practices, channelization and naturally occurring conditions. Figure 3-19 shows land use within the Panther Creek-Scioto River subwatershed which can provide context for the water quality observations.

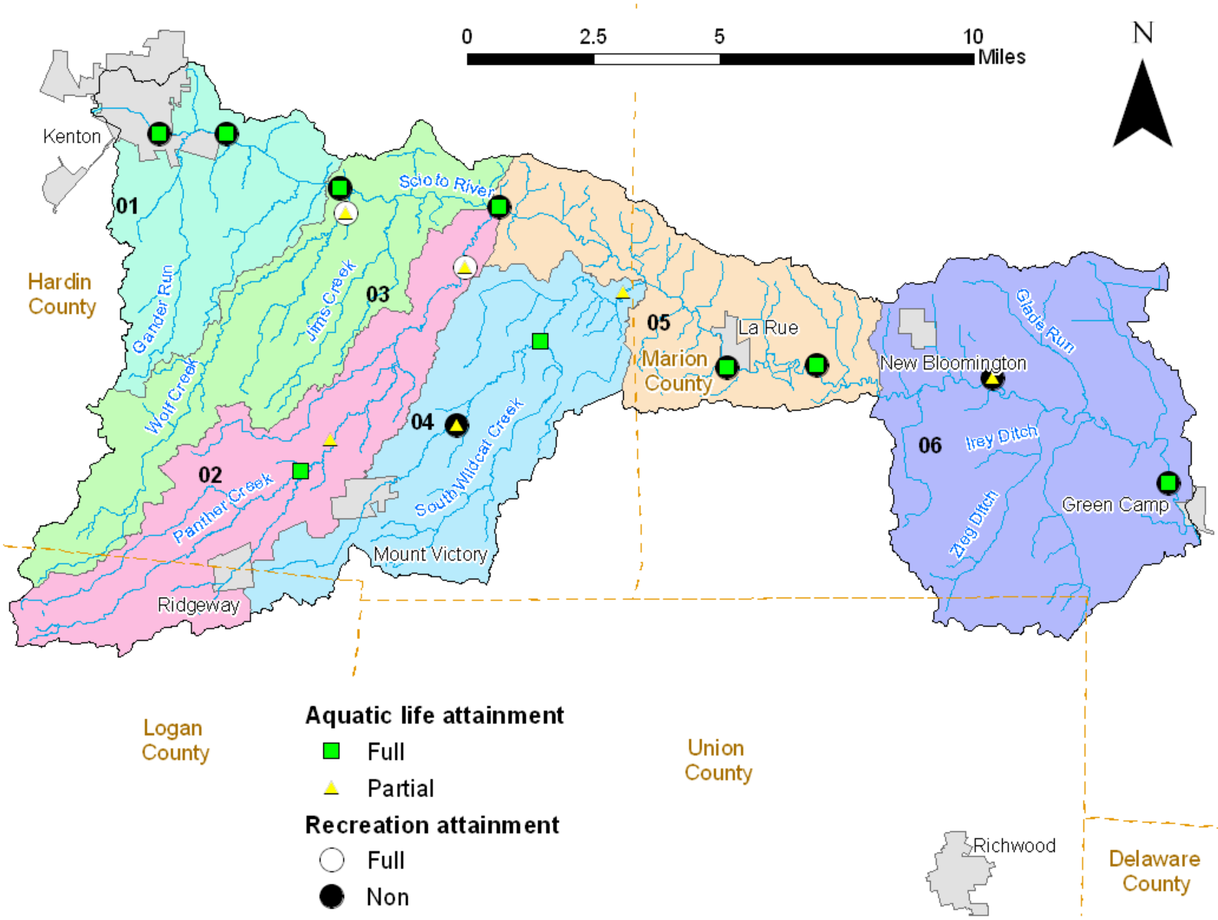


Figure 3-18. Attainment results for the Panther Creek-Scioto River subwatershed.

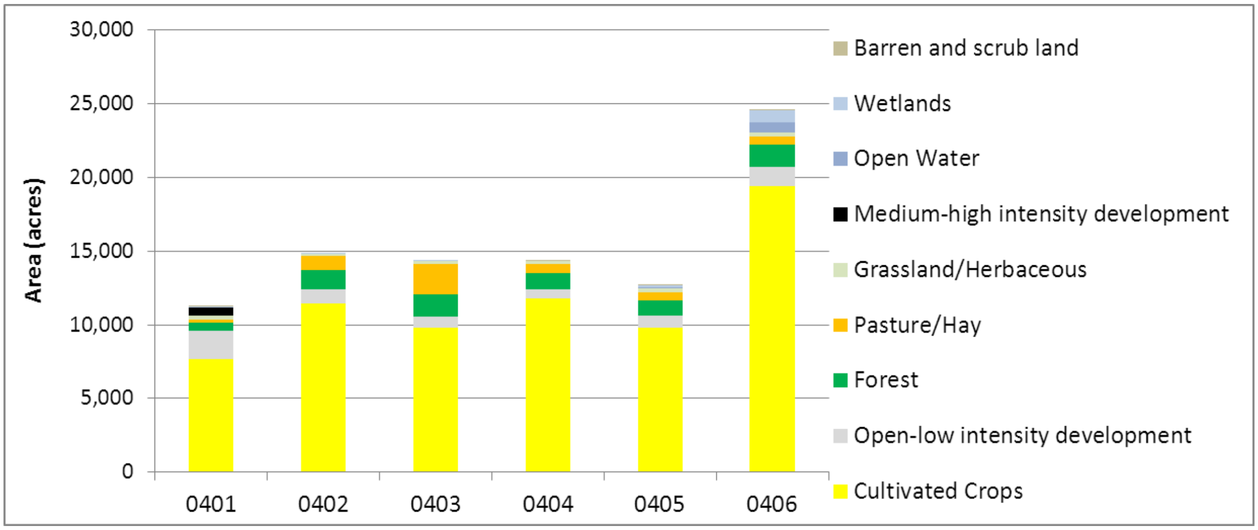


Figure 3-19. Land use in the Panther Creek-Scioto River subwatershed.

Figure 3-20 shows water chemistry results in the subwatershed. Some of these results aided in identifying causes of aquatic life use impairment. Figure 3-21 shows relative occurrence of causes of aquatic life use impairment in the Panther Creek-Scioto River subwatershed. Figure 3-22 shows the relative occurrence of sources of aquatic life use impairment in the Panther Creek-Scioto River subwatershed.

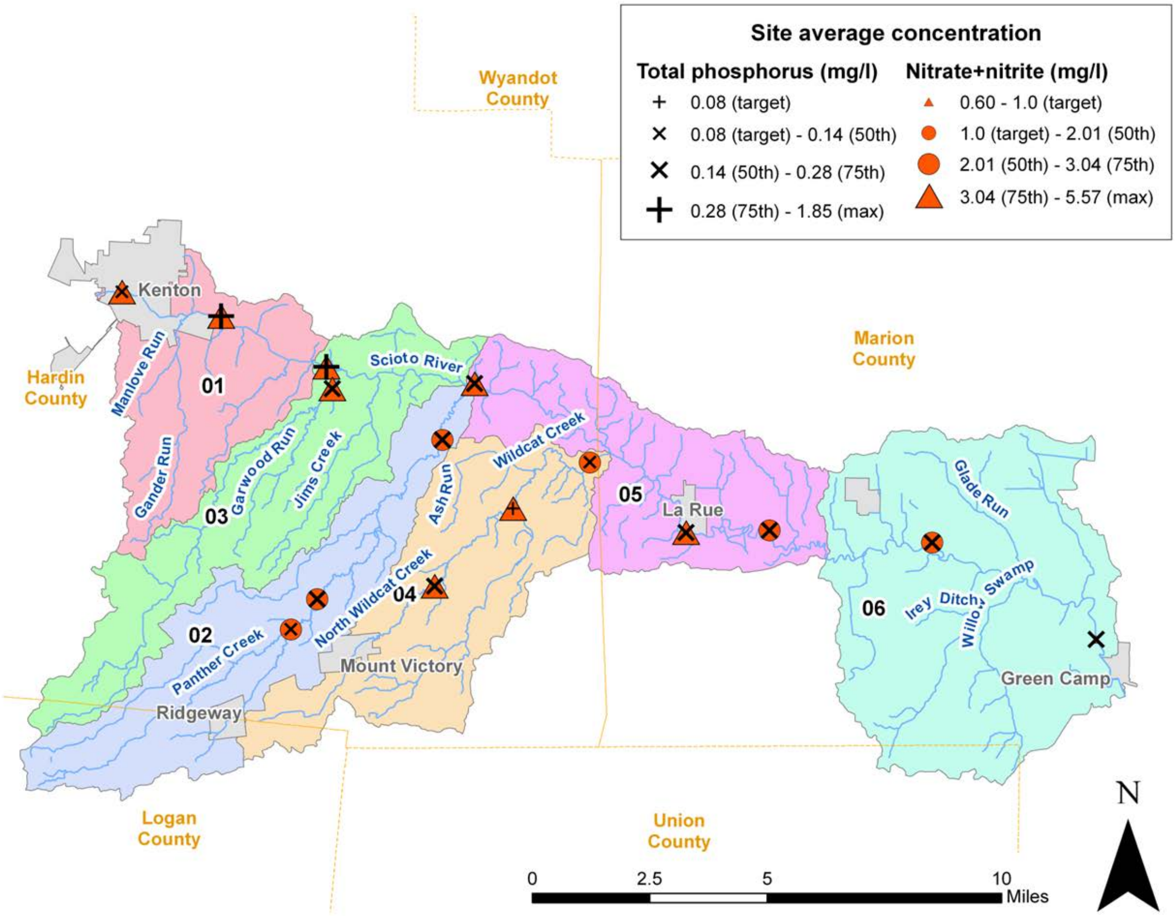


Figure 3-20. Water chemistry results for the Panther Creek-Scioto River subwatershed. Breakpoints in the concentration intervals are based on percentile statistics and water quality targets.

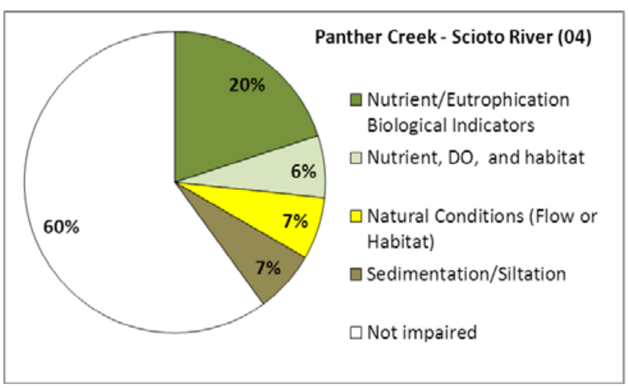


Figure 3-21. Causes of aquatic life use impairment in the Panther Creek-Scioto River subwatershed.

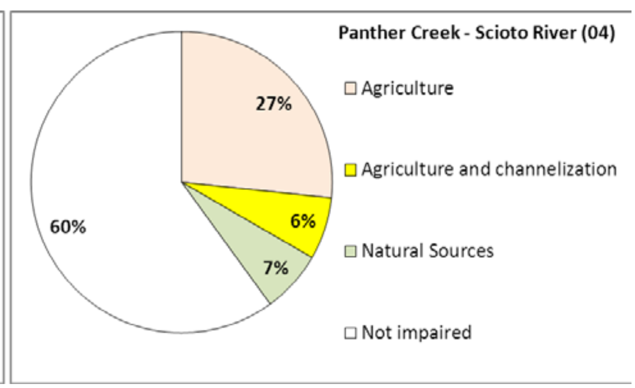


Figure 3-22. Sources of aquatic life use impairment in the Panther Creek-Scioto River subwatershed.

Table 3-4 shows the site-by-site results for each designated beneficial use organized by nested subwatersheds. For more specific information regarding individual site assessment results and supporting chemistry results, please see Appendix B.

Table 3-4. Number of impaired sites, organized by use and nested subwatershed, in the Panther Creek-Scioto River subwatershed.

Nested Subwatershed (05060001 01)		Aquatic Life Use	Recreation Use	Public Drinking Water Supply Use	Human Health Use[1]
04 01	# impaired sites (non/partial)	0	2		
	Index score[2]	100.0	75.0	N/A	N/A
04 02	# impaired sites (non/partial)	2 (0/2)	0		
	Index score	25.0	100.0	N/A	N/A
04 03	# impaired sites (non/partial)	1 (0/1)	1		
	Index score	50.0	87.5	N/A	N/A
04 04	# impaired sites (non/partial)	2 (0/2)	1		
	Index score	25.0	25.0	N/A	N/A
04 05	# impaired sites (non/partial)	0	3		
	Index score	100.0	58.3	N/A	N/A
04 06	# impaired sites (non/partial)	1 (0/1)	2		
	Index score	50.0	75.0	N/A	N/A

[1] Impairments to the human health use are not being addressed in this TMDL.
[2] The index score (between 0 and 100) indicates the relative support of the aquatic life or recreation use in the nested subwatershed. A score of 100 indicates full support of the use.

Habitat quality in the Panther Creek-Scioto River generally met the target conditions, with the majority of sites above target, but some were below the target. For the 15 sites evaluated in the Panther Creek-Scioto River, the average QHEI score is 66.2 (median = 67) with a range in scores from 43.5 to 84.5. Eight sites on the Scioto River from river miles 211.5 to 179.05 showed mostly good habitat quality, with only two site below the target of 60 and one site nearly exceptional (QHEI score = 74.5). Panther Creek showed very good to exceptional habitat as did the lower site on Wildcat Creek. However, the upper two sites on Wildcat Creek (river miles 6.72 and 4.00) were only fair in terms of habitat quality.

3.5 Fulton Creek-Scioto River (05060001 05)

The Fulton Creek-Scioto River subwatershed drains 140 square miles in the southern portion of the watershed (see Figure 3-23). It consists of five nested subwatersheds. The main tributaries to Scioto River include Patton Creek, Ottawa Creek and Fulton Creek. Major causes of impairment include nutrients, dissolved oxygen and poor habitat. Those causes are primarily associated with agricultural practices, channelization and point source discharges. Figure 3-24 shows land use within the Fulton Creek-Scioto River subwatershed which can provide context for the water quality observations.

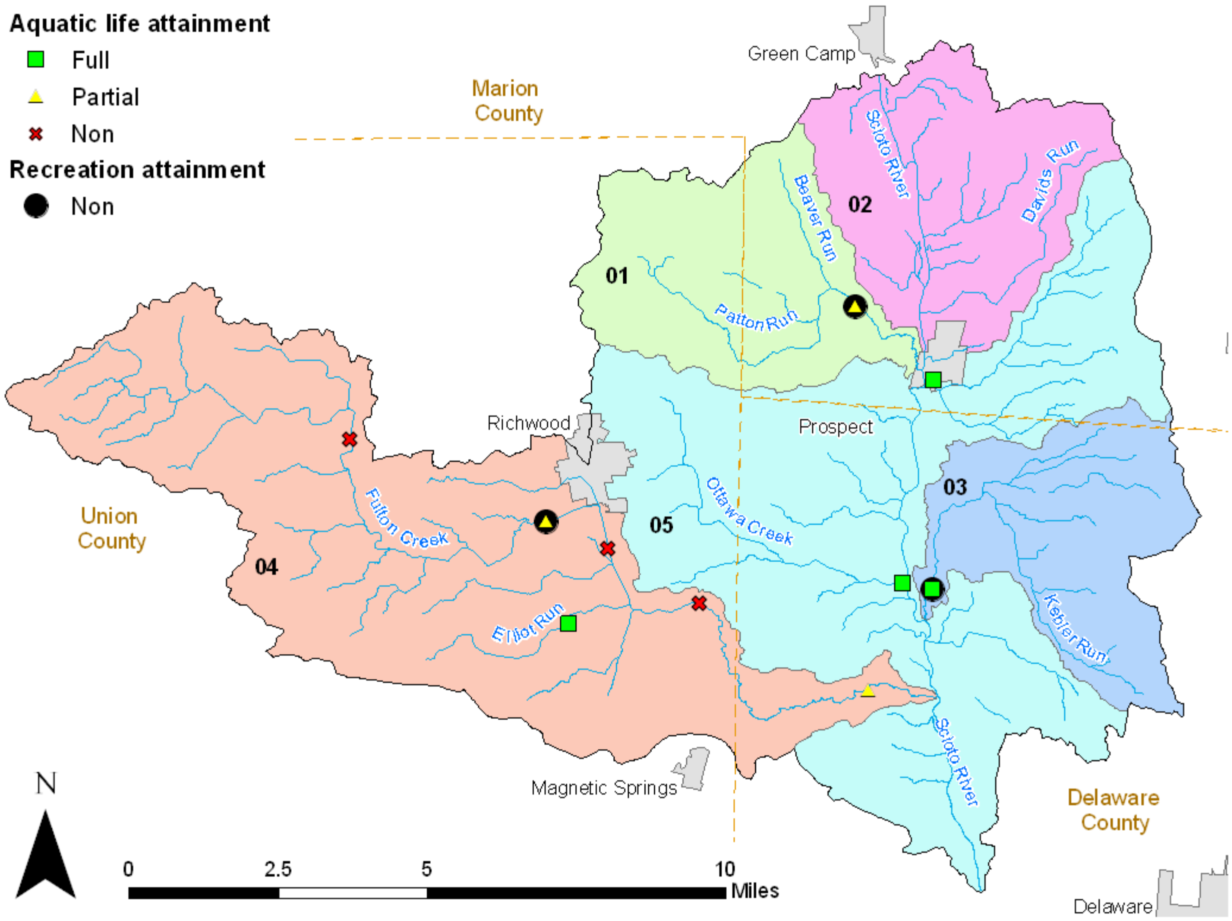


Figure 3-23. Attainment results for the Fulton Creek-Scioto River subwatershed.

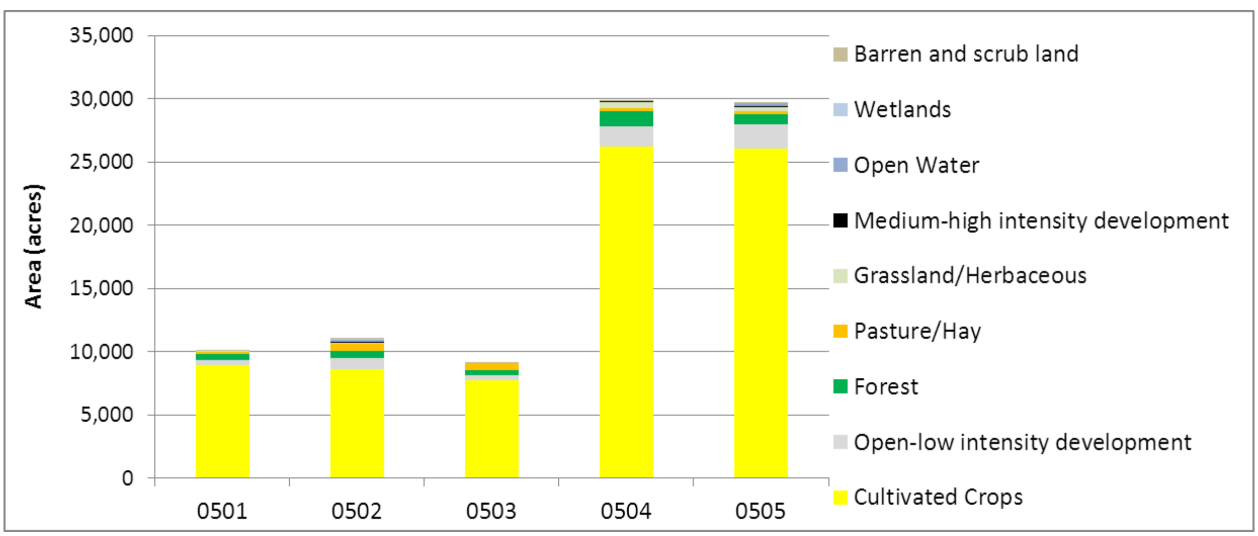


Figure 3-24. Land use in the Fulton Creek-Scioto River subwatershed.

Figure 3-25 shows water chemistry results in the subwatershed. Some of these results aided in identifying causes of aquatic life use impairment. Figure 3-26 shows relative occurrence of causes of aquatic life use impairment in the Fulton Creek-Scioto River subwatershed. Figure

3-27 shows the relative occurrence of sources of aquatic life use impairment in the Fulton Creek-Scioto River subwatershed.

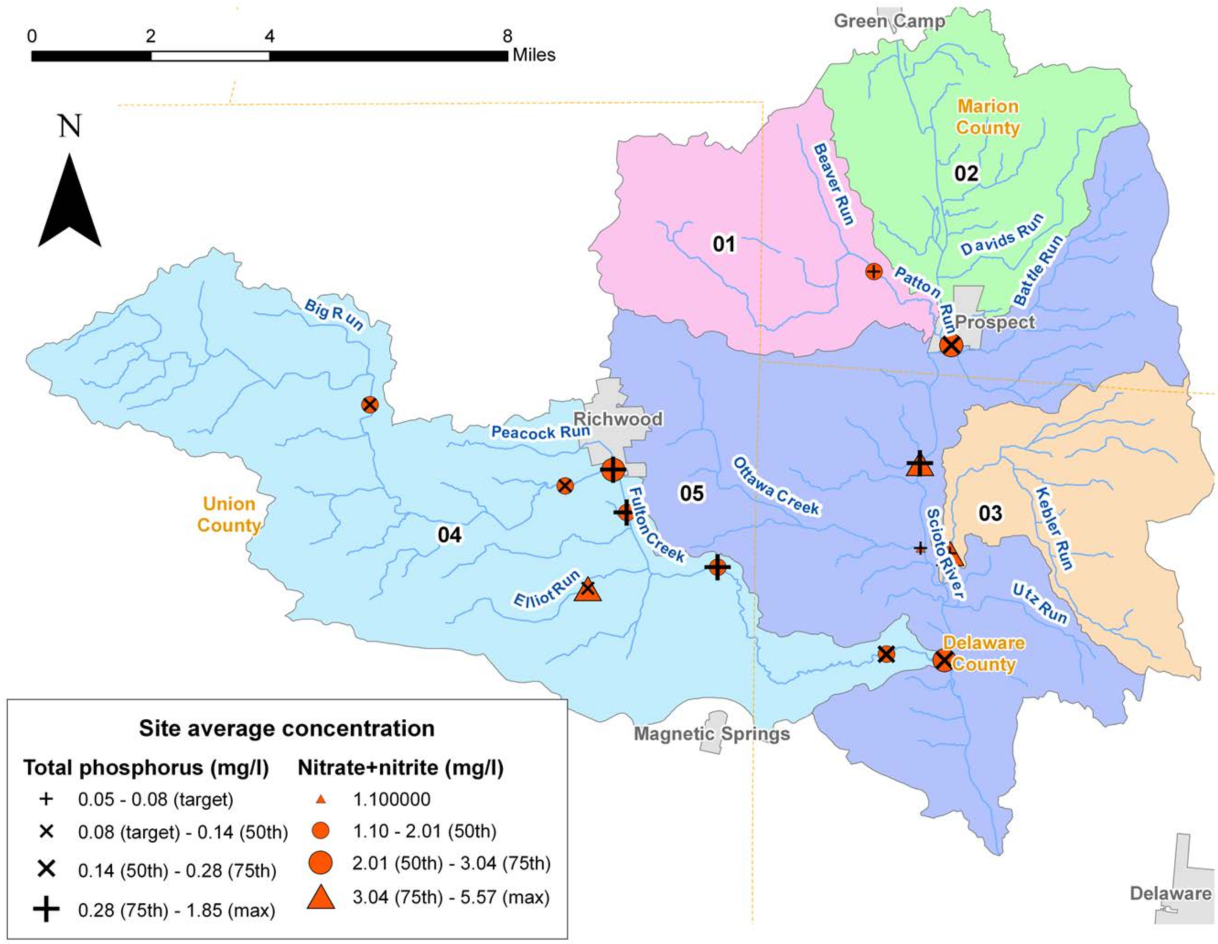


Figure 3-25. Water chemistry results for the Fulton Creek-Scioto River subwatershed. Breakpoints in the concentration intervals are based on percentile statistics and water quality targets.

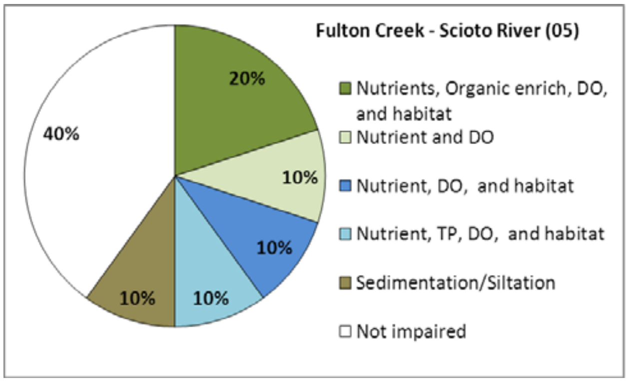


Figure 3-26. Causes of aquatic life use impairment in the Fulton Creek-Scioto River subwatershed.

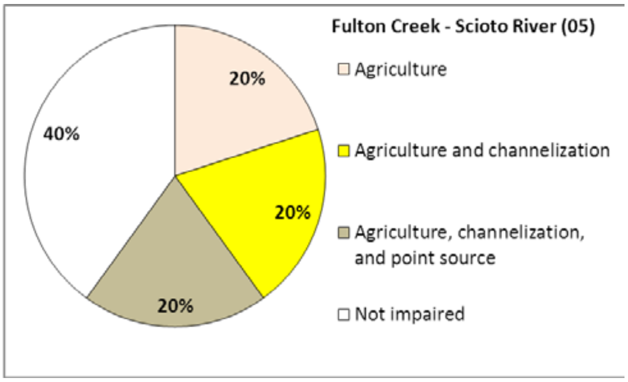


Figure 3-27. Sources of aquatic life use impairment in the Fulton Creek-Scioto River subwatershed.

Table 3-5 shows the site-by-site results for each designated beneficial use organized by nested subwatersheds. For more specific information regarding individual site assessment results and supporting chemistry results, please see Appendix B.

Table 3-5. Number of impaired sites, organized by use and nested subwatershed, in the Fulton Creek-Scioto River subwatershed.

Nested Subwatershed (05060001 01)		Aquatic Life Use	Recreation Use	Public Drinking Water Supply Use	Human Health Use[1]
05 01	# impaired sites (non/partial)	1 (0/1)	1		
	Index score[2]	0.0	50.0	N/A	N/A
05 02	# impaired sites (non/partial)				
	Index score			N/A	N/A
05 03	# impaired sites (non/partial)	0	1		
	Index score	100.0	75.0	N/A	N/A
05 04	# impaired sites (non/partial)	5 (3/2)	1		
	Index score	25.0	75.0	N/A	N/A
05 05	# impaired sites (non/partial)	0			
	Index score	100.0		N/A	N/A

[1] Impairments to the human health use are not being addressed in this TMDL.
[2] The index score (between 0 and 100) indicates the relative support of the aquatic life or recreation use in the nested subwatershed. A score of 100 indicates full support of the use.

Habitat quality in the Fulton Creek-Scioto River generally met the target conditions, with the majority of sites above target, but some were below the target. For the 15 sites evaluated in the Fulton Creek-Scioto River, the average QHEI score is 60.2 (median = 63.25) with a range in scores from 27.0 to 83.5. Fulton Creek showed very poor (in the headwaters) to exceptional habitat as did the lone sites near their mouths on Kebler Run and Ottawa Creek. Battle Run and Patton Run were in the good range while Eliot Run was only fair in terms of habitat quality.

4 Methods to Calculate Load Reductions

The upper Scioto River watershed does not fully meet water quality standards for two beneficial uses – recreation and aquatic life uses. The causes of impairment to aquatic life uses consist of natural conditions; however, poor habitat, excessive fine sediment, nutrients and ammonia, and organic enrichment and dissolved oxygen problems are pollutants for which management actions can be done. The cause of recreation use impairment is excessive concentrations of an indicator bacterium, *E. coli*. The linkage analysis examines the cause and effect relationships between watershed characteristics and pollutant sources and the effect on the stream biology and evaluates the use of surrogate measures to address the pollutant sources that would result in supporting beneficial uses.

The TMDL analyses presented in this report address the following causes of impairment:
- Nutrient enrichment (via total phosphorus)
- Sedimentation and habitat (via QHEI)
- *E. coli*

Nutrient enrichment
Nutrients in excess of the needs of a balanced ecosystem increase algal and aquatic plant life production (Sharpley, 1999). This excess primary production causes negative effects, including large diel fluctuations of dissolved oxygen (DO) and potential for DO criterion violations caused by photosynthesis (O_2 production) and respiration (O_2 consumption). Comprehensive water quality studies in both Ohio and Minnesota have shown high diel fluctuations have strong correlations to declines in biological community performance (Miltner 2010; Heiskary and Markus 2003). Also, in systems where dead organic matter accumulates and decomposes eutrophic conditions can be observed. Such changes shift species composition away from functional assemblages comprised of intolerant species, benthic insectivores and top carnivores typical of high quality streams towards less desirable assemblages of tolerant species, niche generalists, omnivores and detritivores typical of degraded streams (Ohio EPA, 1999). Such a shift in community structure lowers the diversity of the system, thus lowering IBI and ICI scores. This shift may preclude a stream from achieving its aquatic-life use standard. Based on the observed biological indicators, nutrient enrichment occurs in the upper Scioto River watershed.

Phosphorus is selected as the nutrient of concern for TMDLs because it is frequently the limiting nutrient to algal growth in the fresh water streams of Ohio. In a 2010 study by Miltner only 12 of 109 streams analyzed were not limited by phosphorus based on molar ratios. Miltner also suggests that the functional difficulty in limiting nitrogen makes forcing phosphorus limitation a desirable option, even in streams that are nitrogen limited (Miltner 2010). In effect, limiting the loading of phosphorus to streams reduces the impacts described above caused by excessive algal growth, thus addressing a stream's nutrient enrichment. Statewide total phosphorus (TP) targets for various size drainage area streams have been developed by Ohio EPA (1999) in order to address excess nutrients impacting aquatic life.

Organic enrichment using total phosphorus as a surrogate

Organic enrichment is a cause of impairment to McCoy, McDonald and Fulton creeks as well as North Rockswale Ditch and the Little Scioto River. The source of organic *and* nutrient enrichment for McCoy, McDonald and Fulton creeks is agriculture therefore, by limiting TP via a nutrient TMDL, the organic enrichment impairment is also addressed. Organic enrichment issues found in the Little Scioto River watershed will be addressed using a category 4B alternative to TMDLs (see Appendix F).

The pollutant normally associated with organic enrichment is biochemical oxygen demand (BOD). BOD is a widely used indicator of the organic quality of water; it is often defined as the measure of oxygen consuming material. A source of BOD from agricultural is organic matter in livestock manure and an indirect source is the detrital remains of algal growth propagated from subsidized nutrient supply to the stream from agricultural fertilization (Stringfellow, 2008). Agricultural fertilization practices should be modified in such a way that the nutrient TMDL targets can be met. The nutrient TMDL is meant to limit algal production which addresses the detrital component of organic enrichment. Manure is both a direct source of organic matter and a component of agricultural fertilization. If manure is applied using best practices to limit nutrient export to streams; the direct component of organic enrichment will be similarly reduced. Thus successful implementation of a nutrient TMDL will completely address the impacts of organic enrichment in the watershed.

Habitat alteration and sedimentation/siltation

Habitat alteration and sedimentation are causes of impairment at several assessment sites in the upper Scioto River watershed. Habitat alterations impact biological communities directly by limiting the complexity of living spaces available to aquatic organisms. This is significant to freshwater organisms because they have become specialized over millions of years of evolution to the niche habitats afforded in streams undisturbed by human management (i.e., pre-settlement). Consequently, fish and macroinvertebrate communities tend to lose diversity as stream habitat becomes less diverse. The primary functions of habitat for freshwater organisms are to provide protection from stressful environmental conditions, cover for species to species interactions (e.g., predator-prey) and support for specific food resources.

Habitat alteration can result in flow alteration, which is also a listed cause of impairment in the upper Scioto River watershed. Under certain circumstances flow alteration can be viewed as the hydrological consequences of habitat alteration. For example, in an agricultural setting, as is much of the upper Scioto River watershed, channelization of streams to facilitate drainage often exacerbates hydrological extremes; high flows get higher and low flows get lower. The high flows contribute to entrainment of excess sediment in the stream system, and the low flows exhibit low dissolved oxygen and high temperatures (US EPA, 2007). For stream assessment areas where flow alteration is identified as the cause of impairment, the habitat QHEI is carried out in this report.

The Qualitative Habitat Evaluation Index (QHEI) is a quantitative expression of a qualitative, visual assessment of habitat in free flowing streams and was developed by the Ohio EPA to assess available habitat for fish communities (Rankin, 1989, 1995). This tool provides a numeric value, which is assigned to a particular stream segment based on the quality of its habitat. The QHEI evaluates six general aspects of physical habitat that include channel substrate, instream cover, riparian characteristics, channel condition, pool/riffle quality, gradient and drainage area. Analysis of QHEI and biological response data by Ohio EPA (1999) determined the most sensitive aspects and breakpoint values for these aspects. Using these aspects/breakpoints as targets to directly address habitat impairment as a TMDL is an explicit method to mitigate impairment. This has been successfully employed by Ohio EPA (Ohio EPA, 2006, 2009).

In terms of TMDLs for sediment, the QHEI characterizes sediment problems with the substrate metric, which has several sub-metrics that deal with fine material (sediment). Despite not providing an absolute quantity (or load) of fine material, it does deal with the relative quantity expressed as a percent of embeddedness of the channel and the percent of silt cover. Likewise the dominant substrate particle size (e.g., sands or silts) is to be scored and finer sized material score fewer points than coarser substrates. These connections are believed to be strong enough and the fact that they can reflect what is adversely impacting the biological community makes the QHEI suitable for developing sediment TMDLs. Also, other methods for developing sediment TMDLs are problematic. An example is using total suspended solids (TSS) as a surrogate for sedimentation (which is commonly done). Data gathered for modeling TSS (e.g., using GWLF, LSPC, or SWAT models) is often unreliable for calibration and validation TSS demonstrates a high degree of variability both over space and time and is very sensitive to local disturbances which could significantly inflate the concentration well above what is representative of the system. Additionally, there are few models that adequately account for in-stream sediment dynamics (e.g., erosion and deposition processes) or they require very high resource expenditures that are often not feasible (e.g., CONCEPTS).

Pathogens (bacteria) recreational use impairments

Elevated bacteria loading is the cause of recreational use impairment for most streams in the upper Scioto River watershed. The proportion of pathogenic organisms present in assessed waters is generally small compared to non-pathogenic organisms. For this reason most pathogenic organisms are difficult to isolate and identify. Additionally, pathogenic organisms are highly varied in their characteristics and type which also makes them difficult to measure. Nonpathogenic bacteria that are associated with pathogens transmitted by fecal contamination are more abundant and are, therefore, monitored as surrogates because of the greater ease in sampling and measuring. These bacteria are called indicator organisms. Ohio has promulgated water quality standards for the geometric mean concentration for *E. coli* fecal coliform bacteria (3745-1-07). These values serve as the targets used in the development of the TMDLs that address recreation use impairments. Therefore the use of *E. coli* to address recreational use impairment is adequate as it is dictated by state law.

Tables 4-1 through 4-3 indicate how the applicable causes of impairment are addressed in each of the assessment units.

Table 4-1. Summary of causes of impairment and actions taken to address them in assessment units within the 05060001 01 and 05060001 02 ten-digit hydrologic units.

Causes of Impairment	Watershed Assessment Units						
	05060001 01				05060001 02		
	01	02	03	04	01	02	03
Aquatic Life Use							
Nutrient enrichment				D		D	D
Habitat alterations		D				D	D
Other flow alterations							S
Sedimentation/siltation		D			D		
Dissolved oxygen/organic enrichment				S	N	S	
Natural conditions				N			N
Recreation Use							
E. coli	D	D	D	D	D	D	D

D – direct: Means that TMDLs are calculated for this parameter
S – surrogate: Means that TMDLs are calculated for a closely related cause and actions to reduce the impact of that cause should be sufficient to address this cause.
N – not addressed: Means that the impairment is not addressed in this report.
Blank: Indicates that the assessment unit is not impaired for this cause.

Table 4-2. Summary of causes of impairment and actions taken to address them in assessment units within the 05060001 03 and 05060001 04 ten-digit hydrologic units.

Causes of Impairment	Watershed Assessment Units									
	05060001 03				05060001 04					
	01	02	03	04	01	02	03	04	05	06
Aquatic Life Use										
Nutrient enrichment	D			D		D		D		
Habitat alterations	D	D	D	D				D		
Sedimentation/siltation		D	D							D
Dissolved oxygen/organic enrichment			4B					S		
Creosote				N						
Ammonia				4B						
Fish kills	N									
Natural conditions							N			
Recreation Use										
E. coli	D	D	D	D	D		D	D	D	D

D – direct: Means that TMDLs are calculated for this parameter
S – surrogate: Means that TMDLs are calculated for a closely related cause and actions to reduce the impact of that cause should be sufficient to address this cause.
N – not addressed: Means that the impairment is not addressed in this report.
Blank: Indicates that the assessment unit is not impaired for this cause.
4B: Means that the 4B option is being used to address impairment.

Table 4-3. Summary of causes of impairment and actions taken to address them in assessment units within the 05060001 05 ten-digit hydrologic unit.

Causes of Impairment	Watershed Assessment Units 05060001 05				
	01	02	03	04	05
Aquatic Life Use					
Nutrient enrichment				D[1]	
Nutrient/eutrophication biological indicators				S	
Dissolved oxygen				S	
Organic enrichment				S	
Habitat alterations				D	
Sedimentation/siltation	D			S	
Recreation Use					
E. coli	D		D	D	

[1] Total phosphorus is also listed as a cause of impairment in this 12-digit HUC.

D – direct	Means that TMDLs are calculated for this parameter
S – surrogate	Means that TMDLs are calculated for a closely related cause and actions to reduce the impact of that cause should be sufficient to address this cause.
N – not addressed	Means that the impairment is not addressed in this report.
Blank	Indicates that the assessment unit is not impaired for this cause.

Further details on modeling methods and analyses are available in Appendix D.

4.1 Nutrient Modeling Method (Generalized Watershed Loading Function)

The hydrologic cycle for the subwatersheds receiving nutrient TMDLs is simulated using the Generalized Watershed Loading Function or GWLF model (Haith, 1992) through the desktop simulation called BasinSim 1.0 (Dai, 2000). GWLF simulates runoff, groundwater recharge and stream flow by a water-balance method using measurements of daily precipitation and average daily temperature. These are the only two daily inputs that drive this model. Runoff is calculated using the Natural Resources Conservation Service's Runoff Curve Number method (USDA, 1986). This method determines the amount of precipitation that runs off the surface and is adjusted for antecedent soil moisture before the precipitation event, growing or dormant season, detention potential and soil characteristics. Curve numbers vary by land cover, use and soil type; the higher the curve number the more runoff produced. The predicted surface runoff flow is the quick response flow including interflow and drainage from tiles. Stream flow is computed as the sum of the groundwater discharge from the shallow saturated zone (baseflow) and the surface runoff. The model computes the daily water balance and resulting stream flow, however only monthly streamflow values are output by the model.

The GWLF model's BasinSim software application is used to determine the TP load from runoff and groundwater. Table 4-4 shows the runoff TP values for various land uses in this modeling. These values are fixed within a modeling simulation, and are determined from the BasinSim user's manual. GWLF inputs of TP sediment runoff concentrations for various land uses are determined using reference values from the model's user's guide augmented by any known values available. Since the model requires one groundwater phosphorus concentration per watershed, data from Ohio EPA's ambient groundwater sampling program are used. An average value of average TP concentrations from five wells examined yields 0.056 mg/l (standard deviation of 0.019). This value is used for all of the modeled watersheds. See Appendix D for more details.

Table 4-4. TP model input values (in mg/l).

Rural land uses	Concentration (mg/l)		Urban land uses	Concentration (mg/l)
Pasture/Hay	0.250		Transitional	0.1500
Row Crops	0.200		Urban/Recreational Grasses	0.1500
Deciduous Forest	0.008		Woody Wetlands	0
Emergent Herbaceous Wetlands	0		Commercial/Industrial/Transportation	0.0112
Evergreen Forest	0.008		High-Density Residential	0.0112
Mixed Forest	0.008		Low-Density Residential	0.0030
Open Water	0		Quarries/Strip Mines/Gravel Pits	0

4.1.1 Justification

The model predicts stream flow based on precipitation, evapotranspiration, land uses and soil characteristics. It is appropriate for the upper Scioto River subwatersheds because it simulates rural and urbanized land use at a mid-level of complexity.

4.1.2 Sources of Data

The model simulates the USGS gage's watershed using weather stations applicable to the watershed based on geography. This hydrology calibration is carried out for a 30-year period. GWLF predicts stream hydrology on a monthly time step. Initial model simulation hydrology results are compared to the sum of the mean daily flows of the gage.

Land use and weather data are critical components of hydrology functions of GWLF. The National Land Cover Dataset (NLCD) is used as the land cover resource for this study (Homer, 2004). This program distributes weather data measured by the National Climatic Data Center which is part of the National Oceanic and Atmospheric Administration. Daily precipitation and air temperature data acquired from the Midwestern Regional Climate Center are used. The two weather stations used for the upper Scioto River modeling watershed are located in Marion (ID 334937) and Kenton (ID 334189). Whichever station is closest to each watershed's centroid is what is used.

4.1.3 Target(s)

While the Ohio EPA does not currently have statewide numeric criteria for phosphorus, potential targets have been identified in a technical 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 the biological communities of Ohio streams. It recommends statewide total phosphorus (TP) target concentrations based on observed concentrations associated with acceptable ranges of biological community performance. The targets applicable to the upper Scioto River watershed are shown in Table 4-5. It is important to note that these targets are not codified in Ohio's water quality standards; therefore, there is a certain degree of flexibility as to how they can be used in a TMDL setting.

Table 4-5. Total phosphorus targets applicable to the upper Scioto River watershed.

Watershed size	WWH
Headwaters (drainage area < 20 mi^2)	0.08
Wadable (drainage area ≥ 20 mi^2 < 200 mi^2)	0.10

4.1.4 Calibration and Validation

The hydrology calibration is based on the agreement between monthly flow volume from the model output to the observed cumulative monthly gage flow. The model's hydrology output is compared to the records from the Scioto River near Prospect USGS gage, number 03219500. This gage measures the stream discharge of most of the area covered in this TMDL study, 567 square miles. Three types of hydrology output are examined, namely total flows, baseflow and runoff. Gage baseflow and runoff are estimated using a hydrologic stream flow separation algorithm (Sloto, 1996). After analysis, reasonable changes to GWLF transport functions and curve numbers are made whereupon the flow analysis would be repeated. Several calibration simulations have been carried out determining the best fit model setup; however, there is insufficient data to perform a model validation. An R-squared value of 0.66, and a predicted to observed ratio of 0.74 are determined for hydrology of the calibrated upper Scioto GWLF model. See Appendix D for more details.

The GWLF model was simulated for two nutrient TMDL subwatersheds, Rock Fork and Fulton Creek to facilitate water quality calibration. These model simulations examined what is considered to be each watershed's existing condition. To simulate this condition the point sources are set at the current average daily flows. Modeling results mirrored differences in the watershed's TP water quality data, in most flows. The model does not properly predict TP in low flows, and in these circumstances the TP concentration becomes much higher than ever observed. This is in large part due to this model's conservative nature; it is unable to incorporate instream assimilating processes that result in a seeming decay of TP concentration. Model predictions were reduced by 15% which yielded a slightly better match for the two watersheds being examined, and is an acceptable action given the conservative nature of the model. Due to the limited nature of observed water quality data available, the decision to not use low flow water quality model results was made. This is appropriate given the critical condition that is being used for the TMDLs (Section 4.1.6). More robust data do not exist to substantiate further adjustments to the water quality inputs of the model.

4.1.5 Allowance for Future Growth

Population projections for this watershed show insignificant growth in Marion and Hardin counties. Union and Delaware counties are expected to have continued growth, but not in the parts of those counties contained by this watershed. Because of this, a relatively low allowance for future growth (AFG) is reserved from the TMDL load, 2%. This AFG is adequate to incorporate load from future HSTS general permits.

4.1.6 Seasonality and Critical Conditions

A single TMDL critical condition is determined to consider all sources of loading for these TP TMDLs. The average load delivered during the mid-flow periods will be this condition; specifically the 40^{th} to 60^{th} exceedance percentile flow regimes. This flow condition is used in order to create straightforward TMDLs that consider the loads from both point and non-point sources of TP as significant contributors. This is also an appropriate flow condition considering the heavy agricultural land use and relatively flat geography of this watershed. The nutrient loads that runoff from agricultural practices during higher flow regimes must flow into the myriad ditches and then larger streams.

4.2 Habitat and Sediment Method (Qualitative Habitat Evaluation Index)

The Qualitative Habitat Evaluation Index (QHEI) is an index to evaluate stream habitat quality. Components of the QHEI are used for the habitat and sediment TMDLs in this report. The index has six metrics (e.g., substrate quality) each of which is further divided by sub-metrics which often account for discrete habitat features (e.g., a specific size class of substrate). Based on a visual assessment of the study reach (typically 150-200 meters in length), a numeric value is assigned to indicate the quality of its habitat. This is determined by the sum of the scores for each of the metrics. The number values do not represent the quantity of any physical properties of the system but solely provide a means for comparing the quality of stream habitat between various locations. However, even though the numeric value is derived qualitatively, subjectivity is minimized because scores are based on the presence and absence and relative abundance of unambiguous habitat features.

The six general aspects of physical habitat that the QHEI evaluates include channel substrate, instream cover, riparian characteristics, channel condition, pool/riffle quality, and gradient. Within each of these metrics, points are assigned to the sub-metrics based on their ecological utility as well as their relative abundance in the system. Demerits (i.e., negative points) are also assigned if certain habitat 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.

4.2.1 Justification

For decades the Ohio EPA has used the QHEI to help understand the causes of aquatic life use impairment as well as in assigning appropriate aquatic life uses to stream segments. The strong correlation between the paired scores of the QHEI and the Index of Biotic Integrity (IBI), an important biometric in Ohio's water quality standards, supports the idea that the QHEI is assessing aspects of the stream system that are relevant to biological performance. The reliability that the QHEI demonstrates in predicting biological performance (the basis for aquatic life use attainment) as well as the relative ease of its application is the reason it is selected as the basis for the sediment and habitat TMDLs.

4.2.2 Sources of Data

The QHEI analysis uses the scores and metric evaluations that were determined during the water quality survey carried out in 2009 and 2011. No other data are needed for this analysis.

4.2.3 Target(s)

The numeric value assigned to a stream segment through the Qualitative Habitat Evaluation Index (QHEI) is qualitatively derived, however it is based on the presence and absence and relative abundance of unambiguous habitat features. QHEI scores can range from 12 to 100. The appropriate QHEI habitat target score is determined by statistical analysis of Ohio's statewide database of paired QHEI and IBI scores. Simple linear and exponential regressions and frequency analyses of combined and individual components of QHEI metrics in relation to the IBI have been examined. The regressions indicate that the QHEI is significantly correlated with the IBI. Scores greater than 75 indicate excellent stream habitat. Scores between 60 and 75 indicate good habitat quality and scores less than 45 demonstrate habitat not conducive to warm water habitat (WWH) (Ohio EPA, 1999).

The analysis of the QHEI components as they relate to IBI scores led to the development of a list of attributes that are associated with degraded communities. These attributes are modifications of natural habitat and are listed in Table 4-6. Modified attributes are further divided into high influence and moderate influence attributes based on the statistical strength of the relationships. The presence of these attributes can strongly influence the aquatic biology, and the QHEI score itself may not reflect this effect. Since other, less influential habitat components are present, a QHEI score can be above 60 though habitat is impaired. Because of this, an accumulation of four modified attributes corresponds to fewer than 50% of sites achieving a WWH target IBI score of 40. High influence modified attributes are particularly detrimental. The presence of one is likely to result in impairment, and two will likely preclude a site from achieving an IBI of 40. The QHEI score of 60 or greater is correlated with IBIs of 40 or greater. These three factors appear to have about an equal weight. A complete habitat TMDL needs to reflect both a good QHEI score and the relative absence of these modified attributes (Ohio EPA, 1999).

The habitat TMDL equation presented in Table 4-7 reflects the relationship between the QHEI score, modified attributes and aquatic community performance. The TMDL is based upon a total score of three (3), and is the sum of three component scores each worth one point.

Table 4-6. QHEI modified attributes.

<table>
<tr><th rowspan="2">QHEI categories</th><th colspan="2">Modified attributes</th></tr>
<tr><th>High influence</th><th>Moderate modified attributes</th></tr>
<tr><td>QHEI score</td><td>- Channelized or no recovery
- Silt/muck substrate
- Low sinuosity
- Sparse/no cover
- Max pool depth < 40 cm (wadeable streams only)</td><td>- 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</td></tr>
</table>

Table 4-7. Targets of the habitat TMDL.

Scores for the TMDL							
QHEI score >= 60	+1	One or less of the high influence attributes present	+1	Four or less of the modified attributes present (high and moderate influence together)	+1	=	3

Targets for the sediment TMDLs
In the upper Scioto River watershed, several streams have sedimentation listed as a cause of impairment. In order to address this, numeric targets for sediment are also based upon the QHEI metrics. The QHEI substrate, riparian characteristic, and channel metrics all evaluate stream attributes related to sediment. Each of these factors influences the degree to which sediment affects a stream, and cumulatively serves as its numeric target.

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 assimilates (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-stream sediment sources. Finally, the evaluation of floodplain quality is related to the capacity of the system to assimilate sediment loads.

The individual components of the sediment TMDL are QHEI metric scores for substrate, channel and riparian. These metric target scores are based on the same associations made between QHEI and IBI results as explained in the habitat TMDL above (Ohio EPA, 1999). Table 4-8 show the minimum scores expected for the sediment TMDL.

Table 4-8. Targets of the sediment TMDL.

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

4.2.4 Calibration and Validation

No simulations are performed for the QHEI analysis since only observed data is used for comparison to the target conditions.

4.2.5 Allowance for Future Growth

Since no explicit loads are calculated for the habitat and sediment TMDLs, no future growth load are allotted.

4.2.6 Seasonality and Critical Conditions

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

4.3 Pathogen Modeling (Load Duration Curves)

An empirical method of determining TMDL bacteria loading and reductions is utilized in this report via load duration curves (LDCs). This method is appropriate since the sources of bacteria in Ohio streams can be differentiated by stream flow regime.

To create TMDL LDCs, the flow duration for each TMDL site is determined. This involves calculating the flow expected for the full range of exceedance percentile. Since this beneficial use is only applicable to the recreation season, May through October, the stream flows used to calculate this range of exceedance percentile is only that of flows occurring May through October. Exceedance percentile stream flows are the probability that a given flow magnitude is exceeded. This normalizes the flows to a range of natural occurrences from extremely high flows (zero exceedance percentile) to extremely low flows (100). The flow curve is converted into a load duration curve by taking the product of each flow values, the water quality geometric mean standard and a conversion factor. These values, in *E. coli* counts per day are the TMDL for each flow condition. The resulting points are plotted to create a LDC. The LDC is broken up into five flow regimens and TMDL allocations are made for each of these regimens. The TMDL value used for these calculations is that at the middle of each flow regime.

The water quality samples for each impaired site are converted into loads by taking the product of the *E. coli* sample result, the flow at the time the sample was collected and a conversion factor (0.02446 for cfu/100 ml to Billion-org/day). Each calculated load is plotted as a point on the LDC plot and is then compared to the water quality TMDL load. Points that plot above the LDC represent deviations from the water quality standard and the daily allowable load. Points that plot below the curve represent samples in compliance with standards and the daily allowable load.

The load duration curves are grouped into five flow regimes noted with vertical lines and labels. These regimes are defined as the following:

- High flow zone: Stream flows in the 0 to 5 exceedance percentile range; these are related to flood flows.
- Wet weather zone: Flows in the 5 to 40 exceedance percentile range; these are flows in wet weather conditions.
- Normal range zone: Flows in the 40 to 80 exceedance percentile range; this are the median stream flow conditions.
- Dry weather zone: Flows in the 80 to 95 exceedance percentile range; these are related to dry weather flows.
- Low flow zone: Flows in the 95 to 100 exceedance percentile range; related to drought conditions.

All of the area beneath the TMDL curve is considered the *E. coli* loading capacity of the stream. The difference between this area and the area representing the current loading conditions is the load that must be reduced to meet water quality standards/targets. The final step to create an LDC is to determine where reductions need to occur. Samples in exceedance at the right side of the graph occur during low flow conditions, and significant sources might include wastewater treatment plants, malfunctioning home sewage treatment systems, illicit sewer connections and/or animals depositing waste directly to the stream. Any exceedance on the left side of the graph occurs during higher flow events and potential sources are likely land uses or management practices such as manure spreading or livestock production. These supply bacteria that are washed off upland areas with runoff. The LDC approach helps determine which implementation practices are most effective for reducing loads. Table 4-9 shows various pollutant sources and the flows contributing to their occurrence.

Table 4-9. Load duration curve flow zones and typical contributing sources.

Contributing Source Area	Duration Curve Zone				
	High	Moist	Mid-Range	Dry	Low
Point source				M	H
Livestock direct access to streams				M	H
Home sewage treatment systems	M	M-H	H	H	H
Riparian areas		H	H	M	
Storm water: Impervious		H	H	H	
Combined sewer overflow (CSO)	H				
Storm water: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M-H	L-M	
Bank erosion	H	M			

H = high influence; M = moderate influence; L = low influence

4.3.1 Justification

The main advantage of the use of LDCs is that it evaluates loading patterns within specific ranges of stream flow. This provides insight to importance of run off versus point sources or other loading that is not in response to overland wash off. However, a shortcoming of this method is its limited ability to differentiate various sources that may occur in the same flow regime (such as cows in stream and poorly operating home sewage treatment systems during periods of low flow).

4.3.2 Sources of Data

The LDC analysis uses the E. coli concentration values from samples collected throughout the study. The flow data used is from the USGS gage on the Scioto River near Prospect (gage number 03219500).

4.3.3 Target(s)

TMDL numeric targets for *E. coli* bacteria are derived from bacteriological water quality standards. The criteria for *E. coli* specified in OAC 3745-1-07 are applicable outside the mixing zone and vary according to recreation use designation (e.g., class A, B, or C Primary Contact). The Scioto River downstream of its confluence with Taylor Creek and the Little Scioto River are both Class A streams in this watershed. This class indicates the most intensive recreation use.

The remainder of streams assessed in this watershed primary contact is designated Class B with the exclusion of Cottonwood Ditch. Cottonwood Ditch is primary contact designated Class C. For Class A streams the criteria states that the geometric mean of more than one *E. coli* sample taken in each recreational season (May through October) shall not exceed 126 colony forming units (cfu) per 100 ml. For Class B and C streams the geometric mean of more than one *E. coli* sample taken in each recreational season shall not exceed 161 and 206 cfu per100 ml respectively.

TMDLs are created for watersheds that drain to an assessment site that is not meeting the recreational use criterion described in the paragraph above. The criteria values are used as the TMDL targets for this impairment. If an LDC TMDL site within a Class B stream section, but within five river miles of a Class A designated section, then the Class A aspect of the criterion is applied to this TMDL.

4.3.4 Calibration and Validation

Calibration and validation are not done for LDC analyses since only observed data is used for comparison to the target conditions.

4.3.5 Allowance for Future Growth

Population projections for this watershed show insignificant growth in Marion and Kenton counties. Union and Delaware counties are expected continued growth, but not in the parts of those counties contained by this watershed. Because of this, a relatively low allowance for future growth (AFG) is reserved from the TMDL load, 2%.

4.3.6 Seasonality and Critical Conditions

The critical condition for pathogens is the summer dry period when flows are lowest, and thus the potential for dilution is the lowest. Growth rates are higher and mortality rates lower in the warmer months further making this a critical time of the year for bacteria contamination. Likewise, summer is the period when the probability of recreational contact is the highest. For these reasons recreational use designations are only applicable in the period May through the end of October. Pathogen TMDLs are developed for the same time period in consideration of the critical condition, and for agreement with this uses criteria.

4.4 Margin of Safety

The Clean Water Act requires that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality. U.S. EPA guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

To account for model uncertainty an explicit margin of safety (MOS) is included in the TP nutrient TMDLs. The Modeling and Assessment Section at Ohio EPA currently applies a 5% explicit reserved load for this MOS when using watershed model nutrient TMDLs. Implicit MOS is included in these TMDLs through the numerous conservative assumptions made throughout this modeling process. These assumptions include:

- The median flows are used for the TMDL condition. This condition excludes peak flows and provides a lower flow that is used to calculate the loading capacity (i.e., less potential for dilution which would create greater assimilative capacity, or a higher TMDL).
- The reference values that were used as nutrient loading rates for estimating the existing condition were the larger values of the recommended ranges.

A MOS is implicitly incorporated into the sediment and habitat TMDLs through the use of conservative target values. The target values are developed though a 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 are analyzed to determine their magnitude at which WWH attainment is probable. Attainment does; however, occur at levels lower than the established targets. The difference between the habitat and sediment targets and the levels at which attainment actually occurs is an implicit margin of safety.

An explicit margin of safety (MOS) is used to reserve assimilative capacity and accounts for uncertainty in the LDC approach and in monitoring information. A 20% MOS is applied to account for broad fluctuations of *E. coli* concentrations that occur in nature and the relatively low number of data points available for this analysis. For LDC TMDLs, US EPA (2007) recommends this type of MOS for two reasons: 1) allocations will not exceed the load associated with the minimum flow in each regime; and 2) recognition that the uncertainty associated with effluent limits and water quality may vary across different flow conditions.

5 LOAD REDUCTION RESULTS

Several analyses were completed to address the causes of impairment. Results are summarized in this chapter and organized by assessment unit. Further details are available in Appendix D.

The tables for the nutrient TMDL results show the existing and TMDL loads, where the columns under “existing loads” show the loads from the GWLF model simulations (i.e., NPS). Along with total load, the point source (PS) and nonpoint source (NPS) are separated out in these columns. The columns under “allocations” breaks out the allocations for loading regulated through NPDES permits such as waste water discharges, HSTS and MS4s (WLA), unregulated nonpoint source loading (LA), a reserved loading that is set aside for future NPDES based loading (AFG), and a margin of safety taken away from the total allotment (MOS) to better ensure that water quality problems will be resolved upon achieving the TMDL prescribed loadings. Other tables show existing loading from the specific NPDES permit holders and their TMDL wasteload allocations. A column in the tables for total phosphorus results presents the nonpoint source loads reduction required where, generally, watersheds with higher nutrient loads have a higher percent reduction.

Some assessment units will have results from the habitat and sediment TMDLs. Channel modifications and excessive sediment are the most common attributes impacting the TMDLs. Excessive sediment is a result from actual channel modifications and from upland soil runoff.

Tables summarizing the bacteria TMDLs show wasteload and load allocations, margins of safety, and allowances for future growth for each hydrologic condition. The TMDL value for each hydrologic condition is determined from the middle value on the load duration curve of each flow regime. Wasteload allocations for NPDES point sources that are expected to discharge at the same rate no matter what the stream’s hydrologic condition receive the same value for all of those conditions.

5.1 Headwaters Scioto River (05060001 01)

In the Headwaters Scioto River 10-digit HUC TMDLs are developed for total phosphorus in the 01 04 12-digit HUC, E. coli for all of the 12-digit HUCs, and sediment and habitat for the 01 01 12-digit HUC. Reductions required to meet the total phosphorus TMDL from the approximated existing conditions are about 60 percent. Reductions for *E. coli* bacteria range from 17 to 90 percent across both the 12 digit HUCs and the flow intervals.

Table 5-1. Nutrient TMDLs, all loads in TP (kg-P/day).

12-Digit HUC 05060001	Subwatershed	Existing Loads			NPS Reduce required	TMDL	Allocations			
		PS	NPS	Total			WLA	LA	AFG	MOS
01 04[1]	McCoy Run	0	2.83	2.83	61.40%	1.18	0	1.09	0.02	0.06

[1] These TMDLs are only for the portion of the HUC noted in the subwatershed column.

Table 5-2. *E. coli* TMDL table for site on Cottonwood Ditch downstream McGuffey WWTP @ RR bridge HUC12: 05060001 01 01.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	1	6	2	2
Median sample load	*No Data*	71.5	19.1	8.5	12.8
Total WLA	1.9	1.9	1.9	1.9	1.9
McGuffey STP - 2PA00006 WLA	0.7	0.7	0.7	0.7	0.7
Alger WWTP - 2PB00064 WLA	1.2	1.2	1.2	1.2	1.2
Load Allocation	263.5	31.9	4.9	1.2	0.6
Margin of Safety	68.1	8.7	1.7	0.8	0.6
Allowance for future growth	6.81	0.87	0.17	0.08	0.06
TMDL	340.3	43.3	8.7	3.9	3.2
Total load reduction required	*No Data*	39.4%	54.6%	53.5%	75.4%

Table 5-3. *E. coli* TMDL table for site on Scioto R. W of Roundhead @ Arbogast Rd. HUC12: 05060001 01 02.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	1	4	2	3
Median sample load	*No Data*	23.4	31.0	2.4	4.0
Total WLA	0.0	0.0	0.0	0.0	0.0
Load Allocation	250.4	31.0	4.9	1.5	1.2
Margin of Safety	64.2	8.0	1.3	0.4	0.3
Allowance for future growth	6.42	0.80	0.13	0.04	0.03
TMDL	321.0	39.8	6.3	2.0	1.6
Total load reduction required	*No Data*	None	79.7%	17.4%	61.0%

Table 5-4. *E. coli* TMDL table for site on Taylor Creek at Kenton @ St. Rt. 67 HUC12: 05060001 01 03.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	1	2	8		1
Median sample load	345	273.9	14.1		1.7
Total WLA (Green Hills Coach Park Ltd - 2PY00041)	0.01	0.01	0.01	0.01	0.01
Load Allocation	174.5	21.6	3.6	1.2	0.7
Margin of Safety	44.8	5.5	0.9	0.3	0.2
Allowance for future growth	4.48	0.55	0.09	0.03	0.02
TMDL	223.8	27.7	4.6	1.5	0.9
Total load reduction required	35.2%	89.9%	67.3%	*No Data*	44.8%

Table 5-5. *E. coli* TMDL table for site on Silver Creek @ SR 67 HUC12: 05060001 01 04.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	1	2	*No Data*	1
Median sample load	*No Data*	126.8	24.5	*No Data*	0.3
Total WLA	0.0	0.0	0.0	0.0	0.0
Load Allocation	120.9	14.9	2.4	0.7	0.5
Margin of Safety	31.0	3.8	0.6	0.2	0.1
Allowance for future growth	3.10	0.38	0.06	0.02	0.01
TMDL	155.0	19.1	3.1	0.9	0.6
Total load reduction required	*No Data*	88.2%	90.2%	*No Data*	None

Table 5-6. Habitat TMDLs for 10-digit HUC 05060001 01 Headwaters Scioto River.

Habitat TMDL	TMDL Targets	Allocations			TMDL
		QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	
		≥ 60= *1 pt*	**< 2 = *1 pt***	**< 5 = *1 pt***	***3 pts***

Existing Scores Stream/River (Use)	River mile	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	Sub-score: QHEI Score	Sub-score: High Influence	Sub-score: Tot # Mod Attributes	Total Habitat Score
05060001 01 02 - Headwaters Scioto River								
Scioto River	231.86	79.5	0	2	1	1	1	3
	224.20	32.5	2	9	0	0	0	0
	223.05	38	3	9	0	0	0	0

Table 5-7. Sediment TMDLs for 10-digit HUC 05060001 01 Headwaters Scioto River.

<table>
<tr><td rowspan="5">TMDL Target
For WWH</td><td colspan="7">Sediment TMDL</td></tr>
<tr><td colspan="3">QHEI Categories</td><td rowspan="3">TOTAL TMDL SCORE</td><td colspan="3" rowspan="4"></td></tr>
<tr><td>Substrate</td><td>Channel</td><td>Riparian</td></tr>
<tr><td colspan="3">Allocations</td></tr>
<tr><td>≥ 13</td><td>≥ 14</td><td>≥ 5</td><td>32</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td rowspan="2">Existing Scores
Stream/River (Use)</td><td rowspan="2">River mile</td><td colspan="3">QHEI Categories</td><td rowspan="2">Total Sediment Score</td><td rowspan="2">Deviation from target (%)</td><td rowspan="2">Main impairment category</td></tr>
<tr><td>Substrate</td><td>Channel</td><td>Riparian</td></tr>
<tr><td colspan="8">05060001 01 02 - Headwaters Scioto River</td></tr>
<tr><td rowspan="3">Scioto River</td><td>231.86</td><td>13.5</td><td>16.5</td><td>9</td><td>39</td><td>---</td><td>---</td></tr>
<tr><td>224.20</td><td>9</td><td>5</td><td>3.5</td><td>17.5</td><td>45.3</td><td>channel</td></tr>
<tr><td>223.05</td><td>8</td><td>6</td><td>4</td><td>18</td><td>43.8</td><td>channel</td></tr>
</table>

5.2 Rush Creek (05060001 02)

In the Rush Creek 10-digit HUC TMDLs are developed for total phosphorus in the 02 02 and 02 03 12-digit HUCs, and all of the 12-digit HUCs have E. coli, habitat, and sediment TMDLs. Reductions required to meet the total phosphorus TMDLs from the approximated existing conditions are from 45 to 55 percent with nonpoint source reduction ranging from 51 to 60 percent and point source reduction in the 02 02 HUC of 35 percent. Reductions for *E. coli* bacteria range from two to 84 percent across both the 12 digit HUCs and the flow intervals.

One subwatershed has NPDES discharges with less than 0.025 MGD design flows, 12-digit HUCs, 05060001 02 02. Two TMDL scenarios are presented for this subwatershed. The first one, labeled “A”, shows the permitted outfalls with the lower design flows to have a 1.0 mg/l TP limit. The second scenario, labeled “B”, shows adjustments to the nonpoint sources if the dischargers receive no TP limit.

Table 5-8. Nutrient TMDLs, all loads in TP (kg-P/day).

<table>
<tr><td rowspan="2">12-Digit HUC
05060001</td><td rowspan="2">Subwatershed</td><td colspan="3">Existing Loads</td><td rowspan="2">NPS Reduce required</td><td rowspan="2">TMDL</td><td colspan="4">Allocations</td></tr>
<tr><td>PS</td><td>NPS</td><td>Total</td><td>WLA</td><td>LA</td><td>AFG</td><td>MOS</td></tr>
<tr><td>02 02A[1,2]</td><td rowspan="2">McDonald Creek</td><td rowspan="2">0.26</td><td rowspan="2">4.46</td><td rowspan="2">4.72</td><td>59.70%</td><td rowspan="2">2.11</td><td>0.17</td><td>1.80</td><td rowspan="2">0.04</td><td rowspan="2">0.11</td></tr>
<tr><td>02 02B[1,2]</td><td>60.50%</td><td>0.20</td><td>1.76</td></tr>
<tr><td>02 03</td><td>Lower Rush Creek</td><td>0.34</td><td>9.68</td><td>10.02</td><td>51.10%</td><td>5.5</td><td>0.38</td><td>4.74</td><td>0.11</td><td>0.28</td></tr>
</table>

[1] These TMDLs are only for the portion of the HUC noted in the subwatershed column.
[2] “A” and “B” represent different scenarios for allocating the same TMDL value. Scenario “A” has lower wasteload allocations which require new NPDES permit limits for one or more facilities; scenario “B” does not require new NPDES limits and therefore has a larger wasteload allocation, but then requires a greater reduction in nonpoint source loading to achieve the associated lower load allocation.

Table 5-9. Individual NPDES wasteload allocations per 12-digit HUC for nutrient (TP) TMDLs.

12-Dig HUC 05060001	**Subwatershed**	**NPDES/MS4**	**Existing load (kg/day)**	**Proposed limit (mg/l)**	**Allocation load (kg/day)**
02 02A[1]	McDonald Creek	Ohio Fresh Eggs 001	0.1	1	0.07
		Ohio Fresh Eggs 002	0.16	1	0.1
02 02B[1]		Ohio Fresh Eggs 001	0.16	No limit	0.103
		Ohio Fresh Eggs 002	0.16	1	0.1
02 03	Lower Rush Creek	1PB00025 - Rushsylvania WWTP	0.34	1	0.38

[1] "A" and "B" represent different scenarios for allocating the same TMDL value. Scenario "A" has lower wasteload allocations which require new NPDES permit limits for one or more facilities; scenario "B" does not require new NPDES limits and therefore has a larger wasteload allocation, but then requires a greater reduction in nonpoint source loading to achieve the associated lower load allocation.

Table 5-10. *E. coli* TMDL table for site on Rush Creek @ Winnemac Rd. HUC12: 05060001 02 01.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	**High flows**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	1	2	*No Data*	1
Median sample load	*No Data*	597.4	102.7	*No Data*	9.1
Total WLA (Rushsylvania WWTP - 1PB00025)	0.6	0.6	0.6	0.6	0.6
Load Allocation	683.5	83.9	13.2	4.0	2.8
Margin of Safety	175.4	21.7	3.5	1.2	0.9
Allowance for future growth	17.54	2.17	0.35	0.12	0.09
TMDL	877.1	108.3	17.7	5.9	4.3
Total load reduction required	*No Data*	81.9%	82.7%	*No Data*	52.2%

Table 5-11. *E. coli* TMDL table for site on McDonald Creek @ St. Rt. 37 HUC12: 05060001 02 02.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	**High flows**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	1	2	*No Data*	1
Median sample load	*No Data*	131.0	2.7	*No Data*	0.3
Total WLA	0.0	0.0	0.0	0.0	0.0
Load Allocation	131.7	16.3	2.6	1.0	0.7
Margin of Safety	33.78	4.19	0.68	0.25	0.18
Allowance for future growth	3.38	0.42	0.07	0.02	0.02
TMDL	168.9	21.0	3.4	1.2	0.9
Total load reduction required	*No Data*	84.0%	None	*No Data*	None

Table 5-12. *E. coli* TMDL table for site on Rush Creek S of New Bloomington @ Mt. Olive-Green Camp Rd. HUC12: 05060001 02 03.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	3	4	3	2
Median sample load	*No Data*	279.6	77.3	1.7	6.5
Total WLA (Rushsylvania WWTP - 1PB00025)	0.6	0.6	0.6	0.6	0.6
Load Allocation	1053.1	129.6	20.6	6.5	4.3
Margin of Safety	270.2	33.4	5.4	1.8	1.3
Allowance for future growth	27.02	3.34	0.54	0.18	0.13
TMDL	1350.9	167.0	27.2	9.1	6.3
Total load reduction required	*No Data*	40.3%	64.9%	None	2.3%

Table 5-13. Habitat TMDLs for 10-digit HUC 05060001 02 Rush Creek.

Habitat TMDL	TMDL Targets	Allocations: QHEI Score	Allocations: # of High Influence Attributes	Allocations: Total # of Modified Attributes	TMDL
		≥ 60= *1 pt*	**< 2 = *1 pt***	**< 5 = *1 pt***	***3 pts***

Existing Scores Stream/River (Use)	River mile	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	Sub-score: QHEI Score	Sub-score: High Influence	Sub-score: Tot # Mod Attributes	Total Habitat Score
05060001 02 01- Headwaters Rush Creek								
Rush Creek	26.26	66	0	4	1	1	1	3
05060001 02 02 - McDonald Creek								
McDonald Creek	9.17	38	3	9	0	0	0	0
	6.82	43	3	9	0	0	0	0
	2.70	45	2	8	0	0	0	0
05060001 02 03 - Dudley Run-Rush Creek								
Rush Creek	8.80	61.5	0	5	1	1	0	2

Table 5-14. Sediment TMDLs for 10-digit HUC 05060001 02 Rush Creek.

TMDL Target For WWH		Sediment TMDL					
		QHEI Categories			TOTAL TMDL SCORE		
		Substrate	Channel	Riparian			
		Allocations					
		≥ 13	≥ 14	≥ 5	32		
Existing Scores Stream/River (Use)	River mile	QHEI Categories			Total Sediment Score	Deviation from target (%)	Main impairment category
		Substrate	Channel	Riparian			
05060001 02 01- Headwaters Rush Creek							
Rush Creek	26.26	12	16	5	33	---	substrate
05060001 02 02 - McDonald Creek							
McDonald Creek	9.17	10	6	3	19	40.6	channel
	6.82	12	8	3	23	28.1	channel
	2.70	11	10.5	4.5	26	18.8	channel
05060001 02 03 - Dudley Run-Rush Creek							
Rush Creek	8.80	12	13	4.5	29.5	7.8	riparian

5.3 Little Scioto River (05060001 03)

In the Little Scioto River 10-digit HUC TMDLs are developed for total phosphorus in the 03 01 and 03 04 12-digit HUCs, and all of the 12-digit HUCs have E. coli, habitat, and sediment TMDLs. Reductions required for meeting the total phosphorus TMDLs from the approximated existing conditions are from 45 to 62 percent with nonpoint source reduction ranging from 51 to 70 percent and point source reduction ranging from 46 to 48 percent. Reductions for *E. coli* bacteria range from 16 to 88 percent across both the 12 digit HUCs and the flow intervals.

One subwatershed has NPDES discharges with less than 0.025 MGD design flows, 12-digit HUC, 05060001 03 04. Two TMDL scenarios are presented for this subwatershed. The first one, labeled “A”, shows the permitted outfalls with the lower design flows to have a 1.0 mg/l TP limit. The second scenario, labeled “B”, shows adjustments to the nonpoint sources if the dischargers receive no TP limit.

Table 5-15. Nutrient TMDLs, all loads in TP (kg-P/day).

12-Digit HUC 05060001	Subwatershed	Existing Loads			NPS Reduce required	TMDL	Allocations			
		PS	NPS	Total			WLA	LA	AFG	MOS
03 01	Rock Fork	3.82	5.79	9.62	51.00%	5.25	2.05	2.84	0.10	0.26
03 04A[1,2]	Honey Creek	0.66	2.43	3.09	69.60%	1.16	0.34	0.74	0.02	0.06
03 04B[1,2]					86.20%		0.75	0.34		

[1] These TMDLs are only for the portion of the HUC noted in the subwatershed column.
[2] "A" and "B" represent different scenarios for allocating the same TMDL value. Scenario "A" has lower wasteload allocations which require new NPDES permit limits for one or more facilities; scenario "B" does not require new NPDES limits and therefore has a larger wasteload allocation, but then requires a greater reduction in nonpoint source loading to achieve the associated lower load allocation.

Table 5-16. Individual NPDES wasteload allocations per 12-digit HUC for nutrient (TP) TMDLs.

12-Dig HUC 05060001	Sub-watershed	NPDES/MS4	Existing load (kg/day)	Proposed limit (mg/l)	Allocation load (kg/day)
03 01	Rock Fork	2PG00036-001 - Grandview Estates SD 2A	2.27	1	0.76
		2PG00036-002 - Grandview Estates SD 2A	0.91	1	0.30
		2IJ00027 - National Lime & Stone Co Marion Plant[2]	0.64	1	0.64
		City of Marion MS4	1.03	-	0.34
03 04A[1]	Honey Creek	2PG00072 - Harmony Subdiv SD 5B	0.09	1	0.04
		2PR00040 - Pleasant Acres MH Community LLC	0.17	1	0.08
		2PR00240 - Morning View Care Center	0.04	1	0.03
		2PT00048 - Pleasant Local Schools	0.17	1	0.08
		2PW00004 - N Quarry Subdivision	0.20	1	0.08
		City of Marion MS4	0.21	-	0.05
03 04B[1]	Honey Creek	2PG00072 - Harmony Subdiv SD 5B	0.09	No limit	0.11 [3]
		2PR00040 - Pleasant Acres MH Community LLC	0.17	No limit	0.23 [3]
		2PR00240 - Morning View Care Center	0.04	No limit	0.08 [3]
		2PT00048 - Pleasant Local Schools	0.17	1	0.08
		2PW00004 - N Quarry Subdivision	0.20	No limit	0.23 [3]
		City of Marion MS4	0.21	-	0.02

[1] "A" and "B" represent different scenarios for allocating the same TMDL value. Scenario "A" has lower wasteload allocations which require new NPDES permit limits for one or more facilities; scenario "B" does not require new NPDES limits and therefore has a larger wasteload allocation, but then requires a greater reduction in nonpoint source loading to achieve the associated lower load allocation.
[2] Controlled discharge.
[3] These loads are based on permitted design flows and an assumed TP existing concentration of 3.0 mg/l.

Table 5-17. *E. coli* TMDL table for site on Rock Fork N of Marion @ Kenton-Galion Rd. HUC12: 05060001 03 01.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	1	5	2	3	1
Median sample load	380	68.0	59.9	0.8	2.4
Total WLA	29.3	5.0	2.2	1.8	1.8
Grandview Estates-Outfall 001 -2PG00036 WLA	1.2	1.2	1.2	1.2	1.2
Grandview Estates-Outfall 002 2PG00036 WLA	0.5	0.5	0.5	0.5	0.5
Marion MS4 WLA	27.6	3.3	0.5	0.1	0.1
Load Allocation	219.1	26.5	3.8	0.8	0.4
Margin of Safety	63.7	8.1	1.5	0.7	0.6
Allowance for future growth	6.37	0.81	0.15	0.07	0.06
TMDL	318.4	40.4	7.7	3.4	2.8
Total load reduction required	16.2%	40.6%	87.1%	None	None

Table 5-18. *E. coli* TMDL table for site on L. Scioto R. N of Marion @ Kenton-Galion Rd. HUC12: 05060001 03 02.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	4	6	*No Data*	2
Median sample load	*No Data*	60.4	44.4	*No Data*	26.3
Total WLA	20.1	2.6	0.5	0.2	0.2
Ridgedale Elementary School - 2PT00049 WLA	0.1	0.1	0.1	0.1	0.1
Bucyrus MS4 WLA	20.0	2.5	0.4	0.1	0.1
Load Allocation	483.3	59.7	9.6	3.1	2.2
Margin of Safety	129.1	16.0	2.6	0.9	0.6
Allowance for future growth	12.91	1.60	0.26	0.09	0.06
TMDL	645.4	79.8	12.9	4.3	3.1
Total load reduction required	*No Data*	None	70.8%	*No Data*	88.3%

Table 5-19. *E. coli* TMDL table for site on L Scioto R. at Marion, upst WWTP HUC12: 05060001 03 03.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	2	3	*No Data*	*No Data*
Median sample load	*No Data*	887.3	54.3	*No Data*	*No Data*
Total WLA	122.8	16.5	4.0	2.4	2.2
Grandview Estates-Outfall 001 -2PG00036 WLA	1.2	1.2	1.2	1.2	1.2
Grandview Estates-Outfall 002 2PG00036 WLA	0.5	0.5	0.5	0.5	0.5
Ridgedale Elementary School - 2PT00049 WLA	0.1	0.1	0.1	0.1	0.1
Marion MS4 WLA	100.9	12.2	1.8	0.5	0.3
Bucyrus MS4 WLA	20	2.5	0.4	0.1	0.1
Load Allocation	798.3	97.2	14.5	3.9	2.1
Margin of Safety	236.2	29.2	4.7	1.6	1.1
Allowance for future growth	23.62	2.92	0.47	0.16	0.11
TMDL	1180.8	145.8	23.7	8.0	5.5
Total load reduction required	*No Data*	83.6%	56.3%	*No Data*	*No Data*

Table 5-20. *E. coli* TMDL table for site on L. Scioto R. at Green Camp @ Owens-Green Camp Rd. (CR 104) HUC12: 05060001 03 04.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	4	6	2	*No Data*
Median sample load	*No Data*	609.1	202.2	55.8	*No Data*
Total WLA	212.3	71.5	55.0	52.8	52.6
Grandview Estates-Outfall 001 -2PG00036 WLA	1.2	1.2	1.2	1.2	1.2
Grandview Estates-Outfall 002 2PG00036 WLA	0.5	0.5	0.5	0.5	0.5
Ridgedale Elementary School - 2PT00049 WLA	0.1	0.1	0.1	0.1	0.1
Marion WPC - 2PD00011 WLA	50.1	50.1	50.1	50.1	50.1
Pleasant Local Schools - 2PT00048 WLA	0.2	0.2	0.2	0.2	0.2
Pleasant Acres MH Community LLC - 2PR00040 WLA	0.1	0.1	0.1	0.1	0.1
North Quarry Subdivision - 2PW00004 WLA	0.1	0.1	0.1	0.1	0.1
Harmony Subdiv SD 5B - 2PG00072 WLA	0.05	0.05	0.05	0.05	0.05
Morning View Care Center - 2PR00240	0.04	0.04	0.04	0.04	0.04
Marion MS4 WLA	140.0	16.7	2.2	0.4	0.11
Bucyrus MS4 WLA	20	2.5	0.4	0.10	0.10
Load Allocation	1038.8	118.9	10.4	-3.8	-5.9
Margin of Safety	320.8	48.8	16.8	12.6	12.0
Allowance for future growth	32.08	4.88	1.68	1.26	1.20
TMDL	1604.0	244.1	83.8	62.9	59.8
Total load reduction required	*No Data*	59.9%	58.5%	None	*No Data*

Table 5-21. Habitat TMDLs for 10-digit HUC 05060001 03 Little Scioto River.

Habitat TMDL	TMDL Targets	Allocations			TMDL
		QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	
		≥ 60= *1 pt*	< 2 = *1 pt*	< 5 = *1 pt*	*3 pts*

Existing Scores Stream/River (Use)	River mile	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	Sub-score QHEI Score	Sub-score High Influence	Sub-score Tot # Mod Attributes	Total Habitat Score
05060001 03 01 - Rock Fork								
Rock Fork	8.13	35.5	4	9	0	0	0	0
	1.10	74	0	4	1	1	1	3
05060001 03 02 - Headwaters Little Scioto River								
Little Scioto River	25.59	40.5	1	6	0	1	0	1
	19.70	70	0	5	1	1	0	2
	11.10	49.5	1	7	0	1	0	1
05060001 03 03 - City of Marion-Little Scioto River								
Little Scioto River	9.24	73.5	0	4	1	1	1	3
05060001 03 04 - Honey Creek-Little Scioto River								
Honey Creek	0.01	58.5	1	5	0	1	0	1

Table 5-22. Sediment TMDLs for 10-digit HUC 05060001 03 Little Scioto River.

TMDL Target For WWH		Sediment TMDL					
		QHEI Categories			TOTAL TMDL SCORE		
		Substrate	Channel	Riparian			
		Allocations					
		≥ 13	≥ 14	≥ 5	32		
Existing Scores Stream/River (Use)	River mile	QHEI Categories			Total Sediment Score	Deviation from target (%)	Main impairment category
		Substrate	Channel	Riparian			
05060001 03 01 - Rock Fork							
Rock Fork	8.13	10	4	3.5	17.5	45.3	channel
	1.10	18	16	6	40	---	---
05060001 03 02 - Headwaters Little Scioto River							
Little Scioto River	25.59	0	12	5.5	17.5	45.3	substrate
	19.70	15	14	10	39	---	---
	11.10	10	11.5	7	28.5	10.9	substrate
05060001 03 03 - City of Marion-Little Scioto River							
Little Scioto River	9.24	16.5	15.5	9	41	---	---
05060001 03 04 - Honey Creek-Little Scioto River							
Honey Creek	0.01	0	13.5	6	19.5	39.1	substrate

5.4 Panther Creek-Scioto River (05060001 04)

In the Panther Creek - Scioto River 10-digit HUC TMDLs are developed for total phosphorus in the 04 02 and 04 04 12-digit HUCs, and all except the 04 02 12-digit HUC has E. coli, and sediment and habitat for the 04 04 and 04 06 12-digit HUCs. Reductions required to meet the total phosphorus TMDLs from the approximated existing conditions were from 44 to 51 percent with nonpoint source reduction ranging from 48 to 52 percent and point source reduction of 70 percent. Reductions for *E. coli* bacteria ranged from eight to 93 percent across both the 12 digit HUCs and the flow intervals.

Table 5-23. Nutrient TMDLs, all loads in TP (kg-P/day).

12-Digit HUC 05060001	Subwatershed	Existing Loads			NPS Reduce required	TMDL	Allocations			
		PS	NPS	Total			WLA	LA	AFG	MOS
04 02	Panther Creek	1.14	7.47	8.60	51.70%	4.25	0.34	3.61	0.08	0.21
04 04	Wildcat Creek	0	7.35	7.35	48.20%	4.09	0	3.81	0.08	0.20

Table 5-24. Individual NPDES wasteload allocations per 12-digit HUC for nutrient (TP) TMDLs.

12-Dig HUC 05060001	Subwatershed	NPDES/MS4	Existing load (kg/day)	Proposed limit (mg/l)	Allocation load (kg/day)
04 02	Panther Creek	2PA00046- Mt Victory WWTP[1]	1.14	1	0.34
04 04	Wildcat Creek	None	-	-	-

[1] Controlled discharge.

Table 5-25. *E. coli* TMDL table for site on Scioto R. at Kenton @ Leighton St. HUC12: 05060001 04 01.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	1	2	1	6
Median sample load	*No Data*	1759.4	92.0	19.2	27.9
Total WLA	2.0	2.0	2.0	2.0	2.0
Reed Road WWTP - 2PG00004 WLA	0.04	0.04	0.04	0.04	0.04
McGuffey STP - 2PA00006 WLA	0.7	0.7	0.7	0.7	0.7
Alger WWTP - 2PB00064 WLA	1.2	1.2	1.2	1.2	1.2
Green Hills Coach Park Ltd - 2PY00041 WLA	0.01	0.01	0.01	0.01	0.01
Load Allocation	1711.5	209.6	32.7	9.6	6.2
Margin of Safety	439.4	54.2	8.9	3.0	2.1
Allowance for future growth	43.94	5.42	0.89	0.30	0.21
TMDL	2196.8	271.2	44.4	14.8	10.5
Total load reduction required	*No Data*	84.6%	51.8%	23.1%	62.5%

Table 5-26. *E. coli* TMDL table for site on Scioto R. Dst. Kenton @ Twp. Rd. 199 HUC12: 05060001 04 03.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	2	2	*No Data*	1
Median sample load	*No Data*	1487.7	54.9	*No Data*	42.1
Total WLA	13.6	13.6	13.6	13.6	13.6
Reed Road WWTP - 2PG00004 WLA	0.04	0.04	0.04	0.04	0.04
McGuffey STP - 2PA00006 WLA	0.7	0.7	0.7	0.7	0.7
Alger WWTP - 2PB00064 WLA	1.2	1.2	1.2	1.2	1.2
Green Hills Coach Park Ltd - 2PY00041 WLA	0.01	0.01	0.01	0.01	0.01
Morton Buildings Inc - 2PR00233 WLA	0.02	0.02	0.02	0.02	0.02
Fairwayview STP - 2PG00012 WLA	0.2	0.2	0.2	0.2	0.2
Kenton WWTP - 2PD00020 WLA	11.4	11.4	11.4	11.4	11.4
Load Allocation	1902.8	232.1	35.0	9.3	5.7
Margin of Safety	491.4	63.0	12.5	5.9	4.9
Allowance for future growth	49.14	6.30	1.25	0.59	0.49
TMDL	2456.9	315.0	62.3	29.3	24.66
Total load reduction required	*No Data*	78.8%	None	No Data	41.4%

Table 5-27. *E. coli* TMDL table for site on Wildcat Ck @ Larue-Kenton Rd. nr. Larue HUC12:05060001 04 04.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	1	3	*No Data*	1
Median sample load	*No Data*	288.3	71.3	*No Data*	21.5
Total WLA	0.0	0.0	0.0	0.0	0.0
Load Allocation	237.8	29.3	4.9	1.73	1.2
Margin of Safety	61.0	7.5	1.2	0.4	0.3
Allowance for future growth	6.10	0.75	0.12	0.04	0.03
TMDL	304.8	37.6	6.2	2.2	1.5
Total load reduction required	*No Data*	87.0%	91.3%	*No Data*	92.8%

Table 5-28. E. coli TMDL table for site on Scioto R. at LaRue @ St. Rt. 37 HUC12: 05060001 04 05.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	**High flows**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	4	5	2	1
Median sample load	*No Data*	1073.4	101.9	61.9	57.8
Total WLA	14.2	14.2	14.2	14.2	14.2
Reed Road WWTP - 2PG00004 WLA	0.04	0.04	0.04	0.04	0.04
McGuffey STP - 2PA00006 WLA	0.7	0.7	0.7	0.7	0.7
Alger WWTP - 2PB00064 WLA	1.2	1.2	1.2	1.2	1.2
Green Hills Coach Park Ltd - 2PY00041 WLA	0.01	0.01	0.01	0.01	0.01
Morton Buildings Inc - 2PR00233 WLA	0.02	0.02	0.02	0.02	0.02
Fairwayview STP - 2PG00012 WLA	0.2	0.2	0.2	0.2	0.2
Kenton WWTP - 2PD00020 WLA	11.4	11.4	11.4	11.4	11.4
Mt Victory WWTP - 2PA00046 WLA	0.5	0.5	0.5	0.5	0.5
Eldridge Station Hills WWTP - 2PG00005 WLA	0.04	0.04	0.04	0.04	0.04
Load Allocation	2759.5	337.6	52.2	14.9	9.4
Margin of Safety	711.2	90.2	17.0	7.5	6.0
Allowance for future growth	71.12	9.02	1.70	0.75	0.60
TMDL	3556.0	450.9	85.1	37.3	30.2
Total load reduction required	*No Data*	58.0%	16.5%	39.8%	47.7%

Table 5-29. *E. coli* TMDL table for site on Scioto R. Adj. Green Camp River Rd. HUC12: 05060001 04 06.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	1	3	1	*No Data*
Median sample load	*No Data*	1343.7	138.3	50.2	*No Data*
Total WLA	15.9	15.9	15.9	15.9	15.9
Reed Road WWTP - 2PG00004 WLA	0.04	0.04	0.04	0.04	0.04
McGuffey STP - 2PA00006 WLA	0.7	0.7	0.7	0.7	0.7
Alger WWTP - 2PB00064 WLA	1.2	1.2	1.2	1.2	1.2
Green Hills Coach Park Ltd - 2PY00041 WLA	0.01	0.01	0.01	0.01	0.01
Morton Buildings Inc - 2PR00233 WLA	0.02	0.02	0.02	0.02	0.02
Fairwayview STP - 2PG00012 WLA	0.2	0.2	0.2	0.2	0.2
Kenton WWTP - 2PD00020 WLA	11.4	11.4	11.4	11.4	11.4
Mt Victory WWTP - 2PA00046 WLA	0.5	0.5	0.5	0.5	0.5
Eldridge Station Hills WWTP - 2PG00005 WLA	0.04	0.04	0.04	0.04	0.04
Rushsylvania WWTP - 1PB00025 WLA	0.6	0.6	0.6	0.6	0.6
LaRue WWTP - 2PA00051 WLA	0.5	0.5	0.5	0.5	0.5
New Bloomington WWTP - 2PA00065 WLA	0.6	0.6	0.6	0.6	0.6
Elgin High School - 2PT00052 WLA	0.1	0.1	0.1	0.1	0.1
Load Allocation	4354.7	534.4	83.9	25.2	16.5
Margin of Safety	1120.7	141.1	25.6	10.5	8.3
Allowance for future growth	112.1	14.1	2.6	1.1	0.8
TMDL	5603.3	705.5	127.9	52.7	41.6
Total load reduction required	*No Data*	47.5%	7.5%	None	*No Data*

Table 5-30. Habitat TMDLs for 10-digit HUC 05060001 04 Panther Creek-Scioto River.

Habitat TMDL	TMDL Targets	Allocations			TMDL
		QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	
		≥ 60= *1 pt*	**< 2 = *1 pt***	**< 5 = *1 pt***	***3 pts***

Existing Scores Stream/River (Use)	River mile	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	Sub-score: QHEI Score	Sub-score: High Influence	Sub-score: Tot # Mod Attributes	Total Habitat Score
05060001 04 04 - Wildcat Creek								
Wildcat Creek	6.72	43.5	2	9	0	0	0	0
05060001 04 06 - Glade Run-Scioto River								
Scioto River	186.00	67.5	1	7	1	1	0	2

Table 5-31. Sediment TMDLs for 10-digit HUC 05060001 04 Panther Creek-Scioto River.

TMDL Target For WWH		Sediment TMDL					
		QHEI Categories			TOTAL TMDL SCORE		
		Substrate	Channel	Riparian			
		Allocations					
		≥ 13	≥ 14	≥ 5	32		
Existing Scores Stream/River (Use)	**River mile**	**QHEI Categories**			**Total Sediment Score**	**Deviation from target (%)**	**Main impairment category**
		Substrate	**Channel**	**Riparian**			
05060001 04 04 - Wildcat Creek							
Wildcat Creek	6.72	11.5	7.5	2.5	21.5	32.8	riparian
05060001 04 06 - Glade Run-Scioto River							
Scioto River	186.00	8.5	13	9	30.5	4.7	substrate

5.5 Fulton Creek-Scioto River (05060001 05)

In the Fulton Creek - Scioto River 10-digit HUC TMDLs are developed for total phosphorus in the 05 04 12-digit HUC, and all except the 05 02 and 05 05 12-digit HUCs has E. coli, and sediment and habitat for the 05 01 and 05 04 12-digit HUCs. Reductions required to meet the total phosphorus TMDLs from the approximated existing conditions was 48 percent with a nonpoint source reduction of 51 percent and point source reduction of 57 percent. Reductions for *E. coli* bacteria ranged from nine to 89 percent across both the 12 digit HUCs and the flow intervals.

Table 5-32. Nutrient TMDLs, all loads in TP (kg-P/day).

12-Digit HUC 05060001	Subwatershed	Existing Loads			NPS Reduce required	TMDL	Allocations			
		PS	NPS	Total			WLA	LA	AFG	MOS
05 04	Fulton Creek	3.38	13.51	16.89	50.60%	8.73	1.44	6.68	0.17	0.44

Table 5-33. Individual NPDES wasteload allocations per 12-digit HUC for nutrient (TP) TMDLs.

12-Dig HUC 05060001	Subwatershed	NPDES/MS4	Existing load (kg/day)	Propose d limit (mg/l)	Allocation load (kg/day)
05 04	Fulton Creek	4IW00121 - Richwood PWS[1]	0	-	-
		4PB00018 - Richwood WWTP	3.38	1	1.44

[1] Controlled discharge.

Table 5-34. *E. coli* TMDL table for site on Patton Run @ Boundary Rd. HUC12: 05060001 05 01.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	1	3	1	*No Data*
Median sample load	*No Data*	223.7	3.4	4.0	*No Data*
Total WLA	0.0	0.0	0.0	0.0	0.0
Load Allocation	154.1	19.0	3.1	1.0	0.7
Margin of Safety	39.5	4.9	0.8	0.2	0.2
Allowance for future growth	3.95	0.49	0.08	0.02	0.02
TMDL	197.6	24.4	4.0	1.2	0.9
Total load reduction required	*No Data*	89.1%	None	69.3%	*No Data*

Table 5-35. *E. coli* TMDL table for site on Kebler Run S of Prospect @ River Rd. HUC12: 05060001 05 03.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	3	8	*No Data*	1
Median sample load	*No Data*	85.6	4.4	*No Data*	1.2
Total WLA	0.0	0.0	0.0	0.0	0.0
Load Allocation	153.1	19.0	3.1	1.0	0.7
Margin of Safety	39.3	4.9	0.8	0.2	0.2
Allowance for future growth	3.93	0.49	0.08	0.02	0.02
TMDL	196.3	24.4	4.0	1.2	0.9
Total load reduction required	*No Data*	71.6%	8.8%	*No Data*	25.0%

Table 5-36. E. coli TMDL table for site on Fulton Creek SE of Richwood @ St. Rt. 257 HUC12: 05060001 05 04.

Flow regime TMDL analysis (*E. coli* in billion organisms/day)	High flows	Wet weather	Normal range	Dry weather	Low
Flow duration regime interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	*No Data*	1	6	2	2
Median sample load	*No Data*	124.9	10.4	23.2	8.3
Total WLA (Richwood WWTP - 4PB00018)	2.3	2.3	2.3	2.3	2.3
Load Allocation	499.9	59.7	7.8	1.1	0.1
Margin of Safety	128.8	15.9	2.6	0.9	0.6
Allowance for future growth	12.88	1.59	0.26	0.09	0.06
TMDL	643.9	79.5	12.9	4.3	3.1
Total load reduction required	No Data	36.3%	None	81.4%	62.9%

Table 5-37. Habitat TMDLs for 10-digit HUC 05060001 05 Fulton Creek-Scioto River.

Habitat TMDL	TMDL Targets	Allocations			TMDL
		QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	
		≥ 60= *1 pt*	**< 2 = *1 pt***	**< 5 = *1 pt***	***3 pts***

Existing Scores Stream/River (Use)	River mile	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	Sub-score: QHEI Score	Sub-score: High Influence	Sub-score: Tot # Mod Attributes	Total Habitat Score
05060001 05 01- Patton Run								
Patton Run	2.25	56.5	2	6	0	0	0	0
05060001 05 04 - Fulton Creek								
Fulton Creek	16.3	27	4	9	0	0	0	0
	10.35	76.5	0	3	1	1	1	3
	8.70	42.5	2	9	0	0	0	0
Elliot Run	1.25	38	4	10	0	0	0	0

Table 5-38. Sediment TMDLs for 10-digit HUC 05060001 05 Fulton Creek-Scioto River.

<table>
<tr><th colspan="2" rowspan="5">TMDL Target
For WWH</th><th colspan="6">Sediment TMDL</th></tr>
<tr><th colspan="3">QHEI Categories</th><th rowspan="3">TOTAL TMDL SCORE</th><th colspan="2" rowspan="4"></th></tr>
<tr><th>Substrate</th><th>Channel</th><th>Riparian</th></tr>
<tr><th colspan="3">Allocations</th></tr>
<tr><th>≥ 13</th><th>≥ 14</th><th>≥ 5</th><th>32</th></tr>
<tr><td colspan="8"></td></tr>
<tr><th rowspan="2">Existing Scores
Stream/River (Use)</th><th rowspan="2">River mile</th><th colspan="3">QHEI Categories</th><th rowspan="2">Total Sediment Score</th><th rowspan="2">Deviation from target (%)</th><th rowspan="2">Main impairment category</th></tr>
<tr><th>Substrate</th><th>Channel</th><th>Riparian</th></tr>
<tr><td colspan="8">05060001 05 01- Patton Run</td></tr>
<tr><td>Patton Run</td><td>2.25</td><td>6</td><td>12</td><td>5.5</td><td>23.5</td><td>26.6</td><td>substrate</td></tr>
<tr><td colspan="8">05060001 05 04 - Fulton Creek</td></tr>
<tr><td rowspan="3">Fulton Creek</td><td>16.3</td><td>0</td><td>4</td><td>2</td><td>6</td><td>81.3</td><td>substrate</td></tr>
<tr><td>10.35</td><td>16</td><td>15</td><td>7.5</td><td>38.5</td><td>---</td><td>---</td></tr>
<tr><td>8.70</td><td>4</td><td>8</td><td>4</td><td>16</td><td>50.0</td><td>substrate</td></tr>
<tr><td>Elliot Run</td><td>1.25</td><td>8</td><td>6</td><td>3</td><td>17</td><td>46.9</td><td>channel</td></tr>
</table>

6 WATER QUALITY IMPROVEMENT STRATEGY

The rate of impaired water uses in the upper Scioto River watershed is well above that of the entire state. Only 42 percent of sites fully achieved goals for aquatic life uses; however, the overall rate for the 908 subwatersheds evaluated between 2001 and 2010 is 57 percent. Recreation uses are likewise more impaired than the state average since less than seven percent of the sites met goals in the upper Scioto River watershed, while about 15 percent of the assessment units achieved the goals for the 2012 Integrated Report evaluation.

Aside from high bacteria concentrations, the streams in the upper Scioto River watershed are most commonly degraded by poor habitat, nutrient enrichment, and issues related to dissolved oxygen concentrations (wide daily swings and/or extreme lows). In fact, 27, 23, and 21 percent of all the sites evaluated, respectively, were impacted by those stressors. Degradation associated with high concentrations of fine sediment and organic materials (often from fecal waste), was also evidenced at a relatively large proportion of the sites. The above mentioned stressors, in total, account for 86 percent of the of water quality problems that cause aquatic life impairment. Nutrient enrichment was commonly found in sites with poor habitat; likewise, dissolved oxygen issues and poor habitat were also often coincident. Organic enrichment was found to occur with dissolved oxygen problems at a somewhat higher rate than nutrient enrichment and dissolved oxygen problems; however neither occurred at a rate as high as poor habitat and the dissolved oxygen problems.

Sources of these water quality stressors are less variable and largely center on drainage from cropland and channel maintenance. In fact, with respect to aquatic life uses, nearly 70 percent of all of the sources of water quality stressors that were identified were one of these two, and agriculture drainage affected 35 percent of all sites evaluated while channelization affected 26 percent. Human and animal wastes accounted for about 15 percent of the sources that were identified, with seven out of this 15 percent delivered through CSOs, and four percent each associated with failed septic systems and livestock manure.

Regulatory actions to reduce pollutant loading in achieving water quality goals are presented in Table 6-1. These actions involve lower limits for total phosphorus concentrations in the effluent discharges of waste water treatment facilities. Namely, these limits correspond to a monthly average concentration that is not to exceed 1.0 mg/l of total phosphorus. There are eleven facilities with individual NPDES permits that are to receive the lower limits which range in average design discharge from 0.007 to 5.760 million gallons per day.

Table 6-2 shows an overview of all of the nested subwatersheds that contain sites with partial and non-attainment of aquatic life and recreation uses. Causes of impairment are shown within parentheses following each source that might contribute to that cause. Tables 6-3 through 6-7 each represent a separate subwatershed. A series of tables list actions appropriate for addressing the water quality stressors for each nested subwatershed in the basin. The recommended actions are well-established practices with demonstrated effectiveness. Details regarding these practices are included in Appendix E of this report. Additionally, Appendix E discusses various programs and organizations that can be sources for assistance in carrying out the recommended actions.

The recommended actions are not the only means for making the needed water quality improvements but rather highlight the more common approaches. Additionally, there is some repetition in these recommendations because certain stressors can be addressed by a variety of approaches (e.g., both naturalizing watershed hydrology and stream restoration will improve habitat quality). The options were selected considering effectiveness and economy. More costly actions may produce similar or greater levels of improvement but this may go beyond the minimum effort needed to address the stressors causing impairments. Additionally, good land management practices are applicable everywhere, so not specifically recommending a management practice does not necessarily suggest that a given management practice is inappropriate in that location. Instead, the recommendations are made to prioritize watershed restoration activities and not merely list what is beneficial. A primary objective of these recommendations is to assist watershed planning and/or provide guidance regarding investments made to improve water quality.

6.1 Regulatory Recommendations

Recommendations for NPDES permits are summarized by discharger and nested subwatershed in Table 6-1. Any suggestions in permit limits reflect calculated TMDLs. Ohio EPA will work with permit holders to accomplish any needed reductions in loadings.

Table 6-3. Recommended implementation actions through the NPDES program for total phosphorus.

Nested Sub-watershed (05060001)	Entity	Ohio EPA Permit #	Receiving Stream	Design Flow (million gallons per day)	Wasteload Allocation (load)	Wasteload Allocation (concen-tration)	Recommended Permit Conditions		Explanation for difference
							First Phase	Second Phase	
02 02	Ohio Fresh Eggs 001	n/a	n/a	n/a	0.07	1.0	1.0	1.0	
02 02	Ohio Fresh Eggs 002	n/a	n/a	n/a	0.1	1.0	Monitor[1]	1.0	Allocation based on assumed loading
02 03	Rushsylvania WWTP	1PB00025	Unnamed tributary to Rush Creek	0.100	0.38	1.0	No change	No change	
03 01	Grandview Estates SD 2A	2PG00036 - 001	Unnamed tributary to Rock Fork	0.280	0.76	1.0	Monitor[1]	1.0	Allocation based on assumed loading
03 01	Grandview Estates SD 2A	2PG00036 - 002	Unnamed tributary to Rock Fork	0.280	0.3	1.0	Monitor[1]	1.0	
03 01	National Lime & Stone Co Marion Plant	2IJ00027	Harvey Ditch	5.760	0.64	1.0	No change	No change	
03 04	Harmony Subdiv SD 5B	2PG00072	Honey Creek	0.010	0.04	1.0	Monitor[1]	1.0	Allocation based on assumed loading
03 04	Pleasant Acres MH Community LLC	2PR00040	Honey Creek	0.020	0.08	1.0	Monitor[1]	1.0	
03 04	Morning View Care Center	2PR00240	Honey Creek (via tile)	0.007	0.03	1.0	Monitor[1]	1.0	
03 04	Pleasant Local Schools	2PT00048	Little Scioto River	0.034	0.08	1.0	Monitor[1]	1.0	
03 04	N Quarry Subdivision	2PW00004	Honey Creek	0.020	0.08	1.0	Monitor[1]	1.0	
04 02	Mt Victory WWTP	2PA00046	Panther Creek	0.090	0.34	1.0	Monitor[1]	1.0	
05 04	Richwood WWTP	4PB00018	Fulton Creek	0.380	1.44	1.0	1.0	1.0	

[1] NPDES coverage for this facility, because it is a point source of the type of a confined animal feeding operation (CAFO), is under the jurisdiction of the Ohio Department of Agriculture (ODA) per amended Ohio Revised Code 903.08 and 6111.04.

Table 6-2. Recommendations for improving water quality in impaired areas of the upper Scioto River watershed.

	Restoration Categories											
Location Description (10-digit HUC) **Location Description (12-digit HUC)** **Sources (Causes)**	Bank & Riparian Restoration	Stream Restoration	Wetland Restoration	Conservation Easements	Dam Modification or Removal	Levee or Dike Modification or Removal	Abandoned Mine Land Reclamation	Home Sewage Planning and Improvement	Education and Outreach	Agricultural Best Management Practices	Storm Water Best Management Practices	Regulatory Point Source Controls
Headwaters Scioto River (05060001 01)												
Cottonwood Ditch (01 01)												
Not impaired												
Headwaters Scioto River (01 02)												
channelization (poor habitat, sediment)	x	x	x									
agriculture (sediment, bacteria)										x		
Taylor Creek (01 03)												
agriculture (bacteria)										x		
septic systems (bacteria)								x				
unsewered areas (bacteria)								x				
point source discharges (bacteria)												x
Silver Creek-Scioto River (01 04)												
septic systems (organic enrichment)								x				
natural sources												
agriculture (bacteria)										x		
livestock (bacteria)										x		
Rush Creek (05060001 02)												
Headwaters Rush Creek (02 01)												
agriculture (sedimentation, bacteria)										x		
septic systems (bacteria)								x				

Location Description (10-digit HUC) **Location Description (12-digit HUC)** **Sources (Causes)**	**Restoration Categories** Bank & Riparian Restoration	Stream Restoration	Wetland Restoration	Conservation Easements	Dam Modification or Removal	Levee or Dike Modification or Removal	Abandoned Mine Land Reclamation	Home Sewage Planning and Improvement	Education and Outreach	Agricultural Best Management Practices	Storm Water Best Management Practices	Regulatory Point Source Controls
natural sources (dissolved oxygen)												
McDonald Creek (02 02)												
channelization (poor habitat, dissolved oxygen)	x	x										
agriculture (nutrients, dissolved oxygen, bacteria)										x		
septic systems (organic enrichment, dissolved oxygen)								x				
livestock (bacteria)										x		
Dudley Run-Rush Creek (02 03)												
agriculture (bacteria)										x		
woodlot site clearance (poor habitat and flow conditions)												
natural sources												
Little Scioto River (05060001 03)												
Rock Fork (03 01)												
channelization (poor habitat)	x	x										
agriculture (nutrients, bacteria)										x		
manure runoff (fish kills, nutrients)										x		
livestock (bacteria)										x		
Headwaters Little Scioto River (03 02)												
channelization (poor habitat)	x	x										
agriculture (sediment, bacteria)										x		
City of Marion-Little Scioto River (03 03)												
channelization (poor habitat, sediment)	x	x										

Location Description (10-digit HUC) **Location Description (12-digit HUC)** **Sources (Causes)**	**Restoration Categories**											
	Bank & Riparian Restoration	Stream Restoration	Wetland Restoration	Conservation Easements	Dam Modification or Removal	Levee or Dike Modification or Removal	Abandoned Mine Land Reclamation	Home Sewage Planning and Improvement	Education and Outreach	Agricultural Best Management Practices	Storm Water Best Management Practices	Regulatory Point Source Controls
agriculture (sediment)										x		
contaminated sediment (PAHs, metals, fish deformities)												
combined sewer overflows (organic enrichment, dissolved oxygen)												x
point source discharges (bacteria)												x
Honey Creek-Little Scioto River (03 04)												
channelization (poor habitat)	x	x										
agriculture (nutrients, bacteria)										x		
contaminated sediment (creosote, PAHs, metals, fish deformities)												
livestock (bacteria)										x		
septic systems (bacteria)								x				
combined sewer overflows (organic enrichment, ammonia, nutrients)												x
Panther Creek-Scioto River (05060001 04)												
Gander Run-Scioto River (04 01)												
agriculture (bacteria)										x		
point source discharges (bacteria)												x
Panther Creek (04 02)												
agriculture (nutrients)										x		
Wolf Creek-Scioto River (04 03)												
agriculture (bacteria)										x		

Location Description (10-digit HUC) **Location Description (12-digit HUC)** **Sources (Causes)**	**Restoration Categories**											
	Bank & Riparian Restoration	Stream Restoration	Wetland Restoration	Conservation Easements	Dam Modification or Removal	Levee or Dike Modification or Removal	Abandoned Mine Land Reclamation	Home Sewage Planning and Improvement	Education and Outreach	Agricultural Best Management Practices	Storm Water Best Management Practices	Regulatory Point Source Controls
livestock (bacteria)										x		
point source discharges (bacteria- downstream)												x
Wildcat Creek (04 04)												
channelization (poor habitat)	x	x										
agriculture (nutrients, dissolved oxygen, bacteria)										x		
livestock (bacteria)										x		
natural sources												
Town of La Rue-Scioto River (04 05)												
agriculture (bacteria)										x		
livestock (bacteria)										x		
unsewered areas (bacteria)								x				
point source discharges (bacteria)												x
Glade Run-Scioto River (04 06)												
agriculture (sediment, bacteria)										x		
point source discharges (bacteria)												x
Fulton Creek-Scioto River (05060001 05)												
Patton Run (05 01)												
agriculture (sediment)										x		
livestock (bacteria)										x		
septic systems (bacteria)								x				
Davids Run-Scioto River (05 02)												

	Restoration Categories											
Location Description (10-digit HUC) **Location Description (12-digit HUC)** **Sources (Causes)**	Bank & Riparian Restoration	Stream Restoration	Wetland Restoration	Conservation Easements	Dam Modification or Removal	Levee or Dike Modification or Removal	Abandoned Mine Land Reclamation	Home Sewage Planning and Improvement	Education and Outreach	Agricultural Best Management Practices	Storm Water Best Management Practices	Regulatory Point Source Controls
insufficient data												
Kebler Run (05 03)												
agriculture (bacteria)										x		
septic systems (bacteria)								x				
Fulton Creek (05 04)												
channelization (poor habitat)	x	x										
agriculture (nutrients, total phosphorus, bacteria)										x		
point source discharges (nutrients, organic enrichment, dissolved oxygen)												x
livestock (bacteria)										x		
septic systems (bacteria)								x				
Ottawa Creek-Scioto River (05 05)												
Not impaired												

6.2 Headwaters Scioto River (05060001 01)

The headwaters of the Scioto River had a modest rate of impairment where about one third of the sites surveyed did not meet all applicable criteria for aquatic life uses. The rate of impairment for recreation use is much higher with none of the sites showing geometric mean concentrations for *E. coli* below the criteria's maximum value. Sources of the water quality degradation were primarily related to land use and management practices where run off and other drainage from crop production areas and animal agriculture brought bacteria and fine sediment to the stream system. The modification and subsequent maintenance of the streams for drainage diminishes the capacity to expel fine sediment as well as simplifies aquatic habitat.

The Scioto River has an abrupt change in habitat quality down from the state route 67 crossing. In fact, the two sites immediately upstream and downstream of the crossing show QHEI scores dropping from 79.5 to 38.5. The nearly twenty mile stretch of river beyond state route 67 is reasonably characterized as entrenched, mostly straight, with little to no riparian vegetation other than a narrow strip of cool season grasses to one side. State Route 195 is immediately adjacent to west side of the river for much of this stretch. Both local and downstream water quality improvements are likely if floodplain access is provided on the bank opposite the highway. At a cost of some cropland, flooding would likely be abated, and fine sediment could be expelled from the main channel and stored in the floodplain. Streamside wetlands are also likely to provide similar benefits if there is adequate connection with the river. Upland management practices that reduce soil erosion are likely to abate some of the sediment load to the river.

Organic enrichment was found in McCoy Run where improperly treated waste from home septic systems seems to be adversely impacting water quality. Such systems should be well maintained to protect public health and sustain water quality for multiple stream uses. This area should be noted as a priority for inspections and owner assistance and education provided regarding the maintenance of properly functioning septic systems.

Table 6-3. Recommended implementation actions in the Headwaters Scioto River watershed.

Restoration Categories		Specific Restoration Actions	Headwaters Scioto River (05060001 01)			
			Cottonwood Ditch (01 01)	Headwaters Scioto River (01 02)	Taylor Creek (01 03)	Silver Creek-Scioto River (01 04)
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering				
		Restore streambank by recontouring or regrading				
	planted	Plant grasses in riparian areas		x		
		Plant prairie grasses in riparian areas		x		
		Remove/treat invasive species				
		Plant trees or shrubs in riparian areas		x		

Restoration Categories		Specific Restoration Actions	Headwaters Scioto River (05060001 01)			
			Cottonwood Ditch (01 01)	Headwaters Scioto River (01 02)	Taylor Creek (01 03)	Silver Creek-Scioto River (01 04)
Stream Restoration		Restore flood plain		x		
		Restore stream channel		x		
		Install in-stream habitat structures		x		
		Install grade structures				
		Construct 2-stage channel		x		
		Restore natural flow				
Wetland Restoration		Reconnect wetland to stream				
		Reconstruct & restore wetlands		x		
		Plant wetland species				
Conservation Easements		Acquire conservation easements				
Dam Modification or Removal		Remove dams				
		Modify dams				
		Remove associated dam support structures				
		Install fish passage and/or habitat structures				
		Restore natural flow				
Levee or Dike Modification or Removal		Remove levees				
		Breach or modify levees				
		Remove dikes				
		Modify dikes				
		Restore natural flood plain function				
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				
		Install vertical flow ponds				
		Install limestone drains (anoxic and/or oxic)				
		Construct acid mine drainage wetland				
	flow diversion	Repair subsidence sites				
		Reclaim pit impoundments				
		Reclaim abandoned mine land				

Restoration Categories		Specific Restoration Actions	Headwaters Scioto River (05060001 01)			
			Cottonwood Ditch (01 01)	Headwaters Scioto River (01 02)	Taylor Creek (01 03)	Silver Creek-Scioto River (01 04)
		Eliminate stream captures				
		Eliminate mine drainage discharges				
		Restore positive drainage				
		Cover toxic mine spoils				
Home Sewage Planning and Improvement		Develop HSTS plan				
		Inspect HSTS			x	x
		Repair or replace traditional HSTS			x	x
		Repair or replace alternative HSTS			x	x
Education and Outreach		Host meetings, workshops, and/or other events				
		Distribute educational materials				
Agricultural Best Management Practices	farmland	Plant cover/manure crops		x		
		Implement conservation tillage practices		x		
		Implement grass/legume rotations				
		Convert to permanent hayland		x		
		Install grassed waterways				
		Install vegetated buffer areas/strips		x		
		Install location-specific conservation buffer		x		
		Install / restore wetlands		x		
	nutrients / agro-chemicals	Conduct soil testing				
		Install nitrogen reduction practices				
		Develop nutrient management plans				
	drainage	Install blind inlets				
		Install controlled drainage system				
		Implement drainage water management				
		Construct overwide ditch				
		Construct 2-stage channel				
	livestock	Implement prescribed & conservation grazing practices			x	
		Install livestock exclusion fencing				
		Install livestock crossings			x	
		Install alternative water supplies				
		Install livestock access lanes				
	manure	Implement manure management practices			x	

Restoration Categories		Specific Restoration Actions	Headwaters Scioto River (05060001 01)			
			Cottonwood Ditch (01 01)	Headwaters Scioto River (01 02)	Taylor Creek (01 03)	Silver Creek-Scioto River (01 04)
		Construct animal waste storage structures			x	
		Implement manure transfer practices			x	
		Install wastewater treatment strips			x	
	misc. infrastructure 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				
Storm Water Best Management Practices	planning	Develop/implement local ordinances/resolutions				
		Develop local comprehensive land use plans				
	construction practices	Implement erosion controls				
		Implement sediment controls				
		Implement non-sediment controls				
	post construction practices	Reduce pollutant(s) through treatment				
		Reduce pollutant(s) through flow/volume management				
	post development/ storm water retrofit	Implement erosion controls				
		Implement sediment controls				
		Implement non-sediment controls				
		Reduce pollutant(s) through treatment				
		Reduce pollutant(s) through flow/volume management				
Regulatory Point Source Controls (includes Storm Water, Sanitary, and Industrial)	planning	Develop long-term control plan (CSOs)				
		Develop/implement local ordinances/resolutions				
		Develop water quality management/208 plans				
	collection and new treatment	Install sewer systems in communities				
		Implement long-term control plan (CSOs)				
		Eliminate SSOs/CSOs/by-passes				
	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				
	construction	Issue permit(s) and/or modify permit limit(s)				

Restoration Categories		**Specific Restoration Actions**	**Headwaters Scioto River (05060001 01)**			
			Cottonwood Ditch (01 01)	Headwaters Scioto River (01 02)	Taylor Creek (01 03)	Silver Creek-Scioto River (01 04)
	practices	Implement erosion controls				
		Implement sediment controls				
		Implement non-sediment controls				
	post construction practices	Issue permit(s) and/or modify permit limit(s)				
		Reduce pollutant(s) through treatment				
		Reduce pollutant(s) through flow/volume management				
	post development/ storm water retrofit	Issue permit(s) and/or modify permit limit(s)				
		Implement erosion controls				
		Implement sediment controls				
		Implement non-sediment controls				
		Reduce pollutant(s) through treatment				
		Reduce pollutant(s) through flow/volume management				
		Reduce volume to CSOs				

6.3 Rush Creek (05060001 02)

Rush Creek had a high rate of impairment where only about 27 percent of the sites surveyed met all applicable criteria for aquatic life uses and none met recreation use criteria. Sources of the water quality degradation were primarily related to cropland drainage and channelization, especially in the McDonald Creek sub-watershed; however, bedrock geology is likely having a limiting effect for the upper portion of Rush Creek. Localized bank erosion which is probably exacerbated by lack of well-rooted riparian vegetation appears to be limiting aquatic life in the upper reached of Rush Creek (near river mile 26.0). Run off from cropland is a likely source of bacteria throughout this watershed when manure is land applied. Failed home septic systems near Rush Creek (especially upstream form river mile 14.5) and livestock in the McDonald Creek sub-watershed are other likely sources of bacteria.

Table 6--4. Recommended implementation actions in the Rush Creek watershed.

Restoration Categories		Specific Restoration Actions	Rush Creek (05060001 02)		
			Headwaters Rush Creek (02 01)	McDonald Creek (02 02)	Dudley Run-Rush Creek (02 03)
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering	x		
		Restore streambank by recontouring or regrading			
	planted	Plant grasses in riparian areas		x	
		Plant prairie grasses in riparian areas	x	x	
		Remove/treat invasive species			
		Plant trees or shrubs in riparian areas	x	x	
Stream Restoration		Restore flood plain		x	
		Restore stream channel		x	
		Install in-stream habitat structures		x	
		Install grade structures			
		Construct 2-stage channel		x	
		Restore natural flow			
Wetland Restoration		Reconnect wetland to stream	x	x	x
		Reconstruct & restore wetlands	x	x	x
		Plant wetland species			
Conservation Easements		Acquire conservation easements			
Dam Modification or Removal		Remove dams			
		Modify dams			
		Remove associated dam support structures			
		Install fish passage and/or habitat structures			
		Restore natural flow			
Levee or Dike Modification or Removal		Remove levees			
		Breach or modify levees			
		Remove dikes			
		Modify dikes			
		Restore natural flood plain function			
Abandoned Mine Land Reclamation	treatment	Construct lime dosers			
		Install slag leach beds			
		Install limestone leach beds			
		Install limestone channels			
		Install successive alkalinity producing systems			

Restoration Categories		Specific Restoration Actions	Rush Creek (05060001 02): Headwaters Rush Creek (02 01)	Rush Creek (05060001 02): McDonald Creek (02 02)	Rush Creek (05060001 02): Dudley Run-Rush Creek (02 03)
		Install settling ponds			
		Install vertical flow ponds			
		Install limestone drains (anoxic and/or oxic)			
		Construct acid mine drainage wetland			
	flow diversion	Repair subsidence sites			
		Reclaim pit impoundments			
		Reclaim abandoned mine land			
		Eliminate stream captures			
		Eliminate mine drainage discharges			
		Restore positive drainage			
		Cover toxic mine spoils			
Home Sewage Planning and Improvement		Develop HSTS plan			
		Inspect HSTS	x	x	
		Repair or replace traditional HSTS	x	x	
		Repair or replace alternative HSTS	x	x	
Education and Outreach		Host meetings, workshops, and/or other events			
		Distribute educational materials			
Agricultural Best Management Practices	farmland	Plant cover/manure crops	x	x	
		Implement conservation tillage practices	x	x	
		Implement grass/legume rotations		x	
		Convert to permanent hayland	x	x	
		Install grassed waterways			
		Install vegetated buffer areas/strips	x		
		Install location-specific conservation buffer	x	x	
		Install / restore wetlands		x	
	nutrients / agro-chemicals	Conduct soil testing		x	
		Install nitrogen reduction practices		x	
		Develop nutrient management plans		x	
	drainage	Install blind inlets			
		Install controlled drainage system		x	
		Implement drainage water management		x	
		Construct overwide ditch		x	

Restoration Categories		Specific Restoration Actions	Rush Creek (05060001 02)		
			Headwaters Rush Creek (02 01)	McDonald Creek (02 02)	Dudley Run-Rush Creek (02 03)
		Construct 2-stage channel		x	
	livestock	Implement prescribed & conservation grazing practices			x
		Install livestock exclusion fencing			x
		Install livestock crossings			x
		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 wastewater treatment strips			x
	misc. infrastructure 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			
Storm Water Best Management Practices	planning	Develop/implement local ordinances/resolutions			
		Develop local comprehensive land use plans			
	construction practices	Implement erosion controls			
		Implement sediment controls			
		Implement non-sediment controls			
	post construction practices	Reduce pollutant(s) through treatment			
		Reduce pollutant(s) through flow/volume management			
	post development/ storm water retrofit	Implement erosion controls			
		Implement sediment controls			
		Implement non-sediment controls			
		Reduce pollutant(s) through treatment			
		Reduce pollutant(s) through flow/volume management			
Regulatory Point Source Controls (includes	planning	Develop long-term control plan (CSOs)			
		Develop/implement local ordinances/resolutions			
		Develop water quality management/208 plans			
	collection	Install sewer systems in communities			

Restoration Categories		Specific Restoration Actions	Rush Creek (05060001 02)		
			Headwaters Rush Creek (02 01)	McDonald Creek (02 02)	Dudley Run-Rush Creek (02 03)
Storm Water, Sanitary, and Industrial)	and new treatment	Implement long-term control plan (CSOs)			
		Eliminate SSOs/CSOs/by-passes			
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)			
		Improve quality of effluent		x	
	monitoring	Establish ambient monitoring program			
		Increase effluent monitoring		x	
	alternatives	Establish water quality trading			
	construction practices	Issue permit(s) and/or modify permit limit(s)			
		Implement erosion controls			
		Implement sediment controls			
		Implement non-sediment controls			
	post construction practices	Issue permit(s) and/or modify permit limit(s)			
		Reduce pollutant(s) through treatment			
		Reduce pollutant(s) through flow/volume management			
	post development/ storm water retrofit	Issue permit(s) and/or modify permit limit(s)			
		Implement erosion controls			
		Implement sediment controls			
		Implement non-sediment controls			
		Reduce pollutant(s) through treatment			
		Reduce pollutant(s) through flow/volume management			
		Reduce volume to CSOs			

6.4 Little Scioto River (05060001 03)

The Little Scioto River watershed is the most impaired of the five ten-digit HUCs in the project area. None of the sites met criteria for aquatic life or recreation uses. In fact, nearly all of the sites in this watershed are in the more severe non attainment category for aquatic life uses with only two out of eleven sites meeting some of the criteria (i.e., partial attainment status). The most severe problems in the Little Scioto had historically been associated with stream sediment contaminated with creosote. Collaboration between the U.S. EPA, U.S. Coast Guard, and Ohio EPA provided the funding used to dredge contaminated streambed and near shore sediments and replace this material with clean fill. To date, this work extends from the location where the contamination is believed to originate (the former Baker Woods Creosote Company) at the Holland Road crossing of North Rockswale Ditch (about river mile 0.5) through the confluence with the Little Scioto River and down to State Route 95 stream crossing (river mile 5.72).

Continuing studies and feasibility analyses will guide future clean-up activities. The remaining contaminated area has shown to be impacting wildlife and is also listed on the National Priorities List under the federal Superfund Program. See the following link for more information: http://www.epa.gov/region05/cleanup/littlescioto/index.htm.

Other water quality problems in the Little Scioto River watershed include CSO discharges from the City of Marion's waste water system. Two of the City's three CSO outfalls are still active and discharge within the Little Scioto River watershed (the other is no longer active and had discharged to the Olentangy River watershed). Over a longer-term view of the data, the discharge volumes are fairly equal between these two outfalls; however, there is clearly year-to-year variation between the two. The City is carrying out its long-term control plan (LTCP) which includes executing the nine minimum control measures prescribed by U.S. EPA (U.S. EPA, 1995), separation of parts of the combined system, regulator modifications and improvements, construction of storage basins as well as other improvements to the collection system. The overall schedule for completion of the projects prescribed by the LTCP is in the year 2020.

In the watershed upstream from Marion water quality problems are, like much of the upper Scioto River watershed, centered on drainage from cropland, channelization and livestock manure. Improvements to the stream channel, including creating or enhancing floodplain areas, as well as cover cropping, nutrient management, and other well-established farmland conservation practices will likely improve water quality in this area of the sub-watershed.

Table 6-5. Recommended implementation actions in the Little Scioto River watershed.

Restoration Categories		**Specific Restoration Actions**	**Little Scioto River (05060001 03)**			
			Rock Fork (03 01)	Headwaters Little Scioto River (03 02)	City of Marion-Little Scioto River (03 03)	Honey Creek-Little Scioto River (03 04)
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering				
		Restore streambank by recontouring or regrading				
	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	x	x
		Restore stream channel	x	x	x	x
		Install in-stream habitat structures	x	x	x	x
		Install grade structures				
		Construct 2-stage channel	x	x		
		Restore natural flow				
Wetland Restoration		Reconnect wetland to stream	x	x	x	x

Restoration Categories		Specific Restoration Actions	Little Scioto River (05060001 03): Rock Fork (03 01)	Headwaters Little Scioto River (03 02)	City of Marion-Little Scioto River (03 03)	Honey Creek-Little Scioto River (03 04)
		Reconstruct & restore wetlands	x	x	x	x
		Plant wetland species				
Conservation Easements		Acquire conservation easements				
Dam Modification or Removal		Remove dams				
		Modify dams				
		Remove associated dam support structures				
		Install fish passage and/or habitat structures				
		Restore natural flow				
Levee or Dike Modification or Removal		Remove levees				
		Breach or modify levees				
		Remove dikes				
		Modify dikes				
		Restore natural flood plain function				
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				
		Install vertical flow ponds				
		Install limestone drains (anoxic and/or oxic)				
		Construct acid mine drainage wetland				
	flow diversion	Repair subsidence sites				
		Reclaim pit impoundments				
		Reclaim abandoned mine land				
		Eliminate stream captures				
		Eliminate mine drainage discharges				
		Restore positive drainage				
		Cover toxic mine spoils				
Home Sewage Planning and Improvement		Develop HSTS plan				
		Inspect HSTS				x

Restoration Categories		Specific Restoration Actions	Little Scioto River (05060001 03)			
			Rock Fork (03 01)	Headwaters Little Scioto River (03 02)	City of Marion-Little Scioto River (03 03)	Honey Creek-Little Scioto River (03 04)
		Repair or replace traditional HSTS				x
		Repair or replace alternative HSTS				x
Education and Outreach		Host meetings, workshops, and/or other events				
		Distribute educational materials				
Agricultural Best Management 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
		Convert to permanent hayland	x	x		x
		Install grassed waterways				
		Install vegetated buffer areas/strips	x	x	x	x
		Install location-specific conservation buffer	x	x	x	x
		Install / restore wetlands	x	x	x	x
	nutrients / agro-chemicals	Conduct soil testing	x	x		x
		Install nitrogen reduction practices	x	x		x
		Develop nutrient management plans	x	x		x
	drainage	Install blind inlets				
		Install controlled drainage system	x	x		x
		Implement drainage water management	x	x		x
		Construct overwide ditch	x	x		x
		Construct 2-stage channel	x	x		x
	livestock	Implement prescribed & conservation grazing practices	x	x		
		Install livestock exclusion fencing	x	x		
		Install livestock crossings				
		Install alternative water supplies				
		Install livestock access lanes				
	manure	Implement manure management practices	x			
		Construct animal waste storage structures				
		Implement manure transfer practices				
		Install wastewater treatment strips				
	misc. infrastructure and mgt	Install chemical mixing pads				
		Install heavy use feeding pads				
		Install erosion & sediment control structures				

Restoration Categories		Specific Restoration Actions	Little Scioto River (05060001 03)			
			Rock Fork (03 01)	Headwaters Little Scioto River (03 02)	City of Marion-Little Scioto River (03 03)	Honey Creek-Little Scioto River (03 04)
		Install roof water management practices				
		Install milkhouse waste treatment practices				
		Develop whole farm management plans				
Storm Water Best Management Practices	planning	Develop/implement local ordinances/resolutions				
		Develop local comprehensive land use plans				
	construction practices	Implement erosion controls				
		Implement sediment controls				
		Implement non-sediment controls				
	post construction practices	Reduce pollutant(s) through treatment				
		Reduce pollutant(s) through flow/volume management				
	post development/ storm water retrofit	Implement erosion controls				
		Implement sediment controls				
		Implement non-sediment controls				
		Reduce pollutant(s) through treatment				
		Reduce pollutant(s) through flow/volume management				
Regulatory Point Source Controls (includes Storm Water, Sanitary, and Industrial)	planning	Develop long-term control plan (CSOs)				
		Develop/implement local ordinances/resolutions				
		Develop water quality management/208 plans				
	collection and new treatment	Install sewer systems in communities				
		Implement long-term control plan (CSOs)			x	x
		Eliminate SSOs/CSOs/by-passes				
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)				
		Improve quality of effluent				x
	monitoring	Establish ambient monitoring program				
		Increase effluent monitoring				x
	alternatives	Establish water quality trading				
	construction practices	Issue permit(s) and/or modify permit limit(s)				
		Implement erosion controls				
		Implement sediment controls				
		Implement non-sediment controls				
	post construction practices	Issue permit(s) and/or modify permit limit(s)				
		Reduce pollutant(s) through treatment				
		Reduce pollutant(s) through flow/volume management				

Restoration Categories		Specific Restoration Actions	Little Scioto River (05060001 03)			
			Rock Fork (03 01)	Headwaters Little Scioto River (03 02)	City of Marion-Little Scioto River (03 03)	Honey Creek-Little Scioto River (03 04)
	post development/ storm water retrofit	Issue permit(s) and/or modify permit limit(s)				
		Implement erosion controls				
		Implement sediment controls				
		Implement non-sediment controls				
		Reduce pollutant(s) through treatment				
		Reduce pollutant(s) through flow/volume management				
		Reduce volume to CSOs				

6.5 Panther Creek-Scioto River (05060001 04)

The Panther Creek - Scioto River watershed shows the second best water quality in terms of aquatic life with no sites in non attainment and 60 percent fully meeting the criteria. Likewise, the only two sites in the entire project area that meet recreation use criteria are found in this watershed. Of the six out of fifteen sites found to be impaired for aquatic life uses, four suffer from nutrient enrichment from cropland drainage which occurs in Panther and Wildcat Creeks. Excessive fine sediment is also a problem along parts of the Scioto River from the cumulative impacts of upstream cropland run off. The upper portion of Wildcat Creek is likewise degraded from channelization that diminished habitat quality.

Table 6-6. Recommended implementation actions in the Panther Creek – Scioto River watershed.

Restoration Categories		Specific Restoration Actions	Panther Creek-Scioto River (05060001 04)					
			Gander Run-Scioto River (04 01)	Panther Creek (04 02)	Wolf Creek-Scioto River (04 03)	Wildcat Creek (04 04)	Town of La Rue-Scioto River (04 05)	Glade Run-Scioto River (04 06)
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering						
		Restore streambank by recontouring or regrading						
	planted	Plant grasses in riparian areas		x		x		

Restoration Categories		Specific Restoration Actions	Panther Creek-Scioto River (05060001 04)					
			Gander Run-Scioto River (04 01)	Panther Creek (04 02)	Wolf Creek-Scioto River (04 03)	Wildcat Creek (04 04)	Town of La Rue-Scioto River (04 05)	Glade Run-Scioto River (04 06)
		Plant prairie grasses in riparian areas		x		x		
		Remove/treat invasive species						
		Plant trees or shrubs in riparian areas		x		x		
Stream Restoration		Restore flood plain				x		
		Restore stream channel				x		
		Install in-stream habitat structures				x		
		Install grade structures						
		Construct 2-stage channel		x		x		
		Restore natural flow						
Wetland Restoration		Reconnect wetland to stream	x	x	x	x	x	x
		Reconstruct & restore wetlands	x	x	x	x	x	x
		Plant wetland species						
Conservation Easements		Acquire conservation easements						
Dam Modification or Removal		Remove dams						
		Modify dams						
		Remove associated dam support structures						
		Install fish passage and/or habitat structures						
		Restore natural flow						
Levee or Dike Modification or Removal		Remove levees						
		Breach or modify levees						
		Remove dikes						
		Modify dikes						
		Restore natural flood plain function						
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						
		Install vertical flow ponds						
		Install limestone drains (anoxic and/or oxic)						

Restoration Categories		Specific Restoration Actions	Panther Creek-Scioto River (05060001 04)					
			Gander Run-Scioto River (04 01)	Panther Creek (04 02)	Wolf Creek-Scioto River (04 03)	Wildcat Creek (04 04)	Town of La Rue-Scioto River (04 05)	Glade Run-Scioto River (04 06)
		Construct acid mine drainage wetland						
	flow diversion	Repair subsidence sites						
	flow diversion	Reclaim pit impoundments						
	flow diversion	Reclaim abandoned mine land						
	flow diversion	Eliminate stream captures						
	flow diversion	Eliminate mine drainage discharges						
	flow diversion	Restore positive drainage						
	flow diversion	Cover toxic mine spoils						
Home Sewage Planning and Improvement		Develop HSTS plan						
Home Sewage Planning and Improvement		Inspect HSTS					x	
Home Sewage Planning and Improvement		Repair or replace traditional HSTS					x	
Home Sewage Planning and Improvement		Repair or replace alternative HSTS					x	
Education and Outreach		Host meetings, workshops, and/or other events						
Education and Outreach		Distribute educational materials						
Agricultural Best Management Practices	farmland	Plant cover/manure crops		x		x	x	x
Agricultural Best Management Practices	farmland	Implement conservation tillage practices						x
Agricultural Best Management Practices	farmland	Implement grass/legume rotations		x		x		
Agricultural Best Management Practices	farmland	Convert to permanent hayland		x		x		x
Agricultural Best Management Practices	farmland	Install grassed waterways						
Agricultural Best Management Practices	farmland	Install vegetated buffer areas/strips		x		x	x	x
Agricultural Best Management Practices	farmland	Install location-specific conservation buffer		x		x	x	x
Agricultural Best Management Practices	farmland	Install / restore wetlands		x		x		x
Agricultural Best Management Practices	nutrients / agro-chemicals	Conduct soil testing		x		x		
Agricultural Best Management Practices	nutrients / agro-chemicals	Install nitrogen reduction practices		x		x		
Agricultural Best Management Practices	nutrients / agro-chemicals	Develop nutrient management plans		x		x		
Agricultural Best Management Practices	drainage	Install blind inlets						
Agricultural Best Management Practices	drainage	Install controlled drainage system		x		x		
Agricultural Best Management Practices	drainage	Implement drainage water management		x		x		
Agricultural Best Management Practices	drainage	Construct overwide ditch						
Agricultural Best Management Practices	drainage	Construct 2-stage channel						
Agricultural Best Management Practices	livestock	Implement prescribed & conservation grazing practices		x		x	x	x
Agricultural Best Management Practices	livestock	Install livestock exclusion fencing		x		x	x	x

Restoration Categories		Specific Restoration Actions	Panther Creek-Scioto River (05060001 04)					
			Gander Run-Scioto River (04 01)	Panther Creek (04 02)	Wolf Creek-Scioto River (04 03)	Wildcat Creek (04 04)	Town of La Rue-Scioto River (04 05)	Glade Run-Scioto River (04 06)
		Install livestock crossings						
		Install alternative water supplies						
		Install livestock access lanes						
	manure	Implement manure management practices		x		x	x	x
	manure	Construct animal waste storage structures						
	manure	Implement manure transfer practices						
	manure	Install wastewater treatment strips						
	misc. infrastructure and mgt	Install chemical mixing pads						
	misc. infrastructure and mgt	Install heavy use feeding pads						
	misc. infrastructure and mgt	Install erosion & sediment control structures						
	misc. infrastructure and mgt	Install roof water management practices						
	misc. infrastructure and mgt	Install milkhouse waste treatment practices						
	misc. infrastructure and mgt	Develop whole farm management plans						
Storm Water Best Management Practices	planning	Develop/implement local ordinances/resolutions						
	planning	Develop local comprehensive land use plans						
	construction practices	Implement erosion controls						
	construction practices	Implement sediment controls						
	construction practices	Implement non-sediment controls						
	post construction practices	Reduce pollutant(s) through treatment						
	post construction practices	Reduce pollutant(s) through flow/volume management						
	post development/ storm water retrofit	Implement erosion controls						
	post development/ storm water retrofit	Implement sediment controls						
	post development/ storm water retrofit	Implement non-sediment controls	x				x	
	post development/ storm water retrofit	Reduce pollutant(s) through treatment						
	post development/ storm water retrofit	Reduce pollutant(s) through flow/volume management						
Regulatory Point Source Controls (includes Storm Water, Sanitary, and	planning	Develop long-term control plan (CSOs)						
	planning	Develop/implement local ordinances/resolutions						
	planning	Develop water quality management/208 plans						
	collection and new treatment	Install sewer systems in communities						
	collection and new treatment	Implement long-term control plan (CSOs)						
	collection and new treatment	Eliminate SSOs/CSOs/by-passes	x		x		x	x
	enhanced	Issue permit(s) and/or modify permit limit(s)						

Restoration Categories		Specific Restoration Actions	Panther Creek-Scioto River (05060001 04)					
			Gander Run-Scioto River (04 01)	Panther Creek (04 02)	Wolf Creek-Scioto River (04 03)	Wildcat Creek (04 04)	Town of La Rue-Scioto River (04 05)	Glade Run-Scioto River (04 06)
Industrial)	treatment	Improve quality of effluent		x				
	monitoring	Establish ambient monitoring program						
		Increase effluent monitoring		x				
	alternatives	Establish water quality trading						
	construction practices	Issue permit(s) and/or modify permit limit(s)						
		Implement erosion controls						
		Implement sediment controls						
		Implement non-sediment controls						
	post construction practices	Issue permit(s) and/or modify permit limit(s)						
		Reduce pollutant(s) through treatment						
		Reduce pollutant(s) through flow/volume management						
	post development/ storm water retrofit	Issue permit(s) and/or modify permit limit(s)						
		Implement erosion controls						
		Implement sediment controls						
		Implement non-sediment controls						
		Reduce pollutant(s) through treatment						
		Reduce pollutant(s) through flow/volume management						
		Reduce volume to CSOs						

6.6 Fulton Creek-Scioto River (05060001 05)

The Fulton Creek-Scioto River watershed has high rate of aquatic life use impairment; however, this appears to be primarily restricted to Fulton Creek since four of the five other tributaries surveyed in this watershed fully met criteria. Recreation uses were impaired at all three sites surveyed; however, the failure was fairly modest in terms of the magnitude by which the criteria were exceeded. Nutrient enrichment and associated dissolved oxygen issues were found at each site along Fulton Creek due to cropland drainage and waste water discharges from the Richwood WWTP (the last two sites only). Poor habitat was also adversely impacting aquatic communities at all sites along Fulton Creek except the last one located at river mile 1.2. Channelization is the source of the poor habitat quality. Patton Run was only in partial attainment of aquatic life uses due to excessive amounts of fine sediment emanating from cropland areas.

Table 6-7. Recommended implementation actions in the Fulton Creek – Scioto River watershed.

Restoration Categories		Specific Restoration Actions	Fulton Creek-Scioto River (05060001 05)				
			Patton Run (05 01)	Davids Run-Scioto River (05 02)	Kebler Run (05 03)	Fulton Creek (05 04)	Ottawa Creek-Scioto River (05 05)
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering					
		Restore streambank by recontouring or regrading					
	planted	Plant grasses in riparian areas				x	
		Plant prairie grasses in riparian areas				x	
		Remove/treat invasive species					
		Plant trees or shrubs in riparian areas				x	
Stream Restoration		Restore flood plain				x	
		Restore stream channel				x	
		Install in-stream habitat structures				x	
		Install grade structures					
		Construct 2-stage channel				x	
		Restore natural flow					
Wetland Restoration		Reconnect wetland to stream	x	x	x	x	x
		Reconstruct & restore wetlands	x	x	x	x	x
		Plant wetland species					
Conservation Easements		Acquire conservation easements					
Dam Modification or Removal		Remove dams					
		Modify dams					
		Remove associated dam support structures					
		Install fish passage and/or habitat structures					
		Restore natural flow					
Levee or Dike Modification or Removal		Remove levees					
		Breach or modify levees					
		Remove dikes					
		Modify dikes					
		Restore natural flood plain function					
Abandoned Mine Land Reclamation	treatment	Construct lime dosers					
		Install slag leach beds					
		Install limestone leach beds					
		Install limestone channels					
		Install successive alkalinity producing systems					

Restoration Categories		Specific Restoration Actions	Fulton Creek-Scioto River (05060001 05)				
			Patton Run (05 01)	Davids Run-Scioto River (05 02)	Kebler Run (05 03)	Fulton Creek (05 04)	Ottawa Creek-Scioto River (05 05)
		Install settling ponds					
		Install vertical flow ponds					
		Install limestone drains (anoxic and/or oxic)					
		Construct acid mine drainage wetland					
	flow diversion	Repair subsidence sites					
	flow diversion	Reclaim pit impoundments					
	flow diversion	Reclaim abandoned mine land					
	flow diversion	Eliminate stream captures					
	flow diversion	Eliminate mine drainage discharges					
	flow diversion	Restore positive drainage					
	flow diversion	Cover toxic mine spoils					
Home Sewage Planning and Improvement		Develop HSTS plan					
Home Sewage Planning and Improvement		Inspect HSTS	x		x	x	
Home Sewage Planning and Improvement		Repair or replace traditional HSTS	x		x	x	
Home Sewage Planning and Improvement		Repair or replace alternative HSTS	x		x	x	
Education and Outreach		Host meetings, workshops, and/or other events					
Education and Outreach		Distribute educational materials					
Agricultural Best Management Practices	farmland	Plant cover/manure crops	x			x	
Agricultural Best Management Practices	farmland	Implement conservation tillage practices	x			x	
Agricultural Best Management Practices	farmland	Implement grass/legume rotations	x			x	
Agricultural Best Management Practices	farmland	Convert to permanent hayland	x			x	
Agricultural Best Management Practices	farmland	Install grassed waterways					
Agricultural Best Management Practices	farmland	Install vegetated buffer areas/strips	x			x	
Agricultural Best Management Practices	farmland	Install location-specific conservation buffer	x			x	
Agricultural Best Management Practices	farmland	Install / restore wetlands	x			x	
Agricultural Best Management Practices	nutrients / agro-chemicals	Conduct soil testing				x	
Agricultural Best Management Practices	nutrients / agro-chemicals	Install nitrogen reduction practices				x	
Agricultural Best Management Practices	nutrients / agro-chemicals	Develop nutrient management plans				x	
Agricultural Best Management Practices	drainage	Install blind inlets					
Agricultural Best Management Practices	drainage	Install controlled drainage system				x	
Agricultural Best Management Practices	drainage	Implement drainage water management				x	
Agricultural Best Management Practices	drainage	Construct overwide ditch	x			x	

Restoration Categories		Specific Restoration Actions	Fulton Creek-Scioto River (05060001 05)				
			Patton Run (05 01)	Davids Run-Scioto River (05 02)	Kebler Run (05 03)	Fulton Creek (05 04)	Ottawa Creek-Scioto River (05 05)
		Construct 2-stage channel	x			x	
	livestock	Implement prescribed & conservation grazing practices				x	
	livestock	Install livestock exclusion fencing				x	
	livestock	Install livestock crossings					
	livestock	Install alternative water supplies				x	
	livestock	Install livestock access lanes					
	manure	Implement manure management practices	x		x	x	
	manure	Construct animal waste storage structures					
	manure	Implement manure transfer practices					
	manure	Install wastewater treatment strips				x	
	misc. infrastructure and mgt	Install chemical mixing pads					
	misc. infrastructure and mgt	Install heavy use feeding pads					
	misc. infrastructure and mgt	Install erosion & sediment control structures					
	misc. infrastructure and mgt	Install roof water management practices					
	misc. infrastructure and mgt	Install milkhouse waste treatment practices					
	misc. infrastructure and mgt	Develop whole farm management plans					
Storm Water Best Management Practices	planning	Develop/implement local ordinances/resolutions					
	planning	Develop local comprehensive land use plans					
	construction practices	Implement erosion controls					
	construction practices	Implement sediment controls					
	construction practices	Implement non-sediment controls					
	post construction practices	Reduce pollutant(s) through treatment					
	post construction practices	Reduce pollutant(s) through flow/volume management					
	post development/ storm water retrofit	Implement erosion controls					
	post development/ storm water retrofit	Implement sediment controls					
	post development/ storm water retrofit	Implement non-sediment controls					
	post development/ storm water retrofit	Reduce pollutant(s) through treatment					
	post development/ storm water retrofit	Reduce pollutant(s) through flow/volume management					
Regulatory Point Source Controls (includes	planning	Develop long-term control plan (CSOs)					
	planning	Develop/implement local ordinances/resolutions					
	planning	Develop water quality management/208 plans					
	collection	Install sewer systems in communities					

Restoration Categories		Specific Restoration Actions	Fulton Creek-Scioto River (05060001 05)				
			Patton Run (05 01)	Davids Run-Scioto River (05 02)	Kebler Run (05 03)	Fulton Creek (05 04)	Ottawa Creek-Scioto River (05 05)
Storm Water, Sanitary, and Industrial)	and new treatment	Implement long-term control plan (CSOs)					
		Eliminate SSOs/CSOs/by-passes					
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)					
		Improve quality of effluent				x	
	monitoring	Establish ambient monitoring program				x	
		Increase effluent monitoring				x	
	alternatives	Establish water quality trading					
	construction practices	Issue permit(s) and/or modify permit limit(s)					
		Implement erosion controls					
		Implement sediment controls					
		Implement non-sediment controls					
	post construction practices	Issue permit(s) and/or modify permit limit(s)					
		Reduce pollutant(s) through treatment					
		Reduce pollutant(s) through flow/volume management					
	post development/ storm water retrofit	Issue permit(s) and/or modify permit limit(s)					
		Implement erosion controls					
		Implement sediment controls					
		Implement non-sediment controls					
		Reduce pollutant(s) through treatment					
		Reduce pollutant(s) through flow/volume management					
		Reduce volume to CSOs					

6.7 Reasonable Assurances

The recommendations made in this TMDL report will be carried out if the appropriate entities work to implement them. In particular, activities that do not fall under regulatory authority require that there be a committed effort by state and local agencies, governments, and private groups to carry out and/or facilitate such actions. The availability of adequate resources is also imperative for successful implementation.

When a TMDL is developed for waters impaired by point sources only, the issuance of a NPDES permit(s) provides the reasonable assurance that the wasteload allocations contained in the TMDL will be achieved. This is because 40 C.F.R. 122.44(d)(1)(vii)(B) requires that effluent limits in permits be consistent with the assumptions and requirements of any available wasteload allocation in an approved TMDL.

When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur, the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions, as per U.S. EPA's 1991 TMDL Guidance. To this end, Appendix E discusses organizations and programs that have an important role or can provide assistance for meeting the goals and recommendations of this TMDL. Efforts specific to this watershed are described in this section.

6.7.1 Local Zoning and Regional Planning

The impairment found in the upper Scioto River watershed was primarily unrelated to development pressures. Also, growth projections are fairly modest for the watershed. Nevertheless, proactive land use planning will help avoid future degradation of water quality in the upper Scioto River watershed, therefore, local land use planning agencies and any associated land use plans are listed below as references regarding future growth:

- Mid-Ohio Regional Planning Commission (MORPC): http://www.morpc.org/index.asp
- Marion City/County Planning Commission: http://www.marionohioplanning.org/
  - Marion County Land Use Plan (2011)
- Logan-Union-Champaign Regional Planning Commission: http://www.lucplanning.com/
  - Union County Land Use Plan (2013)
  - Union County Land Use Plan Supplemental Maps (2013)
- Delaware County Regional Planning Commission: http://www.dcrpc.org/
  - Comprehensve plans
- Hardin Regional Planning: *no website*
- Crawford County Regional Planning: *no website*

6.7.2 Local Watershed Groups

The upper Scioto River watershed project was one of several watershed projects statewide that was funded, in part, through the federal 319 grants program. A primary deliverable as stipulated through the grant is a watershed action plan which its development was to be guided by both the most recent water quality data available and stakeholder input from those with interests in the watershed. This plan was reviewed by representatives of the grantors and fully endorsed by the State of Ohio in December of 2006 (see: ftp://ftp.dnr.state.oh.us/Soil_&_Water_Conservation/WatershedActionPlans/EndorsedPlans/Scioto%20River%20(Upper).pdf#). Currently there is no watershed coordinator for the project and implementation of the water quality improvement plan likely lack oversight and therefore may be in a stagnate state.

The Friends of the Scioto River is a watershed group that primarily operates in Franklin County, which is outside of the upper Scioto River watershed project area.

6.7.3 Past and Ongoing Water Resource Evaluation

Ohio EPA has conducted several water quality evaluations over all or part of the upper Scioto River watershed since 1979. The next survey to cover the entire watershed is scheduled for 2024. Table 6-8 summarizes these and other studies carried out in this watershed.

Table 6-8. Non-exhaustive set of published water quality studies concerning Upper Scioto River watershed.

Area covered	Survey year(s)	Publication year[1]
Upper Scioto River watershed	2009 and 2011	2012 OEPA TSD
Upper Scioto River watershed	2009 and 2011	2012 OEPA TSD appendices
Little Scioto River watershed	2007	2008 OEPA TSD
Scioto River and miscellaneous tributaries near Marion, Ohio	1998	2000 OEPA TSD
Upper Scioto River watershed	1995	1997 OEPA TSD
Little Scioto River watershed	1992 and 1993	1994 OEPA TSD
Little Scioto River watershed	1991	1992 OEPA TSD
Little Scioto River watershed	multi-years	2012 Ohio Dept. Health report
Upper Scioto River watershed and others	2005-2006	2010 USGS report

[1] TSD stands for technical support document.

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. 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.

6.7.4 Revision to the Improvement Strategy

The upper Scioto River watershed would benefit from an adaptive management approach to restoring water quality. An adaptive management approach allows for changes in the management strategy if environmental indicators suggest that the current strategy is inadequate or ineffective. Adaptive management is recognized as a viable strategy for managing natural resources (Baydack *et al.* 1999).

If chemical water quality does not show improvement and/or water bodies are still not attaining water quality standards after the improvement strategy 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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