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Ohio Environmental Protection Agency

Total Maximum Daily Loads for the Scioto Brush Creek Watershed

Final Report
July 12, 2011

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Photo caption: Scioto Brush Creek at State Route 104, east of McDermott (river mile 0.3).

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Acronyms and Abbreviations

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
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)
DSWC	Division of Soil and Water Conservation (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)
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
MOR	monthly operating report
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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Executive Summary

The Scioto Brush Creek watershed is located in southern Ohio extending from the northeast corner of Adams County to the southwest portion of Scioto County. This 273 square mile watershed area is home to nearly 9,000 people and encompasses all or part of Rarden, Otway and Peebles municipalities in Scioto and Adams counties. The watershed is primarily forested with five percent being developed.

In 2006, Ohio EPA sampled 60 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. Ohio Department of Natural Resources collected fish data at an additional 46 sites in 2001-2003.

Map of Ohio with the Scioto Brush Creek watershed highlighted.

Overall the watershed met criteria for the recreation use at 42% and 70% for aquatic life uses (59% including Ohio Department of Natural Resources data). No analysis for the human health use was completed. There were no public drinking water supplies in the watershed. The causes of impairment included bacteria (Escherichia coli), nutrient eutrophication biological indicators, direct habitat alterations, natural causes (flow or habitat), metals (from natural sources) and unknown causes. Sources of these stressors include channelization and natural sources (for the aquatic life use) and failing home sewage treatment systems and agricultural land uses for the recreation use.

Total maximum daily loads (TMDL) have been developed for pollutants and stressors that have impaired beneficial uses and precluded attainment of applicable water quality standards. Specific TMDLs that have been developed and are described in this report include:

- *Escherichia coli* (*E. coli*)
- Habitat
- Nutrients (total phosphorus)

The needed load reductions ranged from 0 to 99.5% for *E. coli*, 0 to 19.4% for total phosphorus, and improvements in two to three of three habitat subscores. Sources of the pollutants that have been allocated the most significant reductions include nonpoint sources such as failing home sewage treatment systems and agriculture with livestock in streams.

Recommendations include nonpoint source reductions only. Nonpoint sources of *E. coli* should be addressed by identifying and fixing or replacing failing home sewage treatment systems and by fencing livestock out of streams; for total phosphorus by fencing livestock out of streams; and for habitat by ceasing in-stream gravel mining operations and ceasing in-stream habitat alterations such as channel straightening.

1 INTRODUCTION

Scioto Brush Creek is located in southern Ohio near the Ohio River in Scioto and Adams counties and has a drainage area of 273 square miles. Scioto Brush Creek is a direct tributary of the Scioto River entering just east of McDermott. Ohio EPA conducted a comprehensive physical, chemical and biological survey in the Scioto Brush Creek study area from June through September 2006. Several problems were identified in the watershed as summarized below. The survey results were published in 2008 (Ohio EPA 2008); major findings are summarized in this report. Having identified the problems, the next step is an analysis called the total maximum daily load (TMDL). This report documents the TMDL process for the Scioto Brush Creek watershed.

Direct habitat alterations from agriculture and in-stream gravel mining were the most predominant anthropogenic causes of aquatic life use impairment. Natural causes, caused by the geological setting, were also common. Recreation use impairment (caused by high levels of bacteria) was more widespread and was most often caused by livestock and failing home sewage treatment systems (HSTS). There are two facilities (one municipal and one industrial) with National Pollutant Discharge Elimination System (NPDES) permits; in addition, a few facilities have general storm water permits (e.g., General Electric).

1.1 The Clean Water Act Requirement to Address Impaired Waters

The Clean Water Act (CWA) Section 303(d) requires States, Territories, and authorized Tribes to list and prioritize waters for which technology-based limits alone do not ensure attainment of water quality standards. Lists of these impaired waters (the Section 303(d) lists) are made available to the public for comment, then submitted to the U.S. Environmental Protection Agency (U.S. EPA) for approval in even-numbered years. Further, the CWA and U.S. EPA regulations require that total maximum daily loads (TMDLs) be developed for all waters on the Section 303(d) lists. The Ohio EPA identified the Scioto

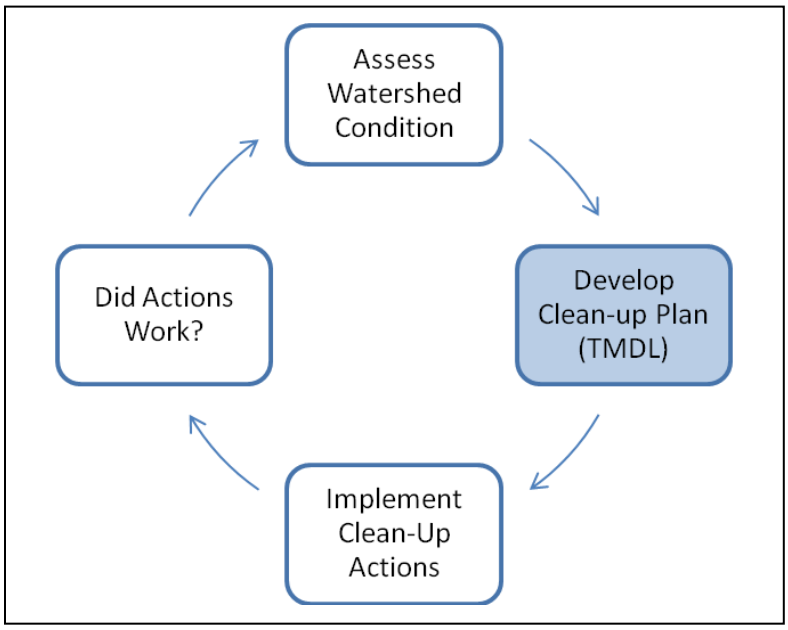

Figure 1-1. Overview of the TMDL project process.

Brush Creek watershed (assessment units 05060002 14 01—06 and 15 01—07) as impaired on the 2010 303(d) list (Ohio EPA 2010; available at http://www.epa.ohio.gov/dsw/tmdl/2010IntReport/2010OhioIntegratedReport.aspx).

In the simplest terms, a TMDL can be thought of as a cleanup plan for a watershed that is not meeting water quality standards. A TMDL is defined as a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards and an allocation of that quantity among the sources of the pollutant. Ultimately, the goal of Ohio's TMDL process is full attainment of water quality standards (WQS), which would subsequently lead to the removal of the waterbodies from the 303(d) list. Figure 1-1**Error! Reference source not found.** shows the phases of TMDL development in Ohio.

Table 1-1 summarizes how the impairments identified in the Scioto Brush Creek watershed are addressed in this TMDL report.

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

Assessment Unit (05060002)	**Narrative Description**	**Causes of Impairment** (Beneficial use in parentheses)	**Action Taken**
South Fork Scioto Brush Creek (05060002 14)			
14 01 *Priority points: 6*	Churn Creek	Unknown (ALU)	Not addressed
		Natural conditions (ALU)	No action necessary
		Bacteria (RU)	Bacteria TMDL
14 02 *Priority points: 4*	Mill Creek	Unknown (ALU)	Not addressed
		Natural conditions (ALU)	No action necessary
		Bacteria (RU)	Bacteria TMDL
14 03 *Priority points: 3*	Turkey Creek *ALU category 4n*	Natural conditions (ALU)	No action necessary
		Bacteria (RU)	Bacteria TMDL
14 04 *Priority points: 4*	Turkey Run-South Fork Scioto Brush Creek *ALU category 4n*	Natural conditions (ALU)	No action necessary
		Bacteria (RU)	Bacteria TMDL
14 05 *Priority points: 2*	Rocky Fork *ALU category 4n*	Natural conditions (ALU)	No action necessary
		Bacteria (RU)	Bacteria TMDL
14 06 *Priority points: 1*	Beech Fork-South Fork Scioto Brush Creek	Direct habitat alterations (ALU)	Habitat TMDL
		Unknown (ALU)	Not addressed
		Natural conditions (ALU)	No action necessary
		No impairment (RU)	No action necessary
Scioto Brush Creek (05060002 15)			
15 01 *Priority points: 6*	Headwaters Scioto Brush Creek	Unknown (ALU)	Not addressed
		Metals (natural sources) (ALU)	No action necessary

Assessment Unit (05060002)	**Narrative Description**	**Causes of Impairment** (Beneficial use in parentheses)	**Action Taken**
		Natural conditions (ALU)	No action necessary
		Bacteria (RU)	Bacteria TMDL
15 02 *Priority points: 8*	Rarden Creek	Direct habitat alterations (ALU)	Habitat TMDL
		Nutrient eutrophication biological indicators (ALU)	Nutrient TMDL
		Natural conditions (ALU)	No action necessary
		Bacteria (RU)	Bacteria TMDL
15 03 *Priority points: 9*	Jaybird Branch-Scioto Brush Creek	Direct habitat alterations (ALU)	Habitat TMDL
		Metals (natural sources) (ALU)	No action necessary
		Natural conditions (ALU)	No action necessary
		Bacteria (RU)	Bacteria TMDL
15 04 *Priority points: 9*	Dunlap Creek-Scioto Brush Creek	Unknown (ALU)	Not addressed
		Natural conditions (ALU)	No action necessary
		Bacteria (RU)	Bacteria TMDL
15 05 *Priority points: 7*	Bear Creek	Unknown (ALU)	Not addressed
		Natural conditions (ALU)	No action necessary
		Bacteria (RU)	Bacteria TMDL
15 06 *Priority points: 4*	McCullough Creek *ALU category 4n*	Natural conditions (ALU)	No action necessary
		Bacteria (RU)	Bacteria TMDL
15 07 *Priority points: 10*	Duck Run-Scioto Brush Creek	Unknown (ALU)	Not addressed
		Natural conditions (ALU)	No action necessary
		Bacteria (RU)	Bacteria TMDL

ALU = aquatic life use
RU = recreation use

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 Scioto Brush Creek watershed TMDL project has been completed using the process endorsed by the advisory group.

On January 19, 2008, the Friends of Scioto Brush Creek hosted a presentation by Ohio EPA regarding the results of the 2006 field survey. Topics of discussion included unique biological features of the watershed and potential sources of impairment. A second presentation was given to the group on February 19, 2011. The focus of the second presentation was on the Section 401 water quality certification program, which reviews applications regarding projects that would physically impact waters of the state, including streams, lakes and wetlands. A review of the 2006 survey results and causes and sources of impairment was also given.

Consistent with Ohio's current Continuous Planning Process (CPP), the draft TMDL report was available for public comment from April 26 through May 26, 2011. A copy of the draft report was posted on Ohio EPA's web page (http://www.epa.ohio.gov/dsw/tmdl/index.aspx). No public comments were received.

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 Scioto Brush Creek watershed.

1.3 Organization of Report

Chapter 2 gives 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.

Readers may also wish to consult the technical glossary and background information available on Ohio EPA's TMDL Web page (http://www.epa.ohio.gov/dsw/tmdl/index.aspx).

2 CHARACTERISTICS AND EXPECTATIONS OF THE WATERSHED

The Scioto Brush Creek watershed drains 273 square miles and is located in southern Ohio near the Ohio River in Adams and Scioto counties. It drains into the Scioto River near its confluence with the Ohio River. It is located in the Western Allegheny Plateau ecoregion (Ohio EPA 2008).

2.1 Watershed Characteristics

The following subsections provide an overview of the characteristics of the Scioto Brush Creek watershed.

2.1.1 Population and Distribution

The U.S. Census Bureau estimates that there are 260 people living in the two towns combined but nearly 9,000 across the watershed (as of 2000). Rarden and Otway are the only towns in the watershed, though a small portion of Peebles overlaps the western border. There are several other small unincorporated communities. Figure 2-1 shows population distribution (in blocks showing numbers of people) according to the U.S. Census (2000). The Ohio Department of Development (2003) projects approximately 1.5% growth by 2010. Results of the 2010 U.S. Census will be released during 2011.

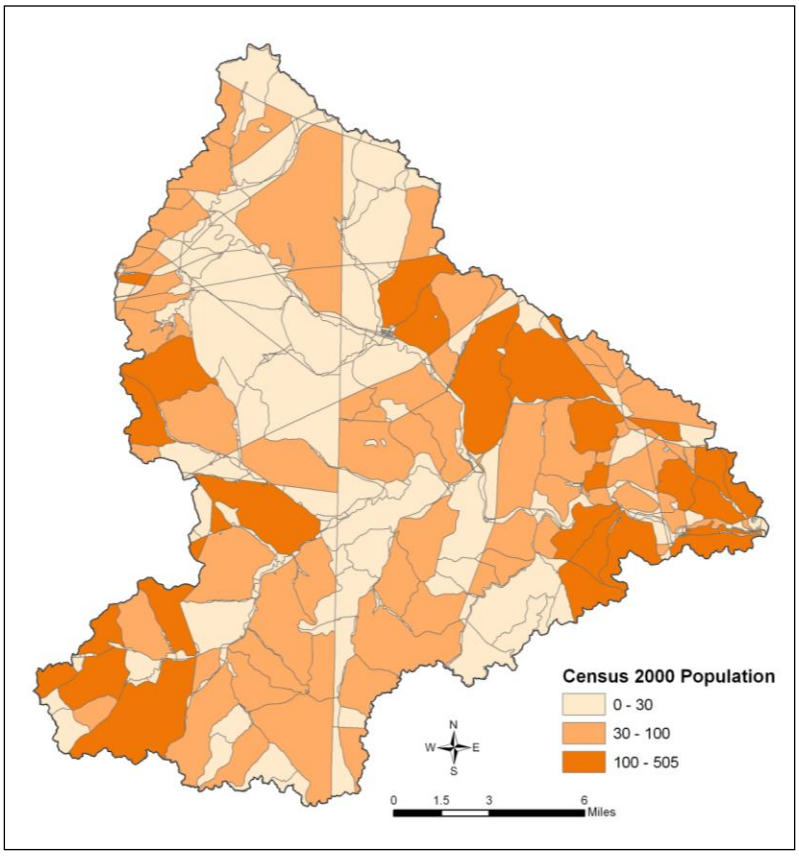

Figure 2-1. Population blocks in the Scioto Brush Creek watershed (U.S. Census Bureau, 2000).

2.1.2 Land Use

The predominant land use in the watershed is forest. The relatively small amounts of pasture and cultivated crop

lands are located along stream valleys and in the northwestern portion of the watershed. Figure 2-2 shows the various land uses in the watershed.

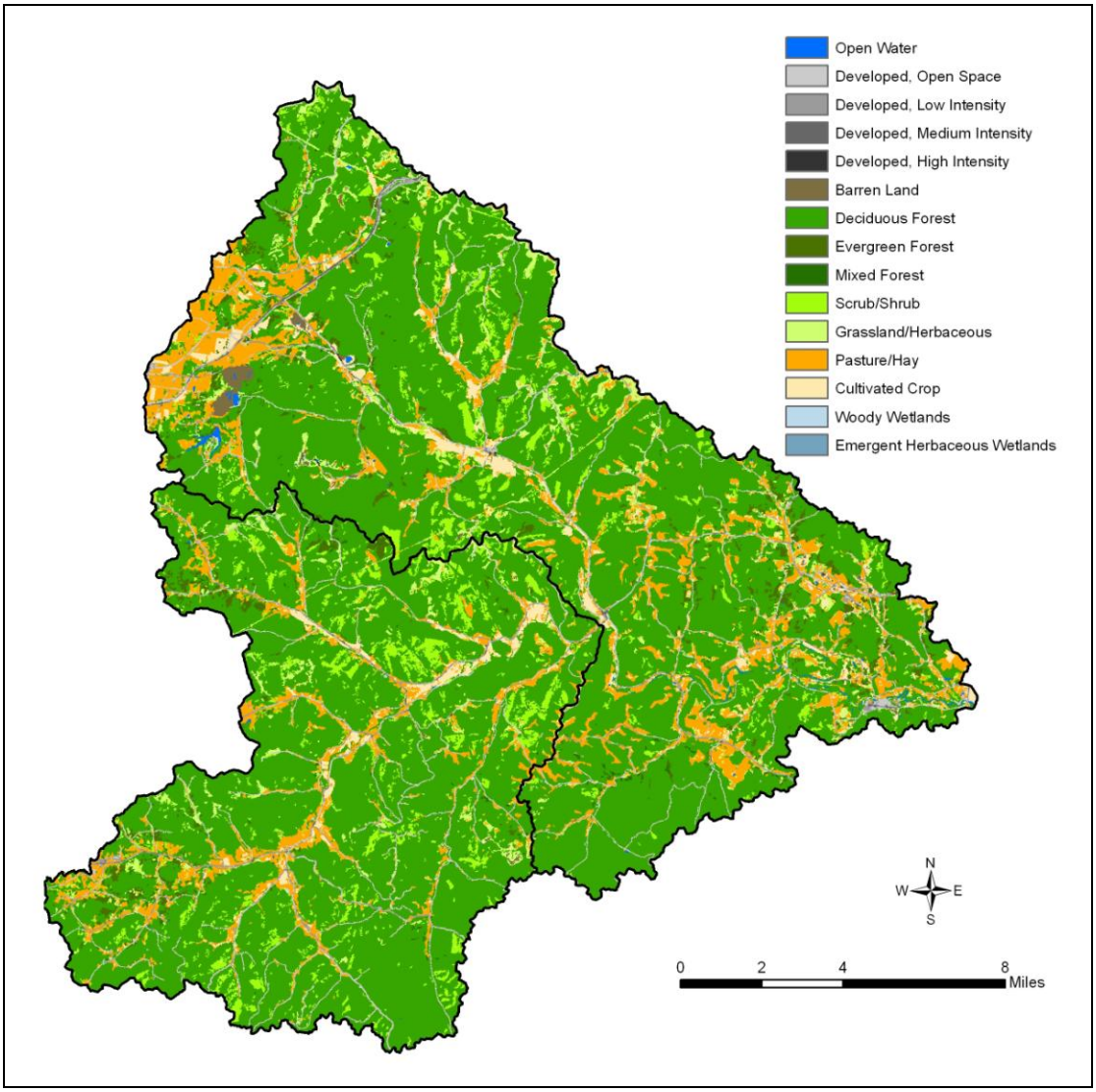

Figure 2-2. Land use in the Scioto Brush Creek watershed.

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, metals and silt.

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 Scioto Brush Creek watershed.

The only municipal wastewater treatment plant (WWTP) is located on the eastern side of the watershed. The design flow of the WWTP is 0.031 million gallons per day (MGD). The only individual industrial storm water permit is located on the western edge of the watershed, just east of Peebles.

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. There are no surface water public drinking water supplies in the Scioto Brush Creek 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, 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, scum, color and odor-producing materials; substances that are harmful to human or animal health; and nutrients in concentrations that may cause excessive algal growth. Narrative “free froms,” also located in rule 3745-1-04 of the OAC, are general water quality criteria 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 Scioto Brush Creek 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. Figure 2-3 shows aquatic life uses for designated streams in the Scioto Brush Creek watershed. Table 2-1 shows the applicable biological criteria.

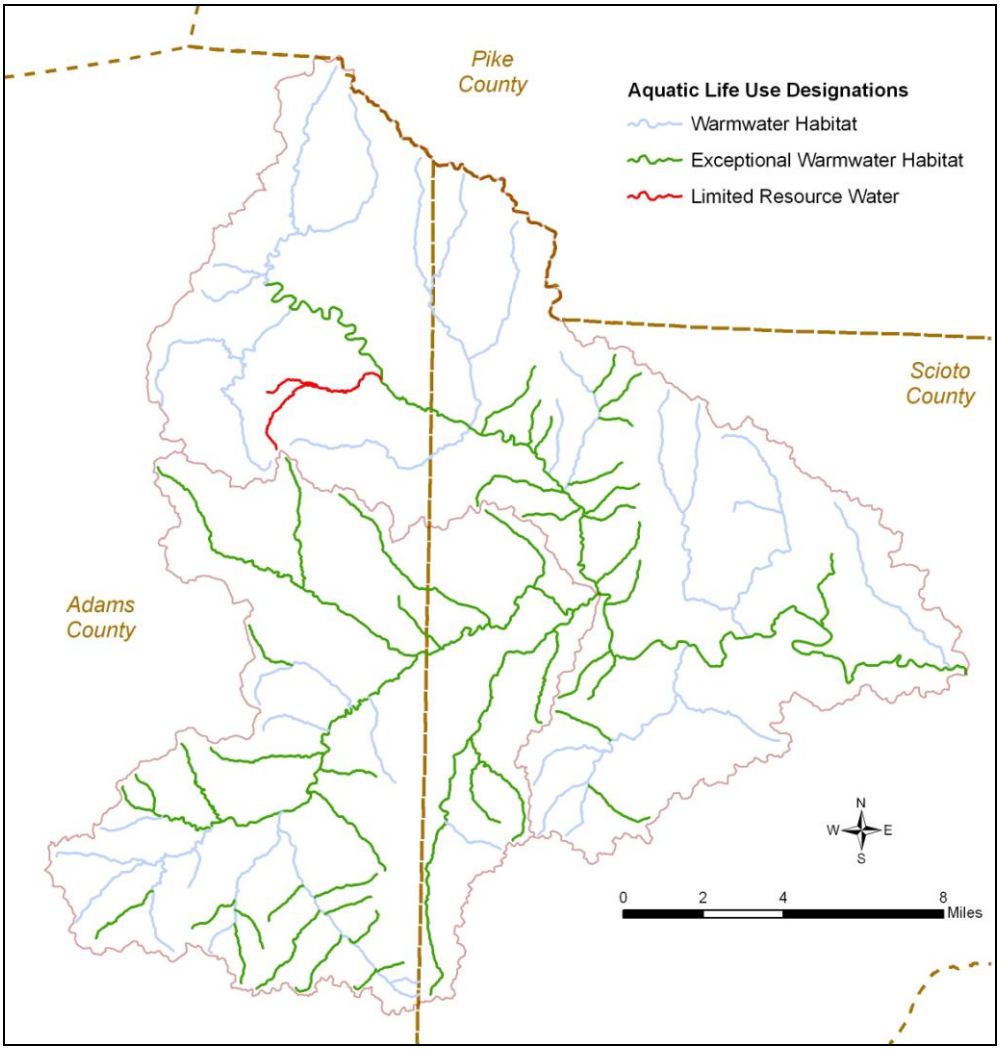

Figure 2-3. Designated aquatic life uses in the Scioto Brush Creek watershed.

Table 2-1. Biological criteria applicable in the Scioto Brush Creek watershed.

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

[1] 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] 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; also see Appendix C. Applicable recreation use designations are shown in Figure 2-4.

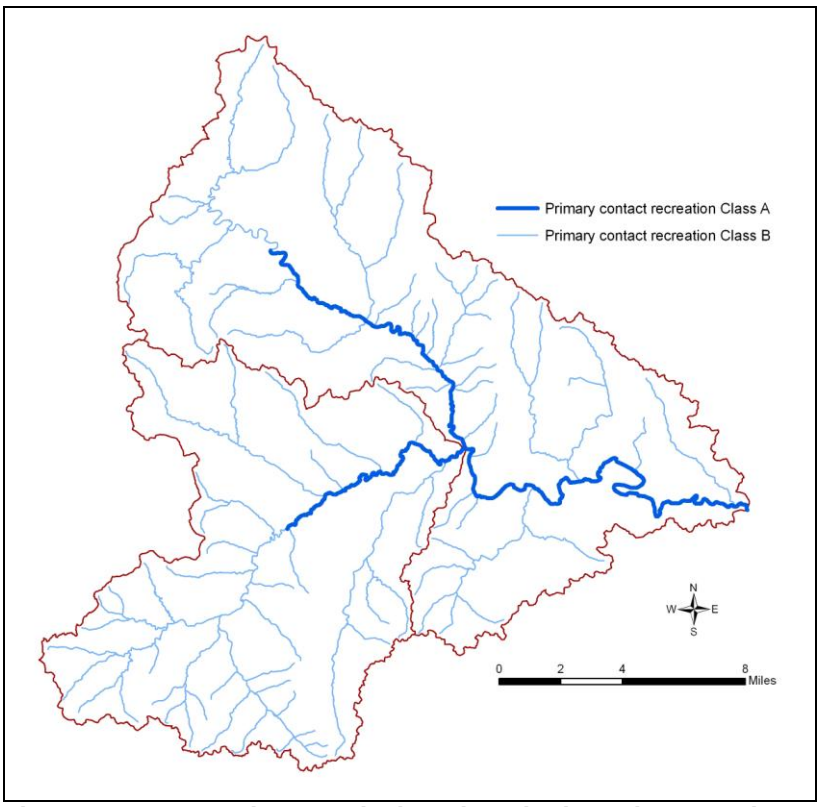

Figure 2-4. Recreation use designations in the Scioto Brush Creek watershed.

Table 2-2 shows applicable water quality criteria for the primary contact recreation use in the Scioto Brush Creek watershed.

Table 2-2. Recreation use water quality criteria that apply in the Scioto Brush Creek watershed.

Recreation Use	*E. coli* (Colony Counts per 100 ml)	
	Seasonal Geometric Mean	Single Sample Maximum[1]
Class A primary contact recreation	126	298
Class B primary contact recreation	161	523

[1] Except as noted in footnote 2, these criteria shall not be exceeded in more than ten per cent of the samples taken during any thirty-day period.

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. There are no surface water public drinking water supplies in the watershed.

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.

No assessment was performed to determine support of the human health use.

The Scioto Brush Creek watershed is included in the statewide fish advisory for mercury. Additional advisories specific to the Scioto Brush Creek watershed do not exist. 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 Scioto Brush Creek watershed in 2006. Sixty sites were studied for biological health, sixty sites for water chemistry, sixty-seven sites for recreation use (including some additional sampling in 2007 and 2008), and no sites for human health (fish contaminants) use. In evaluating the health of the Scioto Brush Creek watershed, Ohio EPA also considered fish sampling data collected by the Ohio Department of Natural Resources (ODNR) in 2001 through 2003 at sites scattered throughout the watershed. Where ODNR noted impairment, the causes and sources were cited as natural. Thus, while the ODNR data add to the understanding of water quality health in the Scioto Brush Creek watershed, they did not affect the number or type of TMDL loading analyses. Figure 3-1 compares the proportions of attaining sites to non-attaining and partially attaining sites without (left) and with (right) ODNR data. Appendix B contains more information about Ohio EPA's 2006 study.

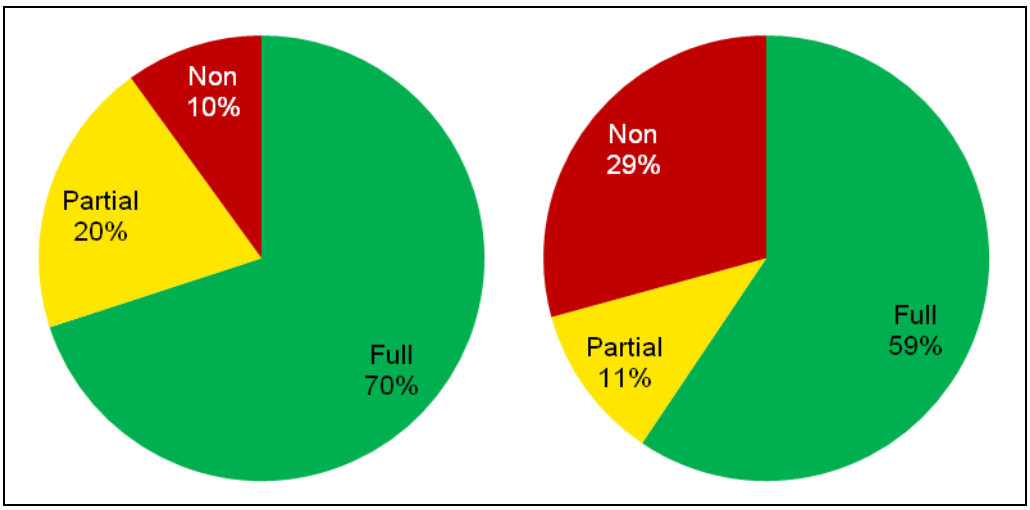

Figure 3-1. Proportion of sites fully, partially and not attaining aquatic life use biocriteria. The graph on the left does not include ODNR data; the graph on the right includes ODNR data.

Most of the biological impairment was caused by natural causes and sources, such as low flow or homogeneous (bedrock) substrates. There were some anthropogenic influences on biological attainment; in most cases these had to do with direct habitat alterations such as channelization and substrate disturbance (usually in the form of gravel mining).
The Scioto Brush Creek watershed TMDL includes two subwatersheds, South Fork Scioto Brush Creek and Scioto Brush Creek (Figure 3-2). Within each of the two subwatersheds, smaller watersheds are nested. This chapter discusses conditions in each of the subwatersheds with detail added in unique nested subwatersheds (12-digit assessment units). Overall, impairment for aquatic life and recreation uses was more common in the eastern portion of the watershed. Most anthropogenic sources were related to habitat modifications.

Figure 3-2. Map of the Scioto Brush Creek watershed.

3.1 South Fork Scioto Brush Creek (05060002 14)

The South Fork Scioto Brush Creek subwatershed drains 113.0 square miles in the western portion of the watershed (see Figure 3-3). It consists of six nested subwatersheds. The main tributaries to South Fork Scioto Brush Creek include Rocky Fork, Beech Fork, Turkey Creek, Mill Creek and Churn Creek. Major causes of impairment include direct habitat alterations, natural (flow or habitat) causes and unknown causes. Those causes are primarily associated with channelization, natural sources and unknown sources.

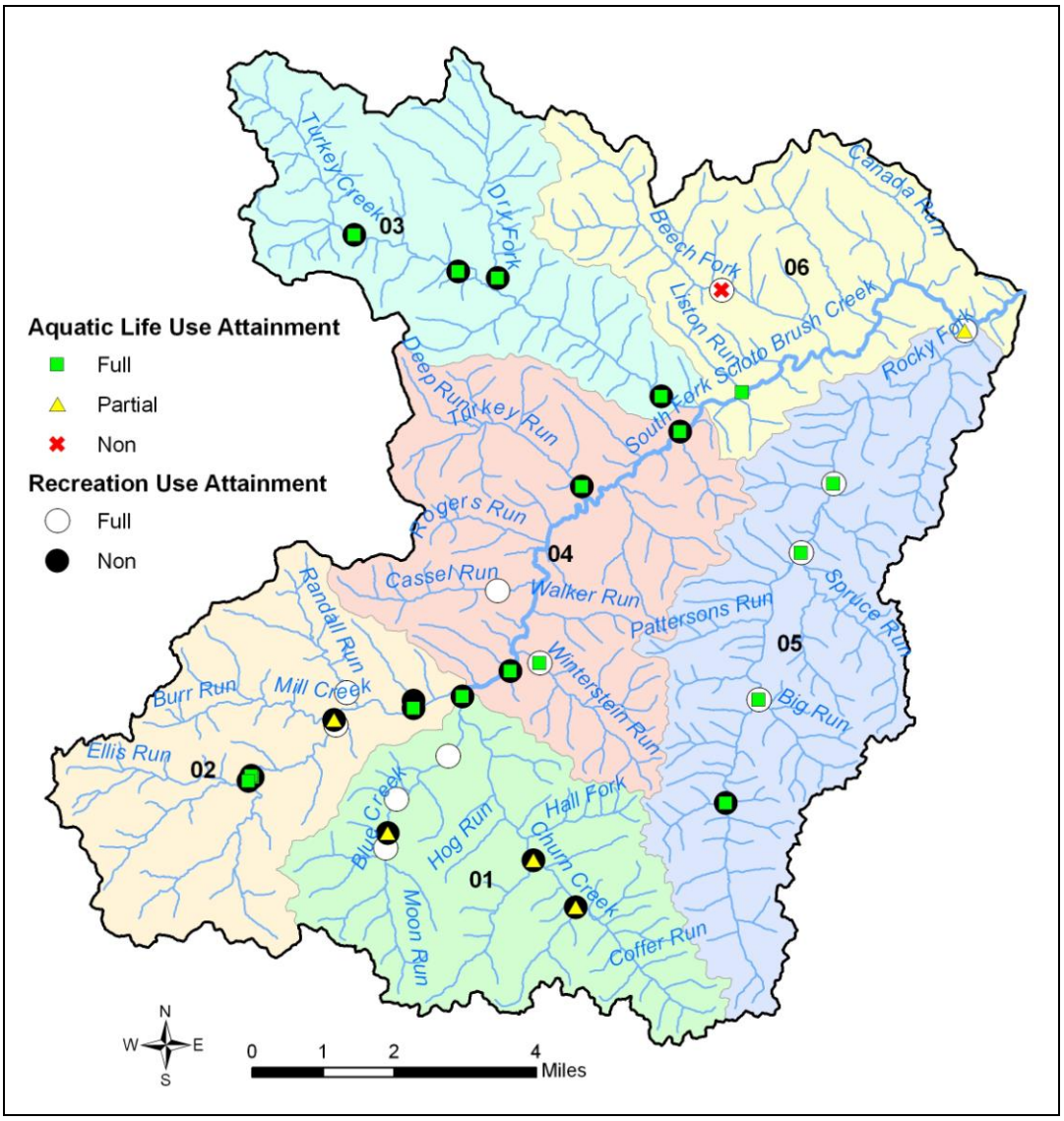

Figure 3-3. Attainment results for the South Fork Scioto Brush Creek subwatershed.

In some cases, these causes are associated with land uses in the subwatershed (see Appendix C for further information). Figure 3-4 shows land use within the South Fork Scioto Brush Creek subwatershed.

Only one site in this subwatershed was identified as having anthropogenic causes of aquatic life use impairment (direct habitat alterations stemming from in-stream gravel mining in Beech

Fork). Natural causes and sources contributed to partial attainment in one site (Blue Creek downstream of Glen Run). Causes of impairment elsewhere were not able to be identified using the data collected during the 2006 field survey. The small amount of aquatic life use impairment was likely aided by the high percentage of forested land in the watershed. High bacteria were spread through the watershed causing non-support of the recreation use.

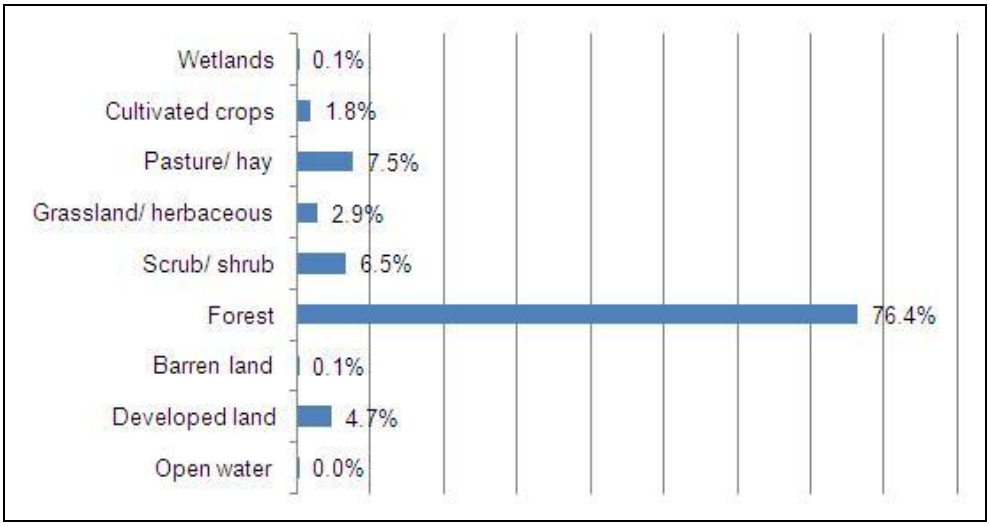

Figure 3-4. Land use in the South Fork Scioto Brush Creek subwatershed.

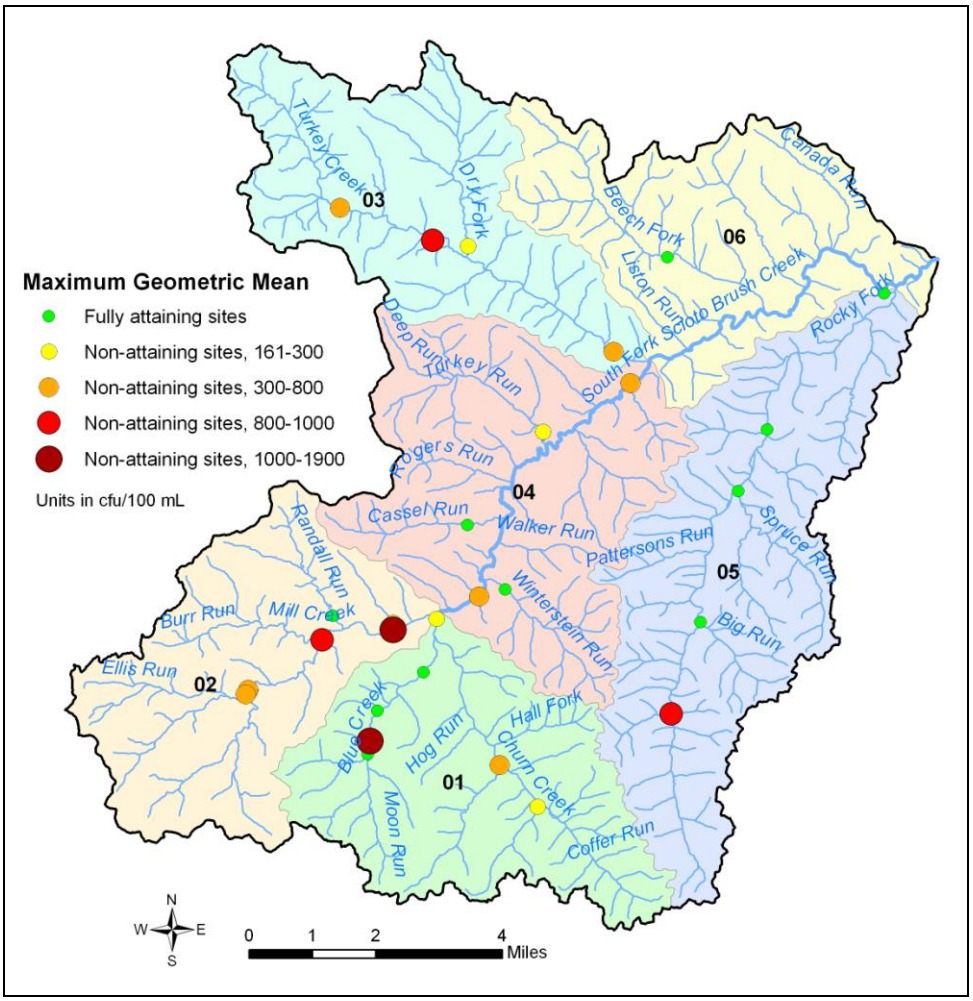

Figure 3-5. Bacteria data (*E. coli*) for the South Fork Scioto Brush Creek subwatershed.

Figure 3-5 shows maximum *E. coli* geometric means at sampled sites within the watershed. Figure 3-6 shows relative occurrence of causes of aquatic life use impairment in the South Fork Scioto Brush Creek subwatershed. Figure 3-7 shows the relative occurrence of sources of aquatic life use impairment in the South Fork Scioto Brush Creek subwatershed.

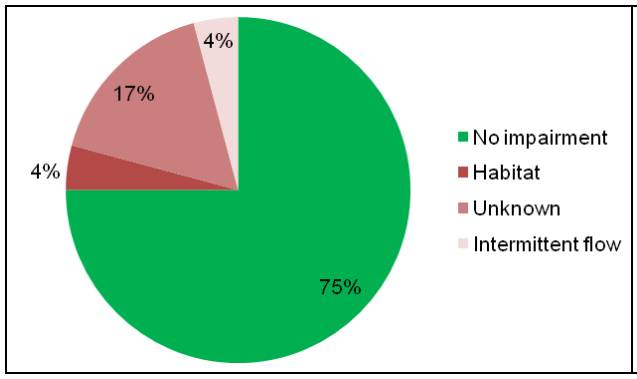

Figure 3-6. Causes of aquatic life use impairment in the South Fork Scioto Brush Creek subwatershed.

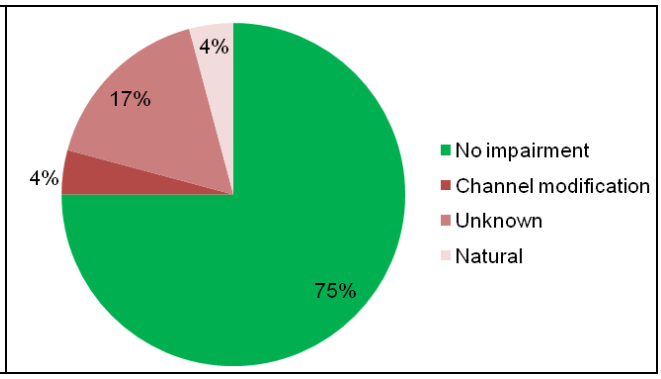

Figure 3-7. Sources of aquatic life use impairment in the South Fork Scioto Brush Creek subwatershed.

Table 3-1 summarizes the site-by-site results from the 2006 field survey for each designated beneficial use organized by nested subwatersheds; see the Ohio 2010 Integrated Report for more information. For more specific information regarding individual site assessment results and supporting chemistry results, please see Appendix B.

Table 3-1. Number of impaired sites, organized by use and nested subwatershed, in the South Fork Scioto Brush Creek subwatershed.

Nested Subwatershed (05060002 14)		Aquatic Life Use	Recreation Use	Public Drinking Water Supply Use[1]	Human Health Use[2]
14 01	# impaired sites (non/partial)	1/3	4	N/A	N/A
	Index score[3]	55.5	82	N/A	N/A
14 02	# impaired sites (non/partial)	1/1	6	N/A	N/A
	Index score	81.8	78	N/A	N/A
14 03	# impaired sites (non/partial)	2/0	4	N/A	N/A
	Index score	66.7	50	N/A	N/A
14 04	# impaired sites (non/partial)	2/0	3	N/A	N/A
	Index score[3]	91.7	81	N/A	N/A
14 05	# impaired sites (non/partial)	1/0	1	N/A	N/A
	Index score	80.0	81	N/A	N/A
14 06	# impaired sites (non/partial)	4/1	0	N/A	N/A
	Index score	25.0	100	N/A	N/A

[1] There are no public drinking water supplies in the watershed.
[2] No assessment was completed to determine support of the human health beneficial use.
[3] 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.

Where they occurred, channel modifications caused reduced habitat diversity for aquatic life, negatively affecting both biological diversity and sport fish populations. QHEI scores ranged from 38 to 76. The lowest quality stream habitat (QHEI=38) occurred in Beech Fork at river mile 1.9, where active gravel mining was occurring. South Fork Scioto Brush Creek has a natural channel, not influenced by habitat modifications (excluding river mile 5.0). Additionally, beneficial in-stream cover, such as logs, aquatic macrophytes, boulders, cobble, and undercut banks were moderately abundant. Deep pool areas, greater than one meter deep, were common throughout the stream. Further details are available in Appendix B.

3.2 Scioto Brush Creek (05060002 15)

The Scioto Brush Creek subwatershed drains 160.2 square miles in the eastern portion of the watershed (see Figure 3-3). It consists of seven nested subwatersheds. The main tributaries to Scioto Brush Creek include McCullough Creek, Bear Creek and South Fork Scioto Brush Creek. Major causes of impairment include direct habitat alterations, nutrient enrichment, metals and unknown causes. Those causes are primarily associated with channelization, unrestricted cattle access and natural sources.

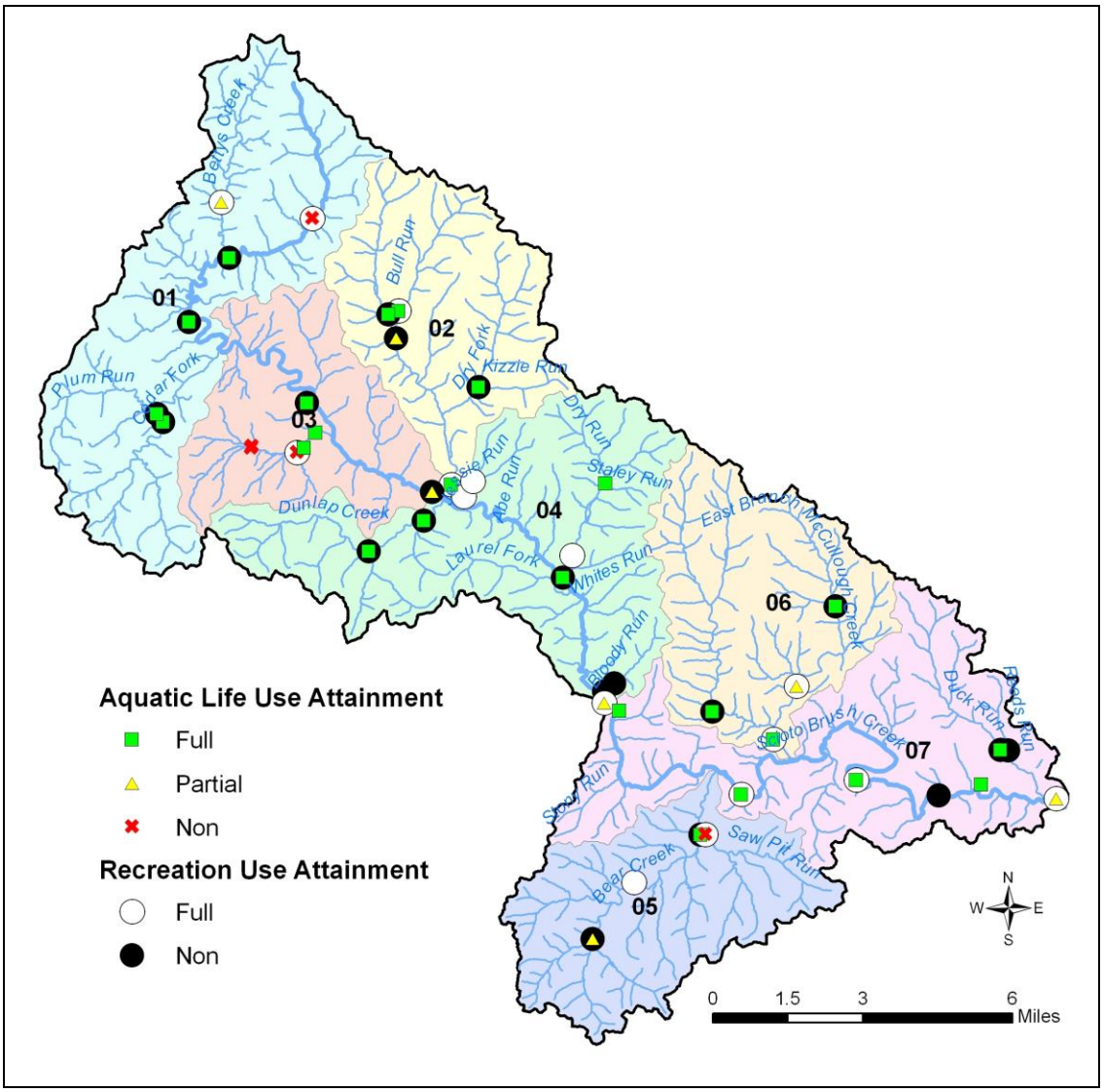

Figure 3-8. Attainment results for the Scioto Brush Creek subwatershed.

In some cases, these causes are associated with land uses in the subwatershed (see Appendix C for further information). Figure 3-9 shows land use within the Scioto Brush Creek subwatershed.

Two sites in this subwatershed were identified as having anthropogenic causes of aquatic life use impairment. In one case (Scioto Brush Creek at RM 24.25), direct habitat alterations resulting from channelization caused partial attainment of biological criteria. In the other case (Rarden Creek at RM 3.86), a combination of direct habitat alterations and nutrient enrichment (total phosphorus) resulting from unrestricted cattle access resulted in partial attainment. Natural causes and sources contributed to partial and non-attainment in two sites. Biological criteria were not met at four sites because of naturally-occurring metals and low pH. Causes of impairment elsewhere were not able to be identified using the data collected during the 2006 field survey. High bacteria were spread through the watershed causing non-support of the recreation use.

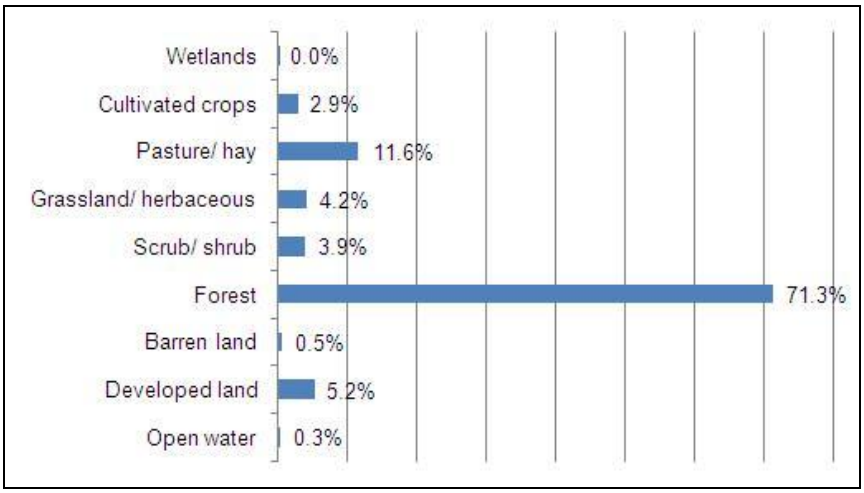

Figure 3-9. Land use in the Scioto Brush Creek subwatershed.

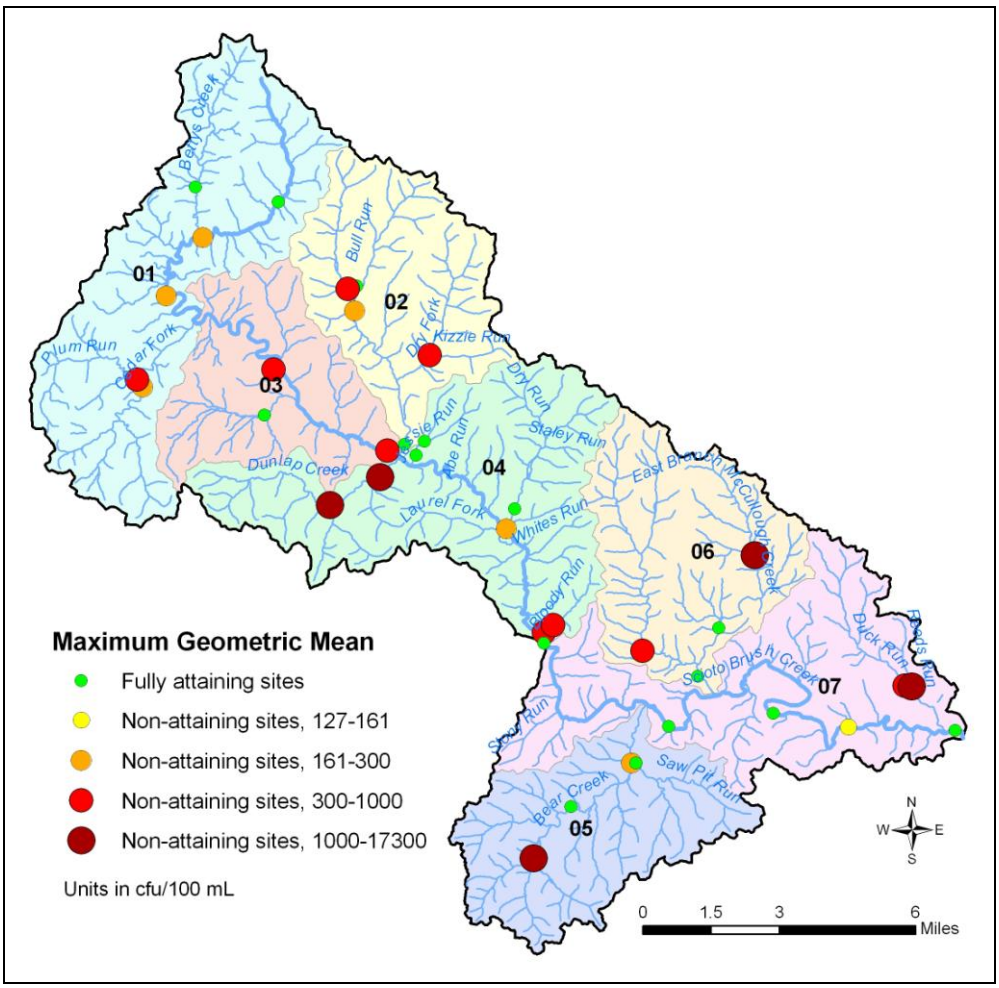

Figure 3-10. Bacteria data (*E. coli*) for the Scioto Brush Creek subwatershed.

Figure 3-10 shows maximum *E. coli* geometric means at sampled sites within the watershed. Figure 3-11 shows relative occurrence of causes of aquatic life use impairment in the Scioto Brush Creek subwatershed. Figure 3-12 shows the relative occurrence of sources of aquatic life use impairment in the Scioto Brush Creek subwatershed.

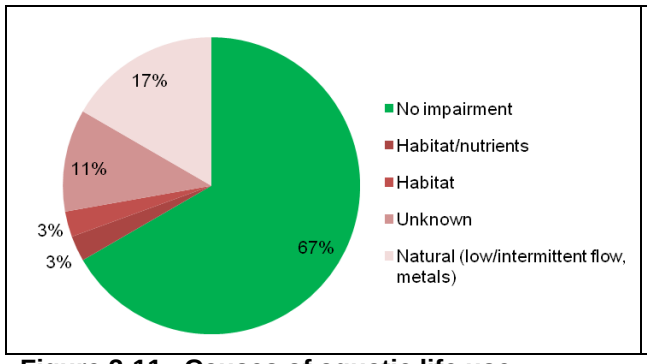

Figure 3-11. Causes of aquatic life use impairment in the Scioto Brush Creek subwatershed.

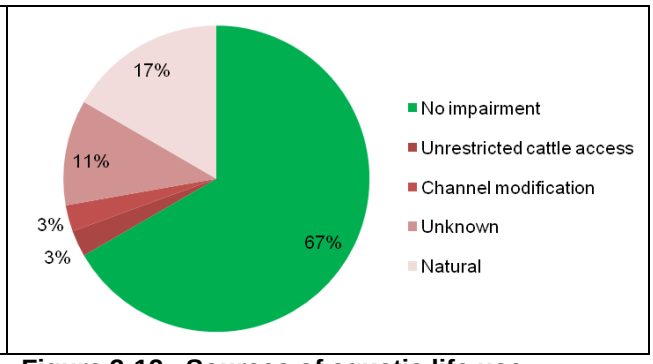

Figure 3-12. Sources of aquatic life use impairment in the Scioto Brush Creek subwatershed.

Table 3-2 summarizes the site-by-site results for each designated beneficial use organized by nested subwatersheds; see the Ohio 2010 Integrated Report for more information. 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 Scioto Brush Creek subwatershed.

Nested Subwatershed (05060002 15)		Aquatic Life Use	Recreation Use	Public Drinking Water Supply Use[1]	Human Health Use[2]
15 01	# impaired sites (non/partial)	2/1	4	N/A	N/A
	Index score[3]	70.0	79	N/A	N/A
15 02	# impaired sites (non/partial)	1/1	3	N/A	N/A
	Index score	66.7	75	N/A	N/A
15 03	# impaired sites (non/partial)	5/1	2	N/A	N/A
	Index score	39.3	67	N/A	N/A
15 04	# impaired sites (non/partial)	2/1	5	N/A	N/A
	Index score[3]	35.7	70	N/A	N/A
15 05	# impaired sites (non/partial)	4/1	2	N/A	N/A
	Index score	28.6	69	N/A	N/A
15 06	# impaired sites (non/partial)	1/1	2	N/A	N/A
	Index score	71.4	69	N/A	N/A
15 07	# impaired sites (non/partial)	5/1	3	N/A	N/A
	Index score	62.2	75	N/A	N/A

[1] There are no public drinking water supplies in the watershed.
[2] No assessment was completed to determine support of the human health beneficial use.
[3] 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.

Scioto Brush Creek at RM 38.2 had acidity levels ranging from 9.3 to 13.5 mg/l, significantly affecting the biological communities. See Section 3.2.1 for a discussion of low pH and high acidity. Scioto Brush Creek has a natural channel, not influenced by habitat modifications. QHEI values ranged from 54 to 83. Additionally, beneficial in-stream cover, such as logs, aquatic macrophytes, boulders, cobble, and undercut banks were moderately abundant. Deep pool areas, greater than one meter deep, were common throughout the stream. Further details are available in Appendix B.

3.2.1 Rarden Creek (05060002 15 02)

The habitat at Rarden Creek (RM 3.86) was in the fair range (a QHEI score of 46). A lack of riffles, channelization and shallow pools were identified specifically as deficient aspects of habitat. The macroinvertebrate community scored in the “good” range. The fish community, however, scored in the “fair” range, a significant departure from biocriteria. The most probable source of these issues was a pasture just upstream of the site where livestock had unhindered access to the stream as evidenced by degraded habitat and indications of nutrient enrichment. Two samples out of seven taken at this location showed total phosphorus concentrations above in-stream target values.

3.2.2 Jaybird Branch-Scioto Brush Creek (05060002 15 03)

Non-attainment of biological criteria was caused at several sites in the Jaybird Branch nested subwatershed. The cause of impairment appeared to be metals. Numerous metals were found at two sites on Jaybird Branch and an unnamed tributary to Jaybird Branch at river mile 2.11 that caused toxicity to the aquatic life. Jaybird Branch had acidity values ranging from 16.4 mg/l to 26.6 mg/l and also had an average pH of 5.52. Because of the low pH values, both the fish and the macroinvertebrate communities were in the fair to very poor range with some locations completely lacking any aquatic life. Low pH and high acidity are typically associated with historic or active mining. However, there are no indications that mining ever occurred around Jaybird Branch. It is possible that sulfur compounds associated with the natural shale deposits found in this area are contributing to the elevated metals as well as the acidity and low pH.

4 METHODS TO CALCULATE LOAD REDUCTIONS

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.

In freshwater systems, phosphorus is typically the nutrient that is in short supply relative to biological needs, which means that the productivity of aquatic plants and algae can be controlled by limiting the amount of phosphorus entering the water. Large diurnal swings in pH and dissolved oxygen may occur as excessive amounts of nutrients are metabolized by aquatic plants and algae. The range of these swings often exceeds the state water quality criteria established to protect fish and other aquatic organisms in their various life stages. The amount of phosphorus currently entering these waters exceeds the seasonal loading capacity and must be reduced if these water quality problems are to be resolved. The sources of phosphorus loading vary depending on the human activities and conditions in a specific watershed (U.S. EPA 2007).

Pathogenic (disease-causing) organisms are typically present in the environment in such small amounts that it is impractical to monitor them directly. Fecal coliform bacteria, including *E. coli*, by themselves are usually not pathogenic. However, some strains of *E. coli* can be pathogenic, causing serious illness. Although not necessarily agents of disease, fecal coliform bacteria and *E. coli* may indicate the potential presence of pathogenic organisms that enter the environment through the same pathways. When fecal coliform bacteria or *E. coli* are present in high numbers in a water sample, it invariably means that the water has received fecal matter from one source or another. Swimming or other recreational-based contact with water having a high fecal coliform or *E. coli* count may result in ear, nose, and throat infections, as well as stomach upsets, skin rashes, and diarrhea. Young children, the elderly, and those with depressed immune systems are most susceptible to infection.

TMDLS were developed for each of the three stressors identified above (habitat, nutrients and *E. coli*). Table 4-1 indicates how the applicable causes of impairment are addressed in each of the assessment units. Natural causes are not included in the table because they cannot be addressed by a TMDL loading analysis.

Table 4-1. Summary of causes of impairment and actions taken to address them in assessment units within the South Fork Scioto Brush Creek and Scioto Brush Creek subwatersheds.

	Watershed Assessment Units												
	05060002 14						05060002 15						
Causes of Impairment	**01**	**02**	**03**	**04**	**05**	**06**	**01**	**02**	**03**	**04**	**05**	**06**	**07**
Aquatic Life Use													
Direct habitat alterations						D		D	D				
Nutrients								D					
Unknown	N	N				N	N			N	N		N
Recreation Use													
E. coli	D	D	D	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. There is substantial overlap in the sources of the loading of both parameters
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.

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

4.1 Load Duration Curves

Load duration curves (LDCs), which were used to calculate total phosphorus and *E. coli* TMDLs, can assist in distinguishing between point and nonpoint sources that contribute to phosphorus and *E. coli* loading by highlighting the flow conditions under which impairment occurs. In essence, LDCs plot pollutant concentrations against flow to determine how much load, or quantity, of a pollutant is entering a stream. Five LDCs were created for *E. coli* and one for total phosphorus (see Appendix D for detail).

4.1.1 Justification

At lower stream flow levels, little to no in-stream dilution of pollutants occurs because of lack of runoff caused by dry conditions. Because of this, any point source contributions to the stream will result in higher concentrations of the pollutant. If there are a high number of samples under dry weather or low flow conditions that fall above the target curve, there is a likelihood of nearby point sources of the pollutant. Examples of nutrient and bacteria point sources include combined sewer overflows (CSOs), municipal separate storm sewer systems (MS4s) and wastewater treatment plants (WWTPs). High nutrient or bacteria concentrations under low flow conditions may also indicate concentrated cattle grazing in the stream channel, leaking sewer lines, or failing home sewage treatment systems.

Under elevated flow conditions, point sources are assumed to be masked by in-stream dilution, implying that high loading is caused by precipitation washoff or erosion of contaminated land surfaces. Among many possibilities, some typical nonpoint sources include manure spreading, stream bank erosion, and washoff from livestock feeding operations. Scenarios where high loads exist under mid-range flow conditions, or high loads occur under all conditions, can be attributed to a mixture of point and nonpoint sources.

It is important to note that the load duration curve method does not enable one to attribute impairment to any particular source; instead it is a tool used to determine pollutant loading for total phosphorus and *E. coli* under various flow conditions and the probable types of sources contributing to high loadings.

4.1.2 Sources of data

Nutrient and *E. coli* data were collected by Ohio EPA during the recreation season in 2006, 2008 and 2010. Flow data were collected at sentinel sites in the watershed in 2006 and 2008. In addition, flow information was used from a USGS gage in the neighboring Ohio Brush Creek watershed. The correlation between USGS gage information and Ohio EPA flow measurements is discussed in Appendix D.

4.1.3 Targets

For a given impaired site, each hydrologic condition (high flows, wet weather conditions, normal conditions, dry weather conditions or low flows) was assigned a target bacteria loading rate (cfu/day) by multiplying the Class A *E. coli* water quality standard, 126 colony forming units (cfu)/100 ml, by the median flow of each hydrologic class at that site and a constant, used to convert cubic feet per second to milliliters per hour: $T = Q_m * S * C$; where T = target bacteria load, Q_m = median flow for a specific hydrologic class, S = water quality standard (126 cfu/100 ml) and C = a unit conversion constant (cubic feet per second to milliliters per day). Median observed bacteria loads in each hydrologic condition were compared to the median target value in that condition, after incorporating a margin of safety and allowance for future growth, in order to quantify needed reductions. Several of the sites at which load duration curves were created were located in primary contact recreation Class B streams (where the WQS is 161 cfu/100 ml). However, all of these sites were within five miles of Class A streams, so the Class A WQS was used to protect downstream uses.

For the purpose of this TMDL, total phosphorus (total P) is used as an indicator for the degree of nutrient enrichment. While the Ohio EPA does not currently have statewide numeric criteria for nutrients, 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 on the aquatic biological communities of Ohio streams and rivers. The study reaches a number of conclusions and stresses the importance of habitat and other factors, in addition to in-stream nutrient concentrations, as having an impact on the health of biologic communities. The study also includes proposed total phosphorus target concentrations based on observed concentrations associated with acceptable ranges of expected biological communities. As suggested in the *Associations* document (Ohio EPA 1999), the total P target used in the Scioto Brush Creek analysis is 0.1 mg/L. It is important to note that nutrient 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 TMDL development.

4.1.4 Allowance for Future Growth

An allowance for future growth (AFG) accounts for reasonably foreseeable increases in pollutant loads. AFGs were included in the *E. coli* and total phosphorus TMDLs.

The Scioto Brush Creek watershed lies within Adams and Scioto counties. The average population change projection from 2010 to 2020 of the two counties is an increase of 3% (ODD 2003). In order to ensure recreation use attainment in the future, an allowance for future growth of 3% was applied to each TMDL.

For the total phosphorus TMDL, which is limited to a single stream in 05060002 15 02 (Rarden Creek at RM 3.86), the allowance for future growth was given based on trends in cattle numbers. The four-year trend in Scioto County is a 15.9 percent decrease in numbers of cattle (USDA 2011). The farms affecting Rarden Creek are small and the cattle herds there could feasibly increase, though not by much given the small acreage. Therefore, to set aside load for future increases in the local herds, a 5% allowance for future growth is made.

4.1.5 Seasonality and Critical Conditions

Critical conditions for in-stream bacteria vary by source and can occur across the hydrograph, from washoff of land-deposited bacteria under moist conditions to in-stream livestock and failing HSTSs in low flow conditions. Nonpoint sources to which bacteria loads are allocated in the Scioto Brush Creek basin include livestock, both manure washoff and in-stream animals, and failing HSTSs.

Since LDCs develop TMDLs for different flow conditions, critical flow conditions are adequately addressed. Total phosphorus is introduced during storm runoff from active pastures so reductions during high flows are important. The only necessary reduction is in the wet/spring weather category.

4.2 Qualitative Habitat Evaluation Index Assessment

Poor habitat quality is an environmental condition, rather than a pollutant load, so development of a load-based TMDL for habitat is not possible. Nonetheless, habitat is an integral part of stream ecosystems and has a significant impact on aquatic community assemblage and consequently on the potential for a stream to meet the biocriteria within Ohio's water quality standards (see below). In addition, U.S. EPA acknowledges that pollutants, conditions or other environmental stressors can be subject to the development of a TMDL to abate those stressors in order to meet water quality standards (U.S. EPA 1991). Thus, sufficient justification for developing habitat TMDLs is established.

4.2.1 Justification

The Qualitative Habitat Evaluation Index (QHEI) was developed by the Ohio EPA (Ohio EPA 1989) with one of the objectives being to create a means for distinguishing impacts to the aquatic community from pollutant loading versus poor stream habitat. The design of the QHEI in conjunction with its statistically strong correlation to the biocriteria makes it an appropriate tool for developing habitat TMDLs.

The QHEI assigns a numeric value to an individual stream segment (typically 150-200 m in length) based on the quality of its habitat. The actual number values of the QHEI scores do not represent the quantity of any physical properties of the system but provide a means for comparing the relative quality of stream habitat. 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. Reduced subjectivity was an important consideration in developing the QHEI and has since been evidenced through minimal variation between scores from various trained investigators at a given site as well as consistency with repeated evaluations (Ohio EPA 1989).

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

4.2.2 Sources of data

Habitat data using the QHEI were collected by Ohio EPA in 2006 concurrent with times when fish sampling occurred.

4.2.3 Target(s), Calibration and Validation

Since its development the QHEI has been used to evaluate habitat at most biological sampling sites and currently there is an extensive database that includes QHEI scores and other water quality variables. Strong correlations exist between QHEI scores and its component submetrics and the biological indices used in Ohio's water quality standards such as the Index of Biotic Integrity (IBI). Through statistical analyses of data for the QHEI and the biological indices, target values have been established for QHEI scores with respect to the various aquatic life use designations (Ohio EPA 1999). For aquatic life use designations of warmwater habitat (WWH) and exceptional warmwater habitat (EWH), respective overall QHEI scores of 60 and 75 are targeted to provide reasonable certainty that habitat is sufficient to support biological community expectations.

One of the strongest correlations found through these statistical analyses described above is the negative relationship between the number of "modified attributes" and the IBI scores. Modified attributes are features or conditions that have low value in terms of habitat quality and therefore are assigned relatively fewer points or negative points in the QHEI scoring. A subgroup of the modified attributes shows a stronger impact on biological performance; these are termed high influence modified attributes.

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For streams designated as WWH, there should no more than four modified attributes, of which no more than one should be a high influence modified attribute. For EWH streams, there should be no more than two modified attributes and zero high influence attributes.

4.2.4 Seasonality and Critical Conditions

Habitat is generally a static condition of a stream. Exceptions include major modifications made by humans (or some animals like beavers) or changes in the hydrology or sediment loading of the watershed (again, typically a man made situation). Since habitat is relatively static,

seasonality has little meaning. Specifically, absent a major disturbance, habitat quality does not change across the seasons but rather over much longer timescales. Finally, there is no seasonal "loading" associated with habitat but instead habitat evolves through changes in morphology and riparian vegetation.

The concept of critical condition has more meaning for habitat. There are times of the year when poor habitat quality is particularly detrimental to the aquatic community, especially summer low flows. Low flow conditions stress the community and competition for space occurs. Under these conditions the greatest threat is a drying of the stream where most aquatic species can survive for only a short period. The availability of a sufficient amount of water is affected by the quality of the stream habitat. Coarse bed substrates are often areas of water storage, and when they are not embedded with fine sediments (a manifestation of degraded habitat) they are accessible to small aquatic species. Deep pools also act as reservoirs when water becomes scarce. An intact riparian corridor will mitigate low flow conditions by reducing direct sunlight, keeping water temperatures lower than what they may otherwise be, which helps to sustain dissolved oxygen concentrations, mitigates excessive increases in metabolic rates and reduces water loss through pan evaporation).

4.3 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).

For the *E. coli* TMDLs, an implicit MOS is incorporated in various ways, including in the derivation of the *E. coli* water quality criterion and in not considering the die-off of pathogens as part of the TMDL calculations. The implicit MOS is also enhanced by the use of the geometric mean target (which is a seasonal target) to calculate daily loads. In addition, an explicit MOS has been applied as part of all of the bacteria TMDLs by reserving 20% of the allowable load because of the broad fluctuation of *E. coli* concentrations that occurs in nature and the relatively low numbers of data points available for this analysis. The explicit MOS in each allocation is shown in the TMDL allocation tables throughout Section 5.

For the total phosphorus TMDL, an explicit MOS of 10% is included. The MOS is set at 10% because of the uncertainty about flows based on the distance from the site to the USGS gage used for the flow calculation basis, a key factor of the load calculation.

There is an implicit margin of safety applied to the habitat TMDLs based on conservative target values used. The targets from the *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA 1999) are conservative because attainment of aquatic life uses has been demonstrated even when the targets are not met.

5 LOAD REDUCTION RESULTS

Several analyses were completed to address the causes of impairment. Results are summarized in this chapter, organized by assessment unit. Figure 5-1 shows the percent reductions necessary within each flow regime for each site at which load duration curves were completed. Further details, including the load duration curves, are available in Appendix D.

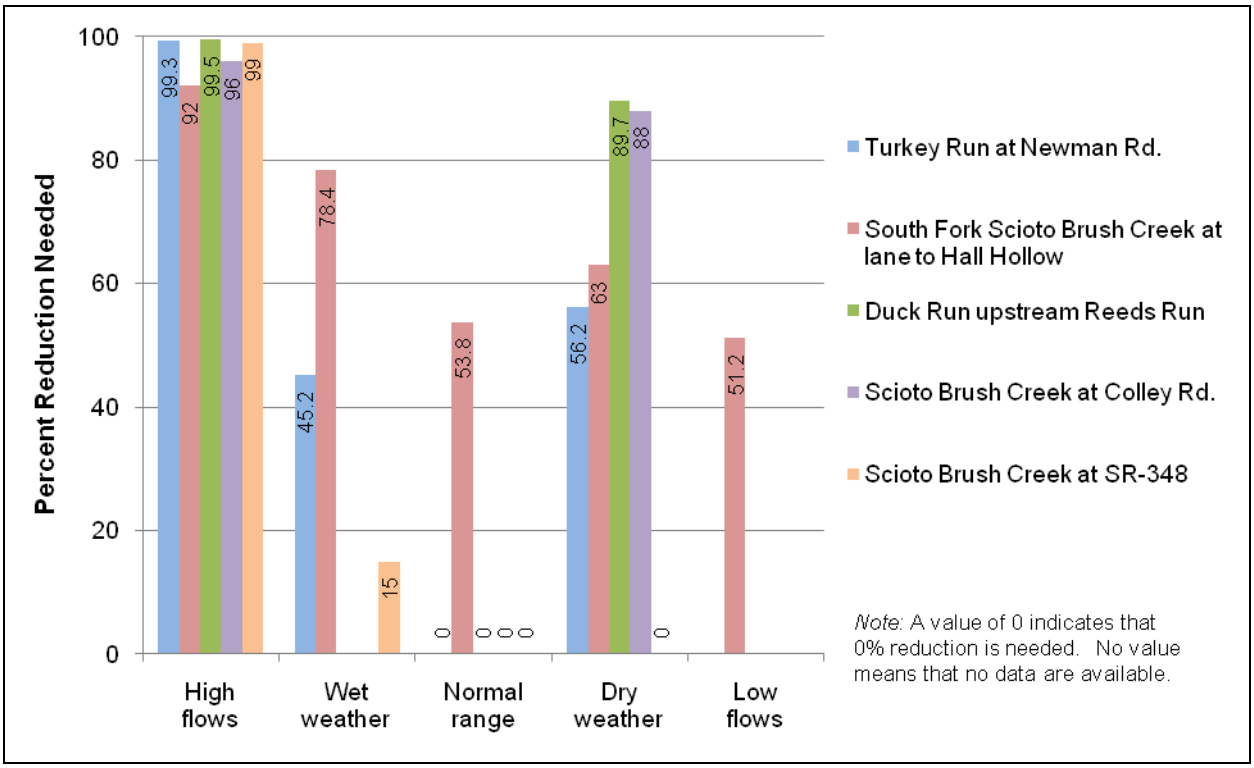

Figure 5-1. Comparison of *E. coli* reductions at each site for which a load duration curve was completed.

5.1 Churn Creek (05060002 14 01), Mill Creek (14 02) and part of Turkey Run-South Fork Scioto Brush Creek (14 04)

Table 5-1 shows the *E. coli* reductions necessary at South Fork Scioto Brush Creek at RM 12.36. The load duration curve (LDC) created at this site includes all drainage area upstream of the site. The largest reduction (92.0%) is needed at the high flow regime.

Table 5-1. Bacteria TMDL table for South Fork Scioto Brush Creek at lane to Hall Hollow.

Flow regime TMDL analysis ***E. coli*** **(billion bacteria/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	1	3	5	4	1
Median sample load	4,099	194	19	5.1	0.9
TMDL	**424.4**	**54.6**	**11.10**	**2.466**	**0.550**
WLA	0.0	0.0	0.0	0.0	0.0
LA	326.8	42.0	8.54	1.899	0.423
MOS: 20%	84.9	10.9	2.22	0.493	0.110
AFG: 3%	12.7	1.6	0.3	0.074	0.016
Nonpoint (LA) % load reduction required	**92.0%**	**78.4%**	**53.8%**	**63.0%**	**51.2%**

Values were adjusted for rounding.

5.2 Turkey Run Basin in Turkey Run-South Fork Scioto Brush Creek (05060002 14 04)

Table 5-2 shows the *E. coli* reductions necessary at Turkey Run at RM 0.26. The LDC created at this site includes all drainage area upstream of the site (i.e., the Turkey Run basin). The largest reduction (99.3%) is needed at the high flow regime.

Table 5-2. Bacteria TMDL table for Turkey Run at Newman Rd.

Flow regime TMDL analysis ***E. coli*** **(billion bacteria/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	2	3	4	4	N/A
Median sample load	5,974	10	1	0.5	N/A
TMDL	**55.3**	**7.1**	**1.44**	**0.304**	**0.072**
WLA	0.0	0.0	0.0	0.0	0.0
LA	42.6	5.5	1.11	0.234	0.055
MOS: 20%	11.1	1.4	0.29	0.061	0.014
AFG: 3%	1.7	0.2	0.04	0.009	0.002
Nonpoint (LA) % load reduction required	**99.3%**	**45.2%**	**0%**	**56.2%**	No Data

Values were adjusted for rounding.

5.3 Headwaters Scioto Brush Creek (05060002 15 01), Rarden Creek (15 02), Jaybird Branch-Scioto Brush Creek (15 03) and Dunlap Creek-Scioto Brush Creek (15 04)

Table 5-3 shows the *E. coli* reductions necessary at Scioto Brush Creek at RM 17.1. The LDC created at this site includes all drainage area upstream of the site. The largest reduction (99%) is needed at the high flow regime.

Table 5-3. Bacteria TMDL table at Scioto Brush Creek at State Route 348.

Flow regime TMDL analysis ***E. coli*** **(billion bacteria/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	2	3	8	3	N/A
Median sample load	105,260	101.7	5.61	0.776	N/A
TMDL	**1,319.8**	**112.8**	**16.64**	**2.466**	**0.308**
WLA	0.0	0.0	0.0	0.0	0.0
LA	1,016.3	86.9	12.82	1.899	0.237
MOS: 20%	264.0	22.6	3.33	0.493	0.062
AFG: 3%	39.6	3.4	0.50	0.074	0.009
Nonpoint (LA) % load reduction required	**99%**	**15%**	**0%**	**0%**	No Data

Values were adjusted for rounding.

Table 5-4 shows the total phosphorus reductions needed at Rarden Creek (river mile 3.86). A load reduction was needed in the wet/spring flow regime. Table 5-5 shows the habitat TMDL for the same site. Based on a target of 3 points, Rarden Creek missed the target in all three subscores; Scioto Brush Creek missed the target in two of three subscores (attaining the target in the high influence attribute subscore).

Table 5-4. Total phosphorus TMDL table for site on Rarden Creek (RM 3.86).

Flow regime TMDL analysis Total phosphorus (kg/day)	**Peak**	**Wet / Spring**	**Wet to Dry**	**Dry / Summer**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples collected per flow regime	0	3	1	2	1
Median grab sample load	N/A	2.35	0	0.0	0.0
TMDL (explicit 10% MOS included)	**26.1**	**1.99**	**0.396**	**0.035**	**0.002**
Allowance for future growth (5%)	1.31	0.100	0.020	0.002	0.000
Estimated % load reduction needed	No Data	**19.4%**	**0%**	**0%**	**0%**
Load allocation	24.8	1.89	0.377	0.033	0.002
Wasteload allocation	0.000	0.000	0.000	0.000	0.000

Table 5-5. Habitat TMDL for Rarden Creek (RM 3.86) and Scioto Brush Creek (RM 24.3).

	Use	**Allocations**			**Subscore**			**TMDL**
	WWH	**> 60 = 1 pt**	**< 2 = 1 pt**	**< 5 = 1 pt**				**3 pts**
TMDL Targets	**EWH**	**> 75 = 1 pt**	**0 = 1 pt**	**< 3 =1 pt**				**3 pts**
Existing Scores Stream/River (Use) (Nested Subwatershed)	River Mile	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes*	QHEI	High Influence	# Modified Attributes	Total Habitat Score
Rarden Cr. (WWH) (05060002 15 02)	3.8	45.5	4	5	0	0	0	0
Scioto Brush Cr. (EWH) (05060002 15 03)	24.3	58.5	0	5	0	1	0	1

* The Moderate Influence Attributes includes the high influence attributes, thus there is a total of 5 moderate influence attributes.

5.4 Turkey Creek (05060002 14 03), part of Turkey Run-South Fork Scioto Brush Creek (14 04), Rocky Fork (14 05), Bear Creek (15 05), McCullough Creek (15 06) and part of Duck Run-Scioto Brush Creek (15 07)

Table 5-6 shows the *E. coli* reductions necessary at Scioto Brush Creek at RM 3.35. The LDC created at this site includes all drainage area upstream of the site except area upstream of South Fork Scioto Brush Creek at RM 12.36. The largest reduction (96%) is needed at the high flow regime.

Table 5-6. Bacteria TMDL at Scioto Brush Creek at Colley Rd.

Flow regime TMDL analysis *E. coli* **(billion bacteria/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	1	N/A	3	2	N/A
Median sample load	69,177	N/A	7.92	46.442	N/A
TMDL	**3,691.4**	**315.3**	**46.23**	**7.089**	**1.233**
WLA	0.0	0.0	0.0	0.0	0.0
LA	2,842.3	242.8	35.60	5.459	0.949
MOS: 20%	738.3	63.1	9.25	1.418	0.247
AFG: 3%	110.7	9.5	1.39	0.213	0.037
Nonpoint (LA) % load reduction required	**96%**	No Data	**0%**	**88%**	No Data

Values were adjusted for rounding.

5.5 Beech Fork-South Fork Scioto Brush Creek (05060002 14 06)

Table 5-7 shows the habitat TMDL for Beech Fork at RM 1.9. Based on a target of 3 points, this site missed the target in all three subscores.

Table 5-7. Habitat TMDL for Beech Fork (RM 1.9).

	Use	**Allocations**			**Subscore**			**TMDL**
	WWH	**> 60 = 1 pt**	**< 2 = 1 pt**	**< 5 = 1 pt**	QHEI	High Influence	# Modified Attributes	**3 pts**
TMDL Targets	**EWH**	**> 75 = 1 pt**	**0 = 1 pt**	**< 3 =1 pt**				**3 pts**
Existing Scores Stream/River (Use)	River Mile	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes*				Total Habitat Score
Beech Fork (EWH)	1.9	36.5	4	5	0	0	0	0

* The Moderate Influence Attributes includes the high influence attributes, thus there is a total of 5 moderate influence attributes.

5.6 Duck Run Basin in Duck Run-Scioto Brush Creek (05060002 15 07)

Table 5-8 shows the *E. coli* reductions necessary at Duck Run at RM 3.35. The LDC created at this site includes all drainage area upstream of the site (i.e., the Duck Run basin). The largest reduction (99.5%) is needed at the high flow regime.

Table 5-8. Bacteria TMDL for Duck Run upstream Reeds Run.

Flow regime TMDL analysis ***E. coli*** **(billion bacteria/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	1	N/A	2	2	N/A
Median sample load	8,653	N/A	0	0.8	N/A
TMDL	**56.2**	**5.1**	**0.76**	**0.302**	**0.209**
WLA	0.148	0.148	0.148	0.148	0.148
LA	43.2	3.8	0.44	0.085	0.013
MOS: 20%	11.2	1.0	0.15	0.060	0.042
AFG: 3%	1.7	0.2	0.02	0.009	0.006
Nonpoint (LA) % load reduction required	**99.5%**	No Data	**0%**	**89.7%**	No Data

Values were adjusted for rounding.

6 WATER QUALITY IMPROVEMENT STRATEGY

Partial and non-attainment of aquatic life uses was scattered throughout the Scioto Brush Creek watershed. Direct habitat alterations from agriculture and in-stream gravel mining were the most predominant anthropogenic causes of aquatic life use impairment. Natural causes, such as geology, were also common. Recreation use (bacteriological) impairment was more widespread and was most often caused by livestock and failing home sewage treatment systems (HSTS).

Table 6-1 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. shows recommended implementation actions for NPDES permittees. Tables 6-3 and 6-4 each represent a separate subwatershed (see Figure 3-2 for a map). For each nested subwatershed, specific actions are recommended.

Recommendations were developed by Ohio EPA. In each case, these actions are intended to be inclusive of possible methods to improve water quality in the watershed based on identified causes and sources of impairment. Because Ohio EPA recognizes that actions taken in any individual subwatershed may depend on a number of factors (including socioeconomic, political and ecological factors), these recommendations are not intended to be prescriptive of actions to be taken, and any number or combination might contribute to improvement, whether applied at sites where actual impairment was noted or other locations where sources contribute indirectly to water quality impairment. Further details about individual practices can be found in Appendix E.

Table 6-1. Recommendations for improving water quality in impaired areas of the Scioto Brush Creek watershed.

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
South Fork Scioto Brush Creek (05060002 14)												
Churn Creek (14 01)												
Failing HSTS (bacteria)								x	x			
Mill Creek (14 02)												
Failing HSTS (bacteria)								x	x			
Turkey Creek (14 03)												
Failing HSTS (bacteria)								x	x			
Turkey Run-South Fork Scioto Brush Creek (14 04)												
Unrestricted livestock access (bacteria)									x	x		
Failing HSTS (bacteria)								x	x			
Rocky Fork (14 05)												
Failing HSTS (bacteria)								x	x			
Beech Fork-South Fork Scioto Brush Creek (14 06)												
Channelization (direct habitat alterations)	x	x		x					x		x	

Table 6-1 (cont.). Recommendations for improving water quality in impaired areas of the Scioto Brush Creek watershed.

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
Scioto Brush Creek (05060002 15)												
Headwaters Scioto Brush Creek (15 01)												
Failing HSTS (bacteria)								x	x			
Rarden Creek (15 02)												
Unrestricted livestock access [direct habitat alterations; nutrient enrichment (biological indicators)]									x	x		
Failing HSTS (bacteria)								x	x			
Jaybird Branch-Scioto Brush Creek (15 03)												
Channelization (direct habitat alterations)	x	x		x					x		x	
Failing HSTS (bacteria)								x	x			
Dunlap Creek-Scioto Brush Creek (15 04)												
Failing HSTS (bacteria)								x	x			
Bear Creek (15 05)												
Failing HSTS (bacteria)								x	x			
McCullough Creek (15 06)												
Failing HSTS (bacteria)								x	x			
Duck Run-Scioto Brush Creek (15 07)												
Failing HSTS (bacteria)								x	x			

6.1 Regulatory Recommendations

Recommendations for NPDES permits are summarized by discharger and nested subwatershed in Table 6-2. Any suggestions in permit limits reflect calculated TMDLs. Ohio EPA will work with permit holders to accomplish any needed reductions in loadings.

Table 6-2. Recommended implementation actions through the NPDES program for *E. coli*.

Nested Sub-watershed (05060002)	Entity	Ohio EPA Permit #	Receiving Stream	Design Flow (million gallons per day)	Wasteload Allocation (load)	Wasteload Allocation (concentration)	Recommended Permit Conditions
15 07	Scioto County Local Schools Northwest School	0PT00039	Duck Run	0.031		126 cfu / 100 ml	

6.2 South Fork Scioto Brush Creek (05060002 14)

The primary source of anthropogenic disturbance in this subwatershed is channelization with associated gravel mining. Recreation use impairment probably came primarily from failing home sewage treatment systems and in one location from unrestricted livestock access. Specific actions that may aid in attaining water quality standards are shown in the checklist in Table 6-3.

Table 6-3. Recommended implementation actions in the South Fork Scioto Brush Creek subwatershed.

Restoration Categories		Specific Restoration Actions	South Fork Scioto Brush Creek (05060002 14)					
			Church Creek (14 01)	Mill Creek (14 02)	Turkey Creek (14 03)	Turkey Run-South Fork Scioto Brush Creek (14 04)	Rocky Fork (14 05)	Beech Fork-South Fork Scioto Brush Creek (14 06)
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering						
		Restore streambank by recontouring or regrading						x
	planted	Plant grasses in riparian areas						
		Plant prairie grasses in riparian areas						
		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						
		Restore natural flow						x
Wetland Restoration		Reconnect wetland to stream						
		Reconstruct & restore wetlands						
		Plant wetland species						
Conservation Easements		Acquire conservation easements						x
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						

Restoration Categories		Specific Restoration Actions	South Fork Scioto Brush Creek (05060002 14)					
			Church Creek (14 01)	Mill Creek (14 02)	Turkey Creek (14 03)	Turkey Run-South Fork Scioto Brush Creek (14 04)	Rocky Fork (14 05)	Beech Fork-South Fork Scioto Brush Creek (14 06)
		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						
		Construct acid mine drainage wetland						
	flow diversion	Repair subsidence sites						
		Reclaim pit impoundments						
		Reclaim abandoned mine land						
		Eliminate stream captures						
		Restore positive drainage						
		Cover toxic mine spoils						
Home Sewage Planning and Improvement		Develop HSTS plan	x	x	x	x	x	
		Inspect HSTS	x	x	x	x	x	
		Repair or replace traditional HSTS	x	x	x	x	x	
		Repair or replace alternative HSTS	x	x	x	x	x	
Education and Outreach		Host meetings, workshops, and/or other events	x	x	x	x	x	x
		Distribute educational materials	x	x	x	x	x	x
Agricultural Best Management Practices	farmland	Plant cover/manure crops						
		Implement conservation tillage practices						
		Implement grass/legume rotations						
		Convert to permanent hayland						
		Install grassed waterways						
		Install vegetated buffer areas/strips				x		
		Install location-specific conservation buffer				x		
		Install / restore wetlands						
	nutrients / agro-	Conduct soil testing						
		Install nitrogen reduction practices						

Restoration Categories		Specific Restoration Actions	South Fork Scioto Brush Creek (05060002 14)					
			Church Creek (14 01)	Mill Creek (14 02)	Turkey Creek (14 03)	Turkey Run-South Fork Scioto Brush Creek (14 04)	Rocky Fork (14 05)	Beech Fork-South Fork Scioto Brush Creek (14 06)
	chemicals	Develop nutrient management plans						
	drainage	Install sinkhole stabilization structures						
		Install controlled drainage system						
		Implement drainage water management						
		Construct overwide ditch						
		Construct 2-stage channel						
	livestock	Implement prescribed & conservation grazing practices				x		
		Install livestock exclusion fencing				x		
		Install livestock crossings				x		
		Install alternative water supplies				x		
		Install livestock access lanes				x		
	manure	Implement manure management practices						
		Construct animal waste storage structures						
		Implement manure transfer practices						
		Install grass manure spreading strips						
	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						x
		Develop local comprehensive land use plans						x
	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						

Restoration Categories		Specific Restoration Actions	South Fork Scioto Brush Creek (05060002 14)					
			Church Creek (14 01)	Mill Creek (14 02)	Turkey Creek (14 03)	Turkey Run-South Fork Scioto Brush Creek (14 04)	Rocky Fork (14 05)	Beech Fork-South Fork Scioto Brush Creek (14 06)
		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 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						

Beech Fork was actively being channelized and mined for gravel from the stream bed during the 2006 survey (Ohio EPA 2008). Activities such as mining can destroy habitat, limit the amount of pollution that streams can process, and increase the severity of flooding downstream. Ceasing mining and channelization activities and allowing the channel to return to its natural state will greatly improve the aquatic biology and water quality of the stream.

6.3 Scioto Brush Creek (05060002 15)

The primary sources of anthropogenic disturbance in this subwatershed are channelization and unrestricted livestock access to streams. Recreation use impairment probably resulted from failing home sewage treatment systems. Specific actions that may aid in attaining water quality standards are shown in the checklist in Table 6-4.

Table 6-4. Recommended implementation actions in the Scioto Brush Creek subwatershed.

Restoration Categories		Specific Restoration Actions	Scioto Brush Creek (05060002 15)						
			Headwaters Scioto Brush Creek (15 01)	Rarden Creek (15 02)	Jaybird Branch-Scioto Brush Creek (15 03)	Dunlap Creek-Scioto Brush Creek (15 04)	Bear Creek (15 05)	McCullough Creek (15 06)	Duck Run-Scioto Brush Creek (15 07)
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering							
		Restore streambank by recontouring or regrading			x				
	planted	Plant grasses in riparian areas							
		Plant prairie grasses in riparian areas							
		Remove/treat invasive species							
		Plant trees or shrubs in riparian areas		x	x				
Stream Restoration		Restore flood plain		x	x				
		Restore stream channel		x	x				
		Install in-stream habitat structures			x				
		Install grade structures							
		Construct 2-stage channel							
		Restore natural flow		x					
Wetland Restoration		Reconnect wetland to stream							
		Reconstruct & restore wetlands							
		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							

Restoration Categories		Specific Restoration Actions	Scioto Brush Creek (05060002 15)						
			Headwaters Scioto Brush Creek (15 01)	Rarden Creek (15 02)	Jaybird Branch-Scioto Brush Creek (15 03)	Dunlap Creek-Scioto Brush Creek (15 04)	Bear Creek (15 05)	McCullough Creek (15 06)	Duck Run-Scioto Brush Creek (15 07)
		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							
		Construct acid mine drainage wetland							
	flow diversion	Repair subsidence sites							
		Reclaim pit impoundments							
		Reclaim abandoned mine land							
		Eliminate stream captures							
		Restore positive drainage							
		Cover toxic mine spoils							
Home Sewage Planning and Improvement		Develop HSTS plan	x	x	x	x	x	x	x
		Inspect HSTS	x	x	x	x	x	x	x
		Repair or replace traditional HSTS	x	x	x	x	x	x	x
		Repair or replace alternative HSTS	x	x	x	x	x	x	x
Education and Outreach		Host meetings, workshops, and/or other events	x	x	x	x	x	x	x
		Distribute educational materials	x	x	x	x	x	x	x
Agricultural Best Management Practices	farmland	Plant cover/manure crops							
		Implement conservation tillage practices							
		Implement grass/legume rotations							
		Convert to permanent hayland							
		Install grassed waterways							
		Install vegetated buffer areas/strips		x					
		Install location-specific conservation buffer		x					
		Install / restore wetlands							
	nutrients / agro-chemicals	Conduct soil testing							
		Install nitrogen reduction practices							
		Develop nutrient management plans							

Restoration Categories		Specific Restoration Actions	Scioto Brush Creek (05060002 15)						
			Headwaters Scioto Brush Creek (15 01)	Rarden Creek (15 02)	Jaybird Branch-Scioto Brush Creek (15 03)	Dunlap Creek-Scioto Brush Creek (15 04)	Bear Creek (15 05)	McCullough Creek (15 06)	Duck Run-Scioto Brush Creek (15 07)
	drainage	Install sinkhole stabilization structures							
		Install controlled drainage system							
		Implement drainage water management							
		Construct overwide ditch							
		Construct 2-stage channel							
	livestock	Implement prescribed & conservation grazing practices		x					
		Install livestock exclusion fencing		x					
		Install livestock crossings		x					
		Install alternative water supplies		x					
		Install livestock access lanes		x					
	manure	Implement manure management practices		x					
		Construct animal waste storage structures							
		Implement manure transfer practices							
		Install grass manure spreading strips							
	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/	Implement erosion controls							
		Implement sediment controls							

Restoration Categories		Specific Restoration Actions	Scioto Brush Creek (05060002 15)						
			Headwaters Scioto Brush Creek (15 01)	Rarden Creek (15 02)	Jaybird Branch-Scioto Brush Creek (15 03)	Dunlap Creek-Scioto Brush Creek (15 04)	Bear Creek (15 05)	McCullough Creek (15 06)	Duck Run-Scioto Brush Creek (15 07)
	storm water retrofit	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 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							

Rarden Creek (at river mile 3.86) was open to livestock at an adjacent pasture. Livestock defecation in streams is detrimental because it increases the bacteria in the water and is a source of nutrients (which can increase algal growth). Additionally, when livestock get into and out of streams, they trample the stream banks and cause an increase in sedimentation entering the streams. Fencing the livestock out of the stream would decrease bacteria, nutrients and sediment and improve the habitat and streambank stability of Rarden Creek. Additional measures to improve streambank stability, such as planting woody vegetation (trees and shrubs) would increase the rate of recovery.

The main cause of impairment on Scioto Brush Creek (at river mile 24.3) was a heavy load of silt. The reach sampled was incised (the streambed was lowered well below the floodplain). The generally flat shale and slate riffles trap silt and sand in them, causing embeddedness. Improving the diversity of the in-stream habitat through means such as root wads and larger cobble would help the habitat issues noted. In addition, any effort to re-connect the streambed to the floodplain would aid the stream's recovery.

6.4 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, U.S. EPA's 1991 TMDL Guidance states that the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions. 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.

6.4.1 Local Zoning and Regional Planning

Adams County has a Land Use Commission (see http://www.adamsoh.net/). From the September 2008 meeting minutes of the commission, it appears that task forces have formed and are actively working on various pieces of a comprehensive land use plan for the county.

6.4.2 Local Watershed Groups

There is a local watershed group called Friends of Scioto Brush that actively promotes education and outreach in the watershed (http://www.friendsofsciotobrushcreek.org/). The group hosts regular awareness and education events for local children and other watershed

residents. Each year a Scioto Brush Creek Sweep is held in concert with local SWCDs to remove trash and other debris from the mainstem. No watershed action or management plan has been completed.

6.4.3 Past and Ongoing Water Resource Evaluation

Ohio EPA conducted an intensive survey of biology, habitat and chemistry in the Scioto Brush Creek watershed in 2006 (Ohio EPA 2008). The next scheduled watershed survey is in 2022 (Ohio EPA 2010). However, as part of the adaptive management approach, Ohio EPA may return sooner than 2022 in order to monitor the results of specific improvement actions taken in the watershed.

Shawnee State University has a monitoring station on Scioto Brush Creek at Tatman-Coe Bridge, Rush Township. In the fall of 2007, a water quality and weather monitoring station was installed in the stream near the Scioto Brush Creek nature preserve at McDermott. Every thirty minutes, the instrument measures various water quality and weather features and displays them on the Web. Among the measurements taken are dissolved oxygen, turbidity, water level, water and air temperature, barometric pressure, and rainfall totals. All measurements are uploaded to the internet in real time.

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.

6.4.5 Revision to the Improvement Strategy

The Scioto Brush Creek 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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