UPDATED
TWIN CREEK
WATERSHED ACTION PLAN

Submitted by
The Institute of Environmental Sciences
Miami University
to
Ohio Department of Natural Resources
and
Ohio Environmental Protection Agency

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TABLE OF CONTENTS

Acronyms vii
Chapter 1 – Introduction 1
1.1 General Characteristics Of The Twin Creek Watershed.....1
1.2 Communities In The Watershed 4
1.2.1 Administrative Boundaries Within The Watershed.....4
1.2.2 Special Districts And Designations 5
1.2.3 NPDES Phase II Stormwater Communities.....5
1.3 Demographics of the Watershed.....6
1.4 Stakeholders.....6
1.5 Twin Creek Advisory Committee.....7
1.6 Decision-making process and edorsements 8
Chapter 2 – Watershed Plan Development 9
2.1 Watershed Advisory Group Roles and Activities.....9
2.1.1 Public Involvement and Education/Outreach 9
2.2 Current and Previous Watershed Protection and Management Activities.....10
2.2.1 Great Miami River Watershed Water Quality Credit Trading Prog. 10
2.2.2 Great Miami Watershed Targeted Watershed Project 10
2.2.3 Stormwater Management Plans 11
2.2.4 Federal Agricultural and Forestry Programs.....11
2.2.5 Section 319 Nonpoint Source Pollution Control Grants.....12
2.2.6 Water Resource Restoration Sponsor Program 12
2.2.7 County Drainage Maintenance Programs 12
2.2.8 Areawide Water Management Treatment Plans (Section 208 Plans) ..13
2.2.9 Sole Source Aquifer Designation.....13
2.2.10 Programs to Conserve Land through Conservation Easements.....14
2.3 Organization Of The Twin Creek Watershed Action Plan 15
Chapter 3 – Watershed Inventory.....16
3.1 Topography.....16
3.2 Geology and Glacial History 16
3.3 Soils 16

3.4 Biological Communities 22
3.4.1 Rare, Threatened and Endangered Species 22
3.4.2 Fish.....23
3.4.3 Freshwater Benthic Macro-invertebrates 23
3.4.4 Freshwater Mussels.....24
3.4.5 Reptiles and Amphibians 25
3.4.6 Indiana Bats 26
3.4.7 Birds.....27
3.4.8 Plants.....27
3.4.9 Invasive Nonnative Species and Their Potential Impacts.....27
3.5 Land Use 28
3.5.1 Overview of Land Use In The Watershed 28
3.5.2 Agricultural Practices and Uses 28
3.5.3 Row Crops 29
3.5.4 Livestock.....29
3.5.5 Forested Areas and Riparian Corridors.....29
3.5.6 Protected Lands.....30
3.5.6.1 Parks.....30
3.5.6.2 Conservation Easements 30
3.5.6.3. Flood Easements 31
3.5.7 Cultural Resources 31
Chapter 4 – Water Resources 32
4.1 Climate And Precipitation.....32
4.2 Surface Water Resources 32
4.2.1 Wetlands 32
4.2.2 Stream System 33
4.2.3 Stream Habitat 34
4.2.4 Current Aquatic Life Use Attainment Status 34
4.2.5 Streams Subject To Ohio's Anti-degradation Rules.....37
4.2.6 Status Of Twin Creek's TMDL Process 37
4.2.7 NPDES Permitted Point Sources 37
4.2.8 Stream Morphology and Channel Mod. along the Mainstem.....38

4.2.9 Stream Flow 40
4.2.10 Stream Physical Attributes.....41
4.2.10 Flood Control Structures.....41
4.3 Groundwater Resources 42
4.3.1 Public Water Suppliers 42
4.3.2 Source Water Assessments 43
4.3.3 Groundwater Pollution Potential.....43
Chapter 5 – Watershed Goals and Recommended Actions 47
5.1 Twin Creek Watershed Goals 47
5.2 Twin Creek Target Improvement Goals 50
5.2.1 Problem Statements 50
Chapter 6 – Subwatershed Details 53
6.1 Upper Twin Creek above Miller"S Fork 57
6.2 Miller's Fork 62
6.3 Twin Creek Watershed Miller's Fork To Price Creek.....66
6.4 Swamp Creek Watershed.....69
6.5 Price's Creek Watershed.....73
6.6 Twin Creek Below Price's Creek To Above Bantas Fork.....77
6.7 Upper Bantas Fork Watershed.....81
6.8 Lower Bantas Fork Watershed.....83
6.9 Goose Run Watershed 85
6.10 Twin Creek below Bantas Fork Above Aukerman.....89
6.11 Aukerman Creek 91
6.12 Twin Creek Watershed Aukerman Creek To Tom's Run 93
6.13 Tom's Run Watershed 95
6.14 Little Twin Creek Watershed.....99
6.15 Twin Creek Watershed below Tom's Run To Great Miami River.....101
Chapter 7 – Evaluation 103
Appendices
A – Participants In The Western Tributaries/Twin Creek Project
B – Twin Creek Watershed Public Comments And Outreach Activities
C – Biological Communities Of The Twin Creek Watershed
D – Ohio EPA Aquatic Life Use Status Data For Twin Creek (Based On 2005 Data)

List of Tables

Table 1-1 Streams of The Twin Creek Watershed
Table 1-2 Administrative Boundaries in The Twin Creek Watershed
Table 1-3 Estimated 2000 Twin Creek Watershed Population By County
Table 1-4 Household Income In 1999
Table 1-5 Partners of the Twin Creek Watershed Partnerships
Table 3-1 Rare, Threatened & Endangered Species
Table 3-2 State Declining Species of Fish in Twin Creek Watershed
Table 3-3 Mussels Occurring in the Twin Creek Watershed
Table 3-4 Lewisburg Limestone Mine Survey
Table 3-5 2000 Land Use Cover in the Twin Creek Watershed
Table 3-6 2008 Livestock Data for Twin Creek Watershed
Table 4-1 Long Term Precipitation Averages for Great Miami River Basin
Table 4-2 Streams of the Twin Creek Watershed
Table 4-3 Aquatic Life Use Designations Applicable To Ohio Streams
Table 4-4 Permitted NPDES Discharges in The Twin Creek Watershed
Table 4-5 Information on USGS Station 03272000 near Germantown
Table 4-6 General Watershed Features as of 2009
Table 4-7 Source Water Assessments & Susceptibility Analyses for Community Systems
Table 5-1 Conservation Easements Current, Anticipated and Planned
Table 5-2 Causes and Sources of Stress

List of Figures

Figure 1-1 Map of Twin Creek Watershed with 14-Digit Huc Subwatersheds
Figure 1-2 Incorporated Areas of Twin Creek Watershed
Figure 3-3.1 Drainage Classes
Figure 3-3.2 Highly Erodible Soils
Figure 3-3.3 Flood Frequency
Figure 3-3.4 Hydric Soil
Figure 3-3.5 Soil Slopes
Figure 4-1 Twin Creek Sampling Sites and Attainment Status
Figure 4-2 Public Water Systems Located In the Twin Creek Watershed
Figure 4-3 Twin Creek Watershed Groundwater Pollution Potential

Figure 6-1 Upper Twin Creek Watershed
Figure 6-2 Miller's Fork Watershed
Figure 6-3 Twin Creek Watershed Miller's Fork to Price Creek
Figure 6-4 Swamp Creek Watershed
Figure 6-5 Price Creek Watershed
Figure 6-6 Lesley Run (Includes Twin Creek below Price's Creek To Above Bantas Fork)
Figure 6-7 Upper Bantas Fork Watershed
Figure 6-8 Lower Bantas Fork Watershed\
Figure 6-9 Goose Run Watershed
Figure 6-10 Twin Creek below Bantas Fork
Figure 6-11 Aukerman Creek Watershed
Figure 6-12 Twin Creek Watershed Aukerman Creek To Tom's Run
Figure 6-13 Tom's Run Watershed
Figure 6-14 Little Twin Creek Watershed
Figure 6-15 Lower Twin Creek Watershed

List of Acronyms*

BMP	Best Management Practices
DNR	Department of Natural Resources
EPA	Environmental Protection Agency
EWH	Exceptional Warmwater Habitat
HEL	Highly Erodible Land
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
MCD	Miami Conservancy District
MIwb	Modified Index of Well being
MVRPV	Miami Valley Regional Planning Commission
MWH	Modified Warmwater Habitat
MU-IES	Miami University – Institute of Environmental Sciences
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
QHEI	Qualitative Habitat Evaluation Index
RM	River Mile
SWCD	Soil and Water Conservation District
TMDL	Total Maximum Daily Load
3VCT	Three Valley Conservation Trust
USDA – NIWQ	U. S. Department of Agriculture – National Integrated Water Quality Program
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WAG	Watershed Advisory Group
WAP	Watershed Action Plan
WWH	Warmwater Habitat
WWTP	Wastewater Treatment Plant

* This list does not include acronyms mentioned only once in the text and spelled out to describe specific programs.

Chapter 1
INTRODUCTION

Twin Creek watershed is of special interest because the quality of its fish and macro invertebrate communities and physical habitat are among the highest of any Ohio stream (OEPA, 2007). The goal of the *Twin Creek Watershed Action Plan* (WAP) is to identify actions to restore and maintain the chemical, physical and biological integrity of stream segments within the Twin Creek watershed. The *Twin Creek* WAP represents a collective multi-county effort to address issues and concerns related to the protection, improvement and management of one of Southwest Ohio's highest quality watersheds. By describing the characteristics of the Twin Creek watershed, identifying issues associated with its water resources, and setting recommendations to reduce water quality impairments and protect water quality, this WAP:

1) identifies methods to protect stream segments that currently meet standards.
2) identifies measures to reduce water resource impairment in stream segments not currently meeting designated water quality standards and/or segments with recently downgraded designations.

An important recommendation of Ohio EPA's 1995 study was the formation of a Twin Creek watershed group. Although no formal 501(c) 3 Twin Creek group exists, interested citizens and agencies have come together to chart a course for the watershed's future, hereafter referred to as the Watershed Advisory Group (WAG). This WAP provides guidance to move forward to implement actions with the support of the WAG that is comprised of a broad spectrum of local, county, and state agencies and organizations. In 2005, the Ohio EPA again conducted an intensive study of the Twin Creek watershed to determine if changes have occurred in key biological, chemical or physical indicators and also to determine the extent to which Ohio's stream use designations are being attained. The results of this most recent biosurvey have been incorporated into this WAP. The mean index of fish health is the highest in Ohio when compared to similar-sized streams sampled in the last 10 years and the third-highest in Ohio of the invertebrate community health (OEPA, 2010). These outstanding attributes underscore the importance of protecting and managing the Twin Creek watershed in response to the cumulative impacts of life in the 21st century.

Although much of the watershed is very high quality, portions of Twin Creek and its tributaries do not attain their water quality goals of aquatic life and recreation. Therefore, OEPA and the Twin Creek WAG together formulated a plan to implement actions to address the impairment. The Twin Creek watershed TMDL was approved in March 2010.

1.1 General Characteristics of the Twin Creek Watershed

Twin Creek is one of the western tributaries of the lower Great Miami River (Figures 1-1 and 1-2). The watershed encompasses 316 square miles (202,240 acres) and located in five counties: Darke, Preble, Montgomery, Warren and Butler. The headwaters of Twin Creek are located at south-central Darke County and the main stem of Twin Creek flows south-southeasterly through Preble County. The easternmost tributaries of Twin Creek drain into the southwest corner of Montgomery County. Twin Creek then briefly flows through Warren County where it converges with the Great Miami River near River Mile (RM) 57. A very small corner (about 1 square mile)

of Butler County is located within Twin Creek watershed but Twin Creek does not flow through Butler County.

The main stem of Twin Creek is 46.2 miles long with approximately 103 miles of tributary streams. The average gradient is 9.1 feet per mile with the elevation changing from 1067 feet above sea level at the headwaters to 645 feet above sea level at its confluence with the Great Miami River (ODNR, 2001).

Located in the Eastern Corn Belt Plains ecoregion, the landscape of Twin Creek watershed is gently rolling glacial till plains; its original vegetation was mostly beech forest with areas of elm-ash swamp forests. Near the Great Miami River confluence, an area of oak-sugar maple and bottomland hardwood forest existed in pre-settlement times. Remnants of these forest types still exist in isolated locations (Gordon, 1966). Silurian and Ordovician era bedrock is exposed principally as limestone with some shale outcrops.

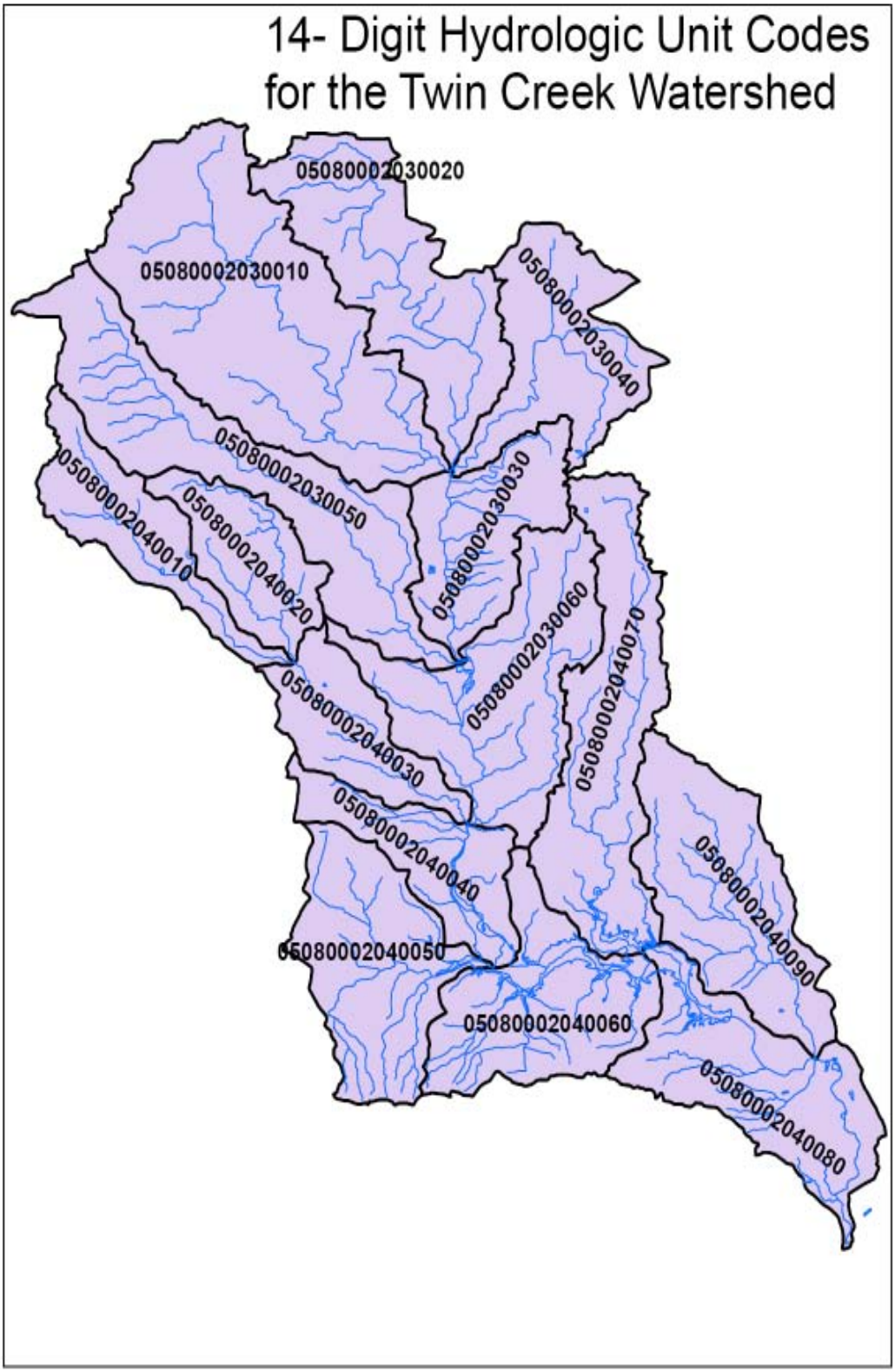
A total of 15 subwatersheds exist within the Twin Creek Watershed. Six are within the 11-digit HUC ending in 030 while the remaining nine are within the HUC ending in 040. Table 1-1 lists the subwatersheds, their HUC identifications, and acreages; Figure 1-1shows their locations.

TABLE 1-1
Streams of the Twin Creek Watershed

Tributary Name	14-Digit HUC	Watershed Area (acres)
Twin Creek above Miller's Fork	05080002-030-010	28,302
Miller's Fork	05080002-030-020	15,513
Twin Creek below Miller's Fork to above Price's Creek	05080002-030-030	9,654
Swamp Creek	05080002-030-040	11,486
Price's Creek	05080002-030-050	18,825
Twin Creek below Price's Creek to above Banta's Fork	05080002-030-060	16,727
Banta's Fork above Goose Creek	05080002-040-010	7,978
Goose Creek	05080002-040-020	7,231
Banta's Fork below Goose Creek	05080002-040-030	7,279
Twin Creek below Banta's Fork above Aukerman Cr. (including Lesley Run)	05080002-040-040	7,974
Aukerman Creek	05080002-040-050	13,327
Twin Creek below Aukerman Creek above Tom's Run	05080002-040-060	13,033
Tom's Run	05080002-040-070	16,481
Twin Creek below Tom's Run to GMR Miami River	05080002-040-080	13,810
Little Twin Creek	05080002-040-090	14,531

SOURCES: (Ohio EPA 2005; NRCS 2006).

FIGURE 1-1
Map of Twin Creek Watershed with 14-Digit HUC Subwatersheds



1.2 Communities in the Watershed

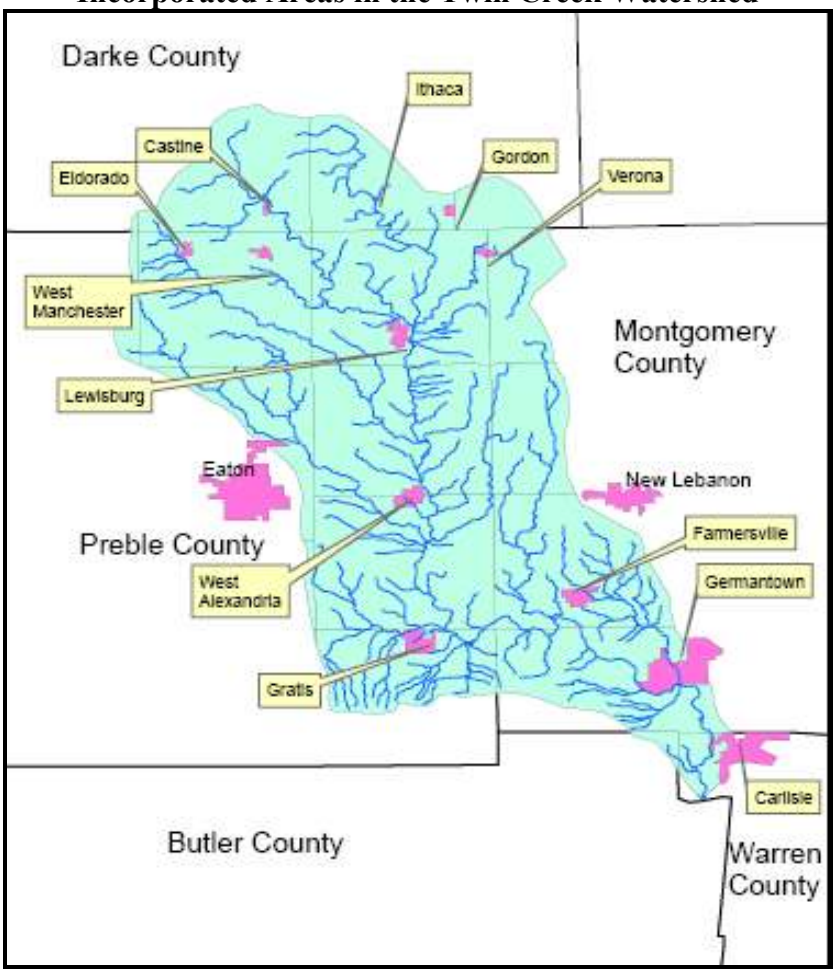
1.2.1 Administrative Boundaries within the Watershed

The Twin Creek watershed is not heavily populated, but includes several communities (Table 1-2). The largest towns in the watershed are Germantown and Carlisle. Eaton, the seat of Preble County, is located just west of the watershed. The watershed's administrative boundaries are listed in the table below and shown in Figure 1-2.

TABLE 1-2
Administrative Boundaries in the Twin Creek Watershed

County	Townships	Incorporated Communities
Darke	Butler, Twin and Monroe	Castine, Ithaca, Gordon
Preble	Jefferson, Monroe, Harrison, Washington, Twin, Gasper, Lanier and Gratis	Eldorado, West Manchester, Lewisburg, West Alexandria, Gratis
Montgomery	Clay, Perry, Jackson and German	Germantown, Farmersville
Warren	Franklin	Carlisle

FIGURE 1-2
Incorporated Areas in the Twin Creek Watershed



1.2.2 Special Districts and Designations

Several special districts are located within the Twin Creek watershed:

- **Park districts** include Darke, Preble, Warren and Five Rivers MetroParks in Montgomery County
- **Soil and Water Conservation Districts** include those in Darke, Preble, Montgomery and Warren counties. County SWCDs also provide oversight to specially zoned agricultural districts.
- **Regional planning areas** include the Miami Valley Regional Planning Commission (MVRPC), which includes Darke, Montgomery, and Preble counties and the Ohio-Kentucky-Indiana Regional Council of Governments (OKI), which includes Warren County
- **Miami Conservancy District** (MCD) includes the entire watershed, and
- **Water and sewer districts** include the Warren County Water & Sewer District and the water and sewer departments of Eldorado, Verona, Lewisburg, West Alexandria, Gratis, Farmersville and Germantown.
- **School districts** include:
    - Valley View Local School District
    - Twin Valley Community Schools
    - Tri-County North School District
    - Arcanum Butler Local School District
    - Eaton Community Schools
    - Carlisle Local Schools
    - Franklin City Schools
    - Preble Shawnee Local Schools
    - National Trail Local Schools

No special national or scenic stream designations are assigned to Twin Creek or any of its tributaries.

1.2.3 NPDES Phase II Stormwater Communities

Five small municipal separate storm water systems are located within the Twin Creek watershed and are subject to the federal Storm Water Program Phase II regulations (http://www.epa.state.oh.us/dsw/storm/). The five governmental jurisdictions affected are:

Incorporated areas:	Germantown Village (German Township, Montgomery County)
	Carlisle Village (Warren County)
Townships:	German Township (Montgomery County)
Counties:	Montgomery County
	Warren County

Each of these entities has an independent Phase II NPDES permit even when they share areas in common (Fyffe, 2006). Additional information on this program is included later in this document.

1.3 Demographics of the Watershed

Data from the Ohio State University Extension Exurban Exchange Program indicate the population in the Twin Creek watershed declined about 3.4 % from an estimated 1990 population of 43,062 to an estimated 2000 population of 41,597. Table 1-3 shows the watershed's population distribution by county.

TABLE 1-3
Estimated 2000 Twin Creek Watershed Population by County

County	2000 Estimate	% of Total
Darke	4,161	**10.0**
Preble	14,556	**35.0**
Montgomery	12,933	**31.1**
Warren	9,947	**23.9**
Totals	**41,597**	**100.0**

SOURCE: Ohio State University Exurban Change Program 2006. http://exurban.osu.edu/countyandtownship.htm

Most small communities in the watershed lost population during the 1990-2000 period, with the exception of Lewisburg in Harrison Township, Preble County, and Farmersville in Jackson Township, Montgomery County. Among the townships, German Township in western Montgomery County experienced the highest growth rate during 1990-2000 - approximately 5.4 percent. According to the American Community Survey of the U.S. Census Bureau, (http://www.census.gov/acs/www/), 36.4 years is the median age nationwide. Median age in the watershed ranged from 35.2 years in Warren County to 37.4 years in Darke County. The percent of persons 25 or older with a Bachelor's degree or higher is 10.1% for Preble County, 22.9% for Montgomery County, 10.1% for Darke County, and 28.4% for Warren County compared to the Ohio average of 21.1%. Regional age and education data were provided by MVRPC online (http://www.mvrpc.org/). The MVRPC database also indicated a regional median household income of $41,926, as compared to the range for the four watershed counties provided in the following table:

TABLE 1- 4
Household Income in 1999
(% of total households in thousands)

County	Less than $10	$10-19.999	$20-29.999	$30-39.999	$40-49.999	$50-59.999	$60-74.999	$75-99.999	$100-149	More than $150	Median Income
Darke	7.3	14.6	14.3	14.6	13.2	10.2	11.0	8.7	4.2	2.0	$39,307
Montg.	9.9	12.8	13.9	13.3	10.7	9.4	10.4	9.9	6.7	3.1	$40,156
Preble	6.2	11.1	15.1	14.6	12.6	11.7	13.3	9.7	4.5	1.2	$42,093
Warren	3.9	7.5	8.9	10.5	10.7	10.5	13.3	15.6	13.0	6.3	$57,952

SOURCE: MVRPC Online (http://www.mvrpc.org/).

Although many watershed residents commute to Dayton and other smaller communities for work, agriculture continues to be a major influence on economic patterns of the Twin Creek watershed. More detailed information on agriculture and associated land use is included in Chapter 3.

1.4 Stakeholders

Many agencies and organizations are interested in the protection of Twin Creek Watershed. Table 1-5 lists current stakeholders. Representatives of these agencies participate in the

watershed advisory group meetings and review of the watershed action plan. This list continues to change as new stakeholders are identified.

TABLE 1-5
Partners of the Twin Creek Watershed Partnership

Darke Soil and Water Conservation District
Miami University - Institute of Environmental Sciences
Montgomery County Commissioners
Montgomery County Soil and Water Conservation District
Ohio Department of Natural Resources
Ohio State University Cooperative Extension Service in Butler, Preble and Montgomery Counties
Preble County Commissioners
Preble County Department of Health
Preble County Engineer's Office
Preble Soil and Water Conservation District
Preble County GIS Office
Preble County Park District
Preble County Historical Society
Tricia Shepherd, Watershed resident
Three Valley Conservation Trust
Five Rivers Metroparks
Miami Conservancy District
Miami Valley Regional Planning Commission
Miami Valley Resource Conservation and Development District
Ohio Department of Natural Resources (Division of Soil and Water, Division of Wildlife)
Ohio EPA (TMDL Coordinator, Nonpoint Source Program and Division of Surface Waters)
Ohio-Kentucky-Indiana Regional Council of Governments (OKI)
USDA - Natural Resources Conservation Service
US Fish and Wildlife
Villages of Gratis and Germantown
Warren County Soil and Water Conservation District

1.5 Twin Creek Advisory Committee

The Twin Creek WAG meetings are held periodically to update activities, events and actions within the watershed. The meetings are typically located at the Preble County District Library in

Eaton Ohio. The meetings are generally 90 minutes in duration and well attended consistently with 10 to 25 members. There are opportunities for unscheduled topics at the end of each meeting and there are updates, discussions and inquires during that time. The Twin Creek WAG continues to build relationships and increase its membership with important and growing stakeholders.

1.6 Decision-making process and endorsements

The Twin Creek watershed project has operated as a collaborative group of organizations, individuals, and agencies with a goal of protecting and improving water quality in Twin Creek and its tributaries. Partners have engaged in decision making process, documents and strategies endorsements and events including education, public outreach and stream monitoring. Since bylaws have not been developed for the Twin Creek Watershed partnership, the decision-making process is informal but consensus driven. The WAG also communicated effectively though emails and phone communications. For the endorsement of the Watershed Action Plan, the draft document has been submitted to the stakeholders which include local governments, soil and water conservation district offices and all the members listed in Table 1-5. Once the draft document was reviewed and endorsed by the stakeholders, the plan was submitted to ODNR for final approval. The TMDL report followed the same decision and endorsement process in addition to the public endorsement protocol.

Chapter 2

WATERSHED PLAN DEVELOPMENT

The Twin Creek watershed project began as a component of a larger project, the Lower Great Miami River - Western Tributaries Project**,** an effort to comprehensively address concerns in four watersheds tributary to the Great Miami River in Southwest Ohio. The Western Tributaries Project was led by a watershed coordinator hired by the Three Valley Conservation Trust (TVCT) through a grant received from the former Ohio Department of Natural Resources' Watershed Planning Program (now Watershed Coordinator Program). Because of coordination and funding challenges inherent in such a large-scale effort, the Western Tributaries project was placed on hold until the completion of the Twin Creek WAP.

Between 2003 and 2007 TVCT developed the Western Tributaries project and the subsequent development of the Twin Creek WAP. The WAP was submitted to ODNR in November 2007 and received conditional endorsement. Since July 2007, Miami University Institute of Environmental Sciences (IES) became the sponsor agency of the Twin Creek Watershed Coordinator (TCWC) for implementing watershed actions. This version of WAP incorporated comments on the November 2007 document and findings and recommendations from the Twin Creek TMDL.

2.1 Watershed Advisory Group Roles and Activities

The roles of the Twin Creek WAG to date have included providing local perspectives on watershed issues, making connections with agencies and individuals that can improve the watershed, and guiding and reviewing the WAP to ensure that it addresses all pertinent concerns. Unlike the Western Tributaries Advisory Board from which it was derived, the Twin Creek WAG lacks formal by-laws neither is it a 501(c) 3 organization. Instead it comprises a group of agencies and individuals interested in the Twin Creek watershed and willing to implement this action plan to safeguard its future. Under the leadership of the TVCT and its watershed staff, the Twin Creek WAG met several times between December 2005 and February 2007. Between July 2007 and March 2010, the group met a total of 18 times. **Appendix A** includes the agencies and individuals whose participation in the Western Tributaries and Twin Creek advisory groups and in technical advisory groups.

2.1.1 Public Involvement and Education/Outreach

Successful implementation of any watershed plan relies on stakeholder involvement and coordination in the planning phase and carried through to implementation. Early in the Twin Creek planning process, the project's watershed coordinator sought out interested landowners and other parties through regular mailings, email, and internet notification. With help from the WAG members, public meetings were held at various locations in the watershed. These focused outreach meetings were open to all watershed residents and interested parties and held in various locations in the watershed to explain the project, review watershed attributes, and encourage participants to express their views. Meeting locations included West Alexandria, Lewisburg, Germantown, and West Manchester. During the meetings, landowners and representatives from local agencies and organizations identified aspects of the watershed they appreciated as well as areas of concern. Areas of appreciation included scenic beauty, the agricultural/rural character of the watershed, its history, wildlife, recreation, water quality, human resources, and good

drainage. Areas of concern included agricultural activities, in-stream or near stream issues, changing land use/development, effectiveness of wastewater treatment systems, distribution of wildlife and other issues that emerged. The compilation of comments from these meetings is in **Appendix B – Public Comments and Outreach Activities**. The watershed coordinator also addressed audiences or prepared displays for several meetings and events to enhance public understanding and awareness. These activities also are listed in **Appendix B**.

2.2 Current and Previous Watershed Protection and Management Activities

The Twin Creek WAP is the first comprehensive plan focused on improving and protecting water quality by implementing best management practices (BMPs) to mitigate nonpoint source pollution in the Twin Creek watershed. Many activities aimed at water quality protection and improvements already are occurring in the watershed or in the larger Great Miami River basin. These activities include initiatives and programs led and, in some cases, mandated by Ohio EPA, ODNR, SWCDs, NRCS, Miami Conservancy District, Miami Valley Regional Planning Commission (MVRPC) and others, as described below. These activities not only have formed a foundation for development of the watershed plan but also that their continuation will be critical to its implementation and success.

2.2.1 Great Miami River Watershed Water Quality Credit Trading Program

Water quality credit trading is a relatively recent concept. In fact, only in late 2006 did Ohio EPA promulgate draft rules for water quality credit trading. Miami Conservancy Districts' 10-year pilot program, however, is already quantifying nutrient reductions occurring throughout the Great Miami watershed. This pilot program began in 2006 focuses on reducing nitrogen and phosphorous run-off throughout the Great Miami River basin. It is coordinated by and managed locally by county SWCDs. The trading program provides opportunities for agricultural producers to receive funds to improve their operations in exchange for implementing nutrient reduction practices on their land. These "on the ground" projects then generate "credits" that wastewater treatment plants can use to meet regulatory requirements. Funding for the projects comes from the wastewater treatment plants and from a grant from the USDA NRCS, which have provided more than $1 million for agricultural projects during the program's first three years. Projects are reviewed and selected by an advisory committee whose members represent wastewater treatment plants, agricultural producers, Ohio Farm Bureau Federation, Ohio Water Environment Association, community-based watershed organizations, SWCDs, ODNR and the NRCS (Miami Conservancy District, 2006). Locally, trading is expected to result in significant benefits, including reductions of other pollutants, improved habitat, enhanced soil carbon storage, and stream bank stabilization (Hamilton 2006). A total of seven projects within the Twin Creek watershed are part of this program resulting in 22,955 lbs of nutrient reductions (http://www.miamiconservancy.org/WQTP/index.asp?data=dataXML.asp)

2.2.2 Great Miami Watershed Targeted Watershed Project

This targeted program, supported by a $700,000 grant received by MCD from USEPA in 2003, covers the entire Great Miami River watershed and supports community-driven initiatives that protect habitat, improve water quality and enhance outdoor recreation. MCD held at least 12 community meetings to bring together watershed organizations and planning commissions to prioritize potential projects and to formulate the grant application. Although none of the specific projects supported by this grant is in the Twin Creek watershed, it is expected that lessons

learned and education materials produced will be applicable to the Twin Creek watershed (Miami Conservancy District 2006b).

2.2.3 Stormwater Management Plans

Each of the five municipal separate storm sewer systems (MS4s) within the Twin Creek watershed has developed a stormwater management plan in accordance with USEPA's Storm Water Phase II Program. These jurisdictions are Carlisle, Germantown, German Township, Montgomery County and Warren County. In conformance with EPA guidelines, these management plans are based on a watershed approach to stormwater management and promote preventative measures, policies and ordinances that protect sensitive areas such as wetlands and riparian areas, minimize impervious-ness, maintain open space, and/or minimize the disturbance of soils and vegetation, especially regarding construction and development (http:// www.epa.state.oh.us/dsw/storm/). In addition to the plans of these five individual jurisdictions, MCD has a stormwater manage-ment plan and has accepted responsibility for implementing Best Management Practices related to public education and outreach, public involvement and participation and the elimination of illicit discharges within the 5-year permit period on behalf of all the five jurisdictions. (Miami Conservancy District 2003).

2.2.4 Federal Agricultural and Forestry Programs

Several federal programs provide assistance to farmers and other property owners in the Twin Creek watershed to improve wildlife habitat and water quality and conserve soil resources. These programs are managed through the county agricultural services agencies including the Farm Service Agency, NRCS and SWCDs. Most programs, as summarized below, are authorized by the 2002 Farm Bill, formally known as the Farm Security and Rural Investment Act.

- **Environmental Quality Incentives Program (EQIP)**
  This program offers financial incentives to install practices that reduce soil erosion and improve water quality on livestock and grain farms. Such practices include waste storage structures, heavy use pads, livestock watering systems, and prescribed grazing systems. Agri-chemical / fertilizer containment facilities and precision nutrient placement / grid sampling are also available for funding. A special EQIP component, the EQIP Forestry Program, emphasizes improving forestland by controlling invasive species such as honeysuckle and wild grapevine. Cost share is available for removal of invasive species and for tree planting. To participate in this program, landowners must have an existing written Forestry Stewardship Plan. According to the Preble SWCD, changes to EQIP under the 2002 Farm Bill, including increased funding, should benefit higher numbers of local farmers than in the past.

- **Conservation Reserve Program (CRP)**
  The Conservation Reserve Program (CRP) provides cost share incentives and soil rental payments for a suite of 27 conservation enhancement practices such as grassed waterways, filter strips, and, more recently, habitat buffers for upland birds (CP33 program). In the CRP, property owners can continuously sign up; applications are approved locally if all eligibility criteria are met. Cost share may be as high as 90% of a set cost with rental payments for 10-15 years based on the length of the agreement. CRP is administered by the Farm Service Agency (FSA) with the NRCS / SWCD offices providing technical assistance.

- **Wildlife Habitat Incentives Program (WHIP)**
  The WHIP program encourages the installation of wildlife habitat practices on private agricultural land by offering cost share incentives and technical assistance. Funding is allocated to applicants based on a ranking score determined by the proposed practices and physical features of the land. Agreements may be made for a 5-15 year period. A wildlife habitat development plan must be followed. Land that is currently enrolled in other CRP, EQIP or similar programs is not eligible for the WHIP program.

2.2.5 Section 319 Nonpoint Source Pollution Control Grants

Ohio EPA, Division of Surface Water, administers the Section 319 competitive grant program, authorized by the Clean Water Act. Federal grant money is available annually to fund projects that address nonpoint source impairments and/or restore impaired waters. Examples of eligible projects include stream and/or wetland restoration, agricultural best management practices, riparian restoration and protection, and conservation easements. No Section 319 grants have been awarded in the Twin Creek watershed, although extensive 319 expertise has been developed in a neighboring watershed through the Stillwater River Watershed Protection Project. A Section 319 grant was awarded to protect 408 acres of land, including two miles of stream frontage, on Indian Creek in the Lower Great Miami Watershed.

2.2.6 Water Resource Restoration Sponsor Program (WRRSP)

The Water Pollution Control Loan Fund (WPCLF) finances publicly-owned wastewater treatment works for new construction or expansion of facilities including treatment plants and collection systems (sewer lines). The Water Resource Restoration Sponsor Program (WRRSP) provides an opportunity for WPCLF funding recipients to finance planning and implementation of projects that address nonpoint source pollution. Although no WRRSP projects have been implemented in the Twin Creek watershed, the following program description offers information that may be useful sometime in plan implementation. Restoration activities under the WRRSP may include riparian buffer acquisition, enhancement, expansion or restoration, conservation easements, riparian zone or wetland buffer extension or restoration, stream bank stabilization/natural channel design techniques and in-stream habitat enhancements/dam removals. WPCLF recipients can initiate projects themselves or sponsor approved projects planned by another group, such as a land trust, park district or other entity with the ability to protect and manage such resources. WRRSP projects are funded by providing the sponsor with an advance refund of its interest payments on the WPCLF loan for its wastewater treatment facilities. In return, the sponsor uses the refunded interest to either implement the project or provide the money through a sponsorship agreement to another entity which implements the project. To further encourage participation in the program, the interest rate on the sponsor's loan is discounted by 0.1 percent (OEPA, 2004).

2.2.7 County Drainage Maintenance Programs

Historically, many agricultural fields in the Twin Creek watershed were drained to enhance crop production by removing excess water from soil and promoting aeration to enhance plant uptake of nutrients. Both ditching and field tiling have been used to drain soils that otherwise would be too wet to farm. As pointed out repeatedly by stakeholders in public participation venues, environmental concerns continue both with ditches and aging tiling systems and their maintenance.

In Preble County, the Drainage Department of the county engineer's office is responsible for the maintenance of 142 ditches under the direction and control of the Preble County Commission. The department also is responsible for the design, calculation of assessments and construction inspection of the county ditches petition by landowners (Preble County Engineers, 2006). Darke County also has approximately 225 agricultural ditches, maintained by the county engineer's office Ditch Maintenance Department while Montgomery County's drainage program is managed through the county's SWCD.

2.2.8 Area wide Water Management Treatment Plans (Section 208 Plans)

Area wide Water Management Treatment Plans focus on wastewater treatment planning and on meeting the requirements of Section 208 of the Clean Water Act. Individual facility plans for wastewater treatment plants are incorporated into the area wide plan. As the designated water quality planning agency for Darke, Greene, Miami, Montgomery and Preble Counties, MVRPC completed a Section 208 plan in 1978 that included the Twin Creek watershed in 1978. MVRPC's Regional Wastewater Facility Planning Areas in the Twin Creek watershed include Eldorado, West Manchester, Lewisburg, Verona, Gratis, and West Alexandria. Likewise, as the designated regional water quality planning agency for the southwestern most counties in Ohio, the Ohio-Kentucky-Indiana Regional Council of Governments (OKI) completed a 208 plan in 1977 that included Warren County**.**

2.2.9 Sole Source Aquifer Designation

Groundwater is an important component of the Twin Creek watershed system. Accordingly, measures to protect groundwater are critical to its quality and quantity. A special measure of groundwater protection to Twin Creek was provided in 1988 when the entire 14-county Great Miami/Little Miami buried valley aquifer system, including all aquifers associated with Twin Creek watershed, was designated as a Sole Source Aquifer (SSA) by USEPA. In summary, SSA designation serves several purposes, including:

- Raising public awareness about the aquifer system, its vulnerability to contamination and the region's dependence on groundwater
- Providing for a review of certain federally financially assisted project to ensure they pose minimal threat to groundwater, and
- Making the region eligible for any applicable federal funds that may become available under the Safe Drinking Water Act.

Groundwater is the source of all drinking water in the Twin Creek watershed. Information on Ohio's Source Water Protection to safeguard public drinking water is further discussed in Chapter 4 and also at the SSA website http://www.mvrpc.org/wq/ssa.php).

In addition, the Miami Conservancy District's Aquifer Preservation Subdistrict was created in 1997 to develop and maintain an ongoing, watershed-wide program to support comprehensive protection and management of the Great Miami River Watershed's groundwater resources. The Twin Creek watershed is located within the Aquifer Preservation Subdistrict which helps communities through grants to develop and implement source water protection plans; provides educational programs; and monitors, analyzes, and reports on the conditions of the aquifer. In addition, it helps citizens collect quality and quantity data on their own private wells through the

Groundwater Monitors and Test Your Well programs. All counties within the Twin Creek watershed had benefitted from the Test You Well program.

2.2.10 Programs to Conserve Land through Conservation Easements

Conservation Easement Donation Program

This program permits unrestricted structuring of conservation easements, while offering tax deductibility opportunities that may be beneficial to certain landowners. Sources of funding can be from the following programs:

Clean Ohio Programs

These four State bond-funded programs offer opportunities for landowners seeking to preserve land for green space or agricultural purposes, and can be used for providing a bargain sale easement grant to farmers or other landowners.

- Conservation Fund- provides green space acquisition funds (last full funding round has occurred); in Butler County, more for land purchases than in Preble, Montgomery Counties. Stream corridors and large forests favored.
- Agricultural Easement Purchase Program- provides farmland preservation easement funding match (2-3 more funding rounds), for a maximum of $500,000 grant per county. These are extremely competitive (1 in 16 chance), and require the land be permanently farmed, better chances for farms nearby many already protected farms, many other applicant farms, farms with excellent soils, etc. These are generally 40% grants
- Brownfields Redevelopment- for cleaning up and re-using abandoned industrial sites.
- Trail Acquisition- for acquiring lands only for trail development. Also extremely competitive.

Federal Farm and Ranch Lands Protection Program

This federal program requires lands be forever agricultural, are extremely competitive (1 in 5 chance), and require the land be permanently farmed, scoring higher for farms nearby many already protected farms, many other applicant farms, farms with excellent soils, etc. These are generally 50% grants that require 25% cash match from someone other than the landowner or his/her family. Funding expires in 2007 with only $800,000-1,200,000 discretionary funding statewide. To date, the TVCT has partnered with NRCS, the Ohio Department of Agriculture, Five Rivers Metroparks and the Ohio Public Works Commission to protect six farms covering 1400 acres, and four miles of stream frontage on Twin Creek and Tom's Run through the FRPP program.

Federal US EPA Section 319 Non-point Source Conservation Easement Funds

This federal program requires that lands be protected from non-point sources of pollution such as storm water or agricultural runoff. These funds are available for organizations to pass through to landowners to protect critical sections of streams from development. There are also funds available for stream enhancement for properties. These funds are difficult to obtain and require extensive documentation of water quality enhancements or pristine corridor protections.

State Water Resource Restoration Sponsorship Program

This US EPA/Ohio EPA competitive program provides funding for enhancing stream corridors and reducing non-point sources of pollution by funding conservation easements and best management practices. The source of funding comes from government conversions of federal loan

repayments from wastewater treatment plant operators that designate specific organizations and projects they sponsor to receive the funds. The sponsoring organizations are often, but not always in the same watersheds. These funds are available for projects such as riparian (stream corridor) easements, or whole property riparian conservation easements where the land is either taken out of production or actively engage in reducing/removing agricultural or other non-point sources of pollution from the property (e.g. breaking field tile combined with reforesting).

Federal NRCS and Fish and Wildlife Service installation programs:

There are a number of programs available for installing habitat, wetlands, grassland, and removing invasive species from properties. These are available with or without easement.

Other Programs

On rare occasions, TVCT uncovers one-time dollars to help landowners meet land protection wishes.

2.3 Organization of the Twin Creek Watershed Action Plan

The remainder of this watershed action plan consists of the following sections:

- **Chapter 3 – Watershed Inventory** includes information on topography, geology and glacial history, soils, biological communities, and land use.
- **Chapter 4 – Water Resources** includes information on climate and precipitation, the Twin Creek stream system, stream habitat, current aquatic life use attainments, stream morphology, flow, groundwater resources and pollution potential, public water suppliers, and source water assessments.
- **Chapter 5 – Watershed Goals** provides background information and problem statement on each goal of the watershed action plan.
- **Chapter 6 – Subwatershed Conditions** presents maps, the attainment statuses, subwatershed conditions, past conservation efforts, and restoration goals and specific actions for the 15 subwatersheds in the Twin Creek watershed.
- **Chapter 7 – Evaluation** summarizes the ultimate performance indicator for the Twin Creek watershed.
- **Several appendices** are included to supplement information in the main text on public participation in the plan, biological communities, conservation easements and other reference materials that may be useful in plan implementation.

Questions or comments concerning this plan should be directed to:

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Chapter 3

WATERSHED INVENTORY

This chapter presents information on the Twin Creek watershed components including its topography, geology, soils, and biotic communities as well as land use condition. Water resources are discussed separately in Chapter 4.

3.1 Topography

The Twin Creek watershed lies within the Eastern Corn Belt Plains ecoregion of Ohio, which is typified by gently rolling glacial till plains including moraines, kames and outwash features (Ohio EPA, 1997). The northern headwaters of the watershed tend to be flat or gentle slope while the southern part of the watershed is characterized by rolling hills. The elevation change in the watershed is slight with a gradient of approximately 9.1 feet per mile, starting at 1,067 feet above sea level in the headwaters and descending to 645 feet near Twin Creek's confluence with the Great Miami River near GM River Mile 57.0 (Ohio Geological Survey, 2005). Some steep ravines are present in the southern portion of the watershed.

3.2 Geology and Glacial History

In the Twin Creek watershed, deposits of glacial till composed of cobbles, gravel, sand, silts, and clays overlay sedimentary bedrock of limestone and shale formations or interbedded limestones and shales. Silurian bedrock deposits (438-408 million years BP) occur in the northern portion of the watershed while Ordovician bedrock deposits (505-438 million years BP) occur in the southern portion (Ohio Geological Survey, 2005). Glacial till, visible as moraines or depositional ridges of glacial outwash, formed lobate ridges according to glacial advance and retreat. Wisconsinian Era (14,000 – 24,000 BP) end moraine and ground moraine compose most of the unconsolidated sediments in the watershed (Ohio Geological Survey, 2005). Drift thickness, the amount of glacial deposition that occurs above bedrock, varies from as thin as 20 feet in the watershed's uplands to as thick as 200 in the outwash areas and bedrock cut valleys that cover ancient river valleys (Ohio Geological Survey 2005.) Because glacial drift or till blanketed ancient river valleys, contemporary surface drainage patterns differ from pre-glacial river systems. The buried river valleys provide excellent drainage and form an interconnected system of aquifers that supplies drinking water to residents and businesses in the watershed. Although the Ohio Division of Geological Survey (2005) does not delineate karst features in the watershed, groundwater movement has contributed to the development of small caves and seeps. Groundwater movement and surface egress to streams also have caused the formation of many seeps and wet areas in the watershed (ODNR, 2005).

3.3 Soils

Upland soils in the Twin Creek watershed are primarily loamy glacial till that are generally high in fertility and have poor to moderate drainage. The dominant upland soil association consists of Miamian-Celina clay and silt loams. It is cultivated in large acreages and is important to farming in the watershed. The control of runoff and soil erosion is the main concern in managing this soil for farming while moderately slow permeability and slope are the dominant limitations to many nonfarm uses (USDA, 1976). Soils along the main stem of Twin Creek primarily are derived from fine to coarse-grained floodplain deposits that overlie older alluvial or outwash sediments. Such floodplain soils tend to be fertile and well-drained. Important

alluvial/outwash soils of the watershed include the Ross-Medway and Fox-Ockley associations. Both soil associations are suitable for row crop agriculture and livestock farming; they tend to be highly erodible in riparian areas. Soils of the Ross-Medway association are deep, loamy, and dark-colored. Formed in loamy alluvium, they are generally well drained and tend to have a moderately coarse to medium textured subsoil. Soils of the Fox-Ockley association are underlain by thick deposits of sand and gravel and serve as a prime source for sand and gravel for construction. Soils in this association are well drained and have a moderately textured subsoil (USDA, 1976, Debrewer, 2000; Montgomery and Preble Soil and Water Conservation Districts, 2005). Soil maps showing drainage classes, highly erodible land, flooding frequency, soil slopes and hydric soils were generated using ArcMap and Soil Data Viewer with instructions by ONDR (http://www.dnr.state.oh.us/H_Nav2/Soils/OhiosSoils/OhioSoilsinaGIS/tabid/17897/Default.aspx). These maps depict the areas of potential wetland and erodible lands that are useful in targeting projects for restoration and BMPs (Figures 3-3.1-.3-3.5)

FIGURE 3-3.1
Drainage Classes

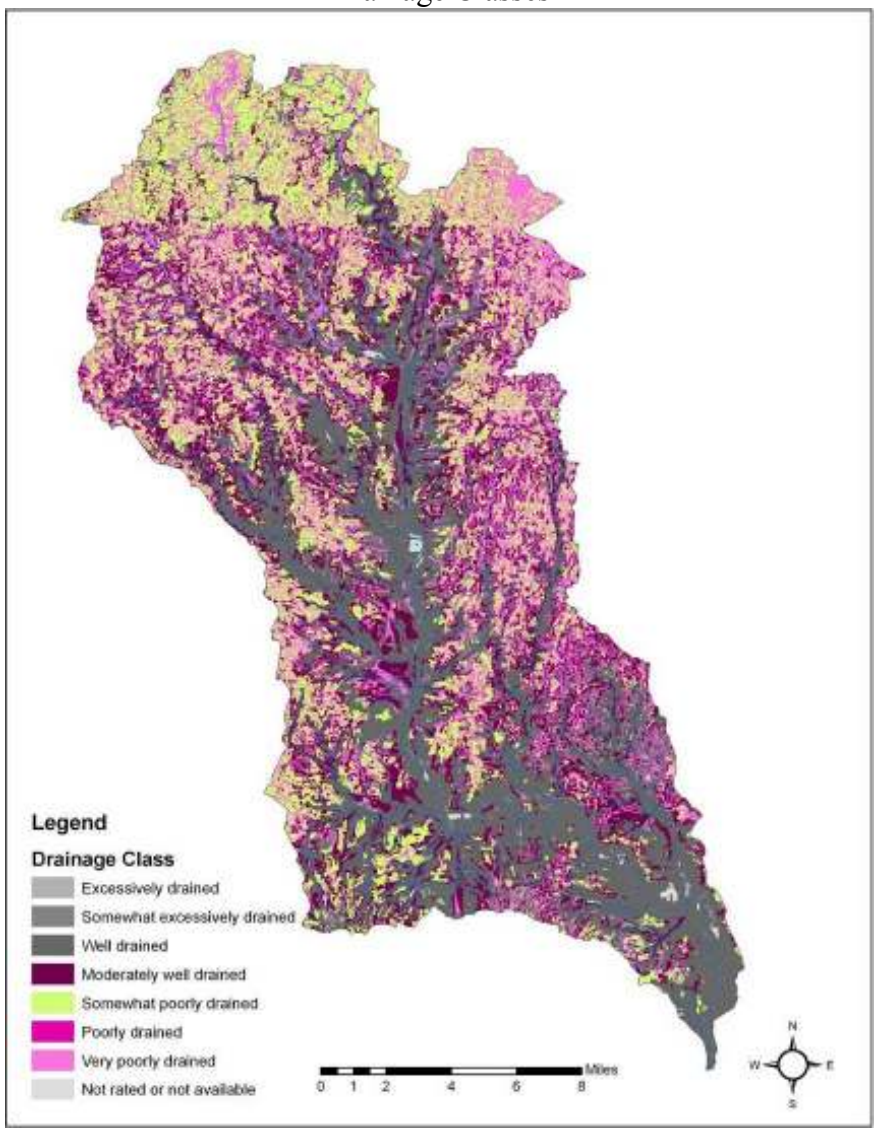


FIGURE 3-3.2
Highly Erodible Soils

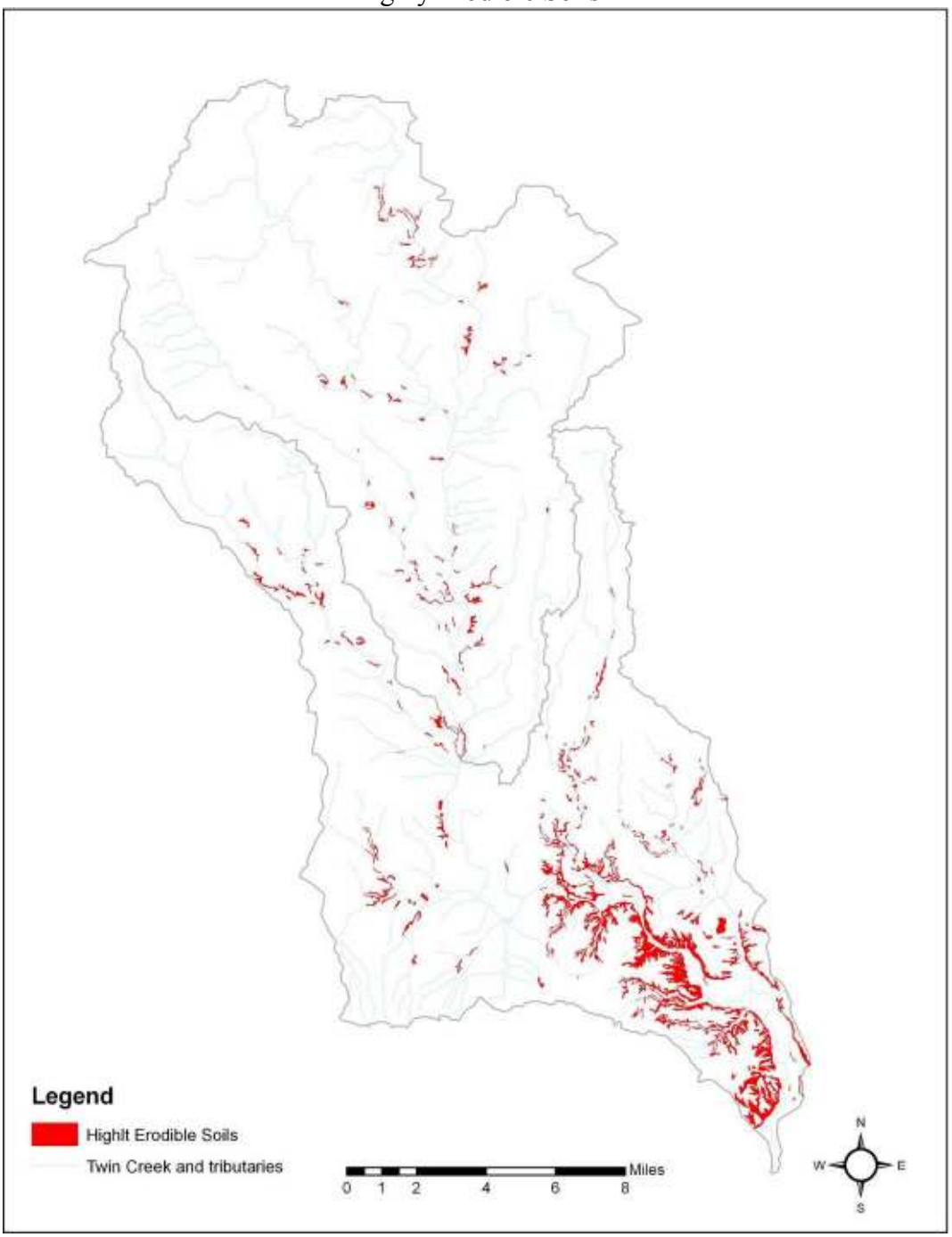


FIGURE 3-3.3
Flooding Frequency

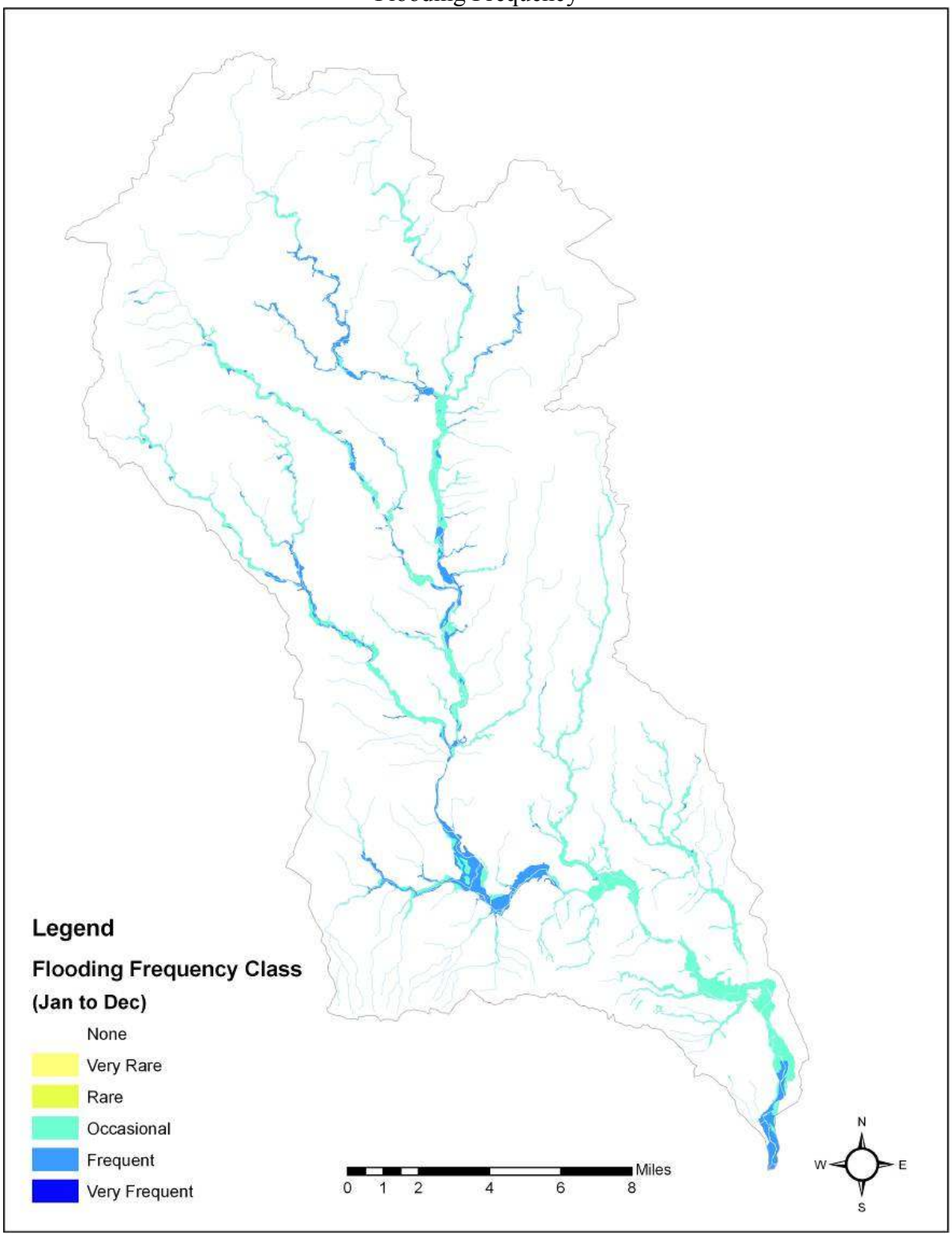


FIGURE 3-3.4
Hydric Soils

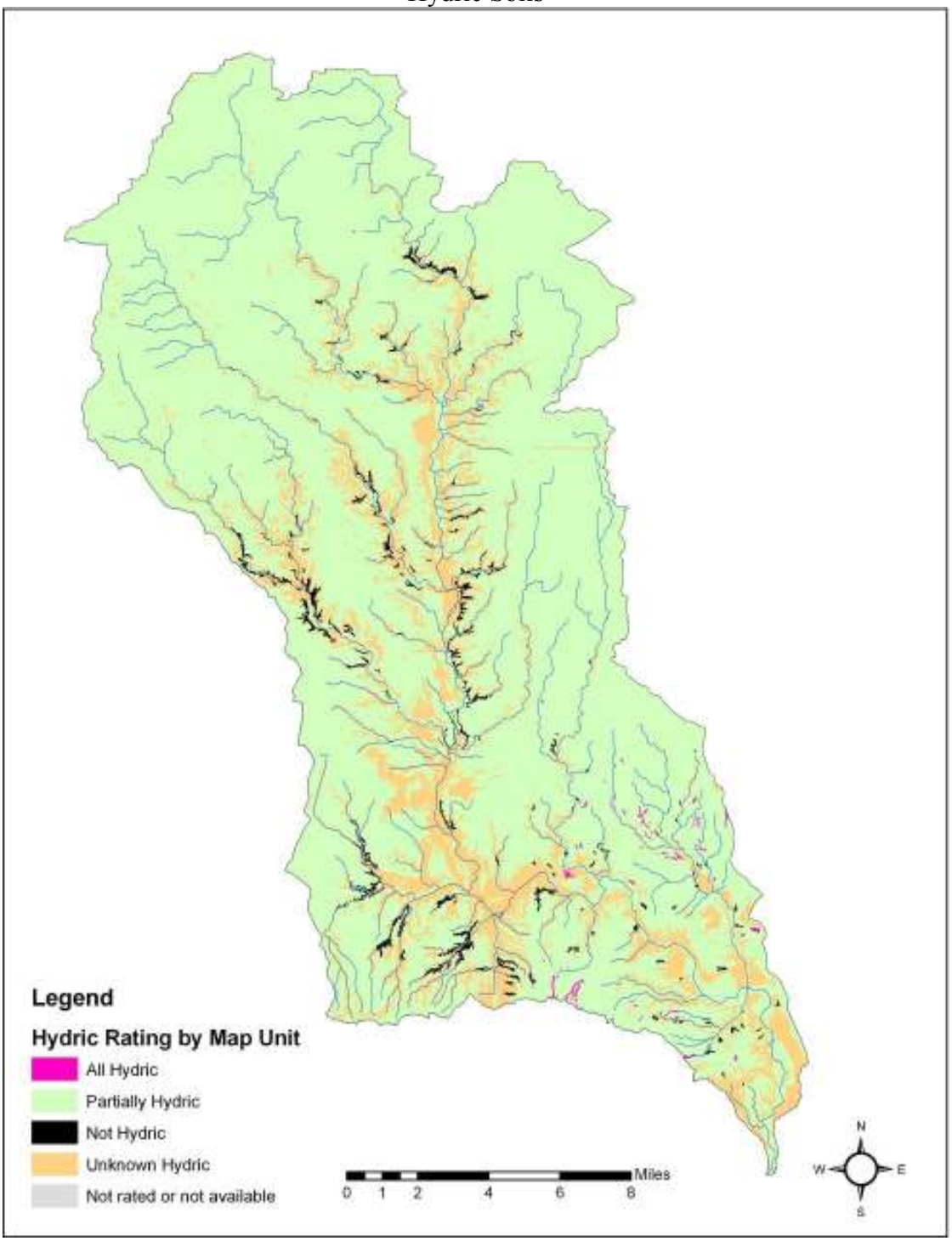
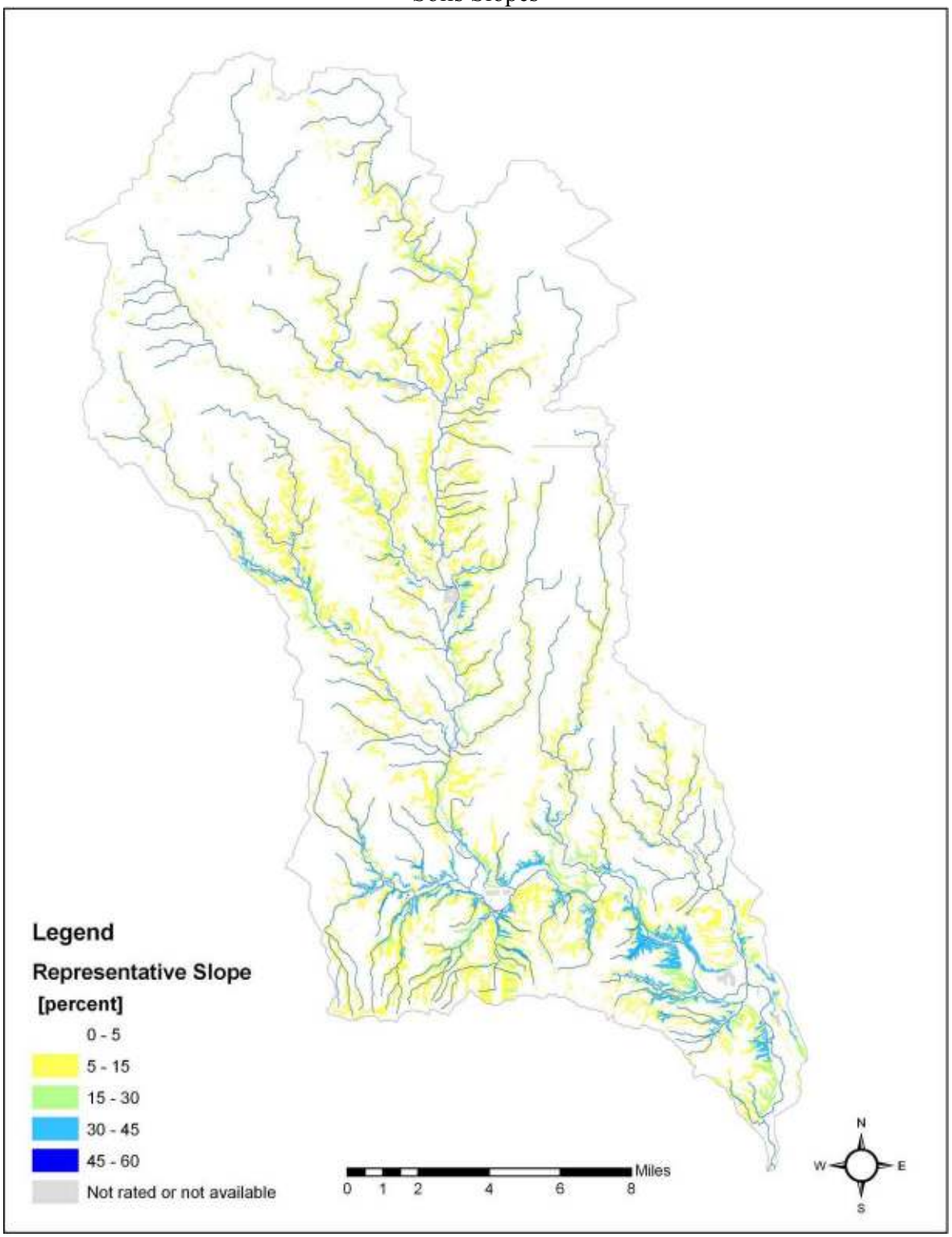


FIGURE 3-3.5
Soils Slopes



Source: Computerized Soils Information (SSURGO) 2006

3.4 Biological Communities

Twin Creek is known for its highly diverse and intact aquatic community. Biodiversity is an indicator of community health, illustrating the range of organisms, often including those intolerant to disturbance, that have adapted to live in a given watershed. Both Ohio EPA and the Nature Conservancy have noted that Twin Creek has retained most of its original species. Studies have found a number of species of live mussels in three different areas within Twin Creek. In addition to these aquatic organisms, the largely rural watershed supports diverse assemblages of terrestrial plants and animals.

3.4.1 Rare, Threatened and Endangered Species

Several rare, threatened, and endangered plant and animal species are known from the Twin Creek watershed and have some level of state or federal protection or concern (Table 3-1).

TABLE 3-1
Rare, Threatened and Endangered Species

Category	Common Name	Scientific Name	Level of Protection
Mammal	Indiana Bat	*Myotis sodalist*	Federally Endangered
Birds	Chuck-will's widow	*Caprimulgus carolinensis*	State Sp. of Special Interest
	Sharp-shinned hawk	*Accipiter striatus*	
Reptiles	Kirtland's Snake	*Clonophis kirtlandii*	State Threatened
	Massasauga	*Sistrurus catenatus catenatus*	Federal Endangered Cand.; State Endangered
Fish	Rosyside dace	*Clinostomus funduloides*	State Threatened
Dragonfly	Blue Corporal	*Ladona diplanata*	State Endangered
Crayfish	Sloan's Crayfish	*Orconectes sloanii*	State Threatened
Mussels	Elktoe	*Alasmidonta marginata*	State Species of Concern
	Sharp-ridged Pocketbook	*Lampsilis ovata*	State Endangered
	Threehorn Wartyback	*Obliquaria reflexa*	State Threatened
Plants	Western Hairy Rock Cress	*Arabis hirsute var. pycnocarpa*	State Endangered
	Snowy Campion	*Silene nivea*	State Endangered
	Soft-leaved Arrow-wood	*Viburnum molle*	State Threatened
	Small-Fringed Gentian	*Gentianopsis detonsa*	State Potentially Threatened
	Missouri gooseberry	*Ribes missouriense*	State Threatened
	Butternut	*Juglans cinerea*	State Potentially Threatened
	Carolina Willow	*Salix carolineana*	State Potentially Threatened
	Southern Wapato	*Sagittaria montevidensis*	State Potentially Threatened
	Midland Sedge	*Carex mesochorea*	State Threatened
	Wood's-hellebore	*Melanthium woodii*	State Threatened
	Lesser Ladies Tresses	*Sprianthes ovalis*	State Potentially Threatened
	Three-birds Orchid	*Triphora trianthophora*	State Potentially Threatened

SOURCES: Ohio Department of Natural Resources 2006; Ohio EPA 1997; Wendeln 2005

3.4.2 Fish

Twin Creek supports one of the most impressive fish faunas in Ohio. The 1995 biological assessment of Twin Creek and its tributaries indicated that in Ohio only Big Darby Creek attains slightly higher fish community and physical habitat scores over a 40-mile reach (Ohio EPA 1997). The more than 70 species of fishes found in the Twin Creek watershed are found in Appendix C, Table 2. Twin Creek watershed's fish community is considered to be appropriately and exceptionally diverse and close to presettlement or low impact conditions (Bouchard 2005, personal communication, and Ohio EPA 1997). Fishes found in riffle/run communities include a diverse assemblage of darters, madtoms and other benthic species indicative of high habitat value and water quality. Similarly, diverse assemblages of redhorses and carpsuckers are documented for the Twin Creek system; these assemblages attest to a watershed's overall excellent water quality and habitat (Kimmel and Argent 2006). A variety of panfish and game fish occur in the watershed and include bluegill, pumpkinseed, longear sunfish, rock bass, smallmouth bass and largemouth bass. Among species noted as numerous below Germantown Dam are channel catfish, yellow bullhead and largemouth bass. Although not officially considered as rare, threatened or endangered, species, ten species of fish that are declining in population throughout Ohio also have been found in Twin Creek, including the least darter, a species of special concern in Ohio (Table 3-2).

TABLE 3-2
State Declining Species of Fish Occurring in the Twin Creek Watershed

Common Name	Latin Name
Bigeye chub	*Notropis amblops*
Blacknose shiner	*Notropis heterolepis*
Brindled madtom	*Noturus miurus*
Creek chubsucker	*Erimyzon oblongus*
Hornyhead chub	*Nocomis biguttatus*
Least darter	*Etheostoma microperca*
Mimic shiner	*Notropis volucellus*
River chub	*Nocomis micropogon*
Rosyface shiner	*Notropis rubellus*
Southern redbelly dace	*Phoxinus erythrogaster*

SOURCE: Ohio Environmental Protection Agency 1997

3.4.3 Freshwater Benthic Macro invertebrates

Macro invertebrates are key components of aquatic system health and biodiversity. This varied group includes organisms that lack backbones; although small, macro invertebrates can be seen without the aid of a microscope. Included are crayfish, bivalves (fingernail clams and freshwater mussels), univalves (snails), segmented worms, and a wide array of larval emergent aquatic insects. In addition to their intrinsic value and importance as food for fish and other life forms, freshwater invertebrates play a critical role in the flow of energy and nutrients in aquatic ecosystems.

The species composition, species diversity and abundance of macro invertebrates in a given water body can provide valuable information on the relative health and water quality of a waterway. Macro invertebrate quality evaluations are based on the principle that invertebrate communities of non-degraded streams are composed of many different types of organisms, including pollution intolerant taxa such as mayflies, stoneflies, and caddis flies (Ephemeroptera, Plecoptera, and Trichoptera). The invertebrate communities of polluted streams, on the other hand, are dominated by a small number of pollution tolerant taxa such as sludge worms and bloodworms (Annelida and Chironomidae). Between the extremes are numerous organisms with intermediate tolerances. This information underscores the significance of the Ohio EPA's (1997) description of the Twin Creek watershed as having "the most exceptional macro invertebrate community in the state". This assessment was not only based on the number and diversity of organisms, but also on the occurrence of macro invertebrates that are highly intolerant of pollution or disturbance, including water penny larvae, mayfly and stonefly nymphs, and caddis fly larvae. Pollution intolerant dobsonfly larvae (hellgrammites) are also found in Twin Creek in the spring. The stream system's excellent aquatic resources appear to be associated with a largely intact riparian zone, perennial groundwater flow, and moderate gradients resulting in moving water (OEPA 1997, 2007, 2010).

Two rare mayfly species and four other intolerant and naturally rare macro invertebrate species have been found in Twin Creek, including a fishfly and two caddis flies. Such organisms thrive in cool, fast-flowing riffles or runs. A river beetle known to exclusively prefer high-quality habitat was also found during the 1995 Ohio EPA sampling, as were six unusual midge fly larvae Macro invertebrate communities with lower population densities composed of pollution or disturbance-tolerant species were found downstream of several large confined livestock operations, wastewater treatment plants, or failing septic systems in the watershed. At one site downstream from a poorly managed construction site, three species of pollution tolerant midges occurred (OEPA, 1997). When intolerant species are disturbed or removed from a stream segment, their ecological functionality (for example, consuming or shredding organic materials) either is un-replaced at a cost of efficiency to the system or is replaced at a lower efficiency by more pollution-tolerant creatures. After an intolerant or rare species is replaced, it is often harder for that species to regain a foothold in a competitive environment. The aquatic macro invertebrate community cited by OEPA (1997) includes 324 species. A complete list of these organisms is included in Appendix C, Table 1.

3.4.4 Freshwater Mussels

Freshwater mussels also are aquatic macro invertebrates of high value as indicators of environmental health. Because historically rich native freshwater mussel faunas have been declining throughout the Midwest and other parts of the U.S., the condition of the freshwater mussel community in Twin Creek merits special consideration. According to Watters (1992), the mussel community of the Twin Creek watershed is appropriately diverse for a watershed its size. Fifteen species of freshwater mussels were collected from 36 sites during a 2004 survey of 47 miles of the Twin Creek main stem. Live specimens of nine species were documented (Table 3-3). Diversity was highest at New Market, where 69 individuals representing five species were found. Only shells were found for the sharp-ridged pocketbook, listed by the Ohio DNR as endangered in Ohio, and the elktoe, listed as an Ohio Species of Special Concern. Two large stream segments above and below Germantown MetroPark did not contain any live mussels. (Wendeln 2005). Mussels from the Twin Creek watershed more closely associated with smaller

streams include the elktoe, fluted shell and rainbow. Mussels from the Twin Creek watershed more closely associated with larger streams include the slippershell, sharp-ridged pocketbook, creek heelsplitter, and wavy-rayed mussel (Cummings and Mayer 1992).

TABLE 3-3
Mussels Occurring in the Twin Creek Watershed

Scientific Name	Common Name	Status
Alasmidonta marginata	Elktoe	Shells only
Alasmidonta viridis	Slippershell	Alive
Anodontoides ferussacianus	Cylindrical Papershell	Shells only
Elliptio dilatata	Spike	Alive
Lampsilis cardium	Plain Pocketbook	Alive
Lampsilis ovata	Sharp-ridged Pocketbook	Shells only
Lampsilis radiata luteola	Fat Mucket	Alive
Lasmigona complanata	White Heelsplitter	Alive
Lasmigona compressa	Creek Heelsplitter	Alive
Lasmigona costata	Fluted Shell	Alive
Ptychobranchus fasciolaris	Kidney Shell	Shells only
Pyganodon grandis	Giant Floater	Alive
Strophitus undulatus undulatus	Creeper	Shells only
Villosa iris iris	Rainbow	Alive
Lampsilis fasciola	Wavy-rayed Lampmussel	Shells only

SOURCE: Wendeln 2005

3.4.5 Reptiles and Amphibians

A diverse group of reptiles and amphibians inhabits the Twin Creek watershed (see Appendix C, Table 3). The watershed's smaller headwater and intermittent streams especially serve as critical habitat for amphibians (OEPA, 2002). Stream reaches or feeder areas such as seeps that do not support fish populations are ideal breeding and habitat locations for frogs and salamanders. Amphibians also colonize small vernal pools found in watershed riparian areas. OEPA (2002) noted that amphibians became the primary predators in fishless areas with intermittent streams.

Salamanders that live in headwater stream areas where there is constant water flowing may live as juveniles for more than a year. These species include the two-lined salamander (*Eurycea bislineata*), and long-tailed salamander (*Eurycea longicauda*). The Northern Red salamander (*Pseudotriton ruber ruber*) also may inhabit parts of the watershed. Given the number of seeps and springs, as well as limestone caves in the northern section of the watershed, cave salamanders (*Eurycea lucifuga*) that occur in other watersheds around the region also may be found in the Twin Creek watershed (OEPA, 2002; Natureserve 2005c). Small streams, headwater streams, or intermittent streams also support salamanders that live as juveniles for less than 12

months. These faster-growing salamanders may include the streamside salamander (*Amystoma barbouri*), the Northern dusky salamander (*Desmoganathus fuscus fuscus*), and the Four-toed salamander (*Hemidactylium scutatum*) (Ohio EPA 2002). Spring peeper (*Acris crepitans*) and Northern cricket frogs (*Pseudacris crucifer*) also are known from the watershed and inhabit wet areas and seeps.

Among the snakes included for the watershed are Kirtland's snake (*Clonophis kirtlandii*) listed as threatened in Ohio, and the Eastern massasauga (*Sistrurus catenatus catenatus*), listed as endangered in Ohio and as a Federal Endangered Candidate Species. Although the Eastern massasauga has not specifically been documented for the Twin Creek watershed, it has been spotted in Montgomery and Preble counties (Szymanski 1998) and is known to occur in the wet riparian habitat types afforded in the Twin Creek watershed.

3.4.6 Indiana Bats

In January 1996, it was discovered that Lewisburg within the Twin Creek watershed has the largest colony of hibernating bats in Ohio. A total of 25,319 bats were counted that year in the abandoned mine including 9,298 Federally-endangered Indiana bat (*Myotis sodalis*). It was concluded that the Lewisburg mine was a Priorty 2 hibernaculum. Priority 2 indicates that the site has a current or historic population of 1,000 or more Indiana bats (Priority 1 being the best and considered essential to recovery of the species). A hibernaculum is defined as a site, usually a cave or a mine, where bats hibernate during winter. A total of six bat surveys of the Lewisburg mine have been completed since 1996. Table 3-4 below shows the diversity between sections and where different bats were found between 1996 and 2006.

TABLE 3-4
Lewisburg Limestone Mine Survey

Species	1996	1998	2000	2002	2004	2006
Indiana Bat	9,298	9,292	9,638	9,623	9,436	7,405
Little Brown Bat	14,205	16,629	21,572	25,270	16,628	18,073
Eastern Pipistrell	1,442	593	1,428	1,442	1,866	950
Northern Bat	1	19	10	324	323	215
Big Brown Bat	373	226	148	159	59	74
Total	**25,319**	**26,760**	**32,796**	**36,818**	**28,312**	**26,717**

Data provided by Jason Duffy of ESI Inc.

Scientific literature suggests that Indiana bats find temperatures between 36 and 43 degrees optimal. Bats, in general, start showing up at the hibernacula as early as September. Some species may stay near the mine year round. The endangered Indiana bat uses both strategies. Males may stay near the mine year round roosting in the mine less often and spending the majority of their time roosting in nearby trees. Females are more likely to disperse along the Twin Creek drainage moving into bottomland hardwood forests where they can find large trees with loose bark. Female Indiana bats generally form maternity colonies under the bark where groups of 10 to 250 bats may aggregate in order to help keep roost temperatures high for young of the year pups. Males do not help in rearing of young. This seems to work because the female only has one pup per year. This allows the mother to concentrate on only one mouth to feed (quality not quantity). This breeding strategy also attributes to their low numbers rangewide.

As of 2007 there were an estimated 513,398 Indiana bats within its range (eastern United States). Historically, there were upwards of 1 million. Increased awareness of habitat needs for winter and summer have helped the Indiana bat increase its population from the low of 362,194 in the 1990s. While since the first survey in 1996, the Lewisburg Priority 2 Hibernaculum has fluctuated in numbers of Indiana bats as well as total number of bats in general. This is consistent with increases and decreases at other hibernacula rangewide and is likely a natural ebb and flow of the population. Surveys are generally conducted every two years and ongoing population data from the Lewisburg mine will prove to be important in understanding the population changes in Indiana bats as well as bats in general. While Ohio has only 1.5 percent of the Indiana bat population, its neighbors--Indiana and Kentucky--have 46.4 and 13.4 percent, respectively. The Twin Creek Watershed is unique in that it is host to Ohio's largest population of hibernating bats, it has one of the most diverse streams in Ohio, and has a mosaic of landuse types and habitats available. All of these factors provide for a rich diversity of aquatic and terrestrial wildlife. The continued significance and uniqueness of the watershed is dependent on water quality, the presence of a good riparian zone, and soil conservation from erosion factors.

3.4.7 Birds

Among the birds with potential occurrences in the Twin Creek watershed listed in Appendix C, Table 5 are the sharp-shinned hawk (*Accipter striatus*), a species of special concern in Ohio because of its rare breeding status, and Chuck-will's widow (*Caprimulgus carolinensis*), a species of special interest in Ohio because its occurrence is unexpected. Both species have been reported along Twin Creek in the Germantown MetroPark. Other rare birds observed in the watershed are the peregrine falcon and osprey. Neotropical migrant birds also occur in the watershed's forested areas and perhaps deserve the most management attention. Creation and enhancement of grassland habitat in the watershed may be beneficial to several other bird species declining the in the Midwest (Sam Fitton, personal communication.)

3.4.8 Plants

Terrestrial plant communities, including trees, shrubs, and groundcover that compose native forests in the Twin Creek watershed, have been classified generally as mixed mesophytic, which includes a variety of plants that thrive in moderately moist conditions. Further, these forests can be divided into three main types: upland, slope, and riparian or streamside. All are dominated by a variety of hardwoods. Upland communities and slope communities are generally well drained and composed of diverse shrub and small trees. In contrast, riparian forests are slower to drain, soils remain wetter for longer periods of time, and they have a more diverse herbaceous or groundcover layer. Native plant communities in the Twin Creek watershed include the Beech Maple Forest in the uplands and the Silver Maple - Elm - (Cottonwood) forest in riparian areas. Species present within each of these communities are listed in Appendix C, Table 6.

3.4.9 Invasive Nonnative Species and Their Potential Impacts

The Twin Creek watershed includes several invasive nonnative species. While all nonnative plants are known to compete with native plants, Amur honeysuckle is probably the most pervasive invasive plant in the watershed. Colonizing both uplands and riparian areas, honeysuckle competes with native grasses, herbs, and trees and lowers the biodiversity level in forests. With less groundcover or significant root systems, soils on lands colonized by honeysuckle are more prone to erosion. Because honeysuckles prefer edge areas, fragmentation of forests through farming, development and road construction leads to additional colonization

while interior mature forests are less prone to invasion. The herbaceous plant garlic mustard also occurs throughout the watershed and has colonized most riparian areas. As with honeysuckles, garlic mustard out competes the native herbaceous layer and lowers the biodiversity on the floodplain. Table 7 in Appendix C provides a list of invasive plants known to occur in Southwest Ohio and expected to occur in the Twin Creek watershed. Several species of nonnative animals are likely inhabitants of the Twin Creek watershed. The Asian clam (*Corbicula fluminea*) was introduced to the area in the 1800s, but has naturalized and it is no longer a native species. Several nonnative fish species also have been introduced or released into the Great Miami and Little Miami River basins since the 1700s. According to Harrington (1999), the common carp, goldfish, and redear sunfish are well established while the American eel, white catfish, eastern banded killifish, western mosquitofish, and brook trout are somewhat established, but occur in very few areas. These fishes have stable populations that do not seem to interfere with native fishes.

3.5 Land Use

3.5.1 Overview of Land Use in the Watershed

Agriculture is the predominant land use in the Twin Creek watershed and will continue to be for the foreseeable future. Table 3-5 indicates approximately 75 percent of watershed land use is agricultural, 10 percent is residential, and 7 percent is forested (Birck et al., 2005). Only about 2 percent of the watershed is commercial while the remainder consists of open land that is neither farmed nor forested. Commercial sand and gravel operations also are scattered along streams in several locations throughout the watershed. Compared with much of Southwest Ohio, the Twin Creek watershed includes considerable green space.

TABLE 3-5
2000 Land Use Cover in the Twin Creek Watershed
(% of watershed area)

Agriculture	75%
Light Residential	8%
Forests	7%
Heavy Residential	2%
Commercial	2%
Open Water	2%
Wetlands	<1%
Shrublands/Grasslands	<1%
Barren/Transitional	<1%

SOURCE: Birck et al. 2005.

3.5.2 Agricultural Practices and Uses

Cultivated tracts interspersed with residences and forested tracts characterize most of the Twin Creek watershed, creating a rural feel throughout most of the Twin Creek watershed. Commercial growth and subdivision development do not appear to be occurring at the

accelerated pace seen elsewhere in Southwest Ohio. Many working farms still contain woodlots, though much reduced in size. Riparian reforestation and wildlife habitat funding programs have been moderately successful in the watershed and have helped retain forested land. Much of the watershed's land is considered "Naturally Prime Farmland" or "Prime Farmland with Conditions" (Miami Valley Regional Planning Commission 2005). "Naturally Prime Farmland" describes soils with level or nearly-level slopes, not highly erodible, typically well drained and not frequently flooded during the growing season. "Prime Farmland with Conditions" describes soils requiring acceptable artificial drainage practices for seasonally high water tables and/or protection from frequent flooding during growing seasons.

Conservation practices supported by watershed Soil and Water Districts include a combination of tiling, grass filter strips, and outfall armoring (Jackson, 2005; Bunger, 2005). Historically, tile systems were extensive in the watershed and drained directly to a receiving stream while agriculture fields bordering streams did not have riparian buffers. Currently, most riparian corridors in the watershed are described as "moderate" (10-50m) to "wide" (>50m) (OEPA, 1997).

3.5.3 Row Crops

Agricultural lands consist mainly of corn and soybean row crops (National Agricultural Statistics Service 2002). The Ohio Department of Agriculture's most recent report (2005) lists Darke County as the state's leading producer of corn for grain and of soybeans. A tillage survey completed for Preble County from 1994-2004 (Preble Soil and Water Conservation District 2004) indicates that 94% of soybeans and 49% of corn were in conservation tillage including no-till, ridge till, mulch till with 30% residue. Chemical use patterns and irrigation data for these crops are not readily available for the watershed.

3.5.4 Livestock

Specific livestock inventories have not been completed by watershed, but an informal driving survey conducted by staff of the Three Valley Conservation Trust did not find a significant number of livestock operations within Twin Creek watershed. Darke County, as a whole however, is listed in the US Department of Agriculture's most recent report (2008) as second in hog production among Ohio counties. At several sites in the watershed, cattle seemed to have direct access to streams running through pasture land. County livestock production data are included in Table 3-6.

TABLE 3-6
2008 Livestock data for Twin Creek Watershed

County	Cattle	Milk Cows	Hogs
Preble	16,400	1,300	51,600
Montgomery	8,400	-	9,800
Darke	32,800	7,600	236,600

SOURCE: http://www.nass.usda.gov/QuickStats/Create_County_Indv.jsp

3.5.5 Forested Areas and Riparian Corridors

Riparian forests play a key role in protecting water quality by stabilizing banks, shading streams, absorbing nutrients, filtering pollutants, decreasing runoff, and increasing groundwater

recharge (Dragoo, 2004). While general land use data exist for the watershed, a more detailed inventory of forests and riparian forests has not been undertaken. Qualitative Habitat Evaluation Index (QHEI) results recorded by Ohio EPA and reported in the Water Resources chapter of this plan provides limited information on the condition of riparian corridors. While an informal driving survey found that cultivation along the banks of streams is not uncommon, particularly along small headwaters, the width of riparian buffer strips seems to improve with higher stream orders.

3.5.6 Protected Lands

Protected lands in the watershed include parkland, historic properties, and numerous conservation easements. Some of the parks are large enough to illustrate the ecological communities typical of this portion of Southwest Ohio.

3.5.6.1 Parks

Five Rivers MetroParks of Montgomery County has three large parks within the Twin Creek Watershed:

- Germantown MetroPark (1,483 acres)
- Twin Creek MetroPark (approximately 1000 acres)
- Upper Twin Creek Preserve (470 acres)

These parks are located in the southern portion of the watershed near Germantown and border the mainstem of Twin Creek. Within Germantown Park is the Germantown Dam, constructed after devastating floods in the Dayton area in 1913. The land above the dam includes the 640-acre Germantown Reserve, owned by the Miami Conservancy District and managed by Five Rivers MetroParks.

Preble County Park District's lands include an approximately 100-acre tract of mixed farmland and forest located in Lewisburg for which a master plan has been developed and a newly constructed wetland. Hiking trails and an historical home are also are part of the Allen and Adaline Garber Nature Center in Lewisburg. In addition, a 225-acre partially forested tract near Gratis along Aukerman Creek surrounding an historic farmhouse is open to the public and operated by the Preble County Historical Society. The Preble County Historical Society also restored a wetland on their property in 2009. No national or state parklands occur in the watershed.

3.5.6.2 Conservation Easements

Conservation Easements are permanent protections of land and water resources to protect vital and substantial conservation values such as habitat, stream quality, protection of rare, threatened or endangered species, as well as agricultural and historical values. By doing so, the easement donor limits or excludes development activities such as subdivisions, shopping centers and gravel quarries. Conservation easements keep working and habitat lands in private hands, but offers protection from development similar to that of a park (although parks are not always permanent in nature). These restrictions run with the land, and are required to be actively monitored on a yearly basis by the easement holder. The easement holder is frequently a nonprofit land trust or a government entity.

Many of the conservation easements held by nonprofit or governmental entities require that certain best management practices be used by the landowner as part of a Whole Farm

Conservation Plan developed by the Natural Resources Conservation Service, an active management plan through US Fish and Wildlife Service, habitat enhancement through the soil and water conservation districts and habitat groups such as Pheasants Forever and Quail Unlimited.

Five organizations independently hold easements in the Twin Creek watershed. Some easements are held jointly by the Three Valley Conservation Trust and the Ohio Department of Agriculture or Five Rivers MetroParks. Some are held solely by Three Valley Conservation Trust, Five Rivers Metroparks, Montgomery County Soil and Water Conservation District, and Clay Township.

The Three Valley Conservation Trust has identified the Twin Creek watershed as one of four watersheds to focus its efforts to establish both agricultural and conservation easements. This focus and a partnership with Five Rivers MetroParks increase the likelihood that additional properties will be protected in the future.

3.5.6.3 Flood Easements

MCD holds approximately 8,000 acres of flood easements in the retarding basin of the Germantown Dam (Doran, 2006). This basin is the land upstream of the dam and below the dam's spillway elevation. The easements allow MCD to flood the land during high-water events, control development and activities, and access the property for inspection (Miami Conservancy District 2006d).

3.5.7 Cultural Resources

The Twin Creek watershed has a rich cultural heritage spanning centuries. Native American earthworks and graves have been found near Banta's Fork and Twin Creek in Lanier Township (Sell-Hiestand and Gilbert, 1992). Further, the Hopewell culture created earthworks, known as Carlisle Fort, which are within Twin Creek MetroParks (Birck et. al., 2005). Early European settlers arrived in the late 18th century and took advantage of the fertile soil surrounding Twin Creek. Agricultural drainage systems in this area were installed and "drainage maintenance" programs established as early as 1864 (Keehner, personal communication). Over 39 "century farms" that have remained in the same family for over 100 years are located in the Twin Creek watershed (Birck et. al., 2005).

The largest community in the watershed, the village of Germantown, was founded in 1814 and still includes several historic homes and buildings. Twin Creek watershed also includes several historic covered bridges including the Geeting Bridge (1894) over Price's Creek in Monroe Township, the Warnke Bridge (1895) over Swamp Creek in Harrison Township, and Brubaker Bridge (1887) over Aukerman Creek in Gratis Township. A unique inverted bow string covered bridge, which formerly spanned Twin Creek, now spans Little Twin Creek in Germantown, as described in Valley View Online (http://www.vvonline.com/government/germantown.html). All the watershed's covered bridges are designated as National Historic Sites and some are still in use.

Chapter 4
WATER RESOURCES

This section discusses the water resources within the Twin Creek Watershed including climate, and surface water and groundwater resources.

4.1 Climate and Precipitation

Climate heavily influences watershed biotic communities, streamflow magnitude and timing, water temperature, and other key watershed characteristics. The Great Miami Valley receives an average of 38.3 inches of precipitation annually with approximately 57% of rainfall occurring from March through August (Table 4-1). Thunderstorms occur 38 days annually, on average, primarily in May through August. The average seasonal snowfall is 29 inches with most occurring in January. The Miami Valley also experiences freezing rain or hail on average once per year. The average temperature is 52 degrees F. with an average of 157 days warmer than 70 degrees F. On average, the temperature equals or exceeds 90 degrees F on 17 days per year and is lower than 10 degrees on 18 days per year. The average wind speed in the Twin Creek watershed is 11.5 miles per hour with prevailing winds from the south-southwest.

TABLE 4-1
Long Term Precipitation Averages for Great Miami River Basin

Month	Average Precipitation	Average Runoff
January	2.72"	1.58"
February	2.21"	1.5"
March	3.3"	1.94"
April	3.7"	1.81"
May	4.06"	1.36"
June	4.06"	1"
July	3.87"	0.7"
August	3.26"	0.45"
September	2.81"	0.29"
October	2.57"	0.33"
November	3"	0.6"
December	2.74"	1.04"
SOURCE: Miami Conservancy District 2000		

4.2 Surface Water Resources

4.2.1 Wetlands

The U.S. Fish & Wildlife Service (USFWS) defines wetlands as transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water (http://www.census.gov/acs/www). Concerns related to the Twin Creek watershed's diminishing wetland resources include loss due to conversion for agricultural use or development projects, decline in quality due to modifications on adjacent lands, inappropriate and unauthorized filling, and fragmentation. Most natural wetlands in the Twin

Creek watershed were likely lost with the installation of field drainage systems that began as long ago as the early to mid 19th century. Wetland restoration on declining agricultural land can improve habitat for native species, reduce flooding, and improve water quality. The amount of undisturbed wetland habitat remaining in a watershed is one measure of the health of its water resources. Currently wetlands in the Twin Creek watershed account for less than 2 percent of the total land cover. Three categories of wetland are found in the watershed: 1) shallow marsh defined as emergent vegetation in water three feet or less 2) wet meadow defined as wet grass areas in water less than six inches on hydric soils, 3) and scrub shrub defined as emergent woody vegetation three feet or less (Birck et. al., 2005). The USFWS has digitized wetlands maps and they are available for viewing through Google Earth at the following website: http://www.fws.gov/nwi/WetlandsData/GoogleEarth.htm and can be consulted as needed for specific projects in the watershed. The Natural Resource Conservation Service and the ODNR Department of Wildlife also provide assistance in wetland determination, restoration and funding. Two wetlands have been constructed within the Twin Creek watershed at the Allen and Adaline Garber Nature Center, Preble County Park District in Lewisburg and Preble County Historical Society near Gratis. The combined acreage of these wetlands reaches 5 acres in wet areas and over 11 acres of buffers with native plants. Additional wetland restoration projects are in the works in the watershed with the collaboration of Twin Creek watershed partnership with NRCS and US Fish and Wildlife Services.

4.2.2 Stream System

The Twin Creek watershed has approximately 149 miles of streams and tributaries. Table 4-2 includes basic information about 16 named streams within the watershed including elevation changes and drainage area of each tributary.

TABLE 4-2
Streams of the Twin Creek Watershed

Stream Name	Flows into	County (at mouth)	Length (miles)	Elev. (source)	Elev. (mouth)	Avg. Fall	Drains (sq.miles)
Twin Creek	Miami River	Warren	46.2	1067	645	9.1	316
Little Twin Creek	Twin Creek	Montgomery	7.8	900	704	25.1	22.7
Toms Run	Twin Creek	Montgomery	13.5	1027	745	20.8	25.7
Wysong Run	Toms Run	Montgomery	2.8	1013	960	18.9	2.4
Aukerman Creek	Twin Creek	Preble	5.6	950	785	29.5	20.8
Banta's Fork	Twin Creek	Preble	16.8	1167	820	20.6	35.1
Goose Creek	Banta's Fork	Preble	5.1	1079	955	24.3	11.3
Lowry Run	Goose Run	Preble	2.6	1070	990	30.7	3.58
Lesley Run	Twin Creek	Preble	8.5	1017	823	22.8	8.32
Coffman Run	Twin Creek	Preble	1.3	916	861	42.3	3.02
Price's Creek	Twin Creek	Preble	14.6	1137	880	17.6	29.4
Jims Run	Price's Creek	Preble	2.6	1016	940	29.2	3.98
Swamp Creek	Twin Creek	Preble	7.3	1017	928	12.2	18
Miller's Fork	Twin Creek	Preble	10.6	1031	929	9.6	24.2
Lick Run	Twin Creek	Preble	2.7	1028	935	34.4	3.46
Dry Fork	Twin Creek	Preble	1.4	1050	1009	29.3	5.76

Source: Ohio DNR- Division of Water. 2001. *Gazetteer of Ohio Streams*.

4.2.3 Stream Habitat

Both the 1995 and 2005 Ohio EPA biological and water quality assessment of Twin Creek watershed used the Qualitative Habitat Evaluation Index (QHEI) as a measure of the stream's physical habitat to support a biotic community. The QHEI effectively evaluates in-stream habitat conditions (e.g. substrate type and quality), stream bank conditions (e.g erosion and quality of riparian cover) and other factors such as channelization and upstream development that can influence current velocities, depths and stream elevations (Ohio EPA 2006a). In a sense, QHEI scores are a numerical composite reflecting the human and natural factors that influence a particular stream segment. Looking at QHEI metric for the entire watershed (e.g. width of riparian areas or floodplain quality) can yield a good overall qualitative assessment of that metric when numerous stream segments are sampled, as the Ohio EPA assessments have done.

During the 2005 OEPA assessment, QHEI evaluations were completed for a total of 48 stream segments in the watershed. Applying the QHEI narrative ranges for larger streams, Ohio EPA found 14 of the 48 sites evaluated were in the excellent range ($\geq$ 75), 19 were in the good range (60-74), 10 were fair (45-59), four were poor (30-44) and one was very poor (Maple Swamp Ditch in the upper Twin Creek watershed). With the exception of the most upstream sampling station at RM 46.5, all stations along the Twin Creek mainstem attained QHEI scores in the excellent or good range; the median score or 75.5 was in the excellent range. The highest scores of 88.5 and 88 were attained at RM 26.7 and RM 13.4, respectively. Exceptionally high QHEI scores also were recorded for stations on Banta's Fork and Aukerman Creek. In contrast, in addition to Maple Swamp Ditch, poor scores occurred in the Miller's Fork and Swamp Creek subwatersheds. The lowest scores were in agricultural areas where channelization, siltation and nutrient enrichment were observed. Ohio EPA personnel also have noted that habitat conditions in the uppermost parts of the watershed reflect the previously swampy nature of the topography prior to the draining of wetlands by ditching streams.

4.2.4 Current Aquatic Life Use Attainment Status

Most water bodies in Ohio are assigned one or more aquatic life habitat use designations based on documented localized conditions (Table 4-3). These designations and specific water quality criteria associated with them are codified in the Ohio Water Quality Standards (Ohio EPA – Division of Surface Water 2003). Figure 4-1 displays the 2005 attainment results and sampling stations for the Twin Creek watershed. The results of Ohio EPA's 2005 biological and water quality assessment recommended some changes in use designations of tributaries in the Twin Creek watershed, but no changes on the mainstem. The Twin Creek mainstem was in full attainment of EWH in all but one location of more than 47 stream miles sampled during 2005. Partial attainment occurred at RM 34.9 near the Lewisburg WWTP due to nutrient enrichment and bacteria. Impairments noted on the mainstem in 1995 at RM 42.2 and 29.7 had recovered and were in full aquatic use attainment in 2005.

Of the stations sampled along the tributary streams, 14 were in partial attainment. As in 1995, the 2005 results recommend that Banta's Fork and Little Twin Creek retain their EWH designations and Goose Run, Aukerman Creek and Tom's Run retain their WWH designations.

TABLE 4-3

Aquatic Life Use Designations Applicable to Ohio Streams

Designation	Description	Application
Exceptional Warm water Habitat (EWH)	A designation reserved for waters which support "unusual and exceptional" assemblages of aquatic organisms, characterized by a high diversity of species, particularly with highly intolerant and/or rare, threatened, endangered, or special status (i.e., declining species).	Represents a protection goal for management of Ohio's best water resources.
Warm water Habitat (WWH)	A designation that defines the "typical" warm water assemblage of aquatic organisms for Ohio rivers and streams.	Represents the main restoration target for the majority of water resource mgmt. efforts in Ohio.
Coldwater Habitat (CWH)	A designation intended for waters which support assemblages of cold water organisms and/or those which are stocked with the intent of providing a put-and-take fishery.	Not applicable to streams in the Twin Creek watershed.
Modified Warm water Habitat (MWH)	A designation applied to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable and where the activities have been sanctioned by state or federal law.	Represents aquatic assemblages that are generally composed of organisms tolerant to disturbance, degradation, pollution, and poor quality habitat.
Limited Resource Water (LRW)	A designation applied to small streams (usually <3 mi.^{2} drainage area) and other water courses which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported.	Includes small streams in extensively urbanized areas, those which lie in watersheds with extensive drainage modifications or completely lack water on a recurring annual basis (i.e., true ephemeral streams), or other irretrievably altered waterways.

SOURCE: Ohio EPA – Division of Surface Water 2003

The 2005 results, however, recommend use designation changes, as follows:

- Changing Miller's Fork from EWH to WWH along its entire length.
- Changing the entire length of Price's Creek to WWH, instead of designating a portion as EWH, as previously occurred.

Additionally, sampling of a few small and previously undesignated streams resulted in the following recommendations:

- MHW designation for Maple Swamp Ditch, a tributary of Twin Creek at RM 47.03
- WWH designation for an unnamed tributary to Swamp Creek at RM 6.45
- WWH designation of an unnamed tributary to Aukerman Creek at RM 2.88 and
- WWH designation of an unnamed tributary to Twin Creek below Aukerman Creek at RM 18.29.

Figure 4-1

SOURCE: OEPA 2007

4.2.5 Streams Subject to Ohio's Antidegradation Rules

Antidegradation refers to provisions that must be followed before authorizing any increased activity on a waterbody that may result in lowering of water quality caused by an increase in the discharge of a regulated pollutant or activities that may alter physical habitat. The Ohio EPA Fact Sheet on the state's antidegradation rules (2002) states simply that the rules establish a procedure to determine that a discharge is necessary before authorizing it.

Ohio's antidegradation rules include a list of exceptional quality waters that are subject to added protections such as pollutant discharges, prohibitive discharges, and mandatory public hearings. Three waterways in the Twin Creek watershed are included in this list, available on the Ohio EPA Division of Surface Waters web site, as follows:

- Goose Run/Creek downstream from Winnerline Road (RM 3.0) to the mouth, designated SHQW
- Banta's Fork, designated OSW-E, and
- the Twin Creek mainstem, designated OSW-E

Superior High Quality Waters (SHQW) possess exceptional ecological value based on a combination of the presence of threatened or endangered species and a high level of biological integrity. Outstanding State Waters based on Exceptional Ecological Values (OSW-E) must not only meet the qualification for Superior High Quality Waters but also must be demonstratively among the best waters of the state from an ecological perspective (http://epa.state.oh.us/dsw/rules/antidegguide_2003.html). Inclusion of Twin Creek waterways on this list attests to the high quality of these streams and the importance of protecting them.

4.2.6 Status of Twin Creek's TMDL Process

The Total Maximum Daily Load (TMDL) program, under Section 303(d) of the Clean Water Act, focuses on restoring waterways that are not attaining their aquatic life use designations. Some streams addressed under Ohio's TMDL program have very serious pollution impairments; others (e.g. Twin Creek) have historically high water quality, but are experiencing some level of impairment. The TMDL is a written quantitative assessment of a waterbody that specifies the amount a pollutant must be reduced to meet water quality standards, allocates pollutant load reductions, and serves as the basis for taking actions needed to restore a water body. The process of TMDL preparation began in 2008. Multiple meetings between OEPA and the Twin Creek watershed partnership were held between 2008 and 2009. The draft TMDL was published in June 2009. The Twin Creek TMDL was approved in March 2010. Recommended strategies and specific actions outlined in the TMDL are summarized in Sections 5 and 6 of this document.

4.2.7 NPDES Permitted Point Sources

While most causes of impairment in the Twin Creek watershed are linked to nonpoint sources of pollution, the watershed also includes at least 14 NPDES-permitted point sources that discharge to receiving waters in the watershed (Table 4-4). Of these facilities, only the Lewisburg WWTP (Twin Creek Station @ RM 34.9) was cited as a source of stress in Ohio EPA's 2005 attainment data. In contrast, Ohio EPA's 1997 assessment of Twin Creek mentioned discharge concerns related to the WWTPs of West Alexandria, Gratis, Lewisburg; the Iams Company and two substandard package plants. The TMDL also recommended actions at these facilities.

TABLE 4-4
Permitted NPDES Discharges in the Twin Creek Watershed

NPDES ID	Name of Permitted Facility	Community	Receiving Stream
1PV00125	Creekside Village Mobile Home Park	West Alexandria	Unnamed Trib to Twin Creek
1PA00014	Eldorado WWTP	Eldorado	Price's Creek

1PB00010	Farmersville WWTP	Farmersville	Unnamed Trib to Little Twin Creek
1PB00041	Gratis WWTP	Gratis	Twin Creek
1IH00012	Lewisburg Product Supply	Lewisburg	Twin Creek
OH0026051	Lewisburg WWTP	Lewisburg	Twin Creek
1IN00184	North American Nutrition Co	Lewisburg	Twin Creek
1PZ00019	Pilot Travel Center	Eaton	Unnamed Trib to Goose Creek
1PT00058	Preble Shawnee High School	Camden	Unnamed Trib to Twin Creek
OH0072770	The Iams Company*	North Lewisburg	Twin Creek
1PA00027	Verona WWTP	Verona	Swamp Creek
1PB00035	West Alexandria STP	West Alexandria	Twin Creek
1PA00025	West Manchester STP	West Manchester	Twin Creek

SOURCES: http://www.epa.gov/npdes and http://www.epa.state.oh.us/dsw/permits/individuals.html

4.2.8 Stream Morphology and Channel Modifications along the Mainstem

Stream morphology considers channel patterns and cross-sectional changes in response to both human and natural sedimentation processes. Accordingly, flow dynamics and sediment transport are important principles. Channel stability refers to a river's ability to respond to changes in sinuosity, slope, flow, and period over time. Changes in hydrology, land use and land management practices can cause instability in a stream reach or throughout the watershed as the stream tries to compensate for the changes.

Stream classification and morphology varies throughout the Twin Creek watershed as would be expected for a watershed its size. In Twin Creek, OEPA has performed geomorphologic assessments during their periodic water quality monitoring (1995 and 2005) and as a part of Primary Headwaters Stream Classification (2002). In the primary headwater habitat study OEPA conducted in 2002, headwater streams in the watershed tended to have a low gradient (below 3%), most often between 2.0% and 0.8% with an average of about 1.9%. Most physical sampling points taken along these same primary headwater reaches show limited sinuosity or winding. Review of aerial photography of the watershed reveals a slight increase in sinuosity downstream.

Bedload sediment in the Twin Creek system varies according to size of stream reach and characteristics of a particular subwatershed. In Swamp Creek, upper reaches deliver sands and fines. In most other small stream reaches, the bedload is dominated by cobbles, with gravels, small rocks, and some boulders. In lower reaches, cobbles and larger rocks dominate with gravels and sands making up the remainder of the bedload. Much of the streambed that is dominated by cobbles and gravel has historically provided excellent interstitial space habitat for macroinvertebrates. In other reaches interstitial habitat is being compromised by layers of fines and silts or layers of algae that catch silts or fines.

To obtain further information on the Twin Creek system's stability and health, a geomorphic characterization was conducted in 2006 using the Rosgen stream classification method (Gosse, 2007). The Rosgen (1996) method is increasingly used to evaluate streams and provides a working description of a system's current or ideal state by taking substrate, slope, sinuosity, and

bankfull factors into account. Gosse (2007) determined that the headwater streams in the watershed could be classified under Rosgen terminology as A3 or A4. These streams are typically high gradient, deeply incised channels in hilly wooded terrain that was never suitable for crop production. The degree of incisement and headcutting may correspond to local historic patterns of timber harvest and livestock pasturage. Many of the low gradient headwater reaches throughout the watershed were most likely E4-5 or B4-5 in presettlement condition. With settlement and agricultural development, the historic forest was cleared and headwater streams were channelized, ditched, drained, incised or otherwise impacted to varying degrees, Most seem to have stabilized to Rosgen's B5-B6 state with moderate sinuosity and entrenchment. However, some headwater streams have re-formed a new meander width within an incised channel in their recovery state. While this state may represent recovery, these reaches should still be considered impaired because: 1) landside impacts continue to affect them and 2) loss of connectivity to the original floodplain continues to inhibit optimal amphibian, macroinvertebrate, and fish migration, feeding, and breeding patterns.

Most wadeable streams in the watershed exhibit C3-4 characteristics while in some reaches bedrock changes the classification to C1. Wadeable streams in the Twin often exhibit a well-defined floodplain with moderate sinuosity and moderate width to depth ratio. Stable reaches will flood easily to disperse energy and drop organics and fines. Such areas are critical to aquatic macroinvertebrates as a food source and to fish communities for opportunistic feeding and breeding. Reaches with a bedrock substrate are often accompanied by exposed bedrock as a small bluff above bankfull, which should not be considered an indicator of instability.

A stable reach's ability to inundate the floodplain helps establish and maintain riparian communities and also slows floodwaters and allows sediments to settle out of the water column. Periodic inundation results in revitalization of the floodplain. Incision and entrenchment in smaller reaches may be common to a certain extent due to agricultural drainage practices. Some entrenched areas, particularly those near to a tributary's confluence with the mainstem, are in a compromised recovery phase where they have developed a secondary floodplain and corresponding meander width inside the entrenched channel. Depending on the level of entrenchment, functionality may be limited.

The historic condition of the mainstem below the Germantown Dam could be considered to have developed an appropriately wide flat floodplain as a C3 reach. Currently, the reach from Germantown Dam to the Great Miami River confluence is unstable, transitioning as a G5-6. Without grade control and restoration, the reach will most likely become an entrenched F5-6 in the next 10 years. In the Rosgen classification system, G streams are unstable and in transition, exhibiting various and higher slopes that do not correspond with the historic sinuosity. In contrast, F streams have recovered limited functionality within an entrenched floodplain. If the recovered floodplain is not connected to the original floodplain, the functionality of the system will always be less than the previous stable state. Entrenchment on the mainstem ranges from mild (1-3 feet) to severe (> 20 feet), though entrenchment is not necessarily related to location downstream. Unstable reaches are characterized by disconnection with the floodplain; steep unstable banks of erodible soils; and trees leaning into the streams. Slope varies as a series of headcuts move upstream from the confluence with the Great Miami.

Causes for the instability at the lower reaches of the Twin may be related to two events: 1) failure of the old Middletown Hydraulic Dam on the Great Miami River, and 2) Warren County's subsequent excavation of the mouth of Twin Creek at its confluence. Failure of the

former Middletown Dam in 1993 dropped the pool height of the Great Miami by 10-15 feet, subsequently changing the gradient of Twin Creek from 7.1 to 8.2 feet per mile. (Rinehart 2006). The gradient change was further accelerated by Warren County's excavation of the last 0.5 mile of Twin Creek at its confluence with the Great Miami in an attempt to protect its North wellfield. This excavation cut off a meander at the mouth of Twin Creek and rerouted flow through a straight channel into the Great Miami. The Miami Conservancy District noted extensive bank erosion and headcutting through lower Twin Creek as the system began to adjust to the new grade. Without intervention, headcutting is expected to continue to the base of the Germantown Dam (Rinehart 2006). A large project to address bank instability near the mouth of Twin Creek was undertaken in 2005 when the Warren County Water and Sewer District installed an extensive streambank biostabilization project along more than 1,000 feet of Twin Creek adjacent to their North wellfield. In his assessment, Gosse observed that effects of system instability on the channel habitat and aquatic macroinvertebrates may take years to become evident at the Ohio EPA state assessment level.

4.2.9 Stream Flow

Three USGS gauging stations are located within the Twin Creek watershed: at Lewisburg (station 03271736), Ingomar (station 03271800) and Germantown (station 0327200); however only the one near Germantown remains operational (USGS, 2006). Information on this station, operated in cooperation with the Miami Conservancy District, is presented in Table 4-5**.**

TABLE 4-5
Information on USGS Station 03272000 on Twin Creek near Germantown

Location: Latitude: 39°38'16", Longitude: 84°24'14"
Montgomery County, Ohio Gage datum 724.00 feet above sea level COE1912

Hydrologic Unit Code: 05080002

Drainage area: 275.00 square miles

Period of Record: 1914 – current

Data Collected: Discharge, Gage Height

SOURCE: http://nwis.waterdata.usgs.gov/nwis/nwisman/?site_no=03272000&agency_cd=USGS

For the period of record, the average stream flow is 271 cfs, with the highest average flows occurring in April (average = 300 cfs) and the lowest average flows in October (average =14 cfs) (Mangus and Frum, 2005; Straub, 1998). Flows in Twin Creek and its tributaries tend to be sustained by groundwater inputs which are greater in the northern part of the Great Miami River basin compared to its southern tributaries. According to Schiefer (2002), Twin Creek has "moderate sustained flows that tend to maintain [with other tributaries] the low flow in the [Great] Miami River."

4.2.10 Stream Physical Attributes

Twin Creek Watershed is predominantly a rural agriculture watershed. Evidence of channelization and levies was noted primarily in the tributaries. A visual and aerial photograph survey with Twin Creek watershed partnership's inputs was conducted in 2009 to examine the general physical attributes of Twin Creek and its major tributaries. However, since most properties along the creeks are private ownership, it was not possible to obtain a precise

measurement of the features. Table 4-6 summarizes the general physical features of the watershed.

Table 4.6 – General Watershed Features as of 2009

Subwatershed	River (mile)	Natural stream (mile)	Modified stream (mile)	Lowhead dams (#)	Unrestricted livestock (#)	Levees (mile)	New development (#)	New Bridges /Culverts (#)
Twin Creek	46.2	36.2	10	0	2 sites (below Banta Fork & Twin Creek/Leslie Run)	1	0	1
Little Twin Creek	7.8	7.8	0	0	0	0	0	1
Toms Run	13.5	7.5	6	0	0	0	0	2
Wysong Run	2.8	1	1.8	0	0	0	0	0
Aukerman Creek	5.6	3.6	2	0	0	0.5	0	0
Banta's Fork	16.8	14.8	2	0	0	0	0	0
Goose Creek	5.1	2.6	2.5	0	0	0	0	0
Lowry Run	2.6	1.4	1.2	0	0	0	0	0
Lesley Run	8.5	4.5	4	0	0	0	0	0
Price's Creek	14.6	9.6	5	0	0	0	0	0
Jims Run	2.6	0.8	1.8	0	0	0	0	0
Swamp Creek	7.3	0	7.3	0	0	0	0	1
Miller's Fork	10.6	5.1	5.5	0	0	0	0	0
Lick Run	2.7	2.7	0	0	0	0	0	0

4.2.10 Flood-Control Structures

The major flood-control structure in the watershed is the Germantown Dam (Twin Creek RM 10.08), constructed by the Miami Conservancy District in 1921-22 following catastrophic floods in 1913. The earthen Germantown dam is 100 ft. high and 1,200 ft. long. The retarding basin behind the dam is referred to as the Germantown Reserve and has a surface area of 3,600 acres with a normal storage capacity of 106,000 acre-feet and a maximum capacity of 142,000 acre-feet. The retarding basin is normally dry, but is designed to store excess water during floods (Debrewer et. al., 2000) and later to release water in a controlled manner that greatly reduces the magnitude of peak floods. The dam was designed with a conduit that allows water to pass through the dam during periods of normal stream flow. No other significant lakes or reservoirs occur in the Twin Creek watershed, although several ponds are large enough to appear on the Ohio Gazeteer map – primarily near the Twin Creek mainstem north of West Alexandria or south of Germantown. Swinging Bridge Lake occurs in the Tom's Run subwatershed.

4.3 Groundwater Resources

Groundwater is a significant component of the water resources of Twin Creek watershed and is the major source of drinking water to private and public drinking water systems. The most important aquifers in the watershed consist of unconsolidated glaciofluvial sediments that have filled in buried ancestral river valleys underlying the present-day stream system (Debrewer et al., 2000). Upland areas drain quickly to shallow alluvial aquifers, which in turn contribute to deeper aquifers dominating the ancient buried river valleys. The aquifers associated with Twin Creek are part of a vast system termed the Buried Valley Aquifer System (BVAS) that supplies drinking water to large populations in Southwest Ohio and, as such, has received Federal sole-source aquifer designation.

The combination of glacial till, moraines, and interbedded limestone, sandstone, and shales contribute to a well-drained watershed. Silt and clay layers between other more permeable sediments may act as a barrier differentiating upper and lower aquifers. While the upper aquifer is directly connected to the surface river system and precipitation cycle, the deeper aquifers that occupy ancient buried river valleys are less connected and tend to have older water. Glacial action that filled in the ancient river valleys also formed layers of varying permeability and drainage patterns sometimes unassociated with surface water river channels (Miami Conservancy District, 2001). The interaction between upper aquifers and the surface water, resulting in the inflow of cooler water to Twin Creek, greatly influences the instream habitat and biota. Conversely, overdrawing the aquifer can lead to induced filtration, with Twin Creek changing from a gaining to a losing stream and surface water feeding groundwater. This results in a loss of water volume and corresponding temperature and habitat changes.

In the Twin Creek watershed, as in other areas overlying the BVAS, the amount of groundwater available for use is influenced by the source and rate of aquifer recharge, physical properties of aquifer sediments and bedrock, surface water-groundwater interactions, and rates of withdrawal by supply wells (Debrewer et al., 2000). The groundwater yield potential is between 5 and 25 gallons per minute (gpm) throughout much of the Twin Creek watershed, but along the lower portions of the Twin Creek mainstem the groundwater yield is 100 to 500 gpm, with yields exceeding 500 gpm near the stream's confluence with the Great Miami River. Associated with these high yields are annual groundwater recharge rates of 7-10 in. along the lower Twin and exceeding 10 in. near its confluence with the Great Miami (Birck et al., 2005).

4.3.1 Public Water Suppliers

Ten Community Public Water Systems use groundwater within the Twin Creek watershed, as follows: the villages of Eaton, Eldorado, Farmersville, Germantown, Gratis, Lewisburg, Verona, West Alexandria and West Manchester and the Warren County-Franklin Area system. These systems are shown in Figure 4-3, provided by OEPA (2006c), along with 25 additional public systems that are either no transient (serving schools, hospitals and other similar facilities year round) or transient (serving campgrounds, rest stops and other facilities for more transient populations).

4.3.2 Source Water Assessments

The 1996 amendments to the Safe Drinking Water Act established the Source Water Assessment and Protection Program (SWAP), which provided funding for states to complete delineation and inventories for all public water systems. Source Water Assessments have been

completed for all ten Community Public Water Systems in the Twin Creek watershed (Table 4-7). These assessments include susceptibility analyses and protective strategies. Within the Twin Creek watershed, susceptibility of public water systems to pollution range from low to high. Moderate to high susceptibility to pollution is most often due to the presence of potential contaminant sources, the presence of a shallow or sand/gravel aquifer, and/or a thin confining layer. Ohio EPA completed "Drinking Water Source Assessments" for five communities in the Twin Creek watershed while five additional communities completed their own assessments.

In September 2007, the Village of Gratis with assistance from Miami University, submitted a proposal to Miami Conservancy District for developing its source water protection plan as recommended by the OEPA in the 2002 Drinking Water Source Assessment. The proposal was funded to support the two year project. The Source Water Protection Plan provides a framework for the Village to implement strategies to safeguard the drinking water quality. The Village of Gratis contracted Dr. Jonathan Levy from Miami University in the preparation of the Source Water Protection Plan. Dr. Levy performed a detail assessment that included the delineation of the source water protection area and time of travel analysis using hydrologic and geologic information incorporated into a numerical groundwater-flow computer model. Field work was conducted in July 2008 including installing a number of groundwater sampling points near the wellfield. The plan was completed in August 2009.

4.3.3 Groundwater Pollution Potential

The DRASTIC mapping system used by ODNR since the late 1980s systematically evaluates the pollution potential of an aquifer using existing information. Vulnerability of groundwater to contamination is a combination of hydrogeologic factors, anthropogenic influences, and sources of contamination for a given area. The DRASTIC system, focuses on the hydrogeologic factors that influence groundwater movement and incorporates those factors (e.g. depth of water, soils, geology etc.) into the acronym DRASTIC. Based on these hydrogeologic factors, pollution potential indices can be graphically mapped. Colors shown on DRASTIC maps range from "cooler" light yellows, greens and blues where pollution potential is lower to "hotter" oranges and reds where pollution potential is higher. Birck et al. (2005) created a composite of the DRASTIC maps for Preble, Montgomery, Darke, and Warren Counties**.** The individual county maps forming the composite were completed by Ohio Department of Natural Resources by Jones, 1992; Hallfrisch and Angle, 1995; Spahr, 1991; and the Center for Groundwater Management, 1992, respectively, and can be found online at http://www.ohiodnr.com/water/gwppmaps/. The oranges and reds generally indicate groundwater is most vulnerable to contamination over the buried valley aquifer adjacent to portions of the Twin Creek mainstem and near Twin Creek's confluence with the Great Miami River (Figure 4-3). With this information, several communities within the high pollution potential area and high pollution susceptibility should consider actions to safeguard the community water supply.

Figure 4-2
Public Water Systems in the Twin Creek Watershed

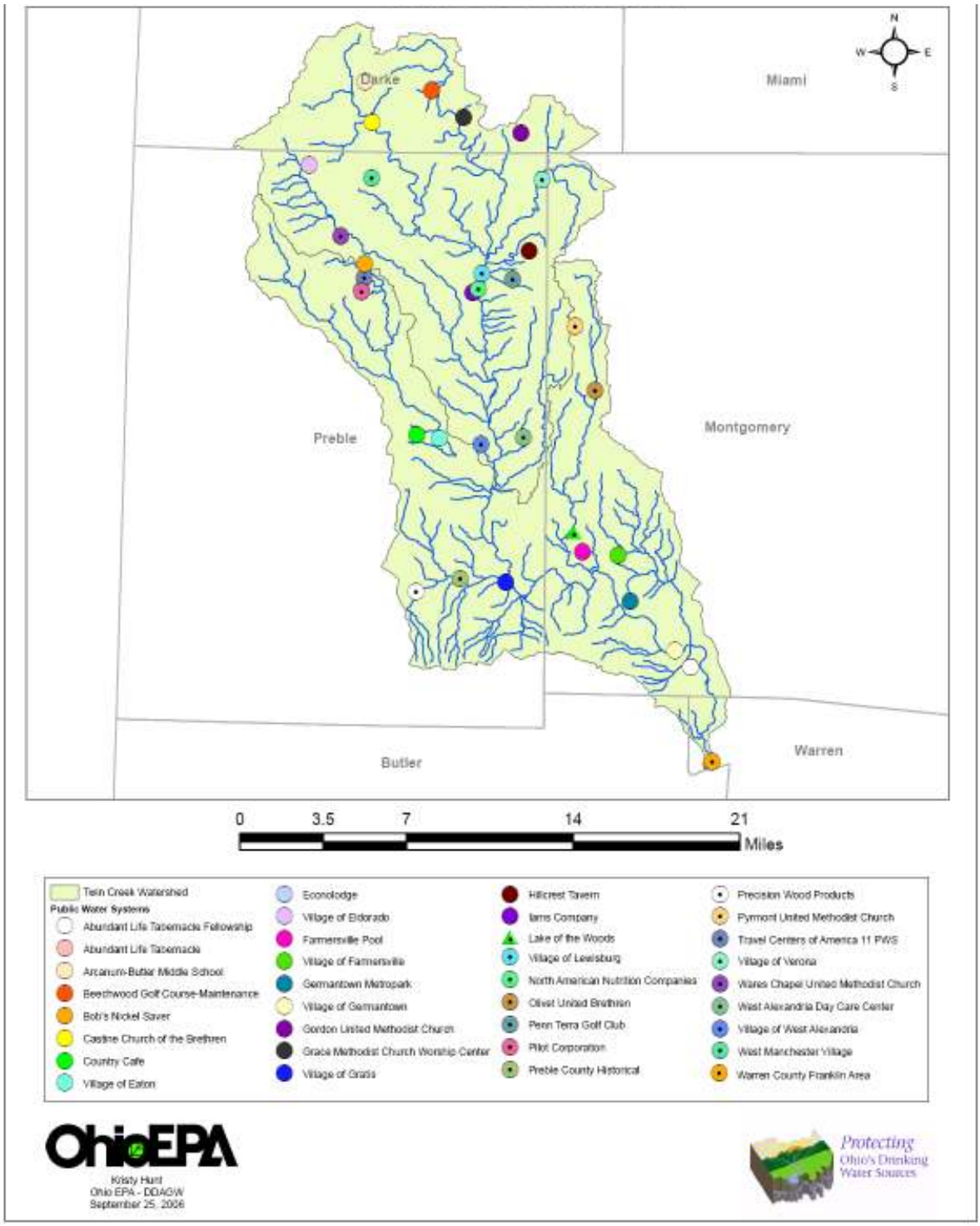


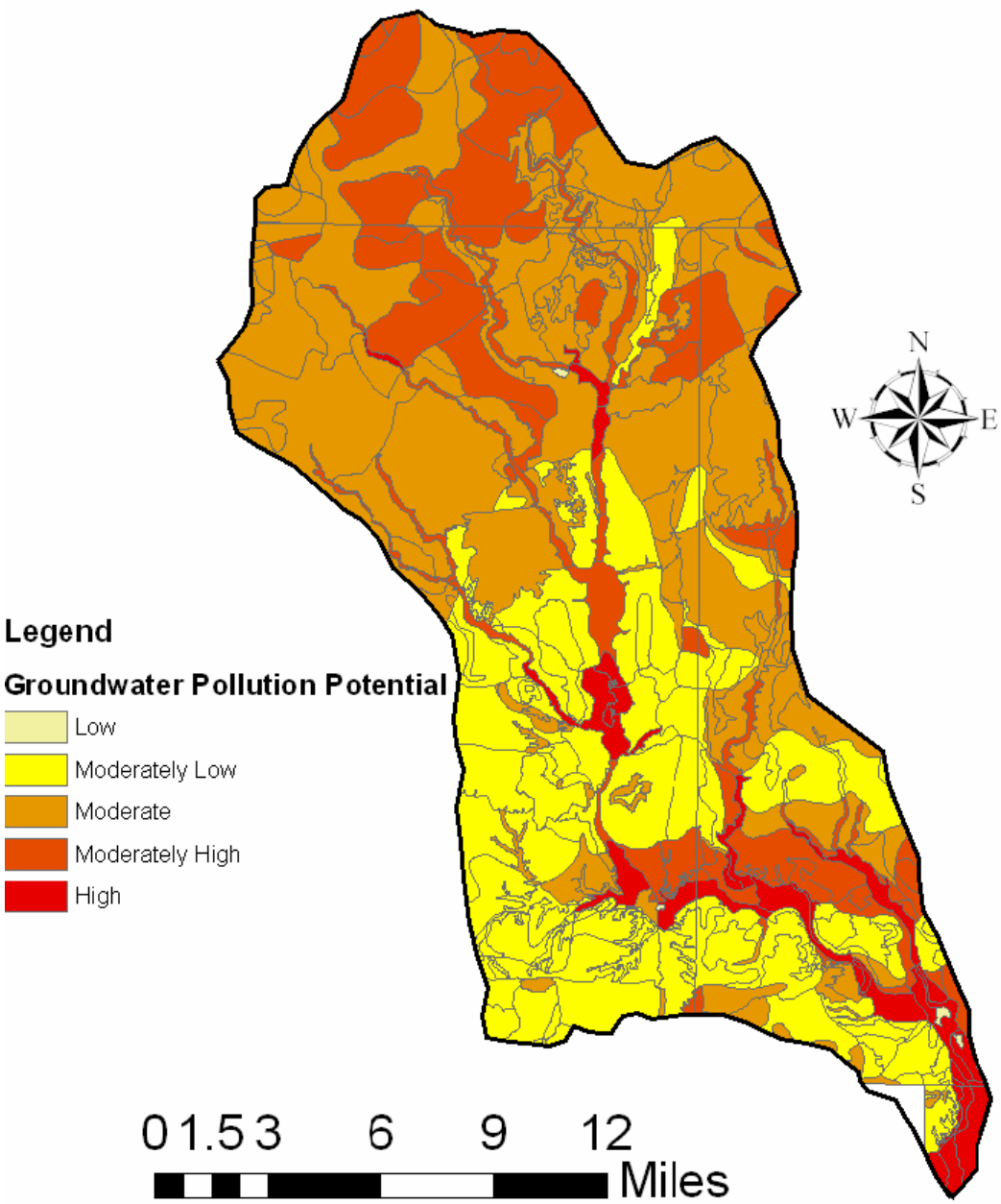
TABLE 4-7
Source Water Assessments

Community (Ohio EPA ID)	Report Date	Pop. Served	Pollution Susceptibility	Reasons
Verona (6801212)	12/2003	585	Moderate	Potential contaminant sources include agriculture, drainage canals/tiles, wastewater lagoon, commercial fertilizer and pesticide storage, septic systems, aboveground storage tanks, highways/roads.
Gratis (6800612)	6/2002	990	High	Results indicated nitrate contamination implying a pathway from ground surface to the aquifer. Potential contaminant sources include agriculture, wastewater treatment plants, wastewater application sites, septic systems, aboveground storage tanks, highways/roads, sanitary sewer lines.
Farmersville (5700912)	6/2002	980	Moderate	Potential contaminant sources include animal burial areas, agriculture, bulk silage storage, garages, NPDES facility, wastewater treatment plant, auto repair shop, cemetery, hazardous waste handler, pipelines, leaking underground storage tanks.
Eldorado (6800512)	6/2002	539	Low	Deep aquifer with thick confining layer.
West Manchester (6801412)	6/2002	462	Moderate	Potential contaminant sources include agriculture, drainage canals/tiles, drinking water treatment plants, garages, storm water basins, auto repair shops, food processing facility, gas stations, lumber store, septic systems, highway/roads
Eaton* (6801612)	Unknown	8,133	Moderate	Potential contaminant sources include underground and above ground storage tanks, roadways, railways, carwash, commercial businesses, oil and gas wells
West Alexandria* (6801312)	Unknown	1,750	Moderate	Potential contaminant sources include agriculture, gas station, highways, stream, roadways, railways
Lewisburg* (6800812)	Unknown	1,798	High	Potential contaminant sources include wastewater treatment plant, highway, underground storage tank, storage yard, stream
Germantown* (5701012)	Unknown	5,200	High	Potential contaminant sources include septic tanks, underground and above ground storage tanks, storage sites, transformers, cemetery, dry cleaning operation.
Warren Co. – Franklin area* (8301613)	Unknown	20,784	High	Potential contaminant sources include underground and above ground storage tanks, gravel pits, railroads, wastewater treatment plant, commercial businesses.

*Indicates assessment report was not prepared by Ohio EPA, but by the community.

SOURCE: Ohio EPA, Division of Drinking and Ground Waters 2006d

Figure 4-3
Twin Creek Watershed Groundwater Pollution Potential Map



Chapter 5
WATERSHED GOALS

Ohio EPA 2005 data (OEPA, 2007) concluded that:

1) Many stream segments (parts of Lower Banta's Creek, Lower Goose Creek, etc., Aukerman Creek, and the mainstem of the Upper and Lower Twin Creek) are in full attainment of EWH use designation with only a few exceptions.
2) Most stream segments designated as WWH are in full attainment.
3) There are 11 stream segments where streams are in partial attainment of use designations.

As a result of the high water quality, habitat, and diversity of species, the mission of the Twin Creek Watershed partnership is to focus on: 1) maintaining and protecting the water quality in streams meeting full attainment through conservation easement, education and outreach, and conservation enhancement and 2) improving water quality in streams segments that did not meet full attainment. This mission meets the objective of the Clean Water Act of 1972 and goal for Ohio in achieving use attainment standards. To address the stream segments with partial attainment use designations, watershed goals have been developed based on inputs from the Twin Creek Watershed Advisory Group, various county and state agencies and guidance from "A Guide to Developing Local Watershed Action Plans in Ohio" and Appendix 8 update. These goals and actions to meet them are consistent with the findings of Twin Creek Watershed TMDL (OEPA, 2010).

5.1 Twin Creek Watershed Goals

Conservation Easement:

Conservation easements held by entities in the Twin Creek watershed covered 3,493 acres of the 202,151 acres in the Twin Creek Watershed prior to initiation of the Watershed Action Plan in January, 2005. During the Watershed Action Planning process, an additional 3,972 acres of easements was acquired. These easements protect at least twelve miles of additional stream frontage from encroachment and development. More than 1,100 acres of these easements are clustered in and around the stream corridor on the mainstem of the Twin Creek from just north of the confluence of Price's Creek and Twin Creek south to north of Banta's Creek. Another 1,000 acres were clustered at the Preble-Montgomery County line on both sides of Twin Creek south of Aukerman Creek and upstream of Tom's Run. An Additional 653 acres were protected along Tom's Run, and another 900 acres primarily along Price's Creek. As of April 1, 2010, a total of 1,016 acres of easements have been approved and 3,700 acres are projected for the next 3 years (Figure 5-1 and Table 5-1). Three Valley Conservation Trust and Five Rivers Metroparks have used both state and federal grant funding to leverage these planned conservation land additions in partnership.

Each of the conservation easements require, as a requirement by the easement holder, and/or as a function of grant applications for easement acquisition, the landowner to implement an NRCS Whole Farm Conservation Plan to manage all natural and cultural resources on the farm to Best Management Practices levels. Thus, the farms are likely to install new conservation measures. Likewise, acquisition of parkland from willing sellers/donors would advance both a preservation and a likely conservation enhancement.

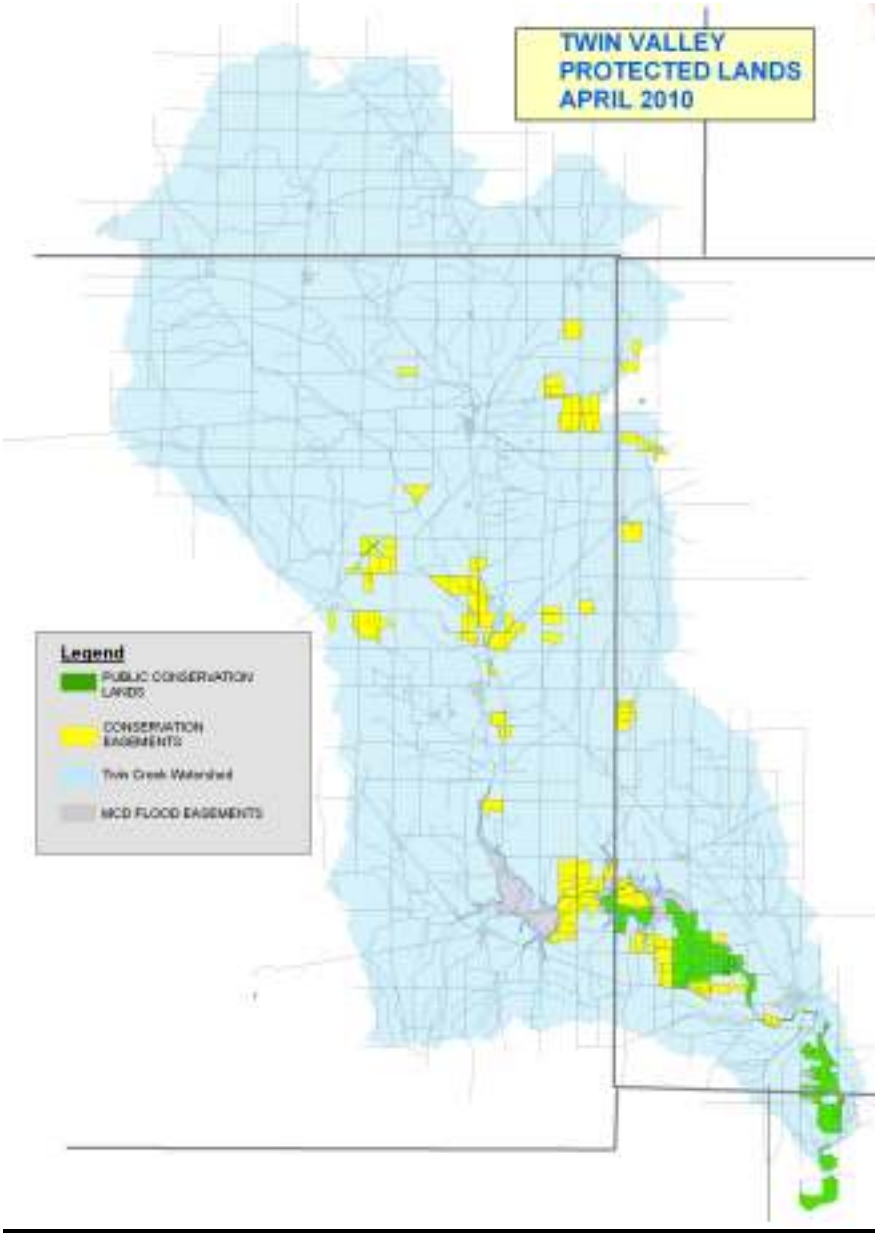
Table 5-1
Conservation Easements Current, Anticipated and Planned
(2008-9, 2010 and beyond)

Subwatershed	#of easement 2008-09	Acres 2008-09	#of easement 2010 (as of April 1)	Acres 2010 (as of April 1)	#of easement >2010	Acres >2010
Upper Twin Creek	0	0	1	125	3	400
Miller's Fork	0	0	0	0	2	200
Upper Twin below Miller's Fork	1	155	0	0	3	450
Swamp Creek	0	0	0	0	1	150
Price's Creek	0	0	0	0	2	150
Twin Creek below Price's C.	4	684	3	645	4	600
Upper Banta's	0	0	0	0	1	50
Goose Creek	2	122	0	0	2	200
Lower Banta's	1	73.4	0	0	1	300
Twin Creek Below Banta	0	0	0	0	2	250
Aukerman C.	0	0	0	0	1	50
Tom's Run	2	247	1	153	5	500
Twin C between Aukerman and Tom's Run	2	206	1	93	1	100
Lower Twin	1	126	0	0	2	200
Little Twin	1	163	0	0	1	100
Total	14	1776	6	1016	31	3700

Education and Outreach

The rural nature of the Twin Creek watershed with its somewhat dispersed population creates a challenge to watershed education, especially in reaching the adult population. Organizations such as the Future Farmers of America (FFA), 4-H, Boy Scouts and other youth groups afford opportunities for education on stream ecology, sustainable farming and other measures aimed at protecting the outstanding resources of the watershed. Outreach at local events and festivals conducted in 2007 and 2008 so far have initiated many productive discussions and possible projects. The county SWCDs and other agencies and groups are concurrently providing various elements of watershed education. Ongoing venues (e.g. Great Miami River Days, Preble County's annual Earth Day, Fall Gathering at Aukerman Creek) and enhancement of science curriculum (e.g. at Tri-County and Twin Valley school districts) afford excellent watershed education opportunities. The first Twin Creek Symposium took place in May 2008 highlighted the natural beauty and among other qualities of the Creek and tributaries. Newspaper articles appearing regularly that highlight the watershed's good qualities, areas of concern, and related activities can raise awareness and provide continuity among watershed residents in general. A monthly newsletter and web site (www.twincreekwatershed.org) have been established to provide information, news and educational material about the watershed. The Three Valley Conservation Trust also has begun to publicize water quality in its newsletter and regular press releases. Furthermore, the Five Rivers Metroparks, Montgomery Soil and Water Conservation District, Three Valley Conservation Trust and others have been holding public meetings, getting press releases of easement signings covered, and working with the regional agricultural and local magazines to raise awareness of the potential for conservation easements in protecting agriculture and the rural character of the Lower Great Miami River watershed.

Figure 5-1
Twin Creek Conservation Easement



Map by D. Nolin, Five Rivers Metroparks April 2010

Conservation Enhancements

Based upon data from Preble, Montgomery, Darke County SWCDs, NRCS, Five Rivers Metroparks, Pheasants Forever, US FWS, and ODNR, a significant number of conservation improvements and enhancements have been planned and completed (or are underway) since the Watershed Action Plan began in January, 2005. Documented practices and calculated savings indicate that an aggregate of at least 23,253 tons per year of soil will be saved from 2005-6 installations and 6,858 tons per year from 2007-9 installations, respectively throughout the watershed. The reductions in nitrogen and phosphorus loadings will be significant at 439,509 and

213,768 pounds per year minimum, respectively. While impressive, these totals do not provide any way to gauge potential water quality improvements or location-specific reductions, thus are in themselves not meaningful. The extensive Montgomery County conservation practices installed were predominately grassed waterways and pasture plantings, which account for the majority of the calculated totals for reductions. This is in large part because the numbers were more easily discerned and calculated. However, significant installations of habitat borders and livestock exclusions such as fences, as well as other nutrient reduction focused installations (Comprehensive Nutrient Management Programs, heavy use pads, waste storage, livestock structures, and stream crossings) in Preble and Darke Counties account for additional load reductions and water quality enhancements.

5.2 Twin Creek Target Improvement Goals

In addition to protection, preservation and maintaining the good quality of Twin Creek, five specific problem statements along with their goals have been identified and presented in this Watershed Action Plan. These problems and goals were identified collectively by the Twin Creek Watershed Advisory Group and OEPA TMDL team and were aimed to address the target enhancement to improve the water quality and specifically address the causes and sources of environmental stress (Figure 5-2 and Table 5-2).

Figure 5-2

Source: OEPA, 2007

Table 5-2
Causes and Sources of Stress

Stream Name	RM	Subwatershed (14 digit HUC)	Causes	Sources	Actions
Maple Swamp Ditch	2.4	05080002-030-010	Sedimentation/siltation; algae	Channelization; loss of riparian, crops with subsurface drainage	(1), (2), (3), (4), (5) & (6)
Miller's Fork	3.9	05080002-030-020	Sedimentation/siltation; low DO; ammonia	loss of riparian; animal feeding operations	(1), (2), (3), (4), (5), (6) & (7)
Miller's Fork	8.0	05080002-030-020	Shallow Bedrock	Natural	None needed
Miller's Fork	10.8	05080002-030-020	Sedimentation/siltation; low DO; ammonia	Channelization; loss of riparian, crops with subsurface drainage	(1), (2), (3), (4), (5), (6) & (7)
Swamp Creek	6.3	05080002-030-040	Sedimentation/siltation	Channelization; loss of riparian, crops with subsurface drainage	(1), (2), (3), (4), (5), (6) & (7)
Twin Creek	34.9	05080002-030-030	Phosphorus	WWTP	None needed*
Price's Creek	13.7	05080002-030-050	low DO; ammonia; phosphorous	Agriculture; failing HSTS	(1), (2), (3), (4), (5), (6) & (7)
Goose Creek	4.4	05080002-040-030	low DO; ammonia; phosphorous; COD	Package plants	(1), (5) & (6)
Banta's Fork	1.3	05080002-040-030	Low Flow	Natural	None needed
Banta's Fork	13.7	05080002-030-010	Low Flow	Natural	None needed
Lesley Run	1.2	05080002-030-060	Low Flow	Natural	None needed
Lesley Run	6.0	05080002-030-060	Sedimentation/siltation; low DO	Channelization; loss of riparian, crops with subsurface drainage	(1), (2), (3), (4), (5), (6) & (7)
Toms Run	8.5	05080002-040-070	Low Flow	Natural	None needed
Toms Run	12.0	05080002-040-070	Sedimentation/siltation; low DO	Channelization; crops with subsurface drainage	(1), (2), (3), (4), (5) & (6)
Little Twin Creek	6.2	05080002-040-090	Low Flow	Natural	None needed

Bank & riparian restoration (1), stream restoration (2), wetland restoration (3), conservation easement (4), education and outreach (5), agricultural BMPs (6), & home sewage improvement (7).
Sources: OEPA 2007, 2010
*See section 6.3

Chapter 6 provides the specific actions and BMPs in subwatersheds details. In general, five watershed wide problems and goals to address them are identified below.

5.2.1 Problem Statements

Problem Statement No. 1: ***The channelized ditches have caused excessive sedimentation particularly at the smaller headwater streams and tributaries.*** These channels were straightened

to convey runoff more efficiently from the fields. Row crops are often planted on the floodplain almost to the edge of the stream. **Goal:** Restore natural channel and floodplain connection especially at the headwaters of Twin Creek.

Problem Statement No. 2: ***Subsurface drainage tiles directly deposit water laden with fertilizers, eroded soil, agrochemicals, and other types of agricultural runoff pollutants to the streams.*** In bypassing the natural flow of water from the surface to the water table, drainage systems often prevent the natural filtration of water provided by soils and wetlands. Further, while no-till farming practices throughout much of the watershed have helped reduce soil erosion and runoff, organic materials left on fields often find their way into drainage outfalls and culverts, creating maintenance problems. **Goal:** Manage subsurface drain tiles beneath the crop fields that have negative ecological effects. Implement a solution that reduces the flow of nutrients, chemicals directly from subsurface drain tile to stream and agricultural best management practices to reduce chemical application onto crop fields.

Problem Statement No. 3: ***Many of the headwater streams have no riparian vegetation as row crops are planted close to the channel.*** A healthy riparian area holds and stores water, providing a slow release and water recharge to the stream and can filter chemicals and nutrients from the crop field before discharging into the streams. Creation and enhancement of riparian buffers have been important initiatives of USDA programs in recent years, but their acceptance and implementation has been challenging in areas like the Twin Creek watershed, where farming practices that maximize land use have been followed for generations especially with the recent increasing emphasis of growing corn for ethanol production. **Goal:** Improve QHEI scores at the headwater streams by **i**ncreasing riparian buffer to improve water quality and to protect existing riparian to prevent further loss of riparian.

Problem Statement No. 4: ***The rural communities are experiencing water quality problems from failing septic systems and lack of fiscal resources for repair.*** Like agricultural drainage systems, septic systems are generally invisible and often do not receive attention until they become problems. Further, diffuse distribution of septic systems in rural areas can make their impacts difficult to quantify. Many septic systems in the watershed serve homes that are not located in villages, but are located in strips along major county roads. **Goal:** Improve QHEI scores by reducing nutrients from un-sewered community to improve water quality that is suitable to support aquatic habitat.

Problem Statement No. 5: ***The animal feeding operations have been identified as one of the contributors of low dissolved oxygen and ammonia***. OEPA identified that animal feeding operations exist within the Miller's Fork subwatershed may have contributed to the water quality impairment of the stream. **Goal:** Improve QHEI scores by reduce nutrients and ammonia from animal feeding operations to improve water quality that is suitable to support aquatic habitat.

Chapter 6
SUBWATERSHED DETAILS

This chapter provides details on each of 15 subwatersheds within the Twin Creek watershed. This includes aquatic life use attainment status and related data, causes and sources of stress, sub-watershed conditions, information on past and present conservation practices, past, present and planned conservation easements and land acquisitions, a problem statement, and a map. Further, it summarizes the TMDL recommended specific actions to address identified water quality concerns. Subwatershed information in this chapter is presented according to the 14-digit HUC order listed in the table below:

Streams of the Twin Creek Watershed

Tributary Name	14-Digit HUC	Watershed Area
Watersheds within 05080002-030		
Twin Creek above Miller's Fork	05080002-030-010	28,302 acres
Miller's Fork	05080002-030-020	15,513
Twin Creek below Miller's Fork to above Price's Creek	05080002-030-030	9,654
Swamp Creek	05080002-030-040	11,486
Price's Creek	05080002-030-050	18,825
Twin Creek below Price's Cr. To above Banta's Fork (including Lesley Run)	05080002-030-060	16,727
Watersheds within 05080002-040		
Banta's Fork above Goose Creek	05080002-040-010	7,978
Goose Creek	05080002-040-020	7,231
Banta's Fork below Goose Creek	05080002-040-030	7,279
Twin Creek below Banta's Fork above Aukerman Creek	05080002-040-040	7,974
Aukerman Creek	05080002-040-050	13,327
Twin Creek below Aukerman Creek above Tom's Run	05080002-040-060	13,033
Tom's Run	05080002-040-070	16,481
Twin Creek below Tom's Run to GMR Miami River	05080002-040-080	13,810
Little Twin Creek	05080002-040-090	14,531

Conservation Easements

Conservation easements within the Twin Creek watershed are primarily acquired by the Five Rivers Metroparks, Three Valley Conservation Trust, Montgomery County SWCD, Darke County Land Trust, Miami Conservancy District, and Clay and Perry Townships in Montgomery County. Conservation easements covered 3,493 acres of the 201,155 acres in the Twin Creek Watershed prior to initiation of the Watershed Action Plan in January, 2005. During the Watershed Action Planning process between 2005 and 2008, an additional 3,972 acres of easements were completed, protecting some twelve miles of additional stream frontage. More than 1,100 acres of these easements are clustered in and around the stream corridor on the mainstem of the Twin Creek from just north of the confluence of Price's Creek and Twin Creek south to north of Banta's Fork. Another 1,000 acres were clustered at the Preble-Montgomery County line on both sides of Twin Creek south of Aukerman Creek and upstream of Tom's Run. Another 653 acres were protected along Tom's Run, and another 900 acres mostly along Price's Creek. Between 2008 and 2009, an additional 1,778 acres of easements have been established

within the watershed. The continuing success of the conservation easement program is an extraordinary strength of the Twin Creek Partnership.

Aquatic Life Attainment

Aquatic life use attainment data presented by subwatershed has been extracted from Appendix D, titled "Ohio EPA Aquatic Life Use Status Data for Twin Creek (Based on 2005 Data)". Additional details concerning Ohio EPA's 2005 sampling procedures are found in Appendix E. Biological community performance measures used by Ohio EPA include the Index of Biotic Integrity (IBI) and Modified Index of Well Being (MIwb), both based on fish community characteristics and the Invertebrate Community Index (ICI) based on macroinvertebrate community characteristics. (See http://www.epa.state.oh.us/dsw/wqs/index.html) for further information on these indices). The Qualitative Habitat Evaluation Index (QHEI), developed by Ohio EPA, score various attributes of aquatic habitat in relation to maintenance of viable, diverse and functional aquatic life. (See http://www.epa.state.oh.us/dsw/bioassess/BioCriteriaProtAqLife.html for further information.). Sources and causes of stress were determined by OEPA TMDL process. In summary, Twin Creek's 15 subwatersheds fall into three attainment categories (2005):

- Four subwatersheds in the lower portion of the drainage basin are in full attainment of their aquatic life use designations: Twin Creek below Banta's Fork to above Aukerman Creek, Aukerman Creek, Twin Creek below Aukerman Creek to above Tom's Run, and Twin Creek below Tom's Run to the Great Miami River. Accordingly, measures to maintain their high quality include land conservation via conservation easements, parkland acquisition, as well as all watershed-wide education and protective measures presented in Table 5-1.

- Three subwatersheds – Upper and Lower Banta's Fork and Little Twin Creek – are in partial attainment, but the contributors are partially the result of low flow based on Ohio EPA data. As with subwatersheds in full attainment, subwatershed goals that focus on land conservation via conservation easements and parkland acquisition, on education and other protective measures are appropriate, but are supplemented with other recommendations when contributors to impairment are known or implied. The Twin Creek Watershed Partnership (TCWP) evaluated these segments during a normal flow condition in 2008.

- The remaining eight subwatersheds, roughly comprising the middle and upper third of the entire watershed, have identified causes and sources of stress for which recommendations are more specific. These eight subwatersheds are: Upper Twin Creek, Miller's Fork, Twin Creek below Miller's Fork to above Price's Creek, Swamp Creek, Price's Creek, Twin Creek below Price's Creek to above Banta's Fork, Goose Creek, and Tom's Run. While all 15 subwatersheds are important and share similarities, those that are most impaired may warrant more immediate attention from the TCWP with regard to specific actions.

Conservation Practices

Since Ohio EPA's 2005 survey, over 300 conservation practices have been installed throughout the Twin Creek watershed and many more are planned. The projected water quality benefits of these practices have been quantified by subwatershed (e.g. soil savings in tons per

year), wherever possible. Additional data collected during plan implementation will further document the actual water quality benefits of recently installed and future conservation practices.

TMDL Findings

The TMDL for the Twin Creek Watershed was published on January 21, 2010 and approved by USEPA on March 4, 2010. The TMDL document identified the sources and causes of impairment of Twin Creek and its tributaries and presented TMDL linkage analysis, numeric targets and contaminants allocations. The Twin Creek Watershed TMDL noted that it is very difficult to adequately characterize impairment in the watershed by addressing each cause independently. The TMDL concluded that because habitat alteration is a cause of impairment throughout the watershed and physical habitat quality is an environmental condition, development of a traditional load-based TMDL for Twin Creek is impractical. The TMDL proposed the use of QHEI as surrogate target. Water quality improvement strategy was laid out specifically to 14-digit HUC subwatersheds and also specific restoration tasks for each subwatersheds and restoration categories. In summary, the TMDL recommended the following strategies for the following subwatersheds:

05080002030010: Bank & riparian restoration, stream restoration, wetland restoration, conservation easement, education and outreach, agricultural BMPs.

05080002030030020/040/050/060 : Bank & riparian restoration, stream restoration, wetland restoration, conservation easement, education and outreach, agricultural BMPs, also home sewage improvement.

05080002040020: Bank & riparian restoration, education and outreach, agricultural BMPs.

05080002040070: Bank & riparian restoration, stream restoration, wetland restoration, conservation easement, education and outreach, agricultural BMPs.

Specifically, restoration actions for each strategy are also recommended:

- Bank & riparian restoration
  - Restore streambank using bio-engineering
  - Restore streambank by recontouring or regrading
  - Plant (prairie) grasses
  - Remove invasive species
  - Plant trees/shrubs
- Stream restoration
  - Restore floodplain
  - Restore stream channel
  - Install in-stream habitat structure
  - Construct 2-stage channel
- Wetland restoration
  - Reconnect wetland to stream
  - Reconstruct & restore wetlands
  - Plant wetland species
- Conservation Easement
- Education & Outreach
- Home Sewage Planning & Improvement
  - Develop HSTS Plan

  - Inspect HSTS
  - Repair/replace traditional HSTS
  - Repair/replace alternative HSTS
- Agricultural BMPs
- Farmland
  - Plant cover/manure crops
  - Implement conservation tillage
  - Implement grass/legume rotations
  - Install grassed waterways
  - Install vegetated buffer areas/strips
  - Install location-specific conservation buffers
  - Install wetlands
- Nutrients/agro-chemicals
  - Conduct soil testing
  - Install nitrogen reduction practices
  - Develop nutrient management plans
- Drainage
  - Install controlled drainage system
  - Implement drainage water management
  - Construct 2-stage channel
- Livestock
  - Implement prescribed & conservation grazing
  - Install livestock exclusion fencing
  - Install alternative water supplies
- Manure
  - Implement manure management practices
  - Construct animal waste storage structures
  - Implement manure transfer practices
- Misc. infrastructure and management
  - Install erosion & sediment control structures
  - Install milkhouse waste treatment practices
  - Develop whole farm management plans

The specific actions for the subwatersheds recommended in the TMDL are listed in each following subsections.

6.1 Upper Twin Creek above Miller's Fork (HUC: 05080002-030-010)

Drainage Area: 28,302 acres
Counties: Darke, Preble

Aquatic Life Use Attainment Status, Causes and Sources of Stress

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of Stress	Sources of Stress
$46.5^{H}/46.6$	50	N/A	Very Good^{ns}	43.0	EWH	Full	None	None
$42.1^{W}/42.0$	48^{ns}	9.1^{ns}	46	75.5	EWH	Full		
$38.0^{W}/38.1$	46^{ns}	9.0^{ns}	50	61.0	EWH	Full		
Maple Swamp Ditch – Tributary to Twin Creek @ RM 47.03								
$2.4^{H}/2.4$	38	N/A	Poor	21.0	MHW recommended	Partial	Sedimentation/ Siltation/algae	Channelization; loss of riparian; crops w/ subsurface drainage
$1.4^{H}/1.4$	44	N/A	Good	38.5	WWH recommended	Full	None	None
Dry Fork – Tributary to Twin Creek @ RM 39.35								
$0.8^{H}/0.8$	40	N/A	Good	50.0	WWH	Full	None	None

Ns: nonsignificant departure from biocriteria used by Ohio EPA to evaluate data
SOURCE: Ohio EPA 2007

Subwatershed Background

The communities of Castine and West Manchester lie completely within this subwatershed as well as portions of Eldorado and Lewisburg. The topography of the subwatershed is nearly level with most slopes in the 0-2% and 2-6% range. Very little HEL acreage occurs as compared with areas in the lower part of Twin Creek watershed (Figure 3.3.2). Livestock production including turkeys, chickens, and beef cattle are not raised in the subwatershed. One confined feeding operation (CAFO) occurs in the Preble County portion of the subwatershed near Dry Fork. Row cropping of soybeans and corn is the dominant agricultural activity in the Preble County portion of the watershed.

Full Attainment of EWH was designated for Upper Twin Creek between 38.0 to 46.5 Stream mile. This represents an improvement from 1995 when Ohio EPA found that at mile 42.2 the stream was in partial attainment because of a "significant departure from EWH biocriterion not considered indicative of any specific water quality perturbation." (Ohio EPA 1997).

Maple Swamp Ditch, which was in only partial attainment at its most upstream station (2.4), is a formerly shallow stream that flows through poorly drained Crosby and Brookston soils. This waterway has no riparian buffer and had been channelized. The stream's low gradient has resulted in little erosion, although apparent nutrient enrichment has occurred due to adjacent row cropping and possible scattered use of septic systems. Darke NRCS/SWCD personnel noted that some older mound systems nearby may be totally nonfunctional, causing untreated home sewage to reach Maple Swamp Ditch without treatment. The Darke County Ditch Maintenance Department manages the Maple Swamp Ditch and other ditches and small creeks with the county.

Past & Present Conservation Efforts

Among the conservation practices and programs utilized within this subwatershed have been grass waterways and filter strips using cool season grasses through the Conservation Reserve Program (CRP), and precision nutrient management and fertilizer containment through the Environmental Quality Incentives Program (EQIP). Some landowners also are participating in the water quality trading program managed by the Miami Conservancy District.

Preble NRCS/SWCD personnel observed a recent increase in no-till corn production and an overall shift from soybeans to corn, perhaps related to an ethanol production plant in Greenville. Further, the increasing cost of fuels and fertilizers may be heightening interest in more efficient and precise agricultural practices consistent with soil and water conservation. The following tables list the conservation practices and measures with calculated load reductions between 2007 and 2009.

Conservation Practices in the Subwatershed

Location	Practice	Area Affected	Date	WQ Benefits
Sec. 19 Harrison Twp.	Field Border (CP33)	20.2 acres	2007	Erosion, chemical & nutrient reduction Soil savings of 1.0 T/ac./yr.
NW Sec. Monroe Twp.	Grass Waterway (CP8a)	1.1 acre	2007	Ephemeral erosion reduced 37 T/yr.
SE ¼, Sec 12, Monroe Twp.	Nutrient Mgmt.	70.1 acres	2007 - 2009	Nutrient application/utilization improved.
" "	Heavy Use Protection	1 structure	2008	Manure runoff controlled; reduced organics in ground & surface waters
" "	Access Road	460 acres	2008	Reduced compaction & erosion
" "	Use exclusion-stream		2008	Reduced stream bank erosion, reduced

Location	Practice	Area Affected	Date	WQ Benefits
				organics in stream
" "	Water Facility	2 tanks	2008	Reduced stream bank erosion, reduced organics in stream

Conservation Measures Installed within the Subwatershed

County	Subwatershed	Practices	2007-2009	tons soil/yr saved 2005-6	Tons Soil saved/yr 07-09	Nitrogen Load Reduction Lbs/yr	Phosphorus Load Reduction LBs/yr
Preble	Upper Twin	CP 33 (acres)		43		69	34
Preble	Upper Twin	Pasture Planting (acres)	102				
Preble	Upper Twin	Nutrient Management (acres)	518	beef 605ppm k reduction		1704	230
Preble	Upper Twin	Grass waterways (acres)	2	8	100	113	88
Preble	Upper Twin	Use Exclusion (acres)	20				
Preble	Upper Twin	Heavy Use area (facilities)	4	beef cattle			
Preble	Upper Twin	Fence (feet)	33,683				
Preble	Upper Twin	Watering facility (facilities)	12	beef cattle			
Preble	Upper Twin	Access Road (feet)	6060				
Preble	Upper Twin	Stream Crossings	3				
Preble	Upper Twin	Waste Storage (facilities)		50 A/U beef cattle		2900	538
Preble	Upper Twin	Waste Storage (facilities)		160 A/U swine		5825	1151
Darke	Upper Twin	Grass Waterways (acres)	6	11	16	37	24
Darke	Upper Twin	Field Border	3				
Darke	Upper Twin	Filter Strips (acres)		59 tons/yr		885	448

Specific Actions:

The Twin Creek watershed TMDL determined that it is difficult to address each causes of impairment independently and recommended specific actions for improving the habitat targets.

The goal to improve this subwatershed is to improve the QHEI scores by:

1) restoring natural channel to improve water quality that is suitable for aquatic life,
2) increasing riparian buffer to improve water quality that is suitable for aquatic life,
3) protecting existing riparian to prevent further loss of riparian.
4) removing drainage tiles and promote wetland to improve water quality that is suitable for aquatic life, and
5) installing controlled drainage devices to regulate and reduce nutrients to improve water quality that is suitable for aquatic life.

Restoration Categories	Specific Tasks	Project Partner	Funding	Time Frame	Performance Indicators
Bank & riparian restoration	• Restore streambank using bio-engineering • Restore streambank by recontouring/ regrading	SWCD, Pheasants Forever, USFW	319 grant, USFW	2011-2013	Restoring 2000 feet of streambanks. Planting 6 acres of grasses and shrubs

	• Plant grasses/prairie grass in riparian areas • Plant trees or shrubs in riparian areas				
Stream restoration	• Restore stream channel • Install in-stream habitat structures • Construct 2-stage channel	Ditch maintenance, county engineers, SWCD,USFW	319 grant, USFW	2011-2013	Restoring 400 feet of natural stream
Wetland restoration	• Reconnect wetland to stream • Reconstruct & restore wetlands • Plant wetland species	SWCD, Pheasants Forever, USFW	USFW, Pheasants Forever	2011-2013	Restoring 4 acres of wetlands
Conservation Easement	• Acquire Conservation easement	TVCT, Preble SWCD, Darke SWCD	319 & other grants	2011-2013	Protect 400 acres in the next 3 years
Education & Outreach	• Host meetings/workshops/events • Distribute education materials	SWCDs, TCWP	OEEF, ODNR, local funds	2011-2013	Hosting 5 events/year; maintaining website/disseminating watershed materials.
Agricultural BMPS – Farmland	• Plant cover/manure crops • Install grassed waterways • Install vegetated buffer areas/strips • Install location-specific conservation buffers	SWCD, USDA, MCD	USDA, MCD – nutrient trading program	2011-203	500 acres of rotation, cover crops, grassed waterways and buffers.
Agricultural BMPS – Nutrient/agro-chemical	• Conduct soil testing • Install nitrogen reduction practices • Develop nutrient management plan	SWCD, USDA, MCD	USDA, MCD - nutrient trading program	2011-2013	500 acres of nutrient reduction
Agricultural BMPS – drainage	• Install controlled drainage system • Implement drainage water management • Construct 2-stage channel	SWCD, USDA, MCD	319 grant EQIP	2011-2013	40 acres of drainage management
Agricultural BMPS – livestock	• Implement prescribed & conservation grazing • Install livestock exclusion fencing • Install alternative water supplies	SWCD, USDA	EQIP	2011-2013	150 acres of livestock management
Agricultural BMPS – manure	• Implement manure management practices • Construct animal waste storage structures • Implement manure	SWCD, USDA	USDA	2011-2013	4 facilities of manure management

	transfer practices				
Agricultural BMPS – Misc. infrastructure and management	• Develop whole farm management plans	SWCD, USDA	USDA	2011-2013	4 whole farm management plans
NPDES-TMDL Recommendation	**Specific Actions**	**NPDES permit holder**			
NPDES permit holder: West Manchester WWTP	• Next permit cycle: monitor for total phosphorous, total kjeldahl nitrogen and nitrate-nitrite	West Manchester WWTP			

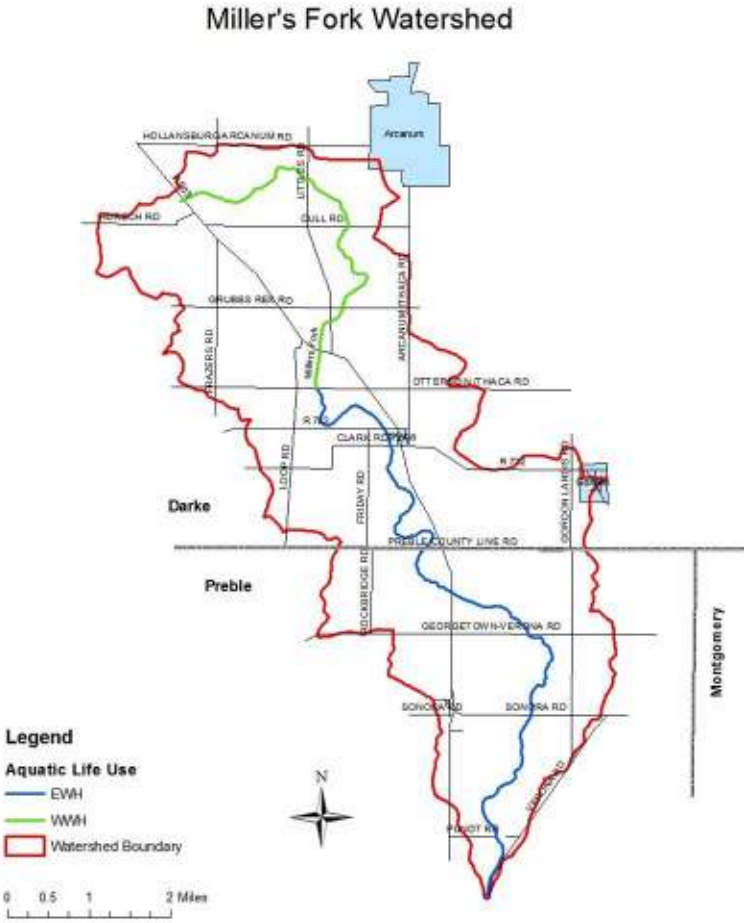
6.2 Miller's Fork –Tributary to Twin Creek @ RM 35.71 (HUC: 05080002-030-020)

Drainage Area: 15,513 acres
Counties: Darke, Preble

Aquatic Life Use Attainment Status, Causes and Sources of Stress

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of stress	Sources of stress
$10.8^{H}/10.8$	40	N/A	LF	33.0	EWH*	Partial	Sedimentation, low DO, ammonia	Channelization; loss of riparian; crops w/ subsurface drainage; unsewered area
$8.0^{H}/8.0$*	48^{ns}	N/A	G	66.5	EWH	Partial	Shallow bedrock	Natural
$3.9^{H}/3.9$	48^{ns}	N/A	MG	58.0	EWH	Partial	Sedimentation, low DO, ammonia	Loss of riparian; animal feeding operations

LF: Low Fair; G: Good; MG: Marginally good
SOURCE: Ohio EPA 2007



Subwatershed Background

Portions of the Darke County communities of Arcanum, Ithaca, and Gordon are located in this subwatershed. The northernmost portion of the subwatershed is characterized by relatively level slopes, but near Otterbein-Ithaca Road and south to the Preble County line the terrain becomes slightly steeper with slopes in the 6-12% range. South of the Preble line the terrain flattens again. Although more than 90% of the agricultural activity in the Preble portion of the subwatershed is related to corn and soybean production, some hay and wheat production occurs. The subwatershed in Preble County also includes a few small hobby farms with horse pastures.

The uppermost portion of Miller's Fork appears to show impacts common to other relatively flat headwater areas in the Twin Creek watershed, including channelization, low flows, small and little riparian vegetation. Stream modifications related to agricultural activities may be very long-standing. As it continues toward its confluence with the Twin Creek mainstem, the stream seems to have a more natural meander pattern; higher QHEI scores reflect improved riparian conditions.

Past and Present Conservation Efforts

A variety of conservation practices and programs have been utilized in this subwatershed, especially grass waterways and, more recently, wildlife field borders through CP-33. At least 303 tons of soil per year are reduced. Preble NRCS/SWCD personnel report working more recently with small beef operations on water supply development to decrease livestock watering in Miller's Fork. Animal waste storage systems and heavy use areas also have been installed. Such practices reduce soil erosion and nutrient loadings to Miller's Fork.

Conservation Measures within the subwatershed

County	Subwatershed	Practices	2005-2006	2007-2009	tons soil/yr saved 05-06	Tons Soil saved/yr 07-09	Nitrogen Load Reduction Lbs/yr	Phosphorus Load Reduction LBs/yr
Preble	Miller's Fork	CP 33	20		20		32	16
Preble	Miller's Fork	Pasture Planting (acres)		7		52	165	83
Preble	Miller's Fork	Grass waterways (acres) soils		2		28	45	22
Preble	Miller's Fork	Use Exclusion (acres)		22				
Preble	Miller's Fork	Fence (feet)		3,680				
Preble	Miller's Fork	Watering facility (facilities)		2				
Preble	Miller's Fork	Access Road (feet)		960				
Preble	Miller's Fork	Waste Storage (facilities)		1		140 a/u beef cattle		
Darke	Miller's Fork	Grass waterways (acres)	32	7	66	17	93	80
Darke	Miller's Fork	Filter Strips (acres)	19		110 tons/yr		1681	851
Darke	Miller's Fork	Access Road (feet)	2129					
Darke	Miller's Fork	Habitat Field Border (acres)		1				

Specific Actions:

The Twin Creek watershed TMDL determined that it is difficult to address each causes of impairment independently and recommended specific actions for improving the habitat targets.

The goal to improve this subwatershed is to improve the QHEI scores by:

- restoring natural channel to improve water quality that is suitable for aquatic life.
- preventing soil erosion and reduce field runoff to improve water quality that is suitable for aquatic life.
- protecting existing riparian to prevent further loss of riparian.
- reducing nutrients from animal feed operations to improve water quality that is suitable for aquatic life.
- reducing nutrients from unsewered community to improve water quality that is suitable for aquatic life.

Restoration Categories	**Specific Tasks**	**Project Partner**	**Funding**	**Time Frame**	**Performance Indicators**
Bank & riparian restoration	• Plant grasses/prairie grass in riparian areas • Plant trees or shrubs in riparian areas	SWCD, Pheasants Forever, USFW	319 grant, USFW	2011-2013	Planting 6 acres of grasses and shrubs
Stream restoration	• Restore floodplain • Install in-stream habitat structures	Ditch maintenance, county engineers, SWCD,USFW	319 grant, USFW	2011-2013	Restoring 600 feet of natural stream
Wetland restoration	• Reconnect wetland to stream • Reconstruct & restore wetlands • Plant wetland species	SWCD, Pheasants Forever, USFW	USFW, Pheasants Forever	2011-2013	Restoring 6 acres of wetlands
Conservation Easement	• Acquire Conservation easement	TVCT	319 and other grants	2011-2013	Protect 200 acres in the next 3 years
Education & Outreach	• Host meetings/workshops/events • Distribute education materials	SWCD, TCWP	OEEF, ODNR, local funds	2011-2013	Hosting 5 events/year; maintaining website/disseminating watershed materials.
Home Sewage Planning & Improvement	• Develop/inspect HSTS Plan • Repair/replace traditional/alternative HSTS	Health departments/TCWP	Unclear at this point	2011-2013	30-50 HSTS repair or replaced.
Agricultural BMPS – Farmland	• Implement conservation tillage practices • Implement grass/legume rotations • Plant cover/manure crops • Install grassed waterways • Install vegetated buffer areas/strips • Install location-specific conservation buffers	SWCD, USDA, MCD	USDA, MCD – nutrient trading program	2011-2013	600 aces of conservation tillage, crop rotation, cover crops, grassed waterways and buffers.

Agricultural BMPS – Nutrient/agro-chemical	• Conduct soil testing • Install nitrogen reduction practices • Develop nutrient management plan	SWCD, USDA, MCD	USDA, MCD - nutrient trading program	2011-2013	600 acres of nutrient reduction
Agricultural BMPS – drainage	• Install controlled drainage system • Implement drainage water management • Construct 2-stage channel	SWCD, USDA, MCD	319 grant EQIP	2011-2013	40 acres of drainage management
Agricultural BMPS – livestock	• Implement prescribed & conservation grazing • Install livestock exclusion fencing • Install alternative water supplies	SWCD, USDA	EQIP	2011-2013	150 acres of livestock management
Agricultural BMPS – manure	• Implement manure management practices • Construct animal waste storage structures • Implement manure transfer practices	SWCD, USDA	USDA	2011-2013	4 facilities of manure management
Agricultural BMPS – Misc. infrastructure and management	• Install erosion & sediment control structures • Develop whole farm management plans	SWCD, USDA	USDA	2011-2013	4 whole farm management plans

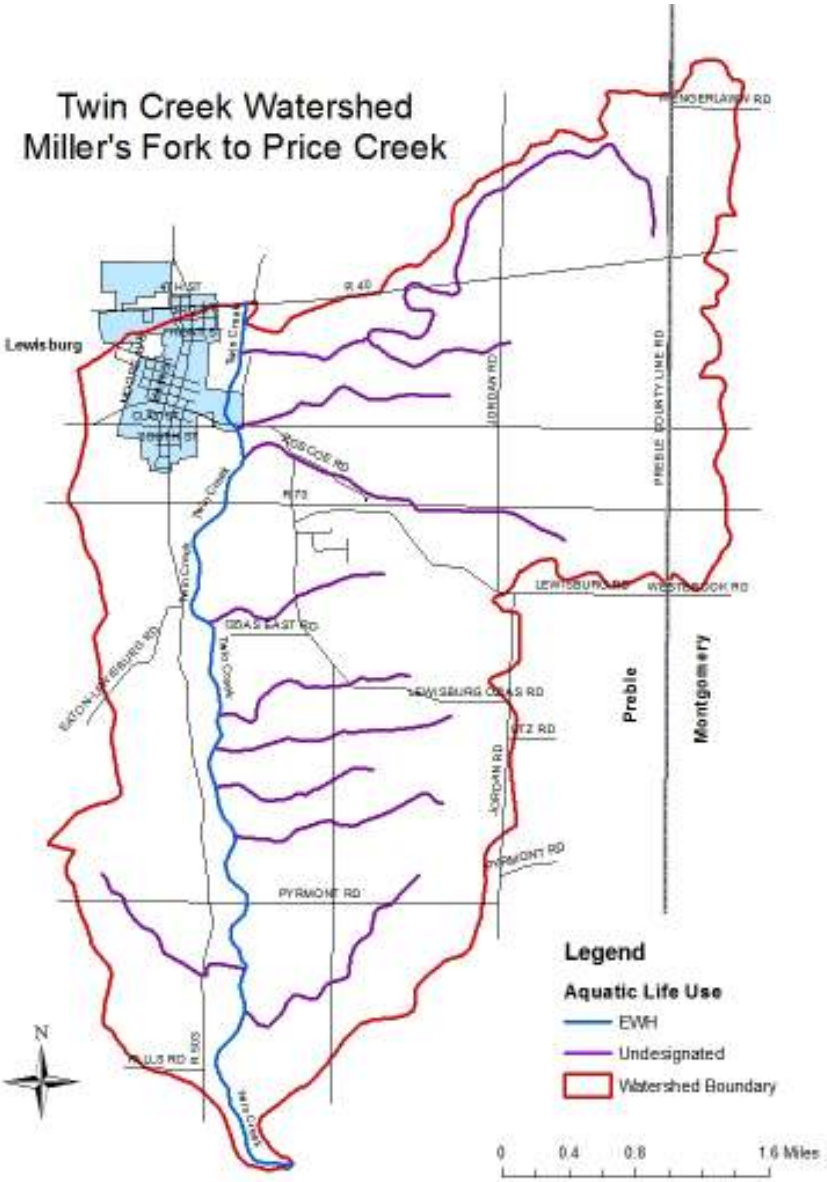
6.3 Twin Creek below Miller's Fork to above Price's Creek (HUC: 05080002-030-030)

Drainage Area: 9,654 acres
Counties: Montgomery, Preble

Aquatic Life Use Attainment Status, Causes and Sources of Stress

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of Stress	Sources of Stress
35.5[W]/35.4	58	10.2	50	67.0	EWH	Full	None	None
34.9[W]/34.9	58	10.2	38	71.0	EWH	Partial	Phosphorous	WWTP
33.6[W]/33.5	58	10.3	52	77.0	EWH	Full	None	None
31.7[W]/31.7	55	9.6	54	72.5	EWH	Full	None	None

SOURCE: Ohio EPA 2007



Subwatershed Background

Most of the community of Lewisburg lies within this subwatershed. Although this subwatershed includes portions that are relatively flat with slow drainage, most of the subwatershed is more rolling than subwatersheds to the north and includes significant acreage with 6-12% and 12-18% slopes. Preble NRCS/SWCD personnel estimate that 15-20% of the subwatershed's area is HEL (Figure 3.2.2). In contrast to subwatersheds to the north, this subwatershed includes more hay and livestock, especially beef and horses. Corn, soybeans and wheat also are raised in the subwatershed. North American Nutrition Companies, a company providing services to the feed, livestock and poultry industries, has a small number of confined hogs at its research facility. Although the Lewisburg WWTP has been upgraded, it was listed as a source of stress at RM 34.9 during Ohio EPA's 2005 stream survey. Some nutrient enrichment and bacteria in that reach also may be contributed by failing septic tanks installed in the 1970s.

Past and Present Conservation Efforts

Filter strips and grass waterways have been the most common conservation practices installed in this subwatershed. The field border and grass waterways were projected to cumulatively save approximately 165 tons of soil per year from reaching this part of Twin Creek.

Conservation Practices in the Subwatershed

Location	Practice	Area Affected	Date	WQ Benefits
Preble County				
Sec. 4 Twin Twp.	Field Border (CP33)	54.7 ac.	2007	Erosion, chemical & nutrient reduction Soil savings of 2.5 T/ac./yr.
Sec. 27 Harrison Twp.	Grass Waterway (CP8a)	1.7 ac.	2007	Ephemeral erosion reduced 28 T/yr.

Conservation Measures Installed in the Subwatershed

County	Subwatershed	Practices	2005-2006	2007-2009	tons soil/yr saved 2005-6	Tons Soil saved/yr 07-09	Nitrogen Load Reduction Lbs/yr	Phosphorus Load Reduction LBs/yr
Preble	Upper Twin	CP 33 (acres)	43		43		69	34
Preble	Upper Twin	Pasture Planting (acres)		102				
Preble	Upper Twin	Nutrient Management (acres)		518	beef 605ppm k reduction			
Preble	Upper Twin	Grass waterways (acres)	2	2	8	100	113	88
Preble	Upper Twin	Use Exclusion (acres)		20				
Preble	Upper Twin	Heavy Use area (facilities)		4	beef cattle			
Preble	Upper Twin	Fence (feet)		33,683				
Preble	Upper Twin	Watering facility (facilities)		12	beef cattle			
Preble	Upper Twin	Access Road (feet)		6060				
Preble	Upper Twin	Stream Crossings		3				
Preble	Upper Twin	Waste Storage (facilities)	1		50 A/U beef cattle		2900	538
Preble	Upper Twin	Waste Storage (facilities)	3		160 A/U swine		5825	1151
Preble	Upper Twin	CP 33 (acres)	7		1		2	1

Problem Statement

No distinct water quality problems were noted in this subwatershed by Ohio EPA during either the 2005 or 1995 sampling except one location associated with the Lewisburg WWTP. The TMDL recommended the following WWTPs to continue to monitor their effluents.

NPDES-TMDL Recommendations	Specific Action	NPDES Facility
NPDES permit holder: Lewisburg WWTP	• Next permit cycle: issue a new permit with compliance schedule and a new limit of 1.0 mg/L for total phosphorous, monitor for total kjeldahl nitrogen and nitrate-nitrite	Lewisburg WWTP
NPDES permit holder: Preble Co. SD#2 WWTP	• Next permit cycle: monitor for total phosphorous, total kjeldahl nitrogen and nitrate-nitrite	Preble Co. SD#2 WWTP
NPDES permit holder: P &G Pet Care	• Next permit cycle: continue to monitor for total phosphorous, total kjeldahl nitrogen and nitrate-nitrite	P &G Pet Care
NPDES permit holder: North American Nutrition	• Next permit cycle: monitor for total phosphorous, total kjeldahl nitrogen and nitrate-nitrite in draft permit	North American Nutrition

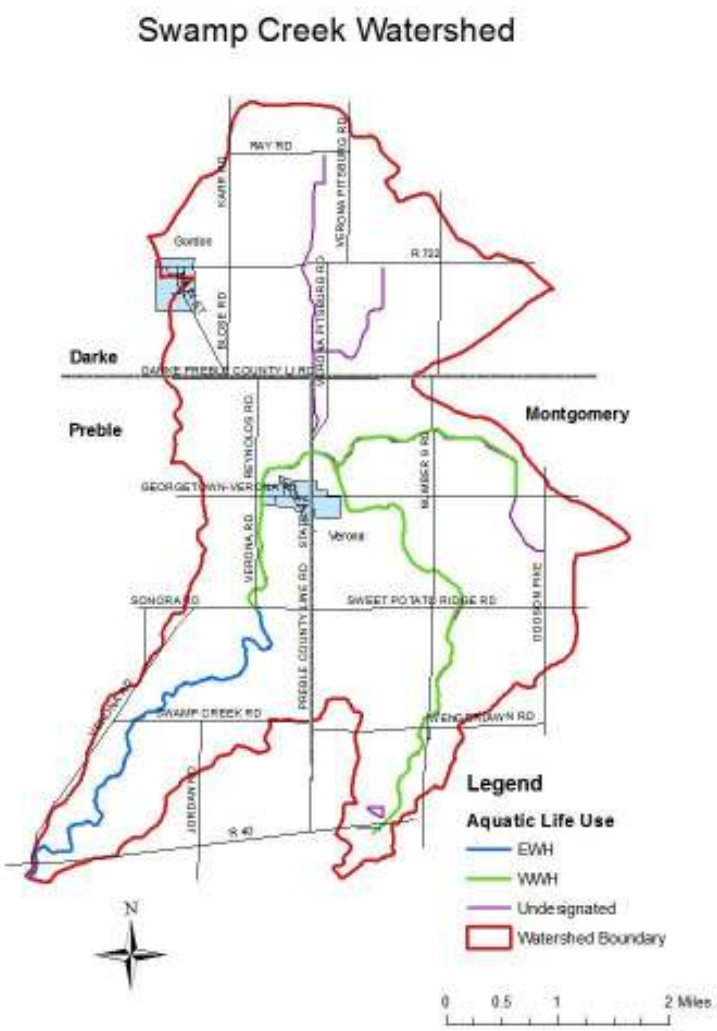
6.4 Swamp Creek – Tributary to Twin Creek @ RM 35.59 (HUC: 05080002-030-040)

Drainage Area: 11,486 acres
Counties: Darke, Montgomery, Preble

Aquatic Life Use Attainment Status, Source and Cause of Stress

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of Stress	Sources of Stress
6.3^{H}/6.4	44	N/A	F	34.0	WWH	Partial	Ammonia; phosphorus, sedimentation	Channelization, loss of riparian, crops with subsurface drainage
-- /0.2	None	None	MG	None	EWH	*	None	None
Trib. to Swamp Creek @RM 6.45 (Fish sample from 0.3^{H})	38^{ns}	N/A	None	37.5	Undesignated (not previously sampled)- WWH recommended	Full, if WWH	None	None

* No status attainment provided by Ohio EPA, presumably because of insufficient data.
SOURCE: Ohio EPA 2007



Subwatershed Background

The community of Verona is in the center of this subwatershed on the Preble-Montgomery line, while the smaller community of Gordon, located in Darke County, is partly in the watershed. Some residential growth is occurring near Verona, but Gordon is not growing. The small village of Wengerlawn is located in Montgomery County and consists of about 30 homes with septic systems. The topography is slightly rolling in the northern portion of the subwatershed, somewhat flatter in the eastern portion in Montgomery County, and tending to steeper in the southwesternmost portion in Preble County. In addition to row cropping in suitable areas of the subwatershed, hay and livestock production, as well as horse boarding, occur along the lowermost reaches of Swamp Creek. Montgomery NRCS/SWCD personnel also noted that lack of storm sewers in Verona make the community prone to flooding on the south side. The southern branch of Swamp Creek south of Potato Ridge Road has undergone channel modification. Similarly, Swamp Creek Ditch, which drains to Swamp Creek northeast of Verona, has been straightened and maintained by the Montgomery SWCD.

Past and Present Conservation Efforts

Grass waterways are the most common conservation practice installed in the subwatershed. Darke County NRCS/SWCD personnel note that participation in conservation practices has historically been low in that part of Darke County. Participation in conservation practices appears to be related both to heightened awareness of beneficial practices and availability of funds to implement them. The following tables list the conservation practices and measures with calculated load reductions between 2007 and 2009.

Conservation Practices in the Subwatershed

Location	Practice	Area Affected	Date	WQ Benefits
Preble County				
SE 1/4 Sec. 14 Harrison Twp.	Waste Storage Facility	2 structures	2008	Manure runoff controlled, reduced organics in ground & surface water
SE 1/4 Sec. 14 Harrison Twp.	Heavy Use Protection Area	2 structures	2007, 2008	Manure runoff controlled, reduced organics in ground & surface water
SE 1/4 Sec. 14 Harrison Twp.	Access Road	4200 feet	2007	Reduced compaction & erosion
SE 1/4 Sec. 14 Harrison Twp.	Use Exclusion - Stream	2720 feet of fence	2007	Reduced stream bank erosion, reduced organics in surface water and stream
SE 1/4 Sec. 14 Harrison Twp.	Stream Crossing	1 crossing	2007	Reduced stream bank erosion, reduced organics in surface water and stream
Montgomery County				
Clay Twp.	Grass Waterway	3,025 Ft.	2006	Soil savings of 15 T/yr.*
Clay Twp.	Grass Waterway	2 waterways total of 3,452 ft.	2006	Soil savings of 8 T/yr.

- *Note there is not a direct or proportional relationship between the number of feet in a waterway and soil loss reduction. This is because each waterway has a unique combination of topography and soil types, the two factors that determine erosion rates.*

Conservation Measures in the Subwatershed

County	Subwatershed	Practices	2005-2006	2007-2009	tons soil/yr saved 2005-6	Tons Soil saved/yr 07-09	Nitrogen Load Reduction Lbs/yr	Phosphorus Load Reduction LBs/yr
Preble	Swamp Creek	Use Exclusion (feet)	4500	2720	56 A/U beef cattle	290 A/U beef cattle	617	93
Preble	Swamp Creek	Heavy Use area (facilities)	2 sites, 3784'	1 site, 1716'	140 A/U beef cattle	100 A/U beef cattle	321	64
Preble	Swamp Creek	Fence (feet)	2355		beef cattle		219	44
Preble	Swamp Creek	Watering facility (facilities)	1	1	beef cattle	beef cattle		
Preble	Swamp Creek	Access Road (feet)	2030	4320				
Preble	Swamp Creek	Stream Crossings		2				
Preble	Swamp Creek	Waste Storage (facilities)		1	37	140 A/U beef cattle		

Specific Actions:

The Twin Creek watershed TMDL determined that it is difficult to address each causes of impairment independently and recommended specific actions for improving the habitat targets.

The goal to improve this subwatershed is to improve the QHEI scores by:

- restoring natural channel to improve water quality that is suitable for aquatic life,
- preventing soil erosion and reduce field runoff to improve water quality that is suitable for aquatic life,
- protecting existing riparian to prevent further loss of riparian,
- removing drainage tiles and promote wetland to improve water quality that is suitable for aquatic life, and
- managing nutrients to improve water quality that is suitable for aquatic life.

Restoration Categories	Specific Tasks	Project Partner	Funding	Time Frame	Performance Indicators
Bank & riparian restoration	• Restore streambank by recontouring/regrading • Plant grasses/prairie grass in riparian areas • Plant trees or shrubs in riparian areas	SWCD, Pheasants Forever, USFW	319 grant, USFW	2011-2013	Planting 8 acres of grasses and shrubs
Stream restoration	• Restore floodplain • Install in-stream habitat structures	Ditch maintenance, county engineers, SWCD,USFW	319 grant, USFW	2011-2013	Restoring 800 feet of natural stream
Wetland restoration	• Reconnect wetland to stream • Reconstruct & restore wetlands • Plant wetland species	SWCD, Pheasants Forever, USFW	USFW, Pheasants Forever	2011-2013	Restoring 10 acres of wetlands

Conservation Easement	• Acquire Conservation easement	TVCT	319 and other grants	2011-2013	Protect 150 acres in the next 3 years.
Education & Outreach	• Host meetings/workshops/events • Distribute education materials	SWCD, TCWP	OEEF,ODNR, local funds	2011-2013	Hosting 5 events/year; maintained website/disseminating watershed materials.
Home Sewage Planning & Improvement	• Develop/inspect HSTS Plan • Repair/replace traditional/alternative HSTS	Health departments/TCWP	Unclear at this point	2011-2013	30-50 HSTS repair or replaced.
Agricultural BMPS – Farmland	• Implement conservation tillage practices • Implement grass/legume rotations • Plant cover/manure crops • Install grassed waterways • Install vegetated buffer areas/strips • Install location-specific conservation buffers	SWCD, USDA, MCD	USDA, MCD – nutrient trading program	2011-2013	800 acres of conservation tillage; 100-300 acres of rotation, cover crops, grassed waterways and buffers.
Agricultural BMPS – Nutrient/agro-chemical	• Conduct soil testing • Install nitrogen reduction practices • Develop nutrient management plan	SWCD, USDA, MCD	USDA, MCD - nutrient trading program	2011-2013	700 acres of nutrient reduction
Agricultural BMPS – livestock	• Implement prescribed & conservation grazing • Install livestock exclusion fencing • Install alternative water supplies	SWCD, USDA	EQIP	2011-2013	200 acres of livestock management
Agricultural BMPS – Misc. infrastructure and management	• Install erosion & sediment control structures • Develop whole farm management plans •	SWCD, USDA	USDA	2011-2013	6 whole farm management plans
NPDES-TMDL Recommendation	**Specific Actions**	**NPDES permit holder**			
NPDES permit holder: Verona WWTP	• Next permit cycle: monitor for total phosphorous, total kjeldahl nitrogen and nitrate-nitrite	Verona WWTP			

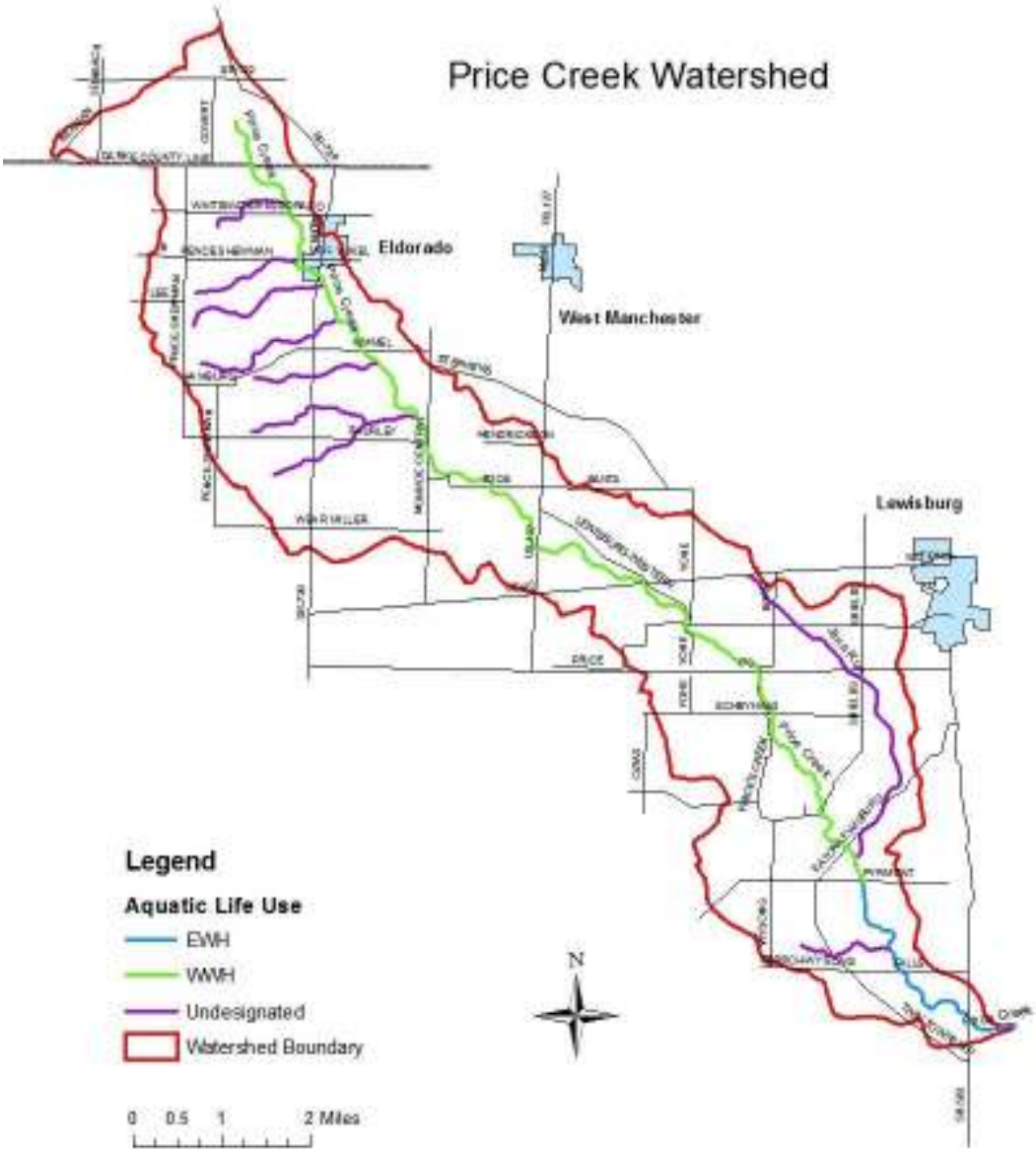
6.5 Price's Creek –Tributary to Twin Creek @ RM 29.74 (HUC: 05080002-030-050)

Drainage Area: 18,825 acres
Counties: Darke, Preble

Aquatic Life Use Attainment Status, Causes and Sources of Stress

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of Stress	Sources of Stress
$13.7^{H}/13.6$	38ns	N/A	LF	47.0	WWH	Partial	Low DO, ammonia, phosphorous	Agriculture, failing HSTS
$10.9^{H}/10.9$	46	N/A	G	62.5	WWH	Full	None	None
$3.8^{W}/3.9$	36	8.4	50	65.5	EWH, but WWH recommended.	Full	None	None

SOURCE: Ohio EPA 2007



Subwatershed Background

The community of Eldorado is partly located in this subwatershed. No other communities are located in the subwatershed. The upper part of this subwatershed is characterized by somewhat steep slopes (6-12%) and HEL acreage. Erosive soils north and west of Eldorado limit crop production. The terrain flattens as Price's Creek travels in a southeasterly direction, although additional HEL occurs along Price's Creek near Scheyhing Road. Residential strip development, served by septic systems, is occurring along major roads southwest of Lewisburg in an area not conducive to farming. Small cattle operations are a common agricultural activity in the subwatershed.

Past and Present Conservation Practices

The Darke NRCS/SWCD personnel indicate historically little participation in conservation practices in their portion of the subwatershed. Grass waterways are the most frequent practice in the northern part of the subwatershed in Preble County, in general. Cattle operators have installed stream crossings, watering facilities, stream exclusion practices, waste storage facilities, and heavy use areas, particularly in the southernmost portion of the watershed. The following tables list the conservation practices and measures with calculated load reductions between 2007 and 2009.

Conservation Practices in the Subwatershed

Location	Practice	Area Affected	Date	WQ Benefits
Sec. 14, Monroe twp.	Grass Waterway (CP8a)	1.5 ac.	2007	Ephemeral erosion reduced 27 tons/year
Sec.21, Monroe Twp.	Grass Waterway (CP8a)	2.9 ac.	2007	Ephemeral erosion reduced 72 tons/year
NE 1/4 Sec. 18, Twin Twp	Use Exclusion - Stream	1200 ft.	2007	Reduced stream bank erosion, reduced organics in surface water and stream
NE 1/4 Sec. 18, Twin Twp	Heavy Use Protection Area	1 structure	2007	Manure runoff controlled, reduced organics in ground & surface water
NE 1/4 Sec. 18, Twin Twp	Waste Storage Facility	1 structure	2008	Manure runoff controlled, reduced organics in ground & surface water
NE 1/4 Sec. 18, Twin Twp	Nutrient Management	89.5 ac.	2007, 2008	Commercial & organic nutrient application and utilization improved
NE 1/4 Sec. 18, Twin Twp	Stream Crossing	1 crossing	2007	Reduced stream bank erosion, reduced organics in surface water and stream

Conservation Measures in the Subwatershed

County	Subwatershed	Practices	2005-2006	2007-2009	tons soil/yr saved 2005-6	Tons Soil saved/yr 07-09	Nitrogen Load Reduction Lbs/yr	Phosphorus Load Reduction LBs/yr
Preble	Price's Creek	CP 33 (acres)	23	7	61	7	72	67
Preble	Price's Creek	Pasture Planting (acres)		5		39	122	61
Preble	Price's Creek	Nutrient Management (acres)		90		100ppm K rmvd/yr		
Preble	Price's Creek	Grass waterways (acres)	4	7	247	439	950	598
Preble	Price's Creek	Watering facility (facilities)		5				
Preble	Price's Creek	Access Road (feet)		21500				
Preble	Price's Creek	Waste Storage (facilities)		1		490 A/U beef cattle	5825	1075
Preble	Price's Creek	CNMP	1					
Preble	Price's Creek	Stream Crossings		1				
Preble	Price's Creek	Heavy Use area (facilities)		1				
Preble	Price's Creek	Use Exclusion (feet)		11645		490 A/U beef	656	131

Specific Actions:

The Twin Creek watershed TMDL determined that it is difficult to address each causes of impairment independently and recommended specific actions for improving the habitat targets.

The goal to improve this subwatershed is to improve the QHEI scores by:

- increasing riparian buffer to improve water quality that is suitable for aquatic life,
- reducing nutrients from animal feed operations to improve water quality that is suitable for aquatic life,
- reducing nutrients from failed septic systems to improve water quality that is suitable for aquatic life.

Restoration Categories	Specific Tasks	Project Partner	Funding	Time Frame	Performance Indicators
Bank & riparian restoration	• Plant grasses/prairie grass in riparian areas • Plant trees or shrubs in riparian areas	SWCD, Pheasants Forever, USFW	319 grant, USFW	2011-2013	Planting 3 acres of grasses and shrubs
Stream restoration	• Install in-stream habitat structures	Ditch maintenance, county engineers, SWCD,USFW	319 grant, USFW	2011-2013	Restoring 200 feet of natural stream
Wetland restoration	• Reconnect wetland to stream • Reconstruct & restore wetlands • Plant wetland species	SWCD, Pheasants Forever, USFW	USFW, Pheasants Forever	2011-2013	Restoring 2 acres of wetlands
Education & Outreach	• Host meetings/workshops/events • Distribute education materials	SWCD, TCWP	OEEF,ODNR, local funds	2011-2013	Hosting 3 events/year; maintained website/disseminating watershed materials.
Home Sewage Planning & Improvement	• Develop/inspect HSTS Plan • Repair/replace traditional/alternative HSTS	Health departments/TCWP	Unclear at this point	2011-2013	30-50 HSTS repair or replaced.
Agricultural BMPS – Farmland	• Plant cover/manure crops • Install vegetated buffer areas/strips • Install location-specific conservation buffers	SWCD, USDA, MCD	USDA, MCD – nutrient trading program	2011-2013	300-500 acres of conservation tillage; 100-300 acres of rotation, cover crops, grassed waterways and buffers.
Agricultural BMPS – Nutrient/agro-chemical	• Conduct soil testing • Install nitrogen reduction practices • Develop nutrient management plan	SWCD, USDA, MCD	USDA, MCD - nutrient trading program	2011-2013	100-300 acres of nutrient reduction
Agricultural BMPS – livestock	• Implement prescribed & conservation grazing	SWCD, USDA	EQIP	2011-2013	50-100 acres of livestock

	• Install livestock exclusion fencing • Install alternative water supplies				management
Agricultural BMPS – manure	• Implement manure management practices • Construct animal waste storage structures • Implement manure transfer practices	SWCD, USDA	USDA	2011-2013	2 facilities of manure management
Agricultural BMPS – Misc. infrastructure and management	• Develop whole farm management plans	SWCD, USDA	USDA	2011-2013	2 whole farm management plans
TMDL Recommendation	**Specific Actions**	**NPDES permit holder**			
NPDES permit holder: El Dorado WWTP	• Next permit cycle: monitor for total phosphorous, total kjeldahl nitrogen and nitrate-nitrite	El Dorado WWTP			

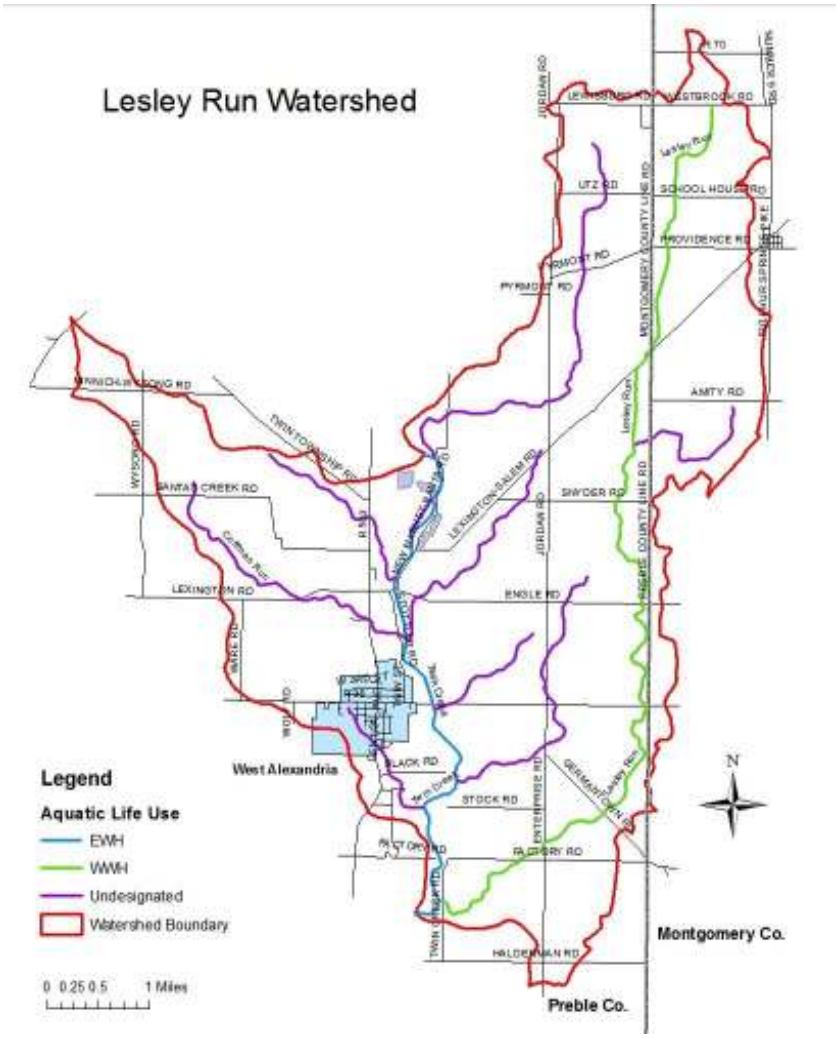
6.6 Twin Creek below Price's Creek to above Banta'ss Fork, including Lesley Run (HUC: 05080002-030-060)

Drainage Area: 16,727 acres, including Lesley Run
Counties: Montgomery, Preble

Aquatic Life Use Attainment Status, Causes and Sources of Stress

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of Stress	Sources of Stress
$27.5^{W}/27.6$	55	10.4	52	80.0	EWH	Full	None	None
$26.7^{W}/26.6$	56	11.1	44^{ns}	88.5	EWH	Full	None	None
Lesley Run – Tributary to Twin Creek at RM 24.60								
$6.0^{H}/4.9$	48	N/A	Low F	35.0	WWH	Partial	Sedimentation Low DO	Channelization Crops with subsurface drainage
$1.2^{H}/1.3$	38^{ns}	N/A	Low F	60.0	WWH	Partial	Low Flow	Natural

SOURCE: Ohio EPA 2007



Subwatershed Background:

Most of West Alexandria, described as slowly growing, is within this subwatershed. North of West Alexandria along Twin Creek are active sand and gravel quarries operated by the Wysong Company. The same stream reach also includes Jaros, a former landfill closed during the 1990s. Small unincorporated communities on septic systems include Pyrmont just east of the subwatershed boundary in Montgomery County, consisting of 40-50 homes, and New Lexington, north of Coffman Run in Preble County, consisting of about 15 homes. Residential development relying on septic systems is occurring along Montgomery County Line Road, which roughly parallels Lesley Run. The subwatershed is very rocky in the southern portion and has considerable HEL along its tributaries (Figure 3.2.2). The terrain flattens in the eastern part of the subwatershed near the Preble-Montgomery County line. In addition to row cropping, where feasible, agricultural activity in Preble County includes beef operations and small recreational horse operations. Montgomery County NRCS/SWCD personnel mentioned that raising corn, beans, wheat and certified organic crops are the major agricultural activities in their part of the subwatershed.

Past and Present Conservation Efforts

Among recent conservation practices was the installation of a long riparian filter strip along both sides of Lesley Run just after it enters Preble County. Such installations greatly enhance water quality and habitat in such channelized reaches. Further upstream from this site, fencing to exclude 200-300 head of cattle from watering in the stream has helped improve water quality. Grass waterways and field borders under the CP33 program also have been installed in the subwatershed. The following tables list the conservation practices and measures with calculated load reductions between 2007 and 2009.

Conservation Practices in the Subwatershed

Location	Practice	Area Affected	Date	WQ Benefits
Preble County				
Sec 13 & 14 Twin Twp.	Filter Strip (CP21)	1.0 ac.	2006	Erosion, chemical & nutrient reduction
Sec.1,Twin Twp	Field Border (CP33)	7.4 ac.	2007	Erosion, chemical & nutrient reduction
Sec.1,Twin Twp	General CRP - CP2 (native grasses)	10.0 ac.	2007	Erosion, chemical & nutrient reduction
Sec. 20, Twin Twp.	Grass Waterway (CP8a)	1.0 ac.	2007	Ephemeral erosion reduced 22 tons/year
Sec. 23, Lanier Twp.	Grass Waterway (CP8a)	3.0 ac.	2007	Ephemeral erosion reduced 28 tons/year
Sec. 26 & 27, Twin Twp.	Comprehensive Nutrient Mgt. Plan (CNMP)	1 plan for 500 AU (cattle)	2007	Commercial & organic nutrient application and utilization improved
Sec.25 & 36, Twin Twp.	Comprehensive Nutrient Mgt. Plan (CNMP)	2 plans for 500 AU (cattle)	2006	Commercial & organic nutrient application and utilization improved
Montgomery County				
Perry Twp.	Grass Waterways	4 waterway, total of 2,096 ft.	2006	Soil savings of 9.4 T/yr.
Sec. 7, Perry Twp.	Grass Waterways	1 waterway, total of 850 ft.	2006	Soil savings of 4 T/yr.
Preble County*	Nutrient Mgmt.	Available upon completion	2007	Commercial & organic nutrient application and utilization improved
Preble County*	Nutrient Mgmt.	Available upon completion	2007	Commercial & organic nutrient application and utilization improved

* These nutrient mgmt. practices are being completed by the Montgomery SWCD at properties which span the Montgomery-Preble county line.

Conservation Measures in the Subwatershed

County	Subwatershed	Practices	2005-2006	2007-2009	tons soil/yr saved 2005-6	Tons Soil saved/yr 07-09	Nitrogen Load Reduction Lbs/yr	Phosphorus Load Reduction LBs/yr
Preble	Lesley Run	CP 33 (acres)	34		59		94	47
Preble	Lesley Run	Pasture Planting (acres)		31		250	488	244
Preble	Lesley Run	Nutrient Management (acres)		166	150 ppm of K removed/yr			
Preble	Lesley Run	Grass waterways (acres)	4	5	104	87	243	174
Preble	Lesley Run	Fence (feet)		3,452				
Preble	Lesley Run	Watering facility (facilities)		1				
Preble	Lesley Run	Access Road (feet)		3600				
Preble	Lesley Run	Chemical containment	1					
Preble	Lesley Run	Waste Storage (facilities)		1		20 a/u beef cows with calves		
Preble	Lesley Run	CNMP	1					

Specific Actions:

The Twin Creek watershed TMDL determined that it is difficult to address each causes of impairment independently and recommended specific actions for improving the habitat targets.

The goal to improve this subwatershed is to improve the QHEI scores by:

- restoring natural channel to improve water quality that is suitable for aquatic life,
- increasing riparian buffer to improve water quality that is suitable for aquatic life,
- protecting existing riparian to prevent further loss of riparian,
- removing drainage tiles and promote wetland to improve water quality that is suitable for aquatic life, and
- managing nutrients to improve water quality that is suitable for aquatic life.

Restoration Categories	Specific Tasks	Project Partner	Funding	Time Frame	Performance Indicators
Bank & riparian restoration	• Restore streambank by recontouring/regrading • Plant grasses/prairie grass in riparian areas • Plant trees or shrubs in riparian areas	SWCD, Pheasants Forever, USFW	319 grant, USFW	2011-2013	Planting 8 acres of grasses and shrubs
Stream restoration	• Restore floodplain • Restore stream channel • Install in-stream habitat structures	Ditch maintenance, county engineers, SWCD,USFW	319 grant, USFW	2011-2013	Restoring 2500 feet of natural stream
Conservation Easement	• Acquire Conservation easement	TVCT	319 and other grants	2011-2013	Protect 600 acres in the next 3 years
Education & Outreach	• Host meetings/workshops/events	SWCD, TCWP	OEEF, ODNR, local	2011-2013	Hosting 5 events/year; maintaining

	• Distribute education materials		funds		website/disseminating watershed materials.
Home Sewage Planning & Improvement	• Develop/inspect HSTS Plan • Repair/replace traditional/alternative HSTS	Health departments/TCWP	Not clear at this point	2011-2013	30-50 HSTS repair or replaced.
Agricultural BMPS – Farmland	• Implement conservation tillage practices • Implement grass/legume rotations • Plant cover/manure crops • Install grassed waterways • Install vegetated buffer areas/strips • Install location-specific conservation buffers	SWCD, USDA, MCD	USDA, MCD – nutrient trading program	2011-2013	300-500 aces of conservation tillage 100-300 acres of rotation, cover crops, grassed waterways and buffers.
Agricultural BMPS – Nutrient/agro-chemical	• Conduct soil testing • Install nitrogen reduction practices • Develop nutrient management plan	SWCD, USDA, MCD	USDA, MCD - nutrient trading program	2011-2013	100-300 acres of nutrient reduction
Agricultural BMPS – livestock	• Implement prescribed & conservation grazing • Install livestock exclusion fencing • Install alternative water supplies	SWCD, USDA	EQIP	2011-2013	50-100 acres of livestock management
Agricultural BMPS – manure	• Implement manure management practices • Construct animal waste storage structures • Implement manure transfer practices	SWCD, USDA	USDA	2011-2013	2 facilities of manure management
Agricultural BMPS – Misc. infrastructure and management	• Install erosion & sediment control structures • Develop whole farm management plans	SWCD, USDA	USDA	2011-2013	2 whole farm management plans
NPDES-TMDL Recommendation	**Specific Actions**	**NPDES permit holder**			
NPDES permit holder: West Alexandria WWTP	• Next permit cycle: continue monitor for total phosphorous, total kjeldahl nitrogen and nitrate-nitrite	West Alexandria WWTP			
NPDES permit holder: Creekside MHP	• Next permit cycle: monitor for total phosphorous, total kjeldahl nitrogen and nitrate-nitrite	Creekside MHP WWTP			

6.7 Upper Banta's Fork – Tributary to Twin Creek @ RM 24.32 (HUCs: 05080002-030-010)

Drainage Area: 7,978 acres (Banta's Fork above Goose Creek)
County: Preble

Aquatic Life Use Attainment Status, Causes and Sources of Stress

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of Stress	Sources of Stress
13.7^{H}/13.7*	46	N/A	G	69.0	EWH	Partial	Low Flow	Natural
9.4^{H}/9.5	56	N/A	54	67.0	EWH	Full	None	None
7.1^{W}/7.0	56	**	50	72.5	EWH	Full	None	None

* No Ohio EPA data previously was collected in this reach.
**Data invalidated due to sampling error associated with significant bridge effect.
SOURCE: Ohio EPA 2007

Subwatershed Background

Part of the city of Eaton is located in the lower end of this subwatershed. Intensive row cropping characterizes the rolling upper half of the subwatershed. Construction of I-70 altered the local hydrology and may account for low flows observed at the uppermost sampling station during Ohio EPA's 2005 stream survey. Scattered development occurs throughout the watershed, often following major roads, including US 40. However, high QHEI scores reflect the excellent riparian habitat occurring in the more downstream portion of this subwatershed.

Past and Present Conservation Practices

As elsewhere in Preble County, grass waterways are the most frequent conservation practice in the subwatershed. Other practices are related to cattle operations and recreational horse management. Good management practices apparently are used at a sizable hog operation on Orphans Road west of Upper Banta's Fork, although the Preble NRCS/SWCD did not participate in the installation of the practices. The following tables list the conservation practices and measures with calculated load reductions between 2007 and 2009.

Conservation Practices in the Subwatershed

Location	Practice	Area Affected	Date	WQ Benefits
Sec. 9 Washington Twp	Field Border (CP33)	3.2 ac.	2007	Erosion, chemical & nutrient reduction
Sec. 21, Monroe Twp.	Grass Waterway (CP8a)	2.7 ac.	2007	Ephemeral erosion reduced 80 tons/year
Sec. 5, Washington Twp	Grass Waterway (CP8a)	1.6 ac.	2007	Ephemeral erosion reduced 43 tons/year

Conservation Measures in the Subwatershed

County	Subwaterswhed	Conservation Practice	2007-2009	Tons/yr Soil Saved 07-09	Nitrogen reduced Lbs/yr	Phosphorus reduced lbs/yr
Preble	Upper Banta's Fork	CP 33 (acres)	3	7	12	6
Preble	Upper Banta's Fork	Nutrient Management (acres)	34	37 ppm K rmvd/yr		
Preble	Upper Banta's Fork	Grass waterways (acres)	9	425	680	340
Preble	Upper Banta's Fork	Chemical containment (facilities)	1			

Problem Statement

The QHEI scores were high for all stations sampled in 2005, the uppermost station in the subwatershed at 13.7 RM only partially attained the EWH designation due to low flow under natural condition. No action is needed at this subwatershed at this time.

6.8 Lower Banta's Fork – Tributary to Twin Creek @ RM 24.32 (HUC: 05080002-040-030) (Banta's Fork below Goose Creek)

Drainage Area: 7,279 acres (Banta's Fork below Goose Creek)
County: Preble

Aquatic Life Use Attainment Status, Causes and Sources of Stress
(Only one site sampled)

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of Stress	Sources of Stress
1.3^{W}/1.2	43	9.8	G	80.5	EWH	Partial	Low Flow	Natural

G: Good
SOURCE: Ohio EPA 2007

Subwatershed Background

This subwatershed includes a corner of the city of Eaton and part of West Alexandria. This area of glacial geological interest is locally known as the "boulder belt" and is much less suitable for farming than other parts of the Twin Creek watershed. In addition to row cropping, several small cattle operations occur in the watershed. The high QHEI values reported by the Ohio EPA both in 2005 and in1995 attest to the intact riparian corridor in the lower portion of the subwatershed.

Past and Present Conservation Practices

Because of more difficult conditions for farming, this area has had less conservation activity than other subwatersheds. A few practices related to livestock, however, have been installed in cooperation with the Preble SWCD, as listed in the table below. The following tables list the conservation practices and measures with calculated load reductions between 2007 and 2009.

Conservation Practices in the Subwatershed

Location	Practice	Area Affected	Date	WQ Benefits
NW 1/4 Sec. 25, Washington Twp	Fencing	1050 feet	2007	Improve pasture quality, reduced soil erosion
NW 1/4 Sec. 25, Washington Twp.	Heavy Use Protection Area	1 structure	2006	Manure runoff controlled, reduced organics in ground & surface water
NW 1/4 Sec. 25, Washington Twp	Water Facility	1 tank	2007	Improved pasture utilization, reduced soil erosion

Conservation Measures in the Subwatershed

County	Subwatershed	Conservation Practice	2005-6	2007-9	Tons/yr soil saved 2005-6	Tons/yr soil saved 2007-9	Nitrogen removed lbs/yr	Phosphorus removed lbs/yr
Preble	Lower Banta's Fork	Grass waterways (acres)	5	3	282	289	744	513
Preble	Lower Banta's Fork	Heavy Use area (feet)	3600		beef cattle			
Preble	Lower Banta's Fork	Fence (feet)		1,050				
Preble	Lower Banta's Fork	Watering facility (facilities)		1	beef cattle			

Problem Statement

Limited data for this subwatershed make formulation of a problem statement somewhat speculative. At the single station sampled in 2005 the QHEI value of 80.5 was exceptional, indicative of the excellent riparian conditions. The site at RM 1.3 was determined to be only partially attained the EWH designation due to low flow under natural condition. No action is needed at this subwatershed at this time.

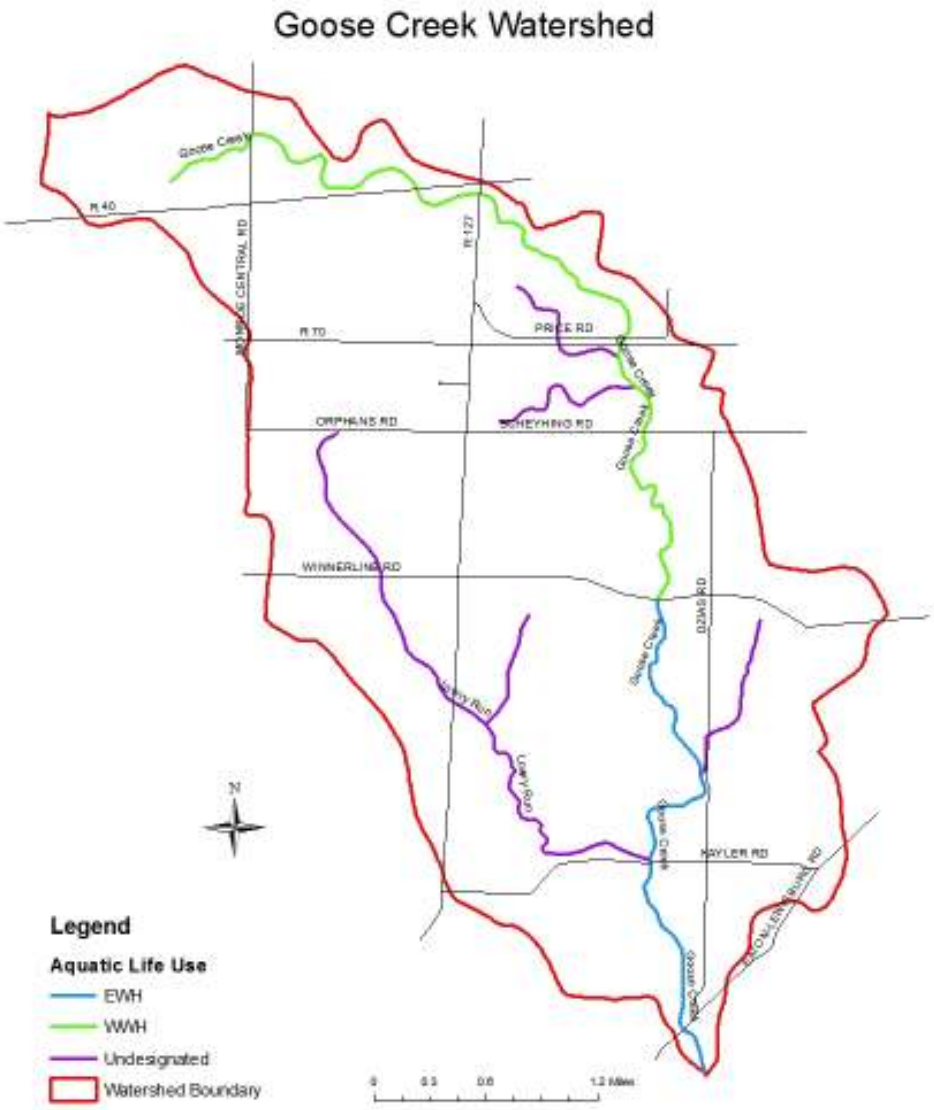
6.9 Goose Creek/Run) Tributary to Banta's Fork @ RM 7.55 (HUC: 05080002-040-030)

Drainage Area: 7,231 acres
County: Preble

Aquatic Life Use Attainment Status, Causes and Sources of Stress

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of Stress	Sources of Stress
$4.4^{H}/4.2$	44	N/A	F	55.0	WWH	Partial	Phosphorous, ammonia, COD; low DO	Upstream packaging plants
$0.3^{H}/0.3$	56	N/A	VG	73.0	EWH	Full	None	None

SOURCE: Ohio EPA 2007



Subwatershed Background

No communities are located within this subwatershed. The topography of the subwatershed is relatively flat in the northern portion and becomes increasingly more rolling toward the lowest third where some HEL occurs. In addition to row cropping, where feasible, agricultural activities in the subwatershed include hay production, small livestock operations, and pasturing of recreational horses. A concentration of businesses near I-70, including a motel, truck stop and Pilot Oil Travel Center, are located near Goose Creek in proximity to the OEPA sample location RM 4.4 both in 1995 and 2005. Preble NRCS/SWCD personnel noted that improved water quality in Goose Creek's lower reaches reflects the higher quality of its riparian corridor compared to the upstream sampling site. EWH was attained at the lower reach of the stream even though a small community relying on septic systems exists nearby.

Past and Present Conservation Efforts

Grass waterways, the most common BMP in the Twin Creek watershed, have been installed in many locations over the years. Some land in the lower subwatershed has been placed in CRP. The following tables list the conservation practices and measures with calculated load reductions between 2007 and 2009.

Conservation Practices in the Subwatershed

Location	Practice	Area Affected	Date	WQ Benefits
Sec. 12 Washington Twp	Field Border (CP33)	2.4 ac.	2007	Erosion, chemical & nutrient reduction
Sec. 13 Washington Twp	Field Border (CP33)	2.0 ac.	2007	Erosion, chemical & nutrient reduction
SE Sec. 27, Monroe Twp.	Grass Waterway (CP8a)	2.2 ac.	2007	Ephemeral erosion reduced 52 tons/year
Ozias Rd., Sec.12, Washington Twp.	Fencing	7570 feet	2007	Improve pasture quality, reduced soil erosion
Ozias Rd., Sec.12, Washington Twp	Use Exclusion - Stream	25.3 ac.	2008	Reduced stream bank erosion, reduced organics in surface water and stream
Ozias Rd., Sec.12, Washington Twp	Heavy Use Protection Area	1 structure	2008	Manure runoff controlled, reduced organics in ground & surface water
Ozias Rd., Sec.12, Washington Twp	Access Road	90 feet	2008	Reduced compaction & erosion
Ozias Rd., Sec.12, Washington Twp	Stream Crossing	1	2008	Reduced stream bank erosion, reduced organics in surface water and stream

Conservation Measures in the Subwatershed:

County	Subwatershed	Practices	2005-2006	2007-2009	tons soil/yr saved 2005-6	Tons Soil saved/yr 07-09	Nitrogen Load Reduction Lbs/yr	Phosphorus Load Reduction LBs/yr
Preble	Goose Creek	CP 33 (acres)	8		8		13	6
Preble	Goose Creek	Pasture Planting (acres) MfB		9		115	327	164
Preble	Goose Creek	Nutrient Management (acres)		80		89ppm K remvd/yr	22	112
Preble	Goose Creek	Grass waterways (acres)	16	2	209	114	392	300
Preble	Goose Creek	Watering facility (facilities)		2				
Preble	Goose Creek	Access Road (feet)		3600				
Preble	Goose Creek	Chemical containment		1				

Preble	Goose Creek	Stream Crossings		1				
Preble	Goose Creek	Use Exclusion (acres)		25		beef		
Preble	Goose Creek	Fence (feet)		5160		beef		

Specific Actions:

The Twin Creek watershed TMDL determined that it is difficult to address each causes of impairment independently and recommended specific actions for improving the habitat targets.

The goal to improve this subwatershed is to improve the QHEI scores by:

- reducing runoff and restore wetlands to improve water quality that is suitable for aquatic life, and
- managing nutrients to improve water quality that is suitable for aquatic life.

Restoration Categories	Specific Tasks	Project Partner	Funding	Time Frame	Performance Indicators
Bank & riparian restoration	• Plant grasses/prairie grass in riparian areas • Plant trees or shrubs in riparian areas	SWCD, Pheasants Forever, USFW	319 grant, USFW	2011-2013	Planting 3 acres of grasses and shrubs
Stream restoration	• Restore stream channel • Install in-stream habitat structures	Ditch maintenance, county engineers, SWCD,USFW	319 grant, USFW	2011-2013	Restoring 200 feet of natural stream
Wetland restoration	• Reconnect wetland to stream • Reconstruct & restore wetlands • Plant wetland species	SWCD, Pheasants Forever, USFW	USFW, Pheasants Forever	2011-2013	Restoring 2 acres of wetlands
Education & Outreach	• Host meetings/workshops/events • Distribute education materials	SWCD, TCWP	OEEF, ODNR, local funds	2011-2013	Hosting 3 events/year; maintaining website/disseminating watershed materials.
Home Sewage Planning & Improvement	• Develop/inspect HSTS Plan • Repair/replace traditional/alternative HSTS	Health departments/TCWP	Not clear at this point	2011-2013	10-20 HSTS repair or replaced.
Agricultural BMPS – Farmland	• Plant cover/manure crops • Install grassed waterways • Install vegetated buffer areas/strips • Install location-specific conservation buffers	SWCD, USDA, MCD	USDA, MCD – nutrient trading program	2011-2013	200-300 acres of cover crops, grassed waterways and buffers.
Agricultural BMPS – Nutrient/agro-	• Conduct soil testing • Install nitrogen reduction practices	SWCD, USDA, MCD	USDA, MCD - nutrient	2011-2013	100-200 acres of nutrient reduction

chemical	• Develop nutrient management plan		trading program		
TMDL Recommendation	**Specific Actions**	**NPDES permit holder**			
NPDES permit holder: Dayton Travel Center	• Next permit cycle: monitor for total phosphorous, total kjeldahl nitrogen and nitrate-nitrite (2 ourfalls)	Dayton Travel Center			
NPDES permit holder: Pilot Travel Center	• Next permit cycle: monitor for total phosphorous, total kjeldahl nitrogen and nitrate-nitrite (2 outfalls)	Pilot Travel Center			

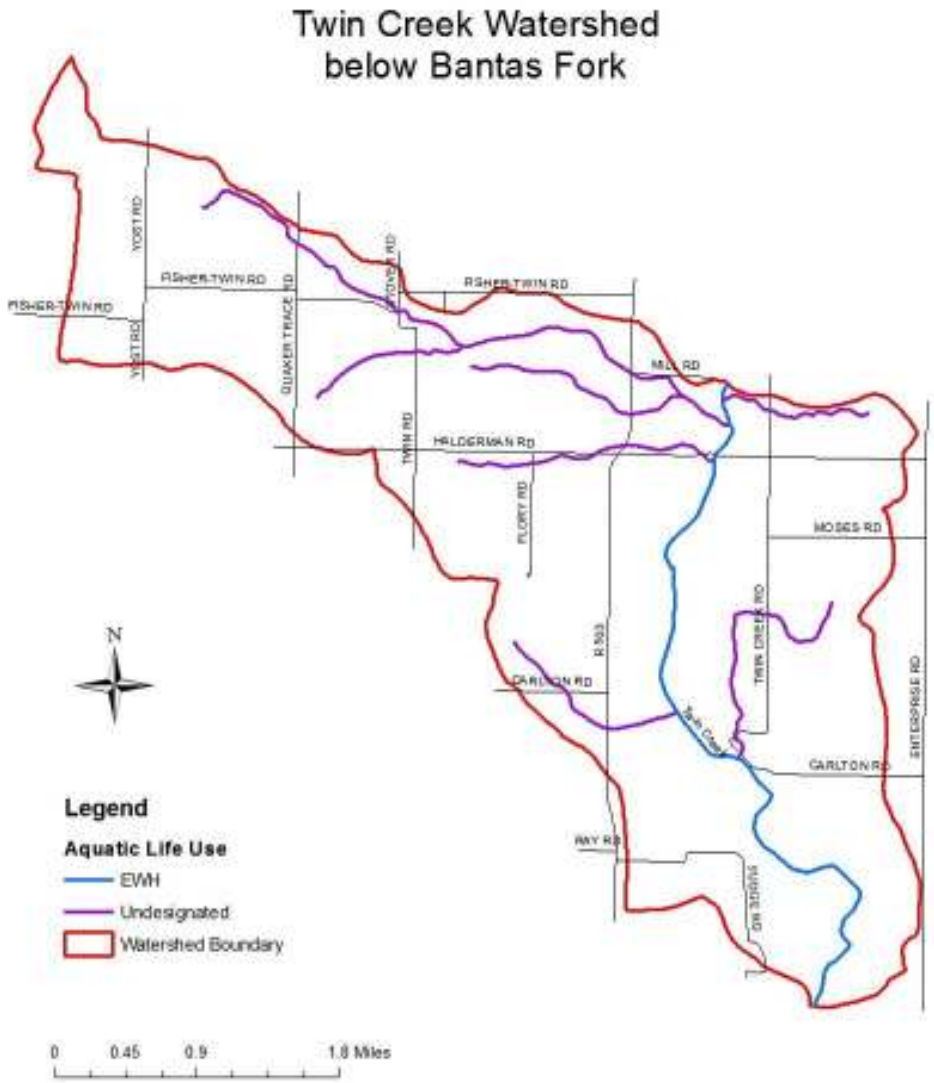
6.10 Twin Creek below Banta's Fork above Aukerman Creek (HUC: 05080002-040-040)

Drainage Area: 7,974 acres
County: Preble

Aquatic Life Use Attainment Status, Causes and Sources of Stress

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of Stress	Sources of Stress
23.9[W]/23.7	54	10.0	50	79.0	EWH	Full	None	None

SOURCE: Ohio EPA 2007



Subwatershed Background

No communities are located in this subwatershed. The northern portion of the subwatershed, located in the "boulder belt", is rolling. Residential development has occurred in this area, which is not very conducive to farming. Continuing south along Twin Creek the topography becomes

steeper with increasingly more HEL acreage. Although the southern tip of the watershed has a good riparian cover, Preble County NRCS/SWCD personnel noted the area is steep and flood-prone with stream bank erosion that is severe in some places. During the 1930s-40s, the Civilian Conservation Corps constructed levees in this portion of the watershed. According to Preble NRCS/SWCD personnel, these levees continue to exist and are thought to be under the Miami Conservancy District's jurisdiction, but there are no public funds for maintenance. Most agricultural activity in the subwatershed is related to cattle operations, dairy farming and hay production.

Past and Present Conservation Efforts

Most conservation practices installed have been related to cattle management and include pasture conversion, fencing to exclude livestock from streams, water supply development, and various other EQIP practices. Cattle currently have access to at least one tributary to Twin Creek in the "boulder belt." In addition, grass waterways and buffer strips have been recently installed as part of two NRCS Whole Farm Conservation Plans for properties with two miles of frontage on Twin Creek, and a third set of plans is being finalized to maximize Twin Creek protection. The following tables list the conservation practices and measures with calculated load reductions between 2007 and 2009.

Conservation Practices in the Subwatershed

Location	Practice	Area Affected	Date	WQ Benefits
Sec.23 Lanier Twp.	Field Border (CP33)	7.3 ac.	2006	Erosion, chemical & nutrient reduction
Preble-Mont. line in Lanier, Jackson Twps	Grass Waterway	600 ft.	2006	Soil savings of 9 T/yr.

Conservation Measures in the Subwatershed

County	Subwatershed	Practices	2005-2006	2007-2009	Tons soil/yr saved 2005-6	Tons Soil saved/yr 07-09	Nitrogen Load Reduction Lbs/yr	Phosphorus Reduced LBs/yr
Preble	Twin Cr below Banta's Fork	CP 33 (acres)	7		1		2	1
Preble	Twin Cr below Banta's Fork	Pasture Planting (acres)		124				
Preble	Twin Cr below Banta's Fork	Use Exclusion (feet)		2295				
Preble	Twin Cr below Banta's Fork	Heavy Use area (facilities)	1					
Preble	Twin Cr below Banta's Fork	Fence (feet)		36,170				
Preble	Twin Cr below Banta's Fork	Watering facility (facilities)		14				
Preble	Twin Cr below Banta's Fork	Access Road (feet)		5980				
Preble	Twin Cr below Banta's Fork	Stream Crossings		3				
Preble	Twin Cr below Banta's Fork	Waste Storage facl	4	2	290 A/U beef cattle	84 A/U beef cattle	5825	1075

Problem Statement

While the limited data collected by OEPA in 2005 (one sampling station at RM 23.9), the data indicate full attainment of the EWH designation. No action is needed at this subwatershed.

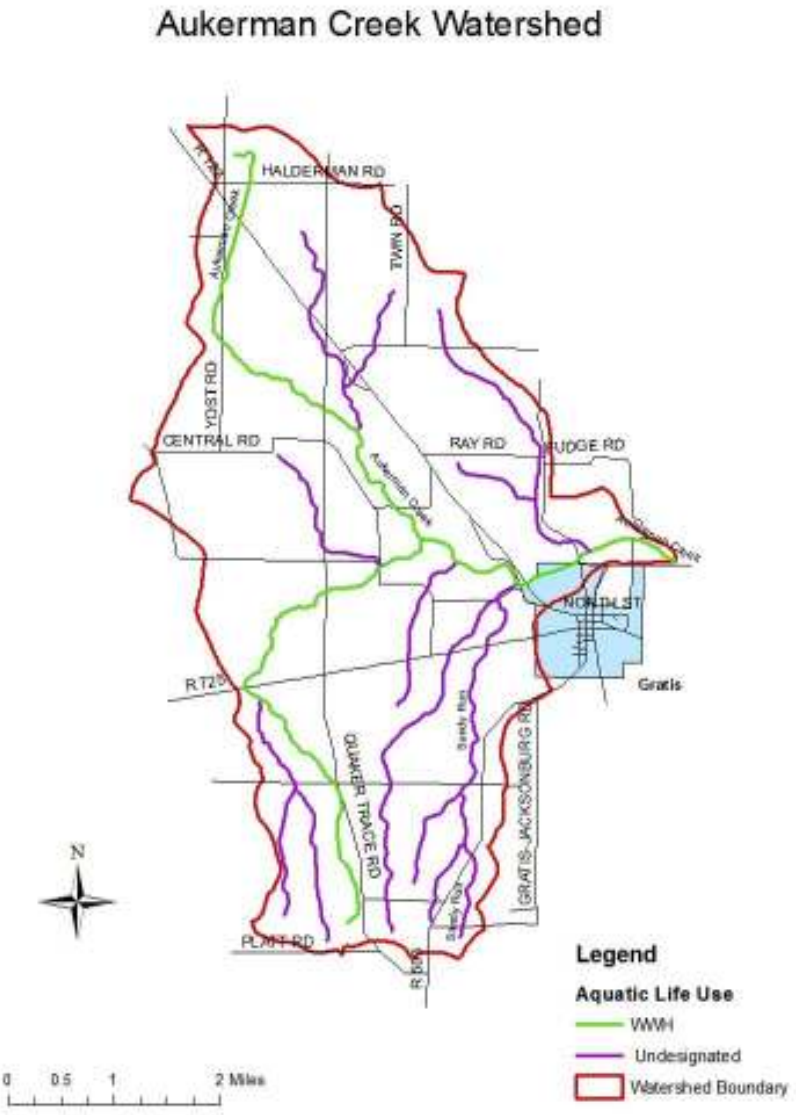
6.11 Aukerman Creek – Tributary to Twin Creek @ RM 19.9 (HUC: 05080002-040-050)

Drainage Area: 13,327 acres
County: Preble

Aquatic Life Use Attainment Status, Causes and Sources of Stress

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of Stress	Sources of Stress
$3.3^{H}/3.3$	50	N/A	VG	82.0	WWH	Full	None	None
$1.8^{H}/1.8$	52	N/A	G	75.5	WWH	Full	None	None
$0.5^{W}/0.4$	46	8.0^{ns}	52	70.5	WWH	Full	None	None
Unnamed Tributary to Aukerman Creek @ RM2.88								
$0.5^{H}/0.5$	48	N/A	VG	73.5	WWH	Full	None	None

VG: very good
G: good
SOURCE: Ohio EPA 2007



Subwatershed Background

Part of the village of Gratis is located in the eastern portion of the subwatershed. Little development is occurring around Gratis. Considerable HEL acreage is associated with the intricate stream system in the lower portion of the subwatershed (Figure 3.2.2). Past channel modifications and marginal riparian conditions were noted by Ohio EPA in sampling near Gratis during 1995. Severe erosion has been a long-standing problem along a 4,000' reach of Aukerman Creek in Lanier Township owned by the Preble County Historical Society (PCHS). Since acquiring the property in 1974, the PCHS has observed significant channel movement. Periodic flooding on the property sometimes makes nature trails impassible and on several occasions, a swinging bridge has been washed away. Regarding agricultural activity, cattle and dairy operations are more common than in some other subwatersheds, but grain production continues as the predominant agricultural activity.

Past and Present Conservation Efforts

Grass waterways, waste storage facilities and other practices related to cattle management are the most common conservation practices in the subwatershed. The sample conservation practices table for 2006-2007 shows that the grass waterway is projected to save approximately 7 tons of soil per year from reaching Aukerman Creek. The additional practices will benefit ground and surface water quality by reducing chemical and nutrient loads and soil erosion. The following tables list the conservation practices and measures with calculated load reductions between 2007 and 2009.

Conservation Practices in the Subwatershed

Location	Practice	Area Affected	Date	WQ Benefits
Sec.17, Gratis Twp	Field Border (CP33)	12.5 ac.	2007	Erosion, chemical & nutrient reduction
Sec. 17, Twin Twp.	Grass Waterway (CP8a)	0.9 ac.	2007	Ephemeral erosion reduced 7 tons/year
Sec.32 Lanier Twp.	Comprehensive Nutrient Mgt. Plan (CNMP)	1 plan for 100 AU (dairy)	2006	Commercial & organic nutrient application and utilization improved
Sec.29, 28 & 33 Lanier Twp.	Comprehensive Nutrient Mgt. Plan (CNMP)	1plan for 200 AU (dairy)	2006	Commercial & organic nutrient application and utilization improved

Conservation Measures Practices in the Subwatershed

County	Subwatershed	Practices	2005-2006	2007-2009	tons soil/yr saved 2005-6	Tons Soil saved/yr 07-09	Nitrogen Load Reduction Lbs/yr	Phosphorus Load Reduction LBs/yr
Preble	Aukerman Creek	CP 33 (acres)	4	13	4	13	20	10
Preble	Aukerman Creek	Grass waterways (acres)	9	5	38	501	839	439
Preble	Aukerman Creek	Heavy Use area (facilities)		1				
Preble	Aukerman Creek	Waste Storage (facilities)		4		200 A/U dairy cattle	5825	1075
Preble	Aukerman Creek	CNMP	1					

Problem Statement

All four sampling locations obtained full attainment of the WWH designation. No action is needed at this subwatershed at this point.

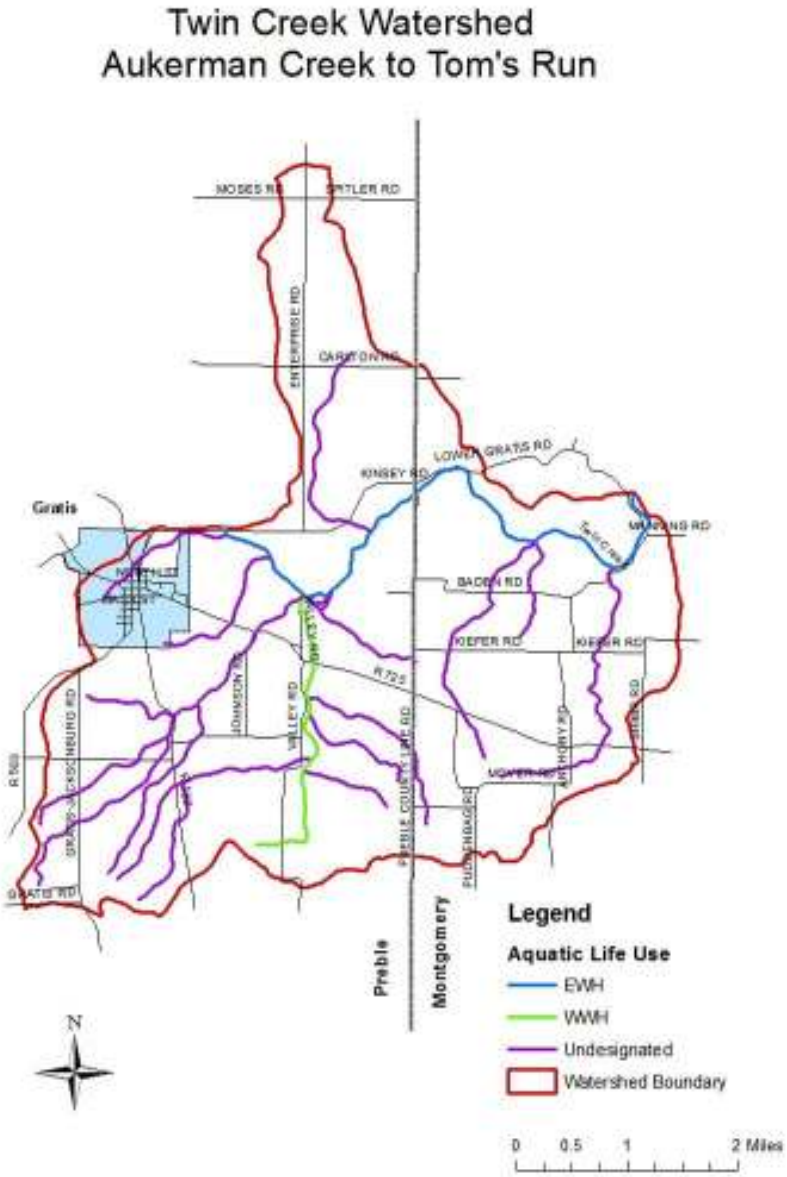
6.12 Twin Creek below Aukerman Creek above Tom's Run (HUC: 05080002-040-060)

Drainage Area: 13,033 acres
County: Montgomery, Preble

Aquatic Life Use Attainment Status, Causes and Sources of Stress

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of Stress	Sources of Stress
19.2W/19.2	50	9.8	52	76.5	EWH	Full	None	None
19.0W/19.0	49^{ns}	10.0	E	72.0	EWH	Full	None	None
Unnamed Tributary to Twin Creek @ RM 18.29								
0.6^{H}/0.7	48	N/A	E	70.5	WWH recommended	Full	None	None

E: excellent
SOURCE: Ohio EPA 2007



Subwatershed Background

Part of the village of Gratis is located in this watershed. Active gravel mining occurs near Twin Creek about one mile east of Gratis. The northern tip of the subwatershed and the portion in Montgomery County is rolling, but somewhat flatter than the steeper southwestern portion that is associated with an intricate stream system and considerable HEL acreage. Residential development relying on septic systems is occurring along the SR 725 and Gratis-Jacksonburg Road corridors. Agricultural activities include cattle operations, hay production, small woodlot management, row cropping and hobby farming.

Past and Present Conservation Efforts

Conservation practices installed by the Preble NRCS/SWCD in recent years have included General CRP for HEL land, grass waterways, and some CP33 (upland buffers). The area south and southeast of Gratis has numerous horses and "hobby" farms with pasture and hay. Although no grass waterways were installed in the Montgomery portion of the subwatershed in 2006-2007, Montgomery NRCS/SWCD personnel mentioned that about 12 grass waterways have been installed in the past eight years. They stated that the potential for installation of grass waterways has been saturated in some subwatersheds of Twin Creek watershed. During 2007, Montgomery SWCD personnel plan to work with two landowners in Sec. 18 & 19, German Twp. on nutrient management which will reduce chemical, nutrient, and soil loadings in the subwatershed.

Conservation Practices in the Subwatershed

County	Subwatershed	Practices	2005-2006	2007-2009	tons soil/yr saved 2005-6	Tons Soil saved/yr 07-09	Nitrogen Load Reduction Lbs/yr	Phosphorus Load Reduction LBs/yr
Preble	Twin Creek below Aukerman Creek	CP 33 (acres)		5		1	2	1
Preble	Twin Creek below Aukerman Cr	Pasture Planting (acres)		51				
Preble	Twin Creek below Aukerman Cr	Heavy Use area (facilities)	1		beef cattle			
Preble	Twin Creek below Aukerman Cr	Fence (feet)		5,177				
Preble	Twin Creek below Aukerman Cr	Watering facility (facilities)		14				
Preble	Twin Creek below Aukerman Cr	Access Road (feet)		3100				
Preble	Twin Creek below Aukerman Cr	Stream Crossings		1				
Preble	Twin Creek below Aukerman Cr	Waste Storage (facilities)	1	1	90 A/U beef cattle	60 A/U beef cattle		

Problem Statement

No distinct water quality problems were noted in this subwatershed by Ohio EPA during either the 2005 or 1995 sampling. No action is needed at this subwatershed at this point. However, the TMDL recommended the Gratis WWTP to continue to monitor it effluent.

NPDES-TMDL Recommendations	Specific Action	NPDES Facility
NPDES permit holder: Gratis WWTP	• Next permit cycle: continue to monitor for total phosphorous, total kjeldahl nitrogen and nitrate-nitrite	Gratis WWTP

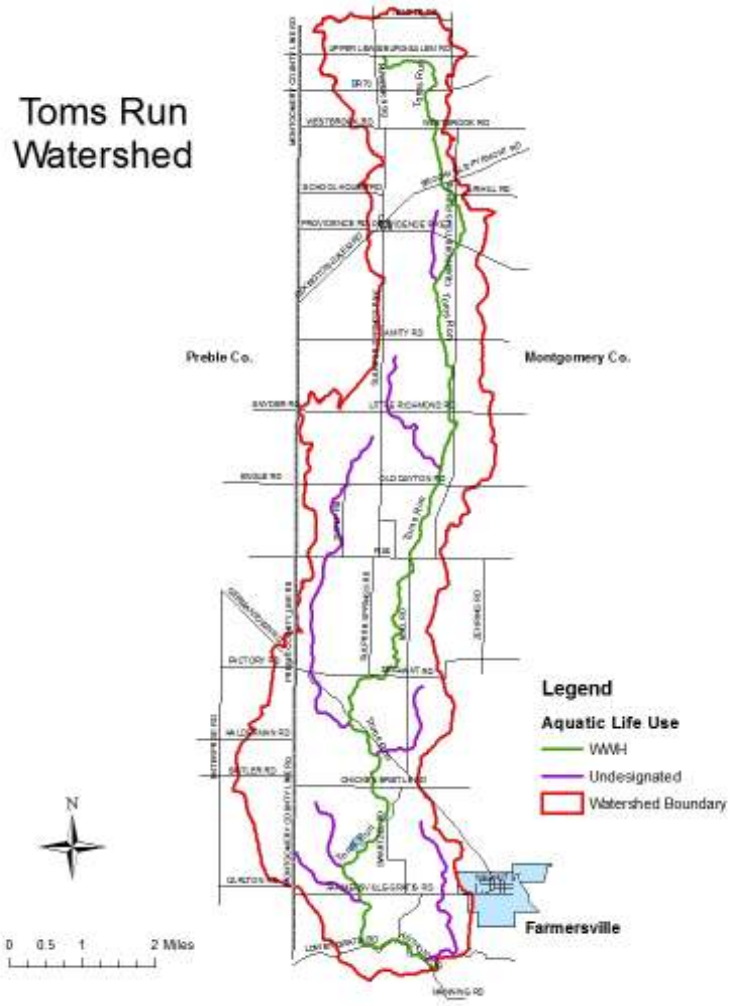
6.13 Tom's Run – Tributary to Twin Creek @ RM 13.52 (HUC: 05080002-040-070)

Drainage Area: 16,481 acres
Counties: Montgomery, Preble

Aquatic Life Use Attainment Status, Causes and Sources of Stress

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of Stress	Sources of Stress
$12.0^{H}/12.0$	52	N/A	Low F	40.5	WWH	Partial	Low DO Sedimentation	Channelization; loss of riparian; crops with subsurface drainage
$8.5^{H}/8.5$	40	N/A	Low F	58.5	WWH	Partial	Low Flow	Natural
$0.4^{W}/0.4$	48	8.7	34^{ns}	82.0	WWH	Full	None	None
Twin Creek Downstream from Tom's Run								
$13.4^{W}/13.4$	53	10.3	50	88.0	EWW	Full	None	None

SOURCE: Ohio EPA 2007



Subwatershed Background

The western edge of the community of Farmersville is in the southeastern portion of the subwatershed. Septic systems are relied on by the residential crossroads of Pyrmont and by single-family homes developing in strips along the roads in this portion of the Twin Creek watershed nearer to Dayton. Most of the subwatershed is relatively flat with slopes of 2-6%. Some HEL acreage occurs in the lower subwatershed near Farmersville, where the terrain becomes noticeably steeper. Corn, soybeans, hay and wheat are the primary agricultural crops. According to the Montgomery NRCS/SWCD, field drainage tiles are now in "good shape" in most of the watershed. The exceptional QHEI value attained on Twin Creek downstream from Tom's Run reflects the stream's contiguous riparian cover, which improves south of SR 35. A recreation/retreat complex called Lake of the Woods is located in the lower part of the subwatershed.

Past and Present Conservation Efforts

Montgomery NRCS/SWCD personnel report that cooperators in this subwatershed have been very active in installing conservation practices over the years. In fact, the potential for grass waterways has been nearly saturated. Where problems have been observed, the NRCS/SWCD office has worked to rectify them. In other cases, cooperators have initiated large scale projects themselves, such as a large project in the headwaters where 3,000 ft. of grass waterways were installed and tiling and erosion repairs and riparian enhancement were done to significantly improve an open ditch. The following tables list the conservation practices and measures with calculated load reductions between 2007 and 2009.

Conservation Practices in the Subwatershed

Location	Practice	Area Affected	Date	WQ Benefits
Montgomery County				
Sec. 8, Jackson Twp.	Grass Waterway	2 waterways, total of 2,100'	2006	Soil savings of 12.5 T/yr.
Sec. 7, Jackson Twp.	Grass Waterway	3 waterways, total of 3,410'	2006	Soil savings of 15.5 T/yr
Sec. 17. Jackson Twp.	Grass Waterway	2 waterways, total of 960'	2006	Soil savings of 17.3 T/yr
Sec. 6, Jackson Twp.	Grass Waterway	3 waterways, total of 1,728'	2006	Soil savings of 9.6 T/yr
Sec. 6, Jackson Twp.	Nutrient Mgmt.	Available upon completion	2007	Commercial & organic nutrient application/utilization improved
Sec. 6, Jackson Twp.	Nutrient Mgmt.	Available upon completion	2007	Commercial & organic nutrient application/utilization improved
Sec. 8, Perry Twp.	Nutrient Mgmt.	Available upon completion	2007	Commercial & organic nutrient application/utilization improved
Sec. 31, Perry Twp.	Nutrient Mgmt.	Available upon completion	2007	Commercial & organic nutrient application/utilization improved
Preble County				
Sec.13 Lanier Twp.	Field Border (CP33)	3.4 ac.	2007	Erosion, chemical & nutrient reduction

Conservation Measures in the Subwatershed

County	Subwatershed	Conservation Practice	2005-6	2007-9	Tons/yr soils saved 2005-6	Tons/yr saved 2007-9	Nitrogen removed lbs/yr	Phosphorus removed lbs/yr
Montgomery	Tom's Run	Grass waterways (filters # watershed acres)	1927	18	14452	135	218805	110861

Specific Actions:

The Twin Creek watershed TMDL determined that it is difficult to address each causes of impairment independently and recommended specific actions for improving the habitat targets.

The goal to improve this subwatershed is to improve the QHEI scores by:

- restoring natural channel to improve water quality that is suitable for aquatic life,
- reducing field runoffs to improve water quality that is suitable for aquatic life,
- protecting existing riparian to prevent further loss of riparian,
- removing drainage tiles and promote wetland to improve water quality that is suitable for aquatic life, and
- managing nutrients to improve water quality that is suitable for aquatic life.

Restoration Categories	Specific Tasks	Project Partner	Funding	Time Frame	Performance Indicators
Bank & riparian restoration	• Restore streambank by recontouring/regrading • Plant grasses/prairie grass in riparian areas • Plant trees or shrubs in riparian areas	SWCD/Pheasants Forever/USFW	319 grant, USFW	2011-2013	Restoring 1000 feet of streambank. Planting 3 acres of grasses and shrubs
Conservation Easement	• Acquire Conservation easement	TVCT; Five Rivers Metropark	319 and other grants	2011-2013	Protect 500 acres in the next 3 years
Education & Outreach	• Host meetings/workshops/events • Distribute education materials	TCWP	OEEF, ODNR, local funds	2011-2013	Hosting 10 events/year; maintaining website/disseminating watershed materials.
Agricultural BMPS – Farmland	• Implement conservation tillage practices • Plant cover/manure crops • Install grassed waterways • Install vegetated buffer areas/strips • Install location-specific conservation buffers	SWCD, USDA, MCD	USDA, MCD – nutrient trading program	2011-2013	150 acres of conservation tillage practice, rotation, cover crops, grassed waterways and buffers.
Agricultural BMPS – livestock	• Implement prescribed & conservation grazing • Install livestock exclusion fencing • Install alternative water supplies	SWCD, USDA	EQIP	2011-2013	10 acres of livestock management
Agricultural BMPS – manure	• Implement manure management practices • Construct animal waste storage structures • Implement manure transfer practices	SWCD, USDA	USDA	2011-2013	10 facilities of manure management

Agricultural BMPS – Misc. infrastructure and management	• Install erosion & sediment control structures • Install milkhouse waste treatment practices • Develop whole farm management plans	SWCD, USDA	USDA	2011-2013	12 whole farm management plans

6.14 Little Twin Creek – Tributary to Twin Creek @ RM 6.69 (HUC: 05080002-040-090)

Drainage Area: 14,531 acres, including Reigle Ditch watershed (sampled only for chemical data in Ohio EPA's 2005 sampling program.)
County: Montgomery

Aquatic Life Use Attainment Status, Causes and Sources of Stress

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of Stress	Sources of Stress
$6.2^{H}/6.3$	46^{ns}	N/A	36	65.5	EWH	Partial	Low Flow	Natural
$4.7^{H}/4.6$	48^{ns}	N/A	50	59.5	EWH	Full	None	None
$2.0^{H}/2.0$	54	N/A	VG^{ns}	77.0	EWH	Full	None	None

VG: very good
SOURCE: Ohio EPA 2007

Subwatershed Background

The southern tip of the subwatershed includes portions of the community of Germantown, located along little Twin Creek, while the eastern portion includes Farmersville, located along Reigle Ditch. The terrain is relatively flat in the northernmost part of the subwatershed, becomes rolling going south, and is noticeably steeper towards Germantown. Agricultural activities focus on the production of corn, soybeans, and wheat, although the subwatershed includes some cattle operations. Montgomery NRCS/SWCD personnel indicated the occurrence of erosion problems and bad tile systems in the headwaters. In the steeper southernmost reaches of the stream, some areas are prone to flooding and stream bank erosion has occurred.

Past and Present Conservation Efforts

During the past 10 years, numerous grass waterways have been installed. These waterways not only filter agricultural runoff at several locations, but also have helped capture a lot of stormwater runoff from Farmersville. The following tables list the conservation practices and measures with calculated load reductions between 2007 and 2009.

Conservation Practices in the Subwatershed

Location	Practice	Area Affected	Date	WQ Benefits
Sec. 1, German Twp.	Grass Waterway	1 waterway, total of 277 ft.	2006	Soil savings of 5 T/yr.
Sec.1, German Twp.	Grass Waterway	2 waterways, total of 1,960 ft.	2006	Soil savings of 2.2 T/yr.
Sec. 15, Jackson Twp.	Grass Waterway	2 waterways, total of 820 ft.	2006	Soil savings of 8.5 T/yr.
Sec. 25, Jackson Twp.	Grass Waterway	3 waterways, total of 3,065 ft.	2006	Soil savings of 14.1 T/yr.
Sec. 26, Jackson Twp	Grass Waterway	2 waterways, total of 1,000 ft.	2006	Soil savings of 14 T/yr.
Sec. 14, Jackson Twp.	Nutrient Mgmt.	Available upon completion	2007	Commercial & organic nutrient application and utilization improved
Sec. 25, Jackson Twp.	Nutrient Mgmt.	Available upon completion	2007	Commercial & organic nutrient application and utilization improved

Conservation Measures in the Subwatershed

County	Sub-watershed	Practices	2005-2006	2007-2009	Tons soil/yr saved 2005-6	Tons Soil/yr Saved 07-09	Nitrogen Reduced Lbs/yr	Phosphorus Reduced Lbs/yr
Montgomery	Little Twin	Grass waterways (filters # watershed acres)	650	135	4875	1012	88312	44745
Montgomery	Little Twin	Nutrient Management		2 structures				

Problem Statement

The high number of conservation practices installed in this subwatershed in the last two years may already be alleviating some problems. Low flow caused by natural condition was the cause of the partial attainment status at RM 6.2. No action is needed at this point. However, the TMDL recommended the Farmersville WWTP to continue monitor its effluent.

NPDES-TMDL Recommendations	Specific Action	NPDES Facility
NPDES permit holder: Farmersville WWTP	• Next permit cycle: continue to monitor for total phosphorous, total kjeldahl nitrogen and nitrate-nitrite	Farmersville WWTP

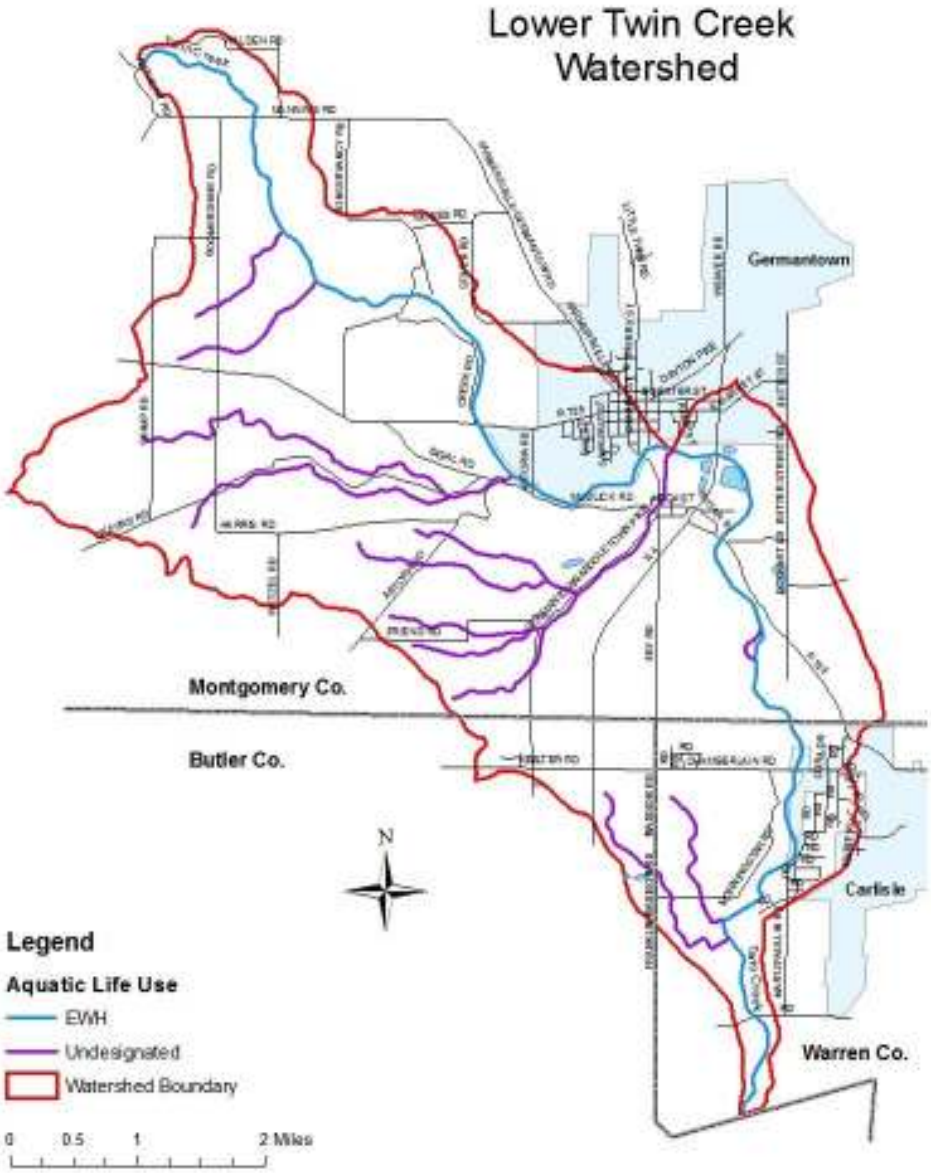
6.15 Twin Creek below Tom's Run to Great Miami River (HUC: 05080002-040-080)

Drainage Area: 13,810 acres
County: Montgomery

Aquatic Life Use Attainment Status, Causes and Sources of Stress

Stream Mile Fish/Invertebrate	IBI	MIwb	ICI	QHEI	Aquatic Life Use Designation	Attainment Status	Causes of Stress	Sources of Stress
9.8^{W}/9.7	56	10.4	52	74.0	EWH	Full	None	None
3.4^{W}/3.4	50	10.2	E	86.5	EWH	Full	None	None
0.9^{W}/0.9	55	9.8	48	82.0	EWH	Full	None	None
0.1^{W}/0.1	52	10.1	46	71.5	EWH	Full	None	None

E: excellent
SOURCE: Ohio EPA 2007



Subwatershed Background

Portions of the incorporated towns of Germantown and Carlisle are included in this subwatershed; both towns are sewered. The topography of this heavily wooded subwatershed is rolling to steep; east of Germantown the stream pattern is particularly intricate. Large, active gravel pits are present along Rt. 4 just south of Germantown. Agricultural activities in the subwatershed focus on corn, soybeans, hay and pasturing. More than 20 percent of the subwatershed is dedicated to public parkland, which includes the Germantown Reserve (1,534 acres) and Twin Creek (972 acres) Metroparks and the Carmody Park-Lower Twin Creek Nature Preserve in the Warren County park system; the latter park will eventually encompass about 400 acres.

Past Conservation Activities

Because of a combination of development, a large amount of dedicated parkland, and steep topography, NRCS/SWCD conservation activity has been relatively limited in this subwatershed to grass waterways compared to other Twin Creek subwatersheds. Five Rivers Metroparks has undertaken the other conservation practices listed. Together, more than 45 tons of nitrogen and 23 tons of phosphorus are estimated to be reduced from grass waterways and pasture plantings.

Conservation Practices Installed in the Subwatershed

County	Subwatershed	Practices	2005-2006	2007-2009	Tons soil/yr saved 2005-6	Tons Soil/yr Saved 07-09	Nitrogen Reduced Lbs/yr	Phosphorus Reduced Lbs/yr
Montgomery	Lower Twin	Grass waterways (filters # watershed acres)	333	467	2497.5 (7.5 T/A/yr)	3502.3	89997	45596
Montgomery	Lower Twin	Pasture native Planting (acres) Brookston soils	265				4491	2246
Montgomery	Lower Twin	Wetland Enhancement (acres)	3					
Montgomery	Lower Twin	Invasive Species Removal (acres)	25					

Problem Statement

Substantial riparian habitat and parkland/easement preservation contribute to excellent QHEI values in the lowermost reach of Twin Creek and full attainment of the EWH designation. No action is needed at this point.

Chapter 7

EVALUATION

As stated in Ohio EPA's updated Appendix 8 to *A Guide to Developing Local Watershed Action Plans in Ohio* (http://www.epa.state.oh.us/dsw/nps/NPS_WAP_APP8.pdf), the evaluation of a watershed action plan is the extent to which non or partially attaining stream segments move toward full attainment of their respective water quality designations as a result of implementation efforts. The WAP consolidates considerable information useful in measuring further progress, as follows:

- **Chapter 5 – Twin Creek Goals** sets forth the framework for the watershed action plan.
- **Chapter 6 – Subwatershed Details** includes background information about Twin Creek's 15 subwatersheds and presents specific protection and restoration goals applicable to addressing concerns in each subwatershed.
- **Ohio EPA's aquatic life use status data** from the 2005 biological and water quality survey, integrated into subwatershed sections and presented in detail in Appendix E, provides baseline data from 48 stream segments in the watershed.

Water quality monitoring during the implementation phase will measure progress towards reducing loads and attaining water quality standards and aquatic life use designations. Ultimately, QHEI scoring will be used to measure the success of implementing the watershed actions. The combined actions should help addressing the impairment problems in the watershed and the QHEI scores will be able to reflect the effort. More immediate progress on the educational outreach to protect Twin Creek's exceptional biodiversity and will be measured by the number of participants in various watershed-wide and more focused outreach events.

APPENDIX A

Participants in the Western Tributaries/Twin Creek Project

The Western Tributaries project was guided by a project advisory board. As the project focus narrowed, many advisory board members also participated in the Twin Creek Watershed Advisory Board. Organizations and individuals participating in one or both of these groups included:

- Butler County Environmental Services
- Butler County Metroparks
- Butler County Stormwater District
- Butler Soil and Water Conservation District
- Darke Soil and Water Conservation District
- Miami University – Institute of Environmental Sciences
- Montgomery County Commissioners
- Montgomery County Soil and Water Conservation District
- Mary Moore, Butler County citizen
- Ohio Department of Natural Resources
- Ohio State University Cooperative Extension Service in
- Butler, Preble and Montgomery Counties
- Preble County Commissioners
- Preble County Department of Health
- Preble County Engineer's Office
- Preble Soil and Water Conservation District
- Tricia Shepherd, Watershed resident
- Three Valley Conservation Trust

In addition to the Project Advisory Board, groups of technical advisors and landowners have met throughout the process to provide input into this plan. The following groups and individuals provided input and guidance during this project:

- Five Rivers MetroParks
- Miami Conservancy District
- Miami Valley Regional Planning Commission
- Miami Valley Resource Conservation and Development District
- Ohio Department of Natural Resources (Division of Soil and Water, Division of Wildlife)
- Ohio EPA (TMDL Coordinator, Nonpoint Source Program and Division of Surface Waters)
- Ohio-Kentucky-Indiana Regional Council of Governments (OKI)
- Preble County Historical Society
- Preble County Park District
- USDA – Natural Resources Conservation Service

- Village of Germantown
- Warren County Soil and Water Conservation District
- Warren County Water and Sewer District
- West Alexandria Mayor Mitch Suggs

APPENDIX B

Twin Creek Watershed Public Comments and Outreach Activities

The following areas of appreciation and concern were identified during public meetings held at various locations in the watershed to gain input in preparing the *Twin Creek Watershed Action Plan*.

Areas of Appreciation:

- Scenic Beauty
- Beautiful scenery, beauty of the stream and riparian corridor
- Big Spring/Mammoth Spring – north of Falls Rd. possible natural spring
- Shallow waterfalls near I-70
- Lower Gratis Road provides a beautiful drive on dirt/gravel road
- Astoria to Cherry Street

Agricultural/Rural Character

- Rural character, including tranquilty of pasture land
- Farmers are good stewards of land
- Grassed waterways help to clear water and slow the flow of runoff from the fields

History

- Covered and historic bridges including "Rohood" Bridge on Price Creek Rd., Pyrmont Rd. and 503, Christman Bridge on Western Rd.
- Mud Lick Bridge – the only bow string bridge left in Ohio
- Native American history along Twin Creek – artifacts, etc.
- Character of Village of Germantown
- Old Tobacco Barn picnic area at the end of the bike path in Germantown

Wildlife and Forests

- Abundant wildlife; especially good along Tom's Run
- Tree cover along the creek

Recreation

- Swimming, including old swimming hole at Iams Park
- Ice skating on creek
- Swimming, fishing, & wildlife at Falls Rd. and elsewhere in watershed
- Bike path along Twin Creek
- MetroParks, Kercher Park, Veterans Memorial Park

Water Quality

- Cleanliness and clearness of water at the bridges

Twin Creek Watershed Public Comments and Outreach Activities

- Human Resources

- Citizens volunteer time to protect watershed
- Sense of community and awareness of land
- Feelings of honesty from community members
- Other
- Good drainage

Areas of Concern:

- Agriculture
- Hog farms
- Agricultural practices
- Need for protection of agricultural way of life
- Maintain continuity & integrity of agricultural land use
- Animal waste disposal may be an issue for chicken farms and other large operations.
- Drainage systems increase amount and force of water going into the streams and sometimes cause scouring at the outlets.
- Some tile drainage systems are old and not functional. In some cases the tiles wash into the waterways and soil washes into the resulting holes.
- The farm economy is generally depressed. The number of small farms is decreasing.
- Historically 18-20% of the farmland was woodlot which helped with water drainage and air purification; now there are fewer and smaller woodlots**.**

Wind erosion

- Open drainage systems within no-till fields are eroding (regular cultivation of conventional tilled fields reconfigures land so that eroded ditches are smoothed out)
- Remnant corn stalks from no-till fields plug culverts

In Stream or Near Stream Issues

- Sedimentation in Aukerman Creek
- Altered hydrologic regime –channelization, accelerated runoff, agriculture drainage, absence of naturally occurring inundation
- Channelization may increase flooding downstream
- Streambanks are eroding more than before, downed trees in stream
- Water levels continue to drop
- Flooding
- Flooding of Bantas Fork at Prices Road after conversion from pasture to row crops
- Building occurring in the floodplain
- Currently many ditches are no longer a part of the ditch maintenance program (since 1959)

Land Use/Development

- There is an increase in impervious surfaces from roofs, driveways, lawns.
- Unsustainable development and negative consequences, desire for low impact development.
- Proximity to Montgomery County makes area more susceptible to growth.
- More houses will increase input to and may stress the wastewater treatment plants.
- Home sites decrease the size of remaining fields and they cannot be farmed easily.

- Planning/zoning is important but not transparent to community members.
- It seems that many are getting around the 40-acre lot split rule in Preble County and the rule does not provide as much protection as needed. There is a misconception about what the rule covers.

Quote: ""We're growing more houses than cows."

Wastewater Treatment

- Septic Systems – impact of systems concentrated in towns or failing systems, costs
- West Alexandria sewage treatment plant

Wildlife

- Mussel population appears to be less than it was 25-40 years ago, confirmed by data
- Beaver activity appears to be increasing and is problematic for farmers.

Other

- Gravel pits impact surface and ground water
- Potential industrial development at Hwy.127 and 70
- Road construction and maintenance, especially at bridges
- Bypass 844, which is discussed every couple of years
- Open geothermal home heating units pump water directly back into stream
- Point sources of pollution
- Health concerns
- Drainage problems in Darke County
- Trash and dumping
- Balancing access & private property rights & quality of creek
- Protect fossils
- Youth don't appreciate nature, outdoors
- Invasive species
- Threats to groundwater
- Logging/drilling

Pubic Education/Outreach Activities

The watershed coordinator spoke or had a table-top display at many meetings to enhance public understanding and awareness of the Western Tributaries watershed project (a larger initiative that is now on hold). In most cases, information for the tributaries projects was applicable to the Twin Creek watershed. Presentations or displays occurred at the following meetings and events:

- Butler SWCD Annual Meeting, 2005, 2006
- Butler County Farm City Tour, 2006
- Eaton Pork Festival, 2006
- Preble County Park Board
- Preble County Township Trustees
- Preble County Mayors Association
- Preble SWCD Annual Meeting, 2006

The watershed coordinator or project partners participated in several larger events to enhance the public understanding of the watershed project, including:

- Preble County Fair 2005, 2006
- Butler County Fair 2005
- Great Miami River Days 2005, 2006

Additionally the Watershed Coordinator participated in several events to provide youth education regarding watersheds:

- Preble SWCD Earth Day event at Pleasant Vineyard Spring, 2006
- ODNR Environmental Education Program at Hueston Woods State Park, 2005
- Great Miami River Days, 2005, 2006
- Hands-On Day of Discovery, 2006
- Preble SWCD Annual Meeting, 2006

APPENDIX C

Biological Communities of the Twin Creek Watershed
(Includes tables listing benthic macroinvertebrates, fishes, amphibians and reptiles, mammals, birds, native plants and invasive species.)

Table C-1

Alphabetical Listing of Benthic Macroinvertebrates

Collected in Twin Creek and its Tributaries by Ohio EPA

Taxa name, A-L	Taxa name M-Z
Ablabesmyia mallochi	macromia illinoiensis
Ablabesmyia simpsoni	macromia sp
Acentrella sp or Plauditus sp (formerly in Pseudocloeon)	macronychus glabratus
Acerpenna macdunnoughi	menetus (micromenetus) dilatatus
Acerpenna pygmaea	meropelopia sp
Aeshna sp	microtendipes "caelum" (sensu simpson & bode, 1980)
Agabus sp	microtendipes pedellus group
Anacaena sp	mooreobdella fervida
Ancyronyx variegata	mooreobdella microstoma
Anodontoides ferussacianus	nanocladius (n.) "rectinervis" (old)
Anopheles sp	nanocladius (n.) "rectinervis" (sensu simpson and bode, 1980)
Anthopotamus sp	nanocladius (n.) crassicornus
Antocha sp	nanocladius (n.) crassicornus (old)
Argia sp	nanocladius (n.) crassicornus or n. (n.) "rectinervis"
Baetis flavistriga	nanocladius (n.) distinctus
Baetis intercalaris	nanocladius (n.) minimus
Baetis sp	nanocladius (n.) sp
Basiaeschna janata	nanocladius (n.) spiniplenus
Belostoma sp	natarsia baltimoreus
Berosus sp	natarsia species a (sensu roback, 1978)
Boyeria vinosa	nematomorpha

Brillia flavifrons group	neophylax sp
Caecidotea sp	nigronia fasciatus
Caenis sp	nigronia serricornis
Callibaetis sp	nilotanypus fimbriatus
Calopteryx sp	nixe perfida
Cambarus (Cambarus) sp A	notonecta sp
Cambarus (Tubericambarus) sp A	nyctiophylax sp
Capniidae	ochthera sp
Cardiocladius obscurus	oecetis sp
Centroptilum sp (w/o hindwing pads)	oligochaeta
Taxa name, A-L	**Taxa name M-Z**
Centroptilum sp or Procloeon sp (formerly in Cloeon)	optioservus fastiditus
Ceraclea ancylus	optioservus sp
Ceraclea sp	orconectes (procericambarus) rusticus
Ceratopogonidae	orconectes (rhoadesius) sloanii
Ceratopsyche morose	orconectes sp
Ceratopsyche morosa group	orthocladius (o.) sp
Chauliodes sp	palmacorixa sp
Cheumatopsyche sp	paludicella articulata
Chimarra aterrima	parachironomus "abortivus" (sensu simpson & bode, 1980)
Chimarra obscura	parachironomus carinatus
Chironomus (C.) decorus group	parachironomus pectinatellae
Chironomus (C.) riparius group	parachironomus sp
Chironomus (C.) sp	paracladopelma nereis
Chrysops sp	paracloeodes sp 3
Cladotanytarsus mancus group	paracymus sp
Cladotanytarsus sp	parakiefferiella n.sp 1
Cladotanytarsus species group A	parakiefferiella n.sp 2
Cladotanytarsus vanderwulpi group Type 1	parakiefferiella sp
Cladotanytarsus vanderwulpi group Type 2	paramerina fragilis
Climacia sp	parametriocnemus sp

Clinotanypus pinguis	parapoynx sp
Coenagrionidae	paratanytarsus n.sp 1
Conchapelopia sp	paratanytarsus sp
Corbicula fluminea	paratendipes albimanus or p. duplicatus
Cordulegaster sp	paratrichocladius sp
Corixidae	peltodytes edentulous
Corydalus cornutus	peltodytes sp
Corynoneura "celeripes" (sensu Simpson & Bode, 1980)	pentaneura inconspicua
Corynoneura lobata	perlesta placida complex
Corynoneura n.sp 1	perlodidae
Corynoneura sp	petrophila sp
Crangonyx sp	phaenopsectra flavipes
Cricotopus (C.) absurdus	phaenopsectra obediens group
Cricotopus (C.) bicinctus	physella sp
Cricotopus (C.) or Orthocladius (O.) sp	pilaria sp
Cricotopus (C.) sp	pisidium sp
Cricotopus (C.) tremulus group	placobdella ornate
Cricotopus (C.) trifascia	placobdella papillifera
Cryptochironomus sp	planorbella (pierosoma) pilsbryi
Culex sp	plathemis lydia
Cyrnellus fraternus	plauditus virilis
Taxa name, A-L	**taxa name m-z**
Dicrotendipes fumidus	plecoptera
Dicrotendipes lucifer	plumatella repens
Dicrotendipes neomodestus	plumatella reticulate
Dicrotendipes simpsoni	plumatella sp
Dicrotendipes sp	polycentropus sp
Dineutus sp	polypedilum (cerobregma) ontario
Diphetor hageni	polypedilum (p.) fallax group
Dixa sp	polypedilum (p.) illinoense
Dixella sp	polypedilum (p.) laetum group
Dromogomphus sp	polypedilum (p.) ophioides
Dromogomphus spinosus	polypedilum (tripodura) halterale group

Dryopoidea	polypedilum (tripodura) scalaenum group
Dubiraphia bivittata	polypedilum (uresipedilum) aviceps
Dubiraphia quadrinotata	polypedilum (uresipedilum) flavum
Dubiraphia sp	potamyia flava
Dubiraphia vittata group	procladius sp
Ectopria sp	procloeon sp (formerly in centroptilum)
Ectoprocta	procloeon sp (w/ hindwing pads)
Elimia sp	procloeon sp (w/o hindwing pads)
Empididae	procloeon viridoculare
Endochironomus nigricans	psectrotanypus dyari
Enochrus sp	psephenus herricki
Ephemera simulans	pseudochironomus sp
Ephemera sp	pseudocloeon frondale
Ephemerella sp	pseudocloeon propinquum
Ephydatia fluviatilis	pseudolimnophila sp
Ephydridae	psychomyia flavida
Epitheca (Tetragoneuria) cynosura	pycnopsyche sp
Erpobdella punctata punctata	pyganodon grandis
Erpobdellidae	ranatra sp
Eunapius fragilis	rheocricotopus (psilocricotopus) robacki
Eurylophella sp	rheotanytarsus pellucidus
Ferrissia sp	rheotanytarsus sp
Fossaria sp	saetheria tylus
Fredericella australiensis	scirtidae
Fredericella sp	sialis sp
Gammarus sp	sigara sp
Glyptotendipes (G.) sp	simuliidae
Gomphus lividus	simulium sp
Gomphus sp	somatochlora sp
Gyraulus (Torquis) parvus	sphaerium sp
Gyrinus sp	spongilla lacustris
Hayesomyia senata	spongillidae
Helichus sp	stempellinella n.sp nr. flavidula
Helicopsyche borealis	stempellinella poss. leptocelloides

Helisoma anceps anceps	stempellinella sp
Helobdella elongata	stenacron sp
Taxa name, A-L	**Taxa name M-Z**
Helobdella stagnalis	stenelmis sp
Helobdella triserialis	stenochironomus sp
Helopelopia sp	stenonema exiguum
Helophorus sp	stenonema femoratum
Hemerodromia sp	stenonema mediopunctatum
Hetaerina sp	stenonema mexicanum integrum
Heteromeyenia latitenta	stenonema pulchellum
Hexagenia atrocaudata	stenonema pulchellum group
Hexagenia limbata	stenonema sp
Hexagenia sp	stenonema terminatum
Hexatoma sp	stenonema tripunctatum (old)
Hyalella azteca	stenonema vicarium
Hydra sp	stictochironomus sp
Hydrachnidia	strophitus undulatus undulates
Hydrochus sp	tabanus fairchildi
Hydrophilidae	tabanus sp
Hydroporus sp	tanypodinae
Hydropsyche aerata	tanypus "punctipennis" (sensu roback, 1977)
Hydropsyche depravata group	tanytarsus curticornis group
Hydropsyche dicantha	tanytarsus glabrescens group
Hydropsyche simulans	tanytarsus sepp
Hydropsyche sp	tanytarsus sp
Hydropsyche valanis	tanytarsus type 3
Hydroptila sp	telopelopia okoboji
Hydroptilidae	thienemanniella lobapodema
Isonychia sp	thienemanniella similes
Isoperla sp	thienemanniella taurocapita
Labrundinia pilosella	thienemanniella xena
Labrundinia sp	thienemannimyia group
Laccobius sp	thienemannimyia norena
Laccophilus sp	tipula abdominalis

Lampsilis cardium	tipula sp
Lampsilis radiata luteola	triaenodes melaca
Larsia sp	triaenodes sp
Lasmigona costata	tribelos fuscicorne
Leptophlebia sp or Paraleptophlebia sp	tricorythodes sp
Leucrocuta sp	tropisternus sp
Libellula pulchella	turbellaria
Libellulidae	tvetenia bavarica group
Limnophora aequifrons	tvetenia discoloripes group
Limnophyes sp	urnatella gracilis
Limonia sp	xenochironomus xenolabis
Lirceus sp	zavrelimyia sp

Note: This list is for all years sampled by OEPA. SOURCE: OEPA 2005.

TABLE C-2

Fishes Occurring in the Twin Creek Watershed

Common Name	Scientific Name
MOTTLED SCULPIN	*cottus bairdii*
LONGNOSE GAR	*lepisosteus osseus*
GIZZARD SHAD	*dorosoma cepedianum*
NORTHERN PIKE	*esox lucius*
CENTRAL STONEROLLER	*campostoma anomalum*
GOLDFISH	*carassius auratus*
ROSYSIDE DACE**	*clinstomus funduloides*
COMMON CARP	*cyprinus carpio*
BIGEYE CHUB*	*hybopsis amblops*
HORNYHEAD CHUB	*nocomis biguttatus*
RIVER CHUB*	*nocomis micropogon*
GOLDEN SHINER	*notemigonus crysoleucas*
EMERALD SHINER	*notropis atherinoides*
SILVER SHINER	*notropis photogenis*
ROSYFACE SHINER*	*notropis rubellus*
SAND SHINER	*notropis stramineus*

MIMIC SHINER*	*notropis volucellus*
SUCKERMOUTH MINNOW	*phenacobius mirabilis*
SOUTHERN REDBELLY DACE*	*phoxinus erythrogaster*
BLUNTNOSE MINNOW	*pimephales notatus*
FATHEAD MINNOW	*pimephales promelas*
BLACKNOSE DACE	*rhinichthys atratulus*
CREEK CHUB	*semotilus atromaculatus*
SPOTFIN SHINER	*cyprinella spiloptera*
STEELCOLOR SHINER	*cyprinella whipplei*
STRIPED SHINER	*luxilus chrysocephalus*
ROSEFIN SHINER*	*lythrurus fasciolaris*
SILVERJAW MINNOW	*notropis buccatus*
RIVER CARPSUCKER	*carpiodes carpio*
QUILLBACK CARPSUCKER	*carpiodes cyprinus*
HIGHFIN CARPSUCKER	*carpiodes velifer*
WHITE SUCKER	*catostomus commersonii*
CREEK CHUBSUCKER*	*erimyzon oblongus*
NORTHERN HOGSUCKER	*hypentelium nigricans*
BLACK REDHORSE	*moxostoma duquesnei*
GOLDEN REDHORSE	*moxostoma erythrurum*
SHORTHEAD REDHORSE	*moxostoma macrolepidotum*
CHANNEL CATFISH	*ictalurus punctatus*
STONECAT MADTOM	*noturus flavus*
BRINDLED MADTOM*	*noturus miurus*
FLATHEAD CATFISH	*pylodictis olivaris*
BLACK BULLHEAD	*ameiurus melas*
BROWN BULLHEAD	*ameiurus nebulosus*
BLACKSTRIPE TOPMINNOW	*fundulus notatus*

Common Name	**Scientific Name**
BROOK SILVERSIDE	*labidesthes sicculus*
WHITE BASS	*morone chrysops*
ROCK BASS	*ambloplites rupestris*
GREEN SUNFISH	*lepomis cyanellus*

PUMPKINSEED SUNFISH	*lepomis gibbosus*
WARMOUTH SUNFISH	*lepomis gulosus*
ORANGESPOTTED SUNFISH	*lepomis humilis*
BLUEGILL SUNFISH	*lepomis macrochirus*
LONGEAR SUNFISH	*lepomis megalotis*
REDEAR SUNFISH	*lepomis microlophus*
SMALLMOUTH BASS	*micropterus dolomieu*
SPOTTED BASS	*micropterus punctulatus*
LARGEMOUTH BASS	*micropterus salmoides*
WHITE CRAPPIE	*pomoxis annularis*
BLACK CRAPPIE	*pomoxis nigromaculatus*
GREENSIDE DARTER	*etheostoma blennioides*
RAINBOW DARTER	*etheostoma caeruleum*
FANTAIL DARTER	*etheostoma flabellare*
LEAST DARTER***	*etheostoma microperca*
JOHNNY DARTER	*etheostoma nigrum*
ORANGETHROAT DARTER	*etheostoma spectabile*
BANDED DARTER	*etheostoma zonale*
LOGPERCH	*percina caprodes*
BLACKSIDE DARTER	*percina maculata*
FRESHWATER DRUM	*aplodinotus grunniens*

* Indicates a species declining in Ohio.
** Indicates a Threatened Species in Ohio
*** Indicates a species of Special Concern in Ohio
SOURCES: Ohio EPA 1997 and 2005

TABLE C-3

Amphibians and Reptiles Occurring in the Twin Creek Watershed

COMMON NAME	SCIENTIFIC NAME
TWO-LINED SALAMANDER	*EURYCEA BISLINEATA*
LONG-TAILED SALAMANDER	*EURYCEA LONGICAUDA*
NORTHERN RED SALAMANDER	*PSEUDOTRITON RUBER RUBER*
CAVE SALAMANDER	*EURYCEA LUCIFUGA*
STREAMSIDE SALAMANDER	*AMYSTOMA BARBOURI*
DUSKY SALAMANDER	*DESMOGANATHUS FUSCUS FUSCUS*

RED-SPOTTED NEWT	*NOTOPHTHALMUS VIRIDESCENS VIRIDESCENS*
JEFFERSON SALAMANDER	*AMBYSTOMA JEFFERSONIANUM*
SPOTTED SALAMANDER	*AMBYSTOMA MACULATUM*
SMALLMOUTH SALAMANDER	*AMBYSTOMA TEXANUM*
STREAMSIDE SALAMANDER	*AMBYSTOMA BARBOURI*
MARBLED SALAMANDER	*AMBYSTOMA OPACUM*
EASTERN TIGER SALAMANDER	*AMBYSTOMA TIGRINUM TIGRINUM*
MOUNTAIN DUSKY SALAMANDER	*DESMOGNATHUS OCHROPHAEUS*
REDBACK SALAMANDER	*PLETHODON CINEREUS*
RAVINE SALAMANDER	*PLETHODON RICHMONDI*
NORTHERN SLIMY SALAMANDER	*PLETHODON GLUTINOSUS*
FOWLER'S TOAD	*BUFO FOWLERI*
AMERICAN TOAD	*BUFO AMERICANUS*
NORTHERN CRICKET FROG	*ACRIS CREPITANS*
NORTHERN SPRING PEEPER	*PSEUDACRIS CRUCIFER CRUCIFER*
GRAY TREEFROG	*HYLA VERSICOLOR*
COPE'S GRAY TREEFROG	*HYLA CHRYSOSCELIS*
WESTERN CHORUS FROG	*PSEUDACRIS TRISERIATA TRISERIATA*
BULLFROG	*RANA CATESBEIANA*
GREEN FROG	*RANA CLAMITANS MELANOTA*
NORTHERN LEOPARD FROG	*RANA PIPIENS*
PICKEREL FROG	*RANA PALUSTRIS*
SOUTHERN LEOPARD FROG	*RANA UTRICULARIA*
WOOD FROG	*RANA SYLVATICA*
COMMON MUSK TURTLE	*STERNOTHERUS ODORATUS*
COMMON SNAPPING TURTLE	*CHELYDRA SERPENTINA SERPENTINA*
SPOTTED TURTLE	*CLEMMYS GUTTATA*
EASTERN BOX TURTLE	*TERRAPENE CAROLINA CAROLINA*
EASTERN SPINY SOFTSHELL TURTLE	*APALONE SPINIFERA SPINIFERA*
NORTHERN FENCE LIZARD	*SCELOPORUS UNDULATUS HYACINTHINUS*
GROUND SKINK	*SCINCELLA LATERALIS*
FIVE-LINED SKINK	*EUMECES FASCIATUS*
EUROPEAN WALL LIZARD	*PODARCIS MURALIS*

QUEEN SNAKE	*REGINA SEPTEMVITTATA*
EASTERN MASSASSAUGA	*SISTRURUS CATENATUS*
KIRTLAND'S SNAKE	*CLONOPHIS KIRTLANDII*
BROWN SNAKE	*STORERIA DEKAYI*
BUTLER'S GARTER SNAKE	*THAMNOPHIS BUTLERI*
EASTERN RIBBON SNAKE	*THAMNOPHIS SAURITUS*
EASTERN HOGNOSE SNAKE	*HETERODON PLATIRHINOS*
RINGNECK SNAKE	*DIADOPHIS PUNCTATUS*
MIDWEST WORM SNAKE	*CARPHOPHIS AMOENUS HELENAE*
BLACK RACER	*COLUBER CONSTRICTOR*
ROUGH GREEN SNAKE	*OPHEODRYS AESTIVUS*
EASTERN RAT SNAKE	*ELAPHE OBSOLETA*
EASTERN MILK SNAKE	*LAMPROPELTIS TRIANGULUM TRIANGULUM*
NORTHERN COPPERHEAD	*AGKISTRODON CONTORTRIX*

SOURCES: ODNR, Division of Natural Area and Preserves 2006; OEPA 2002

Table C-4

Mammals Occurring in the Twin Creek Watershed

Common Name	Species Name
Virginia opossum	*didelphis virginiana*
Short-tailed shrew	*blarina brevicauda*
Least shrew	*cryptotis parva*
Big brown bat	*eptesicus fuscus*
Silver-haired bat	*lasionycteris noctivagans*
Red bat	*lasiurus borealis*
Hoary bat	*lasiurus cinereus*
Gray bat	*myotis grisescens*
Little brown bat	*myotis lucifugus*
Indiana bat	*myotis sodalis*
Evening bat	*nycticeius humeralis*
Eastern pipistrelle	*pipistrellus subflavus*
Eastern cottontail	*sylvilagus floridanus*
Beaver	*castor canadensis*
Meadow vole	*microtus pennsylvanicus*
Woodland vole	*microtus pinetorum*
House mouse	*mus musculus*
Eastern woodrat	*neotoma floridana*

Muskrat	*ondatra zibethicus*
White-footed mouse	*peromyscus leucopus*
Deer mouse	*peromyscus maniculatus*
Norway rat	*rattus norvegicus*
Southern flying squirrel	*glacomys volans*
Woodchuck	*marmota monax*
Gray squirrel	*sciurus carolinensis*
Fox squirrel	*sciurus niger*
Thirteen-lined ground squirrel	*spermophilus tridecemlineatus*
Eastern chipmunk	*tamias striatus*
Red squirrel	*tamiasciurus hudsonicus*
Meadow jumping mouse	*zapus hudsonius*
Coyote	*canis latrans*
Gray fox	*urocyon cinereoargenteus*
Red fox	*vulpes vulpes*
Raccoon	*procyon lotor*
Black bear	*ursus americanus*
River otter	*lutra canadensis*
Striped skunk	*mephitis mephitis*
Long-tailed weasel	*mustela frenata*
Least weasel	*mustela nivalis*
Mink	*mustela vison*
Badger	*taxidea taxus*
Bobcat	*lynx rufus*
White-tailed deer	*odocoileus virginianus*

SOURCE: American Mammal Society 2006.

Table C-5

Common Names of Birds Known from the Twin Creek Watershed

- Cerulean Warbler
- Yellow-billed Cuckoo
- Whip-poor-will
- Eastern Wood-pewee
- Wood Thrush
- Worm-eating Warbler
- Louisiana Waterthrush
- Kentucky Warbler
- Acadian Flycatcher
- Red-eyed Vireo
- Black-and-white Warbler
- Yellow Warbler
- Hooded Warbler
- Summer Tanager
- Scarlet Tanager
- Acadian Flycatcher,
- Red-tailed Hawk
- Cooper's Hawk
- American Kestrel
- Northern Harrier
- Great Horned Owl
- Eastern Screech-Owl
- Red-bellied Woodpecker
- Downy Woodpecker
- Hairy Woodpecker
- Pileated Woodpecker
- Yellow-bellied Sapsucker
- Brown-headed Cowbird
- Eastern Phoebe
- House Finch
- Chipping Sparrow
- Northern Cardinal
- Baltimore Oriole
- Cedar Waxwing
- Carolina Wren
- House Wren
- Sedge Wren
- Chimney Swift
- Purple Martin
- House Sparrow
- Northern Mockingbird
- Rose-breasted Grosbeak
- American Redstart
- Yellow-breasted Chat
- Red-headed Woodpecker
- Great Crested Flycatcher
- Eastern Bluebird
- Eastern Meadowlark
- Horned Lark
- Tufted Titmouse
- Carolina Chickadee
- American Ro
- Ovenbird
- Vesper Sparrow
- Savannah Sparrow
- Grasshopper Sparrow
- Field Sparrow
- Henslow's Sparrow
- Song Sparrow
- Eastern Towhee
- Orchard Oriole
- Dickcissel
- Blue Jay
- Indigo Bunting
- Ruby-throated Hummingbird
- Loggerhead Shrike*
- Northern Bobwhite
- Belted Kingfisher
- Northern Rough-winged Swallow
- Eastern Kingbird
- Rock Dove
- Mourning Dove
- American Crow
- Common Nighthawk
- Northern Parula
- Bobolink
- Mallard
- Wood Duck
- Canada Goose
- Great Blue Heron
- Green Heron
- Killdeer

*Extirpated as a breeder in this range.

SOURCE: Fitzgerald et al., 2000; Ford et al., 2000, and Fitton, personal communication, 2007

Table C-6

NATIVE PLANT COMMUNITIES KNOWN FROM THE TWIN CREEK WATERSHED

BEECH MAPLE GLACIATED FOREST

UPLAND WOODLAND COMMUNITY

SCIENTIFIC NAME	COMMON NAME
CANOPY	
ACER SACCHARUM	SILVER MAPLE
FAGUS GRANDIFOLIA	BEECH
LIRIODENDRON TULIPIFERA	POPLAR
CARPINUS CAROLINIANA	IRONWOOD
FRAXINUS AMERICANA	WHITE ASH
OSTRYA VIRGINIANA	HOP HORNBEAM
QUERCUS RUBRA	RED OAK
TILIA AMERICANA	BASSWOOD
ULMUS AMERICANA	WHITE ELM
SHRUBS	
DIERVILLA LONICERA	NORTHERN BUSH HONEYSUCKLE
EUONYMUS OBOVATA	RUNNING STRAWBERRY BUSH
LONICERA CANADENSIS	AMERICAN FLY HONEYSUCKLE
SAMBUCUS RACEMOSA VAR. RACEMOSA	EUROPEAN RED ELDER
VIBURNUM SPP.	
HERBACEOUS LAYER	
ARISAEMA TRIPHYLLUM	JACK IN THE PULPIT
(ARISAEMA ATRORUBENS)	EVERGREEN WOODFERN
DRYOPTERIS INTERMEDIA	WILD LILLY-OF-THE-VALLEY
GALIUM APARINE	SOLOMON'S PLUME
MAIANTHEMUM RACEMOSUM	SWEET CICELY
OSMORHIZA CLAYTONIA	MAYAPPLE
PODOPHYLLUM PELTATUM	COMMON SOLOMON'S SEAL
POLYGONATUM BIFLORUM	WHITE TRILLIUM
TRILLIUM GRANDIFLORUM	VIOLA
VIOLA SPP	

SILVER MAPLE – ELM - (COTTONWOOD)

FOREST RIPARIAN COMMUNITY

CANOPY	
ACER SACCHARINUM	SILVER MAPLE
POPULUS DELTOIDS	COTTONWOOD

PLATANUS OCCIDENTALIS	SYCAMORE
ULMUS AMERICANA	WHITE ELM
ULMUS RUBRA	RED ELM
SALIX NIGRA	BLACK WILLOW
ACER NEGUNDO	BOXELDER
BETULA NIGRA	RIVER BIRCH
CELTIS OCCIDENTALIS	HACKBERRY
FRAXINUS PENNSYLVANICA	RED ASH
SHRUB AND SAPLING LAYER	
SAMBUCUS CANADENSIS	ELDERBERRY
LINDERA BENZOIN	SPICE-BUSH
PARTHENOCISSUS QUINQUEFOLIA	VIRGINIA CREEPER
VITIS RIPARIA	WILD GRAPE
HERBACEOUS VINES	
APIOS AMERICANA	POTATO BEAN
AMPHICARPAEA BRACTEATA	AMERICAN HOG-PEANUT
ECHINOCYSTIS LOBATA	WILD CUCUMBER
HERBACEOUS GRASSES, FORBS, AND FERNS	
SYMPHYOTRICHUM LATERIFLORUM (ASTER LATERIFLORUS)	STARVED ASTER
BOEHMERIA CYLINDRICA	FALSE NETTLE
ELYMUS VIRGINICUS	VIRGINIA WILD RYE
IMPATIENS PALLIDA	PALE JEWELWEED
LAPORTEA CANADENSIS	WOOD NETTLE
MATTEUCCIA STRUTHIOPTERIS	OSTRICH FERN
ONOCLEA SENSIBILIS	SENSITIVE FERN
PILEA PUMILA	CLEARWEED
URTICA DIOICA	STINGING NETTLE

SOURCES: Faber-Langendoen 2001; Braun 1950

Table C-7

Non-Native or Invasive Plants Known to Occur in Southwest Ohio

COMMON NAME	SCIENTIFIC NAME
AMUR, MORROW, AND TARTARIAN HONEYSUCKLE	*LONICERA MAACKII, L. MORROWII, L. TATARICA*
JAPANESE HONEYSUCKLE AND ASIAN BITTERSWEET	*LONICERA JAPONICA, CELASTRUS ORBICULATUS*
SMOOTHE BROME	*BROMUS INERMIS*
GARLIC MUSTARD	*ALLIARIA PETIOLATA*
PURPLE LOOSESTRIFE	*LYTHRUM SALICARIA*
AUTUMN AND RUSSIAN OLIVE	*ELAEAGNUS UMBELLATA*
	E. ANGUSTFOLIA
TREE OF HEAVEN	*AILANTHUS ALTISSIMA*
MULTIFLORA ROSE	*ROSA MULTIFLORA*
NARROW-LEAVED AND HYBRID CATTAIL	*TYPHA ANGUSTIFOLIA, T. XGLAUCA*
CANADIAN THISTLE	*CIRSIUM ARVENSE*
REED CANARY GRASS	*PHALARIS ARUNDINACEA*
COMMON AND CUT LEAF TEASEL	*DIPSACUS FULLONUM (SYLVESTRIS), D. LACINIATUS*
WHITE AND YELLOW CLOVER	*MELILOTUS ALBA, M OFFICINALIS*

SOURCE: ODNR 2006b

APPENDIX D

Ohio EPA Aquatic Life Use Status Data for Twin Creek

(Based on 2005 Data)

Aquatic life use attainment status for stations sampled in the Twin Creek watershed are based on data collected July-October 2005. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biotic community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community.

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources
Twin Creek (14-500)		*ECBP Ecoregion – EWH Existing*					
46.5^{H} /46.6	50	N/A	VG^{ns}	43.0	FULL		
42.1^{W}/42.0	48^{ns}	9.1^{ns}	46	75.5	FULL		
38.0^{W}/38.1	46^{ns}	9.0^{ns}	50	61.0	FULL		
35.5^{W} /35.4	58	10.2	50	67.0	FULL		
34.9^{W} /34.9	58	10.2	38*	71.0	PARTIAL	Nutrient enrichment, bacteria	Lewisburg WWTP
33.6^{W} /33.5	58	10.3	52	77.0	FULL		
31.7^{W} /31.7	55	9.6	54	72.5	FULL		
27.5^{W} /27.6	55	10.4	52	80.0	FULL		
26.7^{W} /26.6	56	11.1	44^{ns}	88.5	FULL		
23.9^{W} /23.7	54	10.0	50	79.0	FULL		

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources
19.2^{W} /19.2	50	9.8	52	76.5	FULL		
19.0^{W}/19.0	49^{ns}	10.0	E	72.0	FULL		
13.4^{W} /13.4	53	10.3	50	88.0	FULL		
9.8^{W} /9.7	56	10.4	52	74.0	FULL		
3.4^{W} /3.4	50	10.2	E	86.5	FULL		
0.9^{W} /0.9	55	9.8	48	82.0	FULL		
0.1^{W} /0.1	52	10.1	46	71.5	FULL		
Maple Swamp Ditch -Trib to Twin Creek @ RM 47.03 (14-519)							
ECBP Ecoregion – Undesignated – MWH Recommended							
2.4^{H} /2.4	38	N/A	P*	21.0	**(NON)**	Channel alteration, riparian removal, siltation, nutrient enrichment	Agriculture; Darke County ditch maintenance
ECBP Ecoregion – Undesignated – WWH Recommended							
1.4^{H} /1.4	44	N/A	G	38.5	FULL		Darke County ditch maintenance
Dry Fork -Trib to Twin Creek @ RM 39.35 (14-515)					*ECBP Ecoregion – WWH Existing*		
0.8^{H} /0.8	40	N/A	G	50.0	FULL		
Millers Fork -Trib to Twin Creek @ RM 35.71 (14-513)					*ECBP Ecoregion – EWH Existing – WWH Recommended*		

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources
10.8^{H} /10.8	40	N/A	Low F*	33.0	PARTIAL	Channel alteration, siltation, riparian removal, interstitial/intermittent flow, low dissolved oxygen	Agriculture, natural
ECBP Ecoregion – EWH Existing							
8.0^{H} /8.0	48^{ns}	N/A	G*	66.5	PARTIAL	Unknown	Unknown
3.9^{H} /3.9	48^{ns}	N/A	MG^{*}	58.0	PARTIAL	Siltation, riparian removal	Agriculture
Swamp Creek -Trib to Twin Creek @ RM 35.59 (14-512)							
ECBP Ecoregion – WWH Existing							
6.3^{H} /6.4	44	N/A	F*	34.0	PARTIAL	Interstitial flow, channel alteration, riparian removal, nutrient enrichment, siltation	Natural, agriculture
ECBP Ecoregion – EWH Existing							
--- /0.2	---	---	MG*	---		Interstitial flow	Natural
Trib to Swamp Creek @ RM 6.45 (14-521)					*ECBP Ecoregion - Undesignated – WWH Recommended*		
0.3^{H} / ---	38^{ns}	N/A	---	37.5	(FULL)		
Price Creek -Trib to Twin Creek @ RM 29.74 (14-510)					*ECBP Ecoregion – WWH Existing*		
13.7^{H} /13.6	38^{ns}	N/A	Low F*	47.0	PARTIAL	Interstitial/Intermittent flow, nutrient enrichment, bacteria, low dissolved oxygen	Natural, agriculture
10.9^{H}/10.9	46	N/A	G	62.5	FULL		
ECBP Ecoregion – EWH Existing – WWH Recommended							

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources
3.8^{W} /3.9	36	8.4	50	65.5	FULL		
Lesley Run -Trib to Twin Creek @ RM 24.60 (14-508)					*ECBP Ecoregion - WWH Existing*		
6.0^{H} / 4.9	48	N/A	Low F*	35.0	PARTIAL	Interstitial flow, channel alteration, riparian removal, low dissolved oxygen	Natural, agriculture
1.2^{H} /1.3	38^{ns}	N/A	Low F*	60.0	PARTIAL	Interstitial flow	Natural
Bantas Fork -Trib to Twin Creek at RM 24.32 (14-505)							
ECBP Ecoregion -EWH Existing							
13.7^{H} /13.7	46^{ns}	N/A	G*	69.0	PARTIAL	Unknown; low flow conditions?	Natural
9.4^{H} /9.5	56	N/A	54	67.0	FULL		
7.1^{W}/7.0	56	8.7^{na*}	50	72.5	FULL		
1.3^{W} /1.2	53	9.8	G*	80.5	PARTIAL	Unknown; low flow conditions?	Natural
Goose Run -Trib to Bantas Fork @ RM 7.55 (14-506)					*ECBP Ecoregion - WWH Existing*		
4.4^{H} /4.2	44	N/A	F*	55.0	PARTIAL	Interstitial flow	Natural
ECBP Ecoregion – EWH Existing							
0.3^{H} /0.3	56	N/A	VG^{ns}	73.0	FULL		
Aukerman Creek -Trib to Twin Creek @ RM 19.29 (14-504)							
ECBP Ecoregion - WWH Existing							

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources
$3.3^{H}/3.3$	50	N/A	VG	82.0	FULL		
$1.8^{H}/1.8$	52	N/A	G	75.5	FULL		
$0.5^{W}/0.4$	46	8.0^{ns}	52	70.5	FULL		
Trib to Aukerman Creek @ RM 2.88 (14-520)					*ECBP Ecoregion - Undesignated / WWH Recommended*		
$0.5^{H}/0.5$	48	N/A	VG	73.0	FULL		
Trib to Twin Creek @ RM 18.29 (14-518)					*ECBP Ecoregion – Undesignated – WWH Recommended*		
$0.6^{H}/0.7$	48	N/A	E	70.5	FULL		
Tom's Run -Trib to Twin Creek @ RM 13.52 (14-502)					*ECBP Ecoregion - WWH Existing*		
$12.0^{H}/12.0$	52	N/A	Low F*	40.5	PARTIAL	Interstitial flow, channel alteration, low dissolved oxygen	Natural, agriculture
$8.5^{H}/8.5$	40	N/A	Low F*	58.5	PARTIAL	Interstitial flow	Natural
$0.4^{W}/0.4$	48	8.7	34^{ns}	82.0	FULL		
Little Twin Creek -Trib to Twin Creek @ RM 6.69 (14-501)							
ECBP Ecoregion - EWH Existing							
$6.2^{H}/6.3$	46^{ns}	N/A	36*	65.5	PARTIAL	Unknown; low flow conditions?	Natural
$4.7^{H}/4.6$	48^{ns}	N/A	50	59.5	FULL		
$2.0^{H}/2.0$	54	N/A	VG^{ns}	77.0	FULL		

SOURCE: Ohio EPA 2006**.**

Key to Table Symbols

H Headwater site.

W Wading site.

B Boat site.

[a] MIwb is not applicable to headwater streams with drainage areas $\leq$ 20 mi^2.

[b] A narrative evaluation of the qualitative sample based on attributes such as EPT taxa richness, number of sensitive taxa, and community composition was used when quantitative data was not available or considered unreliable due to current velocities less than 0.3 fps flowing over the artificial substrates. VP=Very Poor, P=Poor, LF=Low Fair, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional

c Attainment is given for the proposed status when a change is recommended.

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

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

d Limited Warmwater Habitat is an archaic use designation.

e Low flow precluded use of boat method on the second pass.

f Modified Warmwater Habitat criteria for channel modified habitats.

na* The MIwb for RM 7.1, Bantas Fork, was invalidated to due to a sampling error associated with significant bridge effect.