1.0 Introduction

The Darby Creek watershed, including Big and Little Darby creeks, is an important water resource in central Ohio. Natural resource professionals from private, public and academic institutions are unanimous in citing these streams as among the most biologically diverse streams of their size in the Midwest. Big and Little Darby creeks have been designated as State and National Scenic Rivers, and the watershed is known to provide habitat for several state and federally listed endangered species.

The streams in the watershed are home to unique and diverse biological communities of fish, freshwater mussels and the associated benthic invertebrate fauna (aquatic insects, worms, etc.). However, recent studies document declines in water quality and stream habitat. Point source pollution (from pipes), runoff from urban areas and agricultural land, and poor stream bank land management are degrading some stream segments today. Among the most visible and widely publicized future threats to the Darby is conversion of farm land to suburban and commercial land uses, especially in Franklin County.

Ohio EPA conducted a comprehensive physical, chemical and biological survey of the Darby watershed in 2001-2002, and several problems were identified. The survey results were published in June 2004; major findings are summarized in this report. Having identified the problems, the next step is an analysis called the Total Maximum Daily Load (TMDL). This report documents the TMDL process for the Darby Creek watershed.

1.1 The Clean Water Act Requirement to Address Impaired Waters

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

The Ohio EPA identified the Big Darby Creek watershed (assessment units 05060001 190, 200, 210, 220) as impaired on the 2004 303(d) list (available at http://www.epa.state.oh.us/dsw/TMDL/2004IntReport/2004OhioIntegratedReport.html).

The report, *Biological and Water Quality Study of the Big Darby Creek Watershed, 2001/2002. Logan, Champaign, Union, Madison, Franklin and Pickaway Counties, Ohio, is* available at http://www.epa.state.oh.us/dsw/document_index/psdindx.html.

In the simplest terms, a TMDL is a cleanup plan for a watershed that is not meeting water quality standards. A TMDL is defined as a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards and an allocation of that quantity among the sources of the pollutant. Ultimately, the goal of Ohio's TMDL process is full attainment of ***Water Quality Standards (WQS)***, which would subsequently lead to the removal of the water bodies from the 303(d) list. Table 1.1 shows an overview of the TMDL process.

1.2 Public Involvement

Public involvement is key to the success of any TMDL project. From the beginning, Ohio EPA has invited participation in all aspects of the TMDL program. The Ohio EPA convened an external advisory group (EAG) in 1998 to assist the Agency with the development of the TMDL program in Ohio. The EAG issued a report in July, 2000 to the Director of Ohio EPA on their findings and recommendations. The Big Darby Creek watershed TMDL project has been completed using the process endorsed by the advisory group.

In the Big Darby Creek watershed specifically, Ohio EPA has regularly participated in ongoing watershed activities as part of and beyond the TMDL effort, drawing connections to the TMDL as appropriate. Among the watershed interests that Ohio EPA interacts with are the Darby Creek Joint Board of Supervisors, the Hellbranch Forum, and the Darby Partners. As part of ***208*** planning efforts in the Big Darby Creek watershed, Ohio EPA participated in an effort to identify development standards for western Franklin County in the Big Darby Creek watershed. The Environmentally Sensitive Development Area - External Advisory Group (ESDA-EAG) assembled to develop recommendations for development in the Hellbranch Run watershed. The recommendations reached during this effort will be evaluated along with the results of the Big Darby Creek Watershed TMDL for inclusion in the 2005 update of the Central Scioto Basin 208 plan.

As part of 208 planning, Ohio EPA has hosted public meetings for the Darby Creek watershed. A meeting to discuss the results of the draft TMDL was held on June 16, 2005.

Consistent with Ohio's current ***Continuous Planning Process*** (CPP), the draft TMDL report was public noticed from May 16, 2005 to August 15, 2005. A copy of the draft report was posted on Ohio EPA's web page

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Water Quality Standards establish stream use designations and water quality criteria (scientifically derived ambient concentrations developed by the state) that are protective of the surface waters of the state. Section ***208*** of the CWA requires that states annually certify water quality management plans that focus on planning for future water quality needs. The ***Continuous Planning Process*** is also required under federal regulations and serves to document the system that will be used to update water quality management functions. See http://www.epa.state.oh.us/pic/facts/Section_208_Fact_Sheet.pdf

(www.epa.state.oh.us/dsw/tMDL/index.html). A summary of the comments received and the associated responses is included as Appendix B to this report.

1.3 Organization of This Report

This report summarizes the water quality and habitat condition of the Big Darby Creek watershed, quantitatively assesses the factors causing the impairment, provides for tangible actions to restore and maintain the streams.

This chapter provides some basic information to promote understanding of the materials later in the report. Chapter 2 is a summary of the 'assessment phase' of the TMDL. Much of the material in Chapter 2 is organized into boxes and tables by sub-watershed. Chapter 3 and Chapter 4 represent the 'development phase' of the TMDL. Chapter 3 discusses stream function and target establishment. Chapter 4 provides for quantitative load establishment and other guidance for the watershed. Like Chapter 2, the fourth chapter is organized by sub-watershed. The intent of this organization is to facilitate construction of sub-watershed fact sheets by combining information in Chapters 2 and 4 for each sub-watershed, possibly by watershed action organizations. Chapter 5 of the report discusses implementation of the TMDL.

1.4 Water Quality Standards

As mentioned in Section 1.1, a TMDL is a plan designed to return a stream that does not currently meet water quality standards to a state where it can achieve water quality standards. The Ohio Water Quality Standards (WQS; Ohio Administrative Code (OAC) 3745-1) consist of designated uses and chemical, physical, and biological criteria protective of those uses, and an antidegradation policy as outlined in OAC 3745-1-05. Use designations consist of two broad groups, aquatic life and non-aquatic life uses. In applications of the Ohio WQS to the management of water resource issues in Ohio's rivers and streams, the aquatic life use criteria frequently result in the most stringent protection and restoration requirements, hence their emphasis in biological and water quality reports. Also, an emphasis on protecting for aquatic life generally results in water quality suitable for all uses.

A summary of the WQS is given in Table 1.2.

Table 1.1 Summary of the TMDL Process

"TMDL" Phases	Approach	Target questions to answer	Product
Phase 1. **Assessment** of the 'state' of the streams within a watershed	Collect in-stream chemical, habitat, and biological data from sites around the watershed. Compare biological and bacteriological data with associated criteria to determine if impairment exists. Evaluate data patterns to determine likely reasons for impairment	What are the appropriate beneficial uses? Are the beneficial uses impaired? If so, what factors are contributing to impairment? If not, what factors are contributing to attainment?	Biological and Water Quality Study of the Big Darby Creek Watershed 2001/2002. June 28, 2004 *(often referred to as the Technical Support Document or TSD)* Chapter !3 of the TMDL report is a summary of the findings of this step.
Phase 2. **Development** of the prescription needed to achieve attainment	Based on results from Phase 1, an in depth, targeted analysis of impairing factors is completed. Computer models are constructed to reflect the existing condition of the watershed. Specific physical and chemical data are collected to support the models (different data than Phase 1) These models are then used to predict the changes needed to achieve attainment (i.e., the 'prescription')	What is the allowable load to the stream? What is the existing loading to the stream? What is the existing condition of other non-load impairing factors? What are the appropriate source allocations? What other desired endpoints are needed to achieve full attainment?	Big Darby Creek Watershed Total Maximum Daily Load (TMDL) Report. Draft May 16, 2005. Chapters 3 and 4 of the above report focus on this step.

Table 1.1 Summary of the TMDL Process			
Phase 3. Identification and **implementation** of specific actions to carry out the prescription	Development of a watershed action plan that identifies activities and issues the local watershed group plans to address. Regulatory actions in support of the findings of Phase 2. Voluntary actions encouraged by education and funding opportunities.	This step, while having many questions associated with it, is more action oriented than investigatory.	Chapter 5 of the TMDL report focuses on implementation options. The Big Darby Creek Watershed Action Plan Darby Accord and Hellbranch Forum Watershed Plans 208 plans for counties within the Darby watershed NPDES permits Local action, regulations. Many other vehicles for implementation
Phase 4. **Evaluation** of progress	Collect data as in Phase 1 to establish current 'state' of the watershed. Evaluate as in Phase 1.	Were actions that were identified implemented? If they were implemented, were they successful in achieving targets? Can the watershed be removed from the 303(d) list?	303(d) list status

Table 1.2 Summary of Ohio Water Quality Standards

WQS Components	Examples of:	Description
Beneficial Use Designation	1. Water supply ● Public (drinking) ● Agricultural ● Industrial 2. Recreational contact ● Beaches (Bathing waters) ● Swimming (Primary Contact) ● Wading (Secondary Contact) 3. Aquatic life habitats (partial list): ● Exceptional Warmwater (EWH) ● Warmwater (WWH) ● Modified Warmwater (MWH) ● Limited Resource Water (LRW)	Designated uses reflect how the water is potentially used by humans and how well it supports a biological community. Every water in Ohio has a designated use or uses; however, not all uses apply to all waters (they are water body specific). Each use designation has an individual set of numeric criteria associated with it, which are necessary to protect the use designation. For example, a water that was designated as a drinking water supply and could support exceptional biology would have more stringent (lower) allowable concentrations of pollutants than would the average stream. Recreational uses indicate whether the water can potentially be used for swimming or if it may only be suitable for wading.
Numeric Criteria	1. Chemical	Represents the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. Laboratory studies of organism's sensitivity to concentrations of chemicals exposed over varying time periods form the basis for these.
	2. Biological *Measures of fish health:* • Index of Biotic Integrity • Modified Index of Well Being *Measure of bug (macroinvertebrate) health:* • Invertebrate Community Index	Indicates the health of the instream biological community by using these 3 indices (measuring sticks). The numeric biological criteria (biocriteria) were developed using a large database of reference sites. These criteria are the basis for determining aquatic life use attainment.
	3. Whole Effluent Toxicity (WET)	Measures the harmful effect of an effluent on living organisms (using toxicity tests).
	4. Bacteriological	Represents the level of bacteria protective of the potential recreational use.
Narrative Criteria (Also known as 'Free Froms')	General water quality criteria that apply to all surface waters. These criteria state that all waters shall be free from sludge, floating debris, oil and scum, color and odor producing materials, substances that are harmful to human, animal or aquatic life, and nutrients in concentrations that may cause algal blooms.	
Antidegradation Policy	This policy establishes situations under which the director may allow new or increased discharges of pollutants, and requires those seeking to discharge additional pollutants to demonstrate an important social or economic need. Refer to http://www.epa.state.oh.us/dsw/wqs/wqs.html for more information.	

1.4.1 Aquatic Life Uses

The five different aquatic life uses currently defined in the Ohio WQS are described as follows:

Warmwater Habitat (WWH)
This aquatic life use designation is characterized by the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams; *this use represents the principal restoration target for the majority of water resource management efforts in Ohio.*

Exceptional Warmwater Habitat (EWH)
This aquatic life use designation is reserved for waters which support "unusual and exceptional" assemblages of aquatic organisms that are characterized by a high diversity of species, particularly those which are highly intolerant and/or rare, threatened, endangered, or special status (i.e., declining species); *this designation represents a protection goal for water resource management efforts dealing with Ohio's best water resources.* The Big Darby Creek watershed includes extensive stretches of stream that have the EWH aquatic life use designation.

Coldwater Habitat (CWH)
This aquatic life use is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the Ohio Department of Natural Resources (ODNR), Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic "runs" of salmonids during the spring, summer, and/or fall. The Big Darby Creek watershed has some headwater streams that are being designated CWH. This is exceedingly rare in the Scioto River Basin.

Modified Warmwater Habitat (MWH)
This aquatic life use applies to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodification such that the biocriteria for the WWH use are not attainable *and where the activities have been sanctioned and permitted by state or federal law*; the representative aquatic assemblages are generally composed of species which are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor quality habitat. It is important to note that even where this use designation is applied, that the allowable conditions in the MWH designated stream may be driven by the need to protect a higher downstream aquatic life use designation (e.g., WWH, EWH).

Limited Resource Water (LRW)
This aquatic life use designation applies 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; such waterways generally include small streams in extensively urbanized areas, those that lie in watersheds with

extensive drainage modifications, those which completely lack water on a recurring annual basis (i.e., true ephemeral streams), or other irretrievably altered waterways.

Chemical, physical, and biological criteria are generally assigned to each use designation in accordance with the broad goals defined by the aquatic life use. As such, the system of use designations employed in the Ohio WQS constitutes a tiered approach of graduated levels of protection. This hierarchy is especially apparent for parameters such as dissolved oxygen (DO), NH_3-N (ammonia), temperature, and the biological criteria. For other parameters such as heavy metals, the technology to construct an equally graduated set of criteria has been lacking, thus the same water quality criteria may apply to two or three different aquatic life use designations.

1.4.2 Non-aquatic Life Uses

In addition to assessing the appropriateness and status of aquatic life uses, each biological and water quality survey also addresses non-aquatic life uses such as recreation, water supply and human health concerns as appropriate. The recreation uses most applicable to rivers and streams are the Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR) recreational uses. The criterion for the PCR designation is being suitable for full-body contact recreation. Ohio EPA assigns the PCR use designation to a stream unless it is demonstrated through a use attainment analysis that the combination of remoteness, accessibility, and depth makes full-body contact recreation by adults or children unlikely. In those cases, the Secondary Contact Recreation (SCR) designation is assigned. The attainment status of PCR and SCR is determined using bacterial indicators (e.g., fecal coliform, *E. coli*) and the criteria for each are specified in the Ohio WQS.

Water supply uses include Public Water Supply (PWS), Agricultural Water Supply (AWS), and Industrial Water Supply (IWS). Public Water Supplies are simply defined as segments within 500 yards of a potable water supply or food processing industry intake. The AWS and IWS use designations generally apply to all waters unless it can be clearly shown that they are not applicable. An example of this would be an urban area where livestock watering or pasturing does not take place, thus the AWS use would not apply. Chemical criteria are specified in the Ohio WQS for each use and attainment status is based primarily on chemical specific indicators.

1.4.3 Proposed Water Quality Standards Changes

A water quality standards (WQS) rule making process is underway that includes a number of beneficial use designation changes for water bodies in the Big Darby Creek watershed. This TMDL report was prepared using the water quality standards as they are currently proposed. As a general observation, the anticipated changes to the WQS do not alter the TMDL results in the majority of situations. A few notable exceptions include the WWH and CWH designations for Spain Creek that alter the TMDL results affecting the North Lewisburg sewage treatment plant. The habitat assessment TMDL results for a number of stream segments proposed as WWH are another exception.

After the WQS rule making process is finished, the TMDL results will be assessed for any necessary adjustment(s) should the final WQS be different than the proposed WQS for waters in the Big Darby Creek watershed.

1.4.4 Use Attainment Status

The determination of use attainment status and assignment of probable causes and sources of impairment are the underpinnings of this TMDL. The identification of impairment in rivers and streams is straightforward - the numerical ***biological criteria*** are used to judge aquatic life use attainment and impairment (partial attainment and non-attainment). The rationale for using the biological criteria, within a weight of evidence framework, has been extensively discussed elsewhere (Karr, 1991; Ohio EPA, 1987a,b; Yoder, 1989; Miner and Borton, 1991; Yoder, 1991; Yoder and Rankin, 1995). Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, land use data, and biological results (Yoder and Rankin, 1995). Thus the assignment of principal causes and sources of impairment to stream segments appearing on the §303(d) list represent the association of impairments (as judged by aquatic life use status) with stressor and exposure indicators.

The establishment of instream numeric targets is a significant component of the TMDL process. The numeric targets serve as a measure of comparison between observed instream conditions and conditions that are expected to restore the designated uses of the stream. The TMDL identifies the load reductions and other actions that are necessary to meet the target, thus resulting in attainment of applicable water quality standards, ultimately judged by attainment of designated aquatic life uses as measured by the biocriteria. A detailed discussion of the targets selected for the Big Darby Creek watershed TMDL is contained in Chapter 3.

Biological criteria are criteria in the WQS that relate to aquatic biological communities found in Ohio streams. The biological criteria consist of the Index of Biotic Integrity (IBI), the Modified Index of Well-being (MIwb), and the Invertebrate Community Index. Each of these indices measure a part of the health of the aquatic biological community, the IBI and MIwb measure fish, the ICI measures invertebrates.