State of Ohio
Environmental Protection Agency

Division of Surface Water

Total Maximum Daily Loads for the Big Darby Creek Watershed

Little Darby Creek at its confluence with Big Darby Creek

Final Report
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Bob Taft, Governor
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- Water quality modeling and TMDL development - Erin Sherer
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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.

2.0 Watershed Overview and Assessment

The Big Darby Creek watershed covers 555 square miles of central Ohio just west of the Columbus metropolitan area (see Figure 2.1.1) Big Darby Creek originates in Logan County and flows more than 80 miles before joining the Scioto River near Circleville, Ohio. Land use is predominately row crop agricultural, except for the watershed's suburbanizing eastern edge along the border of Madison and Franklin counties, and in Union County (see Figure 2.1.2).

Coarse glacial deposits (gravels and cobbles) are common in the valleys of lower Big Darby Creek and some of its tributaries. This material, combined with the natural stream gradient, creates excellent stream bed habitat for a wide diversity of plants and animals. Bottom land or flood plain forest of varying age is found adjacent to a significant length of both Big and Little Darby creeks, which is important for stream habitat and water quality. Collectively these features create the home for the diverse array of aquatic animal life in the watershed. Human impacts on these variables (flow, temperature, water chemistry, sediment, stream bed and riparian features) must be understood and properly controlled or managed to protect the ecosystem.

2.1 Chapter Organization

This chapter, and subsequent chapters of this report describe the Big Darby Creek watershed, starting in the headwaters of Big Darby Creek, and moving downstream. The report will organize information, data, and findings by ***watershed*** within the Darby Creek basin. From upstream to downstream, the Big Darby Creek watershed is broken into 4 major sub-watersheds; upper Big Darby Creek, middle Big Darby Creek, Little Darby Creek, and lower Big Darby Creek. These sub-watersheds can be divided further into minor (small) sub-watersheds. A map of the Big Darby Creek watershed showing the major and minor sub-watersheds is provided in Figure 2.1.1.

The sub-watershed names, the conventional numeric codes used to identify them, and the minor sub-watersheds associated with each major one are provided in Table 2.1.1. Figure 2.1.2 displays the land use for the entire watershed. Figures 2.1.3 and 2.1.4 provide a schematic representation of the watershed.

Please note there are two “Little Darby” creeks in the Big Darby Creek watershed. The first is the larger stream, and is the stream generally thought of as the Little Darby Creek and is a major sub-watershed. The second of the Little Darby creeks is in the

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The Big Darby Creek ***watershed*** includes any portion of land that contributes runoff to the river system upstream of the mouth of the Big Darby Creek. Watersheds vary in scope depending on the streams being referenced. For example, the Hellbranch sub-watershed is a contributing area to the Big Darby Creek watershed, but is a smaller division and contains only the land area which contributes drainage to the Hellbranch Run.

upper Big Darby Creek major sub-watershed, and is referred to as “Little Darby Creek (Logan Co.)”.

This chapter is a summary of information gathered during the assessment phase of the Darby TMDL process. For a detailed description of the results of Ohio EPA’s water quality survey results and assessment findings please see the Biological and Water Quality Study of the Big Darby Creek Watershed, 2001/2002 (Ohio EPA, 2004).

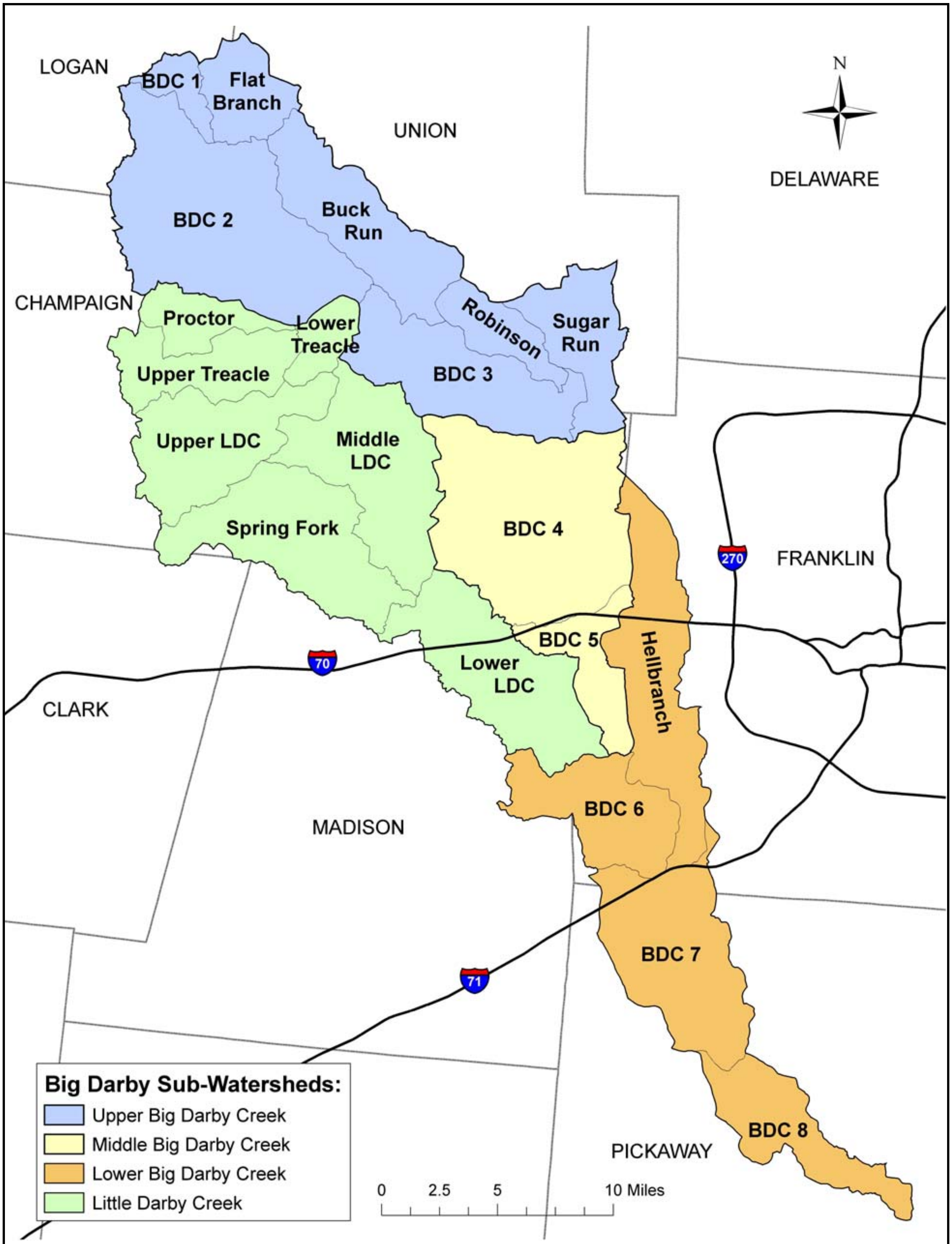


Figure 2.1.1 Sub-watersheds of the Big Darby Creek Watershed.

Table 2.1 Description of hydrologic units in the Big Darby Creek Watershed

Major sub-watershed Description ***HUC* 11**	**Minor sub-watershed and streams in the sub-watershed**	**Reference Number (HUC 14)**	**Chapter section**
Upper Big Darby Creek From the headwaters to Sugar Run 05060001-190	BDC1: Big Darby Creek, Headwaters to Flat Branch	190-010	2.2.1
	Flat Branch	190-020	2.2.2
	BDC2: Big Darby Creek, from Flat Branch to Milford Center ; includes Little Darby Creek (Logan Co.), and Spain Creek	190-030	2.2.3
	BDC3: Big Darby Creek, Milford Center to Sugar Run	190-040	2.2.4
	Buck Run	190-050	2.2.5
	Robinson Run	190-060	2.2.6
	Sugar Run	190-070	2.2.7
Middle Big Darby Creek Sugar Run to Little Darby Creek 05060001-200	BDC4: Big Darby Creek, below Sugar Run to High Free Pike , includes Worthington, Ballenger-Jones, Powell, Yutzy and Fitzgerald Ditches.	200-010	2.3.1
	BDC5: Big Darby Creek, from High Free Pike to above Little Darby Creek	200-020	2.3.2
Little Darby Creek Headwaters to Big Darby Creek 05060001-210	Little Darby Creek Mainstem, headwaters to above Treacle Creek , includes Clover Run, Lake Run, Jumping Run.	210-010	2.4.1
	Treacle Creek, headwaters to above Proctor Run , includes Howard Run	210-020	2.4.2

A ***hydrologic unit code*** or ***HUC*** is the code used to represent an area designated by the United States Geological Survey as belonging to a certain watershed. The code is a series of numbers representing different levels of geographic scope. An 8 digit HUC indicates a region (leftmost two digits), sub-region (next two digits), accounting unit (next 2 digits), and cataloging unit (rightmost two digits). The cataloging unit can be further divided to represent different sub-watershed levels. The Big Darby Creek watershed is HUC 8 code 05060001. The HUC 11 codes in the table represent major sub-watersheds, and the HUC 14 codes identify minor sub-watersheds within each HUC 11 area. The HUC 14 column leaves off the first 8 digits and only specifies those digits that change within the Big Darby Creek watershed.

Table 2.1 Description of hydrologic units in the Big Darby Creek Watershed

Major sub-watershed Description ***HUC* 11**	**Minor sub-watershed and streams in the sub-watershed**	**Reference Number (HUC 14)**	**Chapter section**
	Proctor Run	210-030	2.4.3
	Treacle Creek (below Proctor Run to Little Darby Creek)	210-040	2.4.4
	Little Darby Creek, below Treacle Creek to above Spring Fork , includes Barron Creek and Wamp Ditch	210-050	2.4.5
	Spring Fork, includes Bales Ditch	210-060	2.4.6
	Little Darby Creek, below Spring Fork to Big Darby Creek	210-070	2.4.7
Lower Big Darby Creek Little Darby Creek to mouth 05060001-220	Hellbranch Run, includes Hamilton Ditch and Clover Groff Ditch	220-010	2.5.1
	BDC6: Big Darby Creek, below Little Darby Creek to above Hellbranch Run	220-020	2.5.2
	BDC7: Big Darby Creek, below Hellbranch Run to Darbyville, includes Springwater Run, Greenbrier Creek, and Georges Run	220-030	2.5.3
	BDC8: Big Darby Creek, from Darbyville to Scioto River, includes Lizard Run	220-040	2.5.4

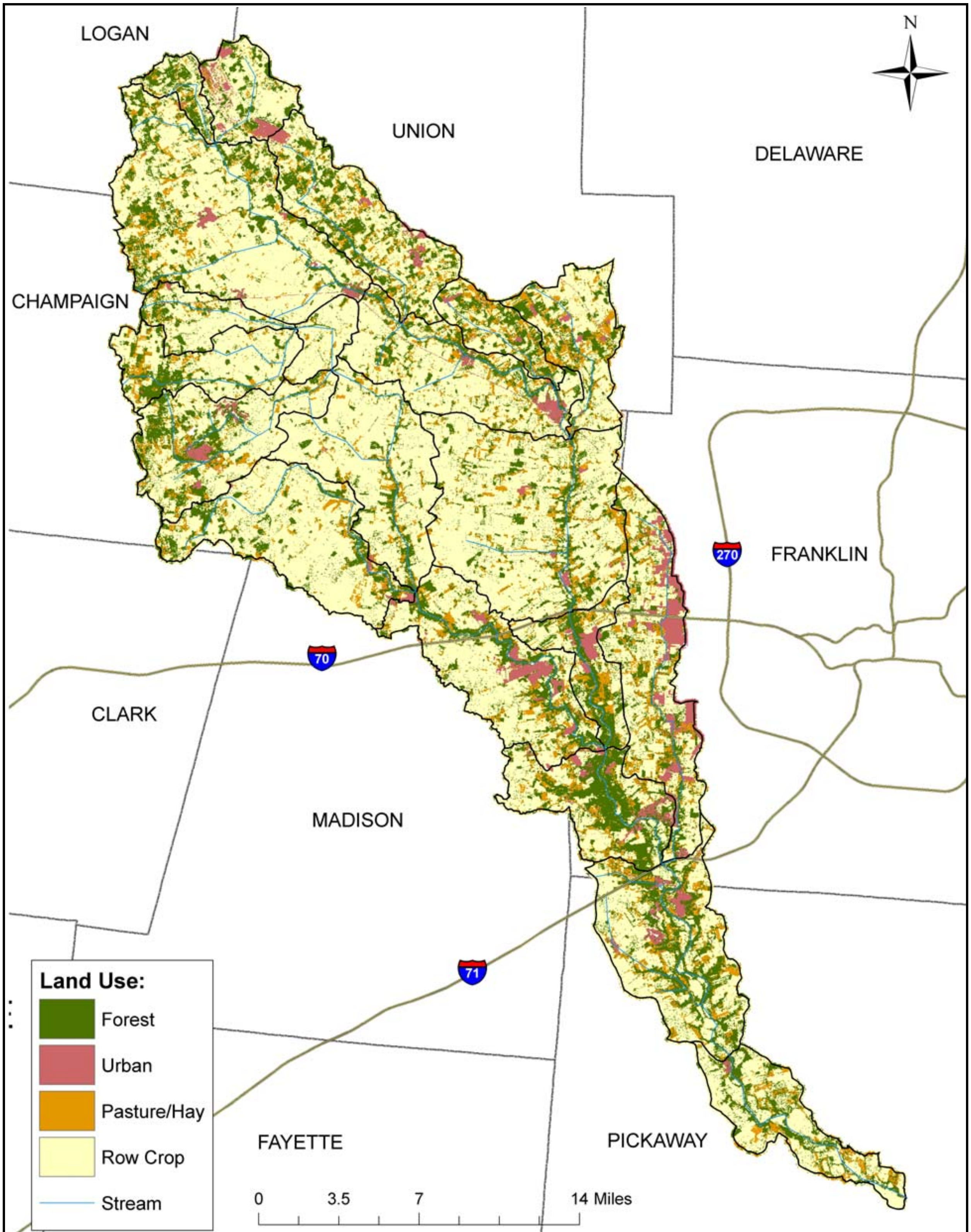


Figure 2.1.2 Land use in the Big Darby Creek watershed.

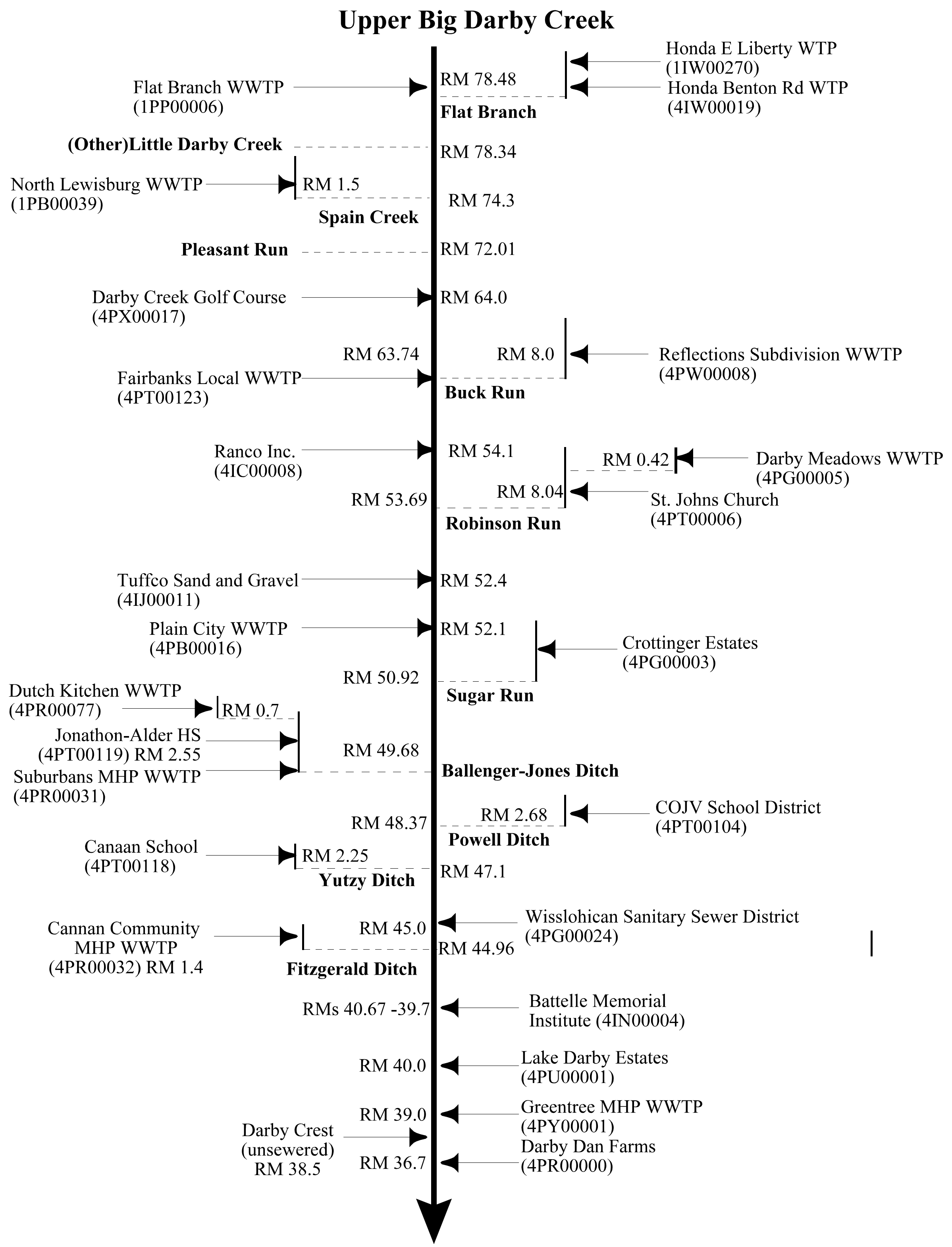


Figure 2.1.3 Schematic representation of upper and middle Big Darby Creek.

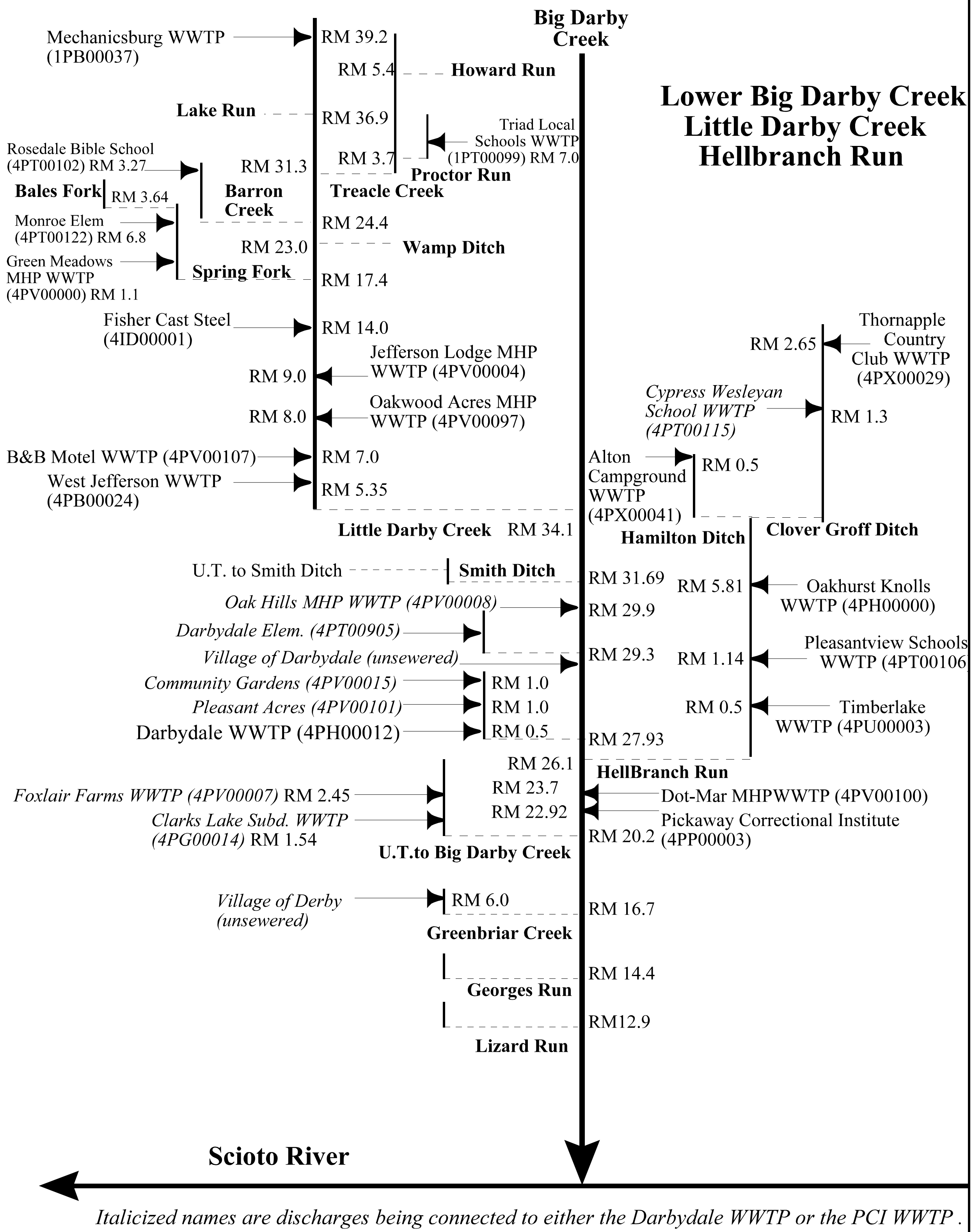


Figure 2.1.4 Schematic representation of lower Big Darby Creek and Little Darby Creek

2.2 Upper Big Darby Creek - (05060001 190)

The upper Big Darby Creek major sub-watershed contains a variety of streams, ranging from ground water fed, relatively pristine streams to highly modified streams. Results of the 2001, 2002 stream assessment indicate that aquatic life uses are impaired. Figure 2.2.1 shows the status of aquatic life use attainment in the upper Big Darby Creek major sub-watershed. As can be seen, aquatic life uses are impaired in parts of upper Big Darby Creek, particularly in the mainstem of Big Darby Creek downstream from Flat Branch. In the following sections, information about the minor sub-watersheds is provided, and they are reviewed with respect to assessment results, and the impairment of aquatic life uses shown in Figure 2.2.1.

Within the discussion of each sub-watershed, there is a presentation of the results of the habitat analysis conducted by Ohio EPA during 2001 and 2002. Following that data collection effort, an independent inventory of the status of the riparian corridor was conducted by Ben Webb, the Darby Creek Watershed Coordinator at the time. The results of this work are presented with each major sub-watershed with permission of the Darby Creek Joint Board of Supervisors. As will be discussed in Chapter 3, the riparian corridor plays an important role in filtering pollutants from upland sources, and by providing shading to the stream to help control temperature and to inhibit algal production caused by excess phosphorus. Figure 2.2.2 shows the status of riparian buffers in the Upper Big Darby Creek major sub-watershed.

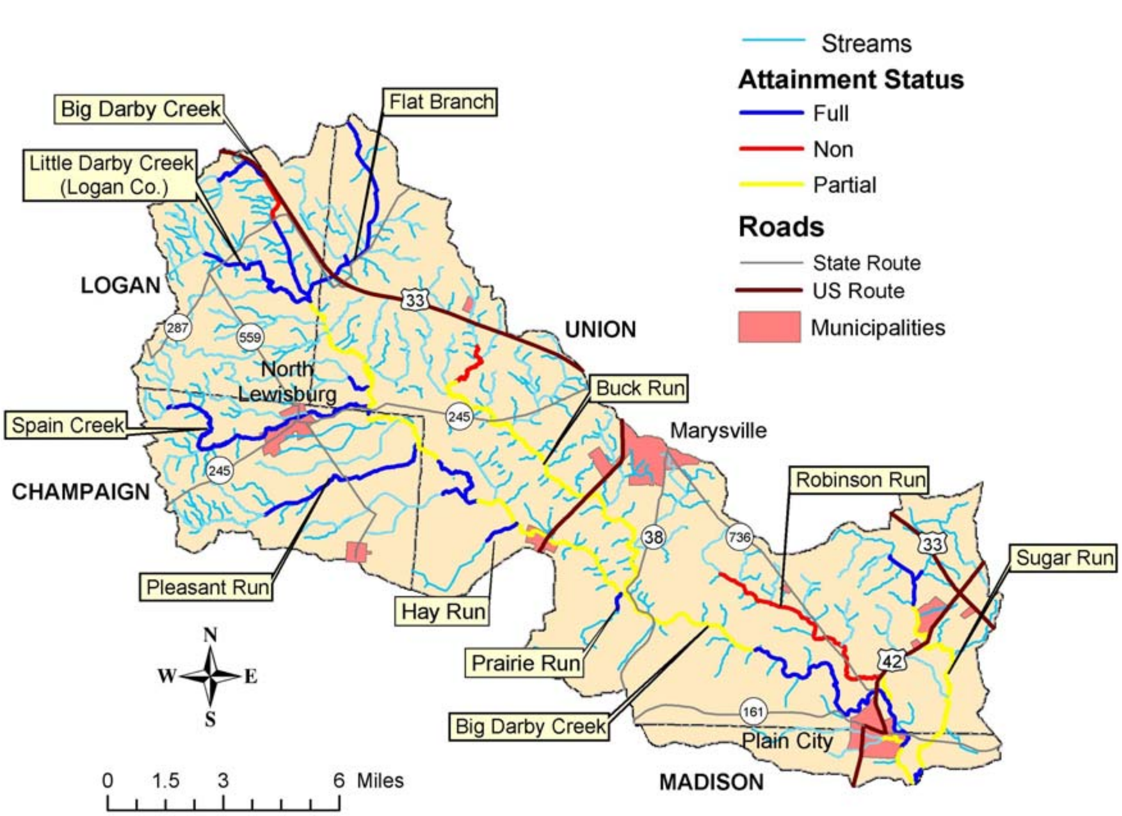


Figure 2.2.1 Aquatic Life Use attainment in the upper Big Darby Creek major sub-watershed.

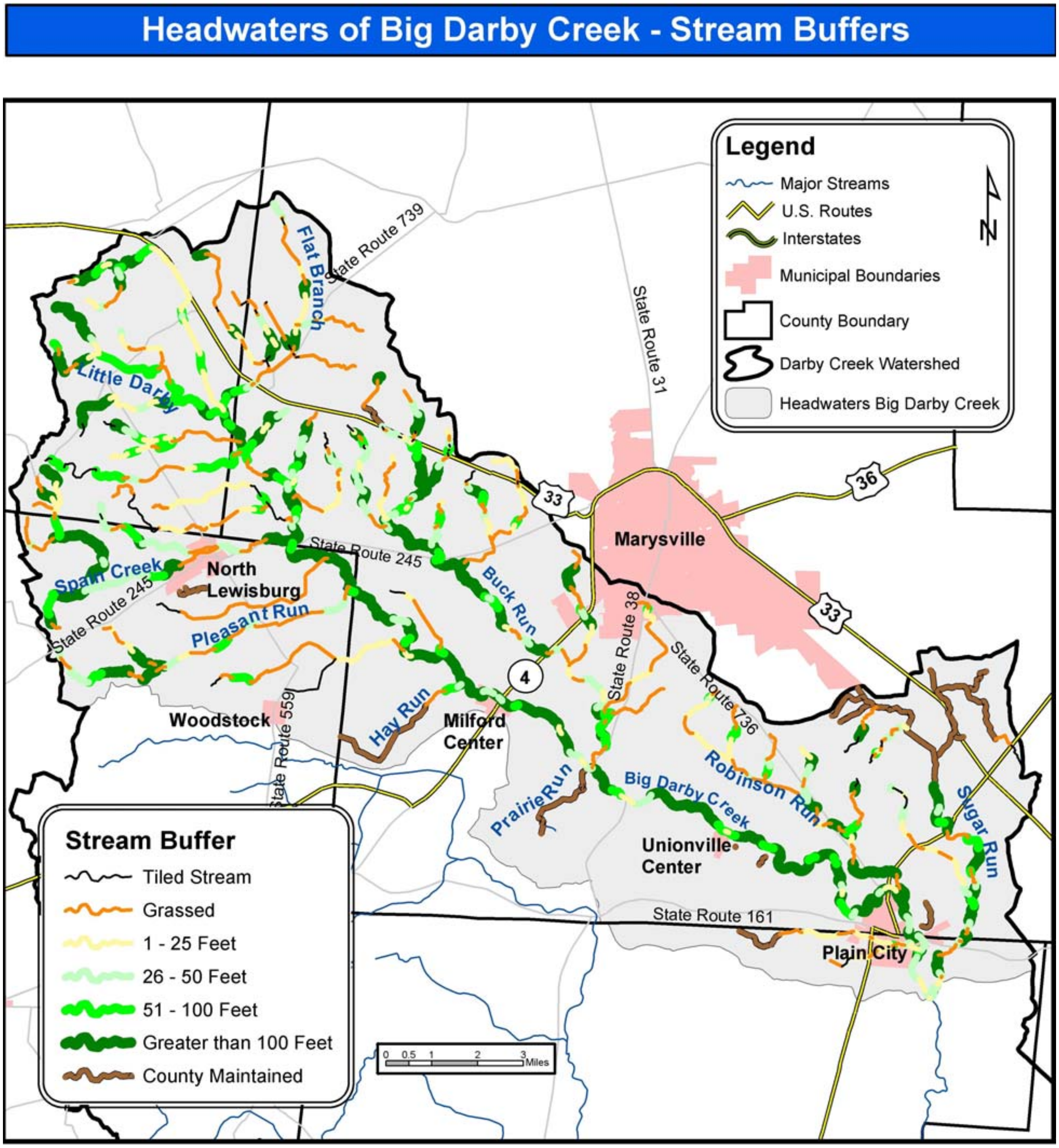


Figure 2.2.2 Riparian Corridor Status in the Upper Big Darby Creek major sub-watershed. Graphics courtesy Ben Webb.

2.2.1 Headwaters of Big Darby Creek (BDC1, 190-010)

The headwaters of Big Darby Creek are described in Box 2.2.1. Results of the habitat assessment are given in Table 2.2.1.

Box 2.2.1 Overview of the headwaters of Big Darby Creek (190-010)				
Area (acres)	3,757			
Streams	Big Darby Creek			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Logan County Flat Branch WWTP	1PP00006	0.1	0.062
Land Use	Figure 2.2.1.1			
Aquatic Life Use	**Designated Use**		**Impairment**	
	EWH, CWH		**Yes** - 25% of sites impaired	
			Deviation	IBI - 0 to 16%
Recreational Use	Primary Contact Recreation		**Yes**	
			Deviation (fecal coliform)	Av. = 18 %
				90^{th} % = 89%
Antidegradation Category	Big Darby Creek - Outstanding State Water			
Causes of impairment		**Sources of Impairment**		**Addressed in this TMDL?**
Direct Habitat Alteration		Channelization, riparian removal		√
Siltation		Road construction		√
Changes in hydrology		Channelization, hardening of the watershed		√
Nutrients		Domestic sewage, spills, land application of manure		√
Low dissolved oxygen, organic enrichment, low D.O.		Municipal Point Sources		√

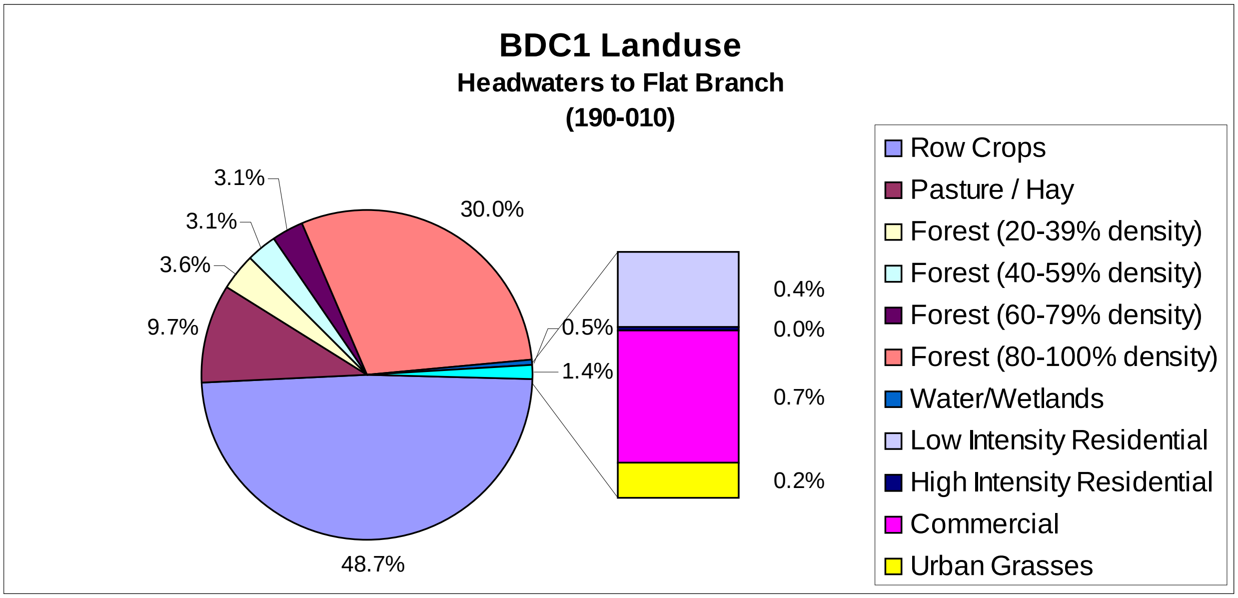


Figure 2.2.1.1 Land use in the headwaters of Big Darby Creek minor sub-watershed.

Big Darby Creek in this area has been subjected to channel modifications associated with the initial construction of U.S. Route 33 and subsequent relocations of portions of the stream to accommodate the widening of U.S. Route 33. The contribution of a significant sediment bed load to the stream channel from the lack of sediment erosion control BMPs during and after construction and the straightening of the channel resulted in declines in instream biological performance and habitat quality. Re-design and re-construction of the stream channel using natural stream channel design have subsequently resulted in improved local habitat quality.

Flushing of sediments downstream have resulted in gradually improving habitat scores in the immediate impact area. However, this movement of sediments downstream also has had the consequence of shifting impacts downstream causing declines in biological community performance. Based on the response pattern documented upstream, this should be a temporary situation with eventual improvement to close to pre-impact conditions.

Full attainment of EWH biological criteria was documented at RM 83.2 (in 1997 and 1999), Logan County Road 152 (RM 82.5) and Township Road 157 (RM 79.2) in 2001; therefore, it is recommended that the existing EWH designation be extended to include the very headwaters of Big Darby Creek. Obligate cold water fish and macroinvertebrate species present in this section of Big Darby Creek indicate the appropriateness of a Cold Water Habitat (CWH) use designation.

Table 2.2.1 Habitat Assessment Results for upper Big Darby Creek (05060001-190)						
Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-190-010						
Big Darby Creek (EWH)	82.5	Channel	68	None	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired
	80.8	Substrate, channel	61	Silt or muck substrates	Channelized-recovering, sand substrate, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
	79.2	Substrate, channel	64.5	None	Channelized-recovering, hardpan substrate origin, no fast current, substrate embeddedness	

Chemical water quality sampling occurred in upper Big Darby Creek five times during the 2001 survey period and was additionally sampled in 2004 in support of the water quality modeling survey. Water quality is generally very good in this part of the creek, and is reflective of a background condition of the soils in the upper watershed.

The recreational use of Big Darby Creek in this minor sub-watershed is impaired. Both measured geometric mean fecal coliform values of 1227 colony forming units/100ml(cfu) and 90th percentile of 19,961 cfu exceed the WQS criteria of 1000 cfu and 2000 cfu, respectively.

2.2.2 Flat Branch (190-020)

Flat Branch is a highly modified stream that primarily drains agricultural land and the Honda complex in western Union County. Description of the Flat Branch watershed is contained in Box 2.2.2. A description of the habitat assessment results is included in Table 2.2.2.

<table>
<tr><th colspan="5">Box 2.2.2 Overview of Flat Branch (190-020)</th></tr>
<tr><td>Area (acres)</td><td colspan="4">8,686</td></tr>
<tr><td>Streams</td><td colspan="4">Flat Branch, Unnamed Tributary to Flat Branch</td></tr>
<tr><td rowspan="3">Point Source Dischargers</td><td>Name</td><td>Permit number</td><td>Design flow (MGD)</td><td>Average flow (MGD)</td></tr>
<tr><td>Honda Benton Road WTP</td><td>4IW00019</td><td>N/A</td><td>0.0285</td></tr>
<tr><td>Honda East Liberty WTP</td><td>1IW00270</td><td>N/A</td><td>0.0106</td></tr>
<tr><td>Land Use</td><td colspan="4">see Figure 2.2.2.1</td></tr>
<tr><td>Aquatic Life Use</td><td colspan="4">MWH. The MWH aquatic life use of Flat Branch is not impaired. However, Flat Branch contributes to impairment of the downstream EWH aquatic life use. Targets will be established to protect that downstream aquatic life use.</td></tr>
<tr><td rowspan="4">Recreational Use</td><td colspan="2">Designated Use</td><td colspan="2">Impairment</td></tr>
<tr><td colspan="2" rowspan="3">Primary Contact Recreation</td><td colspan="2">Yes</td></tr>
<tr><td rowspan="2">Deviation (fecal coliform)</td><td>Av. = 29%</td></tr>
<tr><td>90^{th} % = 91%</td></tr>
</table>

Causes of Impairment	**Sources of Impairment**	**Addressed in this TMDL?**
Changes in hydrology	Channelization, hardening of the watershed	√
Metals	Industrial point source	√
Low dissolved oxygen, organic enrichment/D.O.	Industrial point sources	√

Water emanating from Flat Branch is generally very turbid, and has a marked visual influence on the water quality downstream of its confluence with Big Darby Creek (see Figure 2.2.2.2). Flat Branch also experiences violations of the MWH dissolved oxygen (DO) standard, and causes DO violations in Big Darby Creek downstream of the confluence of Flat Branch and Big Darby Creek.

Water quality sampling by Ohio EPA has revealed a complex chemical interaction emanating from Flat Branch. Analysis of chemical sampling revealed significantly elevated levels of iron, potassium, Total Kjeldahl Nitrogen (TKN) and manganese when comparing Flat Branch with the other minor sub-watersheds. Alkalinity, hardness, and

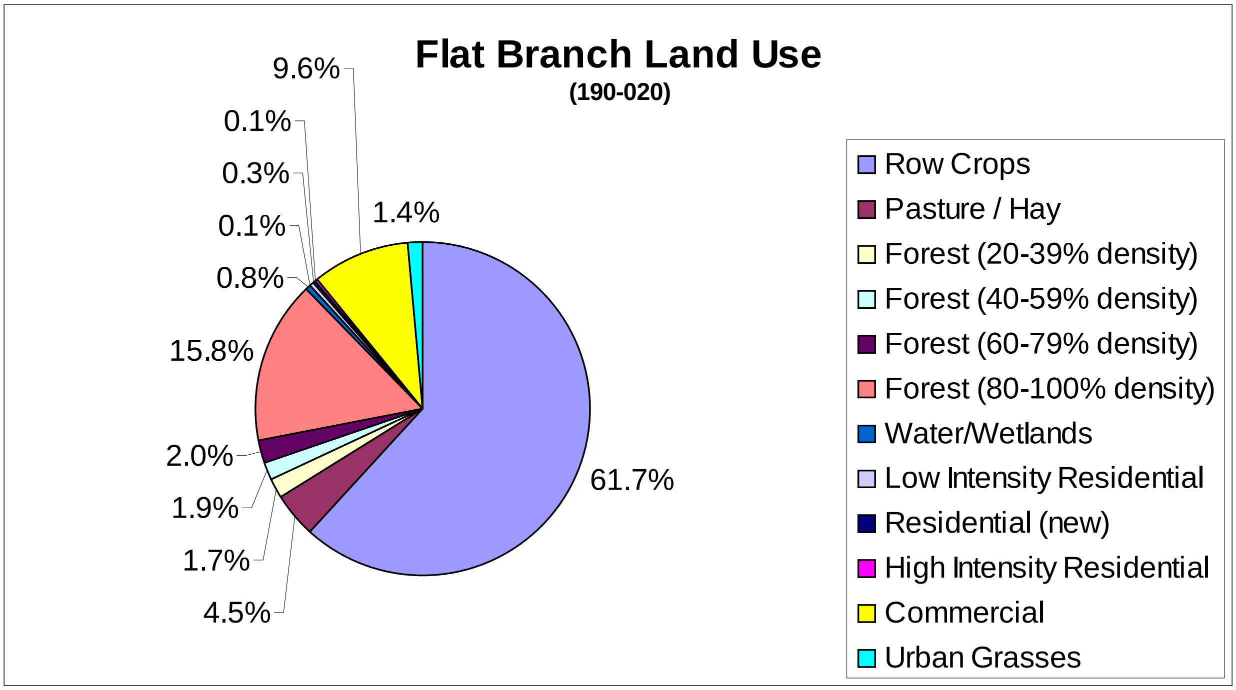


Figure 2.2.2.1 Land Use in the Flat Branch minor sub-watershed.

Figure 2.2.2.2 Confluence of Big Darby Creek (right) with Flat Branch (left). Notice that Flat Branch's turbidity overwhelms the clear water from Big Darby Creek.

magnesium were significantly lower than other minor sub-watersheds (See Chapter 4 discussion).

The recreational use of Flat Branch (HUC 14 190-020) is impaired. Both geometric mean fecal coliform (1419 cfu/100 ml) and 90th percentile (22,616 cfu/100 ml) exceed the WQS criteria.

Table 2.2.2 Habitat Assessment Results for Flat Branch (190-010)						
Stream/River	**River Mile**	**Assessment Results**				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-190-020						
Flat Branch (MWH)	3.2	Not applicable to MWH	25.5	Channelized-no recovery, silt or muck substrates, low sinuosity, sparse or no cover, Max. pool depth less than 40 cm	Sand substrate, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Not Impaired, but contributes to downstream impairment
	0.8	Not applicable to MWH	36.5	silt or muck substrates, low sinuosity, sparse or no cover	Channelized-recovering, sand substrate, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
UT to Flat Branch at RM 1.50 (MWH)	0.1	Not applicable to MWH	36.5	silt or muck substrates, low sinuosity, sparse or no cover	Channelized-recovering, hardpan substrate origin, intermittent or poor pool quality, no fast current, extensive/moderate substrate embeddedness	

2.2.3 Big Darby Creek Below Flat Branch to Milford Center (BDC2, 190-030)

Geographically this section of Big Darby Creek is defined as the mainstem from the confluence of Big Darby Creek and Flat Branch, downstream to about Milford Center, including several large tributaries, and is referred to as middle upper Big Darby Creek. A description of middle upper Big Darby Creek is included in Box 2.2.3. The results of the habitat assessment are given in Table 2.2.3.

<table>
<tr><th colspan="6">Box 2.2.3. Overview of Big Darby Creek below Flat Branch to Milford Center (BDC2, 190-030).</th></tr>
<tr><td>Area (acres)</td><td colspan="5">40,791</td></tr>
<tr><td>Streams</td><td colspan="5">Big Darby Creek, from below Flat Branch to Milford Center (RM 78.48 to RM 66.50), Little Darby Creek (Logan Co.), Unnamed Tributaries at RM 77.56, 77.32, 77.29, and 74.91, Spain Creek, Pleasant Run, Hay Run</td></tr>
<tr><td rowspan="3">Point Source Dischargers</td><td>Name</td><td>Permit number</td><td>Design flow (MGD)</td><td colspan="2">Average flow (MGD)</td></tr>
<tr><td rowspan="2">North Lewisburg</td><td>1PB00039</td><td>0.170</td><td colspan="2">0.188</td></tr>
<tr><td colspan="4">Receiving stream: Spain Creek</td></tr>
<tr><td>Land Use</td><td colspan="5">see Figure 2.2.3.1</td></tr>
<tr><td rowspan="10">Aquatic Life Use</td><td colspan="2">Name</td><td>Designated use</td><td colspan="2">Impairment</td></tr>
<tr><td colspan="2" rowspan="2">Big Darby Creek</td><td rowspan="2">EWH</td><td colspan="2">Yes - 75% of sites impaired</td></tr>
<tr><td>Deviation</td><td>IBI 0-34%
MIwb 0-12%</td></tr>
<tr><td colspan="2">Little Darby Creek (Logan Co.)</td><td>EWH + CWH</td><td colspan="2">No</td></tr>
<tr><td colspan="2">Spain Creek</td><td>WWH + CWH;
EWH + CWH</td><td colspan="2">No</td></tr>
<tr><td colspan="2">Pleasant Run</td><td>EWH</td><td colspan="2">No</td></tr>
<tr><td colspan="2">Hay Run</td><td>EWH</td><td colspan="2">No</td></tr>
<tr><td rowspan="2">Unnamed tributary to Big Darby Creek at RM:</td><td>74.91</td><td>EWH</td><td colspan="2">No</td></tr>
<tr><td>69.4</td><td>WWH</td><td colspan="2">No</td></tr>
</table>

<table>
<tr><td colspan="5">Box 2.2.3. Overview of Big Darby Creek below Flat Branch to Milford Center (BDC2, 190-030).</td></tr>
<tr><td rowspan="7">Recreational Use</td><td colspan="2">Big Darby Creek</td><td>PCR</td><td rowspan="7">Yes - 90th percentile Fecal Coliform values exceed target WQ criteria by 36% (Informational note: E. coli values are highly elevated)</td></tr>
<tr><td colspan="2">Little Darby Creek (Logan Co.)</td><td>PCR</td></tr>
<tr><td colspan="2">Spain Creek</td><td>PCR</td></tr>
<tr><td colspan="2">Pleasant Run</td><td>PCR</td></tr>
<tr><td colspan="2">Hay Run</td><td>PCR</td></tr>
<tr><td rowspan="2">Unnamed tributary to Big Darby Creek at RM:</td><td>74.91</td><td>SCR</td></tr>
<tr><td>69.4</td><td>SCR</td></tr>
<tr><td>Antidegradation Category</td><td colspan="4">Big Darby Creek - Outstanding State Water
Spain Creek - Superior High Quality Water</td></tr>
<tr><td colspan="2">Causes of Impairment</td><td colspan="2">Sources of Impairment</td><td>Addressed in this TMDL?</td></tr>
<tr><td colspan="2">Direct habitat alteration</td><td colspan="2">Channelization, riparian removal</td><td>√</td></tr>
<tr><td colspan="2">Changes in hydrology</td><td colspan="2">Channelization, hardening of watershed</td><td>√</td></tr>
<tr><td colspan="2">Nutrients</td><td colspan="2">Domestic sewage, agriculture, spills, land application of manure</td><td>√</td></tr>
<tr><td colspan="2">Metals</td><td colspan="2">Municipal point sources, industrial point sources</td><td>√</td></tr>
<tr><td colspan="2">Low dissolved oxygen, organic enrichment/D.O.</td><td colspan="2">Municipal point sources, industrial point sources, spills sewage and agriculture products</td><td>√</td></tr>
</table>

Biological sampling results from 2001 and 2002 show that the mainstem of Big Darby Creek is impaired for most of its length within the middle upper Big Darby Creek minor sub-watershed. The exception to the impairment is the site just upstream of Collins Road. Below Flat Branch, the Big Darby Creek mainstem shows definite influences from Flat Branch.

Table 2.2.3 Habitat Assessment Results for upper Big Darby Creek (Flat Branch to Milford Center) (05060001-190-030)

Stream/River	River Mile	Assessment Results: Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site: High Influence	Undesirable habitat attributes present at the site: Moderate Influence	Use Attainment Status
05060001-190-030						
Big Darby Creek (EWH)	78.4	Substrate, channel, riparian	63.5	Low sinuosity	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired
	76.6	None	73.5	None	Sand substrate, no fast current, substrate embeddedness,	
	69.5	Channel	70.5	Low sinuosity	Channelized-recovering, poor pool quality, no fast current, substrate embeddedness	
	66.0	Substrate	74.5	None	no fast current, substrate embeddedness	
Little Darby Creek (Logan County) (EWH/CWH)	3.5[1]	Channel	71.5	None	None	Not impaired (2001)
	3.5[1]	Substrate, cover, channel, riparian	32	Channelized-no recovery, silt or muck substrates, low sinuosity, sparse or no cover	Hardpan substrate origin, fair or poor channel development, no fast current	
	0.4	Riparian	68	None	Poor pool quality	
UT to Big Darby Creek (74.91) (EWH)	0.2	Substrate, riparian	62.5	None	Sand substrate, no fast current, substrate embeddedness	Not Impaired
UT to Big Darby Creek (69.40) (WWH)	0.3	Substrate, cover, channel, riparian, pool, riffle, gradient	33.5	Silt or muck substrates, low sinuosity, sparse or no cover, max. pool depth	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Not impaired
Spain Creek (WWH[2]/EWH)	5.7[2]	None	66	None	Hardpan substrate origin, poor pool quality, substrate embeddedness	Not impaired
	3.7	Riparian	72	None	No fast current	
	0.1	Substrate	76	None	No fast current, substrate embeddedness	

Table 2.2.3 Habitat Assessment Results for upper Big Darby Creek (Flat Branch to Milford Center) (05060001-190-030)

Stream/River	River Mile	Assessment Results: Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site: High Influence	Undesirable habitat attributes present at the site: Moderate Influence	Use Attainment Status
Pleasant Run (EWH)	4.6	Channel, riparian	72	None	Channelized-recovering, poor pool quality	Not impaired
	0.5	Substrate, channel, riparian	59.5	None	Channelized-recovering, sand substrate, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
Hay Run (EWH)	0.3	Substrate, cover, channel, pool, riffle, gradient	52.5	Low sinuosity, max. pool depth less than 40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Not impaired

[1] This sample site was evaluated in 2001 and 2002. In the intervening time frame, this stream was channelized under the Tulloch rule, thereby significantly reducing habitat quality.
[2] Denotes a Warm Water Habitat (WWH) site.

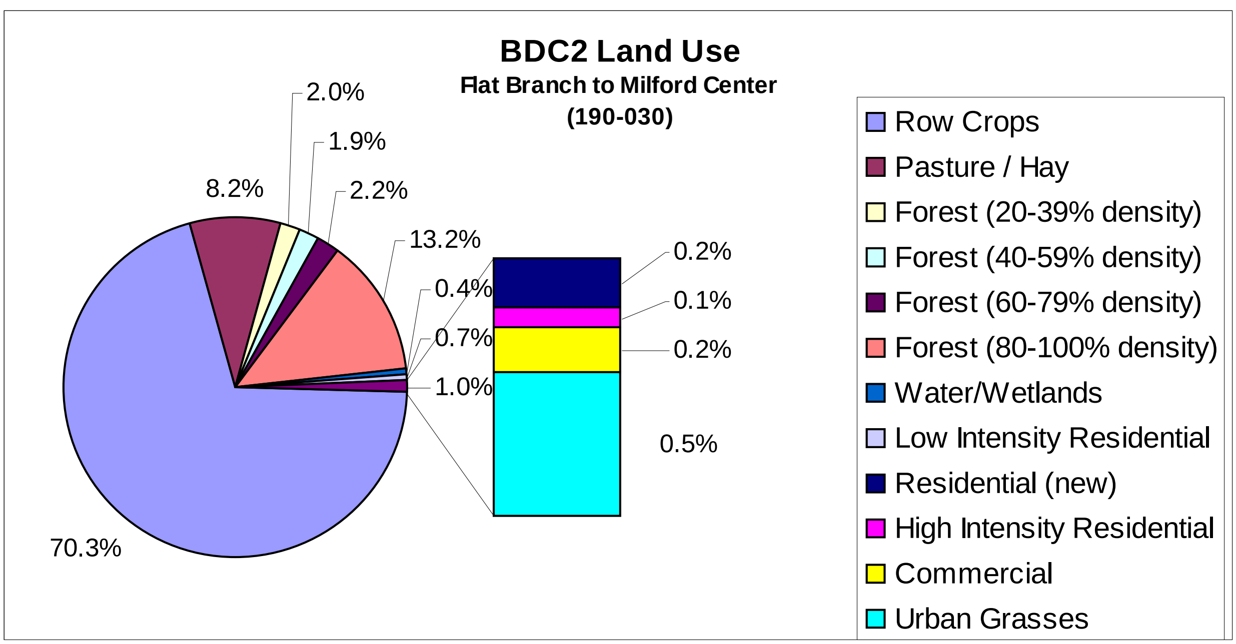


Figure 2.2.3.1 Land use in the middle upper Big Darby Creek minor sub-watershed.

Recreational use in this 14 digit HUC is impaired for both magnitude and frequency of fecal coliform values. The WQS criteria of a 90th percentile of no more than 2000 cfu is exceeded by the measured 90th percentile of 3163 cfu. *E. coli* values are highly elevated, with a geometric mean 800 cfu and a 90th percentile of 3770.

2.2.4 Big Darby Creek Below Milford Center to Sugar Run (BDC3, 190-040)

This part of the upper Big Darby Creek watershed is geographically defined as below Milford Center downstream to Sugar Run. A description of lower upper Big Darby Creek is provided in Box 2.2.4. Habitat assessment results are given in Table 2.2.4

Box 2.2.4 Overview of Big Darby Creek below Milford Center to Sugar Run (BDC3, 190-040)				
Area (acres)	20,964			
Streams	Big Darby Creek, Milford Center to above Sugar Creek (RM 66.50 to RM 50.93), Prairie Run, Sweeney Run			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Plain City WWTP	4PB00016	0.500	0.444
	Darby Creek Golf Course	4PX00017	0.0076	0.0007
	Ranco	4IC00008	0.039	0.032
	Tuffco Sand & Gravel	4IJ00011	N/A	2.16
	Royster Clark	Storm water General Permit		Potential contaminated storm water
	Select Sires	unpermitted AFO[1]		Contaminated storm water discharges from any significant rain.
Land Use	see Figure 2.2.4.1			
Aquatic Life Use	**Name**	**Use Designation**	**Impaired**	
	Big Darby Creek	EWH	**Yes** - 44% of sites impaired	
			Deviation	IBI - 14% MIwb - 20% ICI - 20%
	Prairie Run	LRW	No	
	Sweeney Run	WWH	**Yes** - 100% of sites impaired (1/1)	

Box 2.2.4 Overview of Big Darby Creek below Milford Center to Sugar Run (BDC3, 190-040)				
			Deviation	ICI - Fair ➜Good
Recreational Use	Big Darby Creek	PCR	**Yes** - 90th percentile fecal coliform values exceed maximum WQS by 2%.	
	Prairie Run	SCR		
	Sweeney Run	PCR		
Antidegradation Category	Big Darby Creek - Outstanding State Water			
Causes of impairment		**Sources of impairment**		**Addressed in this TMDL?**
Nutrients		Domestic Sewage, agriculture, spills, livestock breeding facility, land application of manure		√
Low dissolved oxygen, organic enrichment/D.O.		Municipal point source, spills - sewage and agriculture products		√

[1] Select Sires in an animal feeding operation just south of Unionville Center. A permit application has been requested.

Three minor sub-watersheds enter Big Darby Creek in this stretch, namely Buck Run (190-050), Robinson Run (190-060), and Sugar Run (190-070). Big Darby Creek in this area is impaired for most of its length. Part of this impairment is attributed to a major fish kill that occurred in response to a release of animal feed products from a mill in Milford Center. The 2001/2002 biological surveys did not document the expected recovery from this spill, and the effects on the aquatic biota seem to be lingering. In 2004 it was discovered that the Select Sires cattle operation in Unionville Center had a direct, uncontrolled discharge from the onsite storm water system. This system was not protected from contamination by manure. This discharge has the potential to contribute significant pollutant loads during storm events based upon its lack of controls (Figure 2.2.4.2).

At the downstream end of lower upper Big Darby Creek the Plain City Wastewater Treatment Plant discharges to Big Darby Creek. This wastewater load will be discussed further in the context of the water quality model that was developed to evaluate the discharge.

Figure 2.2.4.2. A storm water pond at Select Sires in Unionville Center. Grass in the swale is burned by high strength influent. Note manure piles on right.

Recreational use in Big Darby Creek in this area is impaired by the magnitude and frequency of recorded fecal coliform values. The 90th percentile fecal coliform value of 2039 cfu exceeds the WQS criteria of 2000 cfu. This pattern suggests that runoff induced bacterial contamination is a factor in lower upper Big Darby Creek.

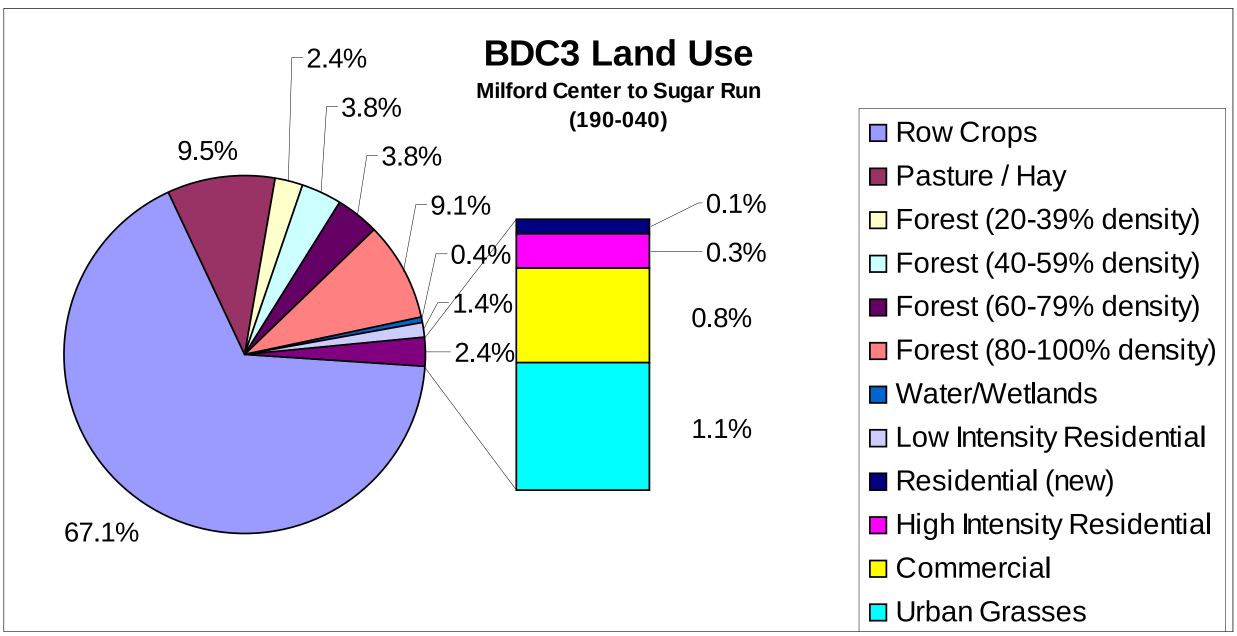


Figure 2.2.4.1 Land Use in the lower upper Big Darby Creek minor sub-watershed.

Table 2.2.4 Habitat Assessment Results for upper Big Darby Creek (Milford Center to Sugar Run) (05060001-190-040)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-190-040						
Big Darby Creek (EWH)	63.8	None	80.5	None	None	Impaired
	62.5	None	83.5	None	None	
	54.2	None	83.5	None	None	
	53.9	None	93	None	None	
	52	Channel	81	None	Channelized-recovering	
Prairie Run (LRW)	0.3	Not applicable to LRW	23	Channelized-no recovery, silt or muck substrates, low sinuosity, sparse or no cover, max. pool depth less than 40 cm	Hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Not impaired
Sweeney Run (WWH)	0.1	Cover, channel	58	Low sinuosity, sparse or no cover	Channelized-recovering, hardpan substrate origin, no fast current, substrate embeddedness	Impaired

2.2.5 Buck Run (190-050)

Buck Run drains into Big Darby Creek from the east. In the headwaters of Buck Run, an unnamed tributary drains storm water from the Honda site. Downstream, land use in the Buck Run basin is primarily agricultural, with additional residential land use.

Buck Run is described in Box 2.2.5. Habitat assessment results are given in Table 2.2.5.

Partial and non-attainment in the upstream reaches of Buck Run resulted from a combination of nutrient enrichment, sedimentation and livestock impacts. Mid reaches were stressed by high nitrogen and phosphorus, low dissolved oxygen (i.e., violations of the WWH minimum criteria) and TSS concentrations amongst the highest in the watershed. These impacts extended into Big Darby Creek and contributed to declines a short distance downstream in that watercourse.

Buck Run is impaired for its recreational use based upon magnitude and frequency of fecal coliform values measured. The 90th percentile value of 8009 cfu greatly exceeds the water quality standard of 2000 cfu.

<table>
<tr><td colspan="5">Box 2.2.5. Overview of Buck Run (190-050).</td></tr>
<tr><td>Area (acres)</td><td colspan="4">19,052</td></tr>
<tr><td>Streams</td><td colspan="4">Buck Run</td></tr>
<tr><td rowspan="2">Point Source Dischargers</td><td>Name</td><td>Permit number</td><td>Design flow (MGD)</td><td>Average flow (MGD)</td></tr>
<tr><td>Reflections Subdivision WWTP</td><td>4PW00008</td><td>N/A</td><td>0.0012</td></tr>
<tr><td>Land Use</td><td colspan="4">see Figure 2.2.5.1</td></tr>
<tr><td rowspan="3">Aquatic Life Use</td><td colspan="2">Designated Use</td><td colspan="2">Impaired</td></tr>
<tr><td colspan="2" rowspan="2">WWH</td><td colspan="2">Yes - 75% of sites impaired</td></tr>
<tr><td>Deviation</td><td>IBI 0-53%
MIwb 19%</td></tr>
<tr><td>Recreational Use</td><td colspan="2">Primary Contact Recreation</td><td colspan="2">Yes -90th percentile values of fecal coliform exceed maximum criteria by 75%</td></tr>
<tr><td colspan="2">Causes of impairment</td><td colspan="2">Sources of impairment</td><td>Addressed in this TMDL?</td></tr>
<tr><td colspan="2">Direct habitat alteration</td><td colspan="2">Channelization, riparian removal</td><td>√</td></tr>
<tr><td colspan="2">Nutrients</td><td colspan="2">Domestic sewage, agriculture, spills, land application of manure</td><td>√</td></tr>
<tr><td colspan="2">Metals</td><td colspan="2">Industrial Point Source</td><td>√</td></tr>
<tr><td colspan="2">Low dissolved oxygen, organic enrichment/D.O.</td><td colspan="2">Industrial Point Source, spills - sewage and agricultural products</td><td>√</td></tr>
</table>

Table 2.2.5 Habitat Assessment Results for Buck Run (05060001-190-050)

Stream/River	**River Mile**	**Assessment Results**				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-190-050						
Buck Run (WWH)	10.4	Substrate, cover, channel, riparian, pool, riffle, gradient	40	Channelized-no recovery, low sinuosity, sparse or no cover, max. pool depth less than 40 cm	Channelized-recovering, sand substrate, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Impaired
	7.8	Substrate, pool, riffle, gradient	55.5	Sparse or no cover	Hardpan substrate origin, only one or two cover types, poor pool quality, no fast current, substrate embeddedness	
	0.1	Riparian	70.5	None	Hardpan substrate origin, poor pool quality, no fast current	

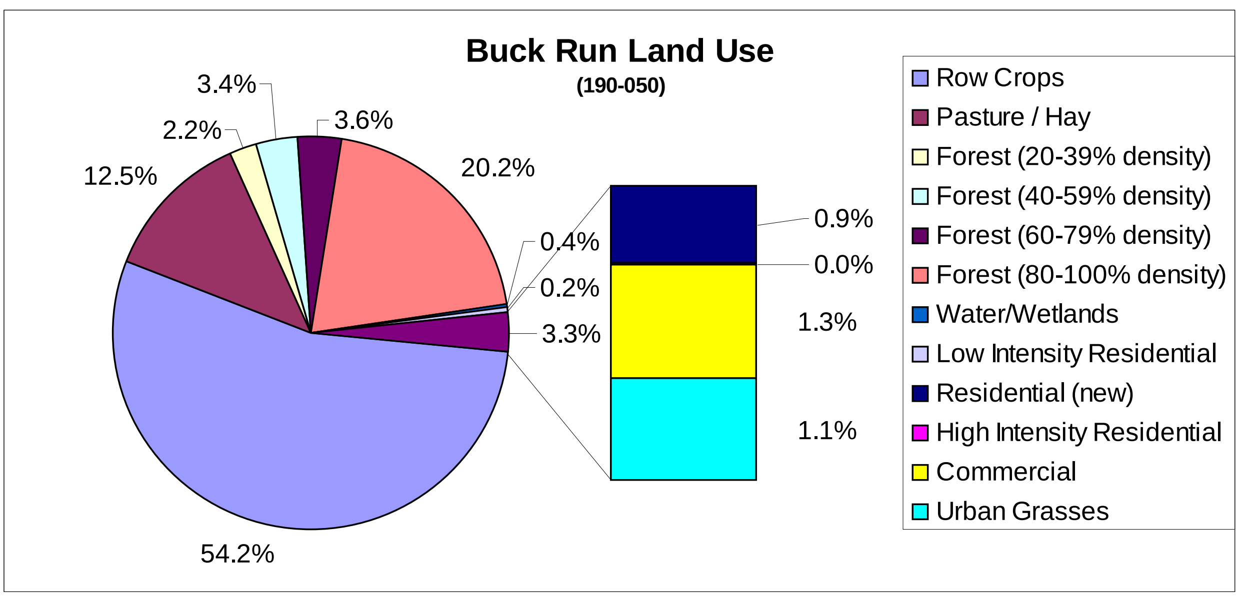


Figure 2.2.5.1. Land use in the Buck Run minor sub-watershed.

2.2.6 Robinson Run (190-060)

Robinson Run arises southeast of the City of Marysville, in Union County, and flows towards Plain City. Robinson Run is described in Box 2.2.6. Habitat assessment results for Robinson Run are given in Table 2.2.6.

Box 2.2.6. Overview of Robinson Run (190-060).				
Area (acres)	6,987			
Streams	Robinson Run			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	St. John's Church	4PT00006	0.0035	0.00097
	Union County Darby Meadows WWTP	4PG00005	0.010	0.014
Land Use	see Figure 2.2.6			
Aquatic Life Use	**Designated use**		**Impairment**	
	WWH		**Yes** - 100% of sites (3/3) impaired	
			Deviation	IBI - 25% ICI - Very Poor ➜ Good
Recreational Use	Primary Contact Recreation		**Yes** - 90^{th} percentile fecal coliform values exceed maximum criteria by 42%	
Causes of Impairment		**Sources of Impairment**		**Addressed in this TMDL?**
Direct habitat alteration		Channelization, riparian removal		√
Changes in hydrology		Channelization, hardening of the watershed		√
Nutrients		Domestic sewage, agriculture, spills, land application of manure		√

Table 2.2.6 Habitat Assessment Results for Robinson Run (05060001-190-060)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-190-060						
Robinson Run (WWH)	2.1	Channel	64	Low sinuosity	Channelized-recovering, sand substrate, hardpan substrate origin	Impaired
	0.7	Channel	70	Low sinuosity	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	

The very poor results in the headwaters are due to very high nutrient concentrations which has led to low dissolved oxygen levels and black anoxic streambed sediments. Channelization has also contributed to the problems documented here. The depressed fish community scores seen at the site downstream from U.S. Route 42 are likely due to a combination of sediment contamination and water quality problems arising from Ranco Inc. One of the highest sediment ammonia concentrations (94 mg/kg) was found at this site. Arsenic and cyanide have been parameters of concern at this location. Further investigation needs to be conducted on Robinson Run bracketing Ranco Inc., the landfill and Chemfix piles with an expanded parameter list to pin down the causes and sources of this impairment.

Robinson Run is impaired for its recreational use. Magnitude and frequency of measured fecal coliform values exceed the WQS criteria of 2000 cfu with a 90th percentile of 3457 cfu.

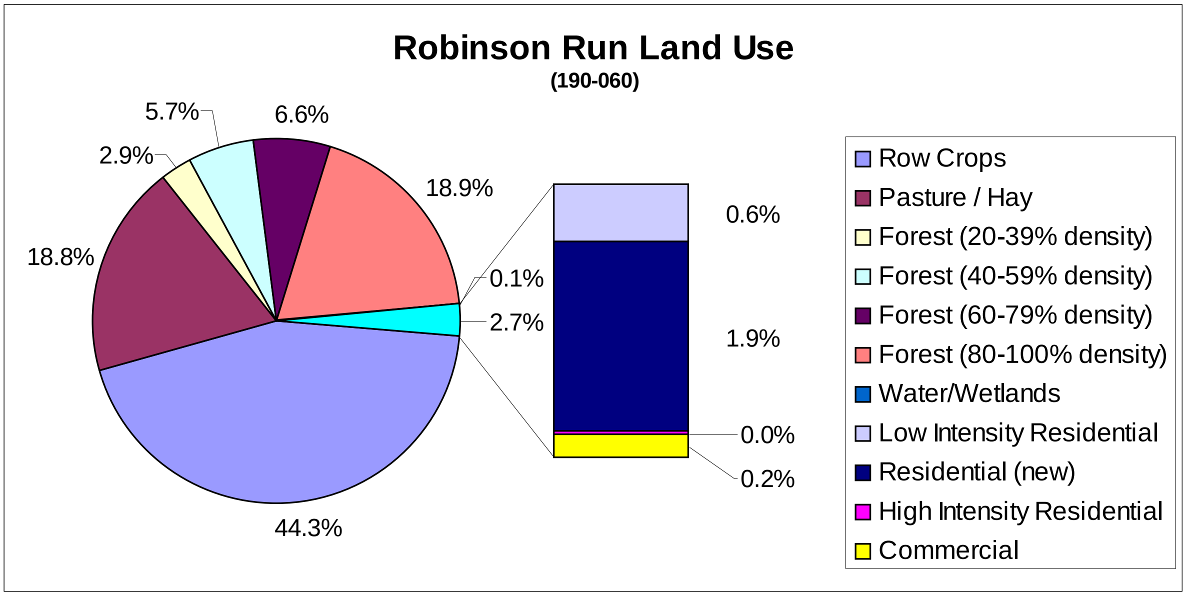


Figure 2.2.6.1. Land use in the Robinson Run minor sub-watershed.

2.2.7 Sugar Run (190-070)

Sugar Run is the most southerly major tributary to Upper Big Darby Creek that arises from the eastern side of the creek. Sugar Run is heavily influenced by agricultural practices along its length. Sugar Run is described in Box 2.2.7. Habitat assessment results for Sugar Run are given in Table 2.2.7.

The upstream reaches of Sugar Run are currently designated as WWH, but are recommended to be re-designated as MWH. Although biological samples met applicable biocriteria values for the recommended aquatic life use even this lower use is threatened in upper Sugar Run. Very high nutrients, degrading habitat, and spills have led to low dissolved oxygen concentrations (i.e, 2.88 mg/l) which do not achieve the MWH criterion, resulting in lowered biological community scores and exported stressors downstream.

The sampling site at the mouth of Sugar Run (RM 0.7) had one of the highest total phosphorus sediment concentrations in the watershed. Other Sugar Run sites had sedimentation, nutrient enrichment and low dissolved oxygen problems which yielded decreased biological community performance.

The most impacted stream locale for sediment contaminants was Sugar Run at RM 7.00. Here, arsenic concentrations were elevated as were chromium and iron. Copper, nickel, and zinc concentrations were slightly elevated. This was the only tributary that exhibited detectable concentrations of chromium and nickel as well as the highest values for copper, iron, and zinc. The Hershberger Landfill is probably source of these metals.

Box 2.2.7. Overview of Sugar Run (190-070).				
Area (acres)	12,443			
Streams	Sugar Run			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Union County Crottinger Estates	4PG00003	0.007	0.00825
Land Use	see Figure 2.2.7			
Aquatic Life Use	**Designated use**		**Impairment**	
	WWH		**Yes** - 50% of sites impaired	
			Deviation	IBI - 17%
	MWH		No	
Recreational Use	Primary Contact Recreation		No - Note: *E. coli* elevated.	

Causes of Impairment	**Sources of Impairment**	**Addressed in this TMDL?**
Direct habitat alteration	Channelization, riparian removal	√
Changes in hydrology	Channelization, hardening of the watershed	√
Nutrients	Domestic sewage, agriculture, spills, land application of manure	√

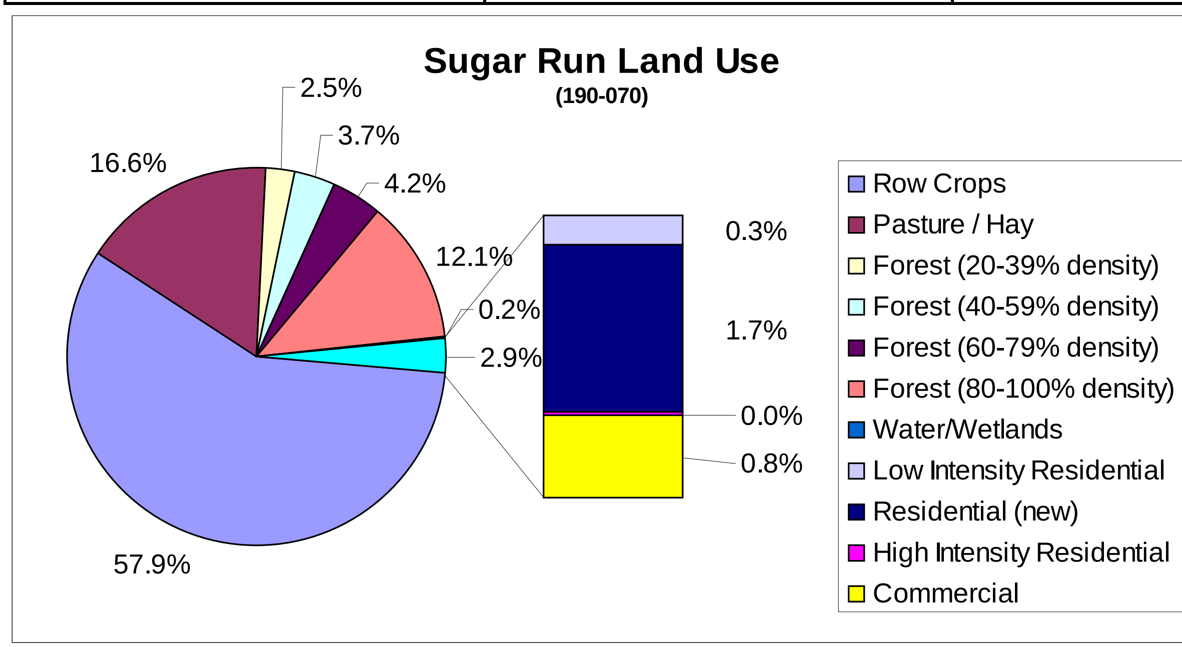


Figure 2.2.7.1. Land use in the Sugar Run minor sub-watershed.

Sugar Run is not impaired for its recreational use for fecal coliform bacteria measurements. Ohio WQS require attainment of only one of the two bacterial indicators. *E. coli* values in Sugar Run exceed WQS or other targets. Future implementation of an *E. Coli* only WQS could result in this stream being evaluated as impaired. Opportunities to reduce *E. Coli* loading to this stream should be pursued where practicable.

Table 2.2.7 Habitat Assessment Results for Sugar Run (05060001-190-070)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-190-070						
Sugar Run (MWH[1]/ WWH)	7.5[1]	Not applicable to MWH	31	Silt or muck substrates, low sinuosity, sparse or no cover, max. pool depth less than 40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Impaired
	7.0[1]	Not applicable to MWH	29.5	Channelized-no recovery, silt or muck substrates, low sinuosity, sparse or no cover, max. pool depth less than 40 cm	Hardpan substrate origin, fair or poor channel development, poor pool quality, no fast current, riffle embeddedness	
	5.4	Substrate, cover, channel, riparian, pool, riffle, gradient	38.5	Channelized-no recovery, silt or muck substrates, low sinuosity, sparse or no cover	Hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	
	0.5	Channel	65.5	None	Channelized-recovering, no fast current, substrate embeddedness	
UT to Sugar Run (RM 7.39) (MWH)	0.1[1]	Not applicable to MWH	27	Channelized-no recovery, silt or muck substrates, low sinuosity, sparse or no cover, max. pool depth less than 40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Not Impaired

[1] Denotes a Modified Warm Water Habitat (MWH) site.

2.3 Middle Big Darby Creek - (05060001 200)

The middle Big Darby Creek major sub-watershed extends from below Sugar Run to above Little Darby Creek. The Big Darby Creek mainstem is the predominant stream in middle Big Darby Creek, but there are also many streams flowing from the West in Madison County. Many of these streams have been influenced by channel modification.

Aquatic life uses in middle Big Darby Creek are impaired. Status of aquatic life uses is shown in Figure 2.3.1. The condition of the riparian corridor in this major sub-watershed is shown in Figure 2.3.2.

Figure 2.3.1 Status of Aquatic Life Uses in the middle Big Darby Creek major sub-watershed.

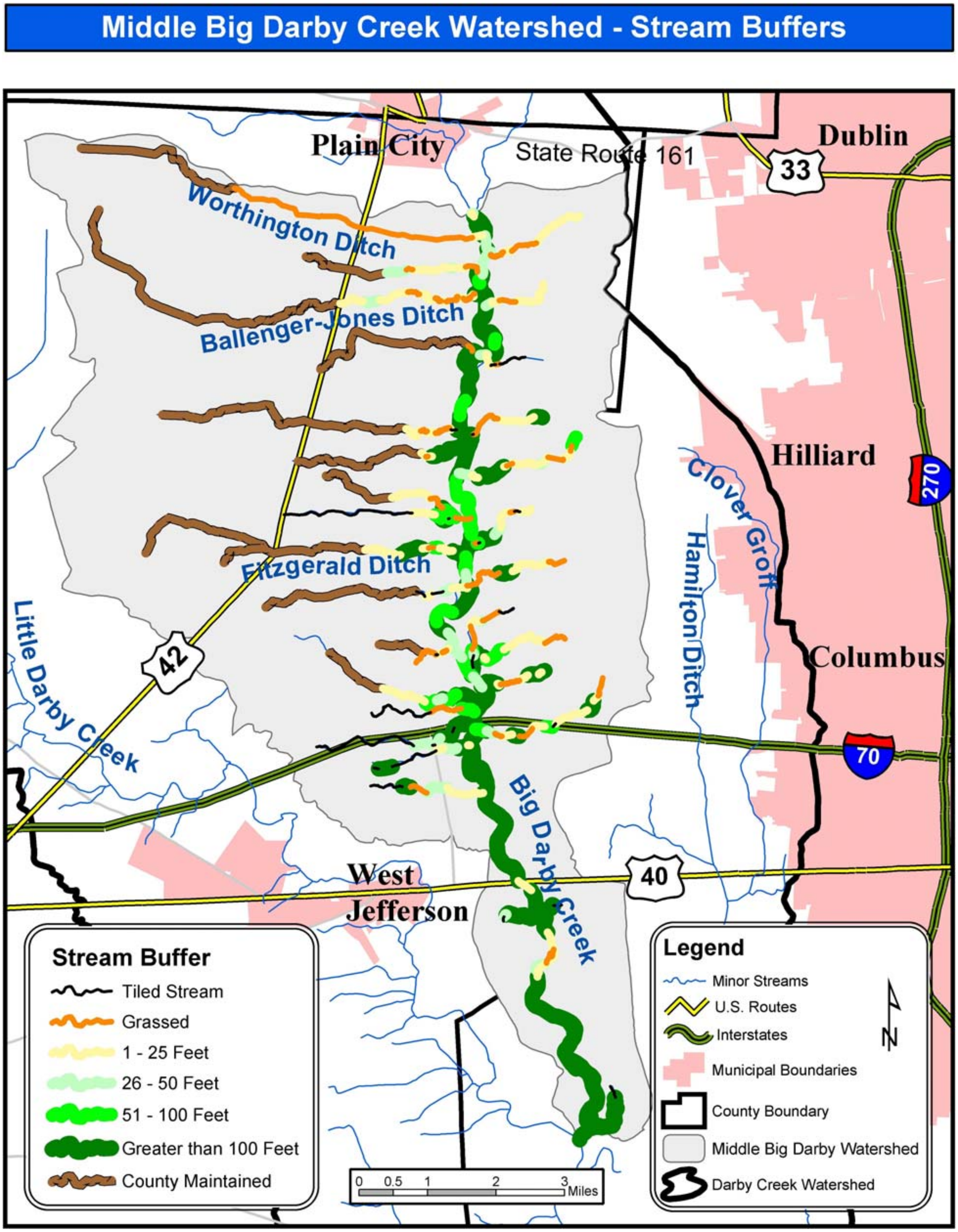


Figure 2.3.2. Riparian Corridor Status in Middle Big Darby Creek. Graphics courtesy Ben Webb.

The upstream reach of Big Darby Creek within middle Big Darby Creek (i.e., RM 49.5) has carryover impacts from the Plain City WWTP, Sweeney Run and Sugar Run. These include high TSS, biosolids, spills (primarily to Sweeney Run) and low dissolved oxygen. The pooled nature of this segment of the stream has a tendency to exacerbate the problems associated with nutrient enrichment due to extended retention times and lower re-aeration rates. However, this does have the benefit of reducing downstream transport of nutrients.

Full recovery to EWH levels of community performance in Big Darby Creek were evident from upstream of Interstate Route 70 (RM 42.1) to the downstream terminus of this major sub-watershed. This was due to a combination of factors. Several of the direct dischargers have been upgraded and documented to be operating within permit limits. One of the largest dischargers, Olen Corporation ceased operation in 2003. Another major potential source of stress, nonpoint source (NPS) inputs, was ameliorated by the relatively intact wide and wooded riparian buffers present throughout most of this reach (Figure 2.3.2). Instream gradient was adequate to flush contributed fines and the intact nature of the stream channel had the net result of a gradual improvement in habitat quality from upstream of exceptional to extraordinary downstream.

All sediment samples taken within middle Big Darby Creek revealed total organic carbon concentrations and total phosphorus concentrations exceeding the lowest effect level (LEL) to cause no harm. The sampling site at the mouth of Sugar Run (RM 0.7), which discharges directly to the BDC3 sub-watershed (Figure 2.1.1), had one of the highest total phosphorus sediment concentrations in the watershed.

2.3.1 Upper Middle Big Darby Creek (200-010)

The upper middle Big Darby Creek begins downstream of Sugar Run, and extends to High Free Pike, which crosses Big Darby Creek just south of the Interstate Route 70 crossing

A description of upper middle Big Darby Creek is given in Box 2.3.1.

<table>
<tr><th colspan="5">Box 2.3.1 Overview of upper middle Big Darby Creek (BDC4, 200-010)</th></tr>
<tr><td>Area (acres)</td><td colspan="4">40,108</td></tr>
<tr><td>Streams</td><td colspan="4">Big Darby Creek, below Sugar Run to High Free Pike (RM 50.92 to RM 41.75), including Worthington, Ballenger-Jones, Powell, Yutzy and Fitzgerald Ditches.</td></tr>
<tr><td rowspan="4">Point Source Dischargers</td><td>Name</td><td>Permit Number</td><td>Design flow (MGD)</td><td>Average flow (MGD)</td></tr>
<tr><td>Suburbans MHP</td><td>4PR00031</td><td>0.044</td><td>n/a - data unreliable</td></tr>
<tr><td rowspan="2">Jonathon Alder High School</td><td>4PT00119</td><td>0.0125</td><td>0.0024</td></tr>
<tr><td colspan="3">Receiving stream: Ballenger-Jones Ditch</td></tr>
</table>

<table>
<tr><th colspan="5">Box 2.3.1 Overview of upper middle Big Darby Creek (BDC4, 200-010)</th></tr>
<tr><td rowspan="11"></td><td rowspan="2">Dutch Kitchen</td><td>4PR00077</td><td>0.008</td><td>0.0014</td></tr>
<tr><td colspan="3">Receiving stream: UT to Ballenger-Jones Ditch</td></tr>
<tr><td rowspan="2">COJV School District</td><td>4PT00104</td><td>0.020</td><td>0.0107</td></tr>
<tr><td colspan="3">Receiving stream :Powell Ditch</td></tr>
<tr><td rowspan="2">Canaan School</td><td>4PR00032</td><td>0.003</td><td>0.0516</td></tr>
<tr><td colspan="3">Receiving stream: Yutzy Ditch</td></tr>
<tr><td>Wissolohican Sanitary Sewer District</td><td>4PG00048</td><td>0.0044</td><td>0.0028</td></tr>
<tr><td rowspan="2">Canaan Community MHP</td><td>4PR00032</td><td></td><td></td></tr>
<tr><td colspan="3">Receiving stream: Fitzgerald Ditch</td></tr>
<tr><td>Olen Corporation</td><td>4IJ00022</td><td colspan="2">Discharge Eliminated</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Land Use</td><td colspan="4">see Figure 2.3.1.1</td></tr>
<tr><td rowspan="9">Aquatic Life Use</td><td>Name</td><td>Designated use</td><td colspan="2">Impairment</td></tr>
<tr><td rowspan="2">Big Darby Creek</td><td rowspan="2">EWH</td><td colspan="2">Yes - 50% of sites impaired</td></tr>
<tr><td>Deviation</td><td>MIwb - 15%</td></tr>
<tr><td rowspan="2">Worthington Ditch</td><td rowspan="2">WWH</td><td colspan="2">Yes - 100% of sites impaired</td></tr>
<tr><td>Deviation</td><td>IBI - 66%</td></tr>
<tr><td>Ballenger-Jones Ditch</td><td>WWH</td><td colspan="2">No</td></tr>
<tr><td>Yutzy Ditch</td><td>WWH</td><td colspan="2">No</td></tr>
<tr><td rowspan="2">Fitzgerald Ditch</td><td rowspan="2">WWH</td><td colspan="2">Yes - 100% of sites impaired</td></tr>
<tr><td>Deviation</td><td>IBI - 25%</td></tr>
<tr><td>Recreational Use</td><td>All</td><td>PCR</td><td colspan="2">No</td></tr>
<tr><td>Antidegradation Category</td><td colspan="4">Big Darby Creek - Outstanding State Water</td></tr>
<tr><td colspan="2">Causes of Impairment</td><td colspan="2">Sources of Impairment</td><td>Addressed in this TMDL?</td></tr>
<tr><td colspan="2">Nutrients</td><td colspan="2">Spills, agricultural run-off, domestic sewage</td><td>√</td></tr>
<tr><td colspan="2">Low dissolved oxygen</td><td colspan="2">Spills, agricultural run-off, domestic sewage</td><td>√</td></tr>
</table>

Box 2.3.1 Overview of upper middle Big Darby Creek (BDC4, 200-010)		
Organic Enrichment	Non-irrigated crop production	√
Direct habitat alteration	Channelization, riparian removal	√
Sedimentation	Channelization, riparian removal	√

Big Darby Creek's aquatic life use is impaired through upper middle Big Darby Creek, with recovery occurring at the downstream edge of the sub-watershed. Recreational uses are not impaired in upper middle Big Darby Creek based upon sampling data collected in 2001. This is due to the fact that Ohio WQS require achieving only one of 2 bacterial criteria for the recreational use. *E. coli* values exceed existing targets, and should future WQS require a shift to *E. coli* only WQS, this sub-watershed could be re-evaluated as not being in attainment. Therefore, opportunities to reduce *E. coli* loading should be pursued where practicable.

Worthington Ditch is a stream that enters Big Darby Creek from the west just south of Plain City. Although channelized upstream from Plain City - Georgesville Road, groundwater influx and shading from a modest amount of wooded riparian vegetation in the lower reach downstream from State Route 142 has yielded cooler instream water temperatures and ameliorated some of the effects from nutrient enrichment introduced to the channelized open stream segment upstream. The macroinvertebrate communities marginally meet the WWH criterion for WWH between State Route 142 and the confluence with Big Darby Creek. As such, this is the recommended aquatic

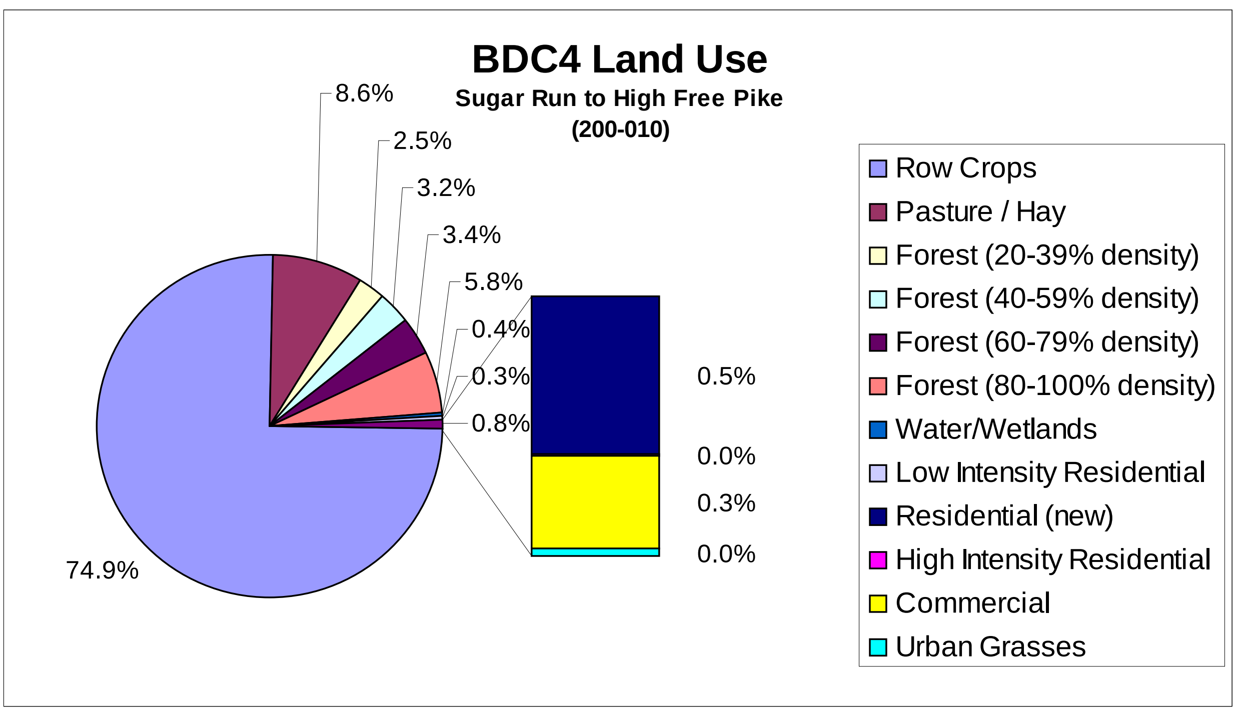


Figure 2.3.1.1 Land use in the upper middle Big Darby Creek minor sub-watershed.

Table 2.3.1 Habitat Assessment Results for upper middle Big Darby Creek (05060001-200-010)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-200-010						
Big Darby Creek (EWH)	49.5	Substrate	76	Low sinuosity	Hardpan substrate origin, no fast current, substrate embeddedness	Impaired
	42	None	81.5	None	Poor pool quality, substrate embeddedness	
Fitzgerald Ditch (WWH)	0.5	Cover, channel, pool, riffle, gradient	56.5	Low sinuosity, max. pool depth < 40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired
Ballenger-Jones Ditch (WWH)	0.4	Riparian	69	None	No fast current, substrate embeddedness	Not impaired
Worthington Ditch (WWH)	0.2	Cover, channel, riparian	46.5	Channelized-no recovery, low sinuosity, no cover	Hardpan substrate origin, fair/poor channel development, no fast current, substrate embeddedness	Impaired

life use for this segment (i.e., RM 0.4 to the mouth). Increasing the grass and/or wooded riparian buffer upstream from State Route 142 would improve water quality of Worthington Ditch and the water quality being delivered to Big Darby Creek at RM 50.62.

Although Ballenger -Jones Ditch has had much of the riparian vegetation removed from the stream bank upstream from State Route 142, the meander pattern of the stream channel and its instream habitat structure have been retained. Additionally, downstream from State Route 142, the wooded riparian vegetation has been retained as well. As a consequence instream habitat quality was judged as good (i.e., QHEI - 69.0) which was reflected in the instream biological community performance. County Ditch maintenance extends from RM 7.35 - 3.72

Yutzy Ditch was of marginally good quality at the site near State Route 142, RM 0.4, and met the recommended WWH aquatic life use biocriterion for macroinvertebrates. There was still some slight flow and groundwater recharge or supplemental interstitial flow and modest canopy in the lower reach that moderated water temperatures (~70^{o} F.). A more natural stream channel was present about 400-500 yards upstream from State Route 142 with riffles and functional pools comprised of predominately rocky substrates. This pattern continued downstream to the mouth (confluence with Big Darby Creek at RM 47.1).

Much of the upper reaches of Fitzgerald Ditch have been channel modified. Lower reaches (i.e., ~RM 1.5 downstream) have been modified to a much lesser degree. The instream habitat evaluation conducted downstream from State Route142 yielded a QHEI of 56.4. Moderate influence negative habitat attributes were the main factors resulting in the slightly less than optimal habitat but were not judged to preclude eventual full attainment of the WWH use with improvements at the MHP WWTP. Fitzgerald Ditch is partially meeting the WWH aquatic life use designation in its lower reaches. The reasons for the partial departure from expectations are stream dessication, nutrient enrichment, inadequate dechlorination from point sources and modest habitat degradation.

Big Darby Creek and its tributaries from Sugar Run to High Free Pike are not impaired for their recreational uses.

2.3.2 Lower Middle Big Darby Creek (200-020)

The minor sub-watershed lower middle Big Darby Creek is comprised exclusively of the mainstem of Big Darby Creek, with no significant tributaries that were evaluated. Much of lower middle Big Darby Creek is owned by Metroparks, and has a well protected and extensive riparian corridor (Figure 2.3.2).

A description of lower middle Big Darby Creek is included in Box 2.3.2.

Big Darby Creek is in attainment of its aquatic life and recreational uses throughout lower middle Big Darby Creek. Continued compliance by smaller point source dischargers will be an important factor in maintaining this condition.

Box 2.3.2 Overview of lower middle Big Darby Creek (BDC5, 200-020)				
Area (acres)	9,183			
Streams	Big Darby Creek, from High Free Pike to above Little Darby Creek (RM 41.75 to 34.2)			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Battelle Memorial Institute	4IN00004	0.050	0.043
	Lake Darby Estates	4PU00001	0.500	0.411
	Greentree MHP	4PY00001	0.016	0.014
	Darby Dan Farms	4PR00000	0.004	0.002
Land Use	see Figure 2.3.2.1			
Aquatic Life Use	**Designated use**		**Impairment**	
	EWH		No	
Recreational Use	Primary Contact Recreation		No	
Antidegradation Category	Big Darby Creek - Outstanding State Water			
Deviation from target	☺ Full attainment in this minor sub-watershed			

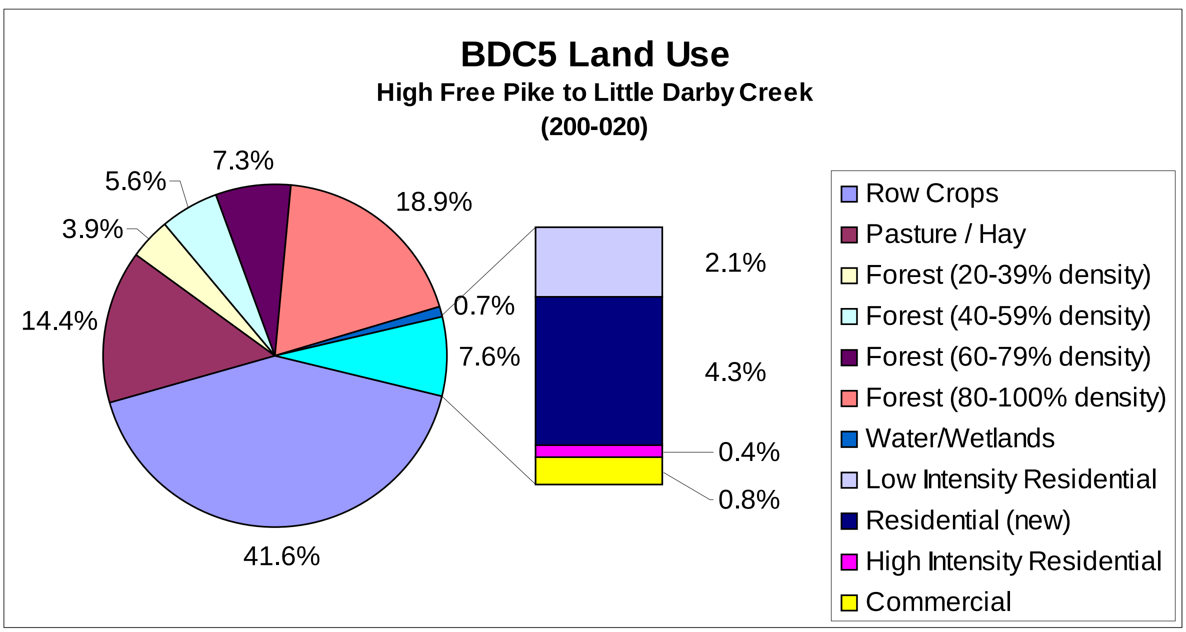


Figure 2.3.2.1. Land use in the lower middle Big Darby Creek minor sub-watershed.

Table 2.3.2 Habitat Assessment Results for lower middle Big Darby Creek (05060001-200-020)						
Stream/River	**River Mile**	**Assessment Results**				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-200-020						
Big Darby Creek (EWH)	38.9	None	82.5	None	No fast current, substrate embeddedness	Not impaired
	34.1	None	93.5	None	None	

2.4 Little Darby Creek - (LDC, 05060001 210)

The Little Darby Creek (LDC) major sub-watershed comprises the entirety of Little Darby Creek and it tributaries. Major tributaries to LDC are Treacle Creek and Spring Fork.

The Little Darby Creek sub-watershed has benefitted greatly by the contribution of ground water to a large percentage of its tributaries. Comparable instream habitat and equivalent concentrations of nutrients in this system without the ground water would have led to a much higher percentage of Warmwater Habitat streams with more widespread and more severe impairment. Thus, recovery can be much quicker if protective measures are taken. Additionally, every effort should be made to protect the aquifer that is supplying cool water to this unique oasis of biodiversity. Aquatic life use attainment in the LDC is shown in Figure 2.4.1. The condition of the riparian corridor in this major sub-watershed is shown in Figure 2.4.2.

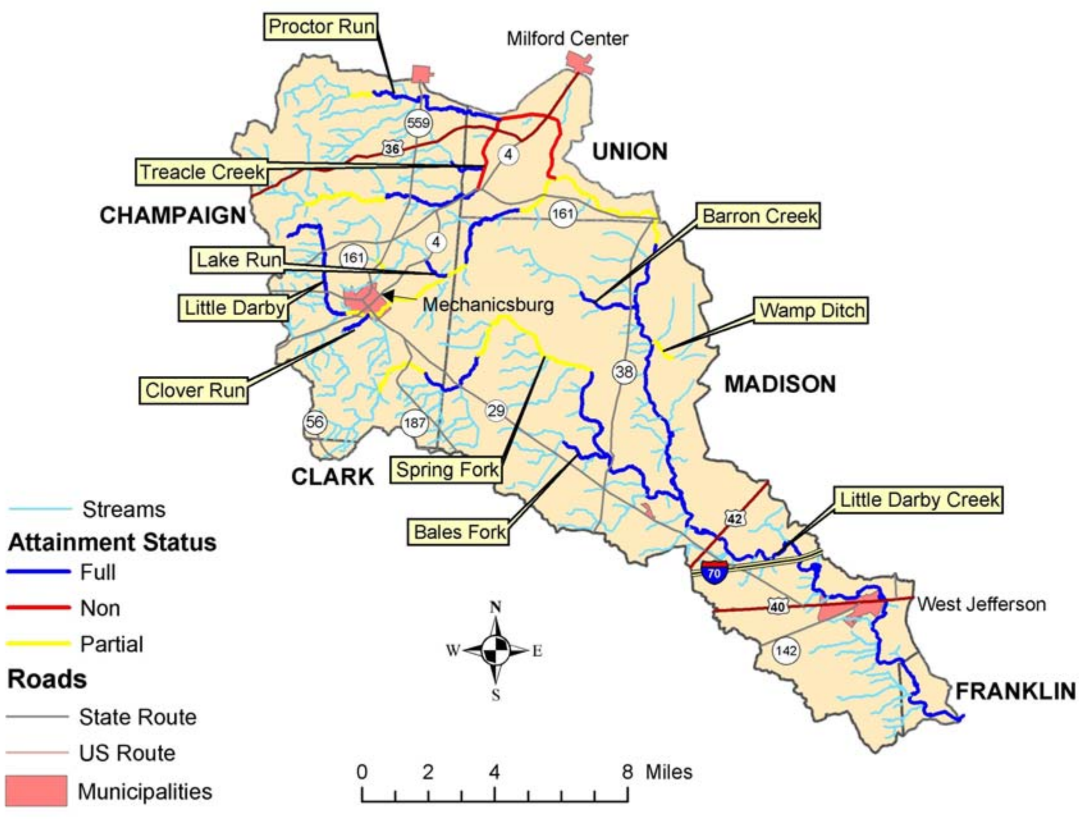


Figure 2.4.1. Status of aquatic life uses in Little Darby Creek (LDC) sub-watershed.

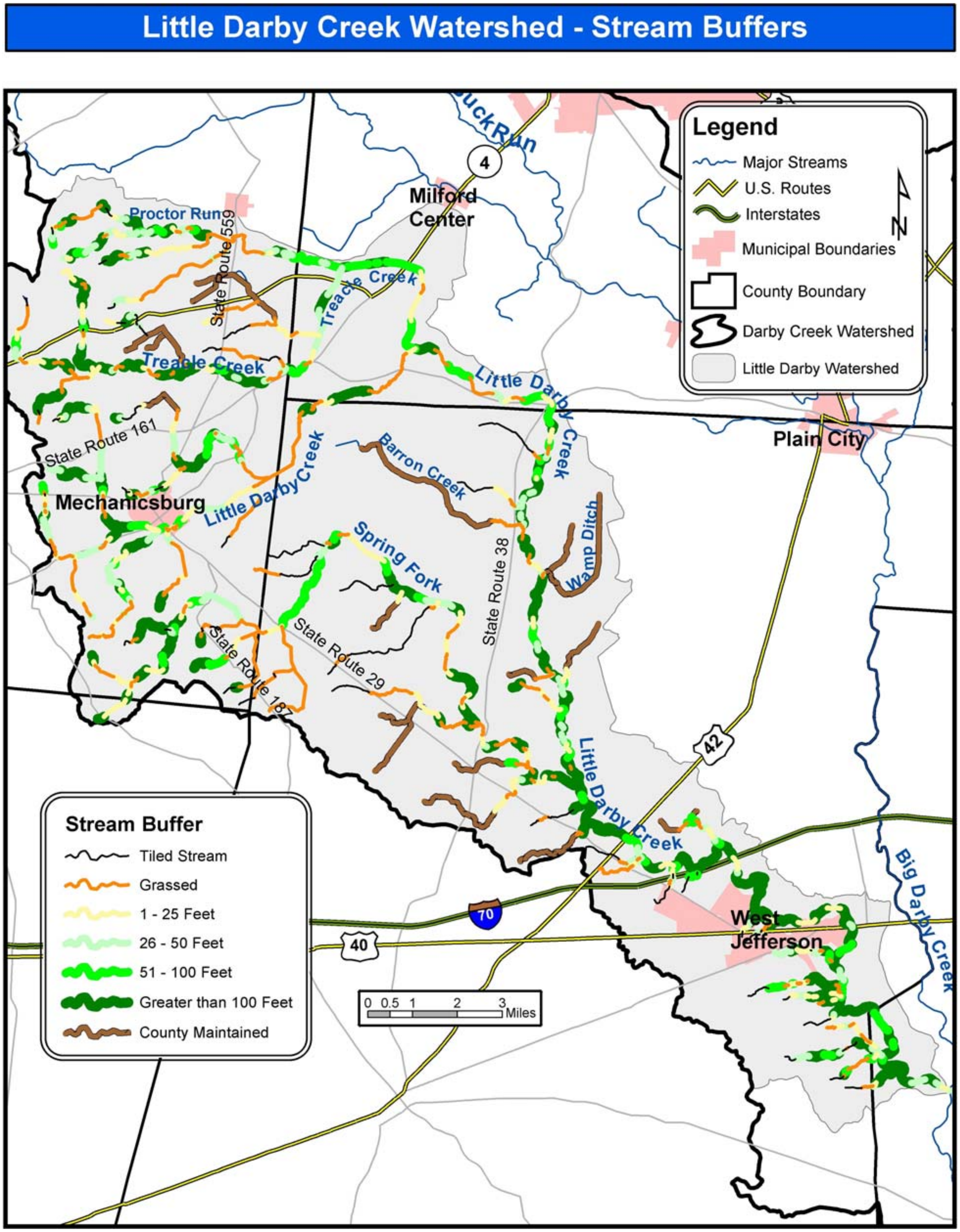


Figure 2.4.2. Status of Riparian Buffer in the Little Darby Creek sub-watershed. Graphics courtesy Ben Webb.

2.4.1 Upper Little Darby Creek (210-010)

The upper Little Darby Creek sub-watershed is comprised of Little Darby Creek mainstem, Clover Run, Lake Run, and Jumping Run. The mainstem section in upper Little Darby Creek extends to above the confluence with Treacle Creek.

A description of Upper Little Darby Creek is given in Table 2.4.1.

<table>
<tr><th colspan="5">Box 2.4.1 Overview of Upper Little Darby Creek (210-010)</th></tr>
<tr><td>Area (acres)</td><td colspan="4">19,055</td></tr>
<tr><td>Streams</td><td colspan="4">Little Darby Creek from its headwaters to above Treacle Creek (RM 41.2 to RM31.4), including Clover Run, Lake Run, and Jumping Run.</td></tr>
<tr><td rowspan="3">Point Source Dischargers</td><td>Name</td><td>Permit number</td><td>Design flow (MGD)</td><td>Average flow (MGD)</td></tr>
<tr><td>Mechanicsburg</td><td>1PB00037</td><td>0.23</td><td>0.275</td></tr>
<tr><td>Champaign Landmark, Mechanicsburg Mill</td><td>unpermitted, unauthorized.</td><td>n/a</td><td>n/a</td></tr>
<tr><td>Land Use</td><td colspan="4">see Figure 2.4.1.1</td></tr>
<tr><td rowspan="8">Aquatic Life Use</td><td>Name</td><td>Designated use</td><td colspan="2">Impairment</td></tr>
<tr><td rowspan="2">Little Darby Creek</td><td rowspan="2">EWH + CWH to RM 37.0</td><td colspan="2">Yes - 60% of sites impaired</td></tr>
<tr><td>Deviation</td><td>IBI 2 - 42%</td></tr>
<tr><td>Clover Run</td><td>WWH</td><td colspan="2">No</td></tr>
<tr><td rowspan="2">Lake Run</td><td rowspan="2">EWH</td><td colspan="2">Yes -100% of sites impaired</td></tr>
<tr><td>Deviation</td><td>IBI 19%</td></tr>
<tr><td rowspan="2">Jumping Run</td><td rowspan="2">WWH</td><td colspan="2">Yes - 100% of sites impaired</td></tr>
<tr><td>Deviation</td><td>IBI 33%</td></tr>
<tr><td>Recreational Use</td><td colspan="2">Primary Contact Recreation</td><td colspan="2">No</td></tr>
<tr><td>Antidegradation Category</td><td colspan="4">Little Darby Creek - Outstanding State Water</td></tr>
</table>

Box 2.4.1 Overview of Upper Little Darby Creek (210-010)		
Causes of Impairment	**Sources of Impairment**	**Addressed in this TMDL?**
Unknown Toxicity	Spills - Note: this impairment is now attributed to the Champaign Landmark Feed Mill in Mechanicsburg.	√
Sedimentation	Pasture land, habitat disruption, channelization	√
Nutrients	Pasture land, agricultural run-off	√
Low dissolved oxygen	Domestic sewage, pasture land agricultural run-off	√

The very headwaters of Little Darby Creek also appears to be suitable for co-designating as CWH. Several lines of evidence point to that conclusion including measured low mean water temperatures, the presence of the requisite number of coldwater macroinvertebrate taxa and the obligate coldwater mottled sculpin. The recommendation is being made to designate Little Darby Creek from its headwaters to RM 37.0 just upstream from the confluence with Lake Run. Although all macroinvertebrate sites on the Little Darby Creek mainstem met either the recommended or current EWH ICI biocriterion there were indications of challenges to this continued level of performance. Impairments to the fish communities were the main reason for partial attainment of the EWH use which was limited to the upper third of the mainstem.

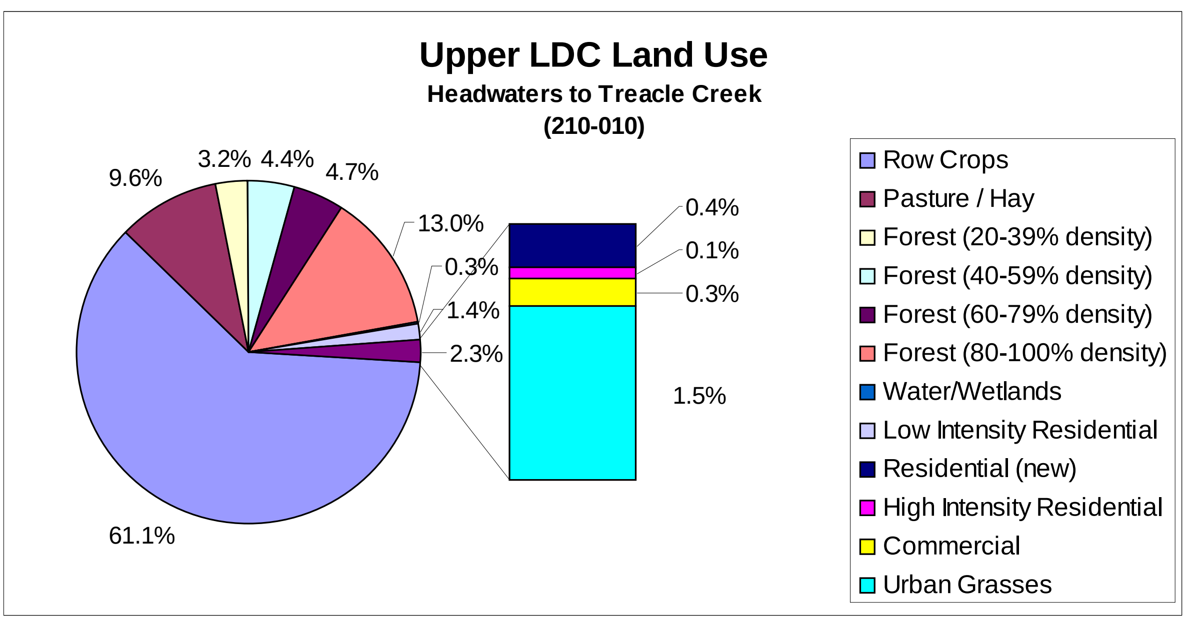


Figure 2.4.1.1. Land use in the upper Little Darby Creek minor sub-watershed.

Table 2.4.1 Habitat Assessment Results for upper Little Darby Creek (05060001-210-010)

Stream/River	**River Mile**	Assessment Results: Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site: High Influence	Undesirable habitat attributes present at the site: Moderate Influence	Use Attainment Status
05060001-210-010						
Little Darby Creek (EWH)	41.2	None	80.5	None	None	Impaired
	41.2[1]	Substrate	70	None	Poor pool quality, no fast current, substrate embeddedness	
	39.6	Substrate, channel, riparian	69.5	No cover	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
	38.8	None	82	None	Hardpan substrate origin, poor pool quality, no fast current	
	34.7	None	82.5	None	None	
Lake Run (EWH)	0.9	Channel	71	None	Channelized-recovering, poor pool quality, no fast current, substrate embeddedness	Impaired
Jumping Run (WWH)	0.3	Substrate	63	Silt/muck substrates	Hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired
Clover Run (WWH)	0.6	Pool, riffle, gradient	60	No cover	Poor pool quality, no fast current	Not Impaired

[1] Results are from the 2002 resampling of this site.

Little Darby Creek upstream from Mechanicsburg as mentioned above is strongly influenced by cool ground water. It is also strongly influenced by the upstream land use which is pasturage. Pasturage has led to false bank formation and the transport of silt and fines downstream smothering substrates and increasing embeddedness. This has led to variable sampling results over time and in the most recent sampling a fish community that did not meet the EWH criteria. The high gradient and strong influx of clean, cool ground water though provide the potential for swift recovery.

The next sampling site was downstream of State Route 29, RM 39.6, where Little Darby Creek winds southeast and east just south of most of Mechanicsburg. This site was also downstream from the confluence with Clover Run and just downstream from a fertilizer / feed distributor storage facility and an open pasture with unrestricted access of livestock to the stream. Fish community scores here appeared to be impaired as a result of historic spills, nutrient enrichment and some sedimentation associated with pasturage.

Downstream from the Wing Road bridge, RM 38.8, untreated sewage discharged from an unpermitted bypass pipe was responsible for the impact to the fish community. The macroinvertebrates sampled just upstream from the pipe were not impacted clearly documenting the culpability of this discharge to the impact. Little Darby Creek should be re-evaluated after the bypass pipe has been sealed and the Mechanicsburg WWTP upgraded.

Clover Run is fully meeting the recommended WWH aquatic life use designation biocriteria for both fish and benthic macroinvertebrates. The significant presence of the obligate coldwater mottled sculpin and the facultative cool water blacknose dace as well as a handful of cold water macroinvertebrate taxa suggest that Clover Run might have been suitable for the Coldwater Habitat aquatic life use in the past. However the removal or thinning of the riparian buffer and sedimentation has lowered biological performance to the point that use designation is not currently being proposed.

Lake Run was designated in the 1978 WQS as EWH based on best professional judgement. Current sampling has revealed biological communities that are only partially meeting the current EWH biocriteria as a consequence of a recent and temporal impact (i.e., inadequate implementation of erosion and storm water BMPs that have delivered excess sediment to the stream channel). It is felt that given time for the disturbed land to stabilize with vegetation and the contributed sediment to be flushed downstream this high gradient stream should easily be able to fully meet the EWH criteria.

Siltation and episodic nutrient enrichment were judged to be the causes for the partial attainment of the recommended WWH biocriteria in Jumping Run.

Recreational uses are being attained in upper Little Darby Creek. This is due to the condition in the Ohio WQS that attainment of one of two bacterial criteria types is necessary for recreational use attainment. *E. coli* values exceed current and potential targets, especially 90^{th} percentile *E. coli* values. In the event that the WQS shift to an *E. coli* only standard, this sub-watershed could be re-evaluated as in non-attainment. Therefore, opportunities to reduce *E. coli* loading should be pursued where practical.

2.4.2 Upper Treacle Creek (210-020)

The upper Treacle Creek minor sub-basin begins at the headwaters of Treacle Creek, and extends downstream to above Proctor Run. A description of upper Treacle Creek is given in Box 2.4.2.

Treacle Creek, currently is designated EWH its entire length and partially met criteria in its headwaters. Habitat although solidly in the very good range is less than generally found in streams that drain the Cable moraine, particularly those streams draining the boulder belt. One attribute that repeatedly appears is the cooler water temperatures

Box 2.4.2 Overview of upper Treacle Creek (210-020).			
Area (acres)	12,625		
Streams	Treacle Creek, from headwaters to above Proctor Run (RM 11.8 to RM 3.7), includes Howard Run.		
Point Source Dischargers	none		
Land Use	see Figure 2.4.2.1		
Aquatic Life Use	**Designated use**	**Impairment**	
	EWH	**Yes** - 33% of sites impaired	
		Deviation	IBI - 25%
Recreational Use	Primary Contact Recreation	No - Note: *E. coli* is highly elevated	
Causes of Impairment	**Sources of Impairment**	**Addressed in this TMDL?**	
Sedimentation	Pasture land, habitat disruption, channelization	√	
Nutrients	Pasture land, agricultural run-off	√	

found in these streams, including Treacle Creek. Siltation and elevated nutrients were thought to be the cause of the slightly lowered values in the headwaters.

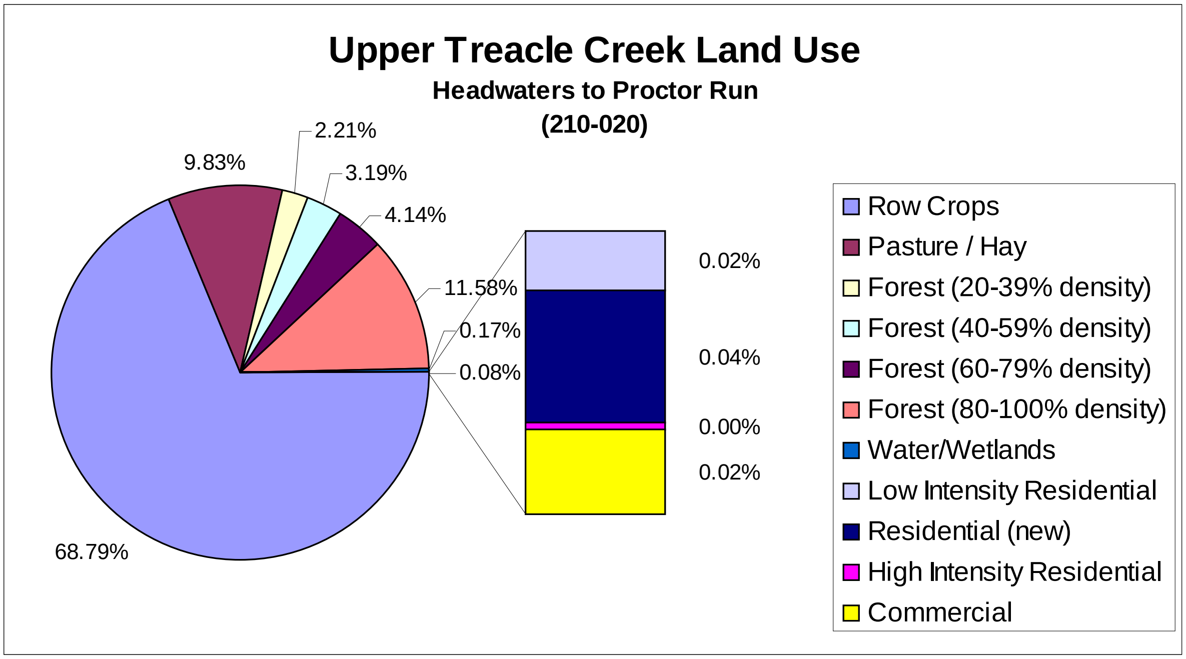


Figure 2.4.2.1. Land use in the upper Treacle Creek minor sub-watershed.

Howard Run, a small tributary to Treacle Creek, is fully meeting EWH biocriteria. Cooler water and a largely closed canopy helped to lessen the impacts from NPS inputs. Reducing siltation, widening the woody riparian corridor and permitting natural recovery from past channelization would improve the quality of Howard Run. These actions would also reduce sedimentation and nutrient inputs to Treacle Creek and in turn improve that receiving stream.

Table 2.4.2 Habitat Assessment Results for upper Treacle Creek (05060001-210-020)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-210-020						
Treacle Creek (EWH)	11.8	Channel	67.5	Low sinuosity	Hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired
	8.3	None	67.5	None	Poor pool quality, no fast current	
	6	Substrate	66.5	None	Hardpan substrate origin, no fast current, substrate embeddedness	
Howard Run (EWH)	0.5	Substrate, channel, riparian, pool, riffle, gradient	55.5	Low sinuosity	Channelized-recovering, Hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Not impaired
	0.5[1]	Substrate, channel, riparian	56	Channelized-no recovery, silt/muck substrates, low sinuosity	Hardpan substrate origin, no fast current, substrate embeddedness	

[1] Results from the 2002 resampling of this site.

2.4.3 Proctor Run (210-030)

Proctor Run is a major tributary to Treacle Creek, and is a minor sub-watershed in Little Darby Creek.

A description of Proctor Run is given in Box 2.4.3. The results of the habitat assessment are given in Table 2.4.3.

<table>
<tr><td colspan="6">Box 2.4.3 Overview of Proctor Run (210-030).</td></tr>
<tr><td>Area (acres)</td><td colspan="5">9,659</td></tr>
<tr><td>Streams</td><td colspan="5">Proctor Run</td></tr>
<tr><td rowspan="2">Point Source Dischargers</td><td colspan="2">Name</td><td>Permit number</td><td>Design Flow (MGD)</td><td>Average Flow (MGD)</td></tr>
<tr><td colspan="2">Triad Local Schools</td><td>1PT00099</td><td>0.010</td><td>0.0072</td></tr>
<tr><td>Land Use</td><td colspan="5">see Figure 2.4.3.1</td></tr>
<tr><td rowspan="3">Aquatic Life Use</td><td colspan="3">Designated use</td><td colspan="2">Impairment</td></tr>
<tr><td colspan="3" rowspan="2">EWH</td><td colspan="2">Yes - 33% of sites impaired</td></tr>
<tr><td>Deviation</td><td>IBI 19%</td></tr>
<tr><td>Recreational Use</td><td colspan="3">Primary Contact Recreation</td><td colspan="2">Yes - 90th percentile fecal coliform exceeds maximum criteria by 97%. E. coli values are extremely elevated.</td></tr>
<tr><td>Antidegradation Category</td><td colspan="5">Proctor Run - Superior High Quality Water</td></tr>
<tr><td colspan="2">Causes of Impairment</td><td colspan="3">Sources of Impairment</td><td>Addressed in this TMDL?</td></tr>
<tr><td colspan="2">Sedimentation</td><td colspan="3">Pasture land, habitat disruption, channelization</td><td>√</td></tr>
<tr><td colspan="2">Nutrients</td><td colspan="3">Pasture land, agricultural run-off</td><td>√</td></tr>
</table>

Proctor Run originates in Champaign County in the boulder belt of the Cable Moraine. It then flows almost directly east downslope through the rest of the Cable moraine and into ground moraine and Union County. Three sites were evaluated in Proctor Run in 2001 yielding QHEI scores ranging from 65 to 73. Positive warmwater habitat attributes predominated at all three sites. No high influence modified habitat attributes were found although moderate amounts of silt and embeddedness somewhat lowered habitat quality.

Bacteria levels in Proctor Run are elevated, and the recreational use is impaired. The magnitude and frequency of fecal coliform values exceed WQS with a 90^{th} percentile value of 7074 cfu. *E. coli* values are extremely elevated, with a 90^{th} percentile value of 6749 cfu. These values indicate run-off related problems with bacteria typically associated with agricultural inputs.

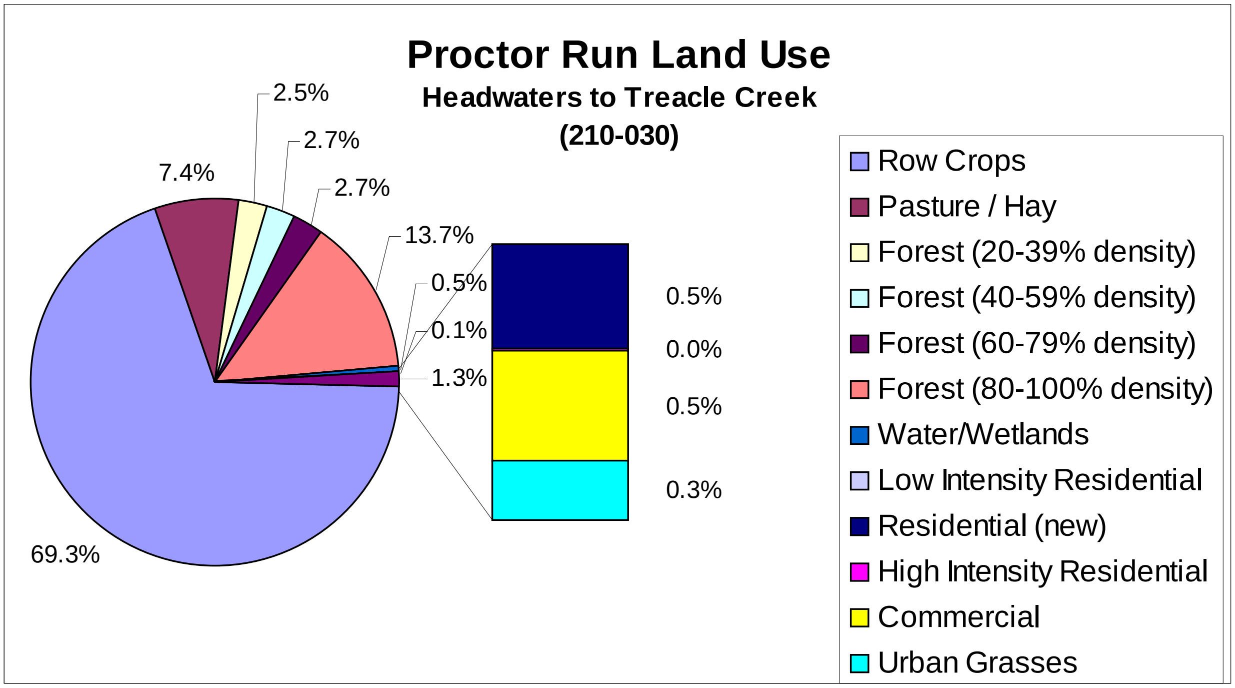


Figure 2.4.3.1. Land use in the Proctor Run minor sub-watershed.

Table 2.4.3 Habitat Assessment Results for Proctor Run (05060001-210-030)

Stream/River	**River Mile**	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-210-030						
Proctor Run (EWH)	4.9	None	71.5	None	Hardpan substrate origin, poor pool quality, no fast current	Impaired
	3.1	Channel, riparian	65	None	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
	1.6	Substrate, channel, riparian	73	None	Channelized-recovering, sand substrate, poor pool quality, no fast current, substrate embeddedness	

2.4.4 Lower Treacle Creek (210-040)

The lower Treacle Creek minor sub-watershed extends from the confluence of Proctor Run and Treacle Creek to the confluence of Treacle Creek with Little Darby Creek.

A description of lower Treacle Creek is given in Box 2.4.4.

<table>
<tr><th colspan="4">Box 2.4.4 Overview of lower Treacle Creek (210-040).</th></tr>
<tr><td>Area (acres)</td><td colspan="3">4,550</td></tr>
<tr><td>Streams</td><td colspan="3">Treacle Creek (RM 3.6 to mouth, RM 0.0)</td></tr>
<tr><td>Point Source Dischargers</td><td colspan="3">none</td></tr>
<tr><td>Land Use</td><td colspan="3">see Figure 2.4.4.1</td></tr>
<tr><td rowspan="3">Aquatic Life Use</td><td>Designated use</td><td colspan="2">Impairment</td></tr>
<tr><td rowspan="2">EWH</td><td colspan="2">Yes - 100% of sites impaired (1/1)</td></tr>
<tr><td>Deviation</td><td>ICI - MG ➜E</td></tr>
<tr><td>Recreational Use</td><td>Primary Contact Recreation</td><td colspan="2">Yes - both geometric mean (45% deviation) and 90^{th} percentile (63% deviation) fecal coliform values exceed criteria. E. coli values are extremely elevated.</td></tr>
</table>

Causes of Impairment	**Sources of Impairment**	**Addressed in this TMDL?**
Sedimentation	Pasture land, habitat disruption, channelization	√
Nutrients	Pasture land, agricultural run-off	√
Low dissolved oxygen	Pasture land, agricultural run-off	√

Figure 2.4.4.2. Unrestricted livestock access to lower Treacle Creek.

Treacle Creek, currently designated EWH its entire length, partially met criteria in it headwaters and is in non-attainment towards its mouth. A wide variety of stressors were adversely affecting biological communities towards the mouth of Treacle Creek. Poor habitat resulting from channelization and free access livestock pasturage (Figure 2.4.4.2) has resulted in all native substrates being covered in a thick layer of soft, unconsolidated clays and silts. High fecal coliform bacteria and elevated nutrients also contributed to the decline which extended its reach into Little Darby Creek.

The recreational use of lower Treacle Creek is impaired. Both geometric mean and 90th percentile fecal coliform values of 1822 cfu and 5389 cfu, respectively, exceed the WQS criteria. *E. coli* geometric mean and 90th percentile values of 1063 cfu and 5720 cfu, respectively, are extremely elevated.

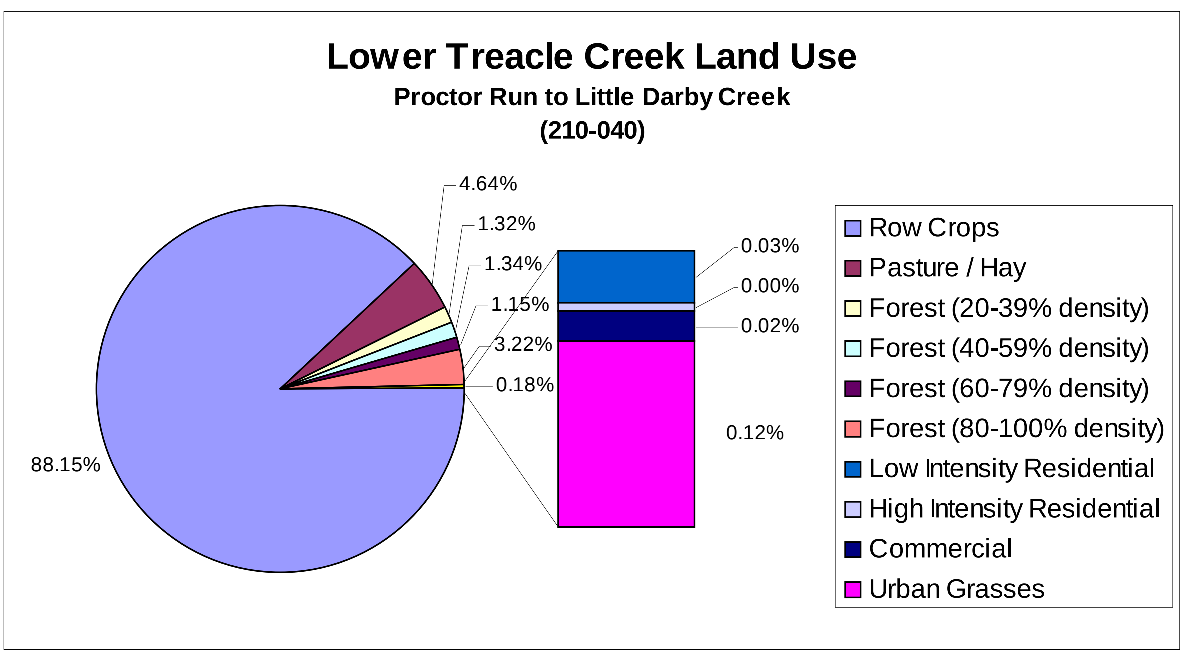


Figure 2.4.4.1. Land use in the lower Treacle Creek minor sub-watershed.

Table 2.4.4 Habitat Assessment Results for Lower Treacle Creek (05060001-210-040)

Stream/River	**River Mile**	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-210-040						
Treacle Creek (EWH)	0.8	Substrate, cover, channel, riparian, pool, riffle, gradient	29.5	Silt/muck substrates, low sinuosity, no cover	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Impaired

2.4.5 Middle Little Darby Creek (210-050)

The middle Little Darby Creek minor sub-watershed extends from Little Darby Creek's confluence with Treacle Creek to above Spring Fork.

A description of middle Little Darby Creek is provided in Box 2.4.5. Habitat assessment results are presented in Table 2.4.5.

Box 2.4.5 Overview of middle Little Darby Creek (210-050).

Area (acres)	24,320			
Streams	Little Darby Creek, below Treacle Creek to above Spring Fork (RM 31.3 to RM 17.47), including Barron Creek and Wamp Ditch.			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Rosedale Bible College	4GS00001	0.009	n/a
Land Use	see Figure 2.4.5.1			
Aquatic Life Use	**Name**	**Designated use**	**Impairment**	
	Little Darby Creek	EWH	**Yes** - 17% of sites impaired	
			Deviation	IBI - 11% MIwb - 7%
	Barron Creek	WWH	No	
	Wamp Ditch	WWH	**Yes** - 100% of sites impaired	
			Deviation	IBI - 33%
Recreational Use	Little Darby Creek -	PCR	**Yes** - geometric mean (35% deviation) and 90th percentile (90% deviation) fecal coliform exceed criteria. Note: *E. coli* is extremely elevated. Barron Creek is the source of this impairment.	
	Barron Creek	SCR		
	Wamp Ditch	SCR		
Antidegradation Category	Little Darby Creek - Outstanding State Water			
Endangered Species	Clubshell Mussel (*Pleurobema clava*)			

Causes of impairment	**Sources of impairment**	**Addressed in this TMDL?**
Sedimentation	Pasture land, habitat disruption, channelization	√
Nutrients	Pasture land, agricultural run-off	√
Low dissolved oxygen	Pasture land, agricultural run-off	√

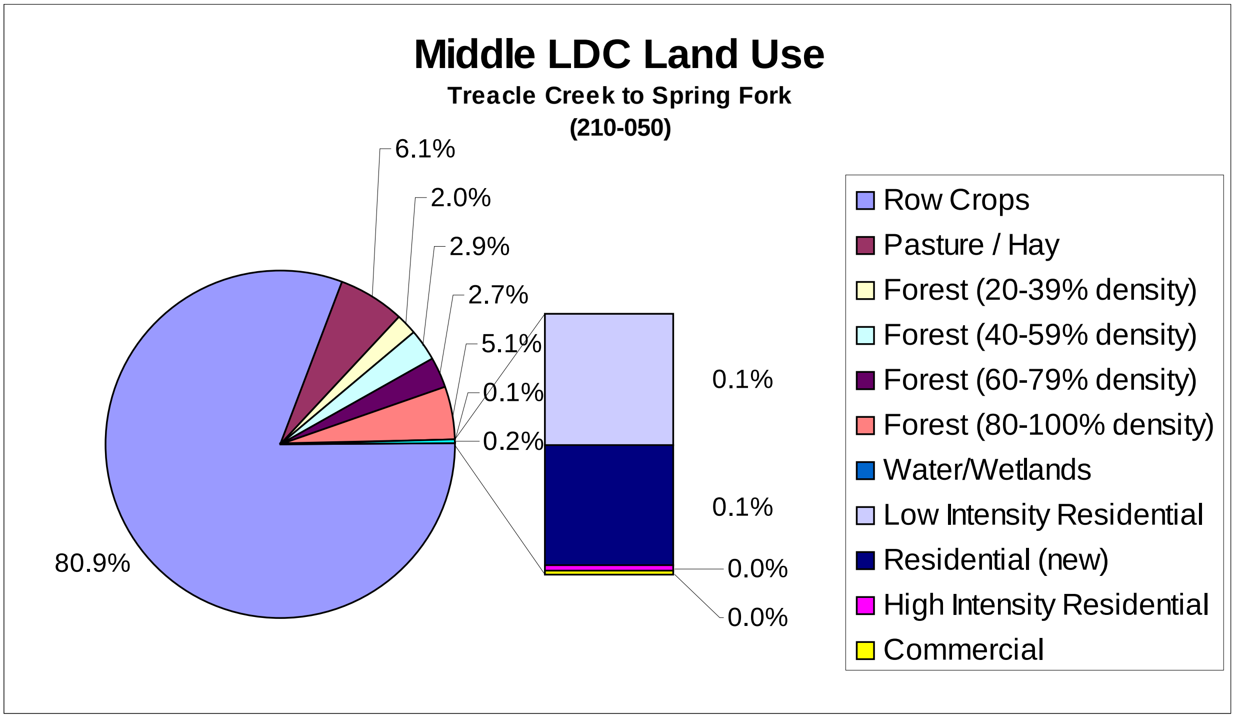


Figure 2.4.5.1. Land use in the middle Little Darby Creek minor sub-watershed.

The next stream segment suffering declines was immediately downstream from the confluence with Treacle Creek and upstream from Axe Handle Road. This segment had previously supported EWH communities and habitat quality had not significantly declined. In 2001 this site dropped below the EWH range. The loss of intolerant species and the fairly low number on non-tolerant individuals were the metrics showing the greatest deviation from expectations. Problems associated with nutrient enrichment and its consequent effects on dissolved oxygen appear to be strong candidates for the depressed fish community results. Continuous dissolved oxygen monitoring has revealed dissolved oxygen dropping below EWH minimums upstream from the bridge and in the downstream reaches of Treacle Creek, whose confluence is immediately upstream.

Barron Creek performed much better than would be predicted based on a cursory evaluation of channel morphology and instream habitat quality. Barron Creek is currently under ongoing maintenance by the Madison County Engineer's Office. A large percent of the watercourse has been channelized yielding an open canopy and groomed grass buffer strips. Excess nutrient inputs caused enrichment with gross algal production and large stands of emergent aquatic macrophytes. Substrates in the bottom of shallow pools were black and anoxic from the accumulated decaying detritus. Cool ground water inputs appear to have ameliorated the impacts that would normally be associated with the elevated levels of nutrients documented in Barron Creek. Establishing a wooded riparian buffer along Barron Creek would benefit the aquatic communities locally and Little Darby Creek downstream from the confluence.

Bacterial sampling of Barron Creek shows it to be grossly polluted, and not attaining the recreational use of secondary contact recreation (2000 cfu average, 5000 cfu maximum). Bacteria levels for both fecal coliform and *E. coli* are extremely elevated. Geometric mean fecal coliform bacteria levels in Barron Creek are 22,000 cfu and 90th percentile of fecal coliform values is 39,952 cfu.

Table 2.4.5 Habitat Assessment Results for middle Little Darby Creek (05060001-210-050)

Stream/River	**River Mile**	Assessment Results: Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site: High Influence	Undesirable habitat attributes present at the site: Moderate Influence	Use Attainment Status
05060001-210-050						
Little Darby Creek (EWH)	29.5	Channel, riparian	66.5	Silt/muck substrates	Channelized-recovering, no fast current	Impaired
	26.6	Substrate, riparian, pool, riffle, gradient	58	None	No fast current, substrate embeddedness	
	24.5	Substrate, channel	62.5	Low sinuosity	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
	23.1	Substrate, channel	55.5	Silt/muck substrates, low sinuosity	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
	20.5	Substrate, channel	64.5	Low sinuosity	Channelized-recovering, hardpan substrate origin, no fast current, substrate embeddedness	
Barron Creek (WWH)	2.1	Cover, channel, riparian, pool, riffle, gradient	44.5	Low sinuosity, no cover	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Not impaired
Wamp Ditch (WWH)	0.1	Cover, channel, riparian, pool, riffle, gradient	45.5	Channelized-no recovery, silt/muck substrates, no cover, max. pool depth < 40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired

Wamp Ditch, a small direct tributary to Little Darby Creek, is one of the few that drain into Little Darby Creek from the east. A significant portion of Wamp Ditch is under maintenance by the Madison County Engineer's Office. However, in this case the ameliorating effects of ground water augmentation did not appear to be as effective in reducing the impacts associated with the adjacent land use, instream habitat degradation and nutrient enrichment as it had been in Barron Creek. Wamp Creek possessed similar habitat, and also had significant ground water contribution leading to the conclusion that the water chemistry was probably more severely impacted. Unfortunately no water chemistry samples were taken. In view of the partially meeting of the WWH criteria the stream is being recommended to be designated as WWH. Future monitoring should include water chemistry sampling in addition to the biological and habitat quality monitoring. Restoration of a woody riparian buffer would also benefit Wamp Ditch and the sensitive portion of Little Darby Creek which receives Wamp Ditch water.

2.4.6 Spring Fork (210-060)

The Spring Fork minor sub-watershed is described in Box 2.4.6. Habitat assessment results for Spring Fork are given in Table 2.4.6.

Spring Fork had a mix of full and partial attainment of the EWH use along its length. As was the case in many of the Little Darby Creek tributaries nutrient enrichment was a significant contributor to the lessened performance and partial attainment seen. Although habitat quality was in the good range throughout most of the reach sampled siltation and sedimentation were felt to have reduced overall performance. Lack of access downstream from the Green Meadows Mobile Home Park WWTP limited the ability to accurately assess the full impact of that point source. However, it was possible to determine that the WWTP was responsible for some of the highest nutrient concentrations in the sub-watershed (including ammonia) and that there was a dissolved oxygen sag downstream from the WWTP which lead to failing to achieve EWH minimum DO instream. Efforts to improve the quality of effluent leaving this WWTP will benefit the downstream reaches of Spring Fork and the sensitive reach of Little Darby Creek that receives water from Spring Fork.

Bales Ditch possessed very good instream habitat (QHEI - 70). Gradient in the moderate - high range indicates the potential energy to recover from habitat disruptions and to transport and expel fine sediments and thus improve. A moderately wide to wide riparian buffer coupled with an undisturbed stream channel, moderately high gradient and glacial till yielded a diverse and moderately stable stream channel. The habitat was judged to be easily capable of supporting a WWH aquatic biological community and yielded an excellent fish community and a good macroinvertebrate community. Again, cool ground water inflow appeared to have ameliorated the effects of elevated nutrient concentrations.

Frequency and magnitude of recorded bacteria levels were elevated in the Spring Fork watershed. The 90^{th} percentile fecal coliform value of 4014 cfu exceeds the criteria (2000 cfu). *E. coli* levels were also elevated.

<table>
<tr><td colspan="5">Box 2.4.6 Overview of Spring Fork (210-060).</td></tr>
<tr><td>Area (acres)</td><td colspan="4">24,320</td></tr>
<tr><td>Streams</td><td colspan="4">Spring Fork, including Bales Ditch</td></tr>
<tr><td rowspan="3">Point Source Dischargers</td><td>Name</td><td>Permit number</td><td>Design flow (MGD)</td><td>Average flow (MGD)</td></tr>
<tr><td>Monroe Elementary School</td><td>4PT00122</td><td>0.005</td><td>0.004</td></tr>
<tr><td>Green Meadows MHP</td><td>4PV00000</td><td>0.081</td><td>0.114</td></tr>
<tr><td>Land Use</td><td colspan="4">see Figure 2.4.6.1</td></tr>
<tr><td rowspan="4">Aquatic Life Use</td><td>Name</td><td>Designated use</td><td colspan="2">Impairment</td></tr>
<tr><td rowspan="2">Spring Fork</td><td rowspan="2">EWH</td><td colspan="2">Yes - 60% of sites impaired</td></tr>
<tr><td>Deviation</td><td>IBI - 25%
ICI G ➜E</td></tr>
<tr><td>Bales Ditch</td><td>WWH</td><td colspan="2">No</td></tr>
<tr><td rowspan="2">Recreational Use</td><td>Spring Fork</td><td>PCR</td><td colspan="2" rowspan="2">Yes - 90th percentile fecal coliform values exceed maximum criteria (50% deviation). Note: E. coli is elevated as well.</td></tr>
<tr><td>Bales Ditch</td><td>SCR</td></tr>
<tr><td>Antidegradation Category</td><td colspan="3">Spring Fork - Superior High Quality Water</td><td></td></tr>
<tr><td colspan="2">Causes of impairment</td><td colspan="2">Sources of impairment</td><td>Addressed in this TMDL?</td></tr>
<tr><td colspan="2">Sedimentation</td><td colspan="2">Pasture land, habitat disruption, channelization</td><td>√</td></tr>
<tr><td colspan="2">Nutrients</td><td colspan="2">Pasture land, agricultural run-off</td><td>√</td></tr>
<tr><td colspan="2">Low dissolved oxygen</td><td colspan="2">Domestic sewage, pasture land, agricultural run-off</td><td>√</td></tr>
</table>

Table 2.4.6 Habitat Assessment Results for Spring Fork (05060001-210-060)

Stream/River	**River Mile**	Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site: High Influence	Undesirable habitat attributes present at the site: Moderate Influence	Use Attainment Status
05060001-210-060						
Spring Fork (EWH)	15.8	Substrate, channel	60.5	Low sinuosity	Channelized-recovering, hardpan substrate origin, poor pool quality	Impaired
	13.7	Substrate, channel, riparian	62.5	Low sinuosity	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
	13.4	Cover, channel, riparian	53	Low sinuosity, no cover	Hardpan substrate origin, substrate embeddedness	
	10.1	Substrate, riparian	69	None	No fast current, substrate embeddedness	
	7.8	Substrate, channel, riparian	54.5	Low sinuosity, no cover	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
	3.3	Channel, riparian	67.5	None	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	
Bales Ditch (WWH)	0.4	None	70	None	Hardpan substrate origin, poor pool quality	Not Impaired

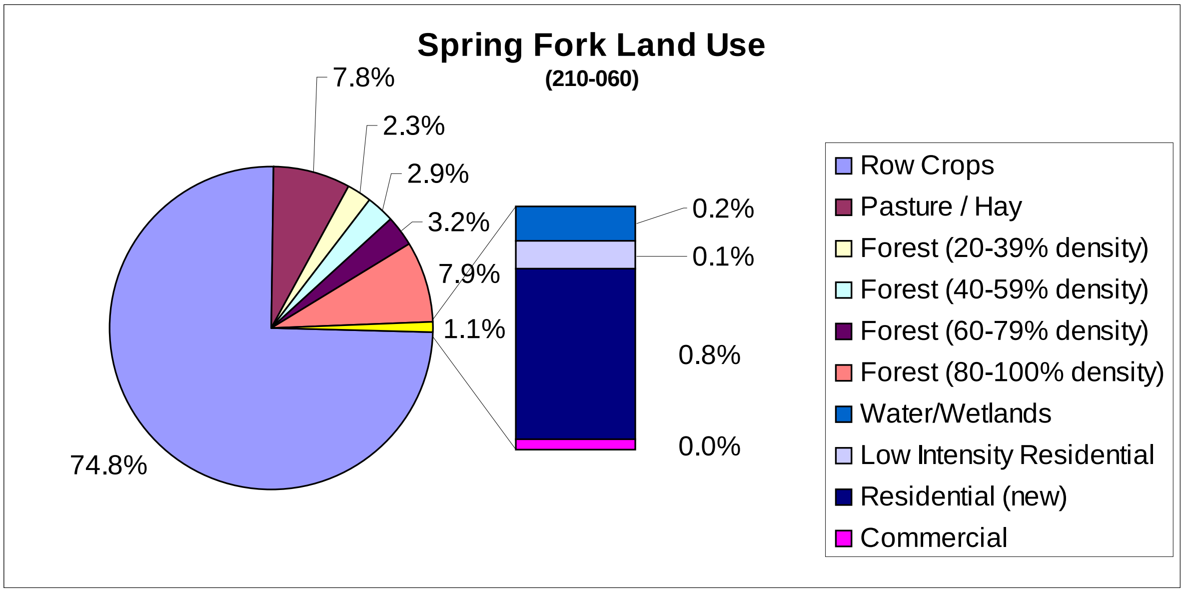


Figure 2.4.6.1. Land use in the Spring Fork minor sub-watershed.

2.4.7 Lower Little Darby Creek (210-070)

The lower Little Darby Creek minor sub-watershed includes the Little Darby Creek mainstem from below Spring Fork to Big Darby Creek.

A description of lower Little Darby Creek is given in Box 2.4.7. Habitat assessment results for lower Little Darby Creek are presented in Table 2.4.7.

Fish community scores in general gradually increased with increasing downstream distance towards the mouth. The major exception to this pattern was the site just upstream from the confluence with Big Darby Creek which is marginally meeting EWH criteria. This site is located in an area that prior to the mid 1990s was impounded by a dam across the mouth of Little Darby Creek. As sediments are flushed and more natural features develop this portion of Little Darby Creek is expected to perform at levels comparable to those found just upstream.

Recreational uses are being attained in lower Little Darby Creek.

Box 2.4.7 Overview of lower Little Darby Creek (210-070).				
Area (acres)	23,514			
Streams	Little Darby Creek, from below Spring Fork to its confluence with Big Darby Creek (RM 17.46 to mouth, RM 0.0).			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Fisher Cast Steel	4ID00001	0.001	n/a
	Jefferson Lodge MHP	4PV00004	0.040	0.047
	Oakwood Acres MHP	4PV00097	0.010	0.006
	B & B Motel	4PV00107	0.0022	0.0014
	West Jefferson WWTP	4PB00024	1.2	0.692
Land Use	see Figure 2.4.7.1			
Aquatic Life Use	**Designated use**	**Impairment**		
	EWH	No		
Recreational Use	Primary Contact	No		
Antidegradation Category	Little Darby Creek - Outstanding State Water			
Endangered species	Clubshell mussel (*Pleurobema clava)*			
Causes and Sources of Impairment	☺ There is no impairment in the lower Little Darby Creek minor sub-watershed.			

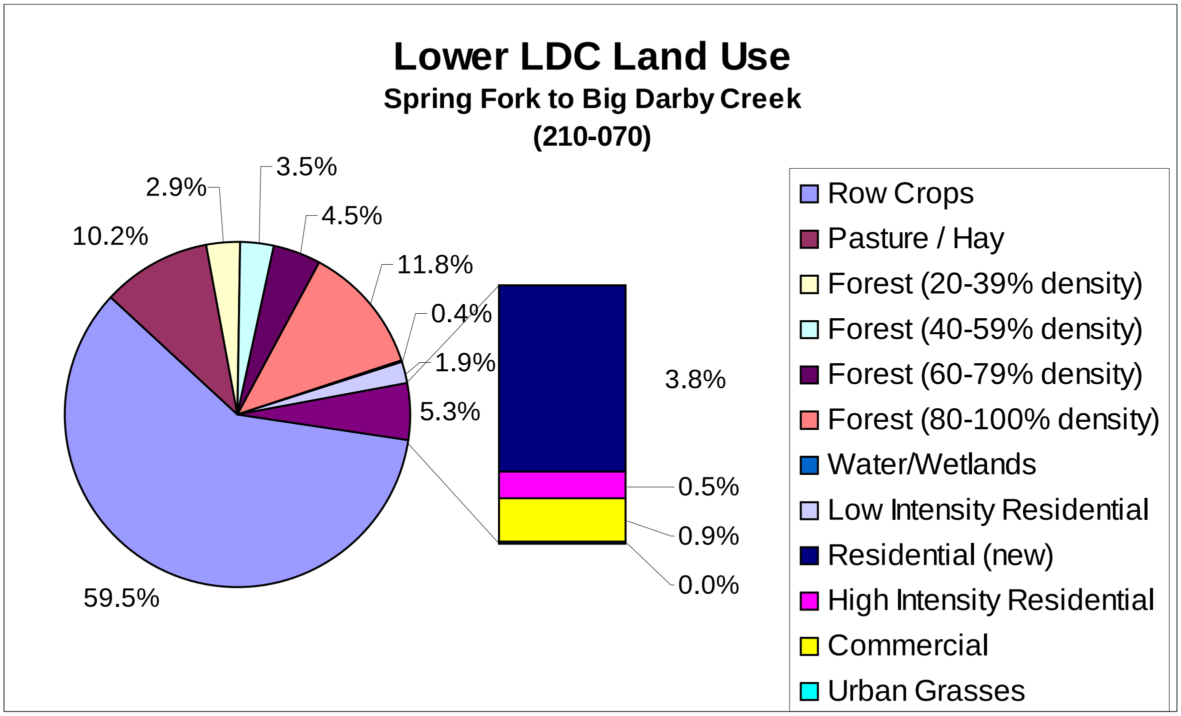


Figure 2.4.7.1. Land use in the lower Little Darby Creek minor sub-watershed.

Table 2.4.7 Habitat Assessment Results for lower Little Darby Creek (05060001-210-017)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-210-070						
Little Darby Creek (EWH)	15.3	None	95.5	None	None	Not impaired
	6.5	None	95.5	None	None	
	4.1	None	99	None	None	
	0.7	Cover, channel	63.5	Low sinuosity, no cover	Hardpan substrate origin, no fast current, substrate embeddedness	
	0.2	Channel	77.5	Low sinuosity	Channelized-recovering, hardpan substrate origin, no fast current, substrate embeddedness	

2.5 Lower Big Darby Creek (05060001 220)

Lower Big Darby Creek is the major sub-watershed that extends from downstream of Little Darby Creek, to Big Darby Creek's confluence with the Scioto River. Within lower Big Darby Creek, the mainstem of Big Darby Creek is in attainment, though there are some areas that are showing signs of stress. Most non-attainment occurs in the minor sub-watershed that includes Hellbranch Run. A map showing aquatic life use attainment is provided in Figure 2.5.1. The condition of the riparian corridor in this major sub-watershed is shown in Figure 2.5.2.

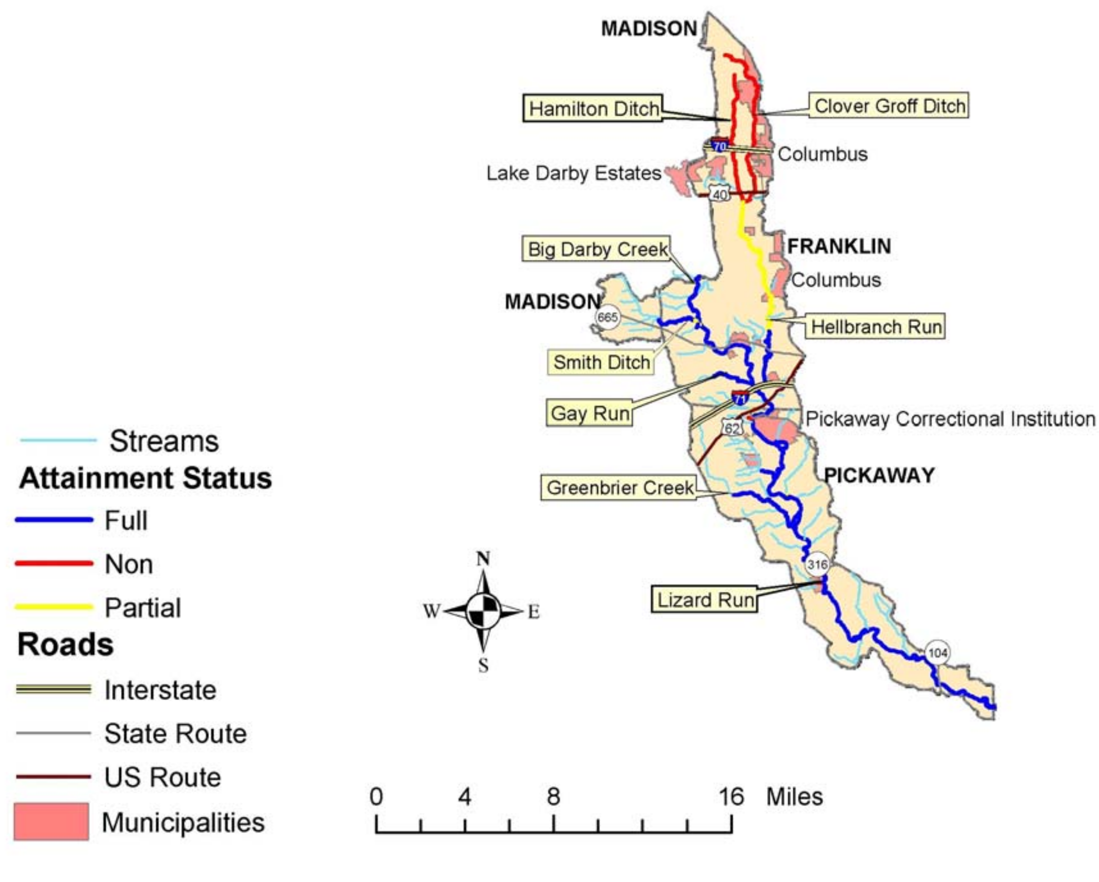


Figure 2.5.1. Aquatic life use attainment in lower Big Darby Creek .

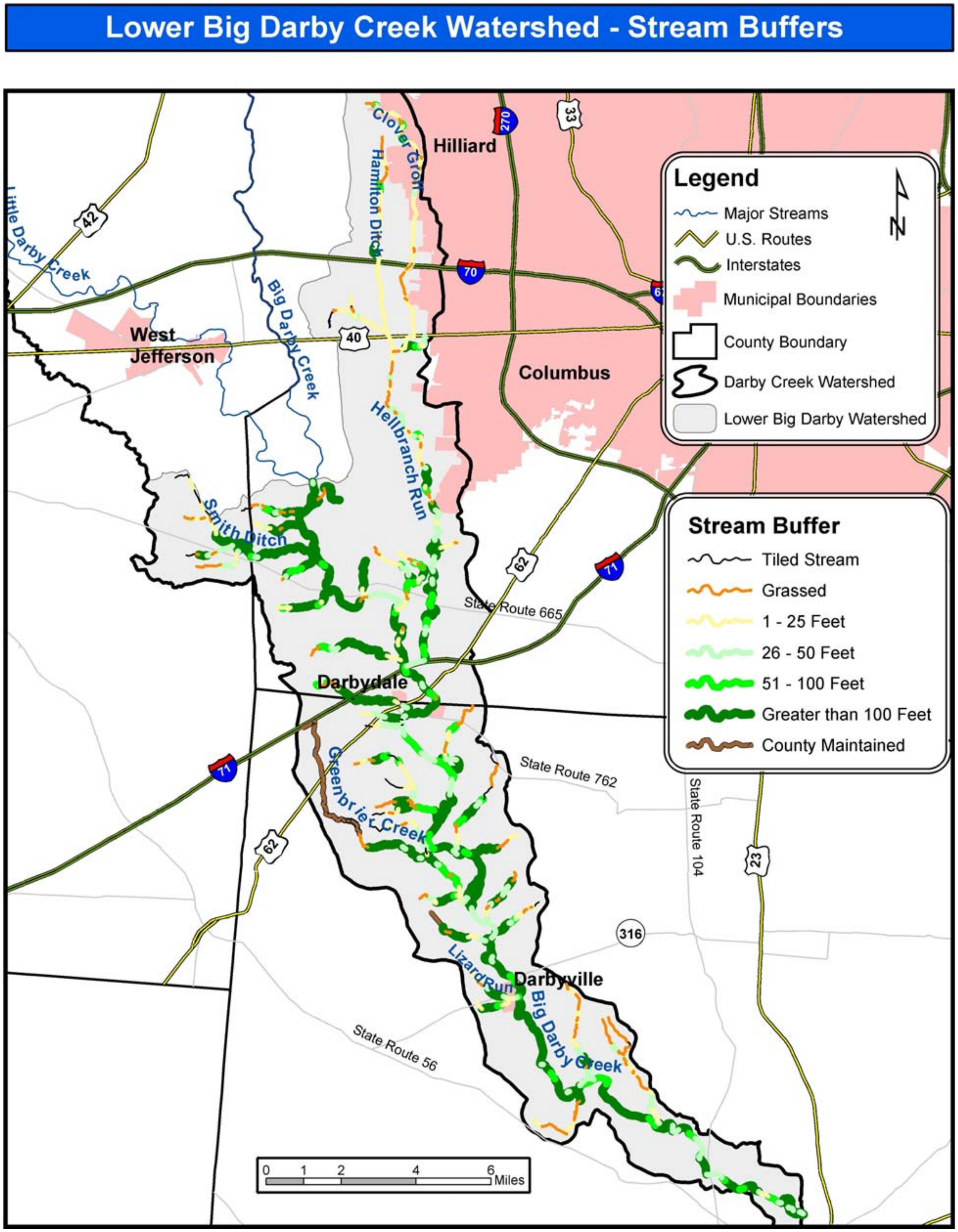


Figure 2.5.2 Status of Riparian Buffers in the lower Big Darby Creek Sub-watershed. Graphics courtesy Ben Webb.

2.5.1 Hellbranch Run (220-010)

The Hellbranch Run minor sub-watershed contains most of the impaired waters in the lower Big Darby Creek major sub-watershed. A description of Hellbranch Run in given in Box 2.5.1. Habitat assessment results are given in Table 2.5.1.

<table>
<tr><th colspan="5">Box 2.5.1 Overview of Hellbranch Run (220-010).</th></tr>
<tr><td>Area (acres)</td><td colspan="4">24,180</td></tr>
<tr><td>Streams</td><td colspan="4">Hellbranch Run, including Hamilton Ditch and Clover Groff Ditch.</td></tr>
<tr><td rowspan="10">Point Source Dischargers</td><td>Name</td><td>Permit number</td><td>Design Flow (MGD)</td><td>Average flow (MGD)</td></tr>
<tr><td rowspan="2">Alton Campground</td><td>4PX00041</td><td>0.0032</td><td>0.0011</td></tr>
<tr><td colspan="3">Receiving stream: Hamilton Ditch</td></tr>
<tr><td rowspan="2">Thornapple Country Club</td><td>4PX00029</td><td>0.002</td><td>0.0004</td></tr>
<tr><td colspan="3">Receiving stream: Clover Groff Ditch</td></tr>
<tr><td rowspan="2">Cypress Wesleyan School</td><td>4PJ00115</td><td>0.002</td><td>n/a</td></tr>
<tr><td colspan="3">Receiving stream: Clover Groff Ditch</td></tr>
<tr><td>Oakhurst Knolls</td><td>4PH00000</td><td>0.100</td><td>0.070</td></tr>
<tr><td>Pleasantview School</td><td>4PT00106</td><td>0.020</td><td>0.0125</td></tr>
<tr><td>Lakeland Utilities, Timberlake</td><td>4PU00003</td><td>0.050</td><td>0.052</td></tr>
<tr><td>Land Use</td><td colspan="4">see Figure 2.5.1.1</td></tr>
<tr><td rowspan="10">Aquatic Life Use</td><td>Name</td><td>Designated use</td><td colspan="2">Impairment</td></tr>
<tr><td rowspan="4">Hellbranch Run</td><td rowspan="2">WWH</td><td colspan="2">Yes - 100% of sites impaired</td></tr>
<tr><td>Deviation</td><td>IBI - 25%
MIwb - 26%</td></tr>
<tr><td rowspan="2">EWH</td><td colspan="2">Yes - 33% of sites impaired</td></tr>
<tr><td>Deviation</td><td>IBI - 22%</td></tr>
<tr><td rowspan="3">Clover Groff Ditch</td><td rowspan="2">MWH</td><td colspan="2">Yes - 100% of sites impaired</td></tr>
<tr><td>Deviation</td><td>IBI - 55%
ICI - VP ➜ F</td></tr>
<tr><td>WWH</td><td colspan="2">Yes - 100% of sites impaired</td></tr>
</table>

			Deviation	IBI - 43% ICI - 80%
	Hamilton Ditch	MWH	**Yes** - 100% of sites impaired	
			Deviation	IBI - 75%
		WWH	**Yes** - 100% of sites impaired	
			Deviation	IBI - 67%
Recreational Use		PCR	**Yes** - 90^{th} percentile fecal coliform values exceed maximum criteria.	
Antidegradation Category	Hellbranch Run - Superior High Quality Water - Kropp Rd. to mouth.			
Applicable 208 Plan	Central Scioto Plan Update (CSPU)			
Causes of impairment		**Sources of impairment**		**Addressed in this TMDL?**
Low dissolved oxygen		Ground water, septic systems, package plants		√
Nutrients		Septic systems, rowcrop agriculture, suburban run-off, package plants		√
Unionized ammonia		Package plants, septic systems		√
Siltation		Construction, hydromodification		√
Sediment metals		unknown source		no

Biological condition at the three upstream sites of Hellbranch Run, although improved from values recorded at the downstream sites in its source tributaries (Hamilton and Clover Groff Ditches), still only marginally and partially met WWH criteria. Habitat quality was obviously a factor in the suppressed performance at the upstream site with a QHEI of only 39.5 recorded there. Habitat quality in general improved with downstream distance and quickly became less of a factor. The improved biological performance did indicate an improved water quality condition and perhaps ground water augmentation given that the biological performance was higher than the improved habitat would normally deliver. The presence of mottled sculpins, an obligate coldwater taxa, not only here but in increased numbers at all sites downstream support this observation. However, there were water column indications of modest nutrient enrichment which extend at least downstream to RM 5.8, downstream from the Oakhurst Knolls WWTP.

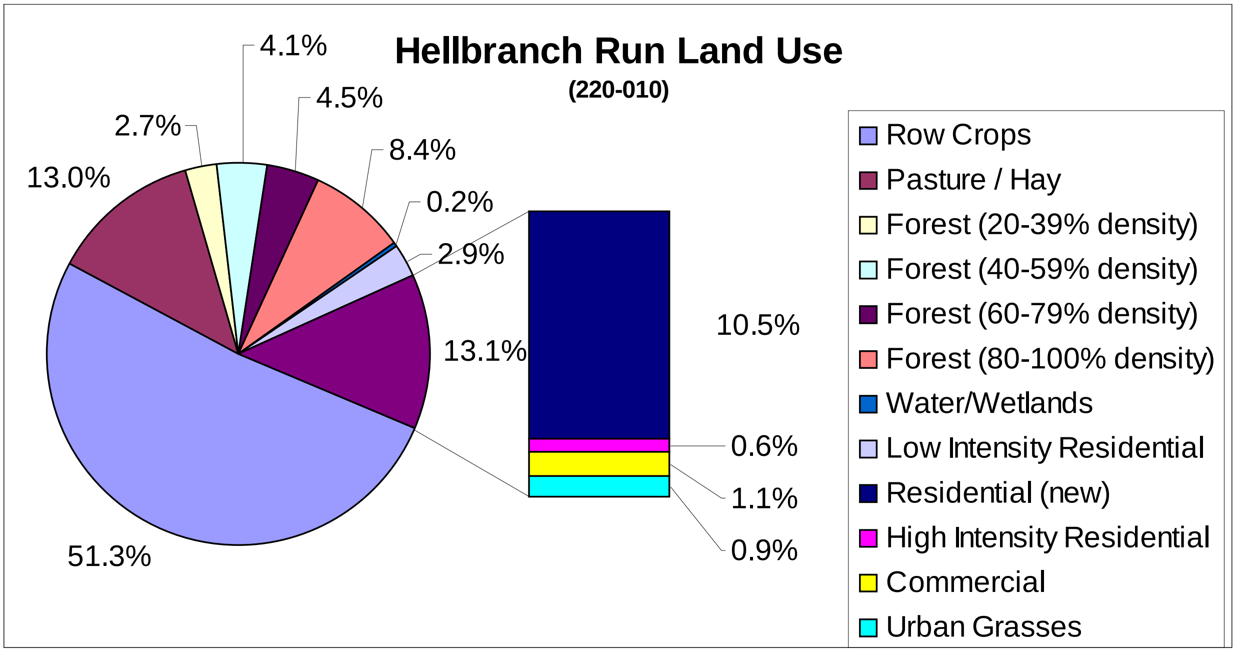


Figure 2.5.1.1. Land use in the Hellbranch Run minor sub-watershed.

Habitat quality in the lower five miles of Hellbranch Run exceeds that necessary to support Exceptional Warmwater Habitat biological communities and marginally meets those criteria at RM 3.7 and 1.0. Hellbranch Run partially attains the EWH use at RM 0.5, downstream from the Timberlake WWTP. This WWTP has a history of operational problems and consistently violates permit limits with sludge frequently detected in stream and very high ammonia concentrations and other nutrient parameters in evidence. The influent to this WWTP is being redirected to a regional WWTP by 2005, which should lead to significant improvement in the lower reach of Hellbranch Run.

Hamilton Ditch and Clover Groff Ditch are both severely impaired in their headwaters with very slight improvement with downstream distance. Hamilton Ditch is the more rural western tributary forming Hellbranch Run. Upstream adverse influences include historical channelization that has resulted in very poor instream habitat. The straightening of the channel has greatly reduced habitat diversity and increased entrenchment, which is particularly harmful because the streambed's low gradient has trapped sediment within the stream channel. Recently, residential construction run-off is delivering silt from sites with inadequate storm water BMPs. Significant suppression of the instream biological community would be expected with the poor habitat but not to the levels evident here. This indicates that poor water quality was contributing to the toxic response observed. Hamilton Ditch was documented to be extremely nutrient enriched with ammonia, TKN and total phosphorus in the 90 to 95th percentile versus ecoregional (ECBP) background concentrations. This enrichment resulted from a mix of agricultural and residential sources.

Table 2.5.1 Habitat Assessment Results for Hellbranch Run (05060001-220-010)

Stream/River	River Mile	Assessment Results: Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site: High Influence	Undesirable habitat attributes present at the site: Moderate Influence	Use Attainment Status
05060001-220-010						
Hellbranch Run (WWH[1]/EWH)	10.3[1]	Substrate, cover, channel, pool, riffle, gradient	39.5	Silt/muck substrates, low sinuosity, no cover	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Impaired
	7.4[1]	Cover, channel	51	Low sinuosity, no cover	Channelized-recovering, hardpan substrate origin, poor pool quality, substrate embeddedness	
	5.8[1]	Channel	65.5	Low sinuosity, no cover	Hardpan substrate origin, poor pool quality, substrate embeddedness	
	3.7	None	83.5	None	None	Not impaired
	1	None	84.5	Low sinuosity	None	
	0.5	None	83.5	None	None	
Clover Groff Ditch (MWH/ WWH[1])	4.7	Not applicable to MWH	22	Channelized-no recovery, silt/muck substrates, low sinuosity, no cover, max. pool depth <40 cm	Hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired
	0.8[1]	Channel	61.5	Low sinuosity	Channelized-recovering, hardpan substrate origin, no fast current, substrate embeddedness	
Hamilton Ditch (MWH/ WWH[1])	3.4	Not applicable to MWH	21	Channelized-no recovery, silt/muck substrates, low sinuosity, no cover, max. pool depth <40 cm	Poor channel development, no fast current, poor pool quality, substrate embeddedness, riffle embeddedness,	Impaired
	0.5[1]	Substrate, cover, channel, riparian, pool, riffle, gradient	36.5	Channelized-no recovery, silt/muck substrates, low sinuosity, no cover, max. pool depth <40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness,	

[1] Denotes a Warm Water Habitat (WWH) use.

Clover Groff Ditch is the easternmost tributary and is being encroached upon by Hilliard and metropolitan Columbus. Clover Groff Ditch has also been channelized historically with accumulated sediment trapped in the modified, entrenched channel. These sediment deposits cover the mostly rocky substrates and have neutralized most of the habitat. Sedimentation has become a more pronounced problem in recent years due to inadequate implementation of construction site erosion control BMPs. Gray septic storm water inputs from the adjacent suburban area as well as inadequately treated sewage have collectively caused enriched conditions that were likely periodically toxic. Supporting this conclusion were measured concentrations of ammonia, nitrite and total phosphorus in the 90 to 95th percentile range of ecoregional (ECBP) background conditions. Fecal coliform counts were also elevated.

The Hellbranch Run watershed (220-010) collectively exceeds fecal coliform criteria (2000 cfu) with a 90th percentile value of 2058 cfu. However, if individual tributaries are examined, Clover Groff Ditch significantly exceeds the criteria with a 90th percentile value of 5266 cfu. Hamilton Ditch exceeds average criteria (1000 cfu) with a value of 1661 cfu, as well as maximum criteria with a value of 4633 cfu. Hellbranch Run on the other hand meets the criteria. Efforts at reduction of bacteria should focus on Clover Groff Ditch and Hamilton Ditch.

2.5.2 Upper Lower Big Darby Creek (220-020)

The upper lower Big Darby Creek minor sub-watershed extends from below Little Darby Creek to above Hellbranch Run. A description of upper lower Big Darby Creek is included as Box 2.5.2.

All sites sampled on the mainstem of Big Darby Creek fully met all applicable biocriteria within this major sub-watershed. There were, however, indications that certain segments are currently under stress and starting to decline.

A short distance downstream from the community of Darbydale nutrient enrichment and low dissolved oxygen have led to several negative macroinvertebrate community attributes including a 300% increase in relative abundance, a 20% drop in sensitive EPT taxa, and the disappearance of viable bivalves. Construction of the planned Darbydale WWTP should eliminate this problem by incorporating all of the existing septic systems and unsewered portions of Darbydale as well as several small package WWTPs. Due to the potential for construction of WWTPs to foster increased development and higher population density the Darbydale WWTP service area has been delineated to keep these problems in check. Ensuring optimum performance of this WWTP will be important to maintaining the very high quality nature of this portion of Big Darby Creek.

Smith Ditch is a high quality direct tributary to Big Darby Creek. Field notes indicate that this site should have been a classic good intermittent stream with very deep pools, strong ground water influence and a wooded riparian corridor. The low number of fish at the downstream site was noteworthy with low D.O. from groundwater a suspected source.

<table>
<tr><th colspan="6">Box 2.5.2 Overview of upper lower Big Darby Creek (BDC6, 220-020).</th></tr>
<tr><td>Area (acres)</td><td colspan="5">16,040</td></tr>
<tr><td>Streams</td><td colspan="5">Big Darby Creek, below Little Darby Creek to above Hellbranch Run (RM 34.1 to RM 26.2), including Smith Ditch, unnamed tributary to Smith Ditch and Gay Run.</td></tr>
<tr><td rowspan="6">Point Source Dischargers</td><td>Name</td><td>Permit number</td><td>Design flow (MGD)</td><td colspan="2">Average flow (MGD)</td></tr>
<tr><td>Oak Hills MHP</td><td>4PV00008</td><td>0.069</td><td colspan="2">0.100</td></tr>
<tr><td>Darbydale Elementary</td><td>4PT00105</td><td>0.0075</td><td colspan="2">0.0075</td></tr>
<tr><td>Pleasant Acres MHP</td><td>4PV00101</td><td>0.039</td><td colspan="2">0.038
Planned to tie into new Darbydale Plant</td></tr>
<tr><td>Community Gardens MHP</td><td>4PV00015</td><td>0.030</td><td colspan="2">0.0143
Planned to tie into new Darbydale Plant</td></tr>
<tr><td>Darbydale WWTP</td><td>4PH00012</td><td></td><td colspan="2">Under Construction</td></tr>
<tr><td>Land Use</td><td colspan="5">see Figure 2.5.2.1.</td></tr>
<tr><td rowspan="6">Aquatic Life Use</td><td colspan="2">Name</td><td>Designated use</td><td colspan="2">Impairment</td></tr>
<tr><td colspan="2">Big Darby Creek</td><td>EWH</td><td colspan="2">No</td></tr>
<tr><td colspan="2" rowspan="2">Smith Ditch</td><td rowspan="2">EWH</td><td colspan="2">Yes - 50% of sites impaired</td></tr>
<tr><td>Deviation</td><td>IBI -78%</td></tr>
<tr><td colspan="2">Unnamed Tributary to Smith Ditch</td><td>EWH</td><td colspan="2">No</td></tr>
<tr><td colspan="2">Gay Run</td><td>WWH</td><td colspan="2">No</td></tr>
<tr><td>Recreational Use</td><td colspan="2">All</td><td>PCR</td><td colspan="2">No</td></tr>
<tr><td>Antidegradation Category</td><td colspan="5">Big Darby Creek - Outstanding State Water</td></tr>
<tr><td colspan="2">Causes of impairment</td><td colspan="2">Sources of impairment</td><td colspan="2">Addressed in this TMDL?</td></tr>
<tr><td colspan="2">Low dissolved oxygen</td><td colspan="2">groundwater</td><td colspan="2">no</td></tr>
</table>

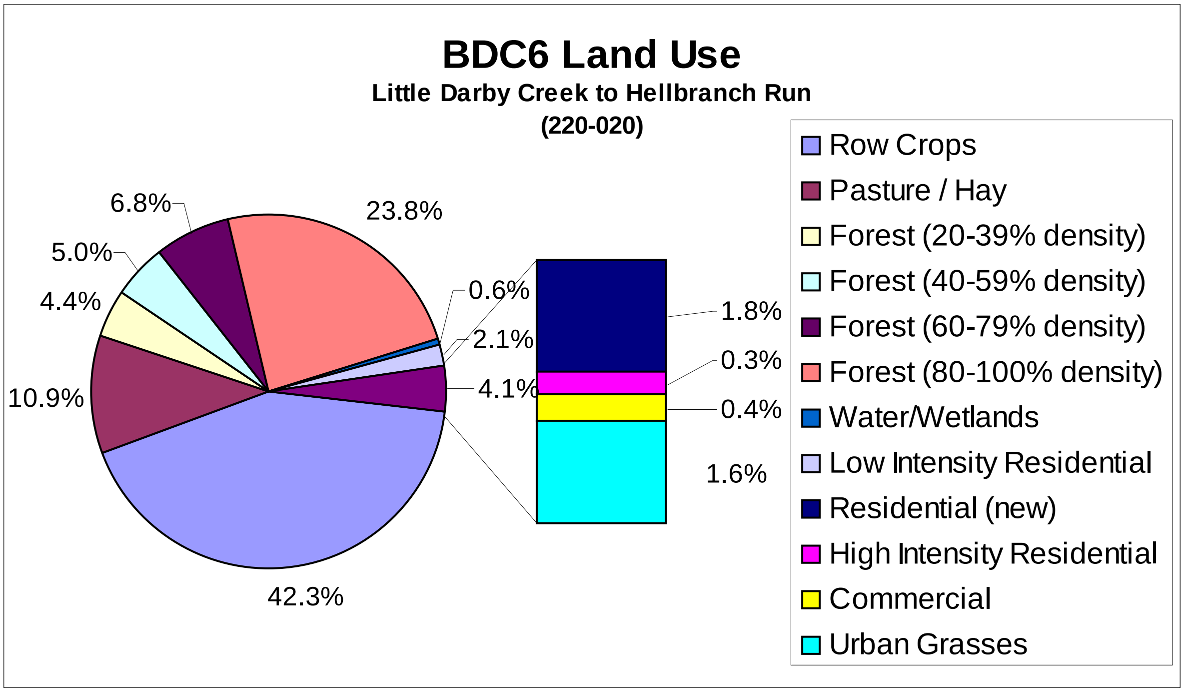


Figure 2.5.2.1. Land use in the upper lower Big Darby Creek minor sub-watershed.

Table 2.5.2 Habitat Assessment Results for upper lower Big Darby Creek (05060001-220-020)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-220-020						
Big Darby Creek (EWH)	29.1	None	86	None	None	Not Impaired
Gay Run (WWH)	2.2	Pool, riffle, gradient	66.5	None	No fast current, substrate embeddedness	Not Impaired
Smith Ditch (EWH)	2.1	None	77.5	None	Poor pool quality, no fast current, substrate embeddedness	Impaired
	0.3	Pool, riffle, gradient	73	None	1 or 2 cover types, poor pool quality, riffle embeddedness	
UT to Smith Ditch (EWH)	0.2	Pool, riffle, gradient	67	No cover	Poor pool quality, no fast current	Not Impaired

2.5.3 Middle Lower Big Darby Creek (220-030)

The middle lower Big Darby Creek minor sub-watershed extends from below Hellbranch Run to Darbyville. A description of middle lower Big Darby Creek is given in Box 2.5.3.

<table>
<tr><th colspan="7">Box 2.5.3 Overview of middle lower Big Darby Creek (BDC7, 220-030).</th></tr>
<tr><td>Area (acres)</td><td colspan="6">25,099</td></tr>
<tr><td>Streams</td><td colspan="6">Big Darby Creek, from below Hellbranch Run to Darbyville (RM 26.1 to RM 13.1), including Springwater Run, unnamed tributaries to Big Darby Creek at RM 23.77, 20.2, and 18.41, Greenbrier Creek and Georges Run.</td></tr>
<tr><td rowspan="7">Point Source Dischargers</td><td>Name</td><td>Permit number</td><td colspan="3">Design flow (MGD)</td><td>Average flow (MGD)</td></tr>
<tr><td>Dot-Mar MHP</td><td>4PV00100</td><td colspan="3">0.004</td><td>0.006</td></tr>
<tr><td>Pickaway Correctional Institute</td><td>4PP00003</td><td colspan="3">2.340</td><td>0.903</td></tr>
<tr><td rowspan="2">Foxlair Farms</td><td>4PV00007</td><td colspan="3">0.050</td><td>0.042</td></tr>
<tr><td colspan="5">Receiving stream: UT to BDC @ RM 20.2</td></tr>
<tr><td rowspan="2">Clark’s Lake Subdivision</td><td>4PG00014</td><td colspan="3">0.100</td><td>not reported</td></tr>
<tr><td colspan="5">Receiving stream: UT to BDC @ RM 20.2</td></tr>
<tr><td>Land Use</td><td colspan="6">see Figure 2.5.3.1.</td></tr>
<tr><td rowspan="11">Aquatic Life Use</td><td colspan="2">Name</td><td>Designated use</td><td colspan="3">Impaired</td></tr>
<tr><td colspan="2">Big Darby Creek</td><td>EWH</td><td colspan="3">No</td></tr>
<tr><td colspan="2" rowspan="2">Springwater Run</td><td rowspan="2">WWH</td><td colspan="3">Yes - 100% of sites impaired</td></tr>
<tr><td colspan="2">Deviation</td><td>ICI F ➜ G</td></tr>
<tr><td rowspan="4">Unnamed Tributary to BDC RM:</td><td rowspan="2">23.77</td><td rowspan="2">WWH</td><td colspan="3">Yes - 100% of sites impaired</td></tr>
<tr><td colspan="2">Deviation</td><td>IBI - 33%</td></tr>
<tr><td>20.2</td><td>WWH</td><td colspan="3">No</td></tr>
<tr><td>18.41</td><td>WWH</td><td colspan="3">No</td></tr>
<tr><td colspan="2">Greenbrier Creek</td><td>WWH</td><td colspan="3">No</td></tr>
<tr><td colspan="2">Georges Run</td><td>WWH</td><td colspan="3">No</td></tr>
</table>

Box 2.5.3 Overview of middle lower Big Darby Creek (BDC7, 220-030).				
Recreational Use	Big Darby Creek		PCR	No
	Springwater Run		PCR	
	Unnamed Tributary to BDC RM	23.77 -	SCR	
		20.2	PCR	
		18.41	SCR	
	Greenbrier Creek		PCR	
	Georges Run		SCR	
Antidegradation Category	Big Darby Creek - Outstanding State Water			Ecological
Causes of impairment	**Sources of impairment**			**Addressed in this TMDL?**
Low dissolved oxygen	Septic systems, package plants			√
Nutrients	Septic systems, rowcrop agriculture, suburban run-off, package plants			√
Siltation	Construction, hydromodification			√

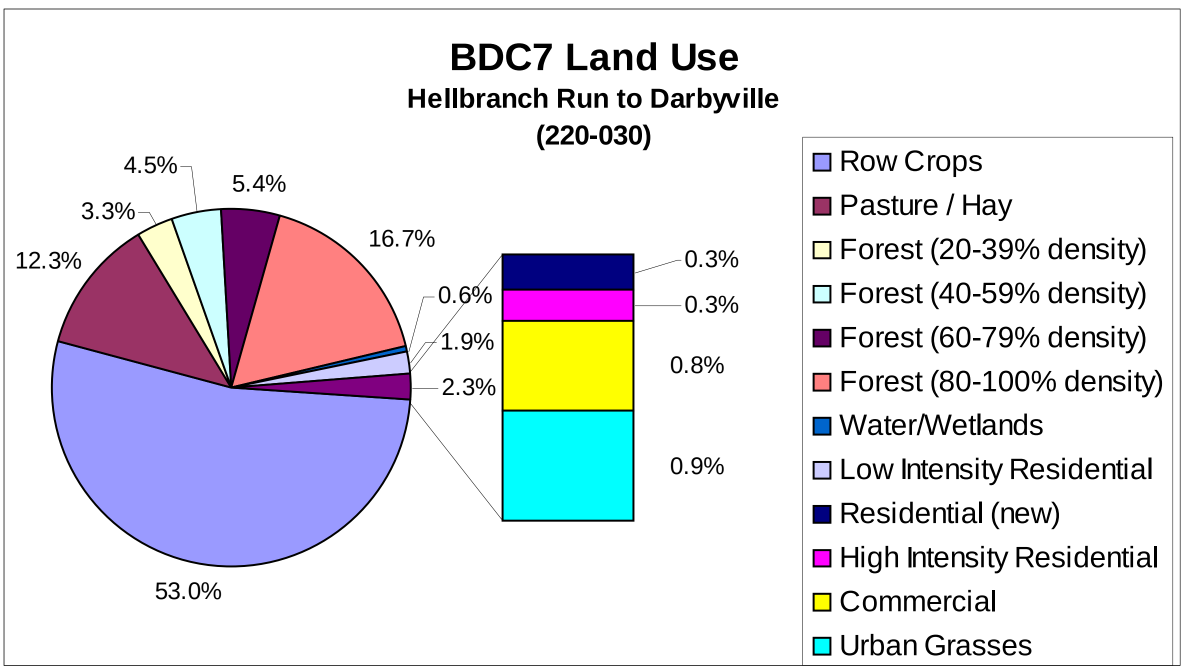


Figure 2.5.3.1. Land use in the middle lower Big Darby Creek minor sub-watershed.

Table 2.5.3 Habitat Assessment Results for middle lower Big Darby Creek (05060001-220-030)

Stream/River	**River Mile**	Assessment Results: Habitat metrics that are not meeting target values at the site	Assessment Results: QHEI	Assessment Results: Undesirable habitat attributes present at the site: High Influence	Assessment Results: Undesirable habitat attributes present at the site: Moderate Influence	Use Attainment Status
05060001-220-030						
Big Darby Creek (EWH)	26.1	None	94.5	None	None	Not impaired
	23.8	None	87.5	None	Substrate embeddedness	
	22.8	None	84.5	None	Substrate embeddedness	
	18.7	None	85	None	Substrate embeddedness	
	15.7	None	88.5	None	None	
	13.4	None	85.5	None	Substrate embeddedness	
Georges Run (WWH)	0.9	Substrate, riparian	61	None	Poor pool quality, no fast current, substrate embeddedness	Not Impaired
Greenbrier Creek (WWH)	2.7	Pool, riffle, gradient	57	None	Sand substrate, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Not Impaired
	1.3	None	74.5	None	Sand substrate, hardpan substrate origin, poor pool quality, no fast current	
Springwater Run (WWH)	0.8	Cover, channel, riparian, pool, riffle, gradient	48.5	Low sinuosity, no cover, max. pool depth < 40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired
UT to Big Darby Creek (RM 23.77) (WWH)	0.1	Cover, pool, riffle, gradient	61.5	Low sinuosity, max. pool depth < 40 cm	hardpan substrate origin, poor pool quality, riffle embeddedness	Impaired
UT to Big Darby Creek (RM 20.20) (WWH)	0.8	None	77.5	None	No fast current, substrate embeddedness	Not Impaired
UT to Big Darby Creek (RM 18.41) (WWH)	0.1	Substrate, cover, channel, pool, riffle, gradient	52.5	Low sinuosity, no cover, max. pool depth < 40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Not Impaired

The extremely high quality habitat downstream from the confluence with Hellbranch Run appeared to have ameliorated most of the impacts that would be expected downstream from this tributary. There was a slight decline in the ICI and, while the IBI recorded was 54, there was a noteworthy decline in the number of sucker species and overall numerical abundance. Elimination of the Timberlake WWTP, which is currently the main source of impairment in lower Hellbranch Run, should improve this situation.

Conditions appear to have improved downstream from the PCI WWTP in recent years. However, when last sampled in 1997 fish communities posted significant declines downstream from the PCI WWTP. The WWTP was routinely operating above design flow between 1988 and 1998, which had led to increased pollutant loadings to this segment of Big Darby Creek and the subsequent biological impairment. Recent upgrades and process improvements at the PCI WWTP have led to much improved treatment, lowered loadings and much improved biological performance. With the planned expansion of this facility and the elimination of several package plants and diversion of their sewage to PCI, the loadings from this plant are expected to increase, while the overall loadings to the stream will decrease. Ensuring optimum performance of the PCI WWTP as the expected changes occur will be important to the very high quality of the receiving stream and protection of sensitive and endangered organisms downstream.

Springwater Run is the small tributary draining Harrisburg. Downstream from town, channelization and nutrient enrichment have led to low dissolved oxygen levels and algal productivity which is impacting the benthic macroinvertebrates. Harrisburg is currently investigating options for dealing with domestic sewage and should eliminate most of the nutrient inputs to Springwater Run

The unnamed tributary to Big Darby Creek at RM 23.77 is believed to be a naturally intermittent stream that dries out after freshets as a result of the underlying alluvial geologic deposits which have resulted in it being a losing stream.

The unnamed tributary to Big Darby Creek RM 20.2 is fully meeting its recommended use, however, the elimination of effluent from the Clark’s Lake Subdivision, Dot Mar MHP WWTP, and Foxlair Farms WWTP should improve water quality to the point that biological communities would meet the criteria for EWH based on the instream habitat potential.

The unnamed tributary to Big Darby Creek at RM 18.41 has habitat that was judged suitable for supporting WWH communities even though it is in a state of partial recovery from past channelization and wood removal. Sedimentation and some nutrient enrichment are still affecting macroinvertebrate communities. Habitat improvement will help support improved biological quality.. Nonpoint source run-off (agriculture, pasture, a golf course) was the source of excess sediment and nutrients.

Natural stream dessication in Greenbrier Creek associated with the underlying alluvial deposits yielded poor macroinvertebrate results in 2001 at RM 1.1. However, both sites upstream in 2001 and 2002 met biocriteria.

Recreational uses are being attained in this minor sub-watershed.

2.5.4 Lower Lower Big Darby Creek (220-040)

The lower lower Big Darby Creek minor sub-watershed extends from Darbyville down to the confluence of the Scioto River and Big Darby Creek. A description of lower lower Big Darby Creek is given in Box 2.5.4.

<table>
<tr><th colspan="6">Box 2.5.4 Overview of lower lower Big Darby Creek (BDC8, 220-040).</th></tr>
<tr><td>Area (acres)</td><td colspan="5">14,038</td></tr>
<tr><td>Streams</td><td colspan="5">Big Darby Creek, from Darbyville to the Scioto River (RM 13.0 to mouth, RM 0.0), including Lizard Run.</td></tr>
<tr><td>Point Source Dischargers</td><td colspan="5">none</td></tr>
<tr><td>Land Use</td><td colspan="5">see Figure 2.5.4</td></tr>
<tr><td rowspan="4">Aquatic Life Use</td><td colspan="2">Name</td><td>Designated use</td><td colspan="2">Impairment</td></tr>
<tr><td colspan="2">Big Darby Creek</td><td>EWH</td><td colspan="2">No</td></tr>
<tr><td colspan="2" rowspan="2">Lizard Run</td><td rowspan="2">LRW</td><td colspan="2">Yes - 100% of sites impaired</td></tr>
<tr><td>Deviation</td><td>ICI VP ➜G</td></tr>
<tr><td rowspan="2">Recreational Use</td><td colspan="2">Big Darby Creek</td><td>PCR</td><td colspan="2" rowspan="2">No</td></tr>
<tr><td colspan="2">Lizard Run</td><td>SCR</td></tr>
<tr><td>Antidegradation Category</td><td colspan="5">Big Darby Creek - Outstanding State Water</td></tr>
<tr><td colspan="2">Causes of impairment</td><td colspan="3">Sources of impairment</td><td>Addressed in this TMDL?</td></tr>
<tr><td colspan="2">Low dissolved oxygen</td><td colspan="3">Ground water</td><td>no</td></tr>
</table>

Conspicuous algal mats observed in recent years at locations where the stream canopy has permitted sunlight to reach the water's surface suggest that lower Big Darby Creek is being subjected to increasing nutrient loads. Additionally, changes in hydrology have resulted in destabilization of the streambed making it hostile to bivalve molluscs, as documented in 2001/2002. See the macroinvertebrate and fish discussions in Sections B.7 and B.8 of the TSD (Ohio EPA, 2004), respectively, for specific details.

Lizard Run is a small stream that was found to be dry even after a recent rain and must flow only during significant precipitation events. The underlying alluvial deposits make it a losing stream.

Recreational uses are being attained in this minor sub-watershed.

Table 2.5.4 Habitat Assessment Results for lower lower Big Darby Creek (05060001-220-040)

Stream/River	**River Mile**	**Assessment Results**				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-220-040						
Big Darby Creek (EWH)	10.4	None	85	None	No fast current, substrate embeddedness	Not Impaired
	8.4	Channel	69.5	None	Channelized-recovering, no fast current, substrate embeddedness	
	3.1	None	82	None	No fast current, substrate embeddedness	
	0.3	Substrate, riparian	71.5	None	No fast current, substrate embeddedness	

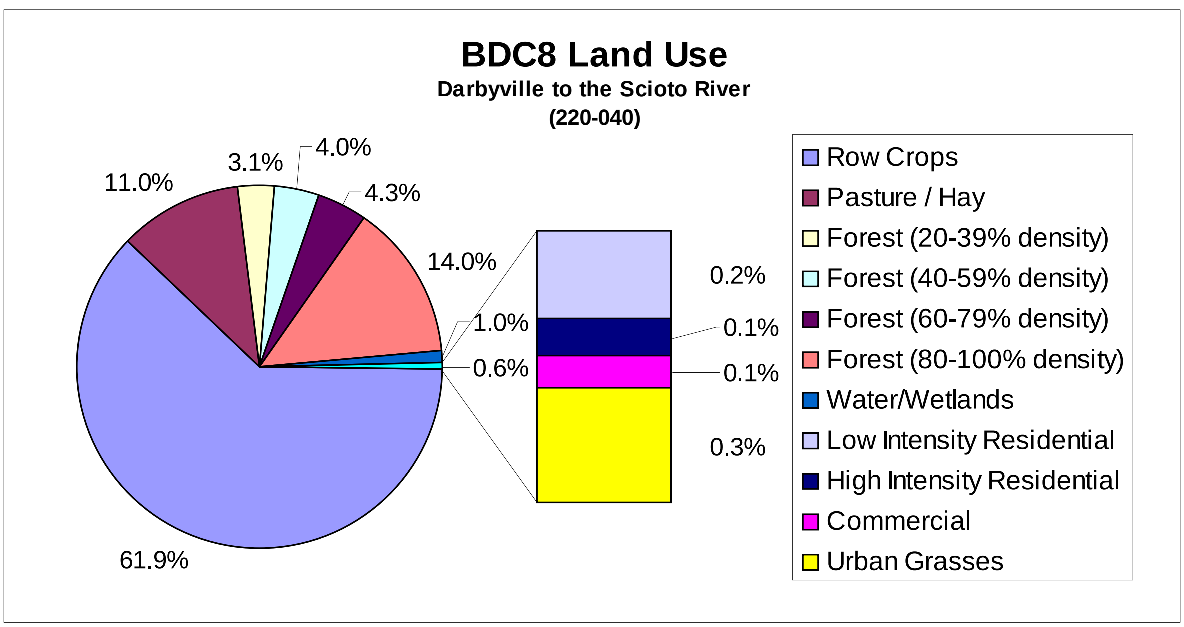


Figure 2.5.4.1. Land use in the lower lower Big Darby Creek minor sub-watershed.

3.0 Description of Watershed Analysis

The goal of the TMDL process is attainment of water quality standards, which include the beneficial uses appropriate for each waterbody. A step in this process is an in-depth watershed analysis which forges the links between the identified impairments and the actions needed to address them. Factors that cause impairment are varied; generally, they can be grouped as either pollutant loads to a stream or as unfavorable environmental conditions within the water or stream corridor (e.g., low in-stream dissolved oxygen or poor habitat quality). Although the TMDL process was originally designed to only address pollutant loading, ultimately its purpose is to bring a water resource into attainment of its beneficial use designations. The beneficial uses in Ohio include aquatic life use designations, and these generally require in-stream conditions as well as pollutant loadings be addressed to achieve full attainment. Indeed, without consideration of other impairing factors, even extreme limitations on pollutants may not result in attainment of beneficial uses. The attainment of aquatic life uses is a goal of this TMDL report and both loading and in-stream conditions are included.

The analysis of the load-based factors entails determination of the *existing load*, calculation of the *loading capacity*, and the *allocation* of the allowable load to each source. The *existing load* is the quantity of a pollutant that is received by a waterbody from all significant sources (e.g. runoff and discharges from pipes to the stream) prior to TMDL implementation. The *loading capacity* is the quantity of a pollutant that a waterbody can receive and achieve in-stream water quality criteria and targets. This is known as the allowable load. *Allocation* involves the distribution of the total allowable load among the various load sources within the watershed.

The analysis of the environmental in-stream conditions (e.g. habitat degradation) follows a similar pattern. The existing condition and the characteristics associated with it (e.g. channel form or sediment quality) are evaluated. A desired state of the condition (the allowable or target condition) is determined which, if achieved, will move the resource towards attainment of its use designation. Determination of the optimal levels, types, or interactions of each of the characteristics associated with the condition being evaluated is similar to the allocation of allowable load described above.

Modeling methods based on mathematical equations and qualitative relationships are generally used for these analyses. The load that a waterbody receives can be calculated using empirically based formulas and data specific to the landscape. The reactions these pollutants undergo in a waterbody have been extensively studied by the scientific community and can be calculated using equations based on this research and in-stream data. However, existing conditions for physically based, non-load factors such as habitat, channel form, and location of active flood plain are difficult to simulate; therefore, an evaluation of these rely mainly on observed data.

The Big Darby Creek watershed analyses are described in this chapter. The impairments addressed and their interactions are discussed in Section 3.1. Targets for the impairing causes are presented in Section 3.2. An overview of the methods used in the watershed analyses is given in Section 3.3.

3.1 Linking the Biological Assessment, Watershed Characteristics, and In-stream Criteria: a Roadmap to Navigate How to Get from Impairment to Attainment

A stream becomes impaired when its capacity to handle stressors is exceeded. This occurs when the external inputs to the stream become excessive, or when the stream characteristics are altered so that it can no longer assimilate these stresses without harm to the aquatic life, or a combination of these occur. The way to get from impairment to attainment is to reverse these changes so that both the external inputs and the stream's ability to handle them are in balance. The challenge for watershed planners and stakeholders to determine how this balance can be achieved in concert with other considerations. Increasing the ability of the stream to handle load may be more desirable for local landowners than reducing load, or vice versa, or some combination of both.

The relationships among major stream integrity components are shown in Figure 3.1 (adapted from Ohio NPSMP, 2004). An illustration of the relationships using storm water runoff as an example is as follows: a portion of rain runs off the land and into a stream bringing with it accumulated soil and pollutants (1). Stream flow increases, resulting in higher velocities, water levels, and stream turbulence (2). This increased energy of the water influences channel form by eroding, moving, and depositing sediment material along its length (3). The type and amount of sediment material deposited can positively affect the habitat if it provides high quality substrate (e.g. cobble and gravel) or negatively affect it if it blankets the bed with fine grained material (e.g. silt and clay) (4b). Channel form also affects how pollutants in the runoff are processed by changing the rate or type of reactions that occur (4a). The chemistry of the water can either positively affect the biota (aquatic life) by providing essential nutrients or negatively affect it by having toxic effects. The quality of the available habitat in which these organisms live also has a large effect on the health and population of aquatic life (5). If the organisms have a viable aquatic environment, the

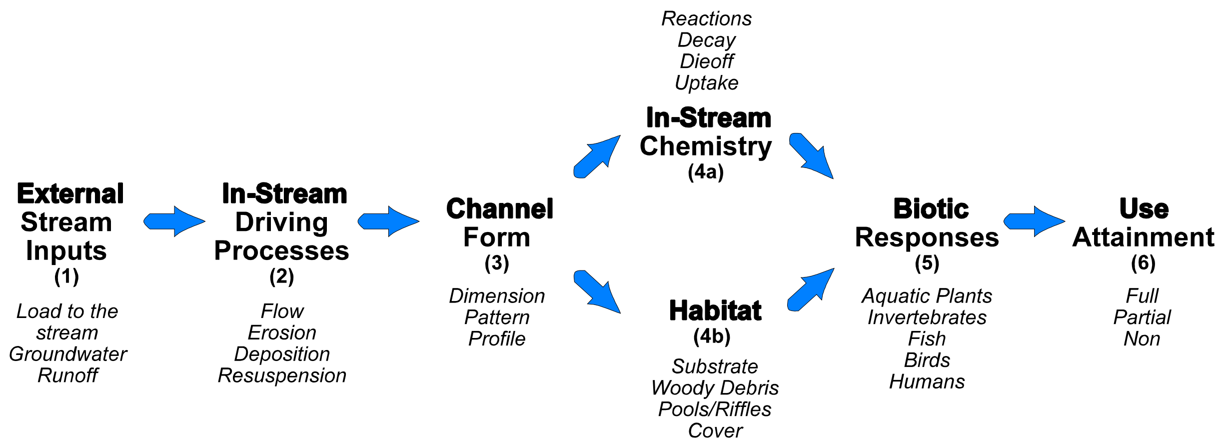


Figure 3.1 Flow diagram of the major stream integrity components

aquatic life use designation metrics (based on population density, species types, and individual specimen health) will be at levels indicative of full attainment status. Otherwise, the use is considered impaired (6).
The specific factors associated with the major stream components addressed in this report include:

1. Load-based pollutants *Figure 3.1 (1)*
   - total phosphorus
   - eroded sediment
   - bacteria
   - ammonia
   - metals
2. Flow quantity *Figure 3.1 (2)*
   - groundwater recharge
   - baseflow and runoff quantity
3. ***Geomorphology*** of the channel *Figure 3.1 (3)*
   - flood plain dimension
4. In-stream conditions *Figure 3.1 (4a)*
   - dissolved oxygen
   - total suspended solids
   - in-stream concentrations of the load-based pollutants
   - temperature (addressed by implementation actions of other factors)
5. Habitat quality *Figure 3.1 (4b)*
   - substrate, in-stream cover, channel, riparian, pool/riffle, and gradient quality
   - bedload
   - attributes that have a strong association with degraded aquatic communities

Each cause of impairment listed in Chapter 2 relates to one or more of the above factors. Each of these factors has a numeric target condition associated with it that serves as a goal that if all are met the water resource would be expected to attain its use designation.

3.2 Target Conditions

3.2.1 Load-based Pollutants and In-stream Conditions

Phosphorus and Total Suspended Solids
Nutrients were identified as a cause of impairment in the Big Darby Creek basin. Nutrients rarely approach concentrations in the ambient environment that are toxic to aquatic life, and nutrients in small amounts are essential to the functioning of healthy aquatic ecosystems. However, nutrient concentrations in excess of the needs of a balanced ecosystem can exert negative effects by increasing algal and aquatic plant life production (Sharpely et al., 1994). This increases turbidity, decreases average dissolved oxygen concentrations, and increases fluctuations in diel dissolved oxygen

River ***geomorphology*** is the study of the channel forming processes that operate in river systems.

and pH levels. Such changes shift species composition away from functional assemblages comprised of intolerant species, benthic insectivores, and top carnivores typical of high quality streams towards less desirable assemblages of tolerant species, niche generalists, omnivores, and detritivores typical of degraded streams (Ohio EPA, 1999). Such a shift in community structure lowers the diversity of the system; the IBI and ICI scores reflect this shift and may a stream may be precluded from achieving its aquatic-life use designation. Phosphorus was selected as the nutrient to focus on because it is frequently the limiting nutrient to algal growth in the fresh water streams of Ohio.

Total suspended solids (TSS) are particles in the water that can be trapped by a filter. High concentrations of TSS can reduce the amount of sunlight available to aquatic organisms and decrease water clarity. This leads to a number of effects including reduction of aquatic plants available for consumption by higher level organisms, lower dissolved oxygen, and the impaired ability of fish to see and catch food. TSS particles can also hold heat resulting in increased stream temperature. Further, TSS can clog fish gills, retard growth rates, decrease resistance to disease, and prevent egg and larval development. When TSS settles, eggs of fish and invertebrates are smothered, larvae can suffocate, and habitat quality is degraded (http://bcn.boulder.co.us/basin/data/FECAL/info/TSS.html).

While the Ohio EPA does not currently have statewide numeric criteria for phosphorus and TSS, potential targets have been identified in a technical report titled *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999). This document provides the results of a study analyzing the effects of nutrients and other parameters on the biological communities of Ohio streams. It recommends total phosphorus (TP) and TSS target concentrations based on observed concentrations associated with acceptable ranges of biological community performance within each ***ecoregion***. The targets applicable to the Big Darby Creek watershed are shown in Table 3.1. It is important to note that these targets are not codified in Ohio's water quality standards; therefore, there is a certain degree of flexibility as to how they can be used in a TMDL setting.

Ohio's standards also include narrative criteria that prohibit excessive input of pollutants to water resources of the state. There are five applicable narrative criteria and these are listed under the organic enrichment discussion below. They apply to excessive concentrations of nutrients and sediment as well as to organic enrichment.

Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources such as geology, soils, and natural vegetation.

Table 3.1 TP and TSS targets for the Big Darby Creek watershed[1]

Watershed Size *Use Designation:*	TP mg/l		TSS mg/l	
	WWH	*EWH*	*WWH*	*EWH*
Headwaters (drainage area < 20 mi^2)	0.07	0.05	10	10
Wadeable (20 mi^2 ≤ drainage area < 200 mi^2)	0.11	0.08	31	26
Small Rivers (200 mi^2 ≤ drainage area < 1000 mi^2)	0.16	0.17	44	41

[1] Based on the Eastern Corn Belt Plains Ecoregion

Sediment
In the context of this TMDL, bedload is the streambed material and the soil particles and solids that have settled out of the water column. The total sediment load carried by the stream is the sum of TSS and bedload. The sediment load to the stream generally implies the runoff of soil particles and the solids loading from septic and point sources. The actual quantity of bedload is difficult to calculate accurately, and this load is not necessarily indicative of impairment as it is not necessarily the quantity of streambed sediment that is a stressor but rather the size and quality of the sediment particles themselves. Therefore, a qualitative approach similar to habitat measurements is used to determine the relative difference in the bedload between stream sites. The bedload and habitat targets will be discussed jointly in Section 3.2.4.

Bacteria and Pathogens
Excessive loading of pathogenic organisms is the cause of recreational use impairment in the Big Darby Creek sub-basin. The number of pathogenic organisms present in polluted waters are generally difficult to determine, and these organisims are highly varied in their characteristics and types. Therefore, scientists and public health officials typically choose to monitor nonpathogenic bacteria that are usually associated with pathogens transmitted by fecal contamination but are more easily sampled and measured. These associated bacteria are called indicator organisms (U.S. EPA, 2001). For the purpose of this report, fecal coliform bacteria were selected as the indicator organism.

Numeric targets for fecal coliform are derived from bacteriological water quality standards. The criterion for fecal coliform specified in OAC 3745-1-07 are applicable during the recreation season defined as May 1st to October 15th, and state that the geometric mean content, based on not less than five samples within a thirty-day period, shall not exceed 1,000 per 100 ml and shall not exceed 2,000 per 100 ml in more than 10 percent of the samples taken during any thirty-day period. As written these criteria establish both chronic and acute permissible in-stream fecal coliform concentration.

Dissolved Oxygen and Organic Enrichment
Organic enrichment is the term used to describe the excess loading of organic oxidizable material which results in depressed dissolved oxygen (dissolved oxygen) concentrations. The potential sources of organic enrichment are numerous, and the

degree of the impact upon dissolved oxygen and aquatic life is dependent on a complex array of in-stream and near-stream processes and conditions. Organic enrichment is not explicitly listed in Ohio water quality standards, but falls under the general water quality criteria of Ohio Administrative Code (OAC) 3745-1-04 applicable to all waters of the state, wherein, to every extent practical and possible as determined by the director, these waters shall be:

(a) Free from suspended solids or other substances that enter the waters as a result of human activity and that will settle to form putrescent or otherwise objectionable sludge deposits, or that will adversely affect aquatic life;
(b) Free from materials entering the waters as a result of human activity producing color, odor or other conditions in such a degree as to create a nuisance;
(c) Free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life and/or are rapidly lethal in the mixing zone;
(d) Free from nutrients entering the waters as a result of human activity in concentrations that create nuisance growths of aquatic weeds and algae;
(e) Free from public health nuisances associated with raw or poorly treated sewage.

Low dissolved oxygen is the primary deleterious effect on aquatic life resulting from organic enrichment. One measurable endpoint of this TMDL is to attain the dissolved oxygen water quality criterion at all times including summer, low-flow conditions that are critical to aquatic life. The dissolved oxygen criteria varies with aquatic life use designation; these criteria are listed in Table 3.2.

Table 3.2 Dissolved Oxygen (mg/l) criteria[1]

	Aquatic Life Use Designation				
	EWH	WWH	MWH	CWH	LRW
Average over a 24-hour period	6.0	5.0	4.0	7.0	3.0
Minimum	5.0	4.0	3.0	6.0	2.0

[1] From Table 7-1 of OAC 3745-1-07

Ammonia, Metals, Temperature and Other Pollutants

Ohio's water quality criteria for ammonia nitrogen are based on the stream's designated use, pH and temperature. The criteria are tabularized and can be found in OAC 3745-1-07, Tables 7-2 through 7-8. Ohio's water quality criteria for metals are based on the stream's hardness. The criteria are tabularized and can be found in OAC 3745-1-07, Table 7-9. Temperature criteria vary by use and by month, and are listed in Tables 7-1 and 7-14 in OAC 3745-1-07. All of these tables are located at: http://www.epa.state.oh.us/dsw/rules/01-07.pdf.

Ammonia, metals, and other miscellaneous pollutants are not impairing factors for the entire watershed. Only certain sources in some sub-watersheds are associated with these pollutants. The specific criteria and targets used to establish allowable loads for these sources will be specified in the load tables or will be identified in the analyses if loads are not calculated for them.

3.2.2 Flow Quantity and Changes in Hydrology

Hydrology is the distribution and movement of water in the environment; it follows a cyclical pattern as depicted in Figure 3.2 (FISRWG, 1998). Precipitation falls on the land where it can do one of three things: be intercepted by plants or storage structures, run off the land surface, or infiltrate into the ground. The infiltrated water can be stored in the soil layer (called the unsaturated zone) or percolate deeper into the groundwater region (the saturated zone). Migration of precipitation to groundwater is called groundwater recharge. Evaporation, plant uptake of soil water, and plant transpiration returns water to the atmosphere completing the cycle.

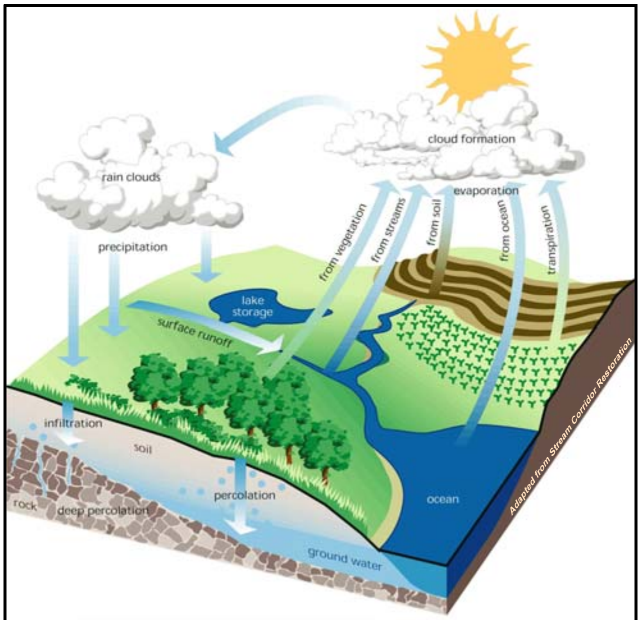


Figure 3.2 The Hydrologic Cycle

Streamflow is the sum of groundwater seepage (baseflow), surface runoff, and direct precipitation. The hydrology of a watershed establishes a streamflow pattern including a range of peak and low streamflow amounts and the frequency at which a particular streamflow occurs. Over time, this pattern develops a dynamic equilibrium with the stream channel and flood plain, and they are formed in balance with the energy of the reoccurring streamflows and the geology of the system. This dynamic equilibrium, in part, depends on the magnitude and frequency of the ***effective discharge*** remaining constant over time and the ability of the flood plain to dissipate the energy of flows exceeding the effective discharge (Ward, 2002).

Changes to hydrology due to human intervention can alter the natural streamflow regime. Changes in the land cover and use from a more natural state to a more managed state results in increased surface runoff and decreased groundwater recharge. As watersheds become increasingly impervious due to roofs, roads, parking lots, and managed fields and lawns, less water is able to infiltrate/percolate to the groundwater leading to reduced baseflows, and more precipitation runs off the land faster during storms leading to higher peak flows. Agriculturally managed lands with poorly drained soils mimic this process to a lesser degree, as infiltrated water is

The ***effective (or bankfull) discharge*** is the flow which has the largest influence on forming the stream channel.

intercepted by drainage tiles and routed to nearby streams. Additional changes to the hydrologic cycle include interception, storage, and discharge of water for municipal and industrial uses. The amount of water may remain the same, but the balance and the pattern of the flow is altered.

Direct alteration of the stream channel and riparian zones by channelization, levees, changes to the bank materials, or other related actions also affect the streamflow regime. Natural channels seek to reduce the energy of the streamflow by slowing the water in meanders and having available areas adjacent to the stream where excess flow can spread and velocity of the flow can decrease (the active flood plain). This reduces flooding outside of the active flood plain, decreases bank and bed erosion, allows suspended material to be deposited on the flood plain instead of the streambed, and results in lower overall peak stream flows and stream stage. As channels are straightened and/or confined, the stream flow energy does not have an outlet with which to decrease its power. This propagates downstream increasing peak flows, channel down-cutting, flooding downstream, bank erosion, and channel de-stabilization. Other stressors are contributed to as well such as increased sedimentation, suspended solids, and degraded habitat.

The numeric targets associated with flow quantity and hydrology are based on the relationship of baseflow and runoff to total streamflow and the amount of groundwater recharge from a stable hydrologic and streamflow regime. This is determined from historic USGS flow data in the watershed and hydrologic model results per sub-watershed based on land use prior to de-stabilization of stream patterns. Most sub-watersheds in the Darby have a stable hydrologic pattern currently and the hydrologic targets for these areas are the existing condition. Developed and developing watersheds have hydrologic targets established from conditions that existed prior to the significant alteration in the streamflow regime.

3.2.3 Geomorphology of the Channel

The hydrology of a watershed is a driving force for both streamflow and stream form. Stream form and the processes associated with it is the geomorphology of the channel. The geomorphology impacts the aquatic environment by affecting the way pollutants are processed in the stream and by setting the foundation for aquatic habitat. Geomorphological processes include the erosion, transport, and deposition of sediment by streamflow which form the channel and the flood plain. The channel and flood plain, in turn, affect how sediment is processed. The relationship is dynamic, and the system works towards a balance between input of material and output of it.

Maintaining the dynamic equilibrium of the Big Darby Creek watershed is part of the suite of actions needed to restore and protect this system. A consistent effective discharge and the ability to dissipate energy associated with higher flows are key factors to this equilibrium. Other contributing factors include achieving a balance between sediment transport, storage and supply and allowing the main channel to adjust its dimension, pattern, and profile to maintain equilibrium (Ward et al., 2002).

Adequate flood plain that is available to the stream during higher flow events is crucial to maintaining such a stable stream system. An adequate width is one which includes the meander pattern of the stream over time and provides an area for flow dissipation during high flow events. The numeric targets for flood plain widths used in this report are from the research of scientists at the Ohio Department of Natural Resources (ODNR). Their research indicates that the wider the stream corridor is, the better it is for the stream environment; however, the area immediately adjacent to the channel is the most critical. The flood plain width targets are in multiples of the bankfull channel width. The ***bankfull width*** for streams in the Big Darby watershed can be estimated from an equation developed by Dan Mecklenburg of the ODNR (personal communication, November 2004). This is the equation of the regression line of bankfull data points, drainage areas, and other stream channel parameters collected in west central Ohio streams. The equation relates bankfull width (W, ft) to drainage area (DA, mi^2):

$$W = 13.3\ DA^{0.43}$$ *(Equation 3.1)*

ODNR established active floodplain performance standards for streams as a function of stream quality (Ohio NPSM, 2004). Ten times the bankfull width is typical of the highest quality streams and is prescribed as the recommended flood plain width for streams designated EWH. Five times the bankfull width is frequently associated with streams of moderate quality; this factor is prescribed for streams designated WWH. Finally, three times the bankfull width is a minimum; this factor is prescribed for streams designated MWH. These multipliers combined with equation 3.1 result in the following minimum flood plain widths (B, ft) per aquatic life use designation:

$$B_{EWH} = 133\ DA^{0.43}$$ *(Equation 3.2)*

$$B_{WWH} = 67\ DA^{0.43}$$ *(Equation 3.3)*

$$B_{MWH} = 40\ DA^{0.43}$$ *(Equation 3.4)*

The flood plain width is the total width including the flood plain on both sides of the stream and the bankfull width. The equations represent the minimum width needed based on scientific data specific to the Big Darby Creek area. It is also essential that the flood plain be accessible to the stream during bankfull storm events.

Watershed groups and other interest groups such as the Hellbranch Environmentally Sensitive Development Area (ESDA) External Advisory Group may choose to increase the minimum recommended widths needed based on additional justifications. The equations proposed by the ESDA are based on data applicable to a wider geographic region and therefore vary slightly from those used here. The ESDA group recommended the appropriate flood plain width to be the largest of the following 3 quantities: the 100-year regulatory flood plain, the result of their equation similar to Equation 3.2, or 200 feet. More information on geomorphology and the flood plain width

Bankfull width is the width of the active channel during the effective discharge.

targets used in this TMDL report is available at:
http://www.epa.state.oh.us/dsw/nps/NPSMP/SI/sicomponentsmorph.html.

3.2.4 Habitat and Bedload Quality

Ohio EPA uses the Qualitative Habitat Evaluation Index (QHEI) to assess the physical habitat quality of streams and rivers (Rankin 1989, 1995). This index measures the important components of stream habitat that are essential to sustaining high value aquatic communities. The components include substrate quality, instream cover (physical structure), stream channel morphology and condition, riparian quality and bank erosion, pool and run-riffle quality, and gradient. Analysis of an extensive dataset of paired QHEI and IBI scores led to the development of target QHEI scores generally shown to be supportive of the biological assemblages typical of WWH and EWH (Ohio EPA, 1999). Comparisons between the QHEI attributes within each component and the IBI resulted in a list of specific habitat attributes that are particularly associated with degraded communities (referred to as modified attributes). These attributes were then grouped as either high influence or moderate influence modified attributes based on the statistical relationship of the presence of an attribute and the IBI score at each site. The recommended targets for habitat per aquatic life use designation are shown in Table 3.3.

The QHEI can also be used to evaluate the degree of bedload and the quality of the substrate at a particular site. The substrate, riparian characteristic, and channel metrics all evaluate stream attributes related to bedload. The substrate metric includes an assessment of streambed sediment quality, quantity, and origin. The riparian metric evaluates riparian width, quality, and bank erosion. The channel metric describes stream physical morphology including sinuosity and extent of development. Each of these factors influences the degree to which siltation affects a stream, and cumulatively serves as its numeric target. Table 3.3 summarizes the bedload TMDL targets.

Table 3.3 Habitat and Bedload TMDL targets

Attribute	Target	
	WWH	EWH
Habitat TMDL targets:		
Number of any Modified Attributes	<5	<3
Number of High Influence Modified Attributes	<2	0
Overall QHEI Score	≥60	≥75
Bedload TMDL targets:		
Substrate Metric Score	≥13	≥15
Channel Metric Score	≥14	≥15
Riparian Metric Score	≥5	≥5

3.2.5 Protecting the Downstream Use

Aquatic life use designations are determined based on a stream or stream segment's ability to support a particular level of aquatic life; it is a stream-specific determination. When a stream with a lower use designation flows into one with a higher use designation, the criteria of the downstream use needs to be maintained. Therefore, there are times when the applicable criteria in a waterbody may need to be more restrictive than those associated with its designated use in order to protect the designated use of the downstream segment or stream.

3.3 Summary of Methods

A different method of analysis was used for each of the stream integrity components in Figure 3.1. The suite of methods selected address the major impairing factors in the Big Darby Creek watershed; each individual method addresses one or more of the following areas listed by section number:

- 3.3.1 Determine the hydrologic response by quantifying the long term average groundwater recharge rate and baseflow and runoff distribution per sub-watershed.
- 3.3.2 Determine the load contributions to the stream from:
  - nonpoint source activities originating on the watershed landscape;
  - municipal and industrial facilities and activities; and,
  - septic system inputs from systems without functioning leach fields.
- 3.3.3 Determine the in-stream response to external loads. Analyze variations in in-stream concentrations to refine cause and source assessment.
- 3.3.4 Establish current flood plain widths in pilot areas. Determine recommended widths in each sub-watershed.
- 3.3.5 Establish current habitat conditions and quantify desired habitat goals per site.

Multiple methods were needed given resource constraints (time and data availability) and applicability. The techniques selected are the most appropriate, applicable, and available methods for the goals and constraints of this project. Tables 3.5 and 3.7 summarize the evaluation methods selected for this TMDL project.

3.3.1 Hydrologic Response

Description of Method

The hydrologic cycle for the Big Darby Creek and its sub-watersheds was simulated using the Generalized Watershed Loading Function or GWLF model (Haith et al, 1992) through the desktop simulation form of this model called BasinSim 1.0 (Dai et al, 2000). The model predicts stream flow based on precipitation, evapotranspiration, land uses, and soil characteristics. Figure 3.3 shows the hydrologic model of GWLF.

GWLF simulates runoff, groundwater recharge, and stream flow by a water-balance method using measurements of daily precipitation and average temperature. Runoff is calculated using a form of the Natural Resources Conservation Service's Curve Number method (SCS, 1986). The Curve Number determines the amount of precipitation that runs off the surface and is adjusted for antecedent soil moisture before the precipitation event, growing or dormant season, detention potential, and for soil characteristics. The Curve Number is an empirical equation based on an extensive database of observed data. The Curve Number varies by land cover, use, and soil type; the higher the curve number the more runoff produced. The surface runoff flow the Curve Number method predicts any ‘quick response’ flow including interflow and drainage from tiles.

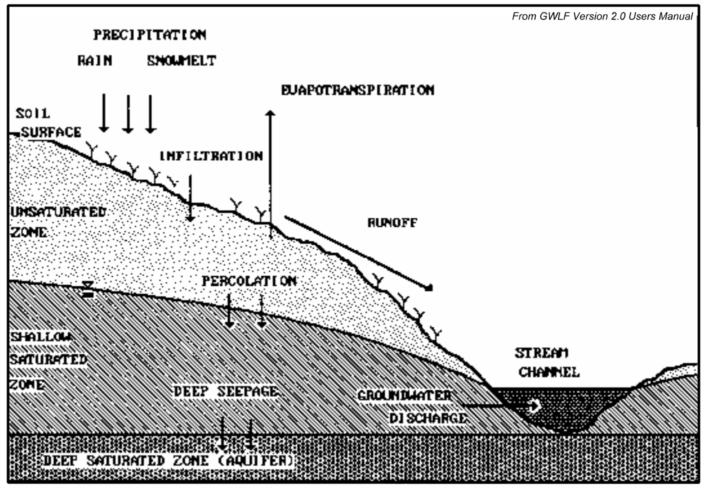


Figure 3.3 The components of the hydrologic cycle calculated by GWLF

Groundwater recharge is determined by tracking daily water balances in the unsaturated and shallow saturated zones; these zones act as reservoirs and have inputs and outputs. The input to the unsaturated zone is the infiltrated water calculated as the amount of the precipitation received less the surface runoff. Outputs of this zone include the moisture lost via plant root uptake (which is lost to the atmosphere in a process called evapotranspiration) and percolation down to the saturated zone. Evapotranspiration is estimated based on the available moisture in the unsaturated zone, the potential evapotranspiration based on day length and temperature, and a cover coefficient based on the type of plant or crop in the area of interest. Percolation occurs when the unsaturated zone volume exceeds the soil water capacity.

The shallow saturated zone receives the percolated water. This zone is treated as a linear reservoir. It can discharge water to the stream as baseflow or lose moisture to deep seepage, at a rate described by the product of the zone's moisture storage and a constant rate coefficient.

Stream flow is computed as the sum of the groundwater discharge from the shallow saturated zone and the surface runoff. The model computes the daily water balance and resulting stream flow allowing comparison of the GWLF-predicted values to a daily record of stream flow such as is collected at USGS flow gages. There are three active USGS gages in the Big Darby Creek watershed:

03230310 Little Darby Creek at West Jefferson, Ohio (162 mi^2 drainage area)
03230450 Hellbranch Run near Harrisburg, Ohio (37 mi^2 drainage area)
03230500 Big Darby Creek at Darbyville, Ohio (534 mi^2 drainage area)

The model was run for each of the areas upstream of these gages using weather data based on several weather stations from around the watershed. A ten year simulation from April 1994 through March 2004 was performed, and the predicted stream flows based on the model results were compared to the observed data from the USGS gages. Two values are used to determine how well the predicted values compare to the observed. The coefficient of determination (the R^2 value) is a statistic that can indicate the relationship between two data sets and is a unitless measure ranging from 0 to 1. Higher values indicate the curve representing the model results are closer to observed data curve with 1 being a perfect fit. The predicted to observed ratio indicates if the model is under or over predicting the stream flow in general and also how well the two data sets compare. The results of this comparison are summarized in Table 3.4.

A joint study by the ODNR and USGS analyzed USGS flow data in Ohio to determine groundwater recharge rates and is summarized in the report *Use of Stream flow Records and Basin Characteristics to Estimate Ground-Water Recharge Rates in Ohio* (ODNR, 2002). The report estimates groundwater recharge rates and the mean baseflow to mean stream flow ratio for USGS gages in Ohio. The three active gages in the Big Darby watershed were included in the report. The findings for these USGS gages based on this study and the GWLF results are also shown in Table 3.4.

Table 3.4 Comparison of GWLF Predicted Streamflow with USGS Streamflow Values

Gage #	Stream	R^2 Value	Predicted to Observed Ratio	ODNR/USGS study % of Mean Stream flow		GWLF Model % of Mean Stream flow	
				Baseflow	Runoff	Baseflow	Runoff
03230310	Little Darby Ck	0.883	1.02	50.8	49.2	51.2	48.8
03230450	Hellbranch Run	0.884	0.99	41.2	58.8	41.4	58.6
03230500	Big Darby Ck	0.895	1.03	46.2	53.8	46.5	53.5

Sources of Data

Landuse, soil, and weather data are critical components of GWLF. A combination of data from a variety of sources supplied the landuse data used in this analysis. No single landuse data set supplied the land cover resolution needed in this analysis. The simulation is for a 10-year period; therefore, land use spanning this period was needed as well. The base layer is the National Land Cover Dataset (NLCD). The NLCD was compiled from Landsat™ satellite imagery circa 1992 and includes 23 classes of land use (USGS, 2000). A more rigorous analysis of forested land cover in the Darby Creek watershed was done by Ohio EPA in 1998. This data was based on 1997 Landsat 5 satellite imagery. The information from this study was merged with the NLCD. The

Ohio EPA funded a project by the University of Cincinnati to update the land use data of Ohio (Ohio EPA, 2001). This dataset is based on 2000 and 2001 Landsat 7 satellite imagery, but has fewer land use classes. The updated and the merged land use sets were compared; where land use changes had occurred based on the newer landuse they were added to the merged dataset (for example, agricultural land changed to urban). Figure 2.1.2 shows the merged land use dataset results and Chapter 2 shows landuse distribution charts by sub-watershed based on this merged dataset. Two other landuse covers were used in the analysis as well. Land use from 1997 based on Landsat Thematic Mapper Data was utilized to refine the row crop land cover into wheat, soybean and corn crops. This data is available online from Ohio State University and Dr. Gordon (http://facweb.arch.ohio-state.edu/sgordon/research/darby/bdlu97.html). The Hellbranch sub-watershed is a rapidly developing area. A third quarter 2003 land use distribution for the Hellbranch was prepared by the Hellbranch Forum and FMSM Engineers. This landuse set was used to evaluate changes in the hydrologic response of the Hellbranch sub-watershed to its changes in landuse.

Soil properties and distribution is collected by the National Resources Conservation Service (NRCS) through county level soil surveys. This data is tabularized and is available in a newer version through the National Soil Information System (NASIS) or the original format the Map Unit Interpretation Record (MUIR). These tables are linked with a digitized mapping system into the Soil Survey Geographic Database (SSURGO). SSURGO is the most detailed soil information available through NRCS and is available on a county basis. However, Logan, Clark, and Champaign counties had only the tabularized data without the associated mapping system available at the time of this study. The Ohio Capability Analysis Program (OCAP) mapping units were linked with the NASIS and MUIR tables to supply the soil information for these counties.

Several weather stations were used from around the Big Darby watershed and its surrounding area. Daily precipitation and temperature data were supplied by NOAA weather stations in the following communities:

- Marysville
- London
- Bellefontaine
- Springfield
- Delaware
- South Charleston
- Urbana
- Columbus

The model stream flow predictions fit the best with observed flow data when the daily averages of all of the weather stations was used as the input weather data set.

3.3.2 Loads to the Stream

3.3.2.1 Total Phosphorus and Sediment

Description of Method

The total phosphorus and sediment loads to the streams of the Big Darby Creek watershed are the sum of the contributions from nonpoint sources, septic systems, and point sources. The load from nonpoint sources was simulated using the GWLF model which uses loading functions specific to each sub-watershed in conjunction with the calculated hydrologic components to predict nutrient and sediment loads from surface runoff and groundwater.

The GWLF model calculates the total nutrient and sediment load per specified watershed area. The Big Darby watershed has 20 sub-watersheds as shown in Figure 2.1; GWLF models were constructed for each of these 20 areas. Within each watershed area GWLF requires that each land use be categorized as either a rural or urban land use which determines how the model calculates the loading from that particular land use area. For the purposes of modeling, “rural” land uses are those with predominantly pervious surfaces, while “urban” land uses are those with predominantly impervious surfaces. Some land uses are appropriate to divide into a pervious (“rural”) and impervious (“urban”) fractions for simulation.

The total phosphorus load is composed of both dissolved and solid-phase forms of phosphorus. Rural loads are transported in runoff water and eroded soil or in a dissolved form from field tiles. The solid-phase rural phosphorus loads are the product of the monthly sediment yield and the average concentration of the phosphorus in the eroded soil. The monthly sediment yield represents the rural sediment load, and is the product of erosion and the sediment delivery ratio. Erosion is calculated using the Universal Soil Loss Equation (USLE) (Wischmeier and Smith, 1978) and watershed-specific input values. The sediment delivery ratio is the ratio of the actual sediment that travels to a watershed outlet versus the total amount of sediment that is detached within the watershed; it is an empirical value relating watershed drainage area to the delivery ratio. The concentration of phosphorus in surface sediment is based on several sources including OSU Extension data and sediment data from the Darby watershed. The dissolved phosphorus load is contributed to by groundwater and rural runoff. Dissolved loads are the product of the volume of water per source and the total phosphorus concentration of that source. Groundwater concentrations were based on groundwater data in the Darby watershed, and dissolved phosphorus concentrations in runoff from each land use was based on empirical nationwide data and tile data collected in the Darby watershed.

For urban land uses, soil erosion is not calculated, and delivery of phosphorus to streams is based on an exponential accumulation and washoff formulation. Nutrients accumulate on urban surfaces over time and approach an asymptotic maximum value. GWLF assumes the accumulation of nutrients reaches 90% of the maximum accumulation in 20 days based in part on research by Sartor and Boyd (1972).
A percentage of this accumulation is washed off during a runoff event. The greater the amount of rain, the greater the washoff percentage is. Data from Amy et al. (1974) indicates that 0.5 inches of rain will wash off 90% of accumulated pollutants. The monthly runoff load from urban land uses is the sum of the daily product of the washoff function and the accumulation function. All nutrients loaded from urban land uses are assumed to move in association with solids.

Data on septic system numbers and performance is not extensively available in the Big Darby watershed. In lieu of this an analysis to determine the potential for failing septic systems was done by Ben Webb, the Darby Creek Watershed Coordinator (Webb, 2004). This analysis used soils and census data in a GIS platform to estimate the number of people served by septic systems and the potential of those systems to not operate optimally based primarily on soil properties. The study found the majority of the soils in the Darby watershed were not conducive to proper home septic system performance.

Ohio EPA discussions with Franklin County Board of Health personnel about this situation determined that where soils are particularly bad, or a proper leach field is not available, alternative systems are installed such as aeration systems. In addition, illegal fixes can occur where existing septic systems are tied into drainage tile. These alternative systems and illegal hook ups can result in direct discharges to waterways. The existing septic loads estimated for this analysis assume most of the septic load to a stream comes from these direct discharges. The known number of alternative systems (Webb, 2004) plus a percentage of the remaining systems to account for other direct septic inputs was estimated. Literature values for flow and septic system quality of total phosphorus and solids and the total number of direct systems determined the septic system load per sub-watershed. Figure 3.4 shows the known number of aerators per township in the Big Darby watershed. The allowable septic load applies only to those systems which meet the legal requirements of OAC 3701-29 and OAC 3701-29-08.

Loads from municipal and industrial facilities which discharge to a waterway were calculated based on actual data from these facilities. Dischargers are generally required to monitor their effluent and report the data to Ohio EPA. In addition, Ohio EPA performs compliance monitoring. Figure 2.1.3 shows the dischargers and their discharge locations in the Big Darby watershed.

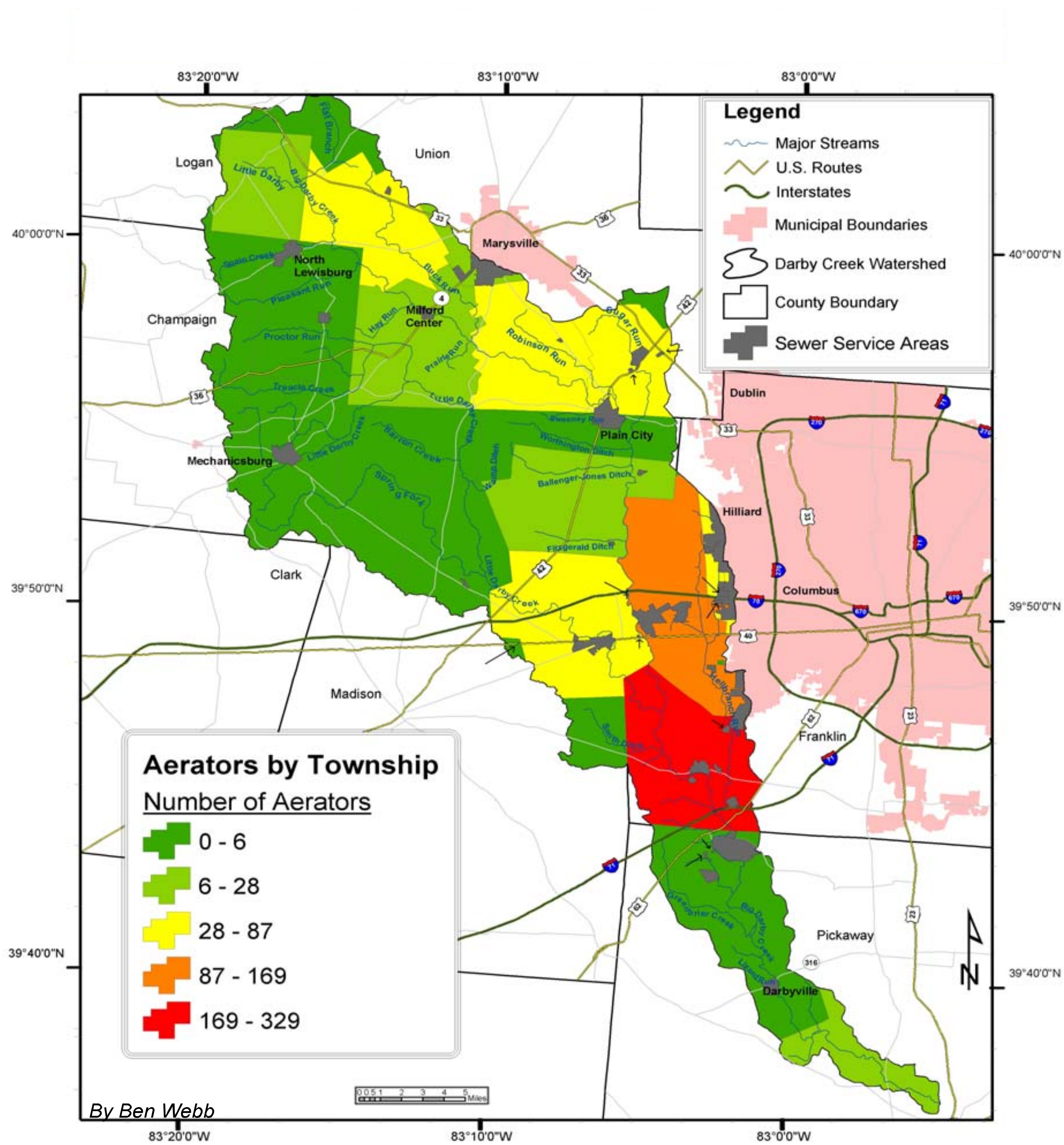


Figure 3.4 Known Aerators by Township in the Big Darby Creek Watershed

TMDL Calculation and Allocation

The allowable total phosphorus and suspended sediment loads were calculated by multiplying the average total annual volume of flow from a sub-watershed by the target in-stream concentrations discussed in Section 3.2.1. This gives an average annual allowable load. The average annual volume is the average of the total annual volumes calculated by GWLF each ***hydrologic year*** from April 1994 through March 2004. The overall percent reduction needed was based on the difference between the existing annual load and the allowable annual load.

The allowable load was allocated among a variety of factors - a margin of safety, a natural load, a point source load, a septic load, a runoff load, and a groundwater load. Five percent of the total load was removed to account for data uncertainties and allocated to the margin of safety factor. A natural load was calculated based on what the runoff and groundwater load would be if the landuse were all unmanaged lands such as forest, prairie, and wetlands. The point source load was the load necessary to meet water quality targets in-stream as calculated by models discussed in Section 3.3.3. The septic load was based on the largest percent reduction needed for the sub-watershed of interest between total phosphorus, suspended sediment, and fecal coliform. The reduction needed by one of these pollutants would result in the same reduction percentage for the other pollutants as the septic systems would need to be returned to functional treatment systems. These allocated loads were removed from the allowable load, and the remaining allowable load was divided by an equal percent reduction between the groundwater and runoff loads.

3.3.2.2 Bacteria and Pathogens

Description of Method

The total fecal coliform load to each sub-watershed is the sum of the washoff load from the land, direct animal inputs, septic system loads, and point source loads. The U.S. EPA's Bacteria Indicator Tool (BIT) was employed to estimate the fecal coliform load accumulated within each sub-watershed in the Big Darby Creek watershed, the direct animal inputs, and the septic system loads. Point source loads were based on actual data as reported by each facility or as monitored by Ohio EPA. Fecal coliform is the indicator bacteria used in this analysis to represent pathogen and other bacteria levels. BIT estimates the monthly accumulation rate of fecal coliform bacteria on four land uses (cropland, forested, built-up, and pastureland), as well as the asymptotic limit for the accumulation should no washoff occur. The tool also estimates the direct input of fecal coliform bacteria to streams from grazing livestock and failing septic systems (U.S. EPA, 2000).

BIT requires three types of values: user-defined, default, and literature. User-defined values are to be specific to the study area. User-defined values required by the tool are land use distribution, numbers of livestock, wildlife densities, number of home sewage treatment systems (HSTS), and the failure rate of HSTS. Default values are supplied by the tool, but it is suggested that they be modified to reflect patterns in the study area.

A ***hydrologic year*** as defined by GWLF is from April 1st to March 31st.

Default values include fraction of each manure type applied each month, fraction of manure type that is incorporated into the soil, and time spent grazing and confined by livestock. Like default values, literature values are supplied by the tool, but they may be replaced with user values if better information is available for the study area. Literature values required by the tool are animal waste production rates and fecal coliform bacteria content, fecal coliform bacteria accumulation rates for built-up land uses, and raw sewage fecal coliform bacteria content and waste production.

Literature and most default values were unchanged because limited watershed-specific information was available. User-defined values were determined via the following methods:

- The land use distribution was derived as discussed in Section 3.3.1. The land use was reclassified to agree with the land use categories of BIT.

- The number of HSTS and the percentage of those which are failing were based on the analysis discussed in Section 3.3.2.1.

- Information regarding livestock counts was obtained from county census data in consultation with Soil and Water Conservation District staff per county.

- Populations of wildlife and dogs were derived from countywide figures. Information regarding dog populations was obtained from county census data. Information regarding wildlife populations was obtained from Ohio Department of Natural Resource census data. In each case, the total number of animals within the county was divided by the total number of acres of relevant land use in the county. The resulting animal densities (animals per acre) were used to estimate the animal populations within each sub-watershed.

- Direct input of bacteria by cattle in streams was limited only to those streams with evidence of cattle access as determined by Ohio EPA and ODNR field staff. Direct input of bacteria by geese in streams was limited to those areas where a concentration of geese are likely to occur or were observed to occur such as golf courses and other mowed areas along waterways.

BIT predicts the maximum surface accumulation rate of fecal coliform, and the asymptotic limit of accumulation should no washoff occur. The actual washoff load was determined by combining the accumulation from BIT, the runoff computed by GWLF, and literature values relating runoff to washoff rates as discussed in Section 3.3.2.1.

TMDL Calculation and Allocation
The allowable bacteria load for the recreational season (May-October) was determined based on the allowable monthly load for each month in the season. The allowable monthly load for each month was calculated by dividing the total existing monthly load by the total monthly stream flow volume to give the average in-stream concentration of bacteria for that month. This existing concentration was compared to the 30-day fecal coliform criterion and the needed percent reduction was determined. The recreational

season allowable load was the product of the needed percent reduction and the total seasonal existing load.

Table 3.5 Summary of the Methods Used to Evaluate Loads to the Stream

Evaluation Method	Sources	Parameters	Time Period
GWLF	Overland Runoff Groundwater Air Deposition	Sediment Total Phosphorus Flow	Monthly Loads; Daily Flows
GIS/ Literature Values	Septic	Solids Total Phosphorus Flow	Daily
BIT	Overland Accumulation Direct Animal Access Septic	Fecal Coliform	Monthly Loads
Monitored Effluent Data	Municipal and Industrial Point Sources	Solids and TSS Total Phosphorus Fecal Coliform Flow Ammonia	Daily
GWLF/ In-stream Data	Bank Erosion	Sediment	Annual
Notes: Existing conditions evaluated based on a 10-year simulation from April 1994- March 2004. Loads totaled for each of the 20 sub-watersheds in the Big Darby Creek watershed. Allowable loads are the product of the average yearly total stream flow and applicable targets.			

The allowable load was allocated to point sources, septic systems, and nonpoint sources consisting of washoff and direct animal inputs. The margin of safety is implicit and discussed in Section 3.5. Point sources were a very insignificant portion of the total load, and as such, were set at their existing permitted loads. The septic system allocation was based on the largest percent reduction needed between total phosphorus, suspended sediment, and fecal coliform for the sub-watershed of interest. These allocated loads were removed from the allowable load, and the remaining allowable load was divided by an equal percent reduction between the washoff and direct animal input loads.

3.3.3 Response in the Stream

Total Phosphorus, TSS, and Bacteria

Duration curves show the percent of time a value is equaled or exceeded within its data set. Flow duration curves relate any individual flow within a flow record with the percent of time that particular flow value is equaled or exceeded. In this application, flow duration curves are developed by ordering median daily flows from high to low and calculating the rank of each flow value as a percentage of the entire flow record. A long term continuous record of flow is needed to properly characterize the hydrologic response of a watershed. A load duration curve (LDC) is simply the flow duration curve multiplied by the applicable water quality target concentration, such as a water quality criterion. Flow multiplied by the allowable in-stream concentration gives the allowable load for that flow. The load duration curve is the TMDL for each flow condition observed in the period of record. The utility of the load duration curve (or the TMDL curve) is increased by adding observed loads to the LDC graph. The observed load can then be compared to the allowable load under the range of flow conditions data were collected for. If there are sufficient observed data, patterns may emerge that demonstrate which hydrologic conditions have loads exceeding the target. This assists with allocating the available load and helps to direct implementation actions. Duration curves do not predict or simulate conditions. Instead, they serve as a method to visualize patterns in the observed data and to set allowable loads based on observed flows and known in-stream targets.

Load duration curves for total phosphorus, total suspended solids, and fecal coliform were developed at the three active USGS gages in the watershed where long term continuous flow records were available. Where chemistry data was available, these plots have individual points depicted which show the in-stream response to the existing watershed loading at the sampling location and flow. The curves themselves show the allowable load. An observed load above the TMDL curve does not necessarily indicate a violation; however, the overall trend of the data over time is indicative of the general watershed condition.

Dissolved Oxygen and Ammonia

The GWLF model predicts only loads to the stream; it does not predict the chemical response that occurs within the stream to input loads. The Enhanced Stream Water Quality Model version K (QUAL2K) predicts the in-stream chemical concentration response of several parameters including dissolved oxygen and ammonia to various inputs and stream conditions under steady, non-varying flows. The major constituent interactions are shown in Figure 3.5 (adapted from Brown and Barnwell, 1987). QUAL2K is an updated version of the QUAL2E model, and it has several new elements including bottom algae and sediment-water interaction simulations (Chapra et al., 2003).

QUAL2K represents the stream as a series of computational elements grouped together within a specified stream reach. A reach is defined as a length of stream that has similar physical properties (gradient, cross section, etc.) and rate constants (decay, settling, source). QUAL2K conceptualizes the stream as a sequential series of completely mixed reactors (the computational elements). It calculates the output from each computational element based on the input from the previous element and on reactions that occur within the element itself.

QUAL2K is appropriate for use only with steady, non-variable stream flows and predicts the average daily in-stream concentration of modeled parameters. It is, therefore, not well suited to work directly with GWLF results which are monthly loads under varying conditions. QUAL2K was used in this project to predict the in-stream concentration of dissolved oxygen and nitrogen compounds during low-flow summer conditions and in-stream phosphorus concentration during average summer conditions. These conditions are considered very stressful to stream biota, and therefore, allocations of loads need to be protective of this critical state. QUAL2K simulates in-stream concentrations which can then be compared to water quality criteria to evaluate if violations of these numeric criteria and targets have the potential to occur. Inputs such as point source loads can be adjusted until the predicted in-stream concentrations meet the water quality criteria. This provides a means of developing the wasteload allocation portion of the TMDL equation. In addition, it enables calculation of appropriate effluent limitations for dissolved oxygen demanding substances that in conjunction with the nutrient reductions and stream channel and habitat improvements recommended in this TMDL report, will serve to address the low dissolved oxygen conditions in the watershed.

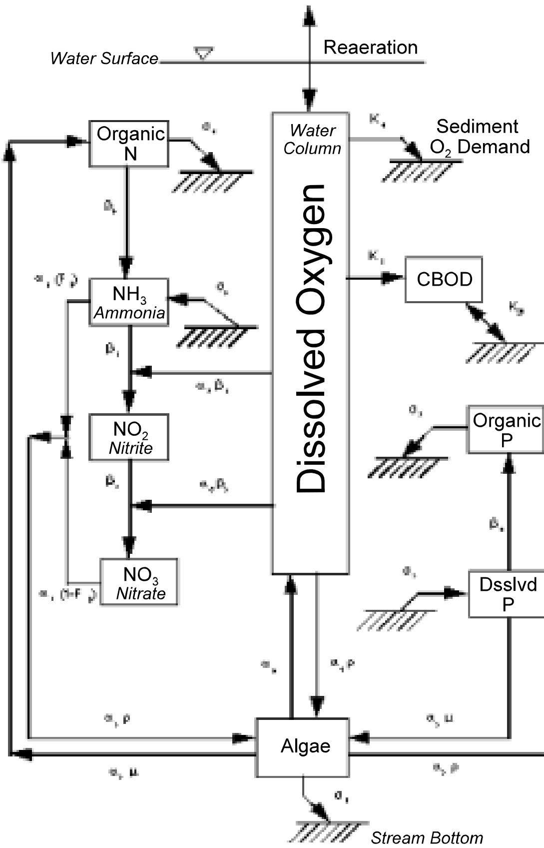


Figure 3.5 QUAL2E Constituent Interactions, and the Basis for the QUAL2K Major Interactions

Six areas in the Big Darby watershed were selected for QUAL2K model development applications. These areas have the potential to be significantly influenced by point source discharges, or are areas that have particularly sensitive mussel populations, or both conditions are present. The six QUAL2K modeled areas include:

- Big Darby Creek from Township Rd 157 (upstream of Flat Branch) to Buck Run Rd (downstream of Pleasant Run).
- Spain Creek from upstream N. Lewisburg WWTP to the mouth.
- Little Darby Creek from S.R. 29 in Mechanicsburg to Irwin Rd.
- Little Darby Creek from upstream Treacle Ck to S.R. 161 in Chuckery.

- Big Darby Creek from upstream Plain City WWTP to Lucas Rd.
- Big Darby Creek from Darbydale to Scioto-Darby Rd.

The models were calibrated with data collected in the summer of 2004. Hydraulic variables were calibrated first, followed by the chemical parameters (biochemical oxygen demand, the nitrogen compounds, and phosphorus), and lastly by dissolved oxygen.

3.3.4 Flood Plain

The overriding goal was to interpolate the actual active floodplain zone using limited field observation. The bankfull height is the incipient stage just prior to full interaction of the stream with the flood plain. When stream stage slightly exceeds the bankfull height, the flood plain becomes inundated. Because capturing evidence of the bankfull height is time-consuming and point-based (e.g., points where there is a change in land slope from flat to steep or a change in vegetation type), a method for interpolating the bankfull height and subsequently depicting the active flood plain (i.e., the inundation zone) was needed.

The ability to generate continuous terrain data (i.e., a digital elevation model) from digital contour data was a critical stage in simulating the active flood plain zone. Digital contour data was produced from 1:24,000-scale USGS topographic quadrangles. Using analytical techniques available in geographical information systems (GIS), field-derived elevations of the active flood plain were anchored to stream centerlines using the hydrologic flow path. This flow path is determined by water flowing from a source to a sink where direction is determined solely by steepest-descent. Once flood plain height was anchored to the stream centerline at selected cross-sections, heights for incremental points within these anchors were interpolated linearly as a function of flow length from the anchor. Stream centerlines were derived from USGS 1:24,000-scale hydrography.

Dunne and Leopold (1978) showed that the maximum bankfull depth (D_{max}, ft) is a strong function of drainage area (DA, mi^2). A drainage area-depth relationship was derived empirically for streams in west central Ohio (including many observations from the Big Darby Creek watershed) and shown in the form:

$$D_{max} = 1.9\ DA^{0.26}$$ *(Equation 3.5)*

Knight and Shiono (1996) suggest that a flood depth of 1.1 to 1.3 (typically 1.2) times the maximum bankfull depth produces maximum interaction of a river with its floodplain. This would suggest a depth capable of maximum pollutant assimilation. Similarly, Rosgen (1996) suggested a water level of two times the maximum bankfull depth yields the width of the flood-prone area. Hence, two flood plain zones resulting from inundation levels of 1.5 and 2 times the maximum bankfull depth are predicted in this simulation. Flood plain set backs are recommended in this TMDL primarily for pollutant assimulation purposes. The appropriate target flood plain to compare the estimated existing flood plain to is the 1.5 times the maximum bankfull depth (e.g. Actual 1.5x) value on Tables 4.1.3 and 4.4.2.

While the active flood plain is predicted from the maximum bankfull depth, the recommended flood plain width is determined from the bankfull width. Bankfull width, like bankfull depth, has a functional relationship with drainage area (Dunne and Leopold, 1978). A drainage area-width relationship was derived empirically for streams in west central Ohio (including many observations from the Big Darby Creek watershed) and shown in Equation 3.1.

3.3.5 Habitat Quality and Bedload

Description of Method
The QHEI is a quantitative expression of a qualitative, visual assessment of habitat in free flowing streams and was developed by the Ohio EPA to assess available habitat for fish communities (Rankin, 1989, 1994). The QHEI is a composite score of six physical habitat categories: 1) substrate, 2) in-stream cover, 3) channel morphology, 4) riparian zone and bank erosion, 5) pool/glide and riffle/run quality, and 6) gradient. Each of these categories are subdivided into specific attributes that are assigned a point value reflective of the attribute's impact on the aquatic life. Highest scores are assigned to the attributes correlated to streams with high biological diversity and integrity and lower scores are progressively assigned to less desirable habitat features. A QHEI evaluation form is used by a trained evaluator while in the stream itself. Each of the components are evaluated on site, recorded on the form, the score totaled, and the data later analyzed in an electronic database. The evaluation form is available on line at http://www.epa.state.oh.us/dsw/bioassess/QHEIFieldSheet062401.pdf

The QHEI is a macro-scale approach that measures the emergent properties of habitat (sinuosity, pool/riffle development) rather than the individual factors that shape these properties (current velocity, depth, substrate size). The QHEI is used to evaluate the characteristics of a short stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. However, QHEI evaluations are segment specific and do not give a strong indication of the quality of the habitat in other stream segments.

QHEI scores can range from 12 to 100. The appropriate QHEI target score was determined by statistical analysis of Ohio's statewide database of paired QHEI and IBI scores. Simple linear and exponential regressions and frequency analyses of combined and individual components of QHEI metrics in relation to the IBI were examined. The regressions indicated that the QHEI is significantly correlated with the IBI. Scores greater than 75 indicate excellent stream habitat, scores between 60 and 75 indicate good habitat quality, and scores less than 45 demonstrate habitat not conducive to WWH. Scores between 45 and 60 need separate evaluation by trained field staff to determine the potential aquatic life use for the stream.

The analysis of the QHEI components as they relate to IBI scores led to the development of a list of attributes that are associated with degraded communities. These attributes are modifications of natural habitat and are listed in Table 3.6. These modified attributes were further divided into high influence or moderate influence attributes based on the statistical strength of the relationships. The presence of these attributes can strongly influence the aquatic biology and the QHEI score itself may not reflect this effect. This explains why habitat can be impaired even with a QHEI score above 60 (because other less influential habitat components are in place).

These three factors appear to have about an equal weight. An accumulation of four modified attributes corresponds to fewer than 50% of sites achieving a WWH target IBI score of 40. High influence modified attributes are particularly detrimental given that the presence of one is likely to result in impairment, and two will likely preclude a site from achieving an IBI of 40 (OEPA, 1999). The QHEI score of 60 or greater is correlated with IBIs of 40 or greater. A complete habitat TMDL needs to reflect both a good QHEI score and the relative presence of these modified attributes.

TMDL Calculation and Allocation

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

Habitat TMDL = QHEI Score ≥ Target + Modified Attribute Score + High Influence Attribute Score
= 1 + 1 + 1
= 3

The bedload TMDL equation presented below is a subset of those factors of the QHEI most directly related to sediment type, quality, build up, and source origin. The sediment TMDL is a score of 32 for WWH sites and 35 for EWH sites. The individual components of the bedload TMDL (QHEI scores for substrate, channel, and riparian) are allocated as described below.

Bedload TMDL = Substrate + Channel Morphology + Riparian Zone/Bank Erosion

For WWH ≥ 13 + 14 + 5
≥ 32

For EWH ≥ 15 + 15 + 5
≥ 35

Table 3.6 provides additional detail describing the habitat and sediment TMDLs.

Table 3.6 Details of Habitat and Bedload TMDLs

Bedload TMDL Categories				Modified Attributes	
QHEI Category	Target			High Influence	Moderate Influence
	WWH	EWH		•Silt/Muck Substrate	•Recovering Channel
Substrate	≥13	≥15		•No Sinuosity	•Sand Substrate (Boat)
Channel	≥14	≥15		•Sparse/No Cover	•Hardpan Substrate Origin
Riparian	≥5	≥5		•Max Depth < 40 cm (Wade)	•Fair/Poor Development
Bedload TMDL	≥32	≥35		•Channelized or No Recovery	•Only 1-2 Cover Types
Habitat TMDL Categories					•No Fast Current
QHEI Score	≥ 60	≥ 75	+1		•High/Moderate Embeddedness
High Influence #	< 2	0	+1		•High/Mod Riffle Embeddedness
Total # Modified	< 5	< 3	+1		•No Riffle
Habitat TMDL			3		•Heavy/Moderate Silt Cover
					•Low SInuosity
					•Intermittent and Poor Pools
					•Max Depth < 40 cm (Headwater)

Notes:

Headwater streams have drainage areas < 20 mi^2

Wadeable streams have drainage areas ≥20 mi^2 and < 200 mi^2

Boat refers to sites requiring a boat to collect the data; generally sites having drainage areas > 100 mi^2

The empirical nature of the QHEI and the data that underlie it provide measurable targets that are parallel concepts to a loading capacity for a pollutant. The components provide a way to evaluate whether habitat is a limiting factor for the fish community and which attributes are the likely stressors. The QHEI can assess both the source of the sediment (riparian corridor, bank stability) and the effects on the stream itself (i.e., the historic sediment deposition) and thus, has aspects of both a loading model and a receiving stream model. When used with biological indices, the numeric measurability of the index provides a means to monitor progress when implementing a TMDL and to validate that a target has been reached.

Table 3.7 Summary of Methods to Evaluate In-stream Responses and Habitat

Parameter	Evaluation Method	Applicable Conditions	Evaluated Locations
Total Phosphorus	LDC	All flow conditions	USGS gages
	QUAL2K	Average flow	Significant point source effected areas
Sediment			
Total Suspended	LDC	All flow conditions	USGS gages
Bedload	QHEI	Cumulative, chronic conditions	Individual sites
Fecal Coliform	LDC	All flow conditions	USGS gages
Dissolved Oxygen	QUAL2K	Low flow	Significant point source affected areas
Ammonia	QUAL2K	Low flow	Significant point source affected areas
Habitat	QHEI	Cumulative, chronic conditions	Individual sites
Flood Plain	GIS	Cumulative, chronic conditions	Upper Darby and Hamilton Ditch (existing conditions) Entire watershed (target conditions)

3.4 Critical Conditions and Seasonality

Aquatic Life

The critical condition for aquatic organisms is the summer when the aquatic life activity and biomass production are at their highest levels and the organisms are most sensitive to environmental conditions. Summer is also when excessive algal growth, high in-stream temperatures, and reduced stream flows occur leading to the lowest dissolved oxygen levels. Ohio EPA biological, habitat, and nutrient targets are protective of the critical period as they are based on data collected only during the summer months. Further, assessing the biology during the summer months evaluates the biological performance during the most critical time of the year.

Seasonality is accounted for in the aquatic life indices. Biological and habitat indices are measures of aggregate annual conditions reflecting compounding factors over time. The use of these indices reflects the collective seasonal effects on the biota. The measurement of these indices during the summer period reflects the biotic performance during critical conditions.

Nutrients and Sediment

The critical condition for nutrient enrichment is the summer warm season, when the potential for primary production is highest. The summer concentration of phosphorus in the water column, however, is dependent upon more than summer phosphorus load contributed to the stream. As phosphorus readily attaches to sediment, detachment of adsorbed phosphorus in bottom sediments can lead to elevated in-stream concentrations regardless of the magnitude of short-term loads. As a result, it is the long-term, or chronic, phosphorus load and sediment load that is more directly related to the degradation of water quality. For this reason phosphorus and sediment TMDLs were developed on an annual basis. The use of a 10-year record of daily weather and stream flow data in GWLF incorporates seasonal and hydrologic variability and protects for all conditions including critical ones.

Seasonality and critical conditions were also considered in the Load Duration Curves used to establish TMDLs for total phosphorus and suspended sediment at USGS gage sites. The LDC approach utilizes all daily recorded flow values in the period of record. Therefore, the critical conditions and seasonal variation are included in the analysis.

Dissolved Oxygen and Ammonia

The conditions that are the most critical to the in-stream dissolved oxygen and ammonia concentrations of the Big Darby Creek occur when water temperatures are high and stream flow is low such as occurs during the summer months. Dissolved oxygen and ammonia in-stream concentrations were simulated under these summer conditions. Point source dischargers were included in this simulation at their maximum permissible loading. These circumstances formed the conditions at which the point sources were evaluated and wasteload allocations were established in this TMDL.

During the winter, water temperatures are lower, dissolved oxygen saturation levels and stream flows are higher, and the aquatic vegetation is reduced. Therefore, the majority of the factors causing low dissolved oxygen concentrations do not exist in the winter months. Simulations protective of summer conditions will be protective of all seasons.

Pathogens

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

3.5 Margin of Safety

The statute and regulations require that a TMDL include a margin of safety to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA § 303(d)(1)(C), 40 C.F.R. § 130.7(c)(1)). U.S. EPA guidance explains that the margin of safety may be implicit, i.e., incorporated into the

TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as a loading set aside. The implicit and explicit margin of safety factors used in the analyses are described below.

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

It is important to keep in mind during the evaluation of the TMDL a major difference in Ohio's program from other state programs. In Ohio, one way a stream segment is listed on the 303(d) list is for failure to attain the appropriate aquatic life use as determined by direct measurement of the aquatic biological community. Other State programs rely solely on chemical samples in comparison to chemical criteria to determine water quality and designated use attainment. However, relying solely on chemical data does not take into account any of the parameters or other factors for which no criteria exist but that affect stream biology nor does it account for multiple stressor situations. Therefore, the chemical specific approach misses many biologically impaired streams and may not detect a problem until it is severe. Ohio's approach incorporates an increased level of assurance that Ohio's water quality problems are being identified. Likewise, de-listing requires attainment of the aquatic life use determined by the direct measurement of the aquatic biological community. This provides a high level of assurance (and an implicit margin of safety) that if the TMDL allocations do not lead to sufficiently improved water quality then the segments remain on the list until true attainment is achieved.

Total Phosphorus and Sediment

A margin of safety was incorporated both implicitly and explicitly into these TMDLs. An implicit margin of safety is incorporated into the target development process. The explicit margin of safety is 5% of the loading capacity specifically reserved to account for any additional uncertainty following the application of the implicit measures. This explicit percentage was selected based on the availability of data, the high level of calibration achieved by the model, and the use of annual loadings which all contribute to decreasing the uncertainty associated with the data and model predictions.

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

Pathogens

A margin of safety was implicitly incorporated into the pathogen TMDL. The fecal coliform load to the streams in each sub-watershed was quantified, as was the fecal coliform loading capacity at the outlet of each sub-watershed. Loading capacity was calculated as the product of the seasonal flow volume and the fecal coliform target concentration. No attempt was made to link downstream loading capacity with upstream loading via in-stream processing. Rather, the load reductions recommended by this report are based upon a direct comparison between the two quantities. In reality, considerable die-off occurs between the source of loading and the TMDL endpoint and this loss represents an implicit margin of safety.

4.0 Watershed Analysis, Loading Capacity, and Allocations

The results of the analyses are summarized in tables and graphics in this chapter. The chapter is divided up by the four major sub-watersheds (upper, middle, lower Big Darby Creek and Little Darby Creek). The bedload, habitat, and flood plain capacity and allocation tables are presented at the beginning of each major watershed section. The bedload and habitat allocations are site specific, and all sites with a habitat assessment within the major watershed are presented in the table. The flood plain recommendations table presents flood plain recommendations by stream within each minor sub-watershed. The loading capacity and allocation tables follow and are organized by minor sub-watershed.

The bedload and habitat TMDL tables show the applicable targets per component in the header row of the table. The information presented in the body of the table is grouped by each of the minor sub-watersheds from upstream to downstream, and it is organized by stream and site river mile. The existing scores for each category and the total existing bedload and habit score is defined. The percent deviation the actual bedload score is from the allowable bedload score is shown followed by the main impaired QHEI category of the three used in determining the bedload score (see Section 3.3.5). The existing total habitat score per site can be compared to the allowable habitat score to make the same deviation determination. This table shows what components of the habitat need improvement and to what degree, and it can be used to guide management decisions and implementation activities.

The recommended flood plain widths are summarized in tables per major sub-watershed. Within the table, the information is grouped by minor sub-watershed and is organized by streams within each. All information is presented from upstream to downstream. Note the abbreviation UNT is used to identify an unnamed tributary, and a river mile of the stream the UNT is tributary to is listed for identification purposes. The appropriate flood plain width is specific to each point along a stream and is based on the use designation of the stream and the drainage area upstream of the point of interest as discussed in section 3.2. The use designation of each stream or stream segment is listed in the table as is the drainage area of the lower end site. Because there is a continuum of flood plain widths that gradually widens as you travel downstream, the flood plain table lists the flood plain needed at the upper reaches of the stream segment (this represents the minimum flood plain needed for the stream) and at the lower end. The lower end determination refers to the most downstream point of the stream segment of interest and represents the maximum flood plain needed for that segment. These give the range of flood plain widths needed and should provide some general guidance as to what appropriate flood plain widths are within the segment itself. Equations 3.2 through 3.4 can be used to determine the site specific recommended flood plain widths needed. The widths presented in the table denote the measurement from the centerline of the stream to a side. The total width of the corridor needed to be accessible as flood plain is the setback width multiplied by 2.

An areal estimate of existing active flood plain was done within two pilot areas of the Big Darby Creek watershed. These areas include parts of the upper Big Darby Creek and the Hellbranch sub-watersheds. The amount of existing active flood plain compared with the desired active flood plain for the two pilot areas is shown in Tables 4.1.3 and 4.4.2 respectively. The column labeled '1.5x Actual' should be used as the estimate of existing flood plain as this quantity is the amount needed to assimilate pollutants and is in keeping with the purpose of the TMDL. The '2x Actual' represents a quantity based on the typical flood plain associated with streams in this ecoregion. The percent the current flood plain meets the desired flood plain area is included in these tables. Two types of graphics are included to highlight the differences in existing versus needed flood plain. Areal plots for the Flat Branch and Buck Run areas are shown in Figures 4.1.1 and 4.1.2 respectively. Note the differences between the amount of actual flood plain available to the tributaries and that available to the Big Darby Creek mainstem. The second type of graphic which shows the comparison of actual and needed flood plain widths is a longitudinal plot of specific site measurements shown in a downstream direction for each sub-watershed in the pilot areas. These figures are included with the minor sub-watershed's sub-section of this chapter. The IBI score and use attainment of sites in the sub-watershed are included in these figures for comparison purposes.

The existing and allowable loads for total phosphorus, suspended sediment, and fecal coliform are given in tables organized by minor sub-watershed. The allowable total load (the TMDL number) is stated followed by the allocations of this load to its sources. The total existing load and the existing load by source is included. The overall percent reduction needed and the reductions per source are also listed. The loads are given in kilograms per year which can be converted to pounds per year by multiplying by a conversion factor of 2.2. The nonpoint sources category for total phosphorus and suspended sediment is divided between runoff from managed lands, groundwater from managed lands, and a natural load which includes both the runoff and groundwater load of the sub-watershed if it was still in its natural state (no point or septic sources, no land management for urban or agricultural needs).

The point source allowable load is further distributed amongst the individual NPDES permit holders within the sub-watershed. These waste load allocations are included in a second table. NPDES permit holders in the Darby watershed are generally municipal WWTPs; however, the Hellbranch Run sub-watershed also has Municipal Separate Storm Sewer Systems (MS4s) which require a NPDES permit. The wasteload allocations for these systems are included in the wasteload allocation table for Hellbranch Run.

The individual point source allocation table also includes the permit concentration limits to protect water quality for dissolved oxygen and ammonia. These permit concentrations are included for facilities that were evaluated as a part of the TMDL process. The permit limits are needed to address in-stream dissolved oxygen and ammonia impairments and to protect for the designated uses.

A table is also included which shows the distribution of existing load among the sources. It gives the percent contribution of the existing total phosphorus load per source. The table is organized in descending order of contribution percentage.

Other analyses were done and are presented in this chapter. A statistical comparison of water quality parameters in the upper Darby watershed was done to further our understanding of the unusual chemical signatures and impairment present there. Load duration curves at the three active USGS gage sites are included in the appropriate sub-watershed discussion. The potential for groundwater influence was explored by an examination of specific geology associated with groundwater - surface water interactions. The results are presented in Appendix A.

4.1 Upper Big Darby Creek

The upper Big Darby Creek analysis had a variety of results. A look at the Big Darby Creek mainstem from the headwaters to above Sugar Run shows the mainstem generally has an intact wooded riparian stream buffer (Figure 2.2.2). However the predicted existing active floodplain (Table 4.1.3) indicates the flood plain corridor for the mainstem from the headwaters to Milford Center is generally not sufficient for an EWH stream. The percent difference between the actual active flood plain and the recommended increases in the downstream direction. The active flood plain pilot area ended just downstream of Milford Center; however the attainment of the habitat and bedload TMDL scores (Table 4.1.1) in the section from downstream Milford Center to above Sugar Run would loosely imply the flood plain corridor is sufficient in this reach. The main QHEI categories in the qualitative bedload analysis indicate riparian was not an issue in the mainstem, but that the channel and substrate metrics were. The habitat TMDL was not met at 7 of the 11 sites on the mainstem (64% of the sites did not meet). The 4 sites that did meet the habitat TMDL were all in the stretch from Milford Center to above Sugar Run. Likewise the majority of this reach is fully meeting its designated use.

The tributaries in this sub-watershed generally do not have intact wooded riparian corridors or sufficient connection with the active flood plain to protect for designated uses - either in the tributary itself or for downstream uses. The Flat Branch tributary has a minimal aquatic life designated use which it meets. However, the bedload, habitat, flood plain, and buffer measurements and indices in Flat Branch are very low and contribute to impairment in the Big Darby mainstem downstream of Flat Branch. In addition, unusual chemical signatures in the Flat Branch and Buck Run may be contributing to this impairment as well (Section 4.1.8). Other tributaries have a variety of deficient bedload categories with the channel category being the most commonly impaired. Most of the tributaries do not meet their habitat TMDL with 15 of the 19 tributary QHEI sites measured in the sub watershed not meeting their habitat TMDL. (79% not meeting).

The pollutant loading analysis (Sections 4.1.1 through 4.1.7) corroborates the above. The upper and middle portions of the mainstem within this sub-watershed need higher reductions in total phosphorus and significantly higher reductions in sediment loading than does the lower portion of the sub-watershed. This reflects the buffering effect the physical properties can have on the load to the system. The loading reductions needed in the tributaries are generally comparable to each other with a 70-80% reduction needed in total phosphorus load and about a 60% reduction needed in sediment load. The Flat Branch WWTP contributes to the phosphorus load and will be asked to reduce its phosphorus output.

The potential for groundwater influence is discussed in Appendix A. The upper Big Darby sub-watershed has geologic indications that groundwater is a buffering factor for some areas of the sub-watershed. Many streams on the western portion of the sub-watershed interact with high-yielding bedrock aquifers making the potential for a strong groundwater contribution likely. A portion of the Big Darby Creek mainstem around Milford Center exhibits this property as well. The tributaries on the eastern side of the sub-watershed do not have geologic properties that indicate groundwater is an unusual buffering influence to the system.

The linkage between multiple factors can be demonstrated by the following situation that has developed in the Big Darby Creek downstream of the Flat Branch tributary. Nutrient sources from the upper Big Darby, Flat Branch and the Flat Branch WWTP enrich the mainstem and supply a rich food source for algae. The hydrologic and hydraulic alterations of the Flat Branch sub-watershed as the watershed has been industrialized by Honda have resulted in increased peak flows to the Big Darby Creek mainstem. This increase in flows and the resultant increased flooding prompted a downstream landowner to levee his land; in addition, he removed the riparian vegetation that had been bordering the stream through his property. The removal of the woody riparian vegetation increased the available sunlight to the stream. The algae now had an unlimited supply of food and energy with which to grow. The bottom algae at this site was the highest recorded at any site within the entire Big Darby Creek watershed leading to dissolved oxygen violations where none had existed before. The levee serves to disconnect this stretch of the mainstem from an effective flood plain which will only exacerbate the flooding, nutrient, and sediment problems downstream.

Actions taken in the watershed have a domino effect. Upstream actions propagate downstream. Proper management of the watershed can allow for development and drainage needs while protecting aquatic life designations. An effective solution to the above situation may have been to start with Flat Branch and to control the export of flow and nutrients from that sub-watershed. This would have likely reduced or removed the flooding problem for the downstream farmer. If the riparian woody corridor had been left intact on the mainstem, the nutrient load in the stream would not necessarily have been reduced significantly; however, the reduced sunlight available to the aquatic vegetation would have controlled their growth. This would have prevented the dissolved oxygen problem that has now arisen.

Table 4.1.1 Bedload and Habitat TMDLs for upper Big Darby Creek (Headwaters to Sugar Run) 05060001-190

		Bedload TMDL						**Habitat TMDL**						
	Use	Allocations			TMDL			Allocations			Subscore			TMDL
TMDL Targets →	*EWH*	*≥15*	*≥15*	*≥5*	*35*			*≥75 = 1*	*0 = 1 pt*	*<3 = 1 pt*				*3 pts*
	WWH	*≥13*	*≥14*	*≥5*	*32*			*≥60 = 1*	*<2 = 1 pt*	*<5 = 1 pt*				*3 pts*
Existing Scores Stream/River (Use) *Impaired indicates use is not met*	**River Mile**	QHEI Categories: Substrate	Channel	Riparian	Total Bedload Score	% Deviation from Target	Main Impaired Category if any	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
Big Darby Creek: Headwaters to Flat Branch 05060001-190-010														
Big Darby Creek (EWH/CWH) *Impaired*	82.5	16.5	13.5	5	35	-	Channel	68	0	5	0	1	0	1
	80.8	7.5	12.5	5.5	25.5	27%	Substrate	61	1	7	0	0	0	0
	79.2	14	12	5.5	31.5	10%	Channel	64.5	0	4	0	1	0	1
Flat Branch 05060001-190-020														
Flat Branch (MWH)	3.2	4.5	4.5	3.5	12.5	n/a	Substrate	25.5	5	10	-	-	-	n/a
	0.8	3.5	8	4.5	16	n/a	Substrate	36.5	3	9	-	-	-	n/a
UT to Flat Branch (RM 1.50) (MWH)	0.1	5.5	7.5	5.5	18.5	n/a	Substrate	36.5	3	8	-	-	-	n/a

Table 4.1.1 Bedload and Habitat TMDLs for upper Big Darby Creek (Headwaters to Sugar Run) 05060001-190

		Bedload TMDL						Habitat TMDL						
	Use	Allocations			TMDL			Allocations			Subscore			TMDL
TMDL Targets →	*EWH*	*≥15*	*≥15*	*≥5*	*35*			*≥75 = 1*	*0 = 1 pt*	*<3 = 1 pt*				*3 pts*
	WWH	*≥13*	*≥14*	*≥5*	*32*			*≥60 = 1*	*<2 = 1 pt*	*<5 = 1 pt*				*3 pts*
Existing Scores Stream/River (Use) *Impaired indicates use is not met*	**River Mile**	QHEI Categories: Substrate	Channel	Riparian	Total Bedload Score	% Deviation from Target	Main Impaired Category if any	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
Big Darby Creek: Flat Branch to Milford Center 05060001-190-030														
Big Darby Creek (EWH) *Impaired*	78.4	13.5	10	4.5	28	20%	Channel	63.5	1	6	0	0	0	0
	76.6	15	15.5	6.5	37	-	Substrate	73.5	0	3	0	1	1	2
	69.5	16.5	13	5.5	35	-	Channel	70.5	1	5	0	0	0	0
	66	14.5	17.5	7	39	-	Substrate	74.5	0	2	0	1	1	2
Little Darby Creek Logan Co. (EWH/CWH)	3.5	6	4	1	11	69%	All	32	4	7	0	0	0	0
	0.4	15	16	4.5	35.5	-	Riparian	68	0	1	0	1	1	2
UT to Big Darby Creek (RM 74.91) (EWH)	0.2	9.5	15	4.5	29	17%	Substrate	62.5	0	3	0	1	1	2
UT to Big Darby Creek (RM 69.4) (WWH)	0.3	5	7	3.5	15.5	52%	Substrate	33.5	4	9	0	0	0	0
Spain Creek (EWH/WWH[1])	5.7[1]	14	16	5	35	-	Good	66	0	3	1	1	1	3
	3.7	15.5	16.5	4.5	36.5	-	Riparian	72	0	1	0	1	1	2
	0.1	14.5	17	6.5	38	-	Substrate	76	0	2	1	1	1	3

Table 4.1.1 Bedload and Habitat TMDLs for upper Big Darby Creek (Headwaters to Sugar Run) 05060001-190

		Bedload TMDL						**Habitat TMDL**						
	Use	Allocations			TMDL			Allocations			Subscore			TMDL
TMDL Targets →	*EWH*	*≥15*	*≥15*	*≥5*	*35*			*≥75 = 1*	*0 = 1 pt*	*<3 = 1 pt*				*3 pts*
	WWH	*≥13*	*≥14*	*≥5*	*32*			*≥60 = 1*	*<2 = 1 pt*	*<5 = 1 pt*				*3 pts*
Existing Scores Stream/River (Use) *Impaired indicates use is not met*	**River Mile**	QHEI Categories			Total Bedload Score	% Deviation from Target	Main Impaired Category if any	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
		Substrate	Channel	Riparian										
Pleasant Run (EWH)	4.6	17	14	4.5	35.5	-	Riparian	72	0	2	0	1	1	2
	0.5	12.5	12.5	4.5	29.5	16%	Substrate	59.5	0	6	0	1	0	1
Hay Run (EWH)	0.3	13.5	10.5	5.5	29.5	16%	Channel	52.5	2	7	0	0	0	0
Big Darby Creek: Milford Center to Sugar Run 05060001-190-040														
Big Darby Creek (EWH) *Impaired*	62.5	17	17	6.5	40.5	-	Good	83.5	0	0	1	1	1	3
	54.2	15	18	6	39	-	Substrate	83.5	0	0	1	1	1	3
	53.9	18	19.5	6	43.5	-	Good	93	0	0	1	1	1	3
	52	18	13	6	37	-	Channel	81	0	1	1	1	1	3
Prairie Run (LRW)	0.3	1	4	3	8	n/a	-	23	5	9	-	-	-	-
Sweeney Run (WWH) *Impaired*	0.1	14	10.5	6	30.5	5%	Channel	58	2	6	0	0	0	0

Table 4.1.1 Bedload and Habitat TMDLs for upper Big Darby Creek (Headwaters to Sugar Run) 05060001-190

		Bedload TMDL						**Habitat TMDL**						
	Use	Allocations			TMDL			Allocations			Subscore			TMDL
TMDL Targets →	*EWH*	*≥15*	*≥15*	*≥5*	*35*			*≥75 = 1*	*0 = 1 pt*	*<3 = 1 pt*				*3 pts*
	WWH	*≥13*	*≥14*	*≥5*	*32*			*≥60 = 1*	*<2 = 1 pt*	*<5 = 1 pt*				*3 pts*
Existing Scores Stream/River (Use) *Impaired indicates use is not met*	**River Mile**	QHEI Categories			Total Bedload Score	% Deviation from Target	Main Impaired Category if any	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
		Substrate	Channel	Riparian										
Buck Run 05060001-190-050														
Buck Run (WWH) *Impaired*	10.4	12.5	6.5	4	23	28%	Channel	40	4	10	0	0	0	0
	7.8	12.5	14.5	5.5	32.5	-	Substrate	55.5	1	3	0	1	1	2
	0.1	16	14.5	2.5	33	-	Riparian	70.5	0	3	1	1	1	3
Robinson Run 05060001-190-060														
Robinson Run (WWH) *Impaired*	2.1	17.5	12	5	34.5	-	Channel	64	1	5	1	1	0	2
	0.7	14.5	13.5	7	35	-	Channel	70	1	6	1	1	0	2
Sugar Run 05060001-190-070														
Sugar Run (MWH[2]/WWH) *Impaired*	7.5[2]	7	6.5	2.5	16	n/a	-	31	4	9	-	-	-	n/a
	7.0	6	4	2.5	12.5	61%	Channel	29.5	5	10	0	0	0	0
	5.4	5	4.5	4	13.5	58%	Channel	38.5	4	8	0	0	0	0
	0.5	16	13	5	34	-	Channel	65.5	0	3	1	1	1	3

[1]Denotes a Warm Water Habitat (WWH) Site.
[2]Denotes a Modified Warm Water Habitat (MWH) Site.

Table 4.1.2 Recommended Flood Plain Widths for Upper Big Darby Creek (Headwaters to Sugar Run) 0506001-190

Stream Segment	Use Designation[a]	Drainage Area[b] (sq.mi)	Setback Width[c] (per side, ft)	
			Upper End	Lower End
Big Darby Creek Headwaters to above Flat Branch -010				
Big Darby Creek -- headwaters to RM 78.48	EWH/CWH[d]	5.90	81.1	142.6
-020 Flat Branch				
Flat Branch	MWH/WWH[f]	13.52	54.3	101.8
UNT[e] to Flat Branch at RM 1.5	MWH	0.59	10.0	15.9
Big Darby Creek below Flat Branch to Milford Center -030				
Big Darby Creek -- RM 78.48 to RM 66.0	EWH	83.22	238.1	445.2
Little Darby Creek (Logan Co)	EWH/CWH[d]	7.12	99.4	154.7
UNT to Big Darby Creek at RM 74.91	EWH	3.72	45.5	117.0
Spain Creek -- headwaters to RM 5.0	WWH/CWH[d]	5.99	31.1	71.8
Spain Creek -- RM 5.0 to mouth	EWH/CWH[d]	10.08	143.5	179.6
Pleasant Run	EWH	7.01	121.4	153.6
UNT to Big Darby Creek at RM 69.4	WWH	4.85	48.1	65.6
Hay Run	EWH	6.43	113.4	148.0
Big Darby Creek from Milford Center to above Sugar Run [except Buck & Robinson Run] -040				
Big Darby Creek -- RM 66.0 to RM 50.92	EWH	155.84	445.2	583.0
Prairie Run	LRW[d]	4.23	11.3	12.4
Sweeney Run	WWH	4.33	33.3	62.5
-050 Buck Run				
Buck Run	WWH	29.86	65.8	143.3
-060 Robinson Run				
Robinson Run	WWH	10.62	39.2	91.8
-070 Sugar Run				
Sugar Run -- headwaters to RM 7.4	MWH	3.92	10.6	35.9
Sugar Run -- RM 7.4 to mouth	WWH	20.22	86.1	121.1
UNT to Sugar Run at RM 7.39	MWH	5.23	28.3	40.6

Notes:
(a) Assignments of use designation taken from *Biological and Water Quality Study of the Big Darby Creek Watershed, 2001/2002. Logan, Champaign, Union, Madison, Franklin and Pickaway Counties, Ohio.*
(b) Drainage area applies to lower end of segment; it is derived from digital topographic model and GIS
(c) Width is **one** side (e.g. left bank or right bank and its corresponding floodplain) of stream segment measured from stream centerline.
(d) EWH/CWH and WWH/CWH assume setback width based on EWH and WWH criteria, respectively. LRW assigned setback of half bankfull width.
(e) UNT: un-named tributary
(f) Based on protection of downstream use.

Table 4.1.3 Comparison of Needed and Predicted Active Floodplain for Selected Segments in the Big Darby Creek

Stream Segment	Aquatic Life Use	Active Floodplain Total Area[2] (Acres)			RM	Use Attainment	IBI[3]	ICI[3]	QHEI
		Area Needed[1]	Actual (2x) % of Needed Area Met	Actual (1.5x) % of Needed Area Met					
Big Darby Creek: Headwaters to Flat Branch 05060001-190-010									
Big Darby Creek -- RM 83.0 to RM 78.5	EWH/ CWH	129.5	111.2 86%	106.3 82%	83.2 82.5 80.8 79.2	(Full) Full (Non) Full	-- 52 42* 48^{ns}	42^{ns} 46 -- 56	-- 68.0 61.0 64.5
Flat Branch 05060001-190-020									
Flat Branch -- RM 5.2 to RM 0.9	MWH/ WWH[4]	72.5	44.4 61%	26.4 36%	3.2 2.2 0.9	Full (Full) Full	26 -- 28	G MG 50	25.5 -- 36.5
UNT (0.6 mi) to Flat Branch at RM 2.8	WWH (default)	6.8	6.0 89%	3.5 51%	--	--	--	--	--
Big Darby Creek: Flat Branch to Milford Center 05060001-190-030									
Big Darby Creek -- RM 78.5 to RM 66.0	EWH	1124.8	888.5 79%	782.0 70%	78.4 76.6 69.5 67.0	Partial Partial Full Partial	37.3* 43* 52 44*	52 56 52 E	63.5 73.5 70.5 --
UNT (0.26 mi) to Big Darby Creek at RM 74.91	EWH	5.4	4.1 75%	3.7 69%	0.2	Full	50	VG^{ns}	62.5
Big Darby Creek: Milford Center to Sugar Run 05060001-190-040									
Big Darby Creek -- RM 66.0 to RM 63.7	EWH	136.4	53.2 39%	33.1 24%	66.0 64.1	Partial Partial	52 49^{ns}	40* 50	74.5 80.5
UNT (0.2 mi) to Big Darby Creek at RM 60.6	WWH (default)	0.07	0.06 83%	0.05 66%	--	--	--	--	--
Buck Run 05060001-190-050									
Buck Run -- RM 9.6 to RM 2.1	WWH	211.1	137.0 65%	79.2 38%	10.4 7.8 5.0	Non Partial (Full)	26* 28* --	MG^{ns} G MG^{ns}	40.0 55.5 --

Table 4.1.3 Comparison of Needed and Predicted Active Floodplain for Selected Segments in the Big Darby Creek

Stream Segment	Aquatic Life Use	Active Floodplain Total Area[2] (Acres)			RM	Use Attainment	IBI[3]	ICI[3]	QHEI
		Area Needed[1]	Actual (2x) % of Needed Area Met	Actual (1.5x) % of Needed Area Met					
UNT (0.22 mi) to Buck Run at RM 9.45	WWH (default)	2.1	0.8 38%	0.0 0%	--	--	--	--	--
UNT (0.17 mi) to Buck Run at RM 8.16	WWH (default)	1.1	0.04 3%	0.0 0%	--	--	--	--	--
Robinson Run 05060001-190-060									
Robinson Run -- RM 6.7 to RM 2.0	WWH	81.6	51.0 63%	29.9 37%	5.1 2.1	(Non) Non	-- 30	VP* F*	-- 64.0

Notes:

1) Assignments of use designation taken from *Biological and Water Quality Study of the Big Darby Creek Watershed, 2001/2002. Logan, Champaign, Union, Madison, Franklin and Pickaway Counties, Ohio*. EWH/CWH designation assigned EWH width recommendation.

2) Actual floodplain predicted by geographical/analytical model using limited field measurements of active floodplain height; this prediction is considered the actual active floodplain and represents a zone inundated by two (2x) or one-and-a-half times (1.5x) maximum bankfull depth. Area shown is amount overlapping recommended zone only.

3) Use Attainment, IBI, ICI, and QHEI per identified stream segment. Specific notation per IBI, ICI, and QHEI are defined as:
   - * Significant departure from ecoregion biocriteria; poor and very poor results are underlined.
   - ns Non-significant departure from ecoregion biocriteria (4 IBI or ICI units; 0.5 Iwb units).
   - a Narrative evaluation is used in lieu of ICI for qualitative samples (E=Excellent, VG=Very Good, G=Good, MG=Marginally good, F=Fair, P=Poor, VP=Very Poor).
   - c Use attainment status based on one organism group is parenthetically expressed.

4) Based on protection of downstream use.

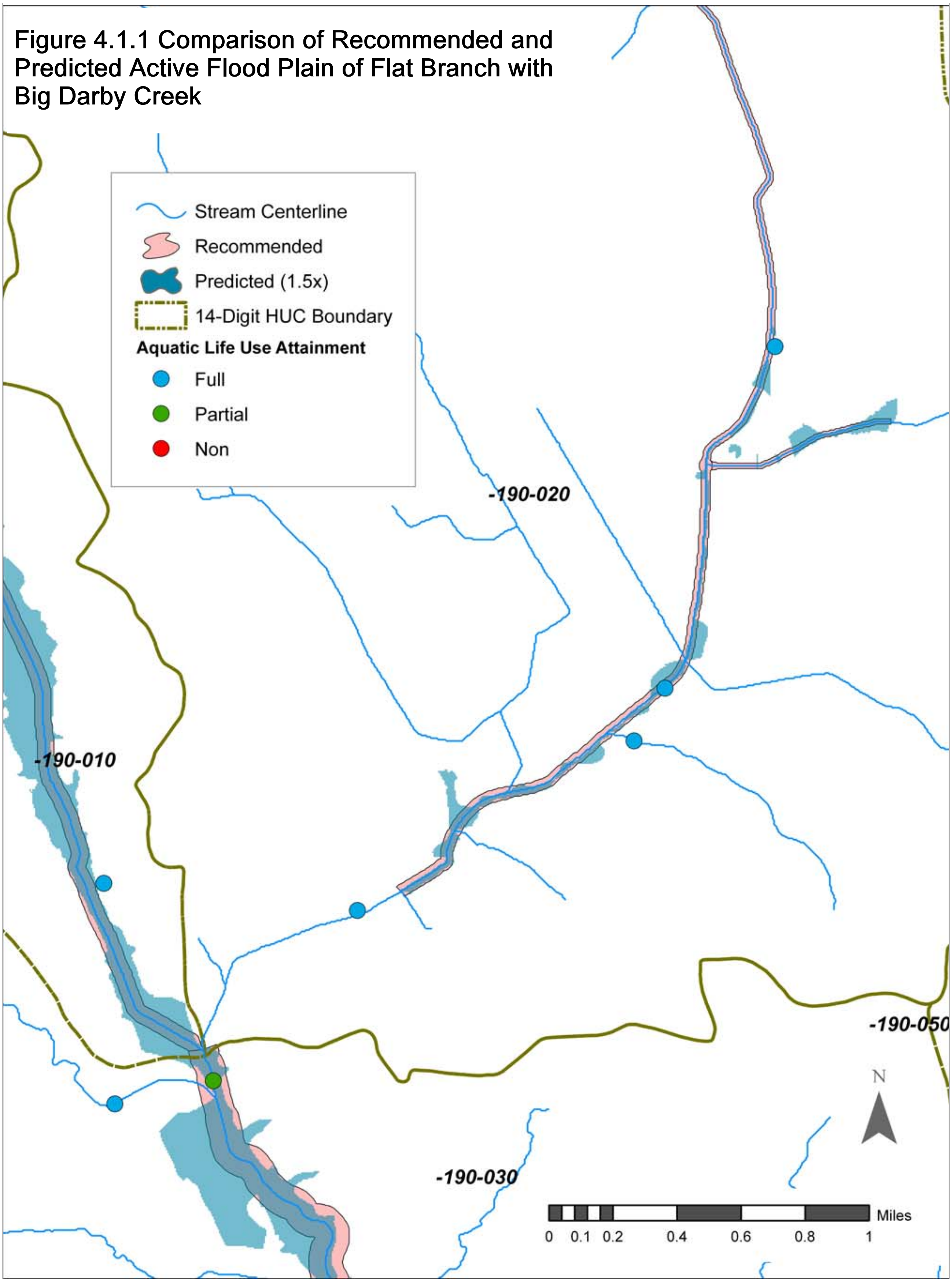


Figure 4.1.1 Comparison of Recommended and Predicted Active Flood Plain of Flat Branch with Big Darby Creek
Stream Centerline
Recommended
Predicted (1.5x)
14-Digit HUC Boundary
Aquatic Life Use Attainment
Full
Partial
Non
-190-020
-190-010
-190-050
-190-030
N
0
0.1
0.2
0.4
0.6
0.8
1
Miles

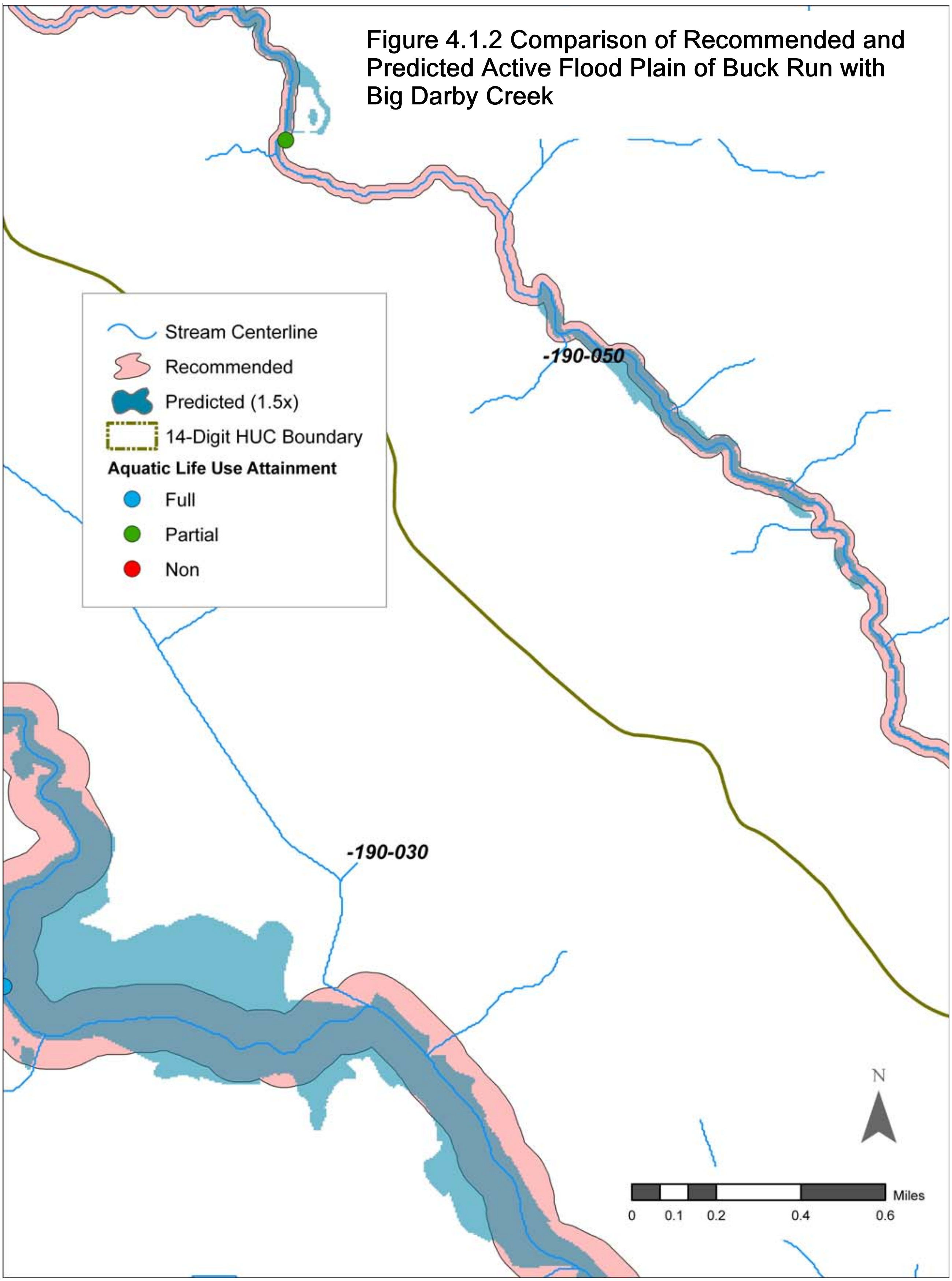


Figure 4.1.2 Comparison of Recommended and Predicted Active Flood Plain of Buck Run with Big Darby Creek
Stream Centerline
Recommended
Predicted (1.5x)
14-Digit HUC Boundary
Aquatic Life Use Attainment
Full
Partial
Non
-190-050
-190-030
N
Miles
0
0.1
0.2
0.4
0.6

4.1.1 Big Darby Creek: Headwaters to above Flat Branch

Table 4.1.1.1 Allocations for Big Darby Creek Headwaters [2] (190-010)

Total Phosphorus (kg/y)[1]

	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	250	1	138	12	81	6	12	1 lb/acre per year
Existing	2121	11	255	0	1725	118	12	
% Reduction	88%	93%	46%	--	95%	95%	0%	

Suspended Sediment (1000 kg/y)[1]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		
		Septic	WWTP		Overland Runoff	Natural	Reduction Needed
Allowable	50	0.005	0.180	3	47	0.007	387 lb/acre per year
Existing	705	0.067	0.180	0	705	0.007	
% Reduction	93%	93%	0%	--	93%	0%	

Fecal Coliform (number*10^{10}/recreational season)[3]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources	
		Septic	WWTP		Direct Animal Inputs	Washoff
Allowable	1120	0.38	2.65	Implicit	1100	23.1
Existing	1510	5.32	2.65	0	1470	31.1
% Reduction	26%	93%	0%	--	25%	25%

Hydrology Targets

% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
61%	39%	12.7 in/yr	

[1] 1 kg = 2.2 lb
[2] Results are rounded to the nearest whole number based on the percent reduction listed.
[3] Recreational season is from May - October.

Table 4.1.1.2 Point Source Allocations and Other Limits for Big Darby Creek Headwaters		
Individual Wasteload Allocations		
WWTP	Flat Branch	Notes
Permit #	1PP00006001	
FC, #/rec.season	2.65E+10	Current permit limit is adequate
Solids, kg/yr	180	Current permit limit is adequate
TP, kg/yr	138	Permit limit of 1 mg/l required
Other permit limits to protect DO and Ammonia Toxicity		
DO, mg/l	6	Current Permit limit is adequate
NH3, mg/l	0.8	Current Permit limit is adequate
$CBOD_5$, mg/l	8	Current Permit limit is adequate
Flat Branch WWTP is contributing to downstream phosphorus enrichment and a permit limit of 1 mg/l is needed. Flat Branch tributary just downstream of the WWTP is having a more deleterious effect on the Big Darby mainstem than the WWTP. A sediment and chemical oxygen demand load from the tributary combined with nutrients from both sources result in depressed DO levels in the downstream pooled area. Further downstream, removal of riparian cover and channelization of the stream adds unlimited sunlight resulting in nuisance algal and eutrophic conditions and violations of DO criteria. The bottom algae was 8 times higher in this reach than ambient conditions - the highest recorded in the watershed.		

Table 4.1.1.3 Total Phosphorus Relative Source Contributions in Big Darby Creek Headwaters	
Source	% of Existing Load
Row Crops	78.56
Point Source	12.01
Groundwater	5.71
Pasture / Hay	1.82
Commercial	0.83
Septic Systems	0.50

4.1.2 Flat Branch

Table 4.1.2.1 Allocations for Flat Branch [2] (190-020)

Total Phosphorus (kg/y)[1]

	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	658	3	2	33	548	46	26	0.9 lb/acre per year
Existing	4136	20	2	0	3771	317	26	
% Reduction	84%	84%	0%	--	85%	85%	0%	

Suspended Sediment (1000 kg/y)[1]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		
		Septic	WWTP		Overland Runoff	Natural	Reduction Needed
Allowable	132	0.020	0.073	6.6	125	0.002	67 lb/acre per year
Existing	390	0.125	0.073	0	390	0.002	
% Reduction	66%	84%	0%	--	68%	0%	

Fecal Coliform (number*10^{10}/recreational season)[3]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources	
		Septic	WWTP		Direct Animal Inputs	Washoff
Allowable	4141	1	0	Implicit	3700	440
Existing	5936	6	0	0	5310	620
% Reduction	30%	84%	0%	--	30%	30%

Hydrology Targets

% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
41%	59%	9.9 in/yr	

[1] 1 kg = 2.2 lb
[2] Results are rounded to the nearest whole number based on the percent reduction listed.
[3] Recreational season is from May - October

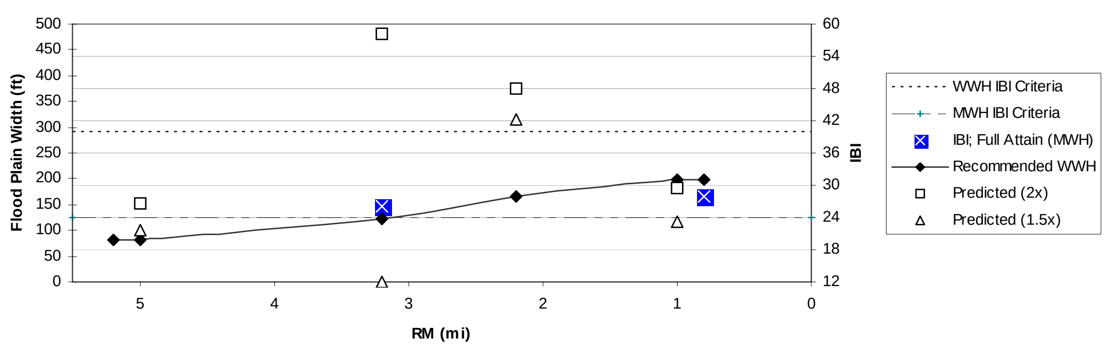
Table 4.1.2.2 Point Source Allocations for Flat Branch

Individual Wasteload Allocations			
WWTP	Honda E. Liberty WTP	Honda Benton Rd WTP	Notes
Permit #	1IW00270	4IW00019	
FC, #/rec.season	0	0	No permit limit
Solids, kg/yr	6.73	66.32	Current permit limit is adequate
TP, kg/yr	0.37	1.16	Permit limit probably not needed

Table 4.1.2.3 Total Phosphorus Relative Source Contributions in Flat Branch

Source	% of Existing Load
Row Crops	76.09%
Commercial	13.31%
Groundwater	7.79%
Pasture / Hay	0.92%
Urban Grasses	0.88%
Residential (new)	0.17%

Figure 4.1.2 Longitudinal distribution of recommended versus predicted flood plain width, IBI, and aquatic life use attainment status for Flat Branch (RM 5.5 to RM 0.5).



4.1.3 Big Darby Creek: below Flat Branch to Milford Center

Table 4.1.3.1 Allocations for Big Darby Creek from below Flat Branch to Milford Center [2] (190-030)

Total Phosphorus (kg/y)[1]

	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	4430	20	350	220	3460	280	100	1 lb/acre per year
Existing	22910	110	660	0	20400	1640	100	
% Reduction	81%	81%	47%	--	83%	83%	0%	

Suspended Sediment (1000 kg/y)[1]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		
		Septic	WWTP		Overland Runoff	Natural	Reduction Needed
Allowable	1441	0.14	1.25	70	1370	0.04	225 lb/acre per year
Existing	5535	0.71	1.25	0	5533	0.04	
% Reduction	74%	81%	0%	--	75%	0%	

Fecal Coliform (number*10^{10}/recreational season)[3]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources	
		Septic	WWTP		Direct Animal Inputs	Washoff
Allowable	11810	14	26	Implicit	4840	6930
Existing	13186	70	26	0	5380	7710
% Reduction	10%	81%	0%	--	10%	10%

Hydrology Targets

% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
51%	49%	11.2 in/yr	

[1] 1 kg = 2.2 lb
[2] Results are rounded to the nearest whole number based on the percent reduction listed.
[3] Recreational season is from May - October

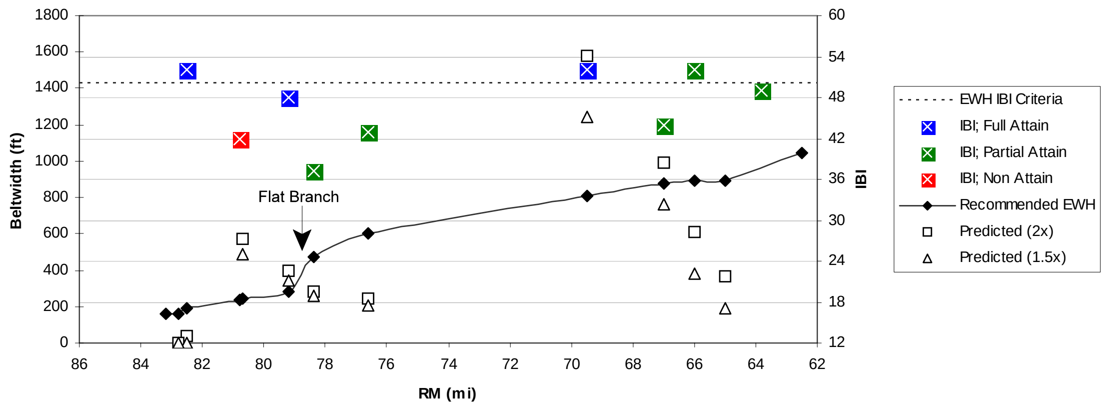
Table 4.1.3.2
Total Phosphorus Load Distribution for Big Darby Creek from below Flat Branch to Milford

Source	% of Existing Load
Row Crops	87.21%
Groundwater	7.31%
Point Source	2.87%
Pasture / Hay	1.38%

Table 4.1.3.3 Point Source Allocations and Other Limits for Big Darby Creek from below Flat Branch to Milford Center

Individual Wasteload Allocations		
WWTP	North Lewisburg	Notes
Permit #	1PB00039	
FC, #/rec.season	2.65E+11	Current permit limit is adequate
Solids, kg/yr	1250	Current permit limit is adequate
TP, kg/yr	347	TP limit is 0.6 mg/l at expanded flow (.42 mgd); 1.5 mg/l at current flow (0.17 mgd)
Other permit limits to protect DO and Ammonia Toxicity:		
CBOD5	10 mg/l	Current permit limit is adequate
DO	6 mg/l	Current permit limit is adequate
TSS	12 mg/l	Current permit limit is adequate
Ammonia	0.4 mg/l	If growth plan is not put in place or if downstream stream corridor degrades
	0.6 mg/l	If growth plan is put into place and downstream corridor is maintained/protected

Figure 4.1.3 Longitudinal distribution of recommended versus predicted flood plain width, IBI, and aquatic life use attainment status for the Big Darby Creek mainstem (RM 84.0 to RM 62.0).



4.1.4 Big Darby Creek from Milford Center to above Sugar Run (190-040)

Table 4.1.4.1 Allocations for Big Darby Creek from Milford Center to above Sugar Run [2]

Total Phosphorus (kg/y)[1]

	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	2487	28	347	124	1758	189	41	0.7 lb/acre per year
Existing	9967	113	949	0	8006	859	41	
% Reduction	75%	75%	63%	--	78%	78%	0%	

Suspended Sediment (1000 kg/y)[1]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		
		Septic	WWTP		Overland Runoff	Natural	Reduction Needed
Allowable	808	0.18	24	40	744	0.007	56 lb/acre per year
Existing	1299	0.72	24	0	1275	0.007	
% Reduction	38%	75%	0%	--	42%	0%	

Hydrology Targets

% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
51%	49%	11.4 in/yr	

[1] 1 kg = 2.2 lb
[2] Results are rounded to the nearest whole number based on the percent reduction listed.

Table 4.1.4.2 Total Phosphorus Load Distribution in Big Darby Creek

SOURCE CONTRIBUTIONS:	
Source	% of Existing Load
Row Crops	77.07%
Point Source	9.52%
Groundwater	8.77%
Pasture / Hay	1.33%
Commercial	1.17%
Septic Systems	1.14%

Table 4.1.4.3 Point Source Allocations and Other Limits for Big Darby Creek from Milford Center to above Sugar Run

Individual Wasteload Allocations						
Discharger:	Darby Ck Golf Course	Fairbanks School	Plain City WWTP	Tuffco Sand & Gravel	Ranco Corp.	Notes
Permit #	4PX00017	4PT00123	4PB00016	4IJ00011002	4IC00008	
FC, #/period	7.68E+09	1.57E+10	7.84E+11	0.00E+00	0.00E+00	Current permit is adequate
Solids, kg/yr	10.47	383	12434	10444	377	Current permit is adequate
TP, kg/yr	10.47	20.72	725.30	149.20	5.39	Permit limits of at least 1 mg/l recommended - monitoring needed

Other permit limits to protect DO and Ammonia Toxicity		
Plain City WWTP (mg/l)	**Current** WWTP Q .5 MGD	***Expanded*** WWTP Q .75 MGD
DO	6	6
cBOD5	10	8
NH3	0.9	0.7
TP	1	0.7

4.1.5 Buck Run

Table 4.1.5.1 Allocations for Buck Run[2] (190-050)

Total Phosphorus (kg/y)[1]

	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	2107	34	3	105	1750	150	65	0.75 lb/acre per year
Existing	8620	140	5	0	7760	650	65	
% Reduction	76%	76%	38%	--	77%	77%	0%	

Suspended Sediment (1000 kg/y)[1]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		
		Septic	WWTP		Overland Runoff	Natural	Reduction Needed
Allowable	685	0.21	0.03	34	650	0.01	115 lb/acre per year
Existing	1650	0.87	0.03	0	1649	0.01	
% Reduction	59%	76%	0%	--	61%	0%	

Fecal Coliform (number*10^{10}/recreational season)[3]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources	
		Septic	WWTP		Direct Animal Inputs	Washoff
Allowable	8270	20	0.012	Implicit	7280	970
Existing	13340	90	0.012	0	11700	1550
% Reduction	38%	76%	0%	--	38%	38%

Hydrology Targets

% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
50%	50%	10.8 in/yr	

[1] 1 kg = 2.2 lb
[2] Results are rounded to the nearest whole number based on the percent reduction listed.
[3] Recreational season is from May - October

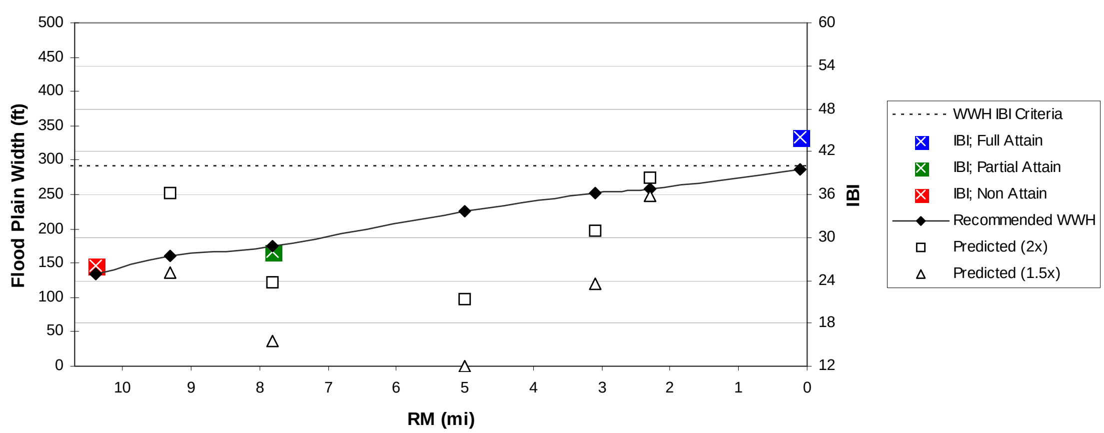
Table 4.1.5.2 Point Source Allocations for Buck Run (190-050)

Individual Wasteload Allocations

WWTP	Reflections Subdivision WWTP	Notes
Permit #	4PW00008	
FC, #/period	1.21E+09	Current permit limit is adequate
Solids, kg/yr	29	Current permit limit is adequate
TP, kg/yr	3	TP limit of 1 mg/l is recommended

Table 4.1.5.3 Total Phosphorus Load Distribution in Buck Run	
Source	% of Existing Load
Row Crops	84.42%
Groundwater	7.67%
Pasture / Hay	2.78%
Commercial	1.85%
Septic Systems	1.59%
Urban Grasses	0.75%
Residential (new)	0.46%

Figure 4.1.5 Longitudinal distribution of recommended versus predicted flood plain width, IBI, and aquatic life use attainment status for Buck Run (RM 10.5 to confluence).



4.1.6 Robinson Run

Table 4.1.6.1 Allocations for Robinson Run[2] (190-060)

Total Phosphorus (kg/y)[1]

	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	757	18	2	38	610	64	25	0.65 lb/acre per year
Existing	2834	68	2	0	2481	258	25	
% Reduction	73%	73%	0%	--	75%	75%	0%	

Suspended Sediment (1000 kg/y)[1]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		
		Septic	WWTP		Overland Runoff	Natural	Reduction Needed
Allowable	245	0.11	0.15	12	233	0.005	119 lb/acre per year
Existing	611	0.43	0.15	0	611	0.005	
% Reduction	60%	73%	0%	--	62%	0%	

Fecal Coliform (number*10[10]/recreational season)[3]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources	
		Septic	WWTP		Direct Animal Inputs	Washoff
Allowable	2750	11	7	Implicit	2620	112
Existing	4560	43	55	0	4280	182
% Reduction	40%	73%	87%	--	39%	39%

Hydrology Targets

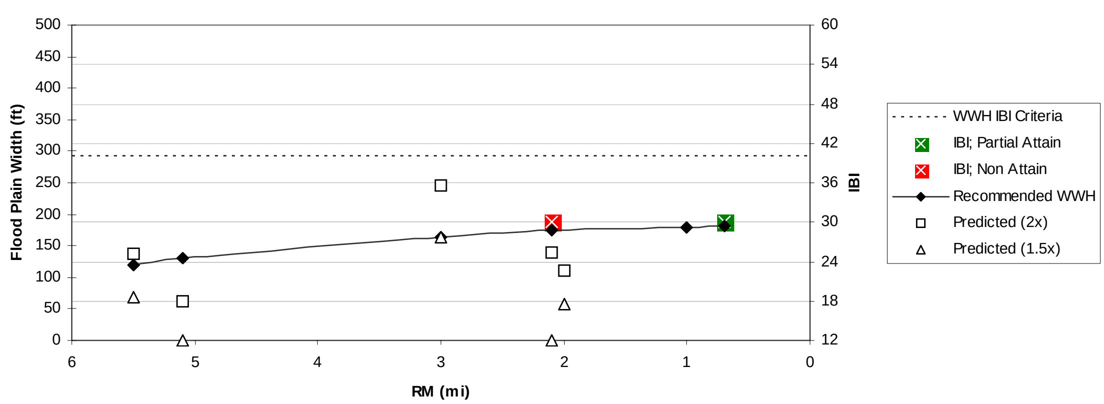
% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
56%	44%	11.5 in/yr	

[1] 1 kg = 2.2 lb
[2] Results are rounded to the nearest whole number based on the percent reduction listed.
[3] Recreational season is from May - October

Table 4.1.6.2 Point Source Allocations in Robinson Run (190-060)			
Individual Wasteload Allocations per Point Source			
WWTP	Darby Meadows WWTP	St. Johns Church	Notes
Permit #	4PG00005	4PT00006	
FC, #/period	6.97E+10	9.69E+08	Darby Meadows needs to comply with permit; otherwise current limits are adequate
Solids, kg/yr	124.34	29.01	Current permit limit is adequate
TP, kg/yr	1.38	0.48	Quarterly monitoring recommended, no permit limit at this time

Table 4.1.6.3 Total Phosphorus Load Distribution in Robinson Run	
Source	% of Existing Load
Row Crops	81.28%
Groundwater	9.28%
Pasture / Hay	4.87%
Septic Systems	2.39%
Residential (new)	1.10%
Commercial	0.35%

Figure 4.1.6 Longitudinal distribution of recommended versus predicted flood plain width, IBI, and aquatic life use attainment status for Robinson Run (RM 6.0 to confluence).



4.1.7 Sugar Run

Table 4.1.7.1 Allocations for Sugar Run[2] (190-070)

Total Phosphorus (kg/y)[1]								
	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	1376	19	1	69	1160	102	25	0.86 lb/acre per year
Existing	6230	86	1	0	5623	495	25	
% Reduction	78%	78%	0%	--	79%	79%	0%	

Suspended Sediment (1000 kg/y)[1]							
	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		
		Septic	WWTP		Overland Runoff	Natural	Reduction Needed
Allowable	447	0.12	0.08	22	425	0.01	149 lb/acre per year
Existing	1265	0.55	0.08	0	1264	0.01	
% Reduction	65%	78%	0%	--	66%	0%	

Hydrology Targets			
% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
48%	52%	10.5 in/yr	

[1] 1 kg = 2.2 lb
[2] Results are rounded to the nearest whole number based on the percent reduction listed.

Table 4.1.7.2 Point Source Allocations in Sugar Run (190-060)

Individual Wasteload Allocations per Point Source		
WWTP	Crottinger Estates WWTP	Notes
Permit #	4PG00003	
Solids, kg/yr	76	Current permit limit is adequate
TP, kg/yr	1	Quarterly monitoring recommended, no permit limit at this time

Table 4.1.7.2 Total Phosphorus Source Contributions in Sugar Run (190-070)

Source	% of Existing Load
Row Crops	84.80%
Groundwater	8.02%
Pasture / Hay	3.48%
Septic Systems	1.39%
Commercial	1.13%
Residential (new)	0.82%

4.1.8 Chemical Associations in the Upper Big Darby Creek Sub-Watershed

The lowest fish community index scores on the Big Darby Creek mainstem were found in the upper Big Darby Creek major sub-watershed in the reach immediately downstream from the confluence with Flat Branch. The results of the water quality and biological survey of 2001 indicated this reach is impacted by a complex mix of causes and sources of pollution. A very visible turbidity plume could be traced in the Big Darby Creek originating in Flat Branch which extended for miles. Elevated nutrients and metals were detected as were depressed dissolved oxygen readings. Several potential sources of these factors were identified in the 2001 study and include road construction activities which had occurred in the headwaters of the BDC, the Flat Branch WWTP, and the Flat Branch tributary.

In June, 2004 a field survey was conducted to provide for development of a water quality model to determine what was occurring in this stretch of Big Darby Creek. Datasonde® continuous data loggers were deployed to gather data on the diel DO pattern in Flat Branch and Big Darby Creek, along with a suite of other data. Results of this sampling effort revealed water quality criteria violations for dissolved oxygen (see Figure 4.1.8.2) in both Flat Branch and Big Darby Creek downstream of Flat Branch. It is clear from the results of the water quality model and data that Flat Branch is the driving force determining water quality in Big Darby Creek downstream of Flat Branch.

The results of the 2001 study and the 2004 model both indicate unusual results for Flat Branch. This lead to further examination of the available water quality data to determine how the totality of the Flat Branch water quality compared with that of other sub-watersheds in the upper basin. Initial review of the data lead to the conclusion that some parameters in Flat Branch greatly exceeded corresponding values in upper Big Darby Creek upstream of Flat Branch. In order to gain definition of the extent of the problem, a detailed statistical analysis of data in the upper Big Darby Creek major sub-watershed was performed, comparing the data from all the minor sub-watersheds to evaluate for differences. The results of this analysis and the chemicals which displayed statistically significant variability are presented in Table 4.1.8 .

Striking similarities exist between water quality of Flat Branch, and of Buck Run, both of which receive discharges from Honda. Flat Branch and Buck Run were grouped together as the highest (or lowest) average concentrations for many of the chemicals examined. In particular, Flat Branch and Buck Run had the highest concentrations and were significantly different from the other sub-watersheds for iron, aluminum, TSS, and potassium. They also had the lowest concentrations and were statistically different from other areas for alkalinity, hardness, and magnesium. In addition, a pervasive turbidity is a shared visual characteristic of these streams. Other than the fact that they both receive discharges from Honda, no immediately apparent cause for this trend has been revealed. A collaborative effort of Ohio EPA and Honda has been initiated to study this situation further.

The U.S. Army Corps of Engineers and the Nature Conservancy contracted with the Ohio State University to study the upper Big Darby Creek sub-watershed and investigate the water quality of the area and ascertain the suitability of certain areas to supporting wetlands (Mitsch et al., 2002). The study found that the water quality of the Flat Branch tributary was of particular concern due to its high turbidity and high concentrations of iron, aluminum, arsenic, and boron. In addition, the study found that Flat Branch makes up a significant portion of the total flow of the upper Big Darby Creek. Flat Branch contributed 56% of the Big Darby Creek flow during flood events and 88% of the flow during normal flow periods as evaluated at a mainstem site just downstream of Flat Branch (at N. Lewisburg Road). It was further found that 11% of the total Big Darby Creek flow at the USGS Darbyville gage was contributed from Flat Branch during April 2002 flooding periods. The drainage area of the Flat Branch is less than 3% of the drainage area of the USGS Darbyville gage.

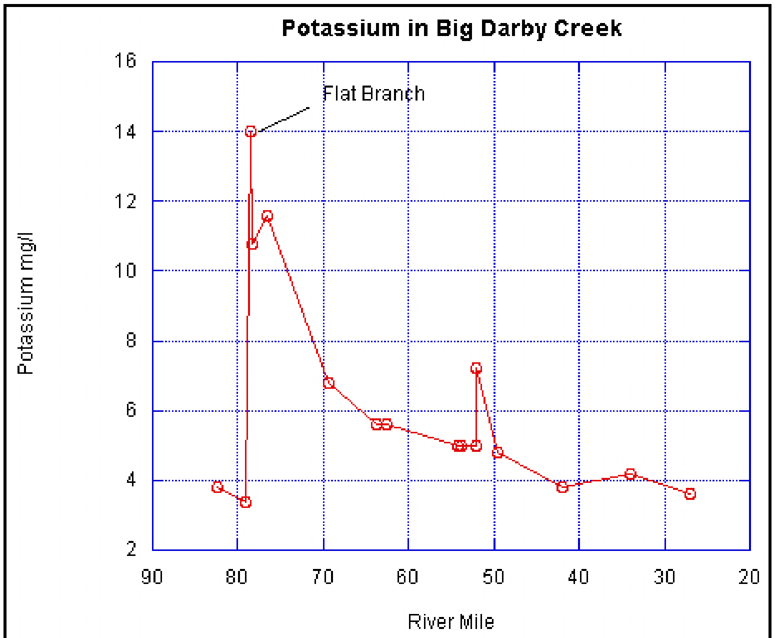


Figure 4.1.8.1 Average potassium levels in the Big Darby Creek Mainstem.

A longitudinal plot of potassium concentrations in the Big Darby Creek mainstem illustrates the degree to which the discharge from Flat Branch effects Big Darby Creek. As a general case, potassium values in the upper Big Darby Creek major sub-watershed are very low. The highest values recorded were in Flat Branch. Graphing mean potassium concentrations from the 2001 water quality survey data in Big Darby Creek, along with the mean concentration from Flat Branch show that the discharge from Flat Branch has a clear influence on water quality in upper Big Darby Creek for miles (see Figure 4.1.8.1)

Based on the results of this analysis, iron, aluminum, zinc, TSS, potassium, and flow contributions are all highly elevated in Flat Branch, and may need to be controlled.

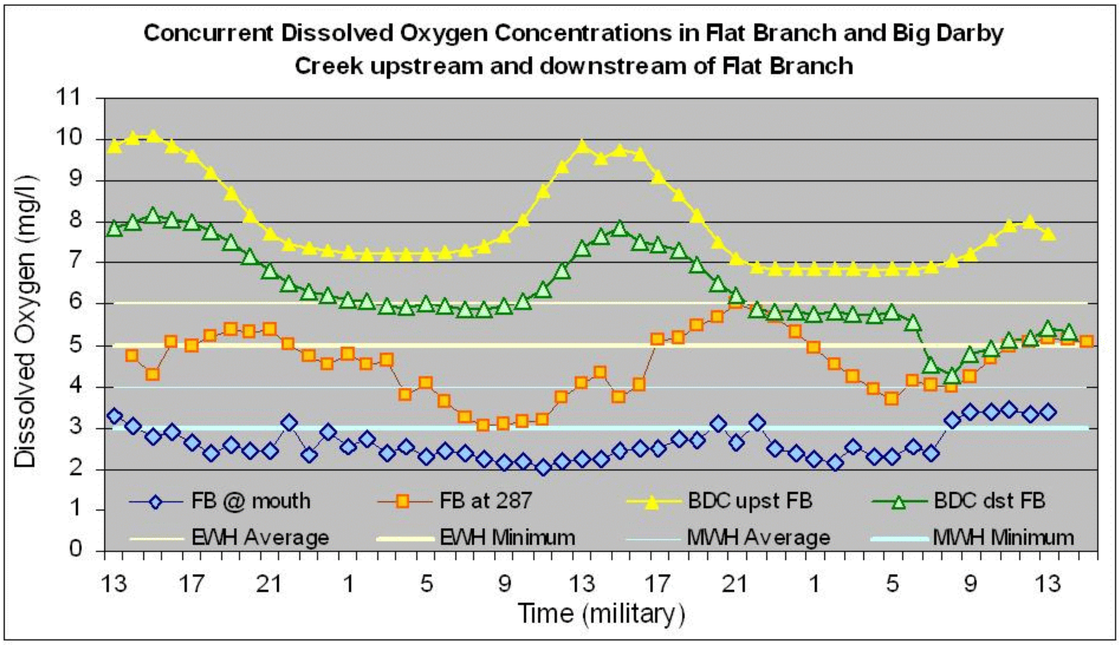


Figure 4.1.8.2 Dissolved Oxygen Concentrations in Flat Branch and Big Darby Creek

Table 4.1.8 Comparisons of the Statistical Significance of Water Chemistry by Sub-watershed in the Upper Big Darby Ck

Parameter	Unit	Sub-watersheds listed in descending order based on mean concentration (in parentheses). Those that are not significantly different are grouped by the colored band underneath the listing.						
Iron	µg/l	**020** (3312.1)	**050** (2128.8)	**010** (1060.3)	**030** (1051.2)	**060** (1031.8)	**070** (978.0)	**040** (757.1)
Aluminum	µg/l	**020** (2068.4)	**050** (1549.1)	**070** (904.7)	**030** (872.1)	**060** (708.9)	**010** (655.0)	**040** (555.8)
Zinc	µg/l	**020** (28.2)	**030** (13.8)	**050** (12.9)	**010** (11.5)	**070** (11.5)	**040** (11.3)	**060** (11.3)
TSS	mg/l	**020** (39.4)	**050** (36.7)	**030** (21.5)	**070** (21.5)	**040** (20.0)	**010** (17.7)	**060** (14.9)
Potassium	mg/l	**020** (12.7)	**050** (9.2)	**070** (8.4)	**060** (7.1)	**040** (5.0)	**030** (4.1)	**010** (3.2)
Alkalinity	mg/l	**010** (257.6)	**030** (254.6)	**040** (238.1)	**060** (191.0)	**070** (181.7)	**050** (169.1)	**020** (102.1)
Hardness	mg/l	**010** (372.1)	**060** (360.1)	**070** (348.8)	**030** (332.1)	**040** (330.5)	**050** (280.3)	**020** (157.1)
Magnesium	mg/l	**060** (38.5)	**010** (38.3)	**030** (33.9)	**040** (33.5)	**070** (33.5)	**050** (26.7)	**020** (13.9)
Nitrate	mg/l	**040** (2.57)	**030** (2.09)	**070** (1.66)	**060** (1.13)	**010** (0.47)	**050** (0.38)	**020** (0.21)
Ammonia	mg/l	**040** (0.170)	**050** (0.079)	**070** (0.072)	**020** (0.065)	**060** (0.062)	**030** (0.057)	**010** (0.052)
Phosphorus	mg/l	**040** (0.186)	**070** (0.168)	**030** (0.115)	**010** (0.114)	**020** (0.093)	**060** (0.093)	**050** (0.085)
Manganese	µg/l	**050** (227.4)	**070** (138.6)	**020** (102.6)	**060** (75.8)	**010** (49.2)	**040** (44.6)	**030** (43.8)

Table 4.1.8 Comparisons of the Statistical Significance of Water Chemistry by Sub-watershed in the Upper Big Darby Ck

Parameter	Unit	Sub-watersheds listed in descending order based on mean concentration (in parentheses). Those that are not significantly different are grouped by the colored band underneath the listing.						
COD	mg/l	**060** (24.4)	**070** (22.7)	**020** (21.3)	**050** (20.8)	**040** (15.1)	**010** (12.7)	**030** (11.8)
TKN	mg/l	**070** (1.172)	**060** (1.051)	**050** (0.841)	**040** (0.720)	**020** (0.665)	**030** (0.423)	**010** (0.419)

Key:

HUC14 Code	Sub-Watershed
010	Big Darby Creek to Flat Branch
020	Flat Branch
030	Big Darby Creek from Flat Branch to Milford Center, Spain Creek, Little Darby Creek (Logan County), UT's
040	Big Darby Creek, Milford Center to just below Plain City WWTP, Sweeny Run
050	Buck Run
060	Robinson Run
070	Sugar Run

4.2 Middle Big Darby Creek

The middle Big Darby Creek mainstem is impaired from Plain City to Lucas Rd. A look at the physical properties of this section of the Big Darby Creek mainstem shows the mainstem generally has an intact wooded riparian stream buffer (Figure 2.3.2). The habitat and bedload targets are generally met, but are stressed by the presence of modified habitat attributes particularly low sinuosity and substrate embeddedness. No estimation of existing active flood plain was done for this area due to resource limitations; however, the substrate embeddedness may be an early sign the flood plain in the area is being threatened. The embeddedness could also be a carry over from the lack of sufficient flood plain in the upper Big Darby sub-watershed. The existing sediment loading in the middle Big Darby Creek sub-watershed is just shy of the allowable sediment loading indicating the existing flood plain is sufficient, but should be protected to prevent future sediment problems.

The fairly good physical condition of the upper middle Big Darby Creek mainstem indicates chemical stressors are the main cause of impairment in this segment. An in-stream water quality model was developed from upstream of the Plain City WWTP to Lucas Road to evaluate this situation. The Plain City WWTP is located in the upper Big Darby Creek sub-watershed but at the very downstream end of it. The effects of the WWTP materialize in the mainstem of the middle Big Darby Creek; hence, it will be discussed in this section. Note that the Plain City WWTP loads are included in section 4.1.4

The model shows there are two critical chemical points in this segment of the mainstem. Both of these areas are large pooled sections of river where the velocity and turbulence of the stream decreases which promotes settling of particulate matter to the streambed sediments. The first area is just downstream of the Plain City WWTP discharge. The extremely high in-stream concentrations of nutrients in the pooled section indicate a cycle of nutrient particles settling to the sediments followed by a release of dissolved nutrients from the sediments when the dissolved oxygen at the sediment/water interface gets low. The Plain City WWTP has a history of problems with release of solids from their plant. These solids have collected in the pooled section downstream of the effluent and are a main contributor to the nutrient sediment-water interactions. The high nutrient concentrations spark the growth of algae in the river which exerts an influence along this entire stretch of river. Both the suspended algae and bottom algae increase in quantity as you progress downstream. The turbidity in the pooled section and the mostly intact riparian corridor protects this segment from gross algal blooms. However, if sunlight has access to the river a serious algal and dissolved oxygen problem would emerge. One other potential source discharges to the pooled section. A small stormwater pipe from a nearby housing development discharges here as well. The pipe had a very small discharge at the time of the field survey (which was during dry weather) indicating it has a connection to groundwater or other flow source other than stormwater. The quality of this effluent was much better than the WWTP, and the flow substantially less; however, the concentrations were twice background. It may be an additional source of nutrients. Plain City is upgrading its WWTP currently; therefore, if the plant is operated well, the solids and nutrient loading from the WWTP should decrease. However, as the nutrients are in the sediments it will take some time before the legacy nutrients are flushed from the system.

The second critical spot is the mainstem from Fitzgerald Ditch to Lucas Rd. This pooled section shows an extremely large nutrient problem. The contributions from the upstream pooled area combine with a legacy of spills from agricultural sources in Fitzgerald Ditch. The settling of organic nutrients to the sediments and the release of their dissolved form from the sediments back into the water column result in a eutrophic situation where dissolved oxygen concentrations are violating the criteria.

Figure 4.2 Plain City WWTP Discharge to the Big Darby Creek

Table 4.2.1 Bedload and Habitat TMDLs for middle Big Darby Creek (Sugar Run to Little Darby Creek) (05060001-200)

		Bedload TMDL						Habitat TMDL						
TMDL Targets →	Use	Allocations			TMDL			Allocations			Subscore			TMDL
	EWH	*≥15*	*≥15*	*≥5*	*35*			*≥75 = 1 pt*	*0 = 1 pt*	*<3 = 1 pt*				*3 pts*
	WW	*≥13*	*≥14*	*≥5*	*32*			*≥60 = 1 pt*	*<2 = 1 pt*	*<5 = 1 pt*				*3 pts*
Existing Scores Stream/River (Use) *Impaired indicates use is not met*	River Mile	QHEI Categories: Substrate	Channel	Riparian	Total Bedload Score	% Deviation from Target	Main Impaired Category if any	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
Big Darby Creek below Sugar Run to High Free Pike 05060001-200-010														
Big Darby Creek (EWH) (Impaired)	49.5	14	15	6.5	35.5	-	Substrate	76	1	4	1	0	0	1
	42	15	16	8.5	39.5	-	Substrate	81.5	0	2	1	1	1	3
Worthington Ditch (WWH) (Impaired)	0.2	14	8	3	25	24%	Channel	46.5	3	8	0	0	0	0
Ballenger-Jones Ditch (WWH)	0.5	16	16.5	4	36.5	-	Riparian	69	0	2	1	1	1	3
Fitzgerald Ditch (WWH) (Impaired)	0.5	13	11.5	7.5	32	-	Channel	56.5	2	7	0	0	0	0
Big Darby Creek from High Free Pike to above Little Darby Creek 05060001-200-020														
Big Darby Creek (EWH)	38.9	15	16	9.5	40.5	-	Good	82.5	0	2	1	1	1	3
	34.1	19	18	8.5	45.5	-	Good	93.5	0	0	1	1	1	3

Table 4.2.2 Recommended Flood Plain Widths for Middle Big Darby Creek (Sugar Run to Little Darby Creek) 0506001-200

Stream Segment	Use Designation[a]	Drainage Area[b] (sq.mi)	Setback Width[c] (per side, ft)	
			Upper End	Lower End
Big Darby Creek below Sugar Run to High Free Pike 05060001-200-010				
Big Darby Creek -- RM 50.92 to RM 41.75	EWH	234.73	614.4	695.3
Worthington Ditch	WWH	6.59	52.7	74.8
Ballenger-Jones Ditch	WWH	6.27	41.6	73.2
Yutzy Ditch	WWH	3.19	35.6	54.8
Fitzgerald Ditch	WWH	5.45	25.7	68.9
Big Darby Creek from High Free Pike to above Little Darby Creek 05060001-200-020				
Big Darby Creek -- RM 41.75 to RM 34.1	EWH	250.84	695.3	715.4

Notes:
(a) Assignments of use designation taken from *Biological and Water Quality Study of the Big Darby Creek Watershed, 2001/2002. Logan, Champaign, Union, Madison, Franklin and Pickaway Counties, Ohio.*
(b) Drainage area (sq.mi) applies to lower end of segment and is derived from digital topographic model and GIS (geographic information system).
(c) Width is **one** side (e.g. left bank or right bank and its corresponding floodplain) of stream segment measured from stream centerline.

4.2.1 Big Darby Creek from Sugar Run to High Free Pike

Table 4.2.1.1 Allocations for Big Darby Creek from below Sugar Run to High Free Pike (200-010)[1,3]

Total Phosphorus (kg/y)[2]								
	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	9853	118	318	493	8119	688	119	0.54 lb/acre per year
Existing	19359	231	318	0	17232	1460	119	
% Reduction	49%	49%	0%	--	53%	53%	0%	
Hydrology Targets								
% of Stream Flow		Average Annual Groundwater Recharge		Targets are based on average annual precipitation of 36.2 inches				
Baseflow	Runoff							
43%	57%	10.2 in/yr						

[1] Existing suspended sediment and fecal coliform loads below allowable; no TMDL needed.
[2] 1 kg = 2.2 lbs
[3] Results are rounded to the nearest whole number based on the percent reduction listed.

Table 4.2.1.2 Point Source Allocations of Big Darby Creek (200-010)

Individual Wasteload Allocations per Point Source				
WWTP	Wisslohican	Suburbans MHP WWTP	Canaan MHP WWTP	Dutch Kitchen
Permit #	4PG00024	4PR00031001	4PR00032001	4PR00077001
FC, #/period	1.07E+10	1.19E+11	3.68E+10	5.22E+08
Solids, kg/yr	41.464	165.783	145.051	6.205
TP, kg/yr	25.84	130.71	145.90	4.56
WWTP	COJV School District	Canaan School	Jonathon-Alder High School	
Permit #	4PT00104001	4PT00118001	4PT00119001	
FC, #/period	5.10E+09	3.71E+03	1.87E+09	
Solids, kg/yr	15.47	3.80E-05	23.83	
TP, kg/yr	6.81	7.60E-06	3.83	
The current permit limits are adequate at this time. Quarterly monitoring for total phosphorus is recommended.				

Table 4.2.1.3 Total Phosphorus Load Distribution for Big Darby Creek (200-010)

Source	% of Existing Load
Row Crops	87.08%
Groundwater	7.68%
Point Source	1.64%
Pasture / Hay	1.49%
Septic Systems	1.19%
Commercial	0.39%
Residential (new)	0.24%

4.2.2 Big Darby Creek from High Free Pike to above Little Darby Creek (200-020)

Table 4.2.2.1 Allocations for Big Darby Creek (200-020)[1,3]								
Total Phosphorus (kg/y)[2]								
	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	2353	59	897	118	1096	147	35	0.43 lb/acre per year
Existing	5393	136	2189	0	2674	360	35	
% Reduction	56%	56%	59%	--	59%	59%	0%	
Hydrology Targets								
% of Stream Flow		Average Annual Groundwater Recharge			Targets are based on average annual precipitation of 36.2 inches			
Baseflow	Runoff							
57%	43%	12.4 in/yr						

[1] Existing suspended sediment and fecal coliform loads below allowable; no TMDL needed.
[2] 1 kg = 2.2 lbs
[3] Results are rounded to the nearest whole number based on the percent reduction listed.

Table 4.2.2.2 Point Source Allocations of Big Darby Creek (200-020)					
Individual Wasteload Allocations per Point Source					
WWTP	BMI	Darby Dan Farms	Lake Darby Estates	Greentree MHP WWTP	Notes
Permit #	4IN00004	4PR00031	4PU00001	4PY00001	
FC, #/period	8.81E+09	5.36E+10	9.05E+10	7.23E+09	Current permit limit is adequate
Solids, kg/yr	552.67	60.79	690.84	66.32	Current permit limit is adequate
TP, kg/yr	249.25	4.99	623.13	19.94	A 1 mg/l TP limit needed and at least quarterly monitoring.

Table 4.2.2.3 Total Phosphorus Load Distribution in Big Darby Creek (200-020)	
Source	% of Existing Load
Row Crops	44.45%
Point Source	40.58%
Groundwater	6.78%
Septic Systems	2.52%
Pasture / Hay	2.18%
Residential (new)	1.76%
Commercial	0.91%
High Intensity Residential	0.19%
Low Intensity Residential	0.18%

4.3 Little Darby Creek

Much of the Little Darby Creek upstream of the town of Chuckery is impaired including the majority of Treacle Creek. The upper portion of Spring Fork is also impaired, but the rest of the Little Darby sub-watershed is mainly in attainment of designated uses.

The quality and width of the riparian buffer zones roughly follows the impairment pattern. A review of Figure 2.4.2 shows that the areas with impairment generally have much spottier and less thick woody riparian zones, and a higher proportion of grassed riparian corridors. Table 4.6 summarizes the bedload and habitat scores. The headwaters of the Little Darby are in attainment and 24% of the total available habitat score is not met. In comparison, the Treacle Creek sub-watershed (including upper and lower Treacle Ck and Proctor Run) is mostly impaired and had 75% of the total available habitat score not met. The bedload scores reflect similar results with 29% of the upper Little Darby sites not meeting the bedload target and 50% of the Treacle Creek sub-watershed sites do not meet. The middle Little Darby Creek had 100% of the QHEI sites not attain either the bedload or the habitat TMDLs. The Spring Fork sub-watershed had 86% of the habitat measured sites not attaining the TMDL and 57% not meeting the bedload TMDL. The lower Little Darby in contrast is in full attainment and all sites meet the bedload TMDL and 75% meet the habitat TMDL.

These results indicate the physical properties of the stream channel and corridor need improvement. An analysis of the existing available flood plain in this area was not done due to project resource constraints; however, the buffer and QHEI analyses imply the existing flood plain available to the streams is not sufficient to maintain the use.

A load duration curve analysis of the the available in-stream suspended sediment load is presented in figure 4.3.7. This site is in the attaining area of the lower Little Darby Creek watershed. The graph indicates that the sediment load at this point in the Little Darby exceeds the target under high flow conditions. The available data is sparse at this site, so strong conclusions cannot be made from it; however, it does serve to groundtruth the GWLF model predictions which state that this portion of the Darby should reduce its total sediment load by 59% (to prevent export downstream). The LDC analysis indicates a 46% reduction is needed. The GWLF model reflects all conditions over many years. The LDC data only represent isolated points. Given these differences, they are in relative agreement as to the predictions. Some of the difference could be due to the activity of the available flood plain in the lower Little Darby allowing the load off the land to settle out and reducing bank erosion; these factors are not accounted for in the GWLF model. However, GWLF predicts a much higher sediment reduction is needed in the upper and middle portions of the Little Darby Creek. These predictions are supported by the bedload analysis which also indicates a sediment-rich stream environment. The predicted model loadings indicate a reduction in land disturbing activities and re-introduction of accessible flood plain is needed to bring the watershed into attainment.

A visual examination of the Little Darby Creek between Mechanicsburg and Van Ness Rd. showed the Little Darby Creek becoming increasingly entrenched with little access to the adjacent riparian land (steep banks, eroding banks) as it travels downstream. In addition, the land use patterns in the impaired areas of Little Darby Creek also indicate a large portion of these sub-watersheds are under land-disturbing activities. Agricultural land use makes up 93% of the lower Treacle Creek and 87% of the middle Little Darby Creek. There is little natural or unmanaged land left in these basins to help to buffer the effects of land disturbing activities. The large proportion of managed land use in these areas makes the need for a riparian corridor and flood plain all the more critical. Recommended set backs are included in table 4.3.2.

Total phosphorus load in streams is often associated with sediment as phosphorus has a tendency to attach to soil particles. This holds true in the Little Darby Creek sub-watershed as well. However, the total phosphorus load duration curve (LDC) in Figure 4.3.7 shows some difference from the suspended sediment curve at the same site. The target load is exceeded more often than the sediment load is, and over a broader range of flows. This difference could indicate the presence of a higher proportion of dissolved phosphorus in the system from field tiles as the site the LDCs were done are upstream of most of the major point sources. Four field tiles were sampled in the Little Darby Ck watershed. Two of these tiles had low total phosphorus concentrations (0.025-0.04 mg/l TP) and two had high concentrations (0.35 - 0.5 mg/l). While this is not a rigorous dataset, it does serve to indicate field tile discharge can be significant sources of total phosphorus to the system (and that they can also function without being significant sources).

A water quality model was developed for the Little Darby Creek from Mechanicsburg to Chuckery. The purpose of the model was to evaluate the Mechanicsburg WWTP and to evaluate the system for protection of the endangered mussel species located in the Little Darby Creek downstream of Chuckery. The Mechanicsburg WWTP bypass has been eliminated and a discharge from a mill upstream of the plant has also been eliminated. The effects of these discharges appear to have been assimilated by the system. The Mechanicsburg WWTP has had a historical compliance issue with its permits. Mechanicsburg is working with Ohio EPA to improve the plant performance. Compliance with its current effluent permit limitations with the addition of a new phosphorus limit should be sufficient to protect water quality as a result of the WWTP discharge. Downstream of the discharge the Little Darby becomes channelized and entrenched as discussed above, and the riparian corridor changes from wooded to grassed as it travels downstream. Masses of algae occur where there is unobstructed sunlight, with concentrated algal growths occurring downstream of many of the tile drainage outlets indicating that nutrients are being lost from the bordering agricultural fields. The recommended management options for this stretch of the Little Darby would be to reserve a riparian corridor around the stream, allow trees to re-vegetate this setback, and to allow the stream to regain some flood plain. The stream downstream from Wing Rd has a forested riparian corridor which is not entrenched despite the farming activities that occur on adjacent land.

The Little Darby Creek from just above Treacle Creek to Chuckery indicated that nutrient export from Treacle Creek is affecting the water quality of the Little Darby as the dissolved oxygen is significantly decreased immediately downstream of Treacle Creek. Further, this study revealed that while groundwater is a factor in much of the rest of the upper Little Darby areas (based on the groundwater and hydrologic analysis), this stretch did not indicate groundwater inflow. Strongly elevated nutrients at two sites indicate that either nutrients are entrained in the sediments due to episodic runoff events or that there is an unidentified source that was not measured in the study. Since the flow did not increase downstream, the likelihood of an additional external source is small. Washoff from row crops and animal operations are the probable sources to the high spikes of nutrients detected given proximity of these sources to the elevated sites. The model predicts increasing suspended and attached algae populations and increasing temperature as the Little Darby flows downstream. The ammonia load exported from Treacle Creek appears to be assimilated by the time it reaches Chuckery. However, the study area did not extend downstream of Chuckery, and nutrient cycling could be occurring resulting in additional nutrient spikes downstream.

The potential for groundwater influence is discussed in Appendix A. The upper Little Darby sub-watershed has geologic indications that groundwater is a buffering factor for some areas of the sub-watershed. The headwaters of Little Darby Creek, Lake Run, and the lower portion of Little Darby Creek interact with high-yielding bedrock aquifers making the potential for a strong groundwater contribution likely. Other areas in the Little Darby sub-watershed do not have geologic properties that indicate groundwater is an unusual buffering influence to the system.

Table 4.3.1 Bedload and Habitat TMDLs for Little Darby Creek (05060001 210)

		Bedload TMDL						Habitat TMDL						
TMDL Targets →	Use	Allocations			TMDL			Allocations			Subscore			TMDL
	EWH	*≥15*	*≥15*	*≥5*	*35*			*≥75 = 1 pt*	*0 = 1 pt*	*<3 = 1 pt*				*3 pts*
	WWH	*≥13*	*≥14*	*≥5*	*32*			*≥60 = 1 pt*	*<2 = 1 pt*	*<5 = 1 pt*				*3 pts*
Existing Scores Stream/River (Use) *Impaired indicates use is not met*	River Mile	QHEI Categories: Substrate	Channel	Riparian	Total Bedload Score	% Deviation from Target	Main Impaired Category if any	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
Little Darby Creek headwaters to above Treacle Creek 05060001-210-010														
Little Darby Creek (CWH[1]/EWH) (Impaired)	41.2[1]	17.5	17	7.5	42	-	Good	80.5	0	0	1	1	1	3
	39.6[1]	14.5	12.5	3.5	30.5	13%	Riparian	69.5	1	6	0	0	0	0
	38.8[1]	16.5	16	7	39.5	-	Good	82	0	3	1	1	1	3
	34.7	17.5	17	6.5	41	-	Good	82.5	0	0	1	1	1	3
Clover Run (WWH)	0.6	14	17	6	37	-	Substrate	60	1	3	1	1	1	3
Jumping Run (WWH) (Impaired)	0.3	6.5	15.5	6	28	13%	Substrate	63	1	6	1	1	0	2
Lake Run (EWH) (Impaired)	0.9	16.5	14.5	7.5	38.5	-	Good	71	0	4	1	1	0	2

Table 4.3.1 Bedload and Habitat TMDLs for Little Darby Creek (05060001 210)

		Bedload TMDL						Habitat TMDL						
TMDL Targets →	Use	Allocations			TMDL			Allocations			Subscore			TMDL
	EWH	*≥15*	*≥15*	*≥5*	*35*			*≥75 = 1 pt*	*0 = 1 pt*	*<3 = 1 pt*				*3 pts*
	WWH	*≥13*	*≥14*	*≥5*	*32*			*≥60 = 1 pt*	*<2 = 1 pt*	*<5 = 1 pt*				*3 pts*
Existing Scores Stream/River (Use) *Impaired indicates use is not met*	River Mile	QHEI Categories: Substrate	Channel	Riparian	Total Bedload Score	% Deviation from Target	Main Impaired Category if any	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
Treacle Creek headwaters to above Proctor Run 05060001-210-020														
Treacle Creek (EWH) (Impaired)	11.8	16	13.5	6	35.5	-	Channel	67.5	1	5	0	0	0	0
	8.3	16	16.5	6	38.5	-	Good	67.5	0	2	0	1	1	2
	6.0	13.5	15	5	33.5	-	Substrate	66.5	0	3	0	1	0	1
Howard Run (EWH)	0.5	9.5	7	3.5	20	43%	Channel	56	3	6	0	0	0	0
Proctor Run 05060001-210-030														
Proctor Run (EWH) (Impaired)	4.9	16.5	16	5.5	38	-	Good	71.5	0	3	0	1	0	1
	3.1	15	12	3	30	14%	Riparian	65	0	5	0	1	0	1
	1.6	13.5	14	4	31.5	10%	Riparian	73	0	5	0	1	0	1
Treacle Creek from below Proctor Run to mouth 05060001-210-040														
Treacle Creek (EWH) (Impaired)	0.8	1	7	1.5	9.5	73%	Substrate	29.5	3	8	0	0	0	0

Table 4.3.1 Bedload and Habitat TMDLs for Little Darby Creek (05060001 210)

		Bedload TMDL						**Habitat TMDL**						
TMDL Targets →	Use	Allocations			TMDL			Allocations			Subscore			TMDL
	EWH	*≥15*	*≥15*	*≥5*	*35*			*≥75 = 1 pt*	*0 = 1 pt*	*<3 = 1 pt*				*3 pts*
	WWH	*≥13*	*≥14*	*≥5*	*32*			*≥60 = 1 pt*	*<2 = 1 pt*	*<5 = 1 pt*				*3 pts*
Existing Scores Stream/River (Use) *Impaired indicates use is not met*	River Mile	QHEI Categories: Substrate	Channel	Riparian	Total Bedload Score	% Deviation from Target	Main Impaired Category if any	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
Little Darby Creek from below Treacle Creek to above Spring Fork 05060001-210-050														
Little Darby Creek (EWH) (Impaired)	29.5	16	12.5	3	31.5	10%	Riparian	66.5	1	3	0	0	0	0
	26.6	11.5	15.5	4.5	31.5	10%	Substrate	58	0	2	0	1	1	2
	24.5	13.5	9.5	6	29	17%	Channel	62.5	1	6	0	0	0	0
	23.1	8	9	5.5	22.5	36%	Substrate	55.5	2	7	0	0	0	0
	20.5	13	11	5	29	17%	Channel	64.5	1	5	0	0	0	0
Wamp Ditch (WWH)(Impaired)	0.1	14.5	7.5	3	25	22%	Channel	45.5	4	9	0	0	0	0
Barron Creek (WWH)	2.1	14.5	8.5	2.5	25.5	23%	Riparian	44.5	2	7	0	0	0	0
Spring Fork 05060001-210-060														
Spring Fork (EWH) (Impaired)	15.8	14	10.5	5.5	30	14%	Channel	60.5	1	4	0	0	0	0
	13.7	13	11.5	4	28.5	19%	Channel	62.5	1	6	0	0	0	0

Table 4.3.1 Bedload and Habitat TMDLs for Little Darby Creek (05060001 210)

		Bedload TMDL						Habitat TMDL						
TMDL Targets →	Use	Allocations			TMDL			Allocations			Subscore			TMDL
	EWH	*≥15*	*≥15*	*≥5*	*35*			*≥75 = 1 pt*	*0 = 1 pt*	*≤3 = 1 pt*				*3 pts*
	WWH	*≥13*	*≥14*	*≥5*	*32*			*≥60 = 1 pt*	*≤2 = 1 pt*	*≤5 = 1 pt*				*3 pts*
Existing Scores Stream/River (Use) *Impaired indicates use is not met*	River Mile	QHEI Categories: Substrate	Channel	Riparian	Total Bedload Score	% Deviation from Target	Main Impaired Category if any	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
	13.4	16	9	3	28	20%	Channel	53	2	4	0	0	0	0
	10.1	12	18	4	34	-	Substrate	69	0	2	0	1	1	2
	7.8	12	10.5	3.5	26	26%	Channel	54.5	2	7	0	0	0	0
	3.3	16	12	4.5	32.5	-	Channel	67.5	0	5	0	1	0	1
Bales Ditch (WWH)	0.4	14.5	16	7	37.5	-	Good	70	0	2	1	1	1	3
05060001-210-070														
Little Darby Creek (EWH)	15.3	19	19.5	9.5	48	-	Good	95.5	0	0	1	1	1	3
	6.5	20.5	19.5	7	47	-	Good	95.5	0	0	1	1	1	3
	4.1	21	20	9.5	50.5	-	Good	99	0	0	1	1	1	3
	0.7	17	11	9.5	37.5	-	Channel	63.5	2	5	0	0	0	0

[1]Denotes a Warm Water Habitat (WWH) Site.
[2]Denotes a Modified Warm Water Habitat (MWH) Site.

Table 4.3.2 Recommended Flood Plain Widths for Little Darby Creek 05060001-210				
Stream Segment	Use Designation[a]	Drainage Area[b] (sq. mi)	Setback Width[c] (per side, ft)	
			Upper End	Lower End
Little Darby Creek headwaters to Treacle Creek -010				
Little Darby Creek -- headwaters to RM 31.30	EWH/CWH[d]	29.41	101.1	284.6
Clover Run	WWH	1.89	35.1	43.7
Lake Run	EWH	6.65	64.1	150.2
Jumping Run	WWH	2.74	39.7	51.3
Treacle Creek headwaters above Proctor Run -020				
Treacle Creek -- headwaters to RM 3.68	EWH	14.52	130.0	210.1
Howard Run	EWH	3.40	73.1	112.5
Proctor Run -030				
Proctor Run	EWH	11.02	99.0	186.6
Treacle Creek below Proctor Run to Little Darby Creek -040				
Treacle Creek -- RM 3.68 to mouth	EWH	38.19	230.0	318.5
Little Darby Creek below Treacle Creek to above Spring Fork -050				
Little Darby Creek -- RM 31.30 to RM 17.46	EWH	106.16	407.1	494.3
Barron Creek	WWH	6.89	39.9	76.3
Wamp Ditch	WWH	8.64	56.5	84.0
Spring Fork -060				
Spring Fork	EWH	39.20	101.5	322.0
Bales Fork	WWH	6.40	31.2	73.9
Little Darby Creek below Spring Fork to Big Darby Creek -070				
Little Darby Creek -- RM 17.46 to mouth	EWH	178.77	565.8	618.5

Notes:
(a) Assignments of use designation taken from *Biological and Water Quality Study of the Big Darby Creek Watershed, 2001/2002. Logan, Champaign, Union, Madison, Franklin and Pickaway Counties, Ohio.*
(b) Drainage area (sq.mi) applies to lower end of segment and is derived from digital topographic model and GIS (geographic information system).
(c) Width is **one** side (e.g. left bank or right bank and its corresponding floodplain) of stream segment measured from stream centerline.
(d) EWH/CWH and WWH/CWH assume setback width based on EWH and WWH criteria, respectively. LRW assigned setback of half bankfull width.

4.3.1 Upper Little Darby Creek headwaters to Treacle Creek[2] (210-010)

Table 4.3.1.1 Allocations for upper Little Darby Creek (Headwaters to Treacle Creek) (210-010)

Total Phosphorus (kg/y)[1]								
	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	2086	6	690	104	1143	88	55	0.93 lb/acre per year
Existing	10542	33	876	0	8896	683	55	
% Reduction	80%	80%	21%	--	87%	87%	0%	

Suspended Sediment (1000 kg/y)[1]							
	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		
		Septic	WWTP		Overland Runoff	Natural	Reduction Needed
Allowable	678	0.04	8.3	33.9	636	0.03	239 lb/acre per year
Existing	2704	0.21	8.3	0	2695	0.03	
% Reduction	75%	80%	0%	--	76%	0%	

Hydrology Targets			
% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
55%	45%	11.8 in/yr	

[1] 1 kg = 2.2 lbs.
[2] Results are rounded to the nearest whole number based on the percent reduction listed.

Table 4.3.1.2 Point Source Allocations and Other Limits for upper Little Darby Creek (Headwaters to Treacle Creek) (210-010)		
Individual Wasteload Allocations per Point Source		
Facility	Mechanicsburg WWTP	Notes
Permit #	1PB00037	
Solids, kg/yr	3813	Current Permit limit is adequate
TP, kg/yr	318	Limit of 1 mg/l needed
Other permit limits to protect DO and Ammonia Toxicity:		
DO, mg/l	6.0	Current Permit limit is adequate
NH3, mg/l	1.5, summer	Current Permit limit is adequate
$CBOD_5$, mg/l	10	Current Permit limit is adequate
Mechanicsburg WWTP compliance with these limits have been problematic; Mechanicsburg is currently working on a plan to improve the performance of their plant with financial and technical assistance provided by Ohio EPA.		

Table 4.3.1.3 Total Phosphorus Load Distribution for upper Little Darby Creek	
Source	% of Existing Load
Row Crops	81.68%
Point Source	8.31%
Groundwater	6.61%
Pasture / Hay	1.63%
Urban Grasses	0.50%
Septic Systems	0.31%
Commercial	0.30%
Residential (new)	0.17%
Low Intensity Residential	0.12%

4.3.2 Upper Treacle Creek (210-020)

Table 4.3.2.1 Allocations for upper Treacle Creek (Headwaters to Proctor Run)[2] (210-020)

Total Phosphorus (kg/y)[1]								
	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	846	2	0	42	711	60	30	1 lb/acre per year
Existing	6682	19	0	0	6117	517	30	
% Reduction	87%	87%	0%	--	88%	88%	0%	

Suspended Sediment (1000 kg/y)[1]							
	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		
		Septic	WWTP		Overland Runoff	Natural	Reduction Needed
Allowable	169	0.02	0	8.5	161	0.01	263 lb/acre per year
Existing	1666	0.12	0	0	1666	0.01	
% Reduction	90%	87%	0%	--	90%	0%	

Hydrology Targets			
% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
52%	48%	11.3 in/yr	

[1] 1 kg = 2.2 lbs.
[2] Results are rounded to the nearest whole number based on the percent reduction listed.

Table 4.3.2.2 Total Phosphorus Load Distribution for upper Treacle Creek

Source	% of Existing Load
Row Crops	90.09%
Groundwater	7.86%
Pasture / Hay	1.51%
Septic Systems	0.28%

4.3.3 Proctor Run (210-030)

Table 4.3.3.1 Allocations for Proctor Run [2] (210-030)

Total Phosphorus (kg/y)[1]								
	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			Reduction Needed
		Septic	WWTP		Runoff	Ground-water	Natural	
Allowable	722	2	20	36	603	46	16	1 lb/acre per year
Existing	3852	10	20	0	3536	271	16	
% Reduction	81%	81%	0%	--	83%	83%	0%	

Suspended Sediment (1000 kg/y)[1]							
	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		Reduction Needed
		Septic	WWTP		Overland Runoff	Natural	
Allowable	235	0.01	0.02	12	223	0.01	279 lb/acre per year
Existing	1067	0.06	0.02	0	1067	0.01	
% Reduction	78%	81%	0%	--	79%	0%	

Fecal Coliform (number*10^{10}/recreational season)[3]						
	Total Load	Point Sources		Margin of Safety	Nonpoint Sources	
		Septic	WWTP		Direct Animal Inputs	Washoff
Allowable	3670	1.2	0.09	Implicit	3390	278
Existing	14300	6.2	0.09	0	13200	1080
% Reduction	74%	81%	0%	--	74%	74%

Hydrology Targets			
% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
51%	49%	11.3 in/yr	

[1] 1 kg = 2.2 lbs.
[2] Results are rounded to the nearest whole number based on the percent reduction listed.
[3] Recreational season is from May - October

Table 4.3.3.2 Point Source Allocations for Proctor Run		
Individual Wasteload Allocations per Point Source		
Facility	Triad Local Schools WWTP	Notes
Permit #	1PT00099	
Solids, kg/yr	19	Current permit limit is adequate
TP, kg/yr	20	Monitoring recommended
FC, #/period	8.75E+08	Current permit limit is adequate

Table 4.3.3.3 Total Phosphorus Load Distribution for Proctor Run	
Source	% of Existing Load
Row Crops	89.87%
Groundwater	7.16%
Pasture / Hay	1.15%
Commercial	0.56%
Point Source	0.51%
Septic Systems	0.26%
Residential (new)	0.20%

4.3.4 Lower Treacle Creek (210-040)

Table 4.3.4.1 Allocations for Lower Treacle Creek (Proctor Run to Little Darby Creek)[2] (210-040)

Total Phosphorus (kg/y)[1]

	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	503	2	0	25	432	35	8	1 lb/acre per year
Existing	2488	12	0	0	2281	186	8	
% Reduction	80%	80%	0%	--	81%	81%	0%	

Suspended Sediment (1000 kg/y)[1]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		
		Septic	WWTP		Overland Runoff	Natural	Reduction Needed
Allowable	164	0.02	0	8.2	155	0.001	112 lb/acre per year
Existing	386	0.07	0	0	386	0.001	
% Reduction	58%	80%	0%	--	60%	0%	

Fecal Coliform (number*10^{10}/recreational season)[3]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources	
		Septic	WWTP		Direct Animal Inputs	Washoff
Allowable	2570	1.5	0	Implicit	1990	586
Existing	5430	7.3	0	0	4190	1240
% Reduction	53%	80%	0%	--	53%	53%

Hydrology Targets

% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
43%	57%	10.2 in/yr	

[1] 1 kg = 2.2 lbs.
[2] Results are rounded to the nearest whole number based on the percent reduction listed.
[3] Recreational season is from May - October

Table 4.3.4.2 Total Phosphorus Load Distribution for lower Treacle Ck

Source	% of Existing Load
Row Crops	91.15%
Groundwater	7.62%
Pasture / Hay	0.53%

4.3.5 Little Darby Creek from below Treacle Creek to above Spring Fork [2]

Table 4.3.5.1 Allocations for middle Little Darby Creek (Treacle Creek to Spring Fork) (210-050)

Total Phosphorus (kg/y)[1]

	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	2574	10	15	129	2184	188	48	0.8 lb/acre per year
Existing	11180	43	15	0	10198	876	48	
% Reduction	77%	77%	0%	--	79%	79%	0%	

Suspended Sediment (1000 kg/y)[1]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		
		Septic	WWTP		Overland Runoff	Natural	Reduction Needed
Allowable	836	0.06	0.02	41.8	795	0.01	64 lb/acre per year
Existing	1481	0.27	0.02	0	1481	0.01	
% Reduction	44%	77%	0%	--	46%	0%	

Fecal Coliform (number*10^{10}/recreational season)[3]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources	
		Septic	WWTP		Direct Animal Inputs	Washoff
Allowable	1.13E+14	6.24E+10	7.07E+09	Implicit	8.47E+13	2.81E+13
Existing	1.92E+14	2.71E+11	7.07E+09	0	1.44E+14	4.78E+13
% Reduction	41%	77%	0%	--	41%	41%

Hydrology Targets

% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
46%	54%	10.6 in/yr	

[1] 1 kg = 2.2 lbs.
[2] Results are rounded to the nearest whole number based on the percent reduction listed.
[3] Recreational season is from May - October

Table 4.3.5.2 Point Source Allocations for middle Little Darby Creek		
Individual Wasteload Allocations per Point Source		
Facility	Rosedale Bible School	Notes
Permit #	4PT00102	
Solids, kg/yr	17	Current Permit limit is adequate
TP, kg/yr	15	Monitoring recommended
FC, #/period	7.07E+09	Current Permit limit is adequate

Table 4.3.5.3 Total Phosphorus Load Distribution for middle Little Darby Creek	
Source	% of Existing Load
Row Crops	90.41%
Groundwater	7.98%
Pasture / Hay	0.90%
Septic Systems	0.39%
Point Source	0.14%

4.3.6 Spring Fork (210 - 060)

Table 4.3.6.1 Allocations for Spring Fork[2] (210-060)

Total Phosphorus (kg/y)[1]								
	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	2641	5	115	132	2155	175	59	0.93 lb/acre per year
Existing	12940	24	249	0	11661	947	59	
% Reduction	80%	80%	55%	--	81%	81%	0%	

Suspended Sediment (1000 kg/y)[1]							
	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		
		Septic	WWTP		Overland Runoff	Natural	Reduction Needed
Allowable	858	0.03	0.44	43	815	0.02	168 lb/acre per year
Existing	2666	0.15	0.44	0	2665	0.02	
% Reduction	68%	80%	0%	--	69%	0%	

Fecal Coliform (number*10^{10}/recreational season)[3]						
	Total Load	Point Sources		Margin of Safety	Nonpoint Sources	
		Septic	WWTP		Direct Animal Inputs	Washoff
Allowable	13100	3.10	3.56	Implicit	10400	2740
Existing	29100	15.2	3.56	0	23000	6080
% Reduction	55%	80%	0%	--	55%	55%

Hydrology Targets			
% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
49%	51%	11 in/yr	

[1] 1 kg = 2.2 lbs.
[2] Results are rounded to the nearest whole number based on the percent reduction listed.
[3] Recreational season is from May - October

Table 4.3.6.2 Point Source Allocations for Spring Fork			
Individual Wasteload Allocations per Point Source			
Facility	Monroe Elem	Green Meadows MHP	Notes
Permit #	4PT00122	4PV00000	
Solids, kg/yr	160	282	Current permit limit is adequate
TP, kg/yr	3	112	A limit of 1 mg/l TP is recommended for Green Meadows
FC, #/period	7.68E+08	3.48E+10	Current permit limit is adequate

Table 4.3.6.3 Total Phosphorus Load Distribution for Spring Fork	
Source	% of Existing Load
Row Crops	88.76%
Groundwater	7.45%
Point Source	1.90%
Pasture / Hay	1.14%
Septic Systems	0.39%
Residential (new)	0.35%

4.3.7 Lower Little Darby Creek (210-070)

Table 4.3.7.1 Allocations for Lower Little Darby Creek (Spring Fork to Big Darby Creek)[2] (210-070)

Total Phosphorus (kg/y)[1]

	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	2694	36	1523	135	848	92	61	0.9 lb/acre per year
Existing	12219	165	1523	0	9441	1030	61	
% Reduction	78%	78%	0%	--	91%	91%	0%	

Suspended Sediment (1000 kg/y)[1]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		
		Septic	WWTP		Overland Runoff	Natural	Reduction Needed
Allowable	876	0.23	5.04	43.8	827	0.02	124 lb/acre per year
Existing	2156	1.04	5.04	0	2150	0.02	
% Reduction	59%	78%	0%	--	62%	0%	

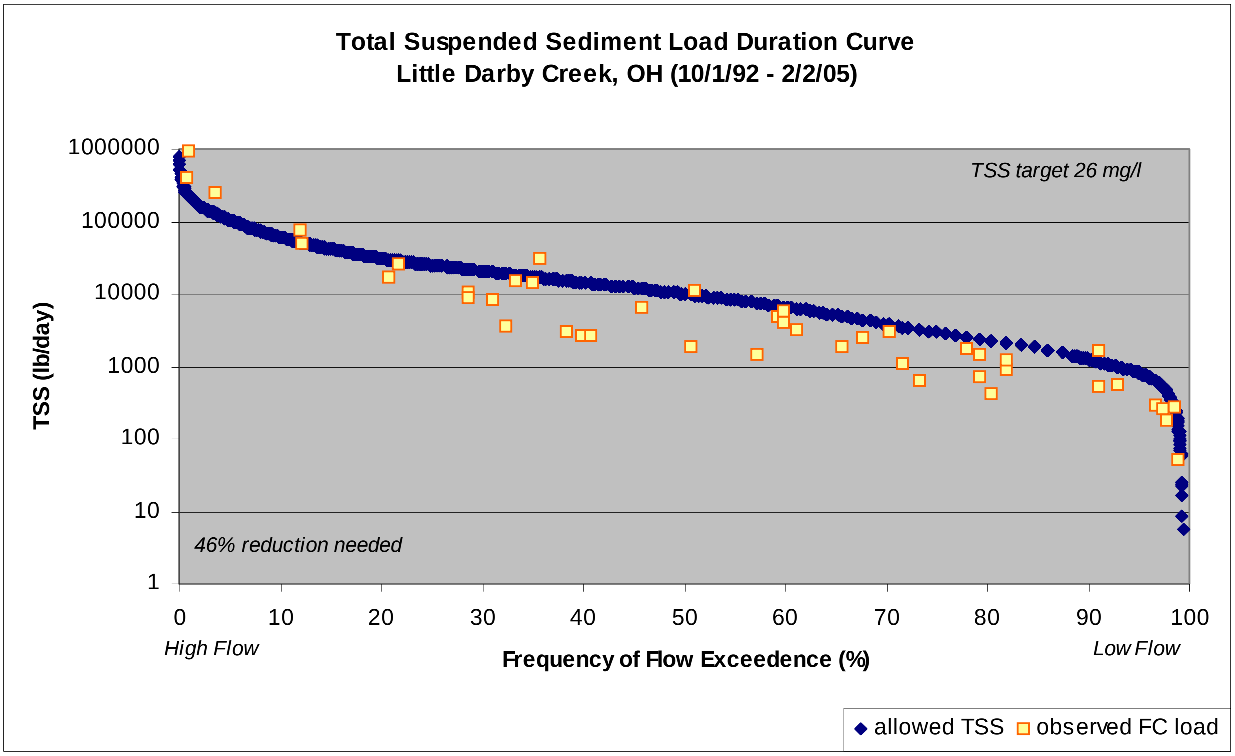
Hydrology Targets

% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
54%	46%	11.9 in/yr	

[1] 1 kg = 2.2 lbs.
[2] Results are rounded to the nearest whole number based on the percent reduction listed.

Table 4.3.7.2 Point Source Allocations for lower Little Darby Creek						
Individual Wasteload Allocations per Point Source						
WWTP	Fisher Steel	West Jefferson WWTP	Jefferson Lodge MHP WWTP	Oakwood Acres MHP WWTP	B&B Motel WWTP	Notes
Permit #	4ID00001	4PB00024	4PV00004	4PV00097	4PV00107	
Solids, kg/yr	0	4960	50	17	13	Current permit limit is adequate
TP, kg/yr	3	1361	122	30	7	Quarterly monitoring recommended, West Jefferson WWTP permit limit of 1 mg/l

Table 4.3.7.3 Total Phosphorus Load Distribution in lower Little Darby Creek	
Source	% of Existing Load
Row Crops	72.54%
Point Source	12.46%
Groundwater	8.57%
Residential (new)	1.75%
Pasture / Hay	1.52%
Septic Systems	1.35%
Commercial	1.08%
High Intensity Residential	0.30%
Low Intensity Residential	0.17%



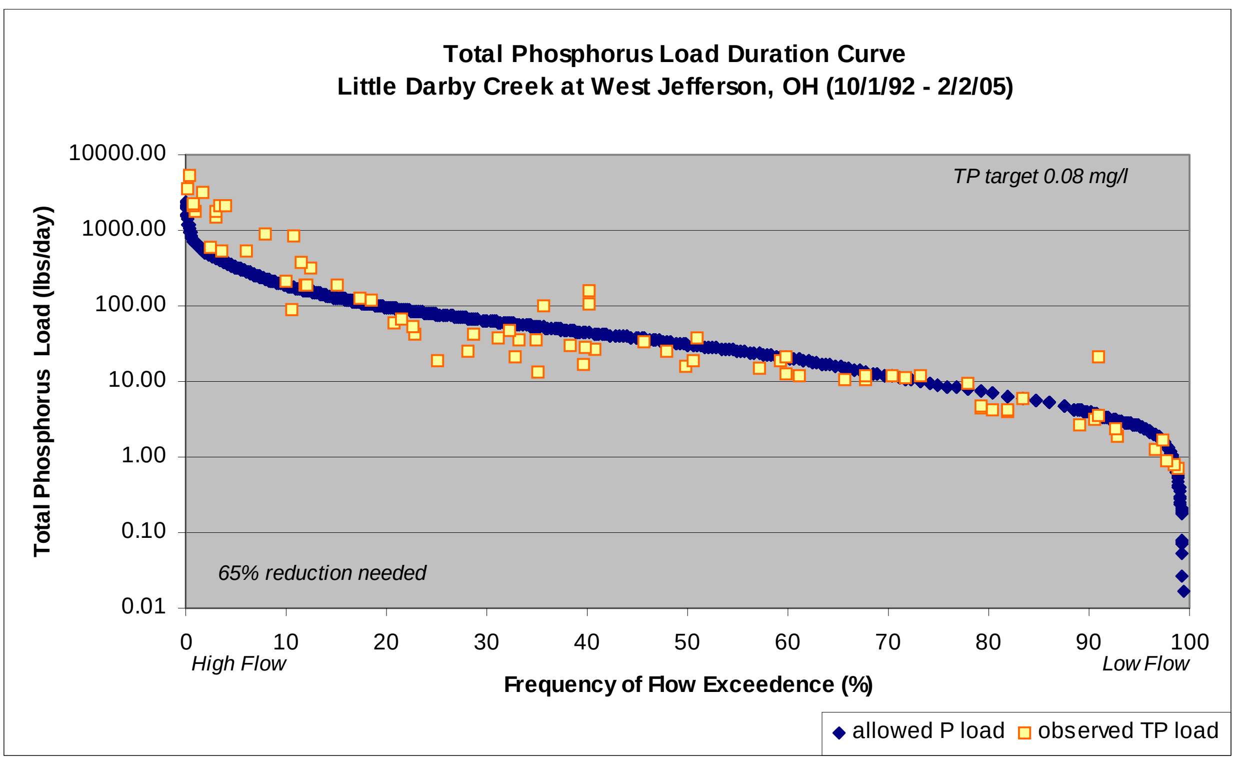


Figure 4.3.7 TSS and Total Phosphorus Load Duration Curves for the Lower Little Darby

4.4 Lower Big Darby Creek

The physical habitat and intact riparian corridor is generally good in the lower Big Darby sub-watershed with the exception of the upper reaches of the Hellbranch Run. Likewise, the lower Big Darby Creek sub-watershed is mainly in attainment with the exception of the Hellbranch watershed. However, there are indications that impacts from upstream loads, loads from within this sub-watershed, and the development of the Hellbranch sub-watershed are starting to be seen in the downstream reaches. Keeping the riparian corridor and existing flood plain intact is of vital importance to protect the lower Big Darby Creek into the future as these strong characteristics of the mainstem help to buffer such stresses. The Big Darby Creek downstream of Darbyville to the mouth (sub-watershed 220-040) is in full attainment of its designated uses and does not contribute to a downstream impairment within the Big Darby Creek watershed; therefore, load calculations for this section were not included in this report. However, habitat and floodplain set back recommendations are included to buffer and protect this section of river into the future.

The load duration curves and GWLF results indicate that the Hellbranch sub-watershed is mainly impacted by stream bank erosion and construction activities. The sediment load duration curve in Figure 4.4.1.2 shows the TSS target is conservatively achieved under all flow conditions except high flows where tremendous suspended sediment loads are observed. GWLF does not predict runoff is the source of this sediment indicating bank erosion and construction activities are the sources. The lack of sufficient existing flood plain in Hamilton Ditch can be extrapolated to similiar conditions in Clover Groff Ditch which gives further evidence that bank erosion and construction activities are the major sediment sources in this watershed. Likewise, incorporation of sufficient flood plain and stormwater control are the needed fixes to this problem. The embedded substrates found in the Darby downstream of the Hellbranch are an early indication of the effects of the Hellbranch sediment load on the Darby.

The hydrologic model for the Hellbranch sub-watershed was run for land use based on a 2000/2001 data set and an updated 2003 dataset; each run using the same weather data and the only differences being land use changes. The development changes in the 3 years resulted in a 3% reduction in annual groundwater recharge and a 13% increase in runoff. Hydrologic targets based on the earlier land use are suggested to be maintained in order to protect the integrity of the Hellbranch and the Big Darby Creek.

The total phosphorus load duration curves for the Hellbranch at Lambert Rd. and the Big Darby Creek at Darbysville indicate excessive total phosphorus loading at most flows is occurring as well. The physical habitat of the lower Big Darby Creek is currently shielding the system from most of the effects of this load. Aeration systems for home septic treatment are pervasive in the Hellbranch watershed. Many unsewered areas or small package treatment plants have historically served the lower Big Darby Creek sub-watershed. However, a new regional WWTP is being constructed in Darbydale and the Pickaway County Correctional WWTP is expanding to accept these poorly serviced areas. The phosphorus and bacteria loads should improve as a result of these actions.

Table 4.4.1 Bedload and Habitat TMDLs for lower Big Darby Creek (05060001 220)

		Bedload TMDL						**Habitat TMDL**						
	Use	Allocations			TMDL			Allocations			Subscore			TMDL
TMDL Targets →	*EWH*	*≥15*	*≥15*	*≥5*	*35*			*≥75 = 1 pt*	*0 = 1 pt*	*<3 = 1 pt*				*3 pts*
	WWH	*≥13*	*≥14*	*≥5*	*32*			*≥60 = 1 pt*	*<2 = 1 pt*	*<5 = 1 pt*				*3 pts*
Existing Scores Stream/River (Use) *Impaired indicates use is not met*	River Mile	QHEI Categories: Substrate	Channel	Riparian	Total Bedload Score	% Deviation from Target	Main Impaired Category if any	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
Hellbranch Run 05060001-220-010														
Hellbranch Run (WWH[1]/EWH) (Impaired)	10.3[1]	5	8	5.5	18.5	42%	Substrate	39.5	3	8	0	0	0	0
	7.4[1]	13	8	6	27	16%	Channel	51	2	6	0	0	0	0
	5.8[1]	13	13	8	34	-	Substrate	65.5	2	3	0	0	1	1
	3.7	18	16	7.5	41.5	-	Good	83.5	0	0	1	1	1	3
	1.0	18	16.5	8	42.5	-	Good	84.5	1	0	1	1	1	3
	0.5	18	17	8.5	43.5	-	Good	83.5	0	0	1	1	1	3
Hamilton Ditch (MWH/WWH[1]) (Impaired)	3.4	1	4	3	8	n/a	-	21	5	9	-	-	-	n/a
	0.5[1]	4	7	3	14	58%	Substrate	36.5	5	10	0	0	0	0
Clover Groff Ditch (MWH/WWH[1]) (Impaired)	4.7	1	4	4	9	-	-	22	5	9	-	-	-	n/a
	0.8[1]	15.5	12	5	32.5	-	Channel	61.5	1	5	1	1	0	2

Table 4.4.1 Bedload and Habitat TMDLs for lower Big Darby Creek (05060001 220)

		Bedload TMDL						Habitat TMDL						
TMDL Targets →	Use	Allocations			TMDL			Allocations			Subscore			TMDL
	EWH	*≥15*	*≥15*	*≥5*	*35*			*≥75 = 1 pt*	*0 = 1 pt*	*<3 = 1 pt*				*3 pts*
	WWH	*≥13*	*≥14*	*≥5*	*32*			*≥60 = 1 pt*	*<2 = 1 pt*	*<5 = 1 pt*				*3 pts*
Existing Scores Stream/River (Use) *Impaired indicates use is not met*	River Mile	QHEI Categories: Substrate	Channel	Riparian	Total Bedload Score	% Deviation from Target	Main Impaired Category if any	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
Big Darby Creek from below Little Darby Creek to above Hellbranch Run 05060001-220-020														
Big Darby Creek (EWH)	29.1	18	18	5.5	41.5	-	Good	86	0	0	1	1	1	3
Smith Ditch (EWH) (Impaired)	2.1	18	20	6.5	44.5	-	Good	77.5	0	3	1	1	0	2
	0.3	19	16.5	9.5	45	-	Good	73	0	1	0	1	1	2
UT to Smith Ditch (EWH)	0.2	18	16.5	7	41.5	-	Good	67	1	3	0	0	0	0
Big Darby Creek from below Hellbranch Run to Darbyville 05060001-220-030														
Big Darby Creek (EWH)	26.1	18	19	9.5	46.5	-	Good	94.5	0	0	1	1	1	3
	23.8	18	16.5	7	41.5	-	Good	87.5	0	1	1	1	1	3
	22.8	18	16.5	5	39.5	-	Riparian	84.5	0	1	1	1	1	3
	18.7	18	16.5	5.5	40	-	Good	85	0	1	1	1	1	3
	15.7	18	18.5	6	42.5	-	Good	88.5	0	0	1	1	1	3
	13.4	18	17	5	40	-	Riparian	85.5	0	1	1	1	1	3

Table 4.4.1 Bedload and Habitat TMDLs for lower Big Darby Creek (05060001 220)

		Bedload TMDL						Habitat TMDL						
TMDL Targets ➤	Use	Allocations			TMDL			Allocations			Subscore			TMDL
	EWH	*≥15*	*≥15*	*≥5*	*35*			*≥75 = 1 pt*	*0 = 1 pt*	*≤3 = 1 pt*				*3 pts*
	WWH	*≥13*	*≥14*	*≥5*	*32*			*≥60 = 1 pt*	*≤2 = 1 pt*	*≤5 = 1 pt*				*3 pts*
Existing Scores Stream/River (Use) *Impaired indicates use is not met*	River Mile	QHEI Categories: Substrate	Channel	Riparian	Total Bedload Score	% Deviation from Target	Main Impaired Category if any	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
Springwater Run (WWH) (Impaired)	0.8	13.5	11.5	4	29	12%	Riparian	48.5	3	8	0	0	0	0
UT to Big Darby Ck (RM 23.77)(WWH) (Impaired)	0.1	18.5	15.5	9.5	43.5	-	Good	61.5	2	5	1	0	0	1
UT to Big Darby Ck (RM 20.20) (WWH)	0.8	15	16.5	9.5	41	-	Good	77.5	0	2	1	1	1	3
UT to Big Darby Ck (RM 18.41)(WWH) (Impaired)	0.1	11	10	9.5	30.5	-	Channel	52.5	3	8	0	0	0	0
Greenbrier Creek (WWH)	2.7	13	15	6	34	-	Substrate	57	0	5	0	1	0	1
	1.3	16	15.5	7	38.5	-	Good	74.5	0	4	1	1	1	3
Georges Run (WWH)	0.9	12.5	16	3	31.5	-	Riparian	61	0	3	1	1	1	3

Table 4.4.1 Bedload and Habitat TMDLs for lower Big Darby Creek (05060001 220)

		Bedload TMDL							**Habitat TMDL**						
	Use	Allocations			TMDL			Allocations			Subscore			TMDL
TMDL Targets →	*EWH*	*≥15*	*≥15*	*≥5*	*35*			*≥75 = 1 pt*	*0 = 1 pt*	*<3 = 1 pt*				*3 pts*
	WWH	*≥13*	*≥14*	*≥5*	*32*			*≥60 = 1 pt*	*<2 = 1 pt*	*<5 = 1 pt*				*3 pts*
Existing Scores Stream/River (Use) *Impaired indicates use is not met*	River Mile	QHEI Categories: Substrate	Channel	Riparian	Total Bedload Score	% Deviation from Target	Main Impaired Category if any	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
Big Darby Creek from Darbyville to Scioto River 05060001-220-040														
Big Darby Creek (EWH)	10.4	16.5	16	6	38.5	-	Good	85	0	2	1	1	1	3
	8.4	15	14	5.5	34.5	1%	Channel	69.5	0	3	0	1	0	1
	3.1	16.5	16.5	5	38	-	Riparian	82	0	2	1	1	1	3
	0.3	14	16	4	34	3%	Riparian	71.5	0	2	0	1	1	2

[1]Denotes a Warm Water Habitat (WWH) Site.
[2]Denotes a Modified Warm Water Habitat (MWH) Site.

Table 4.4.2 Comparison of Needed and Predicted Active Floodplain for Selected Segments in the Big Darby Creek

Stream Segment	Aquatic Life Use	Active Floodplain Total Area[2] (Acres)			RM	Use Attainment	IBI[3]	ICI[3]	QHEI
		Area Needed[1]	Actual (2x) % of Needed Area Met	Actual (1.5x) % of Needed Area Met					
Hellbranch Run 05060001-220-010									
Hamilton Ditch -- RM 5.4 to RM 2.1	MWH	37.2	32.41 87%	25.8 69%	3.4	Non	16*	NA	21.0
Hamilton Ditch -- RM 2.1 to confluence	WWH	26.6	25.94 98%	24.7 93%	0.5	Non	24*	NA	36.5
Hellbranch Run -- RM 11.7 to RM 10.8	WWH	9.7	7.50 77%	6.2 64%	10.3	Partial	36[ns]	46	39.5

Notes:

1) Assignments of use designation taken from *Biological and Water Quality Study of the Big Darby Creek Watershed, 2001/2002. Logan, Champaign, Union, Madison, Franklin and Pickaway Counties, Ohio*. EWH/CWH designation assigned EWH width recommendation.

2) Actual flood plain predicted by geographical/analytical model using limited field measurements of active flood plain height; this prediction is considered the actual active flood plain and represents a zone inundated by two (2x) or one-and-a-half times (1.5x) maximum bankfull depth. Area shown is amount overlapping recommended zone only.

3) Use Attainment, IBI, ICI, and QHEI per identified stream segment. Specific notation per IBI, ICI, and QHEI are defined as:
   - * Significant departure from ecoregion biocriteria; poor and very poor results are underlined.
   - ns Non-significant departure from ecoregion biocriteria (4 IBI or ICI units; 0.5 Iwb units).
   - a Narrative evaluation is used in lieu of ICI for qualitative samples (E=Excellent, VG=Very Good, G=Good, MG=Marginally good, F=Fair, P=Poor, VP=Very Poor).
   - c Use attainment status based on one organism group is parenthetically expressed.

Table 4.4.3 Recommended Flood Plain Widths for Lower Big Darby Creek (Little Darby Creek to Mouth) 0506001-220

Stream Segment	Use Designation[a]	Drainage Area[b] (sq.mi)	Setback Width[c] (per side, ft)	
			Upper End	Lower End
Hellbranch Run -010				
Hellbranch Run -- headwaters to RM 5.0	WWH	29.88	85.6	143.3
Hellbranch Run -- RM 5.0 to mouth	EWH	34.13	286.6	303.5
Hamilton Ditch -- headwaters to RM 2.1	MWH	4.65	33.5	38.6
Hamilton Ditch -- RM 2.1 to mouth	WWH	5.91	64.4	71.4
Clover Groff Ditch -- headwaters to RM 2.5	MWH	5.94	29.1	42.9
Clover Groff Ditch -- RM 2.5 to mouth	WWH	8.11	71.5	81.8
Big Darby Creek below Little Darby Creek to above Hellbranch Run -020				
Big Darby Creek -- RM 34.1 to RM 26.23	EWH	454.56	901.7	923.8
Smith Ditch	EWH	7.54	137.0	158.5
UNT to Smith Ditch at RM 0.06	EWH	0.87	44.1	62.7
Gay Run	WWH	3.20	25.4	54.8
Big Darby Creek below Hellbranch Run to Darbyville -030				
Big Darby Creek -- RM 26.23 to RM 13.35	EWH	526.78	953.0	984.3
Springwater Run	WWH	3.53	26.1	57.2
UNT to Big Darby Creek at RM 23.77	WWH	0.43	16.2	23.2
UNT to Big Darby Creek at RM 20.2	WWH	5.15	34.0	67.3
UNT to Big Darby Creek at RM 18.41	WWH	2.49	33.9	49.2
Greenbriar Creek	WWH	8.80	40.6	84.7
Georges Run	WWH	1.24	32.4	36.4
Big Darby Creek from Darbyville to Scioto River -040				
Big Darby Creek -- RM 13.35 to mouth	EWH	548.81	984.7	1001.8
Lizard Run	LRW[d]	1.15	4.1	7.1

Notes:
(a) Assignments of use designation taken from *Biological and Water Quality Study of the Big Darby Creek Watershed, 2001/2002. Logan, Champaign, Union, Madison, Franklin and Pickaway Counties, Ohio.*
(b) Drainage area (sq.mi) applies to lower end of segment and is derived from digital topographic model

and GIS (geographic information system).
(c) Width is **one** side (e.g. left bank or right bank and its corresponding flood plain) of stream segment measured from stream centerline.
(d) LRW assigned setback of half bankfull width.
(e) UNT: un-named tributary

4.4.1 Hellbranch Run (220-010)

Table 4.4.1.1 Allocations for Hellbranch Run[2] (220-010)

Total Phosphorus (kg/y)[1]

	Total Load	Major Source Allocations							
		Point Sources			Margin of Safety	Nonpoint Sources			
		Septic	WWTP	MS4[4]		Runoff	Ground-water	Natural	Reduction Needed
Allowable	3175	163	193	179	159	2175	161	145	1.1 lb/acre per year
Existing	16359	844	394	1064	0	12955	957	145	
% Reduction	81%	81%	51%	83%	--	83%	83%	0%	

Suspended Sediment (1000 kg/y)[1]

	Total Load	Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Overland Runoff	Bank Erosion/ Construction	Natural	Reduction Needed
Allowable	1086	1.03	1.71	51.6	153	879	0.05	264 lb/acre per year
Existing	20645	5.34	1.71	0	3051	17587	0.05	
% Reduction	95%	81%	0%	--	95%	95%	0%	

Fecal Coliform (number*10^10/recreational season)[3]

	Total Load	Point Sources			Margin of Safety	Nonpoint Sources	
		Septic	WWTP	MS4[4]		Direct Animal Inputs	Washoff
Allowable	11200	100	16.2	22.6	Implicit	10200	851
Existing	16600	527	17.6	32.8	0	14800	1230
% Reduction	33%	81%	8%	31%	--	31%	31%

Hydrology Targets

% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 39 inches
Baseflow	Runoff		
41%	59%	8.6 in/yr	

[1] 1 kg = 2.2 lbs.
[2] Results are rounded to the nearest whole number based on the percent reduction listed.
[3] Recreational season is from May - October
[4] MS4 = municipal separate storm sewer system; this denotes the portion of stormwater that is discharged from MS4s.

Table 4.4.1.2 Total Phosphorus Load Distribution in Hellbranch Run

Source	% of Existing Load
Row Crops	76.09%
Groundwater	5.94%
Septic Systems	5.16%
Residential	4.9%
Pasture / Hay	3.13%
Point Source	2.41%
Commercial	1.07%
Urban Grasses	0.53%

Table 4.4.1.3 Municipal Separate Storm Sewer System (MS4) Allocations in Hellbranch Run

Breakdown of MS4 Jurisdictions and % of Area		Allocated Load to MS4 Area	
MS4 Area (mi^2)	5.83	TP (kg/yr)	FC (#/period)
Columbus	55%	98.5	1.24E+11
Hilliard	10%	17.9	2.26E+10
Norwich township	7%	12.5	1.58E+10
Brown township	1%	1.8	2.26E+09
Prairie township	27%	48.3	6.10E+10
TOTAL	100%	179	2.26E+11

Table 4.4.1.4 WWTP Allocations for Hellbranch Run (220-010)

Individual Wasteload Allocations							
WWTP	Alton Camp	Cypress Wesleyan	Thorn-apple	Oakhurst Knolls	Pleasant-view	Timber-lake	NOTES
Permit #	4PX00041	4PT00115	4PX00029	4PH00000	4PT00106	4PU00003	
FC, #/period	1.14E+10	1.99E+08	2.94E+08	2.76E+10	2.56E+10	9.72E+10	Alton Needs to Comply with Permit
Solids, kg/yr	20	26	6	601	564	490	No changes needed
TP, kg/yr	2.3	2.9	1	67.7	63.5	55.3	All WWTPs go to 1 mg/l concentration

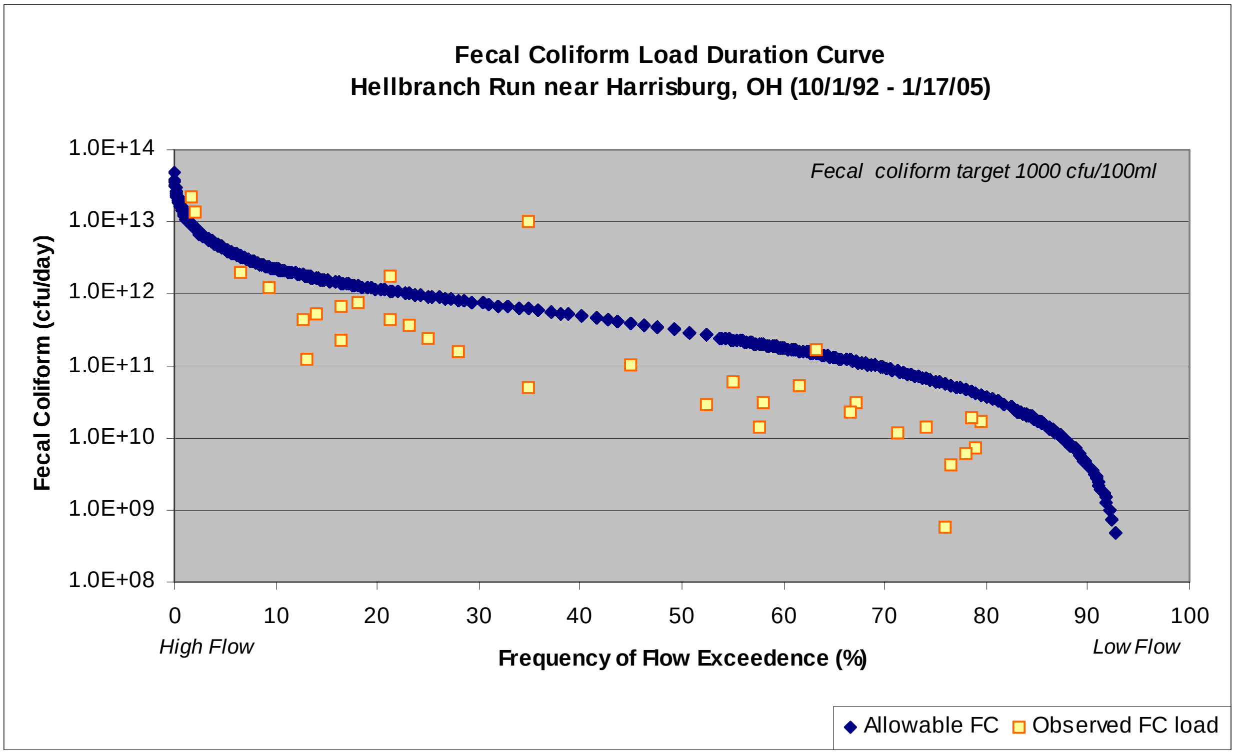
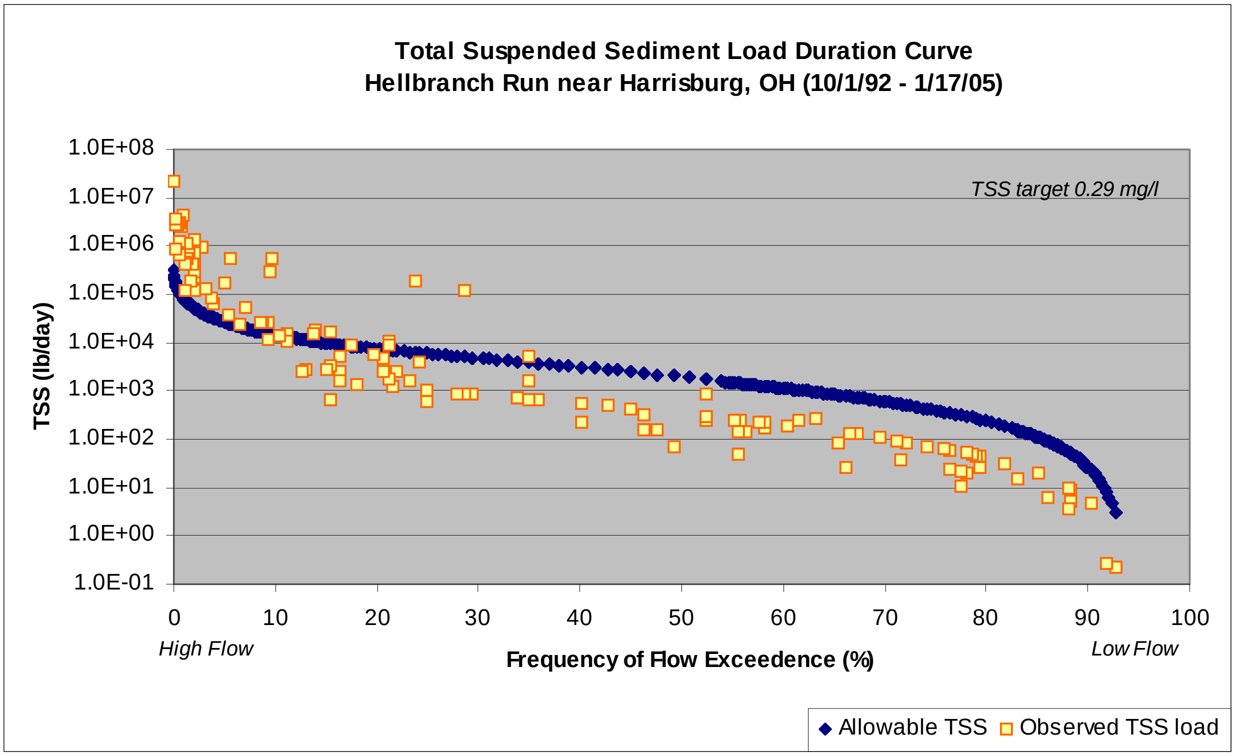


Figure 4.4.1.1 Fecal Coliform Load Duration Curve for Hellbranch Run at Lambert Rd.



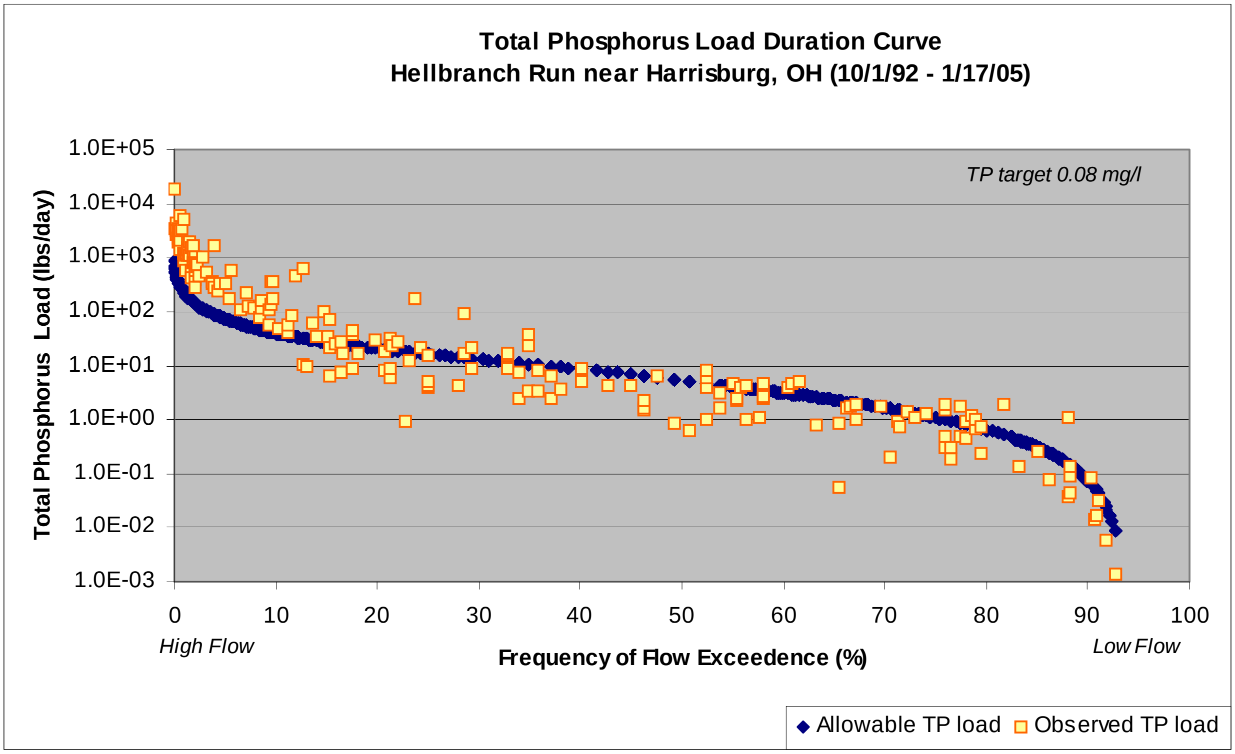


Figure 4.4.1.2 TSS and Total Phosphorus Load Duration Curves for Hellbranch Run

Figure 4.4.1.3 Longitudinal distribution of recommended versus predicted flood plain width, IBI, and aquatic life use attainment status for Hellbranch Run (RM 12.0 to RM 5.5).

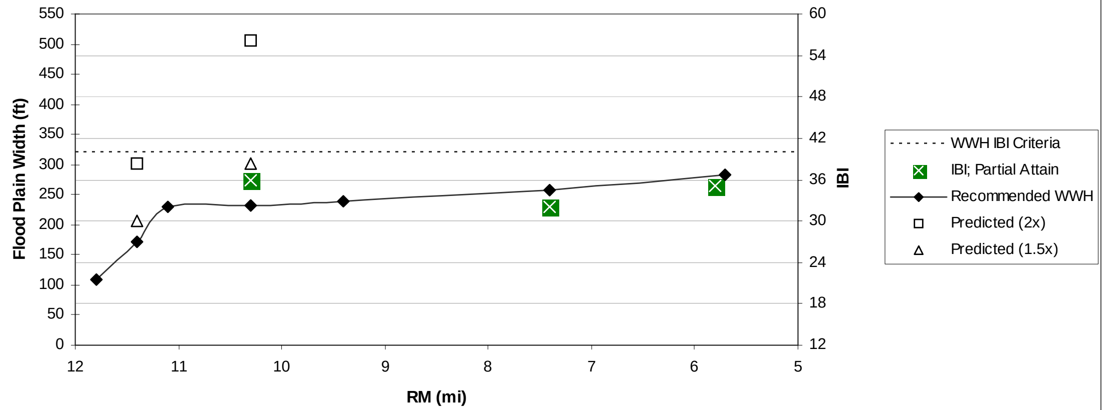
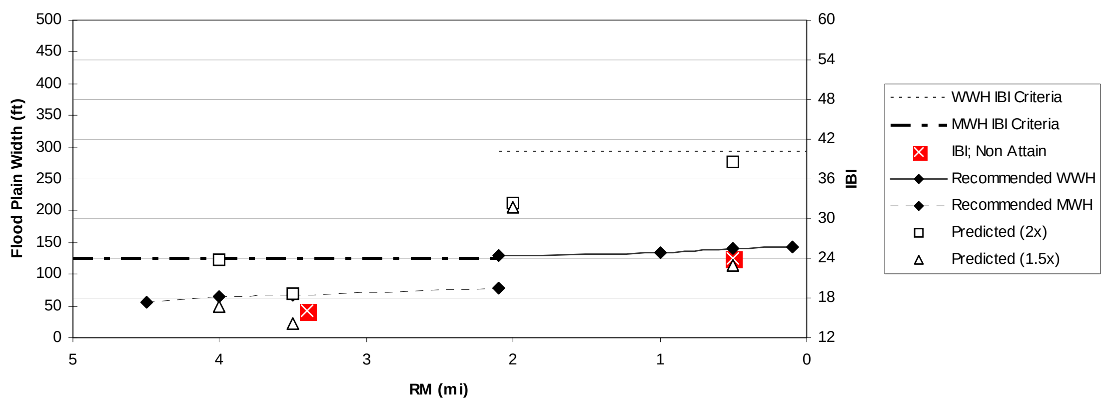


Figure 4.4.1.4 Longitudinal distribution of recommended versus predicted flood plain width, IBI, and aquatic life use attainment status for Hamilton Ditch (RM 5.0 to confluence).



4.4.2 Big Darby Creek from below Little Darby Creek to above Hellbranch Run (220-020)

Table 4.4.2.1 Allocations for upper lower Big Darby Creek (Little Darby Creek to Hellbranch Run)[2] (220-020)

Total Phosphorus (kg/y)[1]								
	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	3871	55	415	194	2839	307	62	0.3 lb/acre per year
Existing	5905	274	442	0	4627	500	62	
% Reduction	34%	80%	6%	--	39%	39%	0%	

Hydrology Targets			
% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
58%	42%	12.4 in/yr	

[1] 1 kg = 2.2 lbs.
[2] Results are rounded to the nearest whole number based on the percent reduction listed.

Table 4.4.2.4 Point Source Allocations for upper lower Big Darby Creek

Individual Wasteload Allocations per Point Source		
Facility	Darbydale WWTP	Notes
Permit #	4PH00012	
Solids, kg/yr	4974.02	Current Permit limit is adequate
TP, kg/yr	414.50	Limit of 1 mg/l needed

Table 4.4.2.3 Total Phosphorus Load Distribution for upper lower Big Darby Creek

Source	% of Existing Load
Row Crops	71.96%
Groundwater	8.65%
Point Source	7.49%
Septic Systems	4.65%
Pasture / Hay	2.66%
Urban Grasses	1.32%
Residential	1.74%
Commercial	0.74%

4.4.3 Middle Lower Big Darby Creek from below Hellbranch Run to Darbyville (220-030)

Table 4.4.3.1 Total Phosphorus Allocations for middle lower Big Darby Creek (Hellbranch Run to Darbyville) [2] (220-030)

Total Phosphorus (kg/y)[1]								
	Total Load	Major Source Allocations						
		Point Sources		Margin of Safety	Nonpoint Sources			
		Septic	WWTP		Runoff	Ground-water	Natural	Reduction Needed
Allowable	6337	33	2079	317	3462	347	100	0.6 lb/acre per year
Existing	12655	166	2547	0	8948	896	100	
% Reduction	50%	80%	18%	--	61%	61%	0%	

Suspended Sediment (1000 kg/y)[1]							
	Total Load	Point Sources		Margin of Safety	Nonpoint Sources		
		Septic	WWTP		Overland Runoff	Natural	Reduction Needed
Allowable	1528	0.21	16.2	76.4	1435	0.04	18 lb/acre per year
Existing	1697	1.05	19.9	0	1676	0.04	
% Reduction	10%	80%	16%	--	14%	0%	

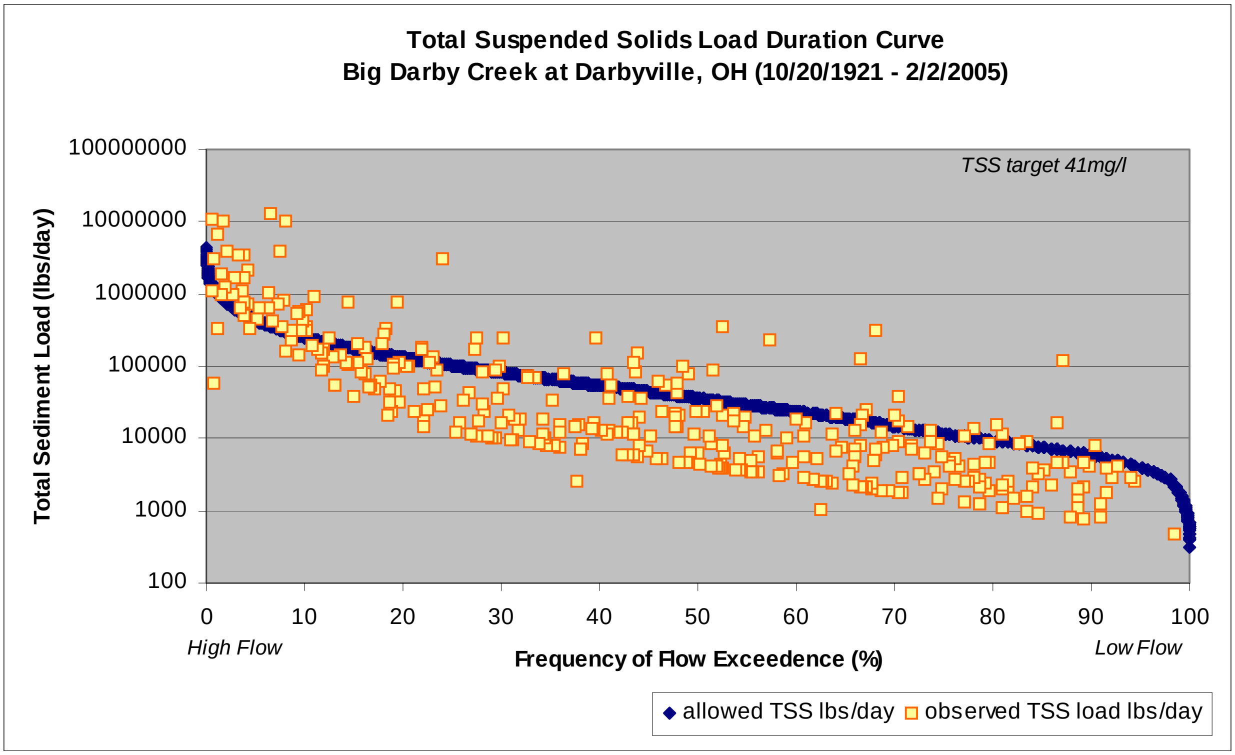
Hydrology Targets			
% of Stream Flow		Average Annual Groundwater Recharge	Targets are based on average annual precipitation of 36.2 inches
Baseflow	Runoff		
52%	48%	11.6 in/yr	

[1] 1 kg = 2.2 lbs.
[2] Results are rounded to the nearest whole number based on the percent reduction listed.

Table 4.4.3.2 Point Source Allocations for Big Darby Creek (220-030)

Individual Wasteload Allocations per Point Source			
Facility	Dot-Mar MHP	PCI WWTP	Notes
Permit #	4PV00100	4PP00003	
Solids, kg/yr	138	16580	Current Permit limit is adequate
TP, kg/yr	6	2073	Limit of 1 mg/l needed for PCI WWTP

Table 4.4.3.3 Total Phosphorus Load Distribution for middle lower Big Darby Ck	
Source	% of Existing Load
Row Crops	66.54%
Point Source	20.08%
Groundwater	7.21%
Pasture / Hay	2.32%
Septic Systems	1.31%
Commercial	0.99%
Urban Grasses	0.57%
Residential	0.50%



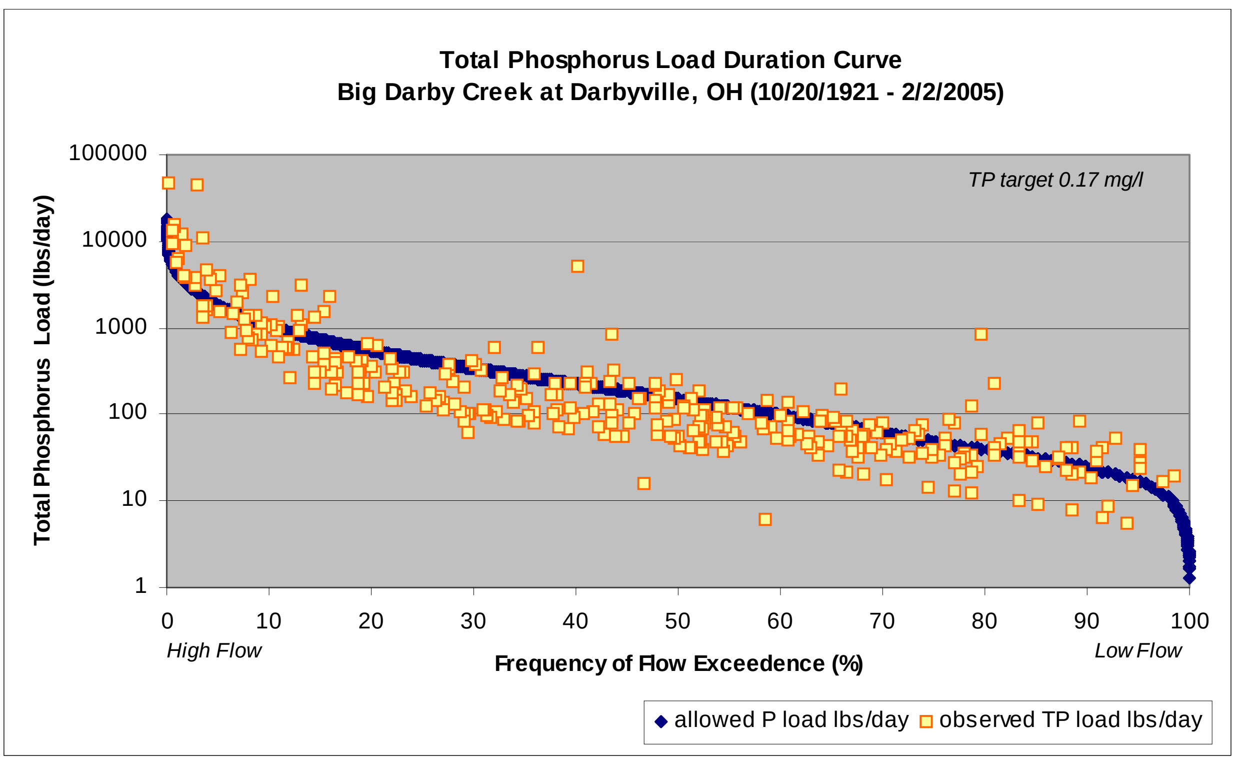


Figure 4.4.3 TSS and Total Phosphorus Load Duration Curves for the Lower Big Darby

4.5 Floodplains of the Big Darby Creek Watershed

This section includes three figures representing different ways of expressing areas that may be subject to inundation in the Big Darby Creek watershed. Figure 4.5.1 depicts the active floodplain as described previously in this report. This floodplain is based on the equations in Chapter 3, and it is a guideline representing the critical floodplain area which the stream needs access to in order to maintain a good, stable stream equilibrium. Activities in this active floodplain area need to be compatible with frequent flooding, and the stream should be able to easily flood into these areas. Figure 4.5.2 represents the 100 year floodplain. No development or inclusion of manmade structures and paved surfaces should be considered within the either of these 2 floodplain areas, or a 100 foot minimum, whichever is greater. Chapter 5 discusses activities that are compatible with inundation in a flood plain in more detail. Figure 4.5.3 shows the frequently flooded soils as determined by county soil scientists. This figure serves as a complement to the 2 floodplain representation, and it can serve to adjust the active floodplain to site specific considerations. The frequently flooded zones based on soils are similar to the active floodplain, and activities in these zones should also be compatible with frequent flooding.

The resolution of these watershed maps is not sufficient to view the small scale of the floodplains. The zoom function can serve to highlight specific areas of interest, and the overall maps give a graphical view of how the floodplains increase with increasing drainage area and stream size.

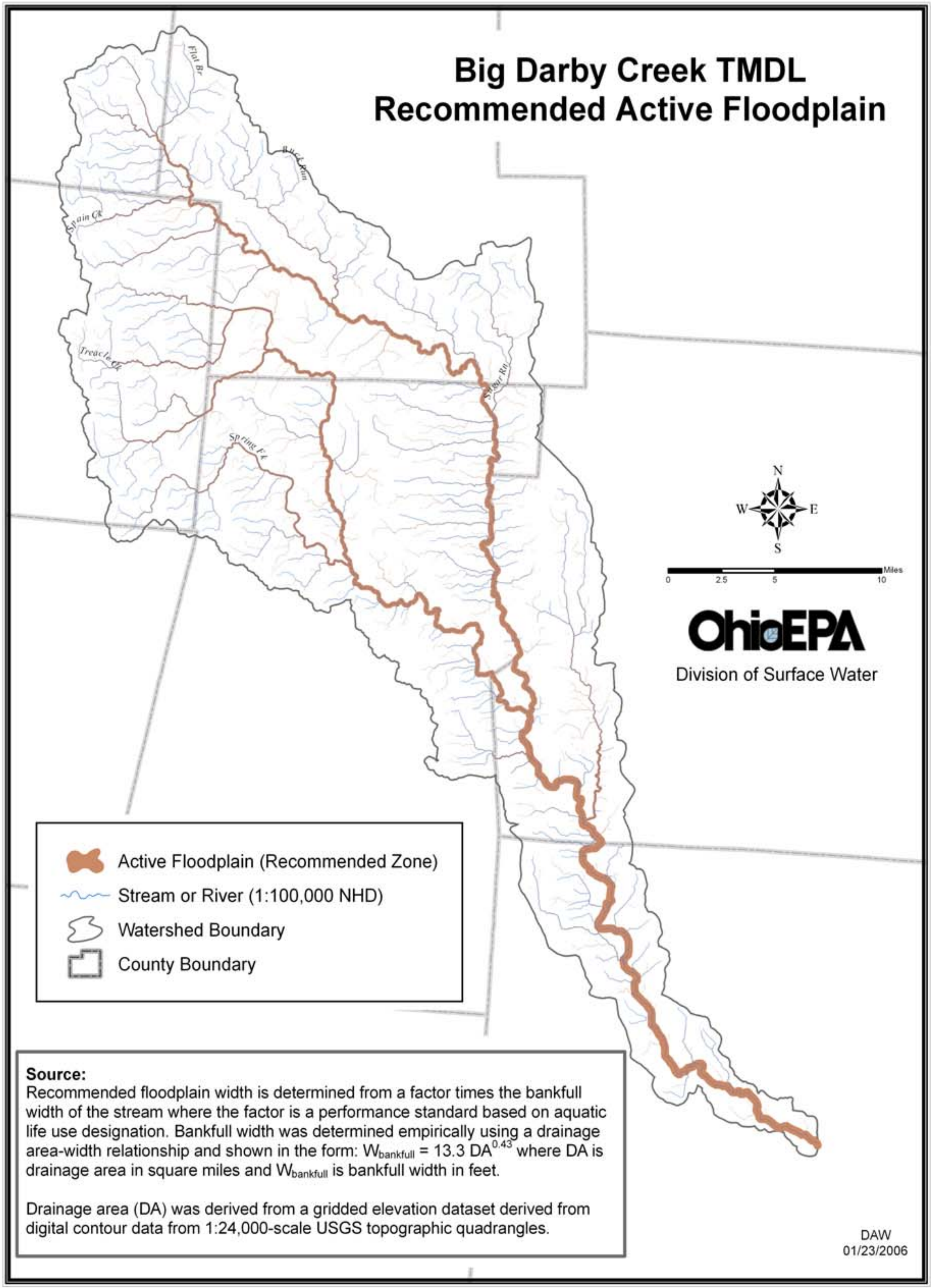


Figure 4.5.1 Big Darby Creek active floodplain

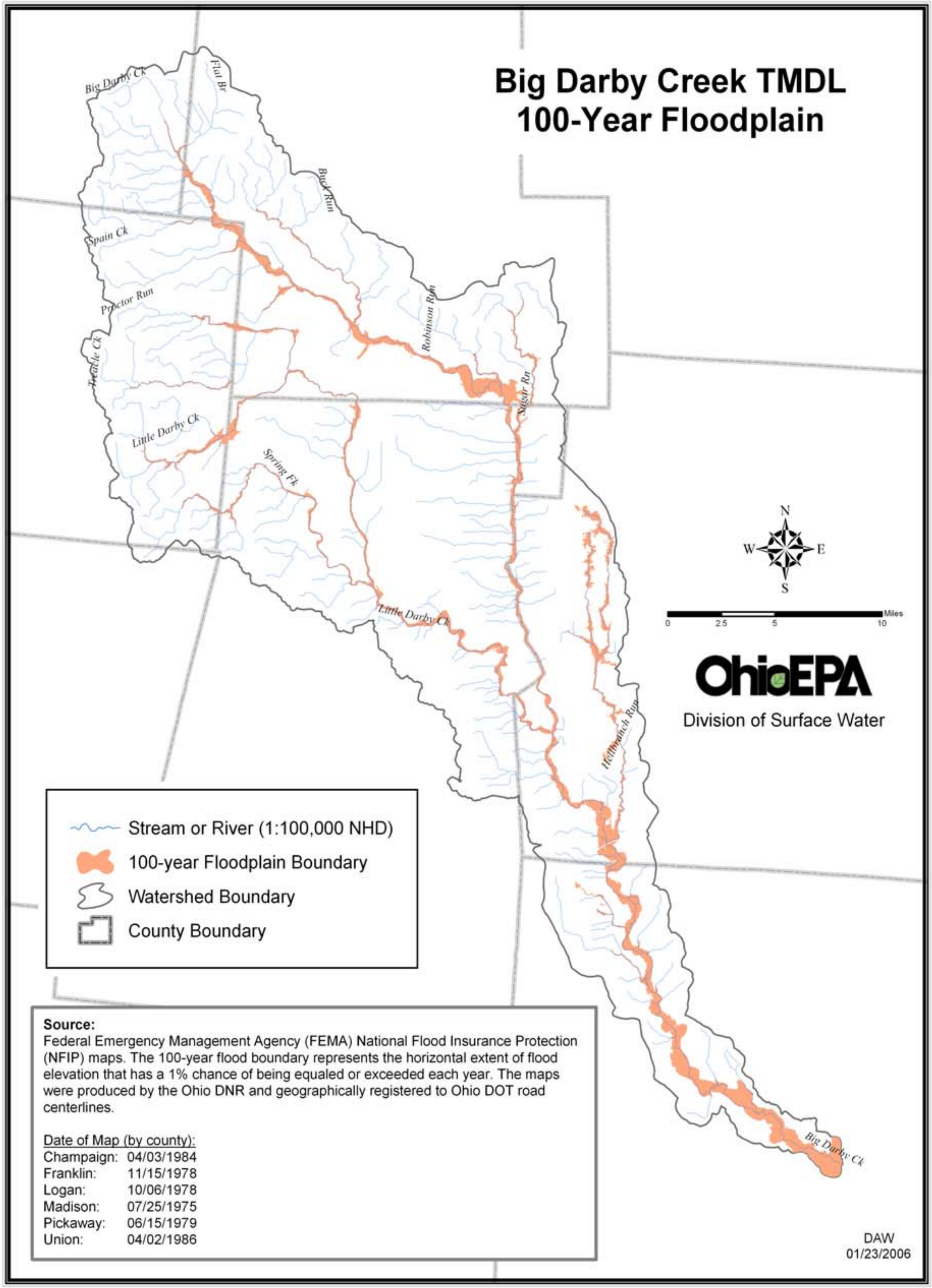


Figure 4.5.2 100-year floodplain of the Big Darby Creek

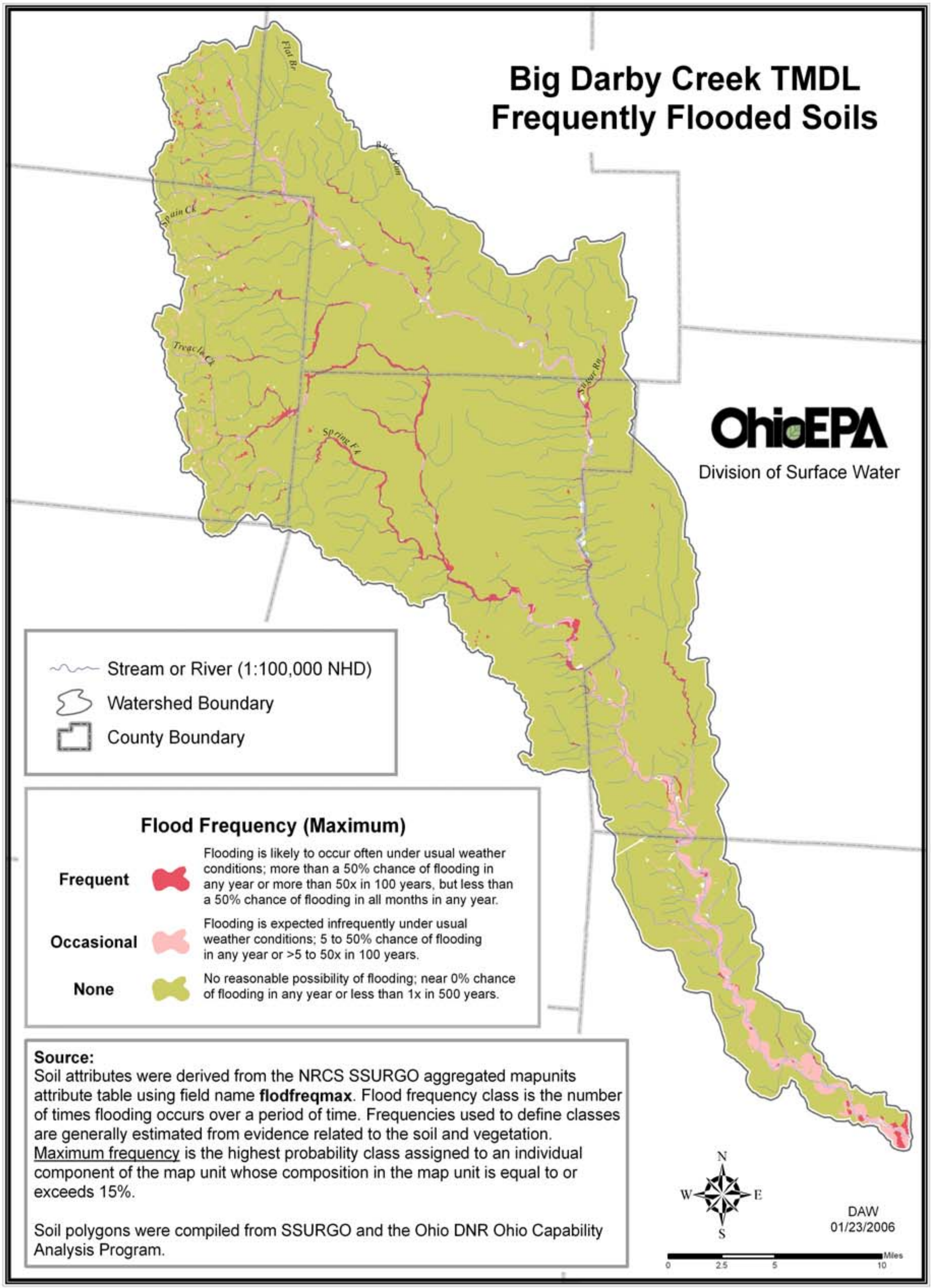


Figure 4.5.3 Frequently flooded soils in the Big Darby Creek watershed

5.0 Implementation of the Big Darby Creek TMDL

A key objective for preserving or restoring the high quality aquatic communities in the Big Darby Creek watershed is to determine ways for human activities to proceed without disrupting the existing natural system. Human intervention usually happens on a local scale. A small swale or ditch is often viewed locally as a conduit for exporting water so that the products of human pursuits can be maximized. But the system as a whole has a finite capacity. The cumulative impact of local interventions in the system has grown to the point that the system can no longer assimilate the changes, particularly in the upper Big Darby Creek watershed, Treacle Creek, Robinson Run and Hellbranch Run. These local interventions are happening from all aspects of our society, as such, solutions will need to come from all aspects of our society. This chapter of the TMDL report outlines the ways to implement the guidelines and loading reductions provided in Chapter 4. Achievement of these are necessary to maintain the Big Darby Creek watershed as a high quality aquatic system.

5.1 Implementation Mechanisms

Stream integrity concepts are discussed in Chapters 3 and 4, as well as the establishment of allowable loads for pollutants, and effluent limitations for point source dischargers. A variety of mechanisms will be evaluated and used to achieve these loading reductions. These mechanisms are discussed in more detail below.

5.1.1 Storm Water Control

Storm water control is largely achieved through the issuance of general permits under the ***NPDES*** program. These permits are issued for construction activities, and for industrial activities, and are issued to control storm water that is discharged from a discrete conveyance, such as pipes or confined conduits. NPDES individual and general permits are issued to individuals, private entities, and local government entities. These permits function together to form a web of state and local authority under which storm water is controlled.

General Permits For Construction Storm Water

Ohio EPA has issued a draft general permit for runoff associated with construction activity that is specific to the Big Darby Creek watershed. Ohio EPA has used existing permit terms and conditions and has included new types of permit terms and conditions to ensure, to the extent authorized by law, that loading targets developed in Chapters 3 and 4 are achieved for storm water. These permit terms and conditions include

NPDES stands for National Pollutant Discharge Elimination System, and is the system for controlling and permitting point source discharges to the waters of the United States. Established under the Clean Water Act, the NPDES permit program mainly regulates point source discharges through individual permits, and storm water discharges using a general permit for the activity generating the storm water.

management practices, effluent targets, infiltration requirements necessary to support stream base flows and stream setbacks necessary to protect the stream channel. The goal is to issue a permit that is protective of the aquatic life uses in the Big Darby Creek watershed.

As is the case with the existing construction storm water general permit, construction companies will be expected to be co-permittees along with developers. This condition of the permit will be an area of emphasis by Ohio EPA in evaluating compliance with the general permit for storm water from construction activity.

Phase I and Phase II MS4 Permits For Local Jurisdictions
Federal storm water regulations call for the issuance of Phase I NPDES storm water permits to large municipalities, and the issuance of Phase II NPDES storm water permits to smaller municipalities. As with the general permits for construction storm water, Ohio EPA intends to revise the MS4 permits, to the extent authorized by law, so as to achieve the loading limitations established in Chapter 4 of this TMDL for storm water. Ohio EPA expects to exercise its authority to designate additional Phase II communities within the Big Darby Creek watershed and to ensure that the permits issued to those jurisdictions are protective of the aquatic life uses.

5.1.2 Point Source Discharge Control

Point sources of pollutants are issued individual NPDES permits for the discharge of pollutants to the Big Darby Creek watershed. Chapter 4 establishes appropriate effluent limitations for point source discharges to the watershed. During State Fiscal Year 2006, all NPDES permits in the Big Darby Creek watershed will be reviewed for compliance with the effluent limitations in Chapter 4. Where the limits are not sufficiently restrictive, the permit will be reissued or modified to include the new effluent limitations, and an appropriate schedule established to bring those point sources in compliance with the new limits.

In the upper Big Darby Creek major sub-watershed there is an impact due to the poor water quality emanating from Flat Branch. Honda's extensive manufacturing facilities are located in this minor sub-watershed. The source of the pollutants contributing to the poor water quality in Flat Branch has not yet been defined. No violations of existing permit conditions by Honda or any other source have been identified. Ohio EPA intends to continue to work collaboratively with Honda to identify sources of pollutants that may be contributing to the impairment of upper Big Darby Creek and to determine appropriate corrective action upon completion of further studies.

Ohio EPA expects that any noncompliant facilities in the Big Darby Creek watershed would come into compliance by October 1, 2005 or be under an enforceable schedule by that time. To the extent that Ohio EPA uses enforcement action to obtain compliance, the sensitive nature of this watershed will be a factor in how Ohio EPA evaluates the severity of the violations, in choosing the level of enforcement and in assessing civil penalties.

5.1.3 Animal Feeding Operations

Ohio EPA is currently responsible for issuing NPDES permits to animal feeding operations (AFO) that meet the definition of a concentrated animal feeding operation (CAFO). The Big Darby Creek watershed does not have any large CAFOs (e.g., greater than 700 dairy cows) that are required to obtain a NPDES CAFO permit at this time. However, there is one medium sized operation that has been required to apply for an NPDES CAFO permit, and others may be required to apply for a permit in the future if they have a discharge from their production area. Ohio EPA will continue to make every effort to investigate operations where discharges are alleged, and determine if a NPDES permit is needed. Most operations in the Big Darby watershed will not be eligible for general permit coverage, and will be required to obtain an individual NPDES permit. Once issued, these permits are expected to result in nutrient reductions since both the production area and land application activities will be more closely regulated and restricted. In addition, most permittees will be required to attend training related to water quality and manure handling as a condition of their permit.

Permit conditions and requirements are not expected to change significantly when the NPDES authority for CAFOs is transferred to the Ohio Department of Agriculture. Ohio EPA will continue to work closely with the Department of Agriculture in establishing requirements to protect water quality, especially in critical watersheds such as Big Darby Creek.

The most critical aspect of minimizing water quality impacts from any size animal feeding operation is the proper management of manure. All operations should have updated manure management plans and make every effort to avoid land application of their manure during wet weather and during the winter when runoff is more likely to occur. Ohio EPA is committed to responding promptly to complaints, and we will strive to work with our partners to inform producers about emerging technology and BMPs as well as updates to the technical standards for manure handling and application. Continued efforts by local Soil Water Conservation District (SWCD) and Natural Resource Conservation Service (NRCS) staff to work with producers and update plans will be critical as well.

5.1.4 Managing Drainage Needs, Channel Erosion and Flood Reduction Work

Agricultural land use and crop productivity throughout large portions of the Big Darby Creek watershed depends upon adequate soil drainage. Agricultural productivity of the land has been enhanced by maintaining a system of subsurface tile drains and adequate outlets for these artificial drainage systems. Over 86 maintained county ditches and many more tile mains are present in the Big Darby watershed, many concentrated in low gradient Darby Plains landscape where channels were dug in the nineteenth century when the land was first farmed. These ditches have their outlets at points in the landscape where the natural gradient increases near the valleys of Big and Little Darby creeks and their larger tributaries (see Figure 5.1 for an example from middle Big Darby Creek). Furthermore, stream bank modifications in the form of levees and armament have been constructed at some locations throughout the watershed for erosion protection and flood reduction efforts.

Previous chapters of this report have established that the ecological health of the Big Darby Creek is dependent upon the preservation and improvement of stream hydrology and geomorphological features through the use of stream setbacks. Chapters 3 and 4 provide targets and allocations or recommendations regarding sediment bedload, habitat and stream setbacks designed to protect the Big Darby Creek system. The water quality benefits to be realized by attaining these targets can be summed up as increasing the natural filtering of pollutants, providing in-stream habitat and shading, increasing the assimilative capacity of the system, and providing a flood plain where sediment and stream flow energy dissipate.

Left unmanaged on a watershed scale, agricultural drainage, erosion control and flood reduction practices are threats to the ecological health of the Big Darby Creek system. Ohio EPA studies have documented that the cumulative impacts of the water, energy and sediment delivered to Big and Little Darby creeks from all the ditch systems, and the more recent disturbances caused by road construction and industrial development along the northern edge of the watershed, are responsible for declines in indicators of biological health of the system. Additional stress to the system has been added by the activities of private landowners and public agency projects to control stream bank erosion and flooding in localized areas.

The challenge of implementing the TMDL recommendations, specifically those steps necessary to meet the sediment bedload, habitat and flood plain widths targets established in Chapter 4, will be to find acceptable methods that simultaneously manage and meet the human needs for agricultural drainage, erosion protection and flood reduction work and the ecological needs of the Big Darby Creek system. Recent scientific evidence suggest these dual objectives can be compatible (Ward et al., 2002).

Ohio EPA has identified four implementation mechanisms that can consider the dual objectives in the evaluation of drainage practices and certain channel erosion and flood reduction projects.

First, in some circumstances, the United States Army Corps of Engineers (US ACOE) issues permits for dredging and placement of fill in a stream below the ordinary high water mark. The determination of when a Section 404 permit is needed is made by the US ACOE and may involve the consideration of comments from Ohio EPA and others. When a 404 permit is needed, Ohio EPA is responsible for reviewing Section 401 water quality certifications and isolated wetland applications for this activity and certifying that

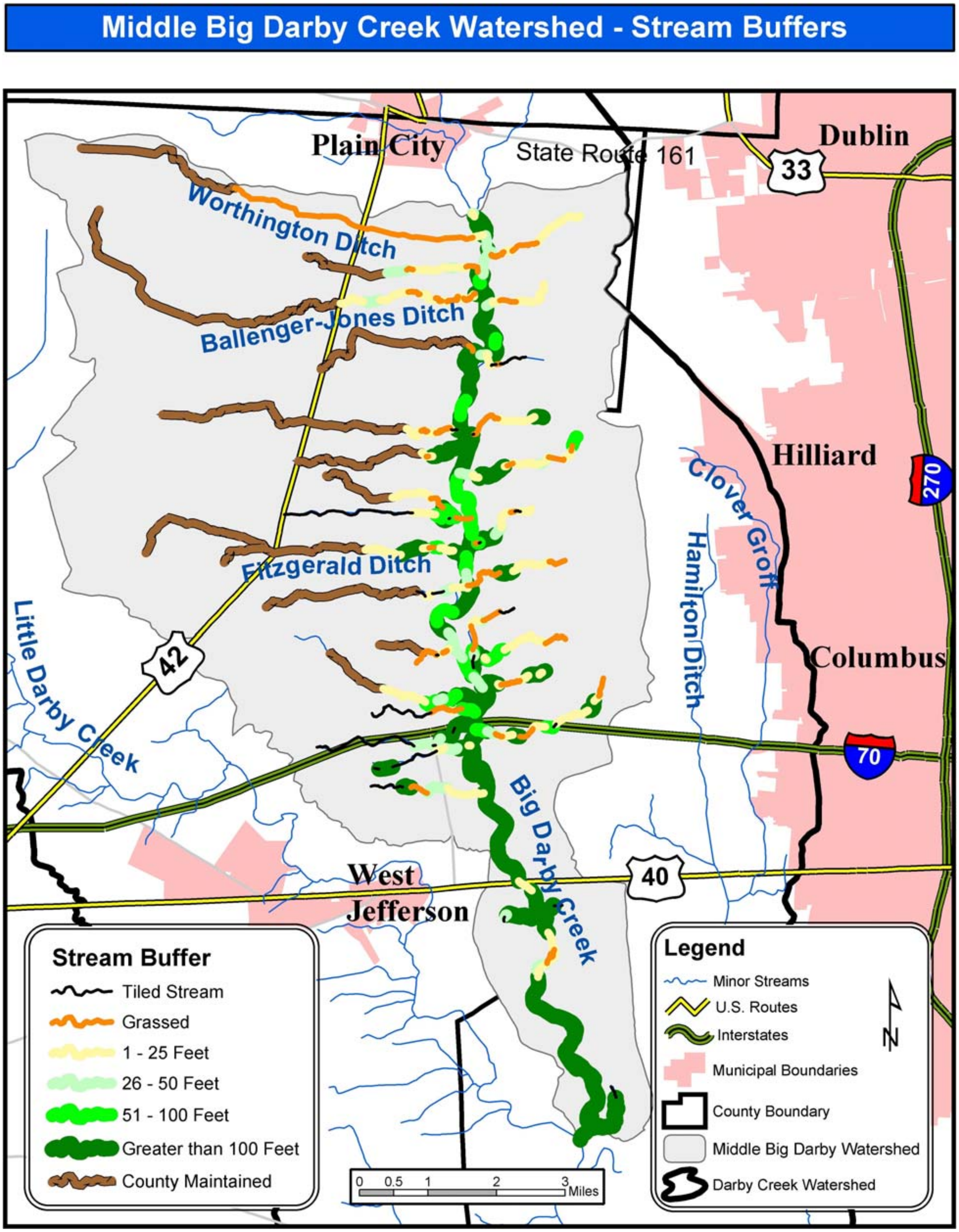


Figure 5.1 Examples of low gradient, county maintained streams in the middle Big Darby Creek sub-watershed, and the buffer conditions at their outlet. Graphics courtesy Ben Webb.

the activity will meet water quality standards. Chapters 3 and 4 of the Big Darby Creek watershed TMDL establish targets for sediment bedload, habitat and flood plain widths in the Big Darby Creek watershed necessary for meeting water quality standards.

Future 401 and isolated wetland certifications by Ohio EPA will include a review for attainment of water quality standards in light of these targets, and where attainment is not possible, the certification will seek mitigation of the proposed activity. Downstream mitigation within the same sub-watershed is highly preferable because it helps the system absorb the increased amount of flood water and erosional energy created when projects fall short of attaining on-site the sediment bedload, habitat and flood plain width allocations and recommendations found in Chapter 4. Where appropriate Ohio EPA will evaluate requiring, as part of the mitigation plan, natural channel design or flood plain excavation to allow the stream channel access to the flood plain.

Many small scale dredge and fill projects are regulated under nationwide permits issued by the US ACOE. Ohio EPA has granted blanket Section 401 certifications for these, in some cases with additional conditions that must be fulfilled by the applicant. As a second implementation mechanism to address better management of drainage, stream bank erosion and flood reduction projects in the Big Darby Creek watershed, Ohio EPA intends to evaluate removing the Big Darby Creek watershed from certification of nationwide permits where appropriate and necessary to continue progress towards meeting sediment bedload, habitat and flood plain widths targets contained in this report. Nationwide Permit number 27, which permits work for natural stream channel design, already contributes to the attainment of the sediment bedload, habitat and flood plain width targets and can be retained and renewed without modification.

The third implementation mechanism is to promote improved drainage through environmentally sound means. An immediate step along this path will occur in January, 2006 as Ohio EPA will participate on a *Rural Drainage Advisory Committee* convened by Ohio DNR Division of Soil and Water Conservation. Other committee participants include environmental groups, county engineers, academia, and federal, state, and local soil and water conservationists. The committee is charged with looking at the current laws and regulations related to ditch construction and maintenance and looking for practical solutions that effectively address drainage needs and protection of water quality. Additional specific outcomes might include State-wide guidelines to assess drainage needs, ditch reconstruction needs and methods, and BMPs for construction and maintenance.

Once further development of some State-wide guidelines are available, the information in Chapter 4 of sediment bedload, habitat and flood plain width targets, allocations and recommendations for many small watershed units will allow a tailored approach to improving conditions within each sub-watershed area of the Big Darby Creek watershed. Petition ditch maintenance work and privately maintained drainage projects on waters designated as Warmwater Habitat (or Exceptional Warmwater) should be performed with an eye towards installing BMPs that would improve sediment bedload, habitat and flood plain width characteristics *within the ditch outlets (the higher gradient channels not actively "maintained" or cleaned of accumulated sediment and brush)*. Conversion of traditional ditch design and maintenance practices to innovative two-stage channel, flood plain excavation, or natural channel design features should also be encouraged. Cost sharing or other mechanisms of funding these efforts are possible (see sections 5.1.5.3 and 5.1.5.4).

Finally, the fourth means of implementing the sediment bedload, habitat and flood plain width recommendations is possible through action by local government entities. Local jurisdictions through zoning and through their authority to enact flood plain regulations have the ability to protect existing flood plains and to make wooded riparian corridors a preferential land use in those areas. There are a number of locally-derived benefits associated with reaching the sediment bedload, habitat and flood plain width targets provide in this report. Meeting these targets will improve and preserve the water resources and will also keep or restore landscape features that could add to local land use values. In addition, zoning and flood plain regulations that keep new development out of the stream setbacks, within which the stream channel itself is likely to move over the course of time, will reduce public and private costs associated with flood damage and loss of property when stream banks erode.

5.1.5 Agricultural BMPs and Programs

The Big Darby Creek watershed TMDL report establishes loading reductions for phosphorus and sediment in Chapter 4 for nonpoint sources that generally range from approximately 60 to 85 percent. Much of this loading occurs during high stream flow events. The adverse impacts of nutrient and sediment loadings that occur at high stream flows can be attenuated by improving the management of sediment bedload, habitat and flood plain width (see discussion in prior section). However, even with improvement in these factors it will be necessary to make incremental progress in reaching the phosphorus and sediment load reduction targets. This section describes how this can be accomplished through the work of several agriculturally oriented programs that stress voluntary adoption of ***BMPs*** by landowners and operators. Each program can bring to bear a variety of BMPs to improve water quality through the reduction of pollutants delivered to stream systems. Their common features are achieving a reduction in erosion and overland runoff, improving nutrient management practices, and offering education and cost incentives. There are many programs available to help with the funding of voluntary implementation of agricultural best management practices. Some of these are summarized below.

A Best Management Practice (***BMP***) is a practice, procedure, method, or program designed to minimize or eliminate the discharge of pollutants that may arise from a particular activity. Storm water BMPs often involve slowing water down so suspended sediments can settle or by stabilizing barren areas. Agricultural BMPs may involve practices such as minimizing nutrient runoff through no-till or providing for the fencing of livestock out of streams. County SWCDs are a good resource for available agricultural BMPs.

5.1.5.1 Scioto River Watershed Conservation Reserve Enhancement Program (CREP)

The Scioto River Watershed Conservation Reserve Enhancement Program (CREP) is a federally and locally funded initiative that is aimed at creating 70,000 acres in a combination of buffers and wetlands on cropland and marginal pastureland throughout the entire Scioto basin. Although the Big Darby Creek watershed makes up only a part of the entire CREP project area (about 8.5% of the total land area), this program can serve as an important means to addressing non-point source pollutants related to agricultural run-off and production farming in this drainage basin. Buffer strips and wetlands have both been noted in their effectiveness in reducing sediment and nutrient loads to surface waters (Osborne and Kovacic, 1993, Peterjohn and Correll, 1984, and Vellidis, 2003) and may improve infiltration capacity of the soil.

The Scioto CREP is a voluntary, incentive-based conservation program that has emerged out of the 1996 Farm Bill as a part of the older Conservation Reserve Program (CRP). The Scioto CREP officially began in February of 2005 and the enrollment period is expected to continue for two years, or as long as acres remain available (i.e., the 70,000 acre total is not yet reached). There are no county limits to the number of acres that can be enrolled therefore it is hard to predict the extent at which the program's conservation practices will be installed in any given area. Practices that are eligible through this program include both native and non-native grass filter strips, hardwood and coniferous tree plantings, wildlife habitat buffers, wetland restoration, and the installation and use of water table management infrastructure. CREP contracts are for 14 to 15 years in duration and enrollees are under no obligation to maintain those conservation practices after that time.

The buffer widths (i.e., linear distance perpendicular to the direction of channel flow) are likely to vary, which is related to the situational differences in the area of eligible land on a particular farm as well as the preferences of the prospective enrollees. Cropland that is eligible for enrollment includes a riparian area that extends 200 feet from the top of bank of the stream or ditch, while the minimum width for enrollment is 20 feet from the top of bank. Other cropland that is eligible includes the full extent of the 100-year flood plain and, if immediately adjacent to other eligible areas (i.e., the 200 ft riparian and/or the 100-year flood plain), highly erodible land (land with an erodibility index of 12 or greater). Permanent conservation easements for buffer strips are also being promoted through this program, however funding for their purchase (roughly half of the fair market value) is limited. Areas to be enrolled for wetland restoration must have at least 51% of its soil classified as hydric, and there is a 10 acre limit for enrollment per wetland.

This program is being advertised and administered through county Soil & Water Conservation Districts, Natural Resource Conservation Service (NRCS) and Farm Service Agency (FSA) staff. Information regarding this program is available on the web at: http://www.dnr.state.oh.us/soilandwater/sciotocrep/default.htm

5.1.5.2 Environmental Quality Incentives Program (EQIP)

The Environmental Quality Incentives Program (EQIP) is a United States Department of Agriculture (USDA) program that began following the1996 Farm Bill and is administered by the Natural Resource Conservation Service (NRCS). The objective of this incentive based, voluntary program is to increase the use of agriculturally related best management and conservation practices. EQIP is available to operators throughout the entire Big Darby Creek watershed irrespective of whether they own or rent the land that they farm. Through this program operators receive cost share and/or incentive payments for employing conservation management practices. Contracts are five years in length.

There are numerous conservation practices that are eligible for payments. These practices cover broad categories such as nutrient and pesticide management, conservation tillage, conservation crop rotation, cover cropping, manure management and storage, pesticide and fertilizer handling facilities, livestock fencing, pastureland management, and drainage water management among others. However, funding for these practices is competitive and limited to the allocations made to any respective county in Ohio.

Each county in receives a baseline of $100,000 per year (this baseline allocation is subject to change due to budgetary constraints) and may receive more monies, however this is decided at the state level. Interested farm operators are to submit an application for EQIP funding for a specific conservation practice to their county's District Conservationist (NRCS). The District Conservationist ranks each of these applications according to a scoring system that takes into account the type of practice and the size of the area affected by the practice. The priorities reflected by this scoring system are determined both at the state level (through the State Technical Committee) and the local level (Local Workgroup). The state's priorities account for 66% of the total points possible, leaving 33% to be determined by local priorities. Currently state priorities focus on livestock related conservation practices. Operators are ultimately funded based upon their ranking and the availability of EQIP dollars in the county.

More information on this program is available on the NRCS website at www.nrcs.usda.gov.

5.1.5.3 Section 319 Nonpoint Source Grants

Section 319 of the 1987 Clean Water Act created a national program to control and prevent nonpoint source pollution of the Nation's surface and ground water resources. The Ohio EPA, Ohio's designated water quality agency, is responsible for administering the program in Ohio. A goal of 80% aquatic life use attainment for Ohio waters by 2010 is a state priority. In concert with this goal, the Section 319 Implementation Grant program is designed to provide financial assistance to projects that eliminate or reduce water quality impairments caused by nonpoint source pollution (NPS) and prevent future NPS related impairments.

A clear, strong rationale for project work is required for each award along with a match of local resources. This rationale directs Ohio 319 awards to watersheds with state endorsed watershed plans, Acid Mine Drainage Abatement - Treatment Plans, and late stage TMDLs. In each case, demonstrable aquatic life use impairments due to NPS pollution must be addressed by the project.

Project categories that will be funded include: 1. Stream Restoration and or Renaturalization Projects. 2. Acid Mine Drainage Abatement and AML Reclamation Projects. 3. Agricultural Best Management Practices and Projects * 4. Riparian Restoration Projects. 5. Riparian Protection and Conservation Easement Projects. 6. Source Water (public water supplies) Protection Implementation Grants. Other projects may be funded particularly if they are highly effective and innovative means to eliminate NPS pollutants and restore impaired waters.

Applicants may apply for a maximum of $500,000 for a three year period. Each project funded must provide an additional 40% matching share. The total federally funded share of project costs may not exceed 60%.

Since inception, Ohio's program has funded over 225 local and state level NPS projects. In April 2005, the Franklin Soil and Water Conservation District was completing a project in Hellbranch Run. This effort has focused on easement purchase within this rapidly developing tributary shed of the Big Darby.

The latest Ohio EPA 319 Grant program Request for Proposals and Application Package can be found on the Agency's website:
http://www.epa.state.oh.us/dsw/index.html

* Section 319 grant funds may not be used to cost share practices that duplicate or supplement traditional Farm Bill program funded practices and activities. Neither may Section 319 Grant funds be used to cost-share for tillage and/or other agricultural equipment purchase.

5.1.5.4 The Ohio Water Pollution Control Loan Fund (WPCLF)

The Ohio EPA's Division of Environmental and Financial Assistance (DEFA) administers the Water Pollution Control Loan Fund. The WPCLF provides financial and technical assistance for numerous types of nonpoint source pollution control actions, and for treatment works improvements, such as wastewater treatment plant expansions and upgrades, new and replacement sewers, correction of clean water inflow and infiltration into sewers, combined sewer overflows (CSOs), and sewer separation projects.

Ohio EPA, through the WPCLF, has awarded over $3.0 billion in loans state-wide since 1989. Within the Big Darby Creek watershed, the Pickaway County Commissioners received a WPCLF loan for the Darby Township Sewer Improvement project. Also, Ohio EPA is currently working with the villages of Plain City and North Lewisburg on wastewater treatment improvement projects, which are under consideration for WPCLF financing in 2005.

Low Interest Rate Financing

The WPCLF awards low interest loans for a wide variety of projects to protect or improve the quality of ground water, rivers, streams, lakes, and other water resources. For example, while conventional long-term financing as of April 2005 may be 4.75%, the standard WPCLF rate is 3.25 %. WPCLF pre-award interest rates are adjusted quarterly to maintain this discount.

The WPCLF offers even lower interest rates to small or hardship communities. A small community is defined as any incorporated area with a population of 5,000 or less, or any unincorporated area that has a current project service population of 5,000 or less and that charges the entire debt for the project solely to the project service population. Currently, small communities receive an interest rate of 2.75 %. Hardship communities, defined as a service population equal to or less than 2,500 and a median household income of $45,500 or less, will receive an interest rate of 0.0 %. Communities with a service population between 2,500 and 10,000 and with a median household income of $38,000 or less will receive an interest rate of 1.0 %.

Interest rates may be further reduced if a community utilizes any of the several discount programs offered by the WPCLF, including construction of septage receiving and treatment facilities, conversion of Class B to Class A sludge, and participation in the Water Resource Restoration Sponsor Program (WRRSP).

Water Resource Restoration Sponsorships

The WRRSP funds the reasonable cost of nonpoint source projects that fully protect and/or restore critical surface water and wetland habitats. This may include several kinds of actions that may be specified within a TMDL. By advancing a portion of the estimated amount of interest due from the loan of a sponsoring WPCLF recipient, Ohio EPA can provide assistance to the WRRSP project which, unlike a loan, is not required to be repaid.

The amount of funds available and projects to be funded by the WRRSP are identified in DEFA's annual Program Management Plan. In the past, approximately $15 million per year has been made available through the WRRSP. Projects previously funded through the WRRSP, or anticipated to be funded in 2005, within the Darby Creek watershed include acquisition and preservation in perpetuity of the riparian corridor along Darby Dan Farm, a portion of the Little Darby Creek riparian corridor, and the headwaters of Big Darby Creek.

Linked Deposit Loans

The linked deposit program is a mechanism for financing nonpoint source projects to be implemented by private organizations and individuals. Linked deposits are a different type of loan, because instead of borrowing directly from the WPCLF, a borrower receives the loan through a private lending institution at a below market interest rate. The interest rate for the loan is reduced through a subsidy provided by a WPCLF-funded certificate of deposit placed with the lender.

Linked deposits can be used with a wide variety of projects, such as source water protection, agriculture best management practices, animal feeding operations, urban storm water runoff control, stream corridor restoration, non-discharging home sewage treatment system replacements, and forestry/ land development best management practices.

To establish a WPCLF linked deposit loan program in a watershed, Ohio EPA and an interested party, such as a county Soil and Water Conservation District or a local health department, enter into an agreement which sets the terms and conditions under which linked deposit loans will be made. The local party then oversees the development of a management plan for the linked deposit borrower's project. Finally, to establish the sources of financing, local banks are invited by Ohio EPA, the borrower, or the local party to participate in the linked deposit program. The financing arrangements are documented in a participating bank agreement among Ohio EPA, the Ohio Water Development Authority, and the local bank.

When the agreements are in place, individual linked deposit loans can then be awarded. For example, a homeowner first submits a proposal to the local health department for a project to upgrade or replace a failing home sewage treatment system. Once the health department has approved the linked deposit project, the homeowner then applies for a loan from any of the local participating linked deposit banks. The homeowner must be deemed credit-worthy by the participating bank to receive the linked deposit loan. If approved, the homeowner will receive the bank's applicable interest rate for the loan, minus the interest rate reduction that the WPCLF linked deposit has subsidized.

Within the Big Darby Creek watershed, a linked deposit program for agricultural BMPs has been in place since 1995. The Big Darby Creek watershed is one of 10 Ohio watersheds with an established agricultural linked deposit program through the WPCLF. In the span of time that the linked deposit program has been available within the Big Darby Creek watershed, Ohio EPA has financed approximately $3.6 million in agricultural BMPs through 94 linked deposit loans. The majority of the BMPs financed have been for conservation tillage practices.

Assistance for Contaminated Sites

The WPCLF also provides financing to both public and private entities for waste disposal remediation activities, including contaminated site assessments, brownfield remediation, landfill closures, and hazardous waste disposal. These projects must demonstrate a benefit to surface or ground water resources, and do not include the cost of site redevelopment. The loans are normally made at the WPCLF's standard rate for a term of up to 10 years with a maximum amount of $3 million, and are subject to common commercial lending practices.

5.1.6 Local Authorities

Local authorities exist that will play very important roles in the implementation of loading reductions contained in this TMDL. Local health departments have a clear and direct role in regulating of discharging household sewage treatment systems (HSTSs).   The regulation of those systems in accordance with state regulations will play an important role in accomplishing the pathogen and phosphorus loading reductions identified in this TMDL. Local expertise and effort will be pivotal in achieving the loading reduction targets.

Recent changes in Ohio law expanding and strengthening the role of health departments in regulating home sewage disposal and small flow disposal systems will make the role of local health departments all the more pivotal.

Ohio EPA encourages local health departments and local government to work collaboratively to develop general plans for HSTS control. Such general plans should identify the location of HSTSs and whether the systems are functioning as designed, and whether the systems are on-lot or off-lot systems, and necessary strategies to repair or replace failing HSTSs as necessary to meet the loading reductions identified in Chapter 4 of this TMDL.

County Soil and Water Conservation District and Natural Resource Conservation Service staff have a key role in setting the tone for achieving pollutant load reductions from nonpoint sources of pollution especially from the agricultural sector. While serving in primarily an advisory role, these local authorities provide key support to land owners who are interested in controlling the impacts from their operations.   Assurances that implementation of nonpoint pollution reductions would occur would be impossible without the efforts of these authorities.

5.1.7 208 Plans

Authorized under Section 208 of the Clean Water Act, 208 plans provide the framework to develop a comprehensive approach for the treatment of wastewater and for controlling water pollution from all point and non-point sources in a geographic area. TMDLs provide the specific analysis of water quality conditions and the allocation of pollutant loads to attain Clean Water Act goals. TMDL reports become part of the State's Water Quality Management Plan when they are completed and approved.

Initial 208 plans were prepared in the 1970s and were a key product necessary for the operation of the construction grants program which provided federal funds for the design and construction of sewage collection and treatment facilities. The State of Ohio is responsible for maintaining the 208 plan applicable in 64 counties, including all of the Big Darby Creek watershed. Ohio EPA Division of Surface Water currently has the role of compiling 208 plan content for the Governor's certification as part of the State Water Quality Management Plan. In 2005, the Division is reshaping the State WQM Plan and the 208 plan content for all 64 counties. Existing 208 plan content will be examined and outdated documents and plan material will be replaced with current information. The Franklin County portion of the Big Darby Creek watershed was included in a State 208 plan update in 2002 (entitled Water Quality Management Plan Scioto River Basin and Blacklick Creek, a.k.a. Central Scioto Plan Update or CSPU). Specific parts of the CSPU must be updated in 2005 (see below).

The State 208 plan and the Big Darby Creek watershed TMDL report findings interface in several ways and will generate new 208 plan content along the lines listed below. Because the State WQM Plan is required by federal regulations to be reviewed and updated annually, it provides a built-in method to implement additional technical findings and program modifications.

1. Address specific issues set out by the CSPU (the last 208 plan for Franklin County portion of the Big Darby Creek watershed)

   a. Use the TMDL findings to help evaluate the recommendations of the External Advisory Group for the Environmentally Sensitive Development Area (Hellbranch Run and other portions of western Franklin County); appropriate recommendations to protect the water quality of the Big Darby Creek system will be included in the next State 208 plan; these recommendation will need to be implemented in order to secure Ohio EPA approval of central sewer projects.
   b. Opt out request from Prairie Township and Ohio-America Water Company (to be considered in next 208 plan update if received by June 30, 2005) -
   Per the framework in the CSPU (see Section 5.03.02), use the TMDL findings and other modeling work to evaluate if the proposal meets water quality standards and protects the downstream superior high quality water (special antidegradation classification) segment of Hellbranch Run, the proposed EWH use designation for Hellbranch Run, and the Big Darby Creek.

2. 208 Plan for Madison County

   The Madison County Commissioners have prepared a water quality plan that could serve a number of purposes, including the technical basis for new and detailed municipal wastewater facility planning areas in the State's 208 plan. This TMDL report serves as the water quality protection reference point to ensure that the master sewer plan and the future plans for Publicly Owned Treatment Works within the Madison County portion of Big Darby Creek Watershed meet applicable water quality standards. Management of storm water, individual home sewage treatment disposal systems, and special riparian habitat needs of the Big Darby Creek system are also appropriate subjects for the State's 208 plan for Madison County.

3. 208 Plan for remaining counties in Big Darby Creek watershed

   The 2005 State WQM Plan will include templates and 208 plan content for the remaining counties in the Big Darby Creek watershed (Champaign, Logan, Union and Pickaway). The 208 plan will include the State's assessment of water quality conditions and any associated directives to address regional planning for municipal sewage collection and treatment needs because of water quality threats. The 208 plan for each of these counties will also cover management of storm water, individual home sewage treatment disposal systems, and special riparian habitat needs of the Big Darby Creek system.

5.2 Sectors of Society and the Big Darby Creek TMDL Recommendations

Based on the results of a detailed physical, chemical, biological and mathematical evaluation, the Big Darby Creek watershed is found to be under stress from all aspects of our society. Agriculture, construction, development, industrial activity, and municipal and private point source discharges (in alphabetical order) are among the sectors of our society that have impacts on the Big Darby Creek watershed. This section of the TMDL report outlines how some sectors of society may be influenced by the implementation mechanisms that are available to achieve the pollutant load reductions that are outlined in Chapter 4.

5.2.1 Agriculture

The agricultural sector has responsibility for pollutant loading reductions in phosphorus, sediment, and pathogens that arise from agricultural operations. Implementation mechanisms that will be applied to this sector are voluntary agricultural BMPs, riparian and flood plain setbacks, and NPDES permits for large animal feeding operations or those with discharges, and 401 certifications for those dredge and fill operations that are regulated under the Clean Water Act. To aid in this implementation effort, there are a variety of cost sharing and grant programs to offset costs involved with voluntary action.

The phosphorus, sediment, and pathogen load reductions outlined in Chapter 4 will be achieved by voluntary action often under the guidance of local Soil and Water Conservation District staff. BMPs on upland areas are important for reducing pollutant loads from the landscape. Riparian set backs and wooded buffers are practices along the stream that aid in pollutant load reduction and improve assimilative capacity. Habitat improvements to meet QHEI targets are directly correlated with improvements to the aquatic biota, the ultimate arbiter of success of a TMDL project.

5.2.2 Construction Activity

Construction activity within the Big Darby Creek Watershed is regulated under the NPDES storm water program. Pollutant loading reductions will be implemented through the issuance of a new general permit for storm water related to construction activity that is specific to the Big Darby Creek Watershed. New characteristics of this permit will be the inclusion of water quality based effluent targets designed to protect sensitive aquatic life uses in the Big Darby Creek watershed. In addition, Ohio EPA will evaluate new permit terms and conditions pertaining to the achievement of geomorphological targets, which will be necessary in addition to the construction BMPs to reduce sediment loading to downstream reaches of the Big Darby Creek watershed.

The impact of these changes on the construction sector may be significant. Construction companies will be expected to be co-permittees on storm water permits. Failure to abide by the general permits for storm water associated with construction activity that are issued for the Big Darby Creek Watershed could potentially lead to direct enforcement against construction companies and contractors who violate the permit. Planning for, and execution of construction activities in this watershed will have to be done in strict compliance with legal requirements. Construction site supervisors will need to ensure their employees are aware of the need to comply, and ensure that compliance is maintained.

5.2.3 Development

Development is the conversion of land from one use to another. It often results in an increase in impervious surface, which creates more runoff and reduces ground water recharge. The Big Darby Watershed TMDL report establishes targets to be achieved for maintaining the ground water recharge rate and the runoff to baseflow ratio as the land is developed. Implementation mechanisms for those targets are NPDES general permits for storm water related to construction activity and Permits to Install for central sewer systems, which must comply with the requirements outlined in the Central Scioto Water Quality Management Plan Update (208 Plans). The hydrologic targets help to control amounts of storm water that are discharged, which is directly related to achieving sediment reduction targets established in Chapter 4 of this report.

In planning for and execution of development in the Big Darby Creek watershed, consultants and developers will be expected to adhere to the conditions of the Central Scioto 208 Plan, and the NPDES General Permit for Storm Water Associated with Construction Activity Located in the Big Darby Creek Watershed, or in some cases, an individual NPDES permit. Sediment controls and the project’s effect on ultimate volume of flow will all need to be accounted for in the planning and design of a development. Particular care will need to be taken with regard to stream buffers, and stream channel morphology when planning a development, in order to achieve sediment reduction targets established in this watershed. Obtaining necessary permits in the Big Darby Creek watershed is critical. Planning for development should allow for the time necessary to accomplish complicated permitting activities, that may require public involvement.

5.2.4 Industrial Activity

Industrial activity is having an influence on water quality in the upper Big Darby Creek watershed. However, existing information is not adequate to support implementation of corrective measures at this time. Ohio EPA intends to continue gathering data, and improving the predictive tools available to assess the situation with the assistance of companies such as Honda. Geomorphological targets have been set to establish conditions necessary to minimize storm water impacts from industrial activity.

5.2.5 Municipal Point Sources

Effluent limitations for municipal point source dischargers will be included in NPDES discharge permits for control of phosphorus, ammonia, bacteria sediment and to ensure that sufficient dissolved oxygen is present in the stream. Table 5.2.5 provides a reference point for locating effluent limitations in the development chapter.

For the proposed expansion of the North Lewisburg WWTP, Ohio EPA is evaluating relaxing the ammonia limit slightly in exchange for activities that will protect a wooded riparian corridor which is deemed essential to protecting the Cold Water Habitat use designation of Spain Creek. Both sets of limits are listed in Chapter 4 and implementation will be dependent upon whether or not North Lewisburg institutes a growth plan that will ensure riparian corridor protection.

Table 5.2.5 Reference to Effluent Limitations for Municipal NPDES Permits

Entity	NPDES Permit Number	Table Reference
Logan County Flat Branch	1PP00006	4.1.1.2
North Lewisburg	1PB00039	4.1.3.2
Mechanicsburg	1PB00037	4.3.1.2
Plain City	4PB00016	4.1.4.2
West Jefferson	4PB00024	4.3.7.2
Pickaway Correctional Institute (regional)	4PP00003	4.4.3.2
Darbydale	4PH00012	4.4.2.2

Another type of municipal point source are municipal separate storm sewer systems (MS4). Load allocations are established in Chapter 4 for Hellbranch Run for MS4s that discharge to that watershed. In the manner, and to the extent allowed by existing procedures and laws, these loading limitations will be included in the Phase I and Phase II NPDES storm water permits for the effected MS4s. Municipalities may expect that a Phase II MS4 General Permit for Storm Water to be issued specific to the Big Darby Creek Watershed that will contain loading limitations and monitoring requirements necessary to achieve those loads. Ohio EPA will evaluate designating additional communities as being required to obtain coverage under the Phase II permit.

5.2.6 Private Point Sources

There are two types of private point sources in the Big Darby Creek watershed. One type are private point sources that are regulated by Ohio EPA, which have NPDES permits issued for their discharges. These permits have loads allocated to them in Chapter 4 to protect Big Darby Creek and its tributaries. Those loading reductions necessary for facilities regulated by Ohio EPA will be implemented through the NPDES permit program.

The other type of private point sources are home sewage treatment systems (HSTS) that fall under the jurisdiction of the local health departments – these sources have loading reduction targets for phosphorus, sediment, and pathogens. Chapter 4 includes necessary loading reductions by minor sub-watershed for these sources. Action by the local health departments will be critical in achieving reductions of these pollutants from these sources.

The important role of local health departments will include identifying the areas of greatest load, and devising means for achieving the loading reduction targets established, whether it be through sewering of the areas, or through improved operation and maintenance of these installations. Private home owners have a major responsibility in ensuring that their home sewage treatment system is operating effectively, and for upgrading the systems as necessary to achieve the loading reduction targets, under the direction of the local health department.

5.3 Endangered Species Protection

Reduction in sediment loads has been identified as critical to endangered species protection in the Big Darby Creek watershed. The recovery plan for the Clubshell mussel (*Pleurobema clava)* states “The clubshell . . . cannot tolerate mud or slackwater conditions, and is very susceptible to siltation” (USFWS, 1994). The Big Darby Creek TMDL establishes sediment reduction targets in Chapters 3 and 4 that are protective of sensitive aquatic communities. In the absence of specific numeric criteria for protection of the Clubshell mussel, it is believed that these targets, if achieved, will be protective of existing populations, and could potentially lead to range expansions. The implementation mechanisms discussed above, especially Storm Water Control and Managing Drainage Needs, Channel Erosion, and Flood Reduction Work are important means of controlling sediment export to the downstream areas inhabited by the Clubshell Mussel.

Key to reduction in sediment loading in the Big Darby Creek watershed is the attainment of geomorphological targets such as the stream setbacks established in Chapter 4. These targets are particularly important during high flow events, which is the focus for sediment reduction efforts in Big Darby Creek. An intact flood plain allows for storage of excess water, and reduced flow velocities, minimizing damage to endangered species habitat.

In addition to the geomorphological targets, an intact, wooded riparian corridor is necessary to protect habitat for endangered mussel species. This need is critical in middle Little Darby Creek, where the endangered Clubshell mussel currently resides. Ohio EPA has documented the complete destruction of mussel habitat due to removal of trees in this section of Little Darby Creek. The increased sunlight, interacting with high nutrient loads from upstream cause concretion (cementing) of the bottom due to changes in pH instream driven by increases in algal productivity.

A critical need for endangered species protection in Little Darby Creek is a meaningful incentive program for landowners to protect existing wooded riparian corridor. Current agricultural incentive programs will not necessarily pay for preservation of this critical habitat. In addition to this need, nutrient loadings from upper Little Darby Creek, Treacle Creek, and Proctor Run must be reduced to eliminate the nutrient driven pH changes that destroy mussel habitat in the event of a loss of riparian corridor. Phosphorus loading reduction targets are established for these sub-watersheds in Chapter 4.

Ammonia has been identified as having a detrimental effect on the Clubshell mussel and Northern Riffleshell mussel. In order to account for this influence, instream water quality models were conducted at several locations (see Chapter 3 and 4). In the lower Big Darby Creek mainstem, ammonia allocations have been established for municipal wastewater treatment plants. In upper Little Darby Creek, water quality models have been performed, and point source allocations have been established. Elevated sediment ammonia in Little Darby Creek downstream of Treacle Creek is likely agricultural in origin. Animal husbandry is one potential source for organic and ammonia inputs to this section of the stream. It is recommended that the Champaign, Union and Madison County SWCDs make this problem an area of focus for ensuing proper handling of animal manure, silage, and other waste products from livestock operations.

5.4 Stream Setbacks and Water Quality

The Big Darby Creek TMDL contains many references to stream setbacks as an important factor contributing to water quality. The intent in identifying stream setbacks is to provide protection for future natural movement by the stream channel and to increase stream assimilative capacity for sediment and nutrients by providing for export of these materials from the channel. The stream setbacks should be considered to be an area of land/water interface, where weather patterns will dictate the degree to which the interface area will be used by the stream. In terms of human activity, it is important to understand that high water levels are to be expected at times, even though it may not happen annually.

Another important concept concerning the stream setbacks is that within the setback zone, the closer you are to the stream, the more important the area is to stream function. Where human activity intrudes into the setback zone, those activities that provide for intensively managed land uses in areas adjacent to the stream result in the greatest pollutant loads to the stream, as well as the greatest reductions in assimilative capacity. Conversely, where human activity results in less intensively managed land uses, such as forested riparian corridors, pollutant loads are lower, and stream assimilative capacity is higher. An important restoration goal for this TMDL is that when current human activity is resulting in highly managed uses near the streams of this watershed, that there be a gradual shift to less highly managed land uses in the stream setback zone. If this shift can be accomplished, it will directly aid in achieving pollutant reduction goals established in this TMDL.

Riparian Setbacks and Development
Development that consists of the conversion of farmland or natural areas into impervious surfaces within the setback zone is very detrimental to water quality. Development by its nature results in storm water discharges that the stream channel must now convey. Development in the setback zone reduces the overall capacity of the stream system to convey water, while directing more water to the system. The inevitable consequence of this practice is reduced water quality, primarily by increasing sediment loads from runoff and bank erosion, and by reducing the capacity of the system to export this material. In order to appropriately address this issue, Ohio EPA has proposed the NPDES General Permit for Storm Water Related to Construction Activity Located in the Big Darby Creek Watershed. This NPDES permit has conditions contained in it to address protection of the stream setback zone during land development.

Riparian Setbacks and Agriculture
So long as certain conditions are adhered to, agriculture can be a land use in the riparian setback zone that can be consistent with maintaining good water quality. The following are conditions that should be considered by agricultural land managers.

- Relatively frequent flooding will occur in this zone.
- The setback zone is a zone to protect long term for natural movement of the stream channel.
- Grass buffers are not a good substitute for forested buffers. Where forested buffers already exist, they should be preserved. Where no buffer exists, grass buffers are an incremental improvement. (Note: grass buffers will not limit sunlight impinging on the stream).
- Where agricultural practices occur in the setback zone very close to the stream (less than 100 feet), land managers should focus on a long-term decision making process to move production away from the stream. A slow withdrawal of production from this zone over a period of 3 - 8 years will accomplish many of the goals of this TMDL. Programs that aid this course of action (e.g., CREP) are beneficial, and may offset costs incurred by agricultural land managers.

So long as agricultural land use is compatible with frequent flooding, and is amenable to changes in channel location, water quality impacts from this land use will be minimized. Where a forested buffer equal to or greater than the setback zone is maintained, and is not short circuited by tile drainage, agricultural land uses should have little or no impact on water quality.

Agricultural practices that focus on elimination of flooding in this zone in the interest of routine crop production or animal husbandry are typically detrimental to maintaining good water quality, and should be avoided.

5.5 Dam Removal

Dams are known to impact river systems by altering several key parameters, including flow regimes and physical habitats, channel shape, sediment transport, water temperature and chemistry, and populations of algae, benthic macroinvertebrates, riparian vegetation, and resident and migratory fish (Poff and Hart, 2002). Dams are a type of hydromodification that greatly affect the flow and sediment transport regimes of streams. Upstream of the dam, riffle-pool habitat is converted into long reaches of homogenous pool habitat. This reduction of habitat type and quantity can reduce biological diversity within the stream and substantially shift species composition from those adopted to flowing lotic systems to lentic systems. In addition, dam pools decrease the ability of the river to assimilate organic wastes, and increase in-stream temperatures, and decrease dissolved oxygen. Dams also adversely affect downstream habitat by altering the types and percentages of sediments being transported.

Since upstream transport of juvenile mussels, as glochidia, is often dependent upon fish populations, structures that inhibit fish migration, such as dams, also have potential to impact endangered species distributions. Because of all of these factors, Ohio EPA recommends that the addition of any dams to the Big Darby Creek watershed should be strongly discouraged. In addition, those structures that currently exist should be evaluated for removal to improve aquatic life habitat and to reduce owner liability due to the known public safety hazards that a dam presents.

5.6 Mineral Extraction in the Stream Setback

One of the main purposes for establishing stream setbacks is to provide protection for future, natural, movement of the stream channel. In several instances, mineral extraction in the form of quarries, has been placed within the stream setback zone. At least one of these operations currently poses a high risk for capture by the stream channel. Capture of the stream channel by an abandoned quarry pit will destroy the aquatic life use of that section of the stream, as the lake-like environment of the abandoned quarry is not suitable for flowing water species currently resident in this system. In addition, capture of the stream channel by quarry pits will jeopardize continued existence of endangered mussel species by creating a barrier for normal dispersion of host species. Any mineral extraction proposed within the stream setback zone must demonstrate protection against capture of the stream channel in perpetuity. In addition, such activities should allow for continued function of the flood plain, instead of deflecting higher stream flows onto downstream properties.

5.7 Implementation Strategy and Reasonable Assurances

As part of an implementation strategy, reasonable assurances provide a level of confidence that the load allocations in this TMDL will be implemented by federal, state, or local authorities. Implementation of the Big Darby Creek Watershed TMDL will be accomplished by both state and local action on many fronts. State implementation of the TMDL will be through action on NPDES permits for both point sources and storm water and through the 401 water quality certification program, as outlined earlier in this section. In addition, the state will be updating the 208 plan for the Central Scioto River Basin, including the Big Darby Creek watershed in 2005. TMDL recommendations will be included in the 208 update, as well as ongoing technical development on the Big Darby Creek watershed.

Locally, a Community Based Watershed Plan is being developed through the Darby Creek Joint Board of Supervisors and Katherine Skalak, the Darby Creek Watershed Coordinator (Ben Web is the former coordinator). This watershed action plan, funded by local match money and 319 funding, is well poised to evaluate and implement TMDL recommendations through a locally driven process. Extensive public involvement for several years has been happening through this process. At present, the community based watershed plan is targeting impairments documented in Robinson Run and will address other sub-watersheds soon.

In the Hellbranch Run watershed, the Hellbranch Watershed Forum is a public group developing a watershed action plan. In conjunction with the US Army Corps of Engineers, the Hellbranch Watershed Forum is developing predictive build out models based upon the development pressure that is facing the Hellbranch Run sub-watershed.

Locally, the City of Columbus, Franklin County, the City of Hilliard, Brown Township, Prairie Township and other local jurisdictions have embarked upon a joint land use planning effort to plan for development that will take into account loading reductions required by the Big Darby Creek Watershed TMDL, as well as recommendations from the Environmentally Sensitive Development Area - External Advisory Group (ESDA-EAG) which was formed to determine methods of development that would be protective of the Big Darby Creek watershed. Columbus, Franklin County, and other local jurisdictions have joined in establishing a building moratorium until the end of 2005 so that the planning mentioned above can be completed, and the watershed protected. Since the public notice of this report, the moratorium has been extended by City of Columbus to June 2006.

At the federal level, funding provided through CREP, EQIP, and Section 319 provide cost share dollars to implement voluntary activities in the watershed.

It is clear that at all levels of government in Ohio that there is a commitment to protecting the Big Darby Creek watershed. This TMDL is a part of that commitment, and it will work in conjunction with other efforts to ensure that pollutant loading reduction targets are met and that clear guidelines for future protection of the Big Darby Creek Watershed have been established.

5.8 Process for Monitoring and Revision

Monitoring of the Big Darby Creek watershed will be necessary to ensure that the pollutant reduction targets and habitat improvements are accomplished so as to ultimately result in attainment of the Biological Criteria, which will result in restoration of the aquatic life uses in this basin. A tiered approach to monitoring progress and validating the TMDL will be followed:

1. Confirmation of completion of implementation plan activities
2. Evaluation of attainment of chemical water quality criteria
3. Evaluation of biological attainment.

A TMDL revision will be triggered if any one of these three broad validation steps is not being completed or if the WQS are not being attained after an appropriate time interval. Once the majority of or the major implementation plan items have been carried out and/or the chemical water quality has shown consistent and stable improvements then a full scale biological and chemical watershed assessment would be completed to evaluate attainment of the use designations. If chemical water quality does not show improvement and/or waterbodies are still not attaining water quality standards after the implementation plan has been carried out, then a TMDL revision would be initiated. The Ohio EPA would initiate the revision if no other parties wish to do so.

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Appendix A: Surface Water and Ground Water Interaction in the Darby

The purpose of this analysis is to identify watershed areas with the potential to receive a proportionately greater ground water contribution to stream flow than the watershed as a whole. The analysis is based upon a characterization of the physical properties of the underlying sub-surface material. The material that composes the watershed sub-surface varies downward along its vertical profile and laterally across the watershed surface. It is this spatial variation that partially explains the relative presence or absence of ground water in stream flow.

The volume of water that flows in a stream originates from multiple sources. Part of the total volume runs-off the land surface directly into the stream. Another part may be piped through storm drains or run through field tiles and ditches to the stream. Yet another part seeps through the sub-surface and into the stream through the banks and bottom of its channel. The relative portion of each of these parts is dependent upon many complex factors within the process by which water circulates on Earth, the hydrologic cycle. This analysis examines only one aspect of the hydrologic cycle, sub-surface flow, and is only an attempt to identify areas within the watershed that have the potential to provide a significant ground-water contribution to stream flow.

A.1.0 Sub-Surface Materials

The vertical profile of the watershed sub-surface is organized into layers. The topmost layer of the profile is the soil. Soil type, depth and management vary across the watershed, and control the amount of precipitation that infiltrates the ground and percolates through the vertical profile of the sub-surface. Under the layer of soil are deposits of gravel, sand, silt and clay that result from multiple glacial advances and retreats through Ohio during the Pleistocene Epoch, 10,000 to over 300,000 years ago. The method of deposition, composition of materials, and depth of these deposits vary across the watershed, and in part dictate the storage and transport capacity of the sub-surface for water. Below the glacial deposits is bedrock. Bedrock in the watershed is sedimentary, and dates to the Devonian and Silurian Periods, 360 to 440 million years ago. Like the glacial deposits above it, bedrock has the capacity to store and transport water. The porosity, degree of fracture, and connection to the surface are important factors in its ability to do so.

A.1.1 Soil

The dominant soil associations in the watershed are Kokomo-Crosby-Miamian, Miamian-Celina-Crosby, and Brookston-Crosby-Celina. Soil associations are areas that are composed of multiple soil types, but are grouped together based upon similar properties or behaviors that distinguish them from surrounding soil types and areas. Of importance to ground-water availability and movement is the soil's physical composition, compaction, and aggregation. These physical properties manifest in a particular drainage behavior that partially determines the amount of precipitation that will infiltrate the surface, percolate through the soil, and eventually reach the sub-surface water stores, or aquifers. Soil scientists qualitatively describe drainage behavior, and in the watershed the Kokomo-Crosby-Miamian association is classified as very poorly drained, Miamian-Celina-Crosby as well drained to moderately well drained, and Brookston-Crosby-Celina as very poorly drained. Associations that are poorly drained have lower infiltration rates, greater runoff or ponding, and typically less water available to recharge ground-water resources. The opposite is true for well drained soils. The following table provides the watershed breakdown of soil drainage behavior.

Watershed	Excessively drained	Well drained	Moderately well drained	Somewhat poorly drained	Poorly drained	Very poorly drained	Not Rated
Upper Big Darby Cr.	0.0%	13.7%	13.9%	40.3%	0.3%	31.3%	0.4%
Middle Big Darby Cr.	0.0%	6.0%	5.2%	42.9%	0.0%	44.7%	1.2%
Little Darby Cr.	0.0%	17.0%	8.9%	34.9%	0.3%	38.8%	0.1%
Lower Big Darby Cr.	0.2%	35.8%	7.2%	29.9%	0.0%	24.9%	1.9%
Grand Total	0.0%	18.6%	9.6%	36.6%	0.2%	34.2%	0.8%

As can be seen, there is some variation in soil drainage behavior from one sub-watershed to another. Based upon the presented data, it appears that the lower Big Darby soils are better drained than the upper Big Darby, and even more so than the middle Darby and Little Darby. It should be noted, however, that the natural ability of the soil to drain water is affected by surface land use and management practices. Urbanization and its associated increase in impermeable surface cover can impact the soil's efficacy in drainage. Agricultural and construction activities that alter the soil's natural structure can also improve or inhibit drainage. The presented statistics therefore represent the potential rather than the actual drainage behavior of the soil. The variability seen in soil drainage behavior between sub-watersheds may partially explain the differences in ground water contributions to stream flow.

A.1.2 Glacial Deposits

Glacial deposits of gravel, sand, silt and clay lie beneath the soil. The capacity of these deposits to serve as a ground-water resource is related to their level of sorting. Sorting is the process by which a given transport medium separates out certain particles on the basis of size, shape, or density. Well sorted materials are typically more hydraulically conductive then poorly sorted material, and therefore serve as a better ground-water resource. The types of glacial deposits found in the Big Darby watershed include end moraine, ground moraine, complex associations, and buried valley deposits.

End and ground moraine are typically poorly sorted, and have only low to moderate hydraulic conductivity. End and ground moraine material was either pushed along the front a glacier or carried atop it, and was deposited as the glacier melted and receded. End and ground moraine consists of an unorganized mix of rock, gravel, and soil, typically with a large silt and clay fraction, with few linear pathways for the transmission of water.

Complex associations vary from poorly to well sorted, and tend to have isolated areas of high hydraulic conductivity amongst larger, less conductive areas. Complex associations are composed end moraine, ground moraine, eskers, and other types of deposits. Eskers are formed in areas where inter-glacial streams cut through the ice, sorting the underlying deposits.

Buried valley deposits are well sorted, and are the most hydraulically conductive of the glacial deposits found in the watershed. Buried valley deposits are composed of sand and gravel carried from the glacier and deposited in historic valleys by glacial melt-water. Depending upon the rate the glacier is melting and the slope of the local land, glacial melt water can create turbulent rivers capable of transporting massive amounts of material.

A.1.3 Bedrock

Ancient bedrock lies below the glacial deposits. Bedrock in the watershed is sedimentary, meaning it was formed by the deposition of particles that were subsequently cemented or bonded together. Examples of sedimentary rock in the watershed are limestone, dolomite, and shale. These rocks are relatively impermeable, but through time the rocks become cracked, or fractured, by tectonic forces and the freeze and thaw of water. Further, passages through limestone are formed as it is slowly dissolved by water. These physical and chemical processes serve to increase the hydraulic conductivity of the bedrock, and increase its potential to serve as an aquifer.

As a general principle, limestone makes for a better aquifer than dolomite, and dolomite is better than shale. In the watershed, however, there is dolomite that produces a high water yield, measured in gallons per minute, and limestone that is characterized by a very low yield. This is because the value of bedrock as a water resource is dependent upon more than just its chemical composition. The degree of fracture, depth, and connection with the surface can play equal if not greater roles.

Throughout the majority of the watershed, streams flow through deep glacial deposits and have little contact with the bedrock. As such, most of the ground water contributed to stream flow originates from the glacial deposits. However, in isolated areas the glacial deposits area shallow enough that there is some connection between the underlying bedrock aquifers and the streams. In such areas, the magnitude of the ground water contribution to the stream maybe primarily dependent upon the hydraulic properties of the rock rather than those of the overlying deposits.

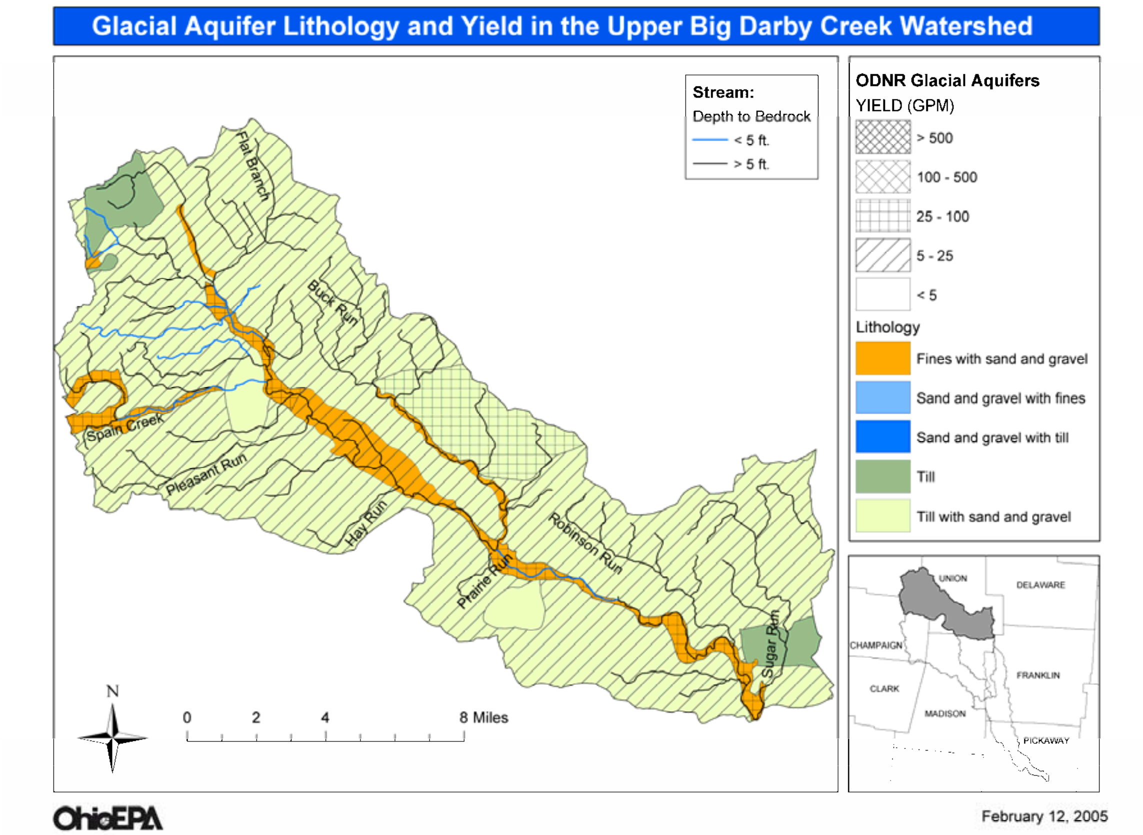
A.2.0 Glacial and Bedrock Water Resources of the Darby Watershed

The following text and figures discuss and portray the glacial and bedrock water resources of each Big Darby watershed, and the effect they may have upon the contribution of ground water to stream flow. The glacial aquifer figures that follow illustrate the lithology and estimated yield of the deposits. Lithology refers to the physical character and composition of the deposits. The lithology of the deposits is classified in order of increasing hydraulic conductivity as till, till with sand and gravel, fines with sand and gravel, sand and gravel with till, and sand and gravel with fines.

Estimated yield is a measure of the aquifer's value to provide water for a well. Yield is used on the following maps as a surrogate for hydraulic conductivity, because data regarding hydraulic conductivity was not available with the spatial specificity that yield was. Hydraulic conductivity is a better measure of the connectivity between ground and surface water, but yield can be useful if its limitations within this context are considered. Hydraulic conductivity is an intrinsic property of the glacial deposits. Conversely, yield is an extensive property and can increase with increasing depth of the glacial deposit of bedrock. The depth of an aquifer is of secondary importance to surface water; it is the relative ease by which water can move horizontally through aquifer that is of primary importance. Therefore, for the purpose of this analysis spatial variability in yield is only singnificant when it results from a change in the local lithology of the glacial deposits.

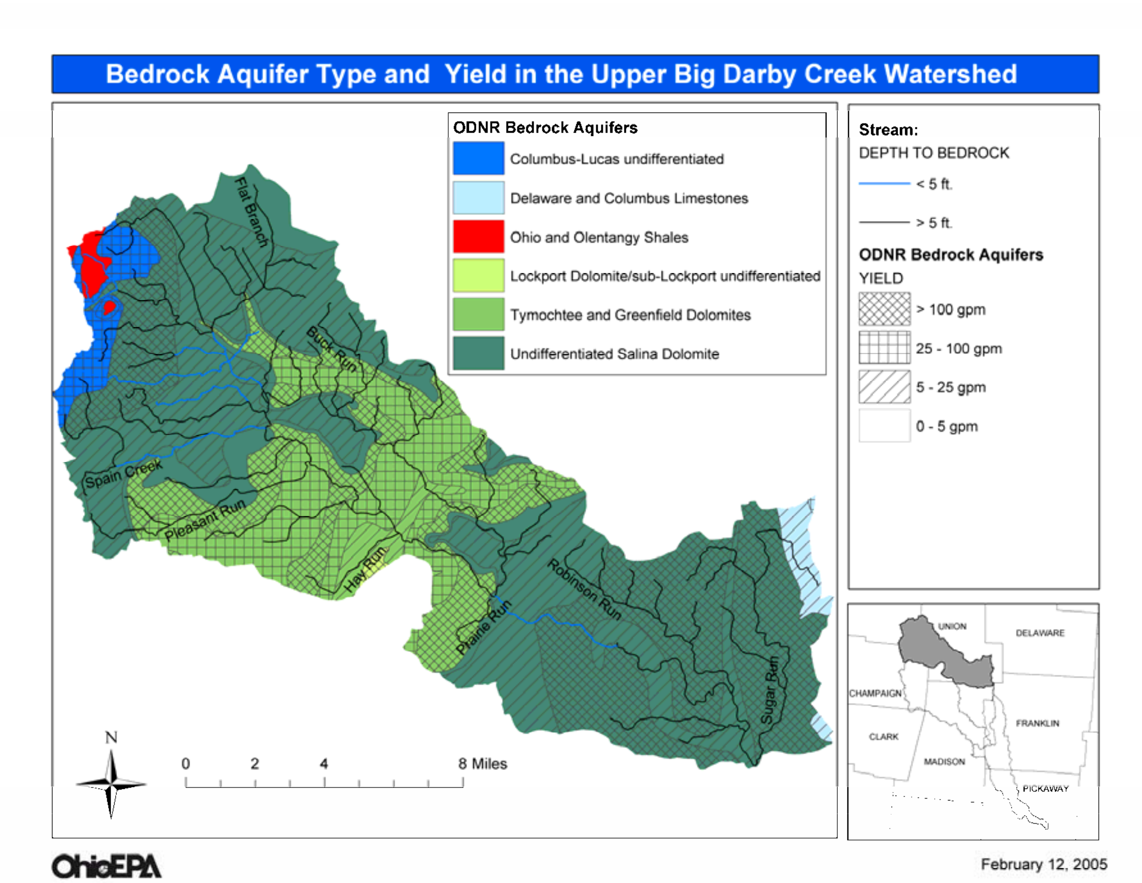
A.2.1 Upper Big Darby Creek Watershed

The upper Big Darby Creek watershed is dominated by till with sand and gravel. Some isolated lenses of till exist throughout, and there are fines with sand and gravel along the Big Darby Creek mainstem, Buck Run, and Spain Creek. Deposits on the northeast side of the sub-watershed are end moraine, while the southwest side is a mix of complex associations and ground moraine. The surficial fines with sand and gravel that are found along the Big Darby Creek mainstem are actually alluvial deposits rather than glacial deposits. This means that they were deposited by the stream after the Pleistocene ice-age. The glacial lithology of the upper Big Darby Creek is illustrated in the following figure.



As can be seen in the preceding figure, glacial aquifer yield in this sub-watershed is generally moderate. The dominant lithology, till with sand and gravel, yields between five and 25 gallons per minute (GPM). The area of higher yield to the north of Buck Run is associated with an increase in depth of the till with sand and gravel deposits, and therefore is of little consequence to stream flow. The area of higher yield along Spain Creek, however, is associated with the change in lithology to fines with sand and gravel. Unlike the fines with sand and gravel found along the Big Darby Creek mainstem, the Spain Creek area is in a buried valley setting that extends far into the adjoining watersheds. Spain Creek is in an uppermost extent of the Mad River Buried Valley Aquifer, and ground water yield from the buried valley may be greater than the surrounding moraine. One could reasonably expect a greater ground water contribution to stream flow in Spain Creek.

The blue streams in the following figure represent areas where the stream is likely in contact with bedrock. This conclusion is based upon a depth to bedrock of less than five feet, which is a conservative allowance for bank height. In areas where the stream is in contact with the bedrock, the hydraulic properties of the rock become important for it may be a source of ground water to the stream. The following figure illustrates the bedrock aquifer types and yields in the upper Big Darby watershed.

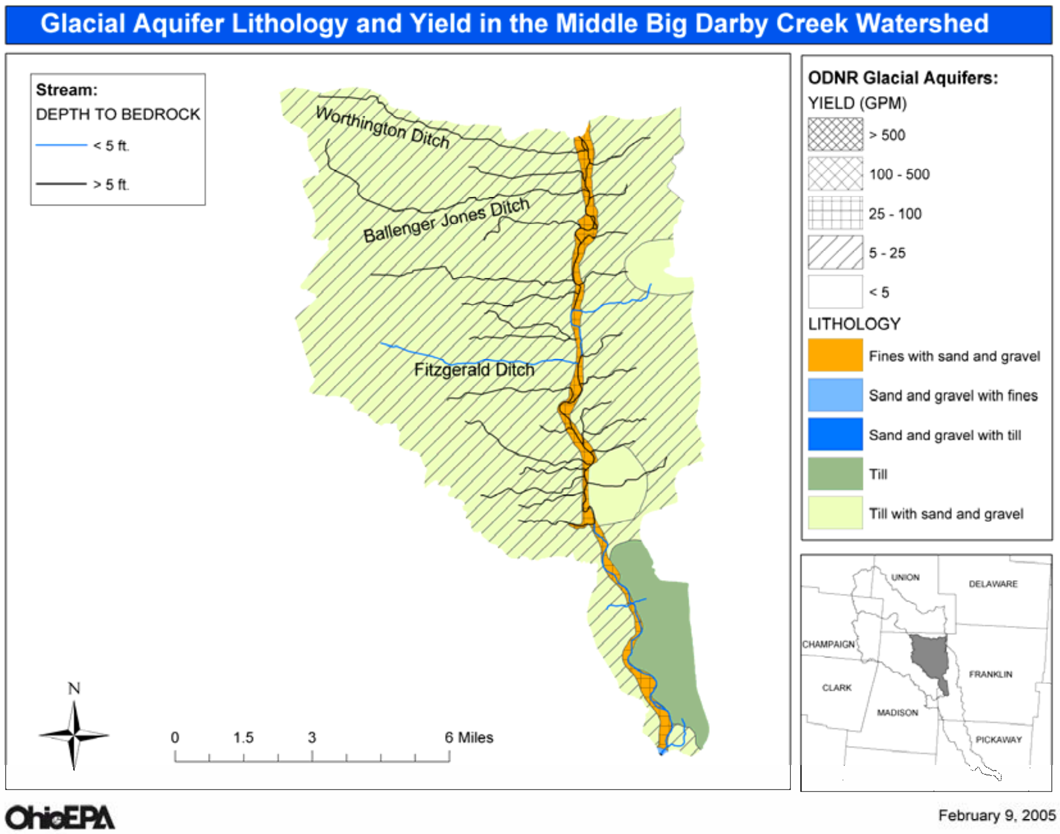


In the northwest area of the watershed several streams come in contact with some moderate and high yielding bedrock aquifers. This may result in higher ground water contributions to these streams than would result from only the overlying glacial deposits.

Where bedrock transitions from one type to another, there is often greater fracture and thus greater potential to move and store water. Note the blue stream segments on the northwest periphery of the watershed that run through Ohio and Olentangy Shale. These segments are part of the Little Darby Creek (Logan County). As the map indicates, shale is a low yield aquifer, but the surrounding Columbus-Lucas undifferentiated group is moderate yielding. While neither of these aquifer types are high yielding, there is potential for a greater ground water contribution to the stream because of the convergence of multiple rock types in the area.

A.2.2 Middle Big Darby Creek Watershed

Glacial aquifer lithology of the middle Big Darby Creek watershed is dominated by till with sand and gravel. Like the upper Big Darby Creek watershed, alluvial fines with sand and gravel are found along the mainstem. Additionally, a large lens of relatively impermeable till is found near the southern boundary of the watershed. The glacial deposits are dominantly ground moraine; complex associations exist throughout but are secondary in prevalence. Ground water yields of the glacial till with sand and gravel is low to moderate, and the alluvial fines with sand and gravel have moderate yields. The glacial aquifer lithology and yield for the middle Big Darby Creek watershed is illustrated in the following figure.

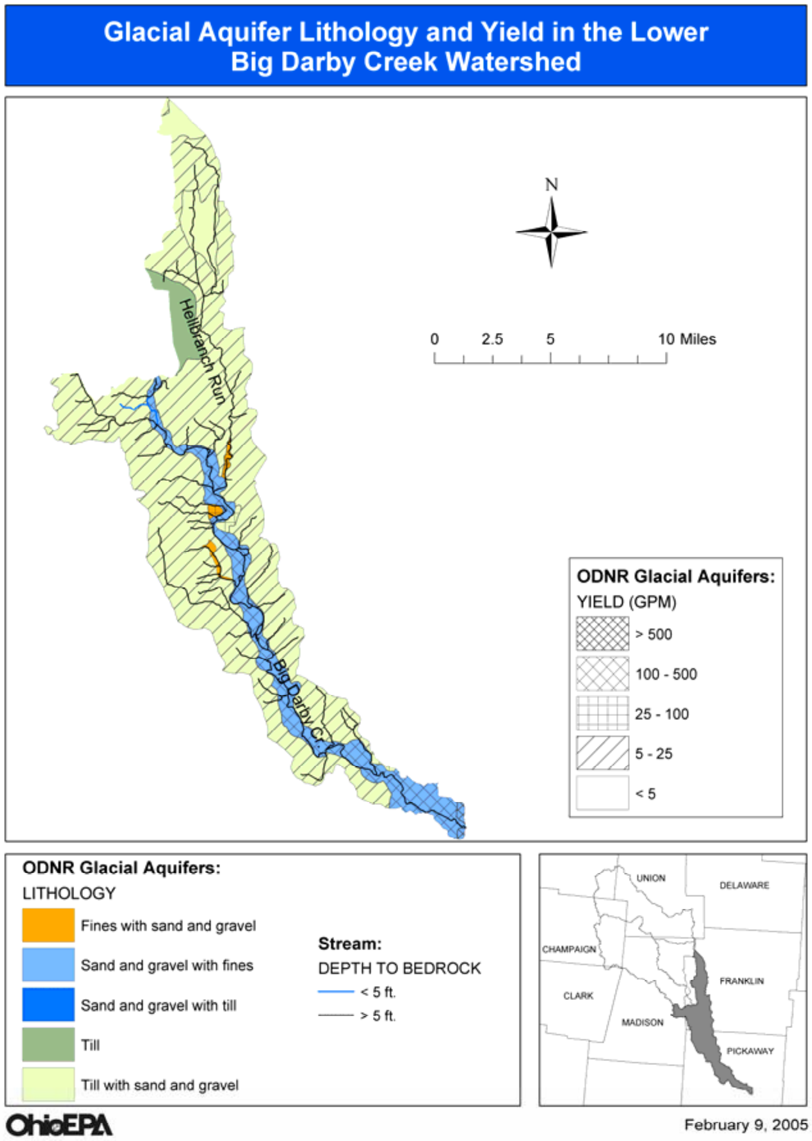


As can be seen in the following and preceding figures there is the potential for contact between the stream and aquifer on Fitzgerald Ditch and on the mainstem near the outlet of the watershed. Bedrock beneath Fitzgerald Ditch is Tymochtee, Greenfield, and Salina dolomite of moderate to high yield, which may result in a greater ground water contribution to this stream compared to other nearby tributaries. Bedrock beneath the mainstem segment is low-yielding limestone, and offers little potential for a significant contribution.

A.2.3 Lower Big Darby Creek Watershed

Lithology of the glacial deposits in the lower Big Darby Creek watershed is dominated by till with sand and gravel deposited as a complex association or ground moraine. Sand and gravel with fines in a buried valley setting is secondary but significant. A small lens of till exists in the Hellbranch Run area of the watershed.

The till with sand and gravel is mostly low-yielding, but the sand and gravel of the buried valley is high to very high yielding. This buried valley setting represents the area of greatest potential for a large ground water contribution in the entire watershed. The high conductivity of the sand and gravel, combined with the greater permeability of the watershed soil (discussed above), results in a greater potential for percolation to the aquifer and lateral transport to the stream. Based upon these two factors, ground water is likely a large component of stream flow during dry periods. Glacial aquifer lithology and yields for the lower Big Darby Creek watershed are illustrated in the following figure.



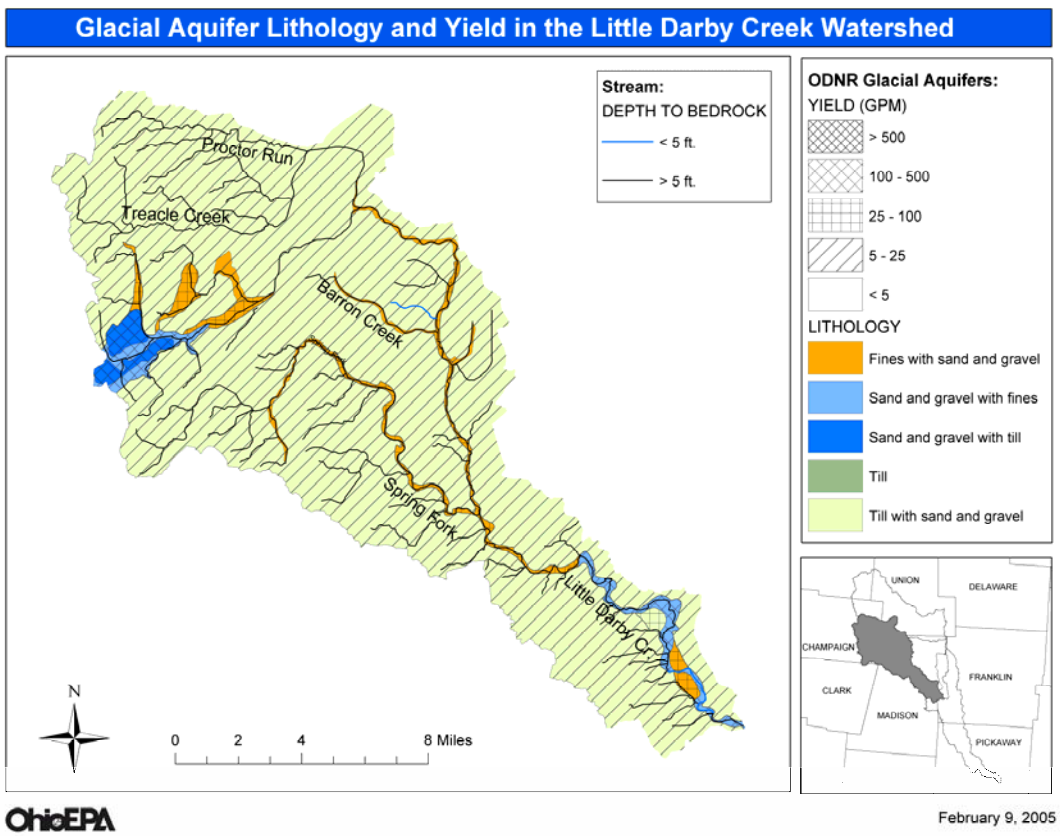
As can be seen in the figure, there is little connection between the streams and bedrock in the lower watershed. The disconnect is because of the greater average depth of the glacial deposits that characterize this watershed.

A.2.4 Little Darby Creek Watershed

Lithology of the glacial deposits in the Little Darby Creek watershed is dominated by till with sand and gravel. The till with sand and gravel deposits in this watershed were deposited as ground moraine or complex associations and are low to moderate-yielding. The headwaters of the Little Darby Creek runs through fines with sand and gravel, sand and gravel with till, and sand and gravel with fines in a buried valley setting. Like Spain

Creek in the upper Big Darby Creek watershed, this is part of the much larger Mad River Buried Valley Aquifer that extends into an adjoining watershed. The sand, gravel, and fines in this area are more conductive than the surrounding deposits, and a comparatively greater ground water contribution to stream flow can be expected.

Alluvial fines with sand and gravel exist in the middle reaches of the Little Darby Creek mainstem, and are characterized by moderate yields. As the Little Darby Creek approaches the Big Darby Creek confluence, the sub-surface deposits transition from alluvial to buried valley and the lithology becomes more coarse and conductive. The glacial deposits in this area are sand and gravel with fines, and the ground water contribution to stream flow is likely greater. Glacial aquifer lithology and yield for the Little Darby Creek watershed are illustrated in the following figure.



Appendix B: Responses to Public Comments

The draft Big Darby Creek Watershed TMDL was made available for public comment from May 16 through August 15, 2005. This appendix contains the many comments received and the responses to those comments. The comments and responses are organized by topic, as follows:

B.1 Riparian Buffers (including setbacks, channels, and hydrology)
B.2 Storm Water
B.3 Recharge
B.4 Use Designations/WQS
B.5 208 Plan
B.6 Authority
B.7 Impervious Surfaces
B.8 Nationwide Permits
B.9 Home Sewage Treatment Systems (HSTS (bacteria))
B.10 Agricultural Influences
B.11 Development
B.12 Area of Applicability
B.13 Flexibility
B.14 Miscellaneous
B.15 Biological Assessment
B.16 Sufficiency of Sampling

Comments were received from 19 parties, as listed below. In this appendix, abbreviations are used to associate each comment with its source.

Commenter	**Abbreviation**
1000 Friends of Central Ohio	1000F
Battelle	Batt
Bob Cornett	BC
Building Industry Association of Central Ohio	BIA
City of Columbus	COLS
David Greene	DG
Darby Creek Association	DCA
Darby Watershed Joint Board	DWJB
Darby Watershed Joint Board – Planning Group	DWJB-PG
Diane Bradford	DB
Gregory Deckler	GD
Honda of America Manufacturing, Inc.	Honda
Lenny Losh	LL
Linda and Dale Rapp	LDR
Ohio Environmental Council	OEC
Ohio Farm Bureau Federation	OFB
Robert H. Green	RHG
The Nature Conservancy	TNC
U.S. Fish and Wildlife Service	FWS

B.1 Riparian Buffers (including setbacks, channels, and hydrology)

1000F
Specifically, we strongly support strategies to protect the stream channel from eroding by ensuring advanced, appropriate storm water management and sufficient protected land along stream banks.

Response: The comment is noted.

1000F
Specifically, we strongly support strategies to significantly reduce sediment from entering the stream by measures such as reducing streambank erosion and improving and enforcing controls on construction sites;

Response: The comment is noted.

BIA
Changes in hydrology have been identified as an issue of concern in the watershed, therefore storm water designs will have to assure that no adverse impacts will occur due to residential development. For instance, the existing runoff rate at the undeveloped Burr Oak site during a 1-year storm event is calculated to be 24.67 cfs; whereas, the post-development runoff rate is expected less than 7.00 cfs, an almost 75% reduction. The duration of runoff during a 1-year or smaller event on the undeveloped, agricultural property is 15.7 hours. The Burr Oak storm water system has been designed to increase the duration of runoff to well over 30 hours. This demonstrates that while development may cause a slight increase in runoff volume, appropriate storm water management can actually create a more natural (pre-agricultural) hydrograph through appropriate retention volumes and release rates. This long retention time may also allow for infiltration if appropriate soils are present, especially in larger storm events where a larger area is inundated.

Response: The comment is noted. One of the intents of The Big Darby Creek Watershed NPDES Permit for Storm Water Related to Construction Activity is to protect the hydrology as the watershed develops. Appropriate storm water management is critical to achieve this intent.

BIA
With respect to riparian buffers, we would strongly urge the agency to avoid establishing blanket prohibitions against any impact to riparian zones. The BIA recognizes the importance of maintaining functioning, vegetated riparian corridors along streams in the Darby Creek watershed. But in some instances it may be impracticable to avoid all impacts to riparian corridors. For example, road crossings and/or utility crossings may be necessary. These may in turn allow the design of a development to maximize other water quality protections. It may be possible to design a development and maintain a larger wooded riparian zone while impacting a small portion of an agricultural riparian zone for a road crossing. Similarly, minor impacts in one area may allow for a better, more environmentally sensitive development design overall. Establishing blanket prohibitions may force future development plans to ignore other opportunities which

would provide greater benefits to the Darby Creek watershed. Moreover, in some instances, it may be necessary to construct a stream crossing in order to even access a parcel of property.

As previously noted, we believe that a flexible, pragmatic approach is necessary to allow property owners and developers to consider a range of alternatives to meet well-defined objectives. There should not be a "one size fits all" approach which could preclude the implementation of alternative and perhaps more effective and environmentally sound approaches.

Response: The Ohio EPA considered these points when developing the Big Darby Creek Watershed NPDES Permit for Storm Water Related to Construction Activity. The BIA will have an opportunity to comment on the specifics of this permit when it is released for public input.

DG
Stream restoration should be part of storm water controls, widening, bank protection and tree planting similar to Grants Run project FCSWCD using qualified restoration experts such as Steve Phillips of Oxbow River and Stream Restoration.

Response: The comment is noted. Ohio EPA typically does not get involved in the selection of contractors for restoration projects.

DCA
DCA was confused by the TMDL's incomplete analysis and recommendations for riparian corridors. Rather than discuss and evaluate the myriad beneficial functions of the corridor and flood plain, the EPA chose to focus on a strictly geomorphological evaluation. As a result, the report limits its recommendations for this, the most critical aspect of protecting a stream, to a beltwidth formula. Beltwidth setbacks are designed to assure that a stream has enough physical space and active flood plain to achieve a dynamic equilibrium that protects a stream's habitat integrity. Unfortunately, beltwidths do not fully address other aspects of flood plain function, most critically hydrological functions having to do with infiltration of surface water and maintenance of baseflow.

DCA is going to defer to the Nature Conservancy and ODNR Scenic Rivers staff for an extensive listing of the justifications for protecting the entire existing flood plain. (We are attaching a copy of Mr. Bob Gable's comments to the Darby Accord consultants for your consideration, as it speaks directly to the corridor issue. Mr. Gable is of course ODNR's Scenic River Project Manager, and has extensive experience in the Darby effort.) We are entirely in agreement with comments you will be receiving from Anthony Sasson, with TNC, and urge you to rewrite this section of the TMDL. We also urge you to consult with the ODNR people with direct oversight of the Darby watershed, namely Scenic River staff.

We urge the agency to recommend a corridor formula similar to the EAG/ESDA proposal. This formula was the consensus choice of all participating stakeholders in Franklin county, including all jurisdictions, the Building Industry Association, ODNR, OEPA, Franklin Soil and Water, Metro Parks, and environmental groups. Finally, we note that the setback would be mandatory only in cases in which new development is proposed. It would be merely a recommendation for existing land uses, such as existing residential properties and farms.

In addition to adopting ESDA language to define the setback, we strongly urge the EPA to include a list similar to the EAG recommendations that would define allowed and prohibited activities in corridor setbacks for new development. In the current draft, it is unclear what, if anything, is an undesirable activity in the setback. At present there is a proposal for an asphalt plant and gravel mine in the Big Darby flood plain and beltwidth in Pickaway County, and we cannot find anything in the TMDL or promised additions to area 208 plans that would preclude such activities. We urge the agency to specify that filling, dredging, industry, impervious surface, mining, and other inappropriate alterations of the flood plain be prohibited in situations where EPA permits are needed.

Finally, we would add that while the beltwidth formula provided by ODNR and OSU researchers is an interesting area of investigation, it is dangerously speculative to conclude that prescribing a beltwidth which is only generally associated with EWH streams will provide adequate protection in the case of an extremely high quality stream such as Darby. We reiterate that EWH water quality measures do not take into account the requirements of a high quality mussel fauna, and we are quite certain that the folks working on beltwidth formulas have not correlated their recommendations with mussel health at this time. Complete protection of the flood plain is urged.

Response: The purpose of the setback recommendations in the TMDL report are to protect for a stable channel and to help control and reduce sediment loads to and in the streams. The setback recommendations are not riparian corridor protections nor were they intended to be. They are intended to establish a minimum protection area which would allow the river to flood and maintain its dynamic channel equilibrium to address a source of sediment load (bank erosion) and to increase the ability of the system to handle sediment loads (the flood prone protection areas). These protection areas are recommended for all land uses.

The Ohio EPA agrees that the corridor formula developed with a consensus of the ESDA EAG increases the protections for the Darby system by providing and protecting the full flood plain and the beneficial functions this can provide. The corridor formula developed by the EAG will be included in the Big Darby Creek TMDL with the exception that the beltwidth formula used in the Draft TMDL will replace the beltwidth formula used within the EAG corridor formula except in Franklin County where there already exists an overlay protection area. The reason for the change in beltwidth formula is the TMDL beltwidth formula was developed with data more specific to the Darby system than the earlier one used by the EAG. The updated corridor formula will be included in the Big Darby Creek Watershed NPDES Permit for Storm Water Related to Construction Activity, and as such will be mandatory for new development. It will be guidance only for all other land uses. In addition, appropriate uses within the flood plain/ riparian protection corridor will be more clearly defined within the final TMDL report.

DWJB

3.1 Active floodplain terminology won’t make sense to people especially in areas when there is no floodplain defined by FEMA. Seems to be more of an in-stream water level.

Response: Active floodplain is generally a much smaller, more frequently flooded area than the 100-year flood plain delineated by FEMA. However, regardless of whether FEMA has delineated the 100-year floodplain for a water course or not, it still floods. If FEMA has determined there is actually no flood plain for an area, and if this was based solely on technical considerations, then the active floodplain should reflect a similar finding as it is based on available elevation data.

LL
The use of active floodplain ignores better data for use in riparian data. USDA soils data and FEMA 100 year defined flood plain negates the need for a new definition that is never clarified in the discussion of floodplain dimensions. The riparian area is ill-defined at best. Reference to an adequate floodplain (3-9) and using bankfull width as part of an active floodplain is a good example of the validity of the data being used.

Response: The active floodplain formula used in the TMDL report to establish recommended setback widths defines an area that is, or should be, frequently flooded. The purpose of this particular setback width is to establish and protect the 'streamway' – the corridor the stream naturally undulates in over time. Protecting this particular area will reduce a source of sediment by reducing bank erosion and it will also increase the capacity of the stream to assimilate sediment by providing areas to deposit it outside of the main channel. The FEMA 100-year floodplain is intended for a different purpose – that of defining an area of catastrophic flooding so that human life and economic interests are protected. Thus, the two definitions are needed to protect for different concerns.

The USDA soils data may be able to be used to define this actively flooded area, and this idea was considered originally. However, ODNR and OEPA specialists felt that it might be too ~~course~~coarse and not provide an adequate level of resolution. It has been our intention to compare the two methods (the active floodplain formula used in the draft TMDL and the USDA soils data) to see how they compare. This work will be included in the final TMDL report if resources are available within the project time frame.

LL
5-18 The Report's emphasis on geomorphological targeting appears to be directed toward two-stage channel proposals. With no research available, it is believed to be premature to be promoting this activity at this time.

Response: The geomorphological targeting is not directed to two-stage channel proposals.

TNC
Riparian corridor protection - The draft TMDL partially addresses the Environmentally Sensitive Development Area (ESDA) in Franklin County, but does not include significant ecological factors, such as adequate riparian corridor protection. The riparian buffer requirements proposed for the ESDA EAG 2004 report should be included. Without these safeguards (and many others), it is unlikely that streams will be protected, or their delivery of pollutants will be reduced. The riparian corridor needs to satisfy multiple

functions. While native vegetation along streambanks is one factor, the corridor also must filter pollutants and provide part of the groundwater recharge and help to maintain streamflow. The TMDL should clarify how these functions are to be adequately achieved by the riparian corridor to protect rare species and protect and improve diversity. An excellent reference regarding the adequacy of stream buffers is:

> Wenger, S. 1999. A Review of the Scientific Literature in Riparian Buffer Width, Extent and Vegetation. Institute of Ecology, University of Georgia, Athens. 59 pp.

Response: The buffer formula proposed by the ESDA EAG will be included in the final TMDL.

TNC

100-year floodplain protection – In order to protect stream integrity, the full 100-year floodplain should be protected from development. The meander belt width is inadequate, and its emphasis might actually encourage floodplain fill and therefore stream degradation. While it is desirable that Ohio EPA uses a stream meander belt formula to encourage at least partial protection of riparian corridors, this is based on engineering calculations and not ecological functions, and ignores key functions of the rest of the floodplain that help protect stream quality. Ohio EPA's failure to recommend protection of the full floodplain goes against the recommendation of the ESDA EAG, which states (from Executive Summary, Page 5):

> **Riparian Corridor Width**
> The group recommends that the buffer width be the width of the 100-year regulatory floodplain as defined by FEMA Flood Insurance Rate Maps (FIRMS) or the Hellbranch Overlay formula, whichever is largest, with a minimum of 200 feet (assumed 100 feet per side).

(Please note that The Nature Conservancy strongly encourages that belt width formula currently used by the ODNR be applied. For the text of ODNR's Rainwater and Land Development manual, see ftp://ftp.dnr.state.oh.us/Soil_&_Water_Conservation/rainwater/.)

It appears that Ohio EPA is not recommending prohibiting floodplain fill. Such fill activity degrades stream functions, such as the ability to form high quality habitat, maximize pollutant filtering and sequestration, and recharge groundwater. Such floodplain fill and development will lead to flooding of additional areas not currently flooded. The TMDL should more strongly discourage floodplain development and fill.

Some of the functions that would be improved by protection of at least the 100-year floodplain, thereby making protection of Big Darby's sensitive species more likely, include[1]:

[1] References: http://www.freshwaters.org/flow/; "Reducing Storm water and Flooding: The Ten Principles of Effective Storm water Management" from Chester County Water Resources Authority.

- Protecting the highest groundwater recharge areas, especially in the Big Darby watershed, and these areas are often in the floodplain outside of the calculated belt width
- Providing contiguous open space with optimally located stream protection features such as water storage and wildlife habitat, which is often outside of the calculated belt width
- Driving lateral movement of river channel, forming new habitats (new and secondary channels, oxbows)
- Lowering flood levels and slowing flood flows in areas where flood flows expand across the stream valley
- Protecting floodplains from fill and construction are strongly encouraged to preserve the maximum flood carrying capacity of the natural floodplains; and therefore avoiding increasing peak flow rates or flood levels
- Undisturbed floodplains reduce the intensity of downstream flows, and thus the potential for streambank erosion, supporting channel stability protection
- Depositing nutrients and other pollutants on the floodplain
- Maintaining diversity in floodplain forest types through prolonged inundation (i.e., different plant species have different tolerances)
- Controlling distribution and abundance of plants on floodplain
- Providing new feeding opportunities for fish, waterfowl
- Disbursing seeds and fruits of riparian plants
- Providing plant seedlings with prolonged access to soil moisture

Ohio EPA also should recognize the floodplain's importance and legal restrictions of floodplain regulation emphasized by the ODNR's Division of Water in ODNR's August 8, 2005, comments to Kevin Wheeler of the City of Columbus regarding the Big Darby Accord. Please note their emphasis that "the 100-year floodplain is considered a highly sensitive environmental resource protection area that should be protected from future encroachments." (emphasis added)

In Section 5.3 Endangered Species, Ohio EPA recognizes the need to protect the floodplain: "An intact flood plain allows for storage of excess water, and reduced flow velocities, minimizing damage to endangered species habitat." Because endangered species have been or are found in much of the watershed, floodplain protection should include the entire 100-year floodplain.

Finally, using only the meander belt width as a "protective" distance will likely lead to minimum protection, with little assurance of a margin of safety. Development encroaching on the floodplain would be the most likely to deliver the highest rate of pollutants, since groundwater recharge and distances for pollutant filtering and infiltration would be minimized. It is not known that the meander belt width is protective of streams' ecological integrity. Therefore, the Agency should expand this recommendation to protection of the full 100-year floodplain.

Response: The final TMDL recommends no development within the full 100-year floodplain zone.

TNC
Section 5.1.4 Managing Drainage Needs, Channel Erosion and Flood Reduction Work – More environmentally friendly options for drainage systems need to be fully explored and applied in the Big Darby watershed. As described in the above comment, such a progress measurement system could be applied to not only pollutant reductions and riparian corridor quality, but also to hydrologic alteration and tributary quality. The Nature Conservancy fully supports review of options concerning the modification of streams for agricultural drainage and flood control. While such options, which attempt to reduce hydrologic and pollutant impacts, are being demonstrated in other parts of Ohio and throughout the Midwest, no alternative channel maintenance projects are in place in the Big Darby watershed, to our knowledge. We welcome a fresh approach that can help regain higher quality fish and other wildlife habitat, and improve pollutant control. We encourage that the State of Ohio and drainage officials to consider a new approach based on need and environmental quality decisions.

Response: The comment is noted.

TNC
Flow based allocation for Hellbranch Run - Page 4-71 - We strongly support Ohio EPA's effort to ensure adequate stream baseflow. Since the greatest, most imminent development is possible in this watershed, it is appropriate to set goals for this area first. Table 4.4.1.4 recommends **a** Recharge Allocation for Hellbranch Run of 17.78 (cm/yr). The estimate must show it will be adequate to protect aquatic life and improve stream quality. Our understanding is that this estimate was based on stream flow from the early 1990s. However, stream flow from that period was altered and might not have been adequate, given the decline in fish species in Hellbranch Run in recent decades.

Besides making this recommendation for Hellbranch Run, we request that Ohio EPA review ODNR recharge estimates for the entire ESDA and other developing areas of the Big Darby watershed, and determine recharge goals in these areas.

Because other groundwater recharge reduction stresses occur throughout the watershed, and the TMDL recognizes the great importance of groundwater to the watershed's streams' quality, further review and recommendations on groundwater recharge protection for the watershed is warranted.

We request that Ohio EPA consider the following:

1. Address the need to encourage and establish more natural, protective hydrologic regimes in other parts of the Big Darby Creek watershed, both from pending development and current hydrologic alteration of other types.
2. Review the recharge rates with parties such as ODNR's Division of Water. What is the natural recharge rate that could be expected, and what is needed to ensure stream integrity?
3. Determine the recharge necessary to protect and improve stream biology and protect sensitive species that could inhabit Hellbranch Run, especially given the nonattainment status of Hellbranch Run and other streams. We suggest

comparing flow regimes to Little Darby Creek, Bokes Creek, and Mill Creek, for example.
4. Determine how much recharge a wider riparian buffer and full 100-year floodplain protection would provide.
5. Investigate setting a goal based on the frequency of low flow.
6. Calculate an increase in low flows due to development.
7. Set a frequency-based low flow goal.
8. Compare these to the Big Darby gage record.

We encourage Ohio EPA to determine the range of natural variability in low flows likely for Hellbranch Run (as well as other key segments). We recommend the Agency set instream flow (hydrologic regime) requirements for these streams and then work backwards to recharge rates and other measures (such as permits for storm water management) that achieves these standards.

Also, the Conservancy requests that Ohio EPA review and consider other hydrologic regime conditions or parameters, including seasonality, frequency, duration, magnitude, and rate of change.[2] The hydrologic regime is the pattern of variation in the amount and movement of water in the system over time. These regimes include surface-groundwater exchange/recharge, local surface runoff, peak flow integrity, low flow integrity, overbank flooding integrity, mean magnitude and degree of inter-annual and seasonal variation, frequency of particular flow magnitudes, duration, and or other aspects of hydrograph shape.

The TMDL should ensure that flooding does not increase as a result of development. The TMDL should ensure that the duration and frequency of the high flows do not increase beyond natural conditions. We recommend the Agency conduct modeling to provide an expected range, frequency and duration of these high flows and compare this to Hellbranch Run records. This may allow storm water/development activities to be planned in a rigorous way.

One of the problems in the watershed is channel instability, likely caused by the scouring of channels by storm water runoff and exacerbated by channelization, levees and floodplain fill. Storm water management in this TMDL should assure channel stability.

Please consider the above in your establishment of geomorphological targets as stated in Section 5.2.2 Construction Activity.

Response: Protection of groundwater recharge has been incorporated in the draft Big Darby Creek Watershed NPDES Permit for Storm Water Related to Construction Activity through the use of a recharge credit system and stream setback requirements; this permit is applicable to the entire Big Darby Creek watershed. The recharge rates in the TMDL and in the Permit are comparable to historical and current findings of the ODNR groundwater and soil scientists.

[2] A discussion of streamflow-based stream ecosystem management targets is found in Richter, B. D., J. V. Baumgartner, R. Wigington, D. P. Braun. 1997. How much water does a river need? Freshwater Biology 37:231-249. http://www.freshwaters.org/pub/pdf/howmuchh2o.pdf

Hydrologic TMDL numbers are available to be included for other sub-watersheds within the Big Darby. The final TMDL includes these recommendations.

The other requests for further flow analysis have been noted and will be considered if resources become available for future modeling work in the Darby watershed.

TNC
Riparian corridor status and species richness – While we appreciate the effort to map the status of the riparian corridor in the Big Darby Creek watershed, the Ohio EPA and TMDL need to more extensively analyze the relationship between riparian corridor conditions and stream health on a watershed basis, especially the existence of high species diversity and richness and rare and declining species. While the TMDL provides maps of an inventory of riparian corridor, the document does not sufficiently address the adequacy of the existing width quality. The Nature Conservancy's analysis of the watershed's riparian quality suggests that there is a positive correlation between riparian quality and species richness, especially for rare and declining species and mussels. These species are most likely to be found where the riparian corridor is of native vegetation and of greatest width. We would appreciate the opportunity to present our analysis and discuss this relationship further.

Response: Ohio EPA is interested in such a meeting.

OEC
Specific allocation reductions for phosphorus are note worthy. While progress can be made to reduce loads from failing septic systems and point sources historically nonpoint reductions are much more challenging. Traditional voluntary efforts are a component of an overall strategy but should be connected to emerging technologies that show the importance of maintaining the assimilative capacity of headwater streams. For example natural stream channel restoration techniques reconnect the stream with the associated floodplain and when coupled with native and other plantings significantly improve and restore vital stream function. In addition some measure of restoration is afforded to streams by developing two stage channel portions of a stream that historically have been disturbed (the subject of much current research by OSU scientists and others). The two-stage channel reconnects some flood plain back to the stream but not the extent that a natural re-design would.

Clearly the maintained and ditched headwaters stream is the least likely stream channel type to assimilate nutrients and provide other important natural function including stream bank water storage, sediment reduction, and habitat growth. Petition ditches are a regressive water policy and a throw back to an era when stream chemistry and biology were sacrificed for drainage. Drainage can be incorporated into a scientifically sound philosophy of natural channel design where maintenance issues are moot since the channel can be re-developed to contain much larger events and afford the necessary drainage that is artificially obtained through ditching.

Response: In those stream systems where the riparian corridor has been compromised or the local land use is encroaching on the stream, total phosphorus reductions will need to be accomplished through the establishment of Best Management Practices (BMPs) on the landscape. Ohio EPA agrees that the ability of a stream modified as described above to process nutrients will have been greatly compromised. Reduction of upland phosphorus loadings then becomes the only option to achieve TMDL targets, due to the loss of assimilative capacity in these streams. It will be very important to limit the phosphorus export attributable to agricultural inputs from of these damaged stream systems.

LDR
In many cases it appears that in order to implement your recommendations, farmers would need to take currently productive farmland out of production. If they are not eligible for CREP, what types of financial incentives are there for complying with your recommendations? Most farmers are not wealthy; they need to make a return on their land. How can you expect them to take land out of productive use and get nothing in return? Large corporations can recoup costs of implementing your recommendations by raising prices on their goods. Farmers do not have that luxury. They must continue to pay taxes, mortgages, and insurance on the land although it is providing no return. The farmer has to be made whole. And the answer is not selling PDR's or conservation easements. Farmers are not interested in selling development rights or easements. They want to keep the land they currently have.

The setback widths recommended in the report are enormous. In some cased they would take an entire farms. Once again, there needs to be compensation if you are asking farmers to take productive land out of service.

Response: Setback widths established in the TMDL are protective of long term movement of the stream. Activities within the setback are recommended to be those activities that are compatible with frequent (annual or bi-annual) flooding. To the extent agricultural practices will not be harmed by flooding, agriculture is an acceptable activity. Those practices designed to move agricultural activity closer to the stream channel should be discouraged. Levees and other structures designed to deflect flood water on to down stream land owners are not acceptable unless easements are obtained from downstream land owners for the land that will be flooded by levee installation. Those levees that exist now should over time be abandoned. As stated before, the setbacks demark an area to provide long term protection to the stream and to land owners. Where activities within the setback that are not compatible with flooding are occurring, a gradual retreat out of the setback zone would be considered successful implementation of the recommendation.

Agricultural incentive programs do exist to compensate some land owners for the restoration of crop land to an activity more compatible with the stream corridor.

COLS
Ohio EPA Should Not Adopt A TMDL that Conflicts with the ESDA EAG Recommendations.

Ohio EPA's recommended floodplain widths are significantly different than those recommended by the ESDA EAG and may not be more protective. The ESDA EAG was comprised of all the political jurisdictions in the ESDA area, development interests, environmental interests and OEPA. These individuals worked extremely hard to reach consensus on riparian corridor recommendations that:

- Include perennial, intermittent and ephemeral streams;
- Require a minimum 200 foot buffer on any of the above three stream types;
- Include the entire FEMA regulatory floodplain, if the calculated floodplain is smaller; and
- Use a philosophy of increasing width with increasing drainage area.

While Ohio EPA's proposed approach uses the last bullet from above, it uses a formula, which greatly expands the width of the buffer. If the efforts of the ESDA are going to be so blithely set aside, the OEPA will, in the long term, be unable to find willing partners to undertake such efforts. There is no perfect science on this topic. Community acceptance, as developed through the open, vigorous discourse in the EAG, is critical to the success of these efforts. The participants in the ESDA EAG should not have their hard work unilaterally undermined by Ohio EPA.

Moreover, Ohio EPA's direction does not include any of the other considerations the ESDA EAG found appropriate and therefore, may, when taken in total, offer less protection. Whether more or less protection is obtained will require a detailed GIS evaluation. However even without this evaluation, Ohio EPA's method does not offer any sort of protection to the headwater systems within the Darby. By Ohio EPA's own internal policies, headwater protection is supposed to be a priority, yet this TMDL offers no such protection.

Response: The setback recommendations in the draft TMDL were not limited to development issues such as the ESDA-EAG recommendations were. Instead, these setback recommendations were focused on establishing activities that can co-exist with frequent flooding and reducing activities that alter the floodplain of the system such as levees. This was a different focus than the ESDA-EAG, and needed to be based solely on current technology as there was not the additional support of a Big Darby watershed-wide representative body with which more consensus based recommendations could be reached. It was not the intent, nor would it be the result, that the TMDL would supersede the ESDA-EAG recommendations within Franklin County for the stream setbacks. The final TMDL endorses the ESDA-EAG setback recommendations for new development. In addition, the setback formula used in the TMDL is based on the same methodology as the one used by the EAG. However, additional data specific to central Ohio was available to use in developing the formula for the TMDL that was not available at the time the EAG was developing their recommendations. Further, the TMDL formula is based on a philosophy of increasing width with increasing drainage area as well as increasing width with increasing ecological sensitivity – something the EAG did not include in their considerations.

FWS

We encourage the establishment of forested buffers along the Darby Creeks and their tributaries as suggested in the TMDL document. These buffers would be beneficial to Federally-listed endangered mussels.

Response: Forested buffers serve many functions in the aquatic ecosystem. The importance to endangered species is noted.

COLS

Section 3.3.1, second paragraph, top of Page 3-13, last sentence. OEPA indicates that the Curve Number method of estimating precipitation "…. predicts any 'quick response' flow including .. drainage from tiles." This statement that Curve Number includes impacts of tiles is factually in error. The only time a Curve Number includes the impacts of tiles is when the Hydrologic Soil Group is revised to account for tiles. In this case, less runoff is calculated due to the presence of tiles, as reflected in a change in hydrologic soil group from a less permeable (more runoff) soil to a more permeable (less runoff) soil. This only occurs in a limited number of situations.

Response: The NRCS (formerly SCS) developed the Curve Number Method. The NRCS National Engineering Handbook, Hydraulics and Hydrology, Part 630, Chapter 10, page 8 states the following:

> "In flood hydrology baseflow is generally dealt with separately, and all other types are combined into *direct runoff,* which consists of channel runoff, surface runoff, and subsurface flow in unknown proportions. The curve number method estimates this combined direct runoff."

The statement in the TMDL the commenter refers to is not in error.

DCA

The report, and the recommendations it contains, advance the goal of Darby protection in several key ways. For the first time we have an attempt to use scientific analysis to determine protections needed. As a result, we now have much detailed information about how various land uses, including agriculture, are impacting the Darby streams. In addition, for the first time we have the EPA looking at treating storm water runoff from new development as a controllable source of pollution. And finally, for the first time the EPA is looking at the need to positively influence hydrology and increase infiltration to maintain baseflow. DCA encourages the EPA to calculate infiltration TMDLs for all developing areas of the watershed, although this may be an evolving area of evaluation.

Response: The comment is noted. Hydrologic targets will be incorporated for all developing areas of the watershed in the final report.

B.2 Storm Water

1000F

Specifically, we strongly support strategies to protect the stream channel from eroding by ensuring advanced, appropriate storm water management and sufficient protected land along stream banks

Response: The comment is noted.

1000F
Specifically, we strongly support strategies to significantly strengthen storm water and sewage permit regulations by ensuring adequate treatment of chemicals, bacteria and solids from permitted discharges, home sewage treatment and disposal systems, and livestock so that water quality is improved

Response: The comment is noted.

BIA
We would like to point out that residential development that incorporates effective storm water controls significantly reduces discharges of TSS when compared to ongoing agricultural uses. For example, recent studies performed in connection with the design of storm water control for the future Burr Oak residential development (located at the west side of Galloway Road between Hall Road and the Village of Galloway) illustrated the expected positive impact and aggressive storm water control techniques indicates that development of this site will both significantly reduce pollutant loads to the Darby Creek and more effectively manage peak flows when compared to agricultural use.

As we understand it, the percent reductions in sediment load and phosphorous called for in the TMDL report depend upon watershed. Target values have been set for several water quality parameters throughout the watershed.

	TP (mg/L) (total phosphorous)		TSS (mg/L) (total phosphorous)	
	WWH	EWH	WWH	EWH
Headwaters (<20 mi^2)	0.07	0.05	10	10
Wadeable (<200 mi^2)	0.11	0.08	31	26
Small Rivers (<1000 mi^2)	0.16	0.17	44	41

One parameter that must be looked at is the storm water effluent values which should fall below the target values for the designated receiving stream. At Burr Oak, the receiving waters are Hellbranch Run around RM 7.4 which places it within the WWH area of Hellbranch. It is a wadeable stream so the limits for TP are 0.11 mg/L and the limits for TSS are 31 mg/L. The storm water system has been designed to discharge storm water flows with an effluent on the order of 0.08 mg/L of TP and approximately 17 mg/L of TSS. Both of these are well below the target levels.

Response: The expected effluent quality of the Burr Oak storm water is encouraging. Ohio EPA appreciates and supports such innovative storm water design.

BIA
We understand that the agency is considering the development of a general construction storm water permit applicable only in the Darby Creek watershed. Echoing our prior comments, we urge the agency to incorporate sufficient flexibility in that permit to allow for cost effective, yet environmentally sound storm water controls. Moreover, we would request the opportunity to have our members work with the agency in the

development of the general construction storm water permit to allow the agency to take advantage of the regulated community's experience in the implementation of the applicable best management practices in the field.

Response: The comment is noted.

BC
Designate additional Phase II communities within the Darby Creek watershed as soon as possible.

The TMDL mentions that the Ohio EPA expects to exercise its authority to designate additional Phase II communities within the Big Darby Creek Watershed. Given the benefits in public education and outreach, plus the additional Best Management Practices required in construction storm water controls and post-construction storm water management, I strongly encourage this be done as soon as possible.

Response: Ohio EPA will evaluate designating additional storm water Phase II communities in calendar year 2006.

DG
Stream restoration should be part of storm water controls, widening, bank protection and tree planting similar to Grants Run project FCSWCD using qualified restoration experts such as Steve Phillips of Oxbow River and Stream Restoration.

Response: Ohio EPA typically does not get involved in the selection of a specific contractor in restoration projects.

DG
LID Low Impact Development can do more than constructed storm water systems (consultation with other cities). Reduce impervious surfaces and create a storm water utility for entire watershed.

Response: The comment is noted and will be considered in the development of the General Permit for Storm Water Associated with Construction Activity for the Big Darby Creek Watershed.

LL
Reference to storm permitting program (5-6) implies that this will include routine ditch maintenance such as county maintained agricultural ditches. Suggest clarifying as I believe these ditches are not subject to this program.

Response: Ohio EPA included this to state our intent of ensuring that dredging spoil from non-regulated channel maintenance activity would not erode back into the stream. Because the authority for Ohio EPA to require a permit depends on all the specific facts of a situation, the reference in the TMDL to the special permit was removed. However, the potential water quality impacts caused by poorly constructed or maintained agricultural drainage projects remains. This is of particular importance in the Big Darby Creek watershed, where the potential impacts could result in the extirpation of sensitive, threatened, and/or endangered species. Failure to adequately control and minimize the impacts of agricultural drainage practices on downstream water resources such that federally listed threatened and endangered species are placed in jeopardy is not an acceptable outcome. It is in the best interests of both the State of Ohio and Ohio's agricultural industry to develop a workable solution that protects the downstream resource.

Ohio EPA has three options for approaching this situation: 1) educational outreach and cooperative problem solving, 2) aggressive enforcement of existing regulatory authorities to the full extent that Sections 401, 402 and 404 of the Clean Water Act and Section 6111.04 of the Ohio Revised Code allow, and 3), seeking increased regulation. The Agency will pursue outreach and problem solving by participating on the *Rural Drainage Advisory Committee* convened by Ohio DNR Division of Soil and Water Conservation. In this forum, Ohio EPA will be able to work with county engineers, environmental groups, academia, and federal, state, and local soil and water conservationists to attempt to address our ongoing concern. The committee is charged with looking at the current laws and regulations related to ditch construction and maintenance and looking for practical solutions that effectively address drainage needs and protection of water quality. Ohio EPA hopes that this will be an effective approach. If a successful outcome is not realized within a reasonable timeframe, then Ohio EPA has the recourse of pursuing more permitting authority under existing or new Federal and State law.

TNC

Section 5.2.2 Construction Activity - and temperature - Storm water management typically increases water temperatures, which is detrimental to aquatic life. This problem needs to be addressed in the draft TMDL. The "new characteristics of these permits" (general permits for storm water) discussed in this section need to address temperatures, and ensure that storm water temperatures are not damaging.

Because of the existence of many pollutants of unknown individual effects, storm water discharge water quality requirements must be based not only on individual parameter goals, but also on cumulative and synergistic effects.

Response: The Agency agrees that the management of summer stream temperatures in segments of Big Darby Creek and its tributaries will become increasingly important as the watershed is developed. Thermal inputs from effluents, storm water and solar radiation must be considered. While no significant changes were made in the TMDL report to address temperature specifically, many of the outputs related to riparian set backs, flood plain protections and ground water recharge will have a positive effect. The Agency will seek methods to properly manage summer temperature levels in Coldwater and Exceptional Habitat areas through NPDES permits and other mechanisms. This comment will be considered in the designation of additional areas under Phase II storm water activities, scheduled for 2006.

TNC

Section 5.2.5 Municipal Point Sources – NPDES Phase II and permit limits - This section states "Ohio EPA will evaluate designating additional communities as being required to obtain coverage under the Phase II permit." Because of their locations, some communities presently not subject to Phase II present considerable storm water threats to stream quality. Additional jurisdictions should be added to the NPDES Phase II program, including Plain City and West Jefferson. It is clear that Plain City, directly on Big Darby Creek, is affecting stream quality in Big Darby Creek, and if the Village expands, will likely affect Sugar Run. West Jefferson includes a significant portion of the lower Little Darby Creek in its Facility Planning Area. If inadequate storm water management continues, it will only make improvement of the stream in these areas more difficult.

We strongly support the review of discharge limits for point sources throughout the watershed, and encourage establishment of permit limits protective of mussel and other species richness.

Response: The TMDL includes an evaluation of point sources throughout the watershed. Most of the point sources will be receiving new limits for the control of Total Phosphorus, unless current permit limits are determined to be adequate to protect water quality. An evaluation of additional storm water Phase II communities will happen in 2006.

TNC
Flat Branch impairment and storm water management - Page 2-15 - Flat Branch is designated as Modified Warmwater Habitat (MWH), and "is not impaired." This stream is one of the lowest quality in the watershed, and the “not impaired” designation is very misleading. Flat Branch clearly contributes significant pollutants to the Big Darby Creek and pollutant loads are far above ecological goals (e.g., see Table 4.1.1.1). This stream, and sub-watershed, needs considerable improvement and a higher goal, clearly because it is not only damaged, but is affecting Big Darby also. Agricultural runoff and sediment delivery to the stream is readily observable in this watershed, and it already has land use development at approximately 10%, clearly demonstrating a need for adequately protective storm water management. Ohio EPA should require enhanced storm water management in this area. Comparable nonpoint source pollution and habitat problems exist in a number of other watersheds and need to be addressed in detail for environmental protection progress to be achieved.

Response: The comment is noted.

B.3 Recharge

1000F
Specifically, we strongly support strategies to prevent flooding as well as drying up of streams by managing runoff, infiltration of storm water into the ground and its release into the streams, and overall protection of groundwater recharge areas;

Response: This comment will be considered in the development of the General Permit for Storm Water Associated with Construction Activity for the Big Darby Creek Watershed.

OEC
One of the important findings in the Technical Support Document for the Darby watershed is the interconnection of surface and groundwater in the Darby system. The occurrence referenced in the report of several areas of coldwater habitat and the groundwater/surface water interaction is obviously a key to understanding the development of Darby's species richness. Forested corridors and high quality habitat alone likely would not have produced this vast ecosystem diversity, therefore the importance of developing scientific understanding of the hydrologic regime at work is significant especially understanding minimum base flow needs to support the Darby's biology. A hydrologic allotment for all sub-watersheds, not just the Hellbranch, is encouraged and in our view a necessary component of the report.

Response: A hydrologic allotment similar to the one included for the Hellbranch in the draft report will be included for the other sub-watersheds in the final report.

COLS
Flow TMDL for the Hellbranch
As discussed in the City's letter, Ohio EPA lacks the legal authority to impose a flow TMDL. In addition, the flow TMDL is not supported by the documents.

Response: In PUD No. 1 of Jefferson County v. Washington Department of Ecology, 511 U.S. 700 (1994), the United States Supreme Court held that a state was allowed under the Clean Water Act to impose a flow restriction in a 401 certification. The Court reasoned that the Act required maintenance of designated uses of waters and that flow restrictions could be an element of maintaining and protecting those designated uses. Ohio Law also requires that water quality standards, including designated uses, be maintained and protected, and that the standards be implemented in permits. Where permitted activities could result in an increase or decrease in flow that affects water quality and maintenance of designated uses, Ohio EPA may impose restrictions that attempt to diminish or eliminate the adverse changes in flow.

COLS
OEPA's initial Technical Support Document indicated that the Upper Big Darby Creek and the upper half of the Little Darby Creek "… benefits from the positive effects of ground water inflow…" The TSD document further indicates "Every effort should be taken to protect the integrity of the ground water resource." This conclusion is re-iterated in the TMDL report in Sections 2.2 and 2.4. However in Section 2.5.1 of the TMDL report regarding the Hellbranch subwatershed there is only an indication of a possible ground water impact, as evidenced by the phrase … "perhaps ground water augmentation given the biological performance…" Yet the only subwatershed that has flow limitations and recharge requirements is the Hellbranch. Simply because a watershed is experiencing development pressure is not sufficient reason to require flow restrictions. In addition to exceeding its legal authority, OEPA does not show sufficient evidence to warrant hydrologic restrictions for the following reasons:

a. The analysis is based on a stream gauge that has only been in existence since 1992. By OEPA's own admission any numeric targets for flow quantity and hydrology should be based on "… conditions that existed prior to the significant alteration in the stream flow regime." The operational period for the Hellbranch gauge does not extend to before any hydrologic modifications have been made in the watershed. While significant development may not have begun until the early 1990's, other significant hydrologic alterations occurred prior to that time including the installation of field tiles and the creation of Hamilton Ditch and Clover Groff Ditch in their current configurations, which certainly did alter the flow regime and may have artificially increased base flow in the existing hydrograph.

b. OEPA's report also indicates that targets should be based on a "… stable hydrologic and stream flow regime." Even if the Hellbranch watershed is in a "stable" hydrologic regime, it is not reasonable to expect that a 13 year record would adequately reflect the true long term behavior of that stream. This is further evidenced by the short term duration of OEPA's analysis and the gauge behavior during that term. OEPA has based the conclusions on a three year record where runoff is reported to increase by 13% and recharge decrease by 3%. During this same three year period the average stream flow at the Hellbranch gauge varied from a 30.5 c.f.s. to 44 c.f.s. (2000 – 31.7 c.f.s., 2001 – 40.9 c.f.s., 2002 – 30.5 c.f.s., 2003 – 44 c.f.s.) with both positive and negative changes year to year. When the range in flows varies by these amounts it is not reasonable to detect the relatively small changes predicted by OEPA, nor is it reasonable to attribute those changes to a single source.

c.. The conclusions drawn from the modeling appear to have been made without regard for the reasonableness of the results. In Section 4.4, OEPA indicates that a 3% reduction in groundwater recharge and a 13% increase in runoff occurred. Based on TMDL report sections outlining the modeling methodology, it can only be assumed that the recharge reduction was evidenced by a corresponding reduction in base flow, while the runoff increase was evidenced by a corresponding increase in storm flows at the gauge. It is unreasonable to expect that any hydrologic model is accurate to within even 10%, much less able to accurately predict results in the 3% range, especially when considering the complex interaction between surface water and ground water. Second, ground water impacts occur very slowly, especially in a low infiltration hydrologic regime such as the Hellbranch. Expecting to verify any significant impact on a ground water resource in only three years is unrealistic and calls into question the accuracy of the conclusions. Moreover, calibrated hydrologic modeling completed for the Hellbranch Forum showed only a 20% increase in peak flow with an increase in development (as measured by a change in impervious area) of over three times. Also, the same modeling indicated a roughly 10% increase in peak flow with over two times more development. While the increase in impervious areas were not provided in the TMDL report, based on the modeling completed for the Hellbranch Forum, it is unreasonable to expect a 13% increase in runoff, from land use changes occurring between 2000 and 2003. Based on the Hellbranch Forum modeling this would require a change in development (as measured by impervious area) of slightly more than twice existing conditions.

d. The above discussion mentioned the complex interaction between ground and surface water. This paragraph expands on that relationship. One **cannot**

casually infer that a single factor has the predominant influence over these complex interactions, especially considering that annual stream flow, both storm runoff and base flow proportions are impacted by many factors including:

- Variation in annual evapotranspiration;
- Lag in groundwater contribution to the stream due to subsurface flow rates;
- Differences in agricultural cover (cropping patterns, no till);
- Amount of runoff during the winter/spring (warmer winter – more infiltration);
- Rainfall intensity – year with less intense storms will have less runoff;
- Amount of impervious surfaces and degree of connectedness;
- Time between storms – drier antecedent conditions result in less runoff; and
- Total rainfall in a given year

Each of these varies on a year to year basis. It is not valid to attribute changes in stream flow to a single variable when the others are also varying, especially over a short period of record (2000 – 2003 in the analysis that demonstrated a 3% reduction in base flow and 13% increase in storm flow).

e. The predominant soil associations in the Hellbranch are the Kokomo-Crosby-Miamian and the Crosby-Celina. Both are classified as “very poorly drained.” As Section A1.1 of the TMDL report indicates “Associations that are poorly drained have lower infiltration rates, greater runoff or ponding, and typically less water available to recharge groundwater resources.” Since the soils in the Hellbranch are considered “very poorly drained” is can only be assumed that their infiltration capacity is even lower. It is not appropriate to require recharge where there is a little chance of actually being able in influence the recharge characteristics.

Finally, the value of recharge required by OEPA’s TMDL is not reasonable when compared to the probable available recharge capacity of the Hellbranch Watershed. Based on NRCS data contained within a Center for Watershed Protection Paper entitled “Why Stormwater Matters,” the estimated recharge values for the soils present in the Hellbranch is between 3 and 6 inches per year. Hydrologic Soil Group D soils exhibit about 3 inches per year recharge, while Hydrologic Soil Group C soils exhibit about 6- inches per year recharge capacity. Based on the soils present in the watershed, and hydrologic soil groups identified by NRCS and published in the Franklin County Soil Survey, the maximum amount of recharge that can reasonably be expected is less than five inches per year. OEPA’s TMDL requires a recharge of seven inches per year. It should be noted that the five inches per year estimate does not include the impacts of field tiles. Because field tiles capture infiltrating surface water, they will reduce the amount of recharge possible, meaning that the actual existing recharge capacity is significantly smaller than five inches per year.

Response: The concern of the commenter appears to be based on a misinterpretation of the 2000 and 2003 land use comparison analysis. The hydrologic model was calibrated to the full flow record at the Hellbranch gage using matching time period daily weather data. The comparison of land use was based on the same 10+ year weather data using the 2000 land use data and again with the 2003 land use data changing no other parameters except those associated with land use. The purpose of the analysis was to show only the relative effect of land use changes on the hydrologic regime. As land use developed, there was a loss of baseflow and a gain of runoff; a result supported by many other studies in other urban settings.

The distribution of the hydrologic soil groups for the Hellbranch sub-watershed is as follows:

Soil Group	% of Total	Estimated Recharge (in/yr)^	Estimated Recharge in the Hellbranch (in/yr)
A	0.2	18	0.04
B	13.9	12	1.67
C	82.0	6	4.92
D	3.9	3	0.12
Rough Estimate of Hellbranch Recharge:			6.75

^ Using the resource referenced by the commenter.

Given the myriad variables associated with groundwater recharge calculation the rough estimate above supports the more site specific based estimation of groundwater recharge in the Hellbranch of 7 inches/year. Other studies and data support the findings of the TMDL. These include the ODNR DRASTIC database of groundwater recharge to deeper aquifers which indicate recharge values comparable to the ones calculated in the TMDL analysis, as does a joint study by USGS and ODNR and published in the document: *Use of Stream flow Records and Basin Characteristics to Estimate Ground-Water Recharge Rates in Ohio.* The recharge values calculated in this study compare very well to the ones calculated in the TMDL for all 3 active USGS gages in the Darby including the Big Darby Creek gage which began recording data in 1921 through today. Note the DRASTIC database is based on landscape and other factors and not on streamflow; hence, these studies arrive at similar recharge conclusions using different data types.

The commenter also discusses the reasonableness of requiring recharge in poorly drained soils. The recharge targets established in the TMDL for the Hellbranch are to protect the existing hydrologic regime, and are based on rates that are already being achieved in the watershed. The recharge rate in the Hellbranch watershed is a low recharge rate in keeping with the soil types within the basin. The commenter also references a number of excerpts from the TMDL concerning groundwater influence in streams of the upper Darby. The streams mentioned as being groundwater influenced in the TMDL are of particular note as they have higher groundwater contribution than most of the other streams in the watershed. However, that does not mean other streams in the watershed do not have any groundwater influence. The baseflow of the Hellbranch is primarily from groundwater; the Hellbranch is also developing more rapidly than any other sub-watershed in the Darby area. If the existing groundwater recharge is not maintained as the sub-watershed develops, the Hellbranch would be in serious danger of becoming an intermittent drainage way. The other sub-watersheds in the Darby will include hydrologic targets in the final report.

COLS
On Page A-4 OEPA classifies the lithology of deposits in order of increasing hydraulic conductivity as till, till with sand and gravel, fines with sand and gravel, sand and gravel with till, and sand and gravel with fines. However, on the figures on page A-5, A-7, A-8 and A-9 a different order is used that does not correspond to the order in the text. The order (from top to bottom) in these figures should correspond to the order in the text (from first to last) to make interpretation easier on the reader.

Response: The comment is noted.

B.4 Use Designations/WQS

Honda
Section 2 and Section 4 of the Report consistently compares Exceptional Warm Water Habitat (EWWH) segments of the BDCW to the Modified Warm Water Habitat (MWWH) segment consisting of FBC. Honda has concerns with the scientific validity of this comparison and the conclusions drawn from this analysis. The specific methodology used to perform this analysis should be part of the public record so it can be examined and verified. The Agency should expect to see a difference in the water chemistry and water quality between such two different stream segments based on the stream buffer structures and stream channel morphology, and not automatically conclude that any such differences are caused solely by Honda's "industrial" activity, as is suggested in the Report. (See, e.g., pp. 2-15, 4-4.) The parameters attributed to industrial activity all occur naturally in the soils and sediments of the area. While Ohio EPA has acknowledged that the Flat Branch meets its designated use, that of a MWWH, Honda is concerned that Ohio EPA is attempting to convert a MWWH stream into a EWWH and that this conversion will be an almost impossible task, even in the absence of Honda's operations.

Response: The use attainability analysis for streams in the Big Darby Creek Watershed was included in the technical support document (TSD) for the watershed, which is entitled: *Biological and Water Quality Study of the Big Darby Creek Watershed, 2001/2002; May 7, 2004*. This report is public information. While Ohio EPA expects some differences in stream chemistry due to the differences in use designation, some of the differences are extreme when comparing within the same major sub-basin (11 digit HUC 190).

Title 40 of the Code of Federal Regulations, Section 131.10(b) states:

> In designating uses of a water body and the appropriate criteria for those uses, the State shall take into consideration the water quality standards of the downstream waters and shall ensure that its water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters.

Flat Branch is meeting its designated use of Modified Warmwater Habitat (MWH), but the water quality of Flat Branch is interfering with the attainment of the downstream

Exceptional Warmwater Habitat (EWH) use. Water quality in Flat Branch must be improved to the extent that it no longer interferes with the attainment of the EWH use in Big Darby Creek.

DWJB
Lastly, the Darby Joint Board and Planning Group would like Ohio EPA to ***consider*** and ***comment*** on the following stream definitions to help clarify the variety of channels that exist in the watershed.

Natural Stream – A watercourse that existed historically and has a steady flow of water

Natural Altered Stream – A watercourse that existed historically, has a steady flow of water, and has been man altered

Historical Channel- A watercourse that existed historically and has periods of intermittent or no water flow

Man-Made Channel – A watercourse that did not exist historically and has periods of intermittent or no water flow

Maintained Man Made Channel – A watercourse that did not exist historically, has periods of intermittent or no water flow and is maintained by authority of Ohio Ditch Law.

Response: Ohio EPA does not feel that these terms add clarity to any description of waters of the State of Ohio. The Ohio Revised Code already creates a term for "historically channelized watercourse" and provides for some limited variance to antidegradation reviews for that type of watercourse. See ORC 611.12(C).

LL
Ohio uses aquatic life uses contrary to other states thus creating an unfair indictment of Ohio's stream conditions.

Response: The Agency does not share this outlook on the State's water quality standards. Ohio EPA prefers to take an approach that provides an accurate assessment, an approach that has been validated by the National Academy of Sciences. USEPA is working with other states to improve their monitoring programs such that data of a quality comparable with the data generated by Ohio is produced.

LL
It is imperative that county maintained and privately maintained agricultural ditches that do not have potential to meet OEPA designated uses (WWH for example) should not be designated.

Response: Ohio EPA received similar comments when it released draft water quality standards rules for public comment in 2005. After reviewing these comments and meeting with officials and landowners, the Division of Surface Water has prepared proposed rules for the Director's approval. This proposed rule package has excluded the county maintained, or privately maintained, ditches found in the draft rule, unless

Ohio EPA biological data from recent surveys documented WWH attainment, or the potential to attain WWH. The Director must approve the proposed rule, file with the Joint Committee on Agency Rule Review and consider additional public comments before the rule is finalized. However, it is important to keep in mind that downstream uses must be protected. All undesignated waters must still meet all chemical WQS associated with the WWH use designation, and must not contribute to impairment of the downstream aquatic life use.

LL
Undesignated channels/ditches should remain as such until additional monitoring is done. In addition, there are roadside ditches that have similar water flow characteristics. Why have these not been included in the Report?

Response: Roadside ditches are waters of the State unless they do not have a flow into other waterways. Roadside ditches are no part of the Agency's sampling program except in certain special investigations of unsanitary conditions, spills, or pollution incidences. Ohio EPA agrees that channels and ditches that have not been monitored to determine the appropriate aquatic life use should remain undesignated. However it is important to note that in order to achieve TMDL pollutant reduction targets that sources of total phosphorus, bacteria, and suspended solids in these waterways be scrutinized to determine ways to make cost effective reductions in these pollutants. All of these types of waterways contribute to overall pollutant loading in the watershed, and all of them should be evaluated for ways in which reductions can be made in order to contribute to achieving pollutant reduction targets.

TNC
Antidegradation goals - The TMDL should ensure no further decline in species richness occurs and streams not meeting Clean Water Act goals are restored. Rare and declining species must be protected. The TMDL should protect the Big Darby and tributaries at Outstanding State Waters (OSW) and Superior High Quality Waters (SHQW) levels, and protect the watershed's streams from further rare species losses. It should further clarify how the TMDL will ensure this protection; only limited discussion is provided as to protection of federally endangered species in Section 5.3.

What is the margin of safety used to assure protection of rare and declining species? How does this differ from another margin of safety in another watershed which does not have comparable rare and declining species occurrences? Because of its exceptional ecological value, Big Darby Creek and tributaries need a greater level of protection than that necessary to achieve the Exceptional Warmwater Habitat (EWH) used attainment level, and a substantial margin of safety is essential.

Response: We agree that efforts to manage and protect State and Federally listed rare and threatened species are important and that the State's water quality programs should assist in these efforts. Ohio EPA amended the State's antidegradation rule (OAC 3745-1-05) in 2003 to include a higher level of protection for waters that demonstrate high biological diversity and the presence of rare, threatened, or declining species. Big Darby Creek and some of its tributaries were assigned the OSW and/or SHQW designations in the 2003 rule making.

Seventy-five (75%) of the remaining available pollutant assimilative capacity for regulated pollutants which have water quality criteria is reserved (i.e. not allocated to sources) on Outstanding State Waters. This antidegradation requirement was incorporated in all applicable NPDES activities associated with the TMDL recommendations. Additional protection for the endangered species of the Darby was incorporated in the TMDL process by inclusion of stream setback requirements and recommendations, protection of groundwater infiltration, regulation of storm water quality, and inclusion of thermal load considerations in NPDES point source discharge permitting all of which are unique at this point to the Big Darby Creek TMDL.

Five percent (5%) of the total allowable load was reserved and unallocated to conservatively account for data and model uncertainties. The target in-stream concentrations for total phosphorus and total suspended solids were set at conservative levels to provide an additional margin of safety. These practices have been used in other (but not all) TMDLs produced in Ohio.

TNC
Flat Branch impairment and storm water management - Page 2-15 - Flat Branch is designated as Modified Warmwater Habitat (MWH), and "is not impaired." This stream is one of the lowest quality in the watershed, and the “not impaired” designation is very misleading. Flat Branch clearly contributes significant pollutants to the Big Darby Creek and pollutant loads are far above ecological goals (e.g., see Table 4.1.1.1). This stream, and sub-watershed, needs considerable improvement and a higher goal, clearly because it is not only damaged, but is affecting Big Darby also. Agricultural runoff and sediment delivery to the stream is readily observable in this watershed, and it already has land use development at approximately 10%, clearly demonstrating a need for adequately protective storm water management. Ohio EPA should require enhanced storm water management in this area. Comparable nonpoint source pollution and habitat problems exist in a number of other watersheds and need to be addressed in detail for environmental protection progress to be achieved.

Response: While Flat Branch is meeting its aquatic life use designation, it is interfering with the attainment of the downstream aquatic life use in Big Darby Creek. This condition is not acceptable under federal regulations (40 CFR 130.10(b). As such conditions need to improve in the Flat Branch watershed such that they no longer interfere with attainment of the EWH use in Big Darby Creek. There are many potential improvements that are being evaluated, and additional data in this watershed is being collected. Should these efforts prove unsuccessful, the Ohio EPA may consider modification of the water quality standards for Flat Branch in order to be protective of downstream uses.

OFB
Assigning aquatic live use designations in the Big Darby Creek watershed must ensure that existing agricultural drainage systems remain intact and allowed to be maintained in the future. Many agricultural ditches have been created under Ohio’s agricultural drainage laws. The goal of these drainage projects is to keep the water flowing by

constructing efficient ditch systems and ensuring that they are maintained and cleaned out when needed.

Ohio's water quality standards need to acknowledge that differences exist between man-made ditches, streams that have been altered or modified to improve drainage and offer flood control, and natural streams. Agricultural drainage ditches, urban storm drains and roadside ditches should not be considered fishable/swimmable and should be assigned an appropriate aquatic life used designations based upon their primary purpose – conveyance of excess surface and subsurface water.

Response: The Ohio WQS regulations do acknowledge that human-made channel and habitat modifications associated with agricultural drainage sometimes preclude meeting Clean Water Act goals. See definitions of Modified Warmwater Habitat and Limited Resource Waters in OAC 3745-1-07. However, Ohio EPA believes that federal regulations would prohibit the adoption of a primary water conveyance scheme as the commenter outlines. Title 40 of the Code of Federal Regulations Section 131.10 (a) requires the States to adopt water quality standards that are protective of fish, shellfish and wildlife, and specifically prohibits the adoption of water quality standards for 'waste transport or waste assimilation" as suggested by the commenter. The full text of 40 CFR 131.10(a) states:

> Each State must specify appropriate water uses to be achieved and protected. The classification of the waters of the State must take into consideration the use and value of water for public water supplies, protection and propagation of fish, shellfish, and wildlife, recreation in and on the water, agricultural, industrial, and other purposes, including navigation. <u>In no case shall a State adopt waste transport or waste assimilation as a designated use for any waters of the United States.</u> (emphasis added).

LDR

Page 1-5, Section 1.4 – Who determines what the "designated uses" of a stream should be? Is there any input from landowners? If one or two unusual species are found in a specific area, does this automatically mean the area is given the EWH designation? How do you know that the area shouldn't actually be designated WWH because the unusual species happened to migrate from an EWH designated area in another part of the stream?

Response: The task of designating the "beneficial uses" for streams in the State's water quality standards is an administrative rule making activity done by the Director of Ohio EPA. The Agency relies on a standardized process of data collection and interpretation of biological results to assign appropriate aquatic life uses. Other uses assigned include a water supply use (public, industrial, or agricultural) and a recreation use.

Input from landowners is typically not directly solicited in advance of preparing recommendations for the appropriate uses. The administrative rule making process does, however, provide for two separate opportunities for the public to comment on both the draft and proposed set of uses.

One or two unusual species recorded in low numbers at a location does not automatically trigger the assignment of the Exceptional Warmwater Habitat use. A stream segment needs to have not only the right species, the right number of species, but also the right number of individuals of the right species. This conclusion is based upon an analysis of carefully selected stream reference sites that allows Ohio EPA to predict the fish and aquatic insect communities that are likely to inhabit both WWH streams and EWH stream of a given region of Ohio.

LDR
Page 1-6, Section 1.4.1 – You indicate that "The Big Darby Creek watershed includes extensive stretches of stream that have the EWH aquatic life use designation." Is it the intent of the Ohio EPA to make the entire watershed EWH? This has to be "wishful thinking" on your part, because it is not physically possible to take a watershed of this size and bring the entire length up to the EWH designation. How do you know what condition the watershed would be in today if there had been no human intervention? After all, you are dealing with nature. It is possible that the watershed would be in far worse condition than it presently is.

I understand you are recommending that drainage ditches be designated as warm water habitats. Many of these were manmade and are used by farmers. Although they are part of the watershed, it is ludicrous to attach an aquatic life use designation to a ditch.

Response: No, the Agency does not have plans to make the entire Big Darby Creek watershed an Exceptional Warmwater Habitat. We have monitored the stream conditions to determine what existing biological communities are present there today. We let the results of these standardized survey results tell us what the appropriate aquatic life use designation should be. Most of the larger streams and some of the smaller waterways in the Big Darby Creek watershed currently possess exceptional and coldwater communities as se have defined those categories of aquatic life in the State's water quality standards.

In the process of setting State water quality standards Ohio EPA does **not** attempt to discern what water quality or biological conditions would be absent all human intervention. An analysis of carefully selected stream reference sites has been conducted that allows Ohio EPA to predict the fish and aquatic insect communities that are likely to inhabit the streams of a given watershed. While this approach sets a goal for water quality and biological condition that may require point and nonpoint source pollution abatement, we nevertheless know that the goal is within reach because it reflects conditions that exist in similar Ohio watersheds with lesser degrees of human disturbances.

Draft water quality standard rules released in 2005 did contemplate assigning the Warmwater Habitat aquatic life use designation to a number of waterways that are actively maintained for agricultural drainage. A series of conversations and tours with Madison County officials and landowners was helpful in understanding the situation within the watershed. The Division of Surface Water has made adjustments in the water quality standard rule package as a result of these discussions. We anticipate that the Director will propose rules that retain the Warmwater Habitat designation only in situations where that level of biological condition was documented to exist. Ditches or other waterways where there were no biological samples collected, or where results indicated Warmwater habitat was not achievable, have been removed from the proposed rule.

COLS
Paragraph 3.2.5, Page 3-11. In the "Protecting the Downstream Use" section OEPA indicates that "… there are times when the applicable criteria in a water body may need to be more restrictive than those associated with its designated use, in order to protect the designated use of the downstream segment or stream." While in principle this makes sense, practical implementation is another matter. In effect, what this allows is a continuously moving target. The regulated community needs and must have a set of standards that are clear. More specificity should be provided. For example in cases where a WWH reach or stream drains into an EWH reach or stream, OEPA could reserve the right to apply EWH criteria for a fixed specified distance upstream into the WWH area. If managed in this way, OEPA should identify those reaches or streams and the specified distance as part of the TMDL. In this context, at least the regulated community would be forewarned and can plan and implement appropriate actions.

Response: The comment is noted.

B.5 208 Plan

TNC
Use of the TMDL recommendations in the 208 plans - The final TMDL should further explain how the 208 plan will protect and enhance the biological integrity of Big Darby Creek and tributaries. Section 208 plan requirements should support and supplement the TMDL. How will they do this? What is the status of Ohio EPA's analysis of the ESDA EAG recommendations, which are necessary to help meet the TMDL goals?

Response: The TMDL is a part of the 208 plan, rather than the reverse. Ohio EPA's analysis of the ESDA EAG recommendations has been completed and incorporated into the draft 208 plan and draft NPDES storm water permit for construction activities in the Big Darby Creek watershed.

TNC
Section 5.2.3 Development – Because of growing need to address storm water impacts and habitat loss, The Nature Conservancy supports application of 208 requirements throughout the watershed, at the same level as for the ESDA, and at least as protective as recommended by the ESDA EAG in its November 2004 report.

Response: The comment is noted.

OEC
Several other areas of significance should be covered within subjects presented in the TMDL report. Without over dramatizing the degradation of the Darby system, time is of

the essence for Darby preservation. The loss of species and the indication of pollution are likely not fully expressive of the decline already in place. There should be timelines included in the final report that can set the stage for additional steps that will be required if voluntary measures undertaken do not stem the trend toward decline. If development is akin to adding air to a balloon at some point too much air can be added resulting in a collapse of the balloon. The TMDL report should identify a timetable mechanism by which “air” can be released to prevent a collapse.

Response: Ohio EPA has adopted the approach of inserting the requirements that are believed to be protective into control documents such as the NPDES General Permit for Storm Water Associated with Construction Activity for the Big Darby Creek watershed, and in the updated 208 plan. The storm water permit is subject to review and reissuance once it expires.

B.6 Authority

BC

Apply EPA’s expertise to strengthen the TMDL recommendations to achieve the most thorough and rigorous set of recommendations possible, based on the latest scientific data and analysis, in order to preserve and restore Darby Creek and protect its endangered species.

From my review of the TMDL, and from the content of the TMDL-related presentations and discussions, it is clear that the scope and rigor of the draft TMDL recommendations have been curtailed in order to make them conform to the boundaries of the EPA’s legal authority.

However, as the EPA has pointed out, there is an immediate and critical need for the most protective measures possible to be implemented in order to save the Darby. If inadequate measures are taken, irrevocable damage may be done, resulting in further degradation of Darby habitats and further declines and even loss of populations of endangered species.

The Ohio EPA has invaluable knowledge and expertise regarding what is needed to protect Darby. Where the EPA is aware of a threat and has the knowledge of a control or remedy needed for protection, it is critical that the EPA document its findings and recommendations, *regardless of legal authority,* so that this information will be available to other parties that are in a position to take the needed actions.

I understand the need to clearly define the scope of the document’s recommendations, but where necessary the distinction can be made between measures that EPA *will legally require* versus what it *recommends* be undertaken. The EPA can also qualify its recommendations in cases where the science is uncertain or there are unknowns. However, the EPA needs to err on the side of protection when there is doubt (which is also in keeping with the adaptive management principles set forth by the EPA for the TMDL process).

The EPA should also consult with ODNR, TNC, OSU, Darby Creek Association, and other agencies and groups involved to make this effort as collaborative as possible and to fully utilize the extensive available knowledge and expertise as regards Darby protection.

Given the above concerns, the following are examples of areas where the EPA should expand and strengthen the TMDL recommendations:

- Full protection of flood plains
- Enhanced riparian buffer requirements
- Defining and quantifying limits to impervious surfaces
- Improved storm water management, pollutant removal, and groundwater recharge methods
- Conservation development standards
- Other new, progressive, and/or innovative techniques and controls that would enhance protection

Response: Ohio EPA has presented the findings in the TMDL based on the best practical science available to us at this time. In the implementation recommendations, those actions that are Ohio EPA's responsibility will be acted upon within the scope of Ohio EPA's legal authority. The TMDL contains many items that are outside Ohio EPA's authority, and rely on voluntary implementation to achieve those items. Stream setbacks are an area such as this. Ohio EPA will implement the setbacks in the General Permit for Storm Water Related to Construction Activity for the Big Darby Creek Watershed where that permit is applicable. For agricultural and non-regulated activities implementation will be the responsibility of individual land owners or local governmental jurisdictions.

OFB

The fourth implementation mechanism for promoting improved drainage through environmentally sound means presented in the first paragraph on page 5-7 is a concern for the Ohio Farm Bureau. It is proposed that all petition ditch maintenance work and privately maintained drainage projects be required to install BMPs that improve ecological conditions downstream from the ditch maintenance area (specifically at the ditch outlet). Mandating these types of conditions on ditch maintenance projects goes will beyond the intent of the drainage project (removing excess water) and is outside the authority of Ohio EPA to regulate when a Clean Water Act Section 401 Water Quality Certification is not required.

Response: The paragraph referred to is a discussion of the Darby Creek Community Based Watershed Plan, not a regulatory document. Ohio remains concerned about the downstream effects of sediment and other materials from ditch maintenance projects. The extent to which these matters will be regulated under Section 404 of the Clean Water Act will continue to fall under the jurisdiction of the U.S. Army Corps of Engineers. Ohio EPA will remain engaged in that process to ensure protection of aquatic life uses to the extent the law allows.

COLS
Ohio EPA Only Has Authority To Establish TMDLs for Pollutants.

The City of Columbus is fully supportive of the goal of achieving all applicable water quality standards in the Big Darby, including aquatic use standards. However, the TMDL process is a limited tool; it is limited, by law and common sense, to pollutants for which Ohio EPA can develop a load or waste load allocation. There are several TMDLs listed in the draft Big Darby TMDL which are not pollutants, including habitat, bedload, floodplain width and flow. As Ohio EPA lacks the legal authority to issue TMDLs for these parameters, they must be deleted from this report.

Ohio EPA's legal authority to issue a TMDL is found in the Clean Water Act Section 303(d), which provides that a state shall prepare a TMDL for impaired waters for the "pollutants" identified by the Administrator. "Pollutant" is defined in the Act by example; except for heat, all of the examples involve physical materials, which are discharged into waters:

> The term "pollutant" means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water.

33 USC 1362(6).

USEPA's regulations also limit TMDLs to pollutants. 40 CFR 130.2 defines a TMDL as the sum of the load allocations and waste load allocations for a stream. Waste load allocation is defined in terms of a source of pollution, and a load allocation is defined as the combination of non-point source pollution and the naturally occurring loading. Moreover, courts often refer to TMDLs as a control on pollutants. See e.g., Dioxin/Organochlorine Center v. Clarke, 57 F.3d 1517, 1520 (9th Cir. 1995) ("A TMDL defines the specified amount of a pollutant which can be discharged or 'loaded' into the waters at issue from all combined sources.")

Finally, USEPA's guidance explicitly states that TMDL's should be limited to pollutants. In "Guidance for 2004 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d) and 305(b) of the Clean Water Act" USEPA provides a category (4(C)) for streams that are impaired, but not because of a source of pollution. The guidance states that these streams should not have a TMDL. Moreover, the Agency specifically addresses flow, and states that it is not a pollutant. ("EPA does not believe that flow, or lack of flow, is a pollutant as defined by CWA Section 502(6).")

The clear legal limitation on TMDLs is also supported by common sense. The Ohio EPA does not have any legal authority to control land use decisions, which it would need to have to enforce a TMDL on a parameter such as habitat or flood plain width. Ohio EPA seems to acknowledge as much in the chapter on implementation, which states that one of the means of implementing these TMDLs is through local zoning. Ohio EPA cannot and should not dictate local land planning decisions.

The City of Columbus is fully supportive of the goal Ohio EPA is seeking to achieve. However, the goal will only be met through comprehensive, cooperative, multi-jurisdictional land planning. Such planning is taking place currently in the Big Darby Accord. Imposing a TMDL on the area that may conflict with those local decisions is neither wise nor legally justified.

Response: A TMDL is a means for recommending controls needed to meet water quality standards (Guidance for Water-Quality-based Decisions: The TMDL Process, US EPA, 1991, EPA440-4-91-001). 40 CFR 130.2(i) states that a TMDL calculation is the sum of the individual wasteload allocations for point sources and the load allocations for nonpoint sources and natural background in a given watershed, and that TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure. Aquatic organisms are affected by a combination of variables that are not limited to load based pollutants. Therefore, the attainment of WQS in Ohio requires that both pollutant loads and environmental conditions (pollution, or non-load based parameters such as habitat) be addressed when identified as impairing causes.

Supporting excerpts from the above referenced document include:

"The purpose of this guidance document is to explain the programmatic elements and requirements of the TMDL process as established by section 303(d) of the Clean Water Act and by EPA's Water Quality Planning and Management Regulations (40 CFR Part 130). A TMDL, or ***total maximum daily load***, is a tool for implementing State water quality standards and is based on the relationship between pollution sources and in-stream water quality conditions. The TMDL establishes the allowable loadings or other quantifiable parameters for a waterbody and thereby provides the basis for States to establish water quality-based controls. These controls should provide the pollution reduction necessary for a waterbody to meet water quality standards….

Historically, the water quality-based pollution control program has focused on reducing the load of chemical contaminants (e.g. nutrients, biochemical oxygen demand, metals) to waterbodies. EPA has defined the terms load, loading capacity, and load allocation in regulations and technical guidance documents so that wasteload allocations can be calculated. Chemical contaminant problems will continue to constitute a major portion of pollution control efforts and the terms "load" and "load reduction" are used throughout this document. However, it is becoming increasingly apparent that in some situations water quality standards -- particularly designated uses and biocriteria -- can only be attained if non-chemical factors such as hydrology, channel morphology, and habitat are also addressed. EPA recognizes that it is appropriate to use the TMDL process to establish control measures for quantifiable non-chemical parameters that are preventing the attainment of water quality standards. Control measures, in this case, would be developed and implemented to meet a TMDL that addresses these parameters in a manner similar to chemical loads. As methods are developed to address these problems, EPA and the States will incorporate them into the TMDL process."

The USEPA document *Guidance for 2006 Assessment, Listing, and Reporting Requirements Pursuant to Sections 303(d), 305(b), and 314 of the Clean Water Act* states the five part segmentation scheme developed by USEPA is a recommendation only and not a requirement; therefore, the use of a Category 4c is also solely a recommendation and not an interpretation of legal authority. Further, the document states:

"Segments should be placed in Category 4c when the state demonstrates that the failure to meet an applicable water quality standard is not caused by a pollutant, but instead is caused by other types of pollution. Segments placed in Category 4c do not require the development of a TMDL. Pollution, as defined by the CWA is "the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water" (section 502(19)). In some cases, the pollution is caused by the presence of a pollutant and a TMDL is required. In other cases, pollution does not result from a pollutant and a TMDL is not required. States should schedule these segments for monitoring to confirm that there continues to be no pollutant associated with the failure to meet the water quality standard and to support water quality management actions necessary to address the cause(s) of the impairment. Examples of circumstances where an impaired segment may be placed in Category 4c include segments impaired solely due to lack of adequate flow or to stream channelization."

Note, the USEPA states that such Category 4c segments do not require a TMDL, but does not prohibit such a development. Further, the example USEPA uses in the above paragraph concerning flow states that such segments may be placed in Category 4c, not that they shall be. This is not an explicit statement that TMDLs should be limited to pollutants nor does it state that TMDLs should not be done for Category 4c segments as the commenter states.

TMDL projects are not limited to only addressing or examining causes and sources that the Ohio EPA has legal authority to regulate. The TMDL program was developed to address situations where the NPDES program was insufficient to meet water quality standards; in Ohio this translates into areas where Ohio EPA does not necessarily have authority. The TMDL program does not grant such an authority, but instead provides a structured method to examine water quality problems and provide recommendations to address these issues regardless of our authority. Local governments may choose to create local ordinances in accordance with TMDL recommendations just as local land owners and other stakeholders may voluntarily choose to incorporate such recommendations into their personal choices. The TMDL gives a prescription for water quality attainment so that appropriate jurisdictions and stakeholders can make better informed decisions on issues that affect water quality.

COLS
Ohio EPA Has No Legal Authority To Determine the Appropriate Floodplain.

Ohio EPA has no authority to define or regulate the floodplain, as the General Assembly has given that authority to ODNR. R.C. 1521.03 places the authority over floodplains with ODNR's Chief of the Division of Water, while R.C. 1521.13 requires the Chief to coordinate all floodplain management activities. Moreover, even ODNR has limited ability to control floodplain activities, as local jurisdictions, with oversight from ODNR and FEMA, issue floodplain fill permits.

Ohio EPA has no statutory authority to define or regulate floodplains. This TMDL must therefore be removed.

Response: Ohio EPA is authorized under Chapter 6111 of the Revised Code to assess flood plain issues for the purposes of making determinations of how flood plain issues affect water quality.

COLS
As discussed below, the City is fully supportive of Ohio EPA's goal of achieving all water quality standards in the Big Darby watershed. The City is also fully supportive of land use decisions that protect this valuable resource. However, we do not believe that Ohio EPA can or should dictate land use planning; such decisions must be made by local governments. Cooperative, multi-jurisdictional efforts, such as the ESDA EAG and the Darby Accord, will be far more effective in protecting the habitat of the Darby than the establishment of TMDLs that Ohio EPA has no to authority to establish or enforce.

Response: Ohio EPA agrees that cooperative, multi-jurisdictional efforts such as the ESDA EAG and the Darby Accord are important for long term protection of water quality in Big Darby Creek. Ohio EPA has not dictated land use planning. Ohio EPA has defined the water-land interface in terms of the long term hydrologic cycle, which takes into account periods of high flow as well as periods of low flow. This definition paves the way for land use decision making that recognizes inundation as a normal occurrence in this area.

B.7 Impervious Surfaces

1000F
Specifically, we strongly support strategies to restrict the amount of impervious land cover, which would promote infiltration of water into the soil and groundwater, and adequate filtering of water pollutants, by requiring careful planning for the amount and location of development

Response: Rather than try to restrict the amount of impervious cover, Ohio EPA has adopted the approach of ensuring that adequate infiltration occurs through the use of requirements in the NPDES General Permit for Storm Water Related to Construction Activity for the Big Darby Creek Watershed.

TNC
While I expect we will submit full comments on the draft Big Darby Creek TMDL next week, I am providing the attached document, "The Etowah Habitat Conservation Plan Runoff Limits Program," prepared as a July 2005 draft by the University of Georgia and U.S.G.S. for your considerations comments on the draft [sic]. Note that instead of relaying [sic] on pollutant load estimates to determine capacity of the streams or watersheds, it bases the capacity for development on the impervious surface limits determined for sensitive aquatic species. This approach might more appropriately take into account the individually unknown effects of a wide variety of pollutant, habitat and hydrologic stresses. Ohio EPA uses biological indices as a better way to measure stream health, with that health being based on the responses of sensitive species. The

Agency is very aware that such measures are more appropriate than pollutant concentrations. Because of the need to protect rare, declining and sensitive species in the Big Darby watershed (e.g., spotted darter, bluebreast darter, northern riffleshell and other mussel species), please consider using such a biologically based approach, as in the attached document.

Response: The comment is noted, and it will be considered if resources are available for such future work on the Darby watershed.

OEC

Likewise while not typically the subject of TMDL reports the importance of the impact of impervious surfaces cannot be overstated. The report should attempt to identify this significant indirect measure of watershed health. Studies in other watersheds across the Midwest should be referenced to demonstrate the destruction that can occur to the hydrologic regime and concomitant irreparable damage that can occur to water quality from too may impervious surfaces in the watershed. This factor alone can mean the difference between success or system failure. Best management practices that are at the leading edge of controlling storm water should be referenced for use in the Darby watershed such as green roofs, porous pavement, bioswales, wetland treatment, rain barrels, cisterns and other techniques to mitigate the destructive and erosive forces of increasing storm water flow.

Response: The commenter is correct in indicating that impervious surface is an indirect measure of impacts on the hydrologic regime. Ohio EPA has chosen to set targets in the TMDL that are more closely linked to the hydrologic regime, namely infiltration, and storm water to base flow ratios. Ohio EPA believes these to be more protective than an indirect measure in this particular instance.

B.8 Nationwide Permits

BIA

We understand that the Ohio EPA is considering withdrawing its Section 401 Certification of Nationwide Permits in the Darby Creek watershed. Obviously, we believe that the Nationwide Permitting program is a valuable mechanism for obtaining timely reviews for minor impacts which do not have a cumulative adverse effect on water quality. To the extent that the Ohio EPA does withdraw the Nationwide Permit Certification, we would strongly encourage the agency to assure that it is capable of timely review and decisions on individual permit applications.

Response: Given the findings of the TMDL study of excessive sedimentation, the need for significant sediment loading reductions, the potential impacts to endangered species, coupled with the declines observed in endangered species, it is unlikely that any projects in this watershed could meet condition 11 of the Nationwide Permits. By withdrawing certification of these permits for the Big Darby Creek watershed, Ohio EPA clarifies the status of these permits for potential permittees. The comment regarding the need for and importance of timely review of individual permits is noted.

OFB

It is encouraging that Ohio EPA recognizes the challenges associated with managing ditches and other surface waterways in the Big Darby Creek Basin for agricultural drainage while considering ecological needs (Chapter 5, Section 5.1.4, Page 5-3). The removal of the blanket 401 certifications for small scale dredge and fill projects regulated under nationwide permits issued by the United States Army Corp of Engineers (especially NWP 03 – Maintenance, NWP -13 – Bank stabilization, NWP 40 – Agricultural Activities and NWP 41 – Reshaping Existing Drainage Ditches) in the Big Darby Creek watershed is a concern for the Ohio Farm Bureau and our members. Removing the blanket certifications removes the certainty of expectations placed on the permit applicant and adds additional time to the project review and approval process. Both are unacceptable.

Ohio EPA used a formal public review and comment process to establish conditions and/or restrictions for all of the Nationwide Permits applicable in Ohio. Establishing permit conditions ahead of time lets the applicant know up front what is expected from them. This level of certainty will be lost when the Nationwide Permits are replaced with individual permits where conditions and/or restrictions vary from project to project. Developing a specific set of Nationwide Permit conditions for the Big Darby Creek watershed (similar to what is being proposed for the General Permit for Construction Storm Water in Section 5.1.1 on page 5-1) would be preferred over the elimination of the use of Nationwide Permits in this basin.

Response: Given the need for protecting endangered species and high quality aquatic communities in this watershed, Ohio EPA believes that where applicable under current law, these projects should be subject to public participation on an individual basis. This allows for balancing social needs for drainage with appropriate protection on a system wide basis. Given the wide variety of aquatic life uses of tributaries in this system, and the demonstrated need to protect downstream uses, Ohio EPA disagrees with a 'one size fits all' approach. Ohio EPA notes the request for Big Darby Creek specific general permits, however, nationwide permits are issued by the federal government. Ohio EPA certifies that they comply with water quality standards. Since there are significant sediment loading reductions needed in this watershed, Ohio EPA will not certify these permits as meeting water quality standards.

B.9 Home Sewage Treatment Systems (HSTS (bacteria))

1000F
Specifically, we strongly support strategies to significantly strengthen storm water and sewage permit regulations by ensuring adequate treatment of chemicals, bacteria and solids from permitted discharges, home sewage treatment and disposal systems, and livestock so that water quality is improved.

Response: The comment is noted.

1000F
We also strongly encourage the collaboration of the Ohio Environmental Protection Agency and the Ohio Department of Health to ensure similar strategies are incorporated

into regulation of home sewage treatment. The opportunity seems particularly timely considering recently passed legislation enabling the Ohio Department of Health to develop new home sewage treatment system regulations.

Response: The comment is noted.

BIA
One of the most significant impacts to Darby Creek water quality is elevated fecal coliform from, in part, failed septic systems and package plants. Establishing development standards which will allow for economically feasible development in the watershed will allow for the extension of existing public sewer systems and the potential establishment of additional centralized sanitary sewer collection and treatment systems to eliminate these discharges. Absent reasonable development standards, the existing discharges are likely to continue and homes will continue to be constructed in the Darby Creek watershed. For lack of an alternative, these homes will rely on septic systems and present the risk of additional discharges in the future.

Response: The comment is noted.

TNC
Home Sewage Treatment Systems (HSTS) – Section 5.2.6 recognizes the HSTS problem in the watershed. While this section recognizes the important role of local health departments and the need for pollutant reductions, it does not identify a specific program for achieving these reductions. A program dedicated to adequately reducing these problems needs to be established and progress measured.

Response: Ohio EPA will work with local health departments to develop a strategy to reduce bacteria loading from HSTS upon approval of the TMDL by USEPA.

TNC
Individual home siting - The TMDL needs to make recommendations and establish requirements for adequate, environmentally protective siting of new individual homes, i.e., those not on central sewers. The impacts of individual homes and those in small subdivisions can be very damaging, such as limiting groundwater recharge, removing riparian vegetation, causing damaging erosion and channel scouring, and directly delivering pollutants. The TMDL needs to encourage local governments to establish protective policies. These are not in place in most of the watershed. Many of these sitings result in complete removal or riparian vegetation, or in obvious delivery of storm water and pollutants to tributaries.

Response: The TMDL is establishing the infiltration and storm water requirements that will be necessary to avoid impacts from new housing. These targets will be implemented in the NPDES General Permit for Storm Water Related to Construction Activity for the Big Darby Creek Watershed. Since all earth disturbing activities greater than one acre fall under this permit, it is Ohio EPA's best mechanism for implementing these requirements. In addition, the 2005 208 plan revision will include recommendations for local governments to consider adopting protections equivalent to the ESDA-EAG recommendations.

FWS
The TMDL would significantly reduce phosphorus loadings from direct septic discharges. However, there are currently few proposed reductions from wastewater treatment plants. It was unclear whether reductions in direct septic discharges would result from fixing the individual systems or expanding sewer lines to these malfunctioning systems.

It appears that the reduction in direct septic discharges would become the responsibility of local departments of health. Funding of this mandate may be problematic and could hinder the achievement of the proposed loading reductions.

Response: The commenter's observation that there would be few proposed reductions in phosphorus loadings from wastewater treatment plants is incorrect. Except where specifically justified by the information available, all wastewater treatment plants in the Big Darby Creek watershed will be required to institute controls on Total Phosphorus in their effluent.

While reduction in loadings from HSTS will be a challenge, Ohio EPA will work with the local health departments to devise ways to achieve the necessary loading reductions.

B.10 Agricultural Influences

1000F
Specifically, we strongly support strategies to significantly strengthen storm water and sewage permit regulations by ensuring adequate treatment of chemicals, bacteria and solids from permitted discharges, home sewage treatment and disposal systems, and livestock so that water quality is improved

Response: The comment is noted.

BIA
The Darby Creek TMDL substantiates both that agricultural land uses far and away predominate in the Darby Creek watershed and that agricultural land uses have the most significant adverse impact on the watershed. The TMDL confirms that, except in the westernmost portion of the watershed, there is little significant residential or commercial development. Accordingly, to the extent to which there are pollutant sources or habitat modification adversely affecting the Darby Creek, they relate primarily to agricultural activities. This is particularly true with respect to elevated levels of total suspended solids ("TSS") and phosphorus and the hydrogeomorphic modification of the Darby and its tributaries. In most areas, historical manipulation of stream channels, limited riparian buffers and TSS are directly related to agricultural land use. Livestock also contribute significantly to elevated fecal coliform levels in certain areas of the watershed.

As the TMDL makes abundantly clear, the Ohio EPA and other regulatory entities have limited authority to effectuate the necessary changes in agricultural land use practices to address water quality. The BIA's members are very concerned that the land development and residential building sector will be unfairly burdened with expensive, inflexible and perhaps unrealistic requirements which are imposed on these entities solely to address historical and current problems caused by agricultural uses. We understand that the Ohio EPA intends encourage the use of a number of voluntary initiatives that are available (some have been available for quite some time) to educate and assist farmers in the watershed to restore riparian buffers, protect and restore wetland areas and the like; however, these programs have not proven to be a workable near term solution for agricultural impacts.

As discussed in greater detail below, we are confident that “smart growth” can occur in the watershed in a manner that protects water quality. In contrast to many prior studies of the impact of often poorly planned urban growth on water quality, the proactive implementation of aggressive storm water controls, adequate protection and enhancement of riparian corridors and environmentally sensitive development design can protect and enhance the Darby Creek watershed without undue burdens on residential development.

Response: The comment is noted.

DG
I have some suggestions to promote short term and long term improvements for Hellbranch Run and Darby Creek:

AG storage systems tile dams and buffers with more tree planting FCSWCD and OSU Extension Office under Phd. Brown.

Response: The comment is noted.

TNC
Recognition of agricultural contributions - e.g., Page 4-15 – Big Darby Creek Headwaters - The total phosphorus contribution of row crops is significant in this area, as one example, and constitutes most of the phosphorus. While there is considerable development in this area that is adding to stresses on these streams, the document also should emphasize the problems caused by agriculture in this area. It is clear from casual observation that runoff from cropland is obvious during and after storm events, and riparian encroachment by agriculture is causing streambank failure and contributing nutrients and sediment.

In Box 2.2.1, page 2-12 - Agricultural row crops are not listed as a source of impairment in the upper Big Darby Creek sub-watershed. Because they constitute half of the land use, and are contributing sediments and nutrients based on casual observation, this stress should be identified. While past road construction is rightly identified as a source of impairment, continuous resupply of sediments from row cop agriculture is much more evident in the area.

Also, streambank erosion is clearly contributing sediment, and is especially observable where there has been channelization, where there are levees, where crops encroach upon the streambank, and where streambanks lack adequate vegetation. This source of siltation also is evident in many other areas of the watershed.

Response: The comments are noted   Agricultural row crops are not listed in Box 2.2.1 as a source of impairment because they were not identified as a specific source of impairment in that stream segment. This area does contribute to the overall nutrient enrichment of the watershed.

TNC
Measurement of agricultural stream quality protection effort progress – Ohio EPA estimates that Section 5.2.1 briefly describes voluntary programs to address agricultural pollutant loading reductions. Row crop agriculture's major contribution to phosphorus and sediments (60 to 85 reductions needed from nonpoint sources, mostly agriculture), and riparian encroachment are two significant problem sources in the watershed. We suggest a measurement program to develop accountability and help direct adequate attention to progress toward needed goals. This will help focus needs and action, and it could direct attention toward areas that need to be protected, and also to those that need to attain use designations. Measurement can be a powerful tool encouraging action, and helps reduce confusion about what progress is being made.

Response: Ohio EPA has established total phosphorus, sediment, and bacteriological targets against which agricultural pollutant reductions can be measured.

COLS
Row Crops
OEPA studied 20 subwatershed as part of this effort. By far, the prevalent land use in all of these 20 subwatersheds was row crops. The range in percentage of row crop land use, per watershed ranged from 41.6 to 88.2 percent with an average of 62 percent.   Likewise, the range in phosphorous contribution from row crops varied from 44.5 to 90 percent with an average of 80 percent. Considering that the largest contributor to the phosphorous loadings appears to be row cropping and that controlling it is likely to see the largest benefit in terms of phosphorous reduction, it is disconcerting that OEPA plans to rely on voluntary means for agricultural phosphorous reduction.

Response: Ohio EPA plans to rely on voluntary means for agricultural phosphorus reductions due to limitations in Ohio EPA's authority. This does not necessarily mean that relying on voluntary action will be ineffectual, but it does mean that the activities cannot be required.

B.11 Development

DB
We are property owners of an 80 acre farm in the Darby Watershed and we have been attempting to sell it for 6 years. During this period of time we have continuously been confronted with a moratorium by some part of government.
Each and every time we have come close to having a buyer it seems there is another moratorium passed and our buyers walk. No one wants to purchase land under a moratorium. We feel that we have been more than patient with allowing government to come up with some written guidelines and are looking forward to the end of this year.

We just hope that no one extends the moratorium and allows us to move on with our lives.

You see there are six of us who own this farm and we are surrounded on 3 sides by housing developments. It is nearly impossible to farm and the 4-wheelers from those subdivisions seem to think our farm is their playground. We had decided twenty years ago to sell the farm as we began reaching retirement age so that the proceeds would be our nest egg. At the present time our ages range from 55-75 years old with my 75 year old sister still working fulltime. As you can imagine, the NOT being able to sell the farm has caused quite a hardship for all of us.

Please do your best to see that all problems involving the Darby Watershed are resolved no later than the end of 2005 so that we may sell.

Response: The comment is noted.

DG
LID Low Impact Development can do more than constructed storm water systems (consultation with other cities). Reduce impervious surfaces and create a storm water utility for entire watershed.

Response: The comment is noted.

DG
Control for existing development should have planted and natural wetland infiltration and retention to improve appearance, habitat and pollution abatement.

A detail of construction for wetlands should be part of engineering plans (Dr. Mitch OSU Dept of Nat Resources).

Tree planting is a basic for this area and should be a mitigation technique for all development FCSWCD. Native trees and shrubs should be planted in all floodplains and stream banks with the owners consent.

Preservation should be the best and most frequently used method to prevent destruction of the watershed and westward expansion of the City of Columbus. Purchase and transfer of development, scenic/conservation easements, buy lease back... and other methods for compensating owners and reducing the development (Consultation with other cities such as Lexington KY).

Response: The comment is noted.

OEC
Build-out is the inevitable outcome of the release of the moratorium currently in place in the Environmentally Sensitive Development Area. While simultaneous efforts are underway to dampen the negative effects of this next phase in Darby's history (Darby Accord, ESDA EAG, and Darby 208 Plan) the Darby TMDL will stand alone as the

scientific high water mark for Darby protection. Does the report go far enough to give the Darby system an underdog's chance of surviving the next 30 years?

Response: Setbacks, pollutant reduction targets, and infiltration targets are all included in the TMDL. Attainment of many of these targets is based on voluntary action. To the best of our knowledge at this point in time, if all of these targets are attained, the system should meet its designated uses. We have a long way to go to meet some of the targets. It can also be said that we do not know all that we need to know about this watershed at this time. For that reason, Ohio EPA will be conducting certain continuing studies in the watershed to further refine our knowledge base.

LDR

Continued development in western Franklin County is a serious deterrent to a cleaner Darby Creek watershed. Even though there are restrictions and a moratorium on further development, waivers seem to keep being approved when some money is put on the table by rich developers. This in turn puts more pressure on the farmers and not-so-rich landowners along the streams of the watershed to clean up the creeks to make up for the pollution of the developers. It appears if you have money behind you, you can get around the regulations. This has to stop! If the developers continue to have waivers approved, there should be high-priced, ongoing financial compensations paid by those developers for the waivers. This money could be used to improve the health of the Darby watershed.

Response: Ohio EPA has issued a storm water permit specific to the Big Darby Creek watershed that will regulate storm water from development.

B.12 Area of Applicability (i.e., whole watershed or part)

1000F

We especially support the application of the above strategies to jurisdictions beyond Franklin County. This is a critical piece of the efforts to protect the watersheds considering the rapidly developing areas such as those surrounding Marysville, West Jefferson, Plain City, Jerome Township, and Northern Pickaway County.

Response: This issue will be addressed in the 208 plan for this watershed.

BC

Adopt the Franklin County ESDA-EAG recommendations for the Hellbranch Run, and extend these recommendations throughout the watershed thru the TMDL and 208 plans.

I urge the EPA to adopt the ESDA-EAG recommendations, complete the additional work that the EAG recommended be undertaken (including developing enhanced storm water regulations), incorporate these recommendations into the TMDL, and carry them forward for implementation throughout the watershed via the upcoming 208 plans. This would address some of the concerns I expressed in item #1, and in any case these increased protective measures are sorely needed in many areas throughout the watershed

Response: Ohio EPA has issued a draft storm water permit specific to the Big Darby Creek watershed. The 208 plan is addressing the ESDA-EAG issues.

DCA

DCA fully supports these initiatives, and urges the EPA to continue in this direction. It will not be possible to protect Darby without the EPA providing guidance on these pervasive issues. We fully support the general tools the agency is proposing to use in addressing these issues, including reviewing wastewater permits with the new loading limits in mind, adding Darby specific requirements to general storm water permits, and updating all watershed 208 plans with ESDA-like protections.

Response: The comment is noted.

TNC

Section 5.2.3 Development – Because of growing need to address storm water impacts and habitat loss, The Nature Conservancy supports application of 208 requirements throughout the watershed, at the same level as for the ESDA, and at least as protective as recommended by the ESDA EAG in its November 2004 report.

Response: Ohio EPA is addressing the area of applicability for the ESDA-EAG recommendations in the 208 plan.

B.13 Flexibility

BIA

In order to accomplish the goals of the TMDL process to protect and enhance the Darby Creek, we believe it is essential that both the Ohio EPA and the other related regulatory agencies avoid rigid, prescriptive requirements and instead focus on providing reasonable objectives which would allow property owners to consider a number of mechanisms to meet those objectives. Implementation of flexible and practicable standards will encourage entities to consider a variety of approaches to meeting the overall goal. For example, if there is some flexibility in the required width of a riparian buffer, this may result in reduction of the buffer in one area, but the preservation of a much larger area of high quality riparian buffer in another. Similarly, different development sites will require different storm water collection and retention systems. Accordingly, the storm water standards should set realistic objectives without prescribing specific mechanisms for meeting those objectives.

The BIA's members are likely to be most affected by future storm water controls (both during construction and after development), riparian corridor protection and stream and wetland permitting. We understand that the Ohio EPA intends to develop storm water pollution prevention plan ("SWP3") requirements applicable to the entire Darby Creek watershed. While we understand the importance of minimizing any increase in sediment loads to the Darby Creek, we would encourage the Ohio EPA to craft the general permit in a manner that provides clear objectives to the permit applicant while still providing adequate flexibility to address unique site conditions.

Response: Ohio EPA believes that an appropriate amount of flexibility has been built into the 208 plan and the NPDES General Permit for Storm Water Related to Construction Activity for the Big Darby Creek Watershed. Both products will be released for public comment before being finalized.

B.14 Miscellaneous

BC
Do everything possible to engage, inform, educate, and guide local government officials and residents throughout the Darby watershed, so there are better prospects for them to become active partners with the EPA in Darby protection.

The *Darby at the Crossroads* document published in June 2004 by Ohio EPA states:

> *"Public participation is key to effective implementation of TMDL projects.*
>
> *…..The work to save the Darby does not fall to any one organization, agency or governmental entity, but is spread among many responsible parties and citizens.*
>
> *.....The Darby needs everyone to be involved in the solution."*

The EPA can't do it alone, and has stressed the need for public participation. However, as a concerned citizen attending TMDL and other Darby related meetings I have seen only limited participation by the public and local officials in the TMDL process. The EPA needs to increase its efforts to reach out to its potential partners and share EPA knowledge and expertise with the public and local government officials throughout the watershed.

I understand that the upcoming 208 plan, which will incorporate TMDL recommendations, will be the primary mechanism for EPA to define and enforce more protective measures. Beyond that, it would help tremendously if the local jurisdictions received guidance from the EPA on incorporating the needed development standards and practices into their own local ordinances. This would serve to guide architects and engineers toward designing essential controls into development projects from the start, rather than leaving it to the EPA to have to continually override weak local regulations and redirect projects in a reactive mode. It would also enhance the possibility that local officials would act on their increased knowledge and awareness and take initiative to pursue more progressive and innovative approaches that go beyond the criteria and protective measures strictly required by the EPA.

In many cases, local officials already understand the need, and are willing to work to improve regulations to better protect Darby, but they need up-to-date information and guidance, and it needs to be communicated and presented in a form that is appropriate to that audience. This is another area where it would be beneficial for the EPA to collaborate with other agencies and organizations, in developing these materials and providing them to the public and local officials.

Response: Ohio EPA has issued a storm water permit specific to the Big Darby Creek watershed that outlines requirements necessary to accomplish much of what the commenter cites.

DG
City staff and departments MUST be trained and required to do this activity or it WILL NOT BE DONE. Every bureaucracy has its naysayers and there must be education and promotion form the top (Mayor, Public Works, Engineer) for this to happen. City budgets must expand for new staff and equipment based on impact fees.

Homes in the floodplain must be relocated using FEMA grants. This is especially true south of Broad St along Alton Darby Road. Other examples exist throughout the watershed.

There are many issues but I feel these are basic to the watershed preservation plan I created and to improve water quality long term. A policy of tree replacement and streambank restoration combined with floodplain preservation and acquisition are critical.

The EPA must work with cities to achieve results and promote citizen participation.

Response: The comment is noted.

DCA
The concept of adaptive management was brought up in discussions among the EAG. Subsequently, the EPA outlined this model in its much-quoted introduction "Darby at the Crossroads," which appeared in the technical support document entitled *Biological and Water Quality Study of the Big Darby Creek Watershed, 2001/2002.*

The concept of adaptive management describes the entire suite of EPA activities in the Darby watershed, of which the TMDL is just one part. However, we believe that the report would be a more effective document if it devoted some space to placing the TMDL recommendations more explicitly within context of the adaptive management model.

The model is described this way in the TSD:

> *The Ohio EPA's TMDL program is designed to be a repetitive process…the process includes follow-up monitoring, feedback and adjustments to pollution control strategies (permits, best management practices, etc.) over a number of years to ensure success… [Adaptive management] is well suited to situations where we have incomplete knowledge or understanding of the pollution issues and the stream's response to the pollution. The current and*

future impacts of development in the Hellbranch Run watershed on the exceptional biological communities of the Darby ecosystem certainly fit this description (p. 12*).*

And later:

Ohio EPA will apply the output from all this work (TMDL assessment and development results, amended Section 208 Plan, Hellbranch Forum output and comprehensive land use planning, if undertaken) in the adaptive watershed management model. The challenge will be to gradually meter the release of growth pressure through action, assessment, and adjustment of future actions (pp.12-13*).*

Adaptive management should be part of the fabric of all documents discussing Darby protection. Realistically, there are many unknowns in the effort to figure out what is affecting Darby biology. These unknowns are multiplied when we start trying to predict the future of a watershed that is facing innumerable changes in land use. It is absolutely essential that the TMDL, and every other EPA document dealing with Darby, remind stakeholders that this is a long-term, ongoing process of assessment, monitoring, and policy adjustments. We realize that many interests, in particular development interests, would prefer to have a set of hard-and-fast rules that they can live by. But realistically, we do not believe this is possible at this time.

We need the EPA to take the lead in this educational process. More specifically, what can the Darby community expect in the future if: 1) load targets aren’t met, 2) standard biological indicators decline, or 3) species disappear? What if new scientific research improves our understanding of storm water thresholds or impervious surface tipping points? What if impacts from agriculture—which are extensive, but not subject to regulation—do not improve significantly? The implementation plan is made considerably weaker by the lack of stated consequences for failure to meet water quality goals in the Darby stream system. Because of the current critical risk to irretrievable aquatic resources, provision should be made in the TMDL for specific consequences of further declines in water quality. For example: a moratorium on water quality certifications in the Darby until a data basis for further granted certifications can be developed, increased restrictions on NPDES dischargers, or increased setback requirements and other restrictions on new developments.

Response: The TMDL process, as implemented in Ohio is an iterative process by nature. Imbedded in the process is a periodic return to previously sampled areas to collect new data to determine the status of streams. At present, the return interval is every 10-15 years. While this may seem like a long time, it is barely sufficient to implement the changes recommended in this TMDL report, and have the appropriate lag time (3-5 years) for the changes to be reflected in the stream biology. If loading targets are not met, or there are reductions in standard biological indicators, then the process will trip another TMDL effort, as necessary to achieve the restoration of aquatic life uses.

Over the short term, the periodic revisions necessary for NPDES permits, water quality standards and for the 208 plan provide a venue to adjust to new information that may come to light about the Big Darby Creek Watershed. In addition, the TMDL process has brought to light some areas that will require further study (e.g. Flat Branch). Ohio EPA has expressed the intention to continue to study those issues that remain unresolved at the time of TMDL completion.

GD

Pages 4-32 and 4-33 discuss the pollution around the Plain City WWTP discharge. The TMDL indicates that since Plain City is upgrading its WWTP that, if the plant is operated well, that the solids and nutrient loading from the WWTP should decrease.

However, the WWTP Upgrade and Expansion document WPCLF No.:CS392658-01 delivered to Plain City by the Ohio EPA in reference to the WWTP upgrade and expansion says:

Page 11 of 18:
"Because the project will increase flows and pollutant loadings from the existing WWTP, it was public noticed and reviewed in accordance with Ohio's Antidegradation Rule, OAC 3745-1-05. The revised NPDES permit was public noticed by Ohio EPA, and is currently out for public review and comment."

Also:
Page 16 of 18:
"Ohio EPA reviewed the proposed project with respect to OAC 3745-1-05, which requires an anti-degradation review for wastewater projects seeking permits from Ohio EPA to increase their discharge of pollutants to waters of the state. As part of this overall process, Ohio EPA issued public notice of the receipt of applications for a NPDES permit renewal and a PTI. ... The comments acknowledged the need for the project, but questioned the potential for adverse impacts from storm water generated by residential development that is expected to occur once the WWTP upgrade/expansion project is completed."

There are a number of issues with these statements. First, they do not agree at all with statements made in the TMDL about a reduction in pollutants. Second, the other major source of discharge very near the Plain City WWTP is a small storm water pipe from nearby housing developments. This concentrations of this effluent is twice background according to the TMDL. It seems that the expansion of the WWTP would increase this discharge as well.

Thus, it is unlikely, if not downright absurd, to predict that by upgrading and expanding the Plain City WWTP that pollutants will decrease when so doing will increase the pollutants and flow from BOTH major sources of nutrients.

In addition, in reviewing NPDES #4PB00016*FD it was noted that there are few limitations placed on most effluents. The only effluents with discharge limitations are:

- ph - S.U.
- Total Suspended Solids

- Oil and Grease, Hexane Extr Method
- Nitrogen, Ammonia (NH3)
- Copper
- Fecal Coliform
- Mercury
- CBOD

Also, I have been unable to find any record of ANY public notice in the archive of the Ohio Newspaper Association regarding any public notices in relation to the Plain City WWTP.

Finally, the area where excavation is to be performed in order to upgrade the WWTP was used as a landfill for decades. Thus, in upgrading the Plain City WWTP, there is no telling what may leak into the Big Darby from disturbing the landfill. In correspondence, the Ohio EPA indicates that it not aware that the area was a landfill. It was.

Response: The TMDL centers on reductions in solids and nutrient loadings, whereas the permit is focused on all pollutants necessary to be regulated. Storm water runoff loading from the pipe downstream will not necessarily increase due to the expansion of the WWTP. Existing loading from the pipe will be investigated further in 2006. Future storm water loadings will be regulated through the construction storm water general permit for the Big Darby Creek watershed.

Honda
Honda is extremely concerned about the Report's allegations regarding the impact of "industrial activity" on the Big Darby. Honda is concerned that a portion, perhaps even a large portion, of the negative impacts in FBC reported by Ohio EPA are not caused by Honda's activities, but are attributable to the characteristics of the local soil, stream sediment, pre-Honda stream channel morphology, and/or sediment being carried onto Honda property by FBC tributary streams and ditches. Based on our experience, the soils in this area tend to be very "clayey" and are therefore subject to <u>very</u> slow settling times. We believe that the FBC "discoloration" that is frequently noted in the Report may not be a result of industrial activity taking place on Honda property, but may well be a result of the natural characteristics of the local soils and sediments.

Response: The comment is noted.

Honda
The Report makes references to industrial point sources as the cause of impairment for various parameters, *e.g.*, metals, low D.O. (See pages 2-15 and 2-16.) As noted above, the only two industrial point sources that Honda operates in the FBC watershed are two permitted lime sedimentation basins that receive water from Honda's water softening plants. If metals **are** being generated from the water softening process, as Ohio EPA asserts, the source of the metals would be from the groundwater, not from the water softening process.

Honda is not required to analyze the lime softening discharge water for dissolved oxygen, thus no data is available to disprove or prove that this discharge is a source of impairment for D.O. Honda requests that Ohio EPA provide the analytical data to support the claim that the permitted water softening process discharge points are a cause of impaired D.O.

Response: The existence of elevated metals and low D.O. are well documented in Flat Branch and upper Big Darby Creek. We acknowledge that the sources of metals and low D.O. are not clearly established and are still under investigation. In order to meet the requirements for listing the resulting impairment under Section 303(d) of the Clean Water Act, Ohio EPA chose to use the 'Industrial Point Sources' category from the narrow list of possibilities to reflect an unusual water quality condition. That choice reflected an exercise of 'best judgment' using the data that was available at the time.

Honda
Numerous vague and negative references to Honda can be found in the Report. Some of these references suggest, without any basis, that water quality impairment observed by Ohio EPA is caused by Honda. For example, page 2-27 states:

> "In the headwaters of Buck Run, an unnamed tributary drains storm water from the Honda site".

This fact is certainly true, but Box 2.2.5 of the Report does not in any way identify Honda's storm water as a cause of impairment in Buck Run, and one wonders about the value of or need for the statement. Honda requests that the factual statement be eliminated or clarified to prevent any misunderstanding.

Another example can be found on page 5-2, which states:

> In the upper Big Darby Creek major sub-watershed <u>there is an **impact**</u> <u>that **may be** associated with Honda's manufacturing activities that has not yet been clearly defined</u>, but is not as a result of violation of any existing permit conditions". (Emphasis added.)

Such a statement is, on its face, sheer speculation which unfairly and without any evidence targets Honda as a cause of some unspecified "impact". As noted above, and as acknowledged by Ohio EPA in the Report itself, Honda has been working collaboratively with Ohio EPA on FBC water quality issues and Honda feels that unsupported conclusions or theories, let alone sheer speculation, should not be part of the Report.

For another example, Section 4.1.8 on p. 4-27 of the Report notes similarities in the water quality of FBC and Buck Run. This section also includes two unsupported statements which clearly target Honda:

> Similarities exist between water quality of Flat Branch, and of Buck Run, <u>both of which receive discharges from Honda</u> … O<u>ther than the fact that they both receive discharges from Honda</u>, no immediately apparent cause for this trend has been revealed.

The unmistakable inference of this passage is that Honda's activities and discharges, through some as-yet-unidentified mechanism, are causing these deleterious water impacts. Again, while we readily acknowledge that we do discharge to both of these streams, the discharges are different in terms of their sources and their characteristics, and neither Honda nor Ohio EPA can identify the sources or causes of the water quality impacts noted. While it is true that both the FBC and Buck Run receive water discharges from Honda, it may also be true that these stream systems have similar pedological, geomorphological, and/or hydrological characteristics that contribute to similar water quality conditions. We simply request that Honda not be targeted, either expressly or by implication, until the cause of a water quality problem has been investigated, evaluated, and demonstrated on the basis of objective technical information.

Response: The comment is noted.

Honda
The TMDL report accuses Honda of altering the hydrologic and hydraulic conditions of the Flat Branch stream. For example, at p. 4-4, the Report states:

> The hydrologic and hydraulic of the Flat Branch sub-watershed <u>as the watershed has been industrialized by Honda</u> have resulted in increased peak flows to the Big Darby Creek mainstem.

First, we note that throughout the development and construction of the existing Honda facilities, all applicable construction and water pollution control permits were applied for and obtained only after Ohio EPA approval. For example, Honda currently maintains several storm water retention ponds and these ponds were constructed per specifications that were reviewed and approved by Ohio EPA. Second, the TMDL report states that increased flows are a direct result from Honda. Honda requests that flow data which objectively supports the cited statement be incorporated into the report. Finally, while Honda recognizes that the "channelized" nature of the FBC is of particular concern to Oho EPA, it must be understood that the FBC was already a largely channelized ditch when Honda first purchased property in the watershed in the late 1970s.

Response: Ohio EPA's statement is meant to reflect observed conditions and is not meant to imply illegality or a failure to obtain necessary permits on behalf of Honda. For example, the paving of hundreds of acres of land as part of Honda's facility, though legal, would affect conditions such as recharge capacity and volume of runoff, which would in turn affect peak and low flows in Flat Branch. The industrial and construction storm water permits in effect at the time referenced did not address the issue of additive impacts of multiple storm water inputs to the hydrology of the whole watershed.

Honda
The TMDL report contains several references that are subjective and emotional by nature, e.g.:

> p. 2-16: "Flat Branch is very turbid" (How does Ohio EPA define "very turbid?")

Response: Please see Figure 2.2.2.2. When one water body is transparent, and the other is opaque, the opaque water body is often considered to be turbid.

> p. 2-16: "significantly elevated levels of" and "significantly lower" (How does Ohio EPA define "significantly?")

Response: Statistically significant at a $p < 0.05$ level. In other words, significant at a 95% confidence level. This was the pre-selected level of significance applied to the analysis, however it is important to note that many of the differences observed would have passed a more restrictive level of significance as well (i.e. 99% confidence level).

> p. 4-3: "However, the bedload, habitat, flood plain, and buffer measurements and indices in Flat Branch are very, very low. (How does Ohio EPA define "very, very low?")

Response: Tables 4.1.1 and 4.1.3 of the Big Darby Creek TMDL report show the bedload, habitat, flood plain, and buffer measurements for Flat Branch as well as the target scores for comparison purposes.

> p. 4-4: "as the watershed has been industrialized by Honda…" (What does Ohio EPA mean by "industrialized"?)

Response: The statement refers to the conversion of the natural land to impervious surface within the Honda property.

> p. 4-4: "An effective solution to the above situation would have been…" (Ohio EPA is drawing conclusions without appropriate data and evaluation.)

Response: The comment is noted. The term 'would' will be replaced with 'may' in the final report.

> Further, to reiterate a key Honda concern, while the data used in the Report may reflect a good snapshot, conclusions are made that are not well-defined or substantiated by the appropriate levels of data. As noted repeatedly above and in our several meetings, Honda believes that additional data gathering and careful evaluation must be completed before any conclusions can be stated, and it is our understanding that Ohio EPA concurs with Honda on this point.

Response: The comment is noted.

DWJB

1.2 No specific mention of Madison County 208 Plan

Response: The Draft Madison County Plan is not part of the TMDL.

DWJB
1.2 Is the TMDL a Plan? Report? Set of Recommendations? Different terms are used to describe the document in various places. We believe it is a **Report.**

Response: A TMDL is all of the above, as well as being an equation, and a process. The term TMDL is very broad. It is not necessarily appropriate to try to narrow the scope of the term without applying several descriptive words to each definition.

DWJB
1.4 *Darby Creek Watershed Action Plan* mentioned throughout – should be the **Darby Creek Community based Watershed Plan.**

Response: The comment is noted.

DWJB
2.6 The inclusion of the *source* and *date* on all maps would be useful

Response: The comment is noted.

DWJB
2.12 In table, the **Impairment** column – it states that 25% of sites are not attaining. How many sites does this include? It should read like page 2-30

Response: The comment is noted.

DWJB
2.13 It is difficult to define the land use based on the colors used in the pie charts. Listing the land use and a percent would be most useful.

Response: The comment is noted.

DWJB
2.30 How many impaired sites are on Robinson Run? 3 were sampled but only 2 documented

Response: All sites on Robinson Run are impaired. The number of sites has been corrected.

DWJB
2.30 Percentiles – Did not notice a good definition of percentiles

Response: If a frequency distribution of environmental data is divided into 100 equal portions, each portion is a percentile. The 90^{th} percentile is equal to the value that exceeds 90% of those in the frequency distribution.

DWJB
2.42 The table on this page should include the river mile to which the aquatic life use designation is applied. Many people only look at the table and may be confused if no RM is listed.

Response: The second column of the table on page 2-42 (Table 2.3.1) gives the river mile of the referenced site.

DWJB
3.2 Several terms could be added to the definitions on the bottom of the page – *Stressors, Riparian Buffer,* and *Diel*

3.8 Definition of *numeric targets* (2nd full paragraph)

3.9 General comment on Active Floodplain: Additional Research needed before widespread approval of this new idea

Response: The comments are noted.

DWJB
3.12 Does the GWLF model include tile drainage? If so does it assume that all poorly drained soils are drained? Less than 50% of poorly drained soils are drained in the Darby Watershed

Response: The GWLF model utilizes the Curve Number method. The Curve Number method can account for field tile response, but there is some flexibility with the method to adjust the curve numbers within a narrow range to reflect tiled versus non tiled soils. The statement the commenter makes "Less than 50% of poorly drained soils are drained in the Darby watershed" is different than information from the Soil and Water Conservation staff. Ohio EPA would be interested in seeing what data this statement is based on.

DWJB
3.13 Further description of the NRCS *Curve Number* in an appendix – in particular the determination of the hydrologic soil group and curve number

Response: The hydrologic soil group is determined by the NRCS and is published in the SSURGO soil data set. A description of the curve number and how to determine it is given at ftp://ftp.wcc.nrcs.usda.gov/downloads/hydrology_hydraulics/tr55/tr55.pdf . The curve numbers used in the TMDL project were based on the procedures recommended in this text.

DWJB
3.14 General comment – Land use data layer may be outdated since most is from 1992-94

Response: Page 3-14 of the Big Darby Watershed TMDL Report states the land use layers and associated years used in the report. The land use was updated for any development that had occurred up to 2001.

DWJB
3.16 Definition – *Sediment Delivery Ratio* (1st full paragraph)
Is soil erosion from development calculated in this Ratio?

Response: No. Urban land uses rely on a build up and washoff equation and not on the sediment delivery ratio used for non-urban land uses.

DWJB
3.28 In the 1st sentence of the 3rd paragraph - … *the primary production (of what) is highest*. Is this referring to Algae?

Response: Yes, it refers to algal productivity.

DWJB
5.6 Nationwide Permit #27 – further explanation and definition

Response: As explained in Chapter 5, Nationwide Permit # 27 is the Nationwide Permit under which in stream work using natural channel design techniques can be performed. Due to the need to reduce sediment loadings to the Big Darby Creek watershed, Ohio EPA will be evaluating not certifying other Nationwide Permits in this watershed.

DWJB
5.6 Define the proposed permit for routine ditch maintenance work

Response: The permit discussed in Section 5.1.4 of the draft TMDL would be triggered by a situation where spoil piles created from routine ditch maintenance triggered the one acre threshold of earth disturbing activity similar to the NPDES Permit for Storm Water Related to Construction Activity. In short, it would require the spoil piles to be stabilized, and storm water related best management practices to be implemented where sediment removed from a waterway to ensure that non-regulated maintenance activities are being properly managed.

DWJB
Edit the 1st full paragraph by removing the words in parenthesis (or Exceptional Warmwater) and removing all words in italics (*within the ditch outlets (the higher gradient channels not actively "maintained" or cleaned of accumulated sediment and brush)*)

Response: Ohio EPA has evaluated the comment and will not edit the sentence. Ditch maintenance should be done such that it does not impact downstream reaches of the stream. Any ditch maintenance activity that will result in impacts to downstream reaches is not exempt from the Clean Water Act, and must be done according to a 404/401 permit and certification.

DWJB
When communicating loading reductions the units utilized in the TMDL are often difficult to understand. Defining loading reductions in a common unit of measure such as lbs/year would assist the agricultural community

Response: The comment is noted.

DWJB
Through the review of the Stillwater TMDL Implementation (Section 5) the watershed group would like Ohio EPA to include in the Darby TMDL the same comments in regards to agricultural ditches and county maintained ditches.

Response: Ohio EPA will decline to add the requested comments because the comparison is not appropriate. Conditions in the Big Darby Creek watershed are not the same as the conditions in the Stillwater River basin.

LL
An overview of the Report contains figures, tables, and facts in metric rather than English. It is suggested that English numbers be put in parenthesis or add a conversion table in the Report. In addition, one has the firm impression that this Report was written and/or prepared either to meet Clean Water Act requirement or for use by colleagues. In either case, the product is not designed for implementation by non-professional persons. As a shelf product, it is an excellent reference document.

The Report refers to excessive total phosphorus. How much total phosphorus is needed for a healthy aquatic system?(3-3; 3-4)

It is believed that much of the data specific to the landscape is outdated, sources are not reflective of landscape conditions, all leading to loading estimates not reflecting true conditions.

Response: The suggestion to use English units is noted, and will be incorporated in to the final report if time allows. As a convenience for the reader the multiplication factor to convert from metric to English units is included in each table. The amount of total phosphorus needed (or can be handled) by a healthy aquatic system varies per waterbody. The TMDL report itself and the allowable total phosphorus loads established in it gives the amount of total phosphorus that can be handled by a healthy population.

The land use in the model is current through the year 2001; all other significant data is based on even more recent data. Even if the land use had changed by some large percent in the intervening 4 years, it certainly has not changed to more natural conditions. While the results may change to some degree should 2005 land use be used, it would still show that major loading reductions are needed in the watershed. The biology of the watershed is impaired and the general trend of declining endangered species populations all substantiate the bottom line recommendations of the TMDL report which are to reduce significant loads to the system and to allow the streams to interact with a healthy floodplain.

LL
3-3 - Refers to needs of a balanced ecosystem. I don' believe there is a balanced ecosystem when change is a constant variable in a watershed with human activity. Plant growth, shifting bedload sediment, streambank trampling are all examples of continuing change over time.

Response: A balanced ecosystem does not imply a static situation, but rather a dynamic balance. It is important to recall that change would be a constant variable in a watershed in the complete absence of human influences. Man induced variations to the watershed are another variable that will affect a streams balance, but the stream can adjust to the variations if they are not too intrusive

LL
3-6 Ignores organic enrichment from wild animals and birds that is detrimental to meeting Ohio Water Quality Standards.

Response: The comment is noted. Organic enrichment from these sources has little significance when compared with human supplied sources of nutrients.

LL
3-7 What is meant by a more natural state? Did the natural state exist prior to Indians in Ohio? The glacial period? Between glacial periods lland human presence in Ohio?

Response: A more natural state for the Big Darby watershed is one where forest and grasslands were the dominate land uses.

LL
3-8 What is a stream of moderate quality? Is "riparian quality" (3-10) defined anywhere? Is the stream part of "riparian quality"?

Response: A stream of moderate quality refers to a typical warmwater habitat stream. The term “riparian quality” is not defined specifically in the Report; however, the factors used in determining riparian quality in regards to the QHEI evaluation data sheet and are listed in section 4 of http://www.epa.state.oh.us/dsw/bioassess/QHEIFieldSheet062401.pdf . The riparian corridor is the interface between the water and the land; as such, it is difficult to separate the riparian area from the stream area. It is unknown exactly what stream characteristics in particular the commenter is referring to with the term “stream”. Some stream characteristics are included in the evaluation of riparian quality; however, the actual stream itself is generally not a factor in evaluating riparian quality.

LL
3-12 Four of the variables for the GWLF model utilize land use and soil characteristics. Where in the Report is there an explanation of how the various land uses were derived. For example, what curve number and Antecedent Moisture

Conditions (AMC), (not Antecedent Soil Moisture) were used for the watershed and subwatersheds? A table would be useful.

Response: The requested information is not in the Report itself, but is available by contacting Erin Sherer at erin.sherer@epa.state.oh.us or at (614) 644-2890.

LL
4-2 How does an active floodplain assimilate pollutants?

Response: Active floodplain provides a depositional area where sediment and the pollutants that attach to sediment can be trapped and removed from the stream water. These deposited materials can be utilized by vegetation growing in the active floodplain.

LL
4-36 What is the rational for the active floodplain widths? What values are to be derived? 5-7 talks about locally derived benefits.

Response: The active floodplain widths are based on principals derived by Dave Rosgen and on studies by ODNR hydrogeologists and OSU faculty. Factors influencing the active floodplain include geology, topography, the drainage area, stream velocity and discharge, sediment and bedload transport, particle size, and channel geometry among others. A description of the rational for the active floodplain widths is given at: http://utilities.ci.columbus.oh.us/project/docs/sizingstream.pdf .
In addition to locally derived benefits that are listed on page 5-7, active flood plain increases the ability of the stream to process pollutant loadings, reduces velocity of the flow, thereby reducing bank erosion, and provides habitat for aquatic life.

LL
4-41 All land disturbance activities will cause impairment. Unless this is eliminated (not reasonable), impairment will continue.

Response: All land disturbance activities do not cause impairment. There are many watersheds and waters in Ohio that have land disturbance and are not impaired. Allowing a buffer between the stream and the land disturbance reduces the impacts of land disturbance on a stream. Utilizing geomorphologic principles in conjunction with economic needs decreases the risk of stream impairment. Managing the land thoughtfully with awareness of how land management and stream health interconnect also reduces the risk of stream impairment.

LL
Reference is made to current "left un-managed" on a watershed scale (5-4). What programmatic source of funding does OEPA plan to use for successful watershed management?

Response: Ohio EPA, Division of Surface Water intends to rigorously enforce requirements under current law. In that manner, much watershed management will be publicly or privately financed by those wishing to conduct regulated activities in the watershed. Ohio EPA, Division of Surface Water also administers the 319 Grant

Program, a competitive program under which grants may be obtained for projects that will result in restoration of impaired waterways or will demonstrably help to achieve the loading reductions necessary to achieve TMDL targets. In addition, the Ohio EPA, Division of Environmental and Financial Assistance has low interest loan money that can be used in some instances towards achieving TMDL targets. For those who undertake voluntary activities to improve water quality, there are cost share programs outlined in Chapter 5 of the TMDL report.

LL
Dam removal. Reference to removal of logjams affecting stream flows similar to dams should be included.

Response: The comment is noted.

LL
Chemical data - The Report does not include data such a defining the Sediment Delivery Ratio. What Sediment Delivery Ratios were used for the main stem and tributaries?

Response: The Sediment Delivery Ratio is a function of drainage area and is based on the equation found in: http://www.vims.edu/bio/vimsida/UsersGuide.doc

LL
The percent reduction for total phosphorus and suspended sediment are not realistic.

Response: The comment is noted.

LL
I appreciate the opportunity to respond to the voluminous and valuable data contained in the Report. I feel it is impossible to fully review the massive amount of data in an adequate manner within the review time OEPA has allowed. The 30 day extension was greatly appreciated

Response: The comment is noted.

TNC
Above all, the protection of the Big Darby Creek and its tributaries is a work in progress, and we expect the same of this TMDL, 208 plans, and local initiatives. We ask that Ohio EPA, and others, make decisions with the caution deserving of one of the best remaining examples of stream diversity in Ohio and the Midwest. Otherwise, we risk losing one of the last remaining and best examples of our natural heritage.

Response: The comment is noted.

TNC
Section 5.4 Dam Removal – Levees and quarries - The draft TMDL rightly recognizes the negative impacts of dams in the watershed, and should expand this recognition to other major habitat threats, including levees and stone and gravel quarries. It should

further address the impacts of and need to remove dams and levees, such as mapping of levees and review of the stream quality in these areas. Levees in the watershed are extensive (streambank encroachment is noted in Section 5.1.4, page 5-4), and observation suggests they play an important role in channel instability, probably affecting mussel survival.

The siting of gravel pits is a major threat to stream habitat quality in the watershed, especially along Big Darby Creek. Over time, the barrier between the pits and the stream degrades, and the stream can be "captured" by the pit and lose its lotic qualities. This is a threat in Union, Madison, Franklin and Pickaway Counties, where several active and abandoned quarries are in the floodplain, close to the streambank, and easily within the meander belt width of the stream. Failure of the streambank and loss of stream habitat is imminent in some locations, such as at the former Olen Corporation quarry downstream of Beach Road. A review of this problem and suggested solutions is warranted.

Response: An intention of the stream setbacks and active flood plain concepts recommended in the TMDL report is to reduce the need for future levees and to help the stream remain or become stable.

Another intention of the setbacks is to encourage land uses within the setbacks that are consistent with frequent inundation, in order to preserve the stream channel. Land uses that do or may result in the destruction of the stream channel should be avoided. A sand and gravel operation that poses a risk for stream capture could certainly be described as a land use inconsistent with the long term health of the watershed.

Chapter 5 of the TMDL will include an expanded section that discusses these issues.

OEC

Perhaps more is needed to provide the measure of scientific conservatism necessary to better guarantee that Darby remains the remarkable celebration of life the bathes the Little and Big Darby Creeks.

The Clean Water Act has the legal framework to allow development of a watershed based system of both individual and general NPDES permits. The Darby watershed is Ohio’s golden opportunity to initiate a progressive system of permits that account for loading and effluent limits which can recognize the importance of the watershed approach. The importance of such an approach is crystal clear and would be supported by USEPA. We encourage OEPA to work with the USEPA Office of Research and Development and scientists in Region V to develop architecture for a watershed based system of industrial, agricultural and storm water individual and general NPDES permits.

Response: The Big Darby Creek TMDL includes a review of all permits in the watershed. In practice, the recommendation is no different than what was done for this TMDL. NPDES permits will be revised, and a new general permit for storm water will be issued to be consistent with the TMDL.

OEC
Similarly, an important report recommendation is the listing of appropriate commercial enterprise and inappropriate activities. Gravel extraction in the in the flood plain especially including dewatering to facilitate mining activites could be an example of an activity not permitted. Another might be factory farm livestock production that relies on a water based manure disposal system. A facility that uses a dry manure disposal system or even better the addition of advanced waste treatment such as solids removal and wastewater clarification could be more acceptable. Such a list may make initial contemplation of inappropriate activities less likely.

Response: The comment is noted. The stream setbacks and the descriptions of appropriate uses of the setbacks included in the report will aid individuals in making decisions about the appropriateness of various commercial enterprises.

Batt
On page 2-44 in Box 2.3.2, Overview of lower middle Big Darby Creek, the design flow for the Battelle Memorial Institute West Jefferson site is listed as 0.020 million gallons per day (MGD). In our current National Pollutant Discharge Elimination System (NPDES) permit issued may 25, 2005, and effective July 1, 2005, the effluent loading limitations are based on an average flow of 22,500 gallons per day for outfall 001 and 27,000 gallons per day for outfall 004. This gives a total average flow of 49,500 gallons per day (rounded to 0.050 MGD). The 0.050 MGD flow is also the design flow of the wastewater treatment plants.

Therefore, Battelle requests that the design flow and average flow in Box 2.3.2 Overview of lower middle Big Darby Creek on page 2-44 be changed to 0.050 MGD to be consistent with Battelle's NPDES permit.

Response: The design and average flow have been corrected as appropriate.

OFB
Upon initial review of the draft TMDL document for the Big Darby Creek Watershed, it is clear that Ohio EPA has put a lot of thought and effort into identifying ways to format the report to best present the information to the reader. Ohio EPA Division of Surface Water staff should be commended for their efforts. The format of this draft TMDL report should serve as a template for future efforts.

Response: The comment is appreciated.

OFB
The inclusion of the sub-basin overview boxes in Chapter 2 helps make the report easy to read and comprehend. By scanning these overview boxes, the reader quickly obtains an understanding of the presence of point source discharges, aquatic life and recreational use attainment status as well as identified causes and sources of use impairment for each of the sub-basins. The percentage of sampling sites that are not attaining their aquatic life designated uses are also presented. To help the reader grasp the extent of the data available to conduct the analysis of aquatic life impairment, the

total number of sampling sites used in the analysis should also be included in each overview box.

Response: The comment is noted.

OFB
The land use pie charts in Chapter 2 visually provides the reader with a quick understanding of the current land use conditions in each sub-basins[sic]. Because land use composition can change rapidly in Ohio, the date of the land cover data set used to develop each of the land use pie charges should be included on each pie chart. For ease of comparison between the sub-basin land use pie charts, the colors for each land use category should remain constant (i.e., bright yellow should represent urban grasses on all of the pie charts).

Response: The comment is noted. The suggestion is valuable; however, it may not be able to be incorporated into this final version.

OFB
Chapter 4 of the document contains pollutant allocation tables for each sub-basin of the Big Darby Creek watershed. These tables identify the existing and allowable load for total phosphorus, and suspended sediment in values of kilograms per year. The utilization of this unit of measurement, while being readily accepted and understood by the research community, is not easy for the general public to get their arms around. Ohio EPA should consider presenting the same information in the following manner. The values for total phosphorus in Table 4.1.1.1 on page 4-14 for nonpoint source runoff indicates a necessary annual load reduction of 95%. In other words, the existing load of 1,725 kg/y has to be reduced down to 81 kg/y or a difference of 1,644 kg/y. Given that this sub-basin has a drainage area of 5.90 square miles, on a per acre basis the 1,644 kg/y reduction comes to a value of slightly less than 1 pound of total phosphorus per acre per year. This value is one that can be easily understood by the general public and incorporated directly into an implementation plan.

Response: The comment is noted.

LDR
First of all, this is a very technical report, and most people will understand very little of what actually went into the report, how the various analyses were performed , and what the report is actually saying. It is very difficult to comment on something that you don't understand. I am sure there are many people who are vitally interested in this report and what it may mean to them as landowners along the streams within the watershed. However, due to the technical nature of the report, I doubt if many of them will comment on it. My fear is that you will equate lack of response with total agreement. Rather I think you should equate lack of response with lack of understanding or lack of knowledge of the existence of the report. There needs to be a better way to get this information to the individuals who are going to be affected by the report – the landowners along the streams within the watershed. These are the people who need to do something, and if they cannot understand what you are saying, or do not even know

the report exists, they are not going to implement any of the things you are recommending.

In addition, another factor you need to be aware of is that some of these people spent several years fighting a wildlife refuge along Little Darby Creek, because they wanted to keep their land out of government control. They may not be receptive to what they may perceive to be another infringement upon their personal property rights.

Response: The comment is noted.

LDR
Page 3-1, Section 3.0 – This section discusses loading capacity, allocation of allowable load, and allowable or target condition of the environment. You indicate that the analyses of these factors are determined by a large degree by modeling. I have a great respect for mathematics and equations, but I am not sure how you can 'model' nature.

This comment applies to the entire report, not just the loads modeling. What do you do if a model indicates that if you perform this activity, you should reach a condition of 4. You perform all the activities the model wants you to perform, but you only reach a 3. Does this mean the model is wrong? Do we say we did the best we could and stop? Or do we try to do the impossible because the model says we can? How do you fit nature into a model?

Response: A model is a representation of a state or a reality that is not practicable to observe directly. A water quality model is based on data, relationships, observations, and equations which represent different aspects of the environment that one is wishing to model. The loading model utilized in the TMDL does not strive to fit the entirety of nature into its framework. Instead, it focuses solely on simulating loading from certain sources, namely storm water runoff. The equations and data used in the model are based on decades of observations relating land use, soil type, storm data, and other factors to runoff loads; these equations are adjusted to the specific watershed by inputting site specific data.

The loading model used in the TMDL indicates that if you achieve a certain reduction in current load, you should reach a target level indicative of healthy streams in Ohio. However, the loading model is only one piece of the entire puzzle of the Darby. Other pieces as described in the report (stream set backs, habitat, etc) need to be reached as well in order to attain or maintain a healthy stream network. If the reductions in existing load as recommended in the TMDL report are attained (note, specific activities are not prescribed for loading reductions), and the targets are still not met then the other recommendations of the TMDL should be examined to see if these are being met or not. If all recommendations are being met and the target is still not reached, then the situation at that time would be re-examined to identify if a new stressor has been introduced or had been masked during the original assessment. The process would enter a new cycle of examination. The statement, "do we try the impossible" is a personal statement of the commentator. The purpose of the TMDL is to suggest a prescription for the Darby; for the most part, it is up to the individual land owner to determine what they are willing and able to do towards the prescription. The TMDL does not dictate specific activities for land owners and others to strictly follow. The suggestions in the TMDL are not impossible, although they might be uncomfortable to some, and therefore viewed as 'impossible' by those individuals.

LDR

Page 5-6, Section 5.1.4 – This section discusses mitigation *downstream* of the proposed activity if attainment is not possible at the site of the problem. Whose responsibility does that become? Aren't you simply transferring the problem downstream, expecting people who did not cause the problem to fix it? This is simply passing the buck, probably most often to individuals who have fewer financial means to fix the problem than the people who caused the problem.

Response: The commenter raises an excellent point. The purpose for requiring mitigation downstream is designed to avoid the situation the commenter has suggested will occur. While the commenter is correct in saying that the issue will be transferred downstream, the intent is to make sure that the person who would be causing the problem takes responsibility for it and works with downstream land owners to ensure that it does not become a problem.

LDR

A number of years ago we cost shared with Madison County SWCD in a project to fence off a creek from access by cattle. Madison County SWCD paid for half the fencing materials, but paid for none of the labor because we provided that ourselves. They indicated they could not pay us for the labor, but if we had hired it done, they would have paid half the labor cost. We could not afford to pay half the labor cost – it was cheaper for us to provide all the labor and be reimbursed nothing for it. This shows a lack of willingness to work with the landowner. We were more than willing to do what we could to help clean up the creek, but the government would not meet us halfway. If these rules are still in effect, they need to be changed. If a farmer is willing to spend his time putting up fence for environmental improvements, the government should recognize that effort and compensate the farmer. Instances like this make the landowner reluctant to deal with the government.

As a result of fencing off the creek, we at least annually have to clean up along the fences where floodwater has deposited trees, branches, and other debris. This year we had to replace a number of posts and restring much wire. This is always done totally at our own expense. Again, we are trying to be conscientious stewards of the creek, and we end up spending much of our time and additional dollars each year trying to maintain the cleanliness of the creek, and are compensated nothing for our efforts. The efforts to keep the creeks clean are ongoing, but we see no assistance from the government. It appears to be a one way street – we are expected to do all the work, with nothing coming back to us.

Response: The comment is noted.

LDR

I feel that landowners, even if they read this report, really will not know what is expected of them. What specifically does the Ohio EPA want from the landowners? What is the next step? Moreover, how will the landowners be compensated for work performed or land taken out of productive use?

Response: For agricultural land, there are programs mentioned in the TMDL that can provide compensation for agricultural land voluntarily taken out of service. For landowners not engaged in agriculture, it is a personal decision based on weighing the costs of work performed or land taken out of service weighed against how much they value a healthy watershed. Ohio EPA is asking land owners to minimize pollutant loadings from their land, and to concede that land adjacent to the stream will flood at times, and make land use decisions that are consistent with occasional inundation.

LDR

Many of my comments appear to be negative in nature. I want to stress that most people are in general agreement that they would like the Darby Creek watershed to be cleaner and healthier. But I think this report may be focusing on a utopia that is not possible to achieve. You may be asking too much, more than most landowners along the watershed can afford to give. Many of us feel we have been good stewards of the watershed for many years already, and you are trying to tell us that what we do will never be enough. However, we have proved that humans can successfully coexist with the natural environment. We must have been doing something right, or there would be no EWH designations anywhere in the watershed today.

Response: While there are certainly challenges to implementing the report, it is Ohio EPA's position that the pollutant reduction targets are achievable over time. It has been Ohio EPA's experience that most people are in general agreement that they would like the Big Darby Creek watershed to be cleaner and healthier which bodes well for the overall implementation of the pollutant reductions.

RHG

A major source of pollution on Darby Creek is the State of Ohio Prison Center at Orient. Raw sewage is routinely dumped. The state has repeatedly said they will update (the) sewage system. Never has.

Response: The Pickaway Correctional Institute (PCI) completed construction necessary to upgrade the wastewater treatment plant to comply with their NPDES permit in the summer of 2004.

FWS

We noticed on page 4-28 a graph showing that potassium contamination from Flat Branch was contaminating about 40 river miles of the upper Big Darby Creek with concentrations ranging from 40 mg/l to 4 mg/l. Wildrege et al., 1998 (Acute affects of potassium on Filtration Rates of Adult Zebra Mussels, *Dressena polymorpha*, J. Great Lakes Res. 24(3):629-636) states that filtration rates of freshwater bivalves have not been measured, but ciliary activity (filtration) ceased when zebra mussel gills were exposed to 4.3 mmol/l (168 mg/l) of K+. Further, "Chronic exposure to extremely low levels of K+ is lethal to North American freshwater bivalves (Imlay, 1973). Imlay (1973) reported that a K+ concentration of 0.27 mmol/l is lethal to 90% of individuals of three unionid bivalve species in 52 days and only 0.18 mmol/l is lethal to two species within 8

months. Several investigators also report that valve activity patterns of the freshwater clam *Anodonta cygnea* are altered at K+ concentrations of 1 mmol/l (Loshtovants and Salanki, 1958; Lukacsovics and Salinki, 1968) (Waldridge et al, 1998 page 630) (0.27 mmol/l = 10.6 mg/l, 0.18 mmol/l = 7.04 mg/l, 1 mmol/l = 39.1 mg/l).
Potassium apparently interferes with a mussel's ability to use oxygen and results in asphyxiation at lethal concentrations. Potassium at lower concentrations can cause the valves of mussels to open and allow other toxicants access to tissues.
The information above would indicate that potassium concentrations found in upper Big Darby Creek could be having affects on freshwater mussels of their potential habitat. Ohio EPA may wish to more specifically address reductions of potassium in the Flat Branch and upper Big Darby Creek in the TMDL document.

Response: At present, Ohio EPA does not have enough information to include a potassium TMDL in this report. However, Ohio EPA has committed to further investigation of chemical inputs to Big Darby Creek from Flat Branch, and in the upper Big Darby Creek and will continue to collect information and conduct further studies on the potassium issue.

COLS

TSS Pollutant Loadings
OEPA's existing TSS pollutant loadings for the Hellbranch are significantly higher than the loadings for the same pollutants generated in the Hellbranch Forum loading modeling. This brings into question the loadings from all other subwatershed and watersheds. While pollutant loading modeling is certainly not an exact science, OEPA's loadings for TSS are almost seven times higher than the loadings from the Hellbranch modeling. Loadings from the Hellbranch modeling were calibrated to the Hellbranch gauge, so it includes all TSS contributions, including overland, bank erosion and construction (to the extent that construction activities were conducted during the 10 year period of record used for calibration). Given that OEPA had the gauge TSS data available for calibration, it would seem reasonable that the results would be more comparable. If, however, OEPA used its own short term data to calibrate the model, then the results are likely to be unreliable due to the relatively short period of record for OEPA's calibration data. If OEPA's results are found to be in error for the Hellbranch, then the results in other watersheds would also be in question.

Response: The Ohio EPA used the full period of record at the USGS gage on Hellbranch Run to calibrate the Hellbranch model. The hydrology calibration resulted in an R^2 value of 0.88. The TSS loading reductions were not based on model predictions, but instead were based on the actual data collected at the Hellbranch gage. The loading model used by the Ohio EPA calculates a loading per each month of the modeled period. The Hellbranch Forum loading model only calculates an annual loading. There is not sufficient data to calibrate for TSS either the Ohio EPA model or the Hellbranch Forum model as data was collected only sporadically on a daily basis at the gage. There were 133 data points available to ground truth the loading models to, both for the Hellbranch Forum and the Ohio EPA. It is a misconception to say the Hellbranch Forum loading model is calibrated for TSS. The Ohio EPA compared the actual loads as measured at the gage to loads generated with its loading model. It found the loading model to be underpredicting the TSS loads actually observed at the gage. The difference was attributed to bank erosion and construction activities that are not predicted by either the Hellbranch Forum loading model or the OEPA loading model. The Hellbranch Forum loading model could not be 'calibrated' to the loading data at the gage for it does not take into account these major sources of load. In summary, the Ohio EPA model results at all three gages in the Big Darby watershed calibrated extremely well for the hydrology. In addition, the were closely groundtruthed with the existing data at the gages. Further, the Darby Accord modeling results on the Hellbranch agreed very closely with the Ohio EPA modeling results. It may be of value to Columbus to discuss the Hellbranch Forum modeling with the consultant who performed the work to better understand the results and the strengths and weaknesses of the model used for that effort.

COLS
Table 4.2.1, Page 4-34. The Habitat score for the Mainstem portion of the Big Darby from Sugar Run to High Free Pike appears to have a mistake. The stream is classified s EWH, so by having 4 modified attributes in the QHEI, it should have received a score of 0 for the "Total # of Modified Attributes" column, resulting in a total Habitat Score of 1, instead of 2.

Response: The comment is noted and the final report has been corrected.

DWJB-PG
The group believes that it should finish its assessment of each subwatershed and determine if the proposed TMDL load reductions are attainable, logical and economically feasible to each subwatershed area. Continuing with the current system of gathering information from landowners, local governments and agencies is a very important part of this process.

Response: Ohio EPA agrees that the group should continue its process. The TMDL report is an important source of information regarding quantifiable water quality improvement needs that should aid the group in its effort.

DWJB-PG
Findings from each subwatershed should be presented to the Joint Board for their input and approval. OEPA should include our findings and suggestion in the TMDL, before any final document is presented and any endorsement is made by governments, landowners or agencies.

Response: As the Darby Creek Community Based Watershed Plan and the TMDL are on different schedules, it will not be possible to wait until the plan is completed. Ohio EPA will not delegate its responsibility to conduct and complete a TMDL for the Big Darby Creek Watershed to the Joint Board.

DWJB-PG
The group believes that OEPA needs to be reminded that the <u>cooperation and acceptance of the</u> <u>watershed community</u> is the most important element in the success of a TMDL.

Response: Ohio EPA agrees that cooperation and acceptance of the watershed community is an important element in the success of a TMDL.

DWJB-PG
5.1.1 Storm Water Control**:** Changing rules for more stringent control over Storm Water Phase I and Phase II. How will this affect 208 and other plans already written?

Response: The 208 plan for Central Ohio will be able to accommodate these changes.

DWJB-PG
All noncompliant facilities will come into compliance by October 1, 2005? Is this attainable?

Response: Noncompliant facilities should not be waiting until October 1, 2005 to come into compliance. Compliance is a duty imposed by their NPDES permit.

DWJB-PG
5.1.4 Managing Drainage Needs, Channel Erosion and Flood Reduction Work:
There are many rules changes referred to from designations, to 401 changes, to ditch maintenance, to new responsibilities for local health departments which are not final and should have been addressed and resolved before this TMDL was written. The document states agricultural drainage is necessary but then continues on by saying:

"Left un-managed on a watershed scale, agricultural drainage, erosion control and flood reduction practices are threats to the ecological health of the Big Darby Creek system. Ohio EPA studies have documented that the cumulative impacts of the water, energy and sediment delivered to Big and Little Darby creeks from all the ditch systems, and the more recent disturbances caused by road construction and industrial development along the northern edge of the watershed, are responsible for declines in indicators of biological health of the system. Additional stress to the system has been added by the activities of private landowners and public agency projects to control stream bank erosion and flooding in localized areas.

The challenge of implementing the TMDL recommendations, specifically those steps necessary to meet the sediment bedload, habitat and flood plain widths targets established in Chapter 4, will be to find acceptable methods that simultaneously manage and meet the human needs for agricultural drainage, erosion protection and flood reduction work and the ecological needs of the Big Darby Creek system. Recent scientific evidence suggest these dual objectives can be compatible" (Ward et al., 2002)**.**

I was under the impression that 2 stage ditch design was not going to be pushed until more testing is done. Dan Dudley stated this at our meeting on April 14, 2005.

Response: While 2 stage ditches will not be a requirement, they have features that single channel ditches lack, such as an appropriately sized low flow channel, and some capacity for storage of higher flows. Ditch activities must be performed such that they do not interfere with attainment of pollutant load reduction targets, or with existing aquatic life uses. There are many techniques that can be used to accomplish these objectives. 2 stage ditches are one option.

DWJB-PG
Questions and comments on the 401 permits and the removing of Big Darby from Nationwide Permit 27.

Nationwide Permit 27 controls practices which have minimal adverse effects on the aquatic environment such as removal of accumulated sediment, dikes and berms, restoration of stream meanders, removal of undesirable vegetation and other related activities (Army Core website, 2005).

A permit for routine ditch maintenance? Which BMP's are they going to attach?

Response: Ohio EPA will certify Nationwide Permit 27 as meeting water quality standards, as it typically involves a natural channel design or stream restoration. Ohio EPA will not certify nationwide permits for routine ditch maintenance in this watershed, and will require the submission of an individual 404 permit application and 401 water quality certification. This provides predictability to applicants, as in most cases, applicants for the nationwide permit for routine ditch maintenance will not be able to comply with nationwide permit condition number 11, protection of endangered species. BMPs will likely involve the minimization of discharges of sediment to downstream reaches, and consideration of downstream impacts of the proposed activity.

DWJB-PG
Page 5-7
"The Big Darby Creek watershed action plan is the fourth implementation mechanism for promoting improved drainage through environmentally sound means. The presentation in Chapter 4 of sediment bedload, habitat and flood plain width targets, allocations and recommendations for many small watershed units will allow a tailored approach to improving conditions within each sub-watershed area. Petition ditch maintenance work and privately maintained drainage projects on waters designated as Warmwater Habitat (or Exceptional Warmwater) should be performed with an eye towards installing BMPs that would improve sediment bedload, habitat and flood plain width characteristics within the ditch outlets (the higher gradient channels not actively "maintained" or cleaned of accumulated sediment and brush). Conversion of traditional ditch design and maintenance practices to innovative two-stage channel, flood plain excavation, or natural channel design features should also be encouraged. Cost sharing or other mechanisms of funding these efforts are possible (see sections 5.1.5.3 and 5.1.5.4)."

Again, this is not what I understood at the April 14, 2005 meeting. Dan Dudley said 2 stage ditches were not an approved scientific method. Why this being quoted as a forgone conclusion of recommendations the planning committee has not made?

Response: The statement does not mention or imply that this is a recommendation of the planning group. It does state that improved designs should be encouraged, as they are predicted to have less of a downstream impact than traditional designs.

DWJB-PG
5.1.5 Agricultural BMPs and Programs: *Page 5-7 "However, even with improvement in these factors it will be necessary to make incremental progress in reaching the phosphorus and sediment load reduction targets. This section describes how this can be accomplished through the work of several agriculturally oriented programs that stress voluntary adoption of BMP's by landowners and operators."*

What is meant by "incremental progress" and what is the timetable?

Response: Incremental progress is considered to be progress that continues in steps over time. There is no fixed timetable, but over a period of roughly 3 – 8 years would be considered to be making progress.

DWJB-PG
5.1.6 Local Authorities: Health Departments will play a major role in regulating household sewage treatment. Are they aware of the "pivotal role" they are to assume?

Response: Health Departments are authorized by Ohio law to regulate household sewage treatment. Their role in regulating these sources of pollutants will be important for achieving load reduction targets.

DWJB-PG
5.1.7 208 Plans: Are Pickaway, Logan, Champaign, and Union counties aware that OEPA will be writing their 208 plans if they don't provide any input? Will Madison County's 208 plan be affected?

Response: This TMDL report is not a 208 plan, it is part of a 208 plan. The 208 Plan for central Ohio will be public noticed in January, 2006.

DWJB-PG
5.2 Sectors of Society and the Big Darby Creek TMDL Recommendation
5.2.1 Agriculture
Last sentence in this section Page 5-15:

"Habitat improvements to meet QHEI targets are directly correlated with improvements to the aquatic biota, the ultimate arbiter of success of a TMDL project."

Does this include maintained ditches? Seems like the ultimatum of "plant trees or else" is implied.

Response: The statement is a statement of a fact. The QHEI and results from sampling of aquatic biological communities are strongly correlated. Statement of a fact is not an ultimatum. It is a statement that describes an activity that will be highly effective in achieving goals of the TMDL, which would be improving habitat to meet QHEI targets. Planting trees may be an efficient way to accomplish this in some circumstances.

DWJB-PG
5.2.5 Municipal Point Sources – are these changes going to cause more tax payer dollars for raising the bar?

Response: The lowering of effluent limitations for municipal point sources to meet the capacity of the system they discharge into may cause increases in user rates.

DWJB-PG
5.2.6 Private Point Sources **–** home sewage systems – private homeowners are to maintain their systems and keep them up to date. Health Departments are being charged with pointing out failures and achieving load reductions. How is each county health department going to address this and enforce? (New rules may address these issues)

Response: Ohio EPA will work with the local health departments to plan best approaches to achieving load reductions in areas of health department responsibility.

DWJB-PG
5.4 Dam Removal: Is there a real problem with dams in this watershed?
Would need to evaluate disturbance to take out and what harm removal could cause. Need to check inventory and find out what they are referring to. (Only 2 dams remain and the one in Milford Center is partially breached).

Response: Dams may play an important role in the health of endangered species by blocking routes for host species to travel to acceptable habitat.

DWJB-PG
5.5 Implementation Strategy and Reasonable Assurance: Where are the reasonable assurances for the watershed that rules will not change in "mid-stream" when efforts are being made? How high will the "bar be raised" in this process? Just how much will the TMDL process work with reduction efforts or will more rules and limitations simply "turn off" landowners when fish, bugs and mussels are given more importance than the health and economic stability of the people?

Response: The first reasonable assurance is the amount of time and effort invested by the state in creating the TMDL report. This is a data intensive process that has produced solid results. Changing or revising the results would require new data to be brought into the problem and to be considered, and it would require that the new data come up with different results. The data intensive approach used for the Big Darby Creek Watershed TMDL provides for robust results.

In spite of the data intensive approach, there has been no data submitted to support the notion that valuing a high quality aquatic resource results in damage to anyone's economic stability, with the exception of comments from landowners who want to sell their land for development, a practice dependent upon the ability of the watershed to handle the excess storm water generated by the land conversion. The health of people is a definite concern of the TMDL, and it has resulted in the establishment of loading reduction targets for pathogens so that the recreational uses of this watershed are no longer impaired.

B.15 Biological Assessment

DCA
The TMDL's biological assessment of the Darby watershed is of course extensive, and it would be a disservice to all who worked on it to criticize the work that has been done so far. Having said this, the Darby conservation community has recognized for years that the standard EPA biocriteria system has its limitations when it comes to assessing outstanding streams of Darby's caliber. These limitations are significant, especially given the state's antidegradation responsibilities.

The biggest problem is that the Ohio EPA's biocriteria system does not consider freshwater mussels—Darby's most sensitive and significant aquatic resource--and only indirectly considers rare or endangered species (sensitive fish count positively in IBI scores, but the status of their populations is not specifically addressed). *As a result, Darby has lost or is losing mussel species and some of its rarer fish, and yet is still attaining its Exceptional Warm-water Habitat designation in many areas.* For example, according to the TMDL assessment, the Big Darby mainstem is fully attaining its biocriteria standards for all of its length from the Prairie Oaks Metro Park to its confluence with the Scioto River. At the same time, the mussel community in the mainstem has shown a serious decline. This divergence between attainment status and actual instream conditions of the mussel fauna must be evaluated, explained, and solutions proposed in the TMDL.

Response: In Appendix B.7.4 of the TSD (Trends in Unionid Mussel communities) extensive analysis of trends of current and historical population, water chemistry, spill, and sediment information were examined to ascertain causes and sources of declines to better protect mussel populations in the future. Recommendations appropriate to better protect the mussel populations were incorporated into the TMDL process as well as other current basin protection activities

DCA
The TMDL's analysis has other limitations. For example, although biocriteria scores give a linear snapshot of the watershed—the attainment map—they do not provide a picture of the watershed through time. To understand the Darby ecosystem, and thus begin to understand how to protect it, it is critical to understand the trends in species diversity and abundance. To help give a better picture of the true state of Darby's biodiversity, DCA is submitting two documents with these comments. The first is an annotated list of Darby's fish, the second an annotated list of Darby's mussels. Both are specifically designed to illustrate trends in species health in these two critical aquatic faunas. These documents consolidate the best available data on the subject, with sources listed in each document. In general, sources used are EPA sampling, museum records, sampling and observations by historical naturalists, and sampling and observations by recent naturalists.

Response: In Appendix B.7.4 of the TSD (Trends in Unionid Mussel communities) a list of mussel species collected through time in the Darby basin was created from current and historical data *from EPA sampling, museum records, sampling and observations by historical naturalists, and recent sampling and observations by naturalists*. Extensive analysis of trends of current and historical population, water chemistry, spill, and sediment information were examined to ascertain causes and sources of declines to better protect mussel populations in the future. Recommendations appropriate to better protect the mussel populations were incorporated into the TMDL process as well as other current basin protection activities.

DCA
The fish and mussel tables we are submitting list the 151 fish and mussels of the Darby watershed. Fifty-one of these species have been identified by the state of Ohio as being of particular conservation interest. This includes species which are endangered, threatened, or of special concern, and also fish species that the EPA has identified as sensitive and "declining" throughout the state. In these documents, trends are indicated by colors: red indicates an extirpated species, orange a severely declining species, yellow a moderately declining species, white a stable species, and green an increasing species. The timeframe of these tables varies with available data, but in general they reflect trends over the last few decades.

The tables illustrate the divergence between the fish community and the mussel community. Although a number of Darby fishes are in decline—mostly in the headwaters—as a whole Darby's fish community appears to be relatively stable, with perhaps 10-15 percent of species in decline—not an insignificant number, by any means, but generally in line with attainment data. In contrast, Darby's mussels have clearly undergone a precipitous, serious decline. At least 15 species are listed as being in various stages of decline, or roughly 35-40 percent of the fauna, depending on which species you consider part of the regular community. (Please note: species richness analysis of Darby's mussels can be misleading, as over the last few decades the stream has seen an influx of 5 or 6 species that may or may not have been part of the prehistoric fauna. This tends to augment richness numbers at any given site, essentially masking the loss of other species.)

Although the EPA's analysis did pick up a number of problems in the watershed through its standard biological, habitat, and chemistry testing, these problems and their solutions were based on bugs and fish; therefore there is no guarantee that the problems detected are the same ones that are affecting mussels, or, if they *are* the same problems, there is no guarantee that the load targets recommended for fish and bugs will fix these problems for mussels. On the contrary, the fact that mussels are declining at a much greater rate than fish indicates that these faunas do not share similar sensitivity to existing stressors. As one probable example, there is strong evidence that the decline of mussels in the lower Big Darby is at least partly due to mussels' greater sensitivity to storm water loads.

The fact that the EPA has a standard biocriteria assessment system that it uses statewide does not preclude the agency from using other means of assessment, especially given the Clean Water Act's unambiguous directive to protect <u>all</u> uses of a stream. In fact, we believe the EPA has an *obligation* to evaluate all existing uses of a stream, including its use as a mussel refuge. In conversations with EPA officials, DCA has argued that Darby should be designated a Tier 3 stream for antidegradation purposes. We believe that Darby fits every conceivable requirement of that designation, including overall public support for taking that step. However, if the agency is unwilling to designate Darby a Tier 3 stream, we certainly believe that the EPA must demonstrate a specific strategy to protect Darby's mussels.

In short, for the TMDL to be complete it needs to address the mussel situation. We recommend that the agency seek additional advice from mussel experts, including consultation with the U.S. Fish and Wildlife Service. Mussels are Darby's most unique natural feature, and if they cannot be maintained the agency will not be succeeding in its task of preserving Darby's high quality.

Response: The OEPA did make a thorough as possible mussel analysis (many extra months of effort). Besides other historical and current causes and potential sources identified, a major issue identified in the mussel trends analysis (Section B.7.4 in the Appendix of the TSD) was mussel sensitivity to storm water loads and the loss of stable habitat where long-lived beds have been affected. We have been keeping abreast of some current applicable chemical toxicity data and spatial density and reproduction with regards to mussels (though some is provisional or in experimental research phases). That research is continuing at the federal level. We have consulted with USFWS; more interaction will likely be occurring in the future concerning endangered species in the Big Darby Creek basin. To counteract the probable lower reproductive success in scattered low density populations, it is possible that human intervention by part of state and national agencies, public and private groups in cooperatively working together to supplement mussel populations might be needed. The moving of individuals to stable beds to increase density, the rearing and restock juvenile individual species or possibly glochidia-infested fish (as scientifically capable and shown credible by research) are all possibilities to enhance and increase individual critical species *after initial NPDES and TMDL directives have been implemented to correct identified issues*. Usually the USFWS is the lead organization working with qualified groups and individuals orchestrating such an effort. With the amount of protected or park areas encompassing big and Little Darby Creek, these efforts are certainly viable options in future protection efforts.

Ohio EPA has relied on the endangered species recovery plans available (1), prepared by the experts (USFWS) to determine appropriate actions to take in this TMDL. The TMDL has outlined significant pollutant reductions as necessary for the long term health of the Big Darby Creek watershed. If Total Phosphorus and sediment reductions necessary to meet the TMDL targets are achieved in this watershed, it will go a long way towards meeting the needs of the sensitive species. Based on that rationale, Ohio EPA intends to move forward with activities targeted towards achieving these pollutant reductions. During this period, more information about the specific needs of these sensitive species may emerge. This is in keeping with the strategy of adaptive management.

TNC
Section 5.3 Endangered Species Protection - In addition to the clubshell (*Pleurobema clava*), the TMDL should address protection of the northern riffleshell (*Epioblasma rangiana*). While we agree with what is said about the clubshell, Ohio EPA also needs to address loss of mussel host habitat and host water quality requirements.

Response: Critical reaches of Big Darby Creek will improve through NPDES actions (elimination of periodically toxic discharges from small WWTP through tie-in to regional WWTP with also another new WWTP to capture previously poor performing STPs and formerly unsewered areas with direct NPS runoff to BDC), which are anticipated to prevent future episodic events. Careful monitoring of regional WWTPs in area will be critical and therefore a priority for OEPA.

LDR
Page 2-25, Table 2.2.4 – In this table, how can the Big Darby Creek be "impaired" when there are no undesireable habitat attributes present at this site?

Response: Big Darby Creek is impaired in this stretch due to a fish kill from the release of contaminated water from a feed mill in Milford Center. The aquatic community has been slow to recover in this zone for unexplained reasons.

FWS
The TMDL document should require future mussel surveys to ascertain the effectiveness of the TMDL objectives in protecting Federally-listed endangered mussels.

Response: The comment is noted.

FWS
We encourage the removal of dams as suggested in the TMDL document. Removal of dams would be beneficial to Federally-listed endangered mussels.

Response: The comment is noted.

COLS
Page 2-36, Second Paragraph. The first sentence of this paragraph indicates that the "Aquatic life uses in the middle Darby Creek are impaired." However, based on the graphic in Figure 2.3.1, more than 50% of the Big Darby (the "predominate stream" in the subwatershed) is in full attainment status. To classify the entire subwatershed as impaired when more than 50% is meeting Ohio water quality standards is an overstatement. Since this section of the report is intended to "assess" the condition of the waters in each subwatershed, a more objective assessment should be provided, one that delineates the upper part of the watershed separately from the downstream portion of the watershed. Similar, more objective assessments are provided in other portions of the document.

Response: The assessment of the attainment status of this subwatershed was identical to those assessments for other subwatersheds, and was performed within HUC 14 boundaries. The impairment in the mainstem is attributable to the discharge from the Plain City wastewater treatment plant. The impairment in the tributaries is from different sources.

COLS
Page 2-38, Second Paragraph. The first sentence indicates that full recovery to EWH was evident from I-70 downstream to the terminus of the sub-watershed. However, the graphic in Figure 2.3.1 indicates the stream from Fitzgerald Ditch to the terminus of the sub-watershed is in full attainment status. Either the graphic or the text should be revised to provide consistency.

Response: The comment is noted.

B.16 Sufficiency of Sampling

Honda
If Honda has reviewed the Report and Ohio EPA's June 28, 2004 *Biological and Water Quality Study of the Big Darby Creek Watershed, 2001/2002* correctly, Honda understands that Ohio EPA's key concerns regarding low dissolved oxygen ("D.O.") concentration and high total suspended solids ("TSS") in the Flat Branch are, from a <u>quantitative</u> standpoint, largely based on a total of less than 15 samples taken from 3 sampling points on 5 days (July 2, 16 & 30, August 27, and September 10) in the summer of 2001. See *Biological and Water Quality Study of the Big Darby Creek Watershed, 2001/2002* at pp. C.1.26 -27.)[3]

First, Honda notes the disparities in these sample results; for example, with respect to TSS, the July 2nd sampling event detected levels in excess of 100 mg/l at two of the sampling sites, while on all other dates at these same two locations the TSS samples were below 50 mg/l. Similarly, with respect to D.O., the July 16 sampling event detected D.O. levels of 3.8 mg/l at two of the sampling sites, while on all other dates the D.O. level at these same two sites ranged between 4.4 mg/l and 7.0 mg/l (and therefore exceeded Ohio EPA's minimum criteria for both the MWH and the WWH designation).

Second, Honda notes that it has undertaken many water quality improvement activities in the FBCW since the date of these sampling events, and Honda cannot help but wonder whether the 2001 and 2002 data is truly representative of conditions in FBC <u>today</u>.

Honda does not focus on the date of and/or disparities within Ohio EPA's data in order to dismiss its importance or challenge its accuracy. Rather, Honda wishes to emphasize its belief that it is extremely difficult and potentially dangerous to draw meaningful conclusions based on a very small "snapshot" of data which was collected three to four years ago. It is for this reason that Honda hopes to work with Ohio EPA to develop plans for additional sampling events so that any conclusions reached are based on adequate amounts of current, accurate, and precise data

[3] Honda is also aware of the D.O. data collected from the BDC via datasonde CMUs on August 20-22, 2002. (See *Biological and Water Quality Study of the Big Darby Creek Watershed, 2001/2002* at p. B.4.2.) Similarly, this too represents a single sampling episode conducted several years ago.

Response: Ohio EPA conducted a detailed survey of the confluence of Flat Branch and Big Darby Creek in June and July of 2004 to collect data to support the water quality modeling effort. These data are remarkably consistent with the 2001 data. The data variability cited by Honda in the above comment support an episodic impact on the waterbody such as can be associated with rain events, industrial activities, or other intermittent sources. Variability in water quality data is not an unusual occurrence in such impacted streams, and it is not an indication of inaccurate data. In addition, the TSS concentrations cited above are all very elevated in comparison to the typical stream in Ohio, regardless if the concentrations are just below 50 mg/l or at 100 mg/l. Again, a strong indication of an unusual disturbance present in the Flat Branch sub-watershed. For these reasons, Ohio EPA strongly supports the ongoing data collection Honda is performing in an effort to clearly identify the source or sources of the disturbance to Flat Branch.

Honda
As noted above, the Report is based on a sampling event that occurred in 2001 and 2002. As noted in the introduction, Honda has been working on improvements which will positively impact the water quality of FBC and notes that many of these improvements were implemented or enhanced <u>after</u> the 2001 Ohio EPA study, thus the collection of new data may generate new results. Honda has been working with Ohio EPA for some time to address potential FBC water quality issues and Honda believes that these improvements are not reflected in Ohio EPA's data or the Report.

Response: Ohio EPA acknowledges the work that Honda has done. However, the water chemistry data collected in 2004 indicate unusual water chemistry comparable to the findings of the 2001 study.