
Total Maximum Daily Loads for the Upper Cuyahoga River

Final Report

prepared by

**Ohio Environmental Protection Agency
Division of Surface Water**

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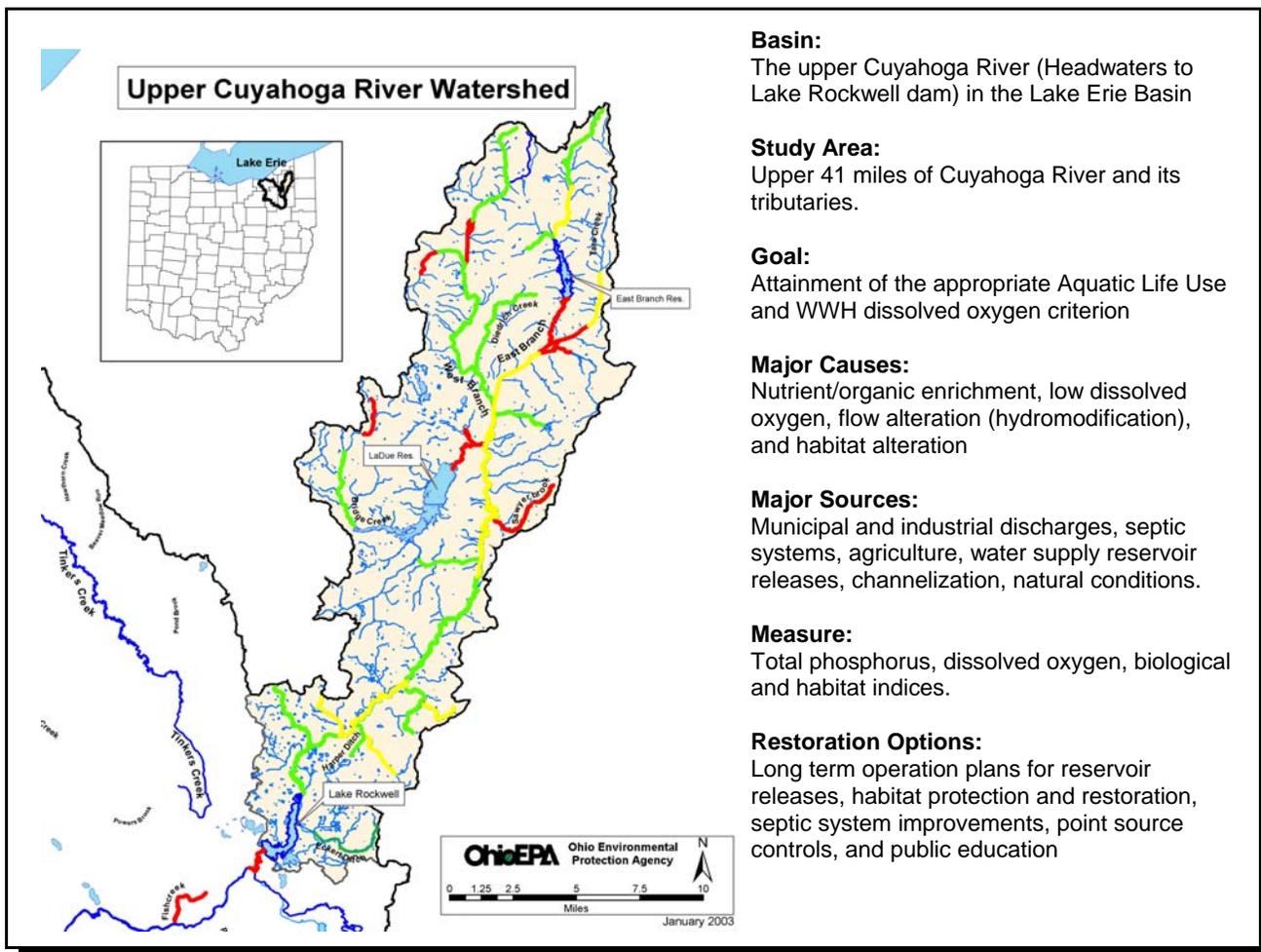


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EXECUTIVE SUMMARY

The upper Cuyahoga River watershed is located in northeast Ohio, flowing through Geauga and Portage counties on its way to Lake Erie. The watershed is predominately rural in nature with significant amounts of wetlands.

Based on Ohio EPA's monitoring of the upper Cuyahoga River watershed, a number of water bodies within this watershed appear on Ohio's 303(d) list (Ohio's impaired waters listing). Organic enrichment, nutrients, flow alteration, and habitat alteration are cited as the primary causes of impairment. Major sources of impairment include channelization, home sewage treatment systems, municipal and industrial point source discharges, water supply reservoir releases, agriculture, and natural conditions.

Stream surveys conducted in 2000 updated the information used to develop the 1998 303(d) list. Nutrients, while essential to the functioning of healthy aquatic ecosystems, can exert negative effects at relatively low concentrations by altering trophic dynamics, increasing algal and macrophyte production, increasing turbidity, decreasing average dissolved oxygen (DO) concentrations, and increasing fluctuations in diel dissolved oxygen and pH. Ohio's water quality standards include numerical biological criteria, which forms the basis of the numerical targets for the TMDLs. The success of the implementation actions resulting from the TMDLs will be evaluated by observed improvements in biological scores. Intermediate nutrient targets complement the biocriteria and are used as a tool to help evaluate the impact of nutrient loadings. These nutrient targets were based on a recent Ohio EPA technical bulletin (Ohio EPA, 1999) which relate instream nutrient concentrations to aquatic community performance.

Reasonable assurances proposed for the upper Cuyahoga River watershed include a combination of regulatory, incentive, and non-regulatory actions such as NPDES permit actions, riparian protection and restoration efforts, and Section 319 projects.

Table 1. Components of the Upper Cuyahoga River TMDL Process	
Study Area	Upper Cuyahoga River Basin - Headwaters to Lake Rockwell Dam
Listed Watersheds (see Table 2 for segments)	04110002-010 Headwaters to below Black Brook 04110002-020 Below Black Brook to below Breakneck Creek
Target Identification	Total phosphorus, dissolved oxygen, and biological and habitat/sediment indices
Applicable Water Quality Criteria	<u>OAC 3745-1-04 (A) and (E)</u> Free from suspended solids and other substances that enter the waters as a result of human activity and that will settle to form objectionable sludge deposits, or that will adversely effect aquatic life or create nuisance growths of aquatic weeds and algae. <u>OAC 3745-1-07</u> Dissolved Oxygen, instantaneous minimum: 4.0 (WWH) mg/l 24-hour average: 5.0 (WWH) mg/l Ecoregion Biocriteria, refer to Appendix A
Current Deviation from Target	Violations of instantaneous minimum dissolved oxygen criteria have been recorded. Phosphorus and habitat levels exceed targets. Biological communities fail to achieve biocriteria.
Sources	Municipal treatment plants, industrial wastewater discharges, septic systems, agriculture (cattle grazing), water supply reservoir releases, channelization, natural conditions
Load Allocation	Refer to Section 5-2 for habitat/sediment and Section 5-3 for total phosphorus.
Critical Season/Conditions	Summer low flow conditions coupled with high temperatures are critical for low DO (increased possibility of hypolimnetic reservoir releases)
Safety Margin	Explicit and implicit in calculations.
Implementation Plan	Currently being developed; a draft copy is in Section 7.2. Components include stormwater management, septic system management, agriculture and riparian corridor initiatives, point source controls, and education. Plans will be developed in cooperation with owners of the reservoirs to operate the releases that are subject to control in as environmentally friendly a manner as possible. An iterative, adaptive implementation approach will be used.
Validation	Tiered approach to validation; assessment progression includes: 1. Confirmation of completion of implementation plan activities 2. Evaluation of attainment of chemical water quality criteria 3. Evaluation of attainment of recreational criteria 4. Evaluation of biological attainment
Public Participation	Public information sessions, public notice and meeting on report, stakeholder groups.

1.0 INTRODUCTION

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 waters (the Section 303(d) lists) are made available to the public and submitted to the U.S. Environmental Protection Agency (U.S. EPA) in every even-numbered year (40 CFR 130.7(d) did not require a 303(d) list submittal in the year 2000). The Ohio Environmental Protection Agency (Ohio EPA) identified the upper Cuyahoga River watershed as a priority impaired water on the 2002 303(d) list. Results of the year 2000 watershed sampling and assessment have been used to update the current knowledge of water quality within the basin. A summary of the upper Cuyahoga watershed portion of the 2002 303(d) list is included in Table 2. A general overview of Ohio's water quality standards is included in Table 3. Attainment status based on the 2000 watershed survey is included as Appendix A.

The Clean Water Act and U.S. EPA regulations require that Total Maximum Daily Loads (TMDLs) be developed for all waters on the section 303(d) lists. A TMDL is 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 amount to the pollutant's sources. The process of formulating TMDLs for specific pollutants is therefore, a method by which impaired water body segments are identified and restoration solutions are developed. Ultimately, the goal of Ohio's TMDL process is full attainment of biological and chemical Water Quality Standards (WQS) and, subsequently, removal of water bodies from the 303(d) list. The Ohio EPA believes that developing TMDLs on a watershed basis (as opposed to solely focusing on impaired segments within a watershed) is an effective approach towards this goal.

This report documents the upper Cuyahoga River TMDL process and provides for tangible actions to restore and maintain this water body. The main objectives of the report are to describe the water quality and habitat condition of the upper Cuyahoga River and to quantitatively assess the factors affecting non or partial attainment of WQS. A draft implementation plan is also included. This plan identifies actions to address these factors and specifies monitoring to ensure actions are carried out and to measure the success of the actions proscribed. The report is organized in sections forming the progression of the TMDL process.

The primary causes of impairment in the upper Cuyahoga River watershed are hydromodification (dam releases and channelization), nutrient enrichment, low instream dissolved oxygen, and habitat degradation. The Qualitative Habitat Evaluation Index (QHEI), a measure of habitat condition, directly or indirectly measures all of these causes. Aquatic life and sediment TMDLs based on this index as well as total phosphorus TMDLs are included in this report. Activities currently underway and planned for the near future will address nutrients and the non-load based impairing

causes of DO, habitat, and hydromodification. They are included here and are considered to be a parallel concept to a TMDL for load-based parameters.

2002 303(d) List		Assessment Unit Impairment Detail		TMDLs in this Report ²
Description	Major Causes	Description	Major Causes	
Cuyahoga River (headwaters to below Black Brook) [04110002 010] Assessment unit score for Aquatic Life Use attainment: full = 19 partial = 61 non = 20 Overall Priority Points: 9 (high)	<ul style="list-style-type: none"> • Siltation • Org Enrich/DO • Flow Alteration • Habitat Alteration • Natural Limits (Wetlands) • Bacteria ³ 	Cuyahoga River (headwaters to Black Brook) [OH 88 13]	<ul style="list-style-type: none"> • Org Enrich/DO • Flow Alteration • Habitat Alteration • Natural (Wetlands) • Nutrients 	<ul style="list-style-type: none"> • Org Enrich/DO • Flow Alteration • Habitat Alteration • Nutrients
		Tare Creek [OH 88 19]	<ul style="list-style-type: none"> • Org Enrich/DO • Habitat Alteration • Natural (Wetlands) • Nutrients 	<ul style="list-style-type: none"> • Org Enrich/DO • Flow Alteration • Habitat Alteration • Nutrients
		West Branch Cuyahoga River [OH 88 16]	<ul style="list-style-type: none"> • Org Enrich/ DO • Natural (Wetlands) 	<ul style="list-style-type: none"> • Org Enrich/DO • Flow Alteration • Habitat Alteration • Nutrients
		Butternut Creek [OH 88 17]	<ul style="list-style-type: none"> • Org Enrich/ DO 	<ul style="list-style-type: none"> • Org Enrich/DO • Flow Alteration • Habitat Alteration • Nutrients
		Bridge Creek [OH 88 15] (1996 data)	<ul style="list-style-type: none"> • Org Enrich/DO • Flow Alteration • Habitat Alteration • Natural (Wetlands) 	<ul style="list-style-type: none"> • Org Enrich/DO • Flow Alteration • Habitat Alteration • Nutrients
		Sawyer Brook [OH 88 14]	<ul style="list-style-type: none"> • Siltation • Org Enrich/ DO 	<ul style="list-style-type: none"> • Org Enrich/DO • Flow Alteration • Habitat Alteration • Nutrients
		Trib (RM 88.02) to Sperry Pond (Middlefield) [OH 88 19.1]	<ul style="list-style-type: none"> • Nutrients 	<ul style="list-style-type: none"> • Org Enrich/DO • Flow Alteration • Habitat Alteration • Nutrients
		Tributary to Bridge Creek (Snow Lake Outlet) [OH 88 15.1]	<ul style="list-style-type: none"> • Natural (Wetlands) 	

Table 2. 303(d) List Status for the Upper Cuyahoga River Watershed ¹				
2002 303(d) List		Assessment Unit Impairment Detail		TMDLs in this Report ²
Description	Major Causes	Description	Major Causes	
Cuyahoga River (below Black Brook to below Breakneck Creek) [04110002 020] Assessment unit score for Aquatic Life Use attainment: full = 80 partial = 16 non = 4 Priority Points: 3 (low)	<ul style="list-style-type: none"> • Siltation • Org Enrich/DO • Flow Alteration • Habitat Alteration • Natural Limits (Wetlands) • Unknown Toxicity 	Cuyahoga River below Black Brook to Lake Rockwell dam [OH 88 11]	<ul style="list-style-type: none"> • Org Enrich/DO • Flow Alteration • Nutrients 	<ul style="list-style-type: none"> • Org Enrich/DO • Flow Alteration • Habitat Alteration • Nutrients
		Cuyahoga River Lake Rockwell dam to below Breakneck Creek [OH 88 11] (1996 data)	<ul style="list-style-type: none"> • Org Enrich/DO • Flow Alteration • Nutrients 	This segment is included in the Middle Cuyahoga TMDL (approved in 2001 ⁴)
		Trib to Harper Ditch [OH 88 93]	<ul style="list-style-type: none"> • Habitat Alteration 	<ul style="list-style-type: none"> • Org Enrich/DO • Flow Alteration • Habitat Alteration • Nutrients
		Trib (RM 65.19) to Cuyahoga River near Coit Rd. [OH 88 11.5]	<ul style="list-style-type: none"> • Habitat Alteration 	<ul style="list-style-type: none"> • Org Enrich/DO • Flow Alteration • Habitat Alteration • Nutrients

¹ The 1998 303(d) list was based on data collected in 1991. This report also includes more current data collected in 1996 and 2000, which formed the basis for the 2002 303(d) list. Refer to text and to Appendix A for detailed discussion of watershed condition, attainment status, and causes and sources of impairment.

² TMDL numbers are included for nutrients. Low DO, flow alteration, natural (wetlands), and altered habitat are not load based causes of impairment. Allocations for factors affecting instream DO (TP, NH₃, cBOD₅, DO), shading and habitat (components of the QHEI scores) are included and are considered to be a parallel concept to a TMDL for load-based parameters. TMDLs are included for attaining waters to protect downstream uses.

³ The inclusion of bacteria on the 2002 303(d) list was based on a preliminary screening methodology for the recreation use designation. The 2004 303(d) list contains a more rigorous methodology that does not result in listing for bacteria (based on 168 records from 19 sites). See page D.2 -79 of the 2004 Ohio Integrated Water Quality Monitoring and Assessment Report for a summary and the report text for more information about the methodology (<http://www.epa.state.oh.us/dsw/TMDL/2004IntReport/2004OhioIntegratedReport.html>). The final 2004 303(d) list was approved by U.S. EPA on May 5, 2004.

⁴ The Middle Cuyahoga River TMDL can be viewed at <http://www.epa.state.oh.us/dsw/tmdl/midcuy.html>.

2.0 APPLICABLE WATER QUALITY STANDARDS AND TARGETS

Under the Clean Water Act, every state must adopt water quality standards to protect and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the goal of the Clean Water Act “to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters”. Table 3 provides a brief description of Ohio’s water quality standards. Further information is available in Chapter 3745-1 of the Ohio Administrative Code (OAC) <http://www.epa.state.oh.us/dsw/wqs/criteria.html>.

2.1 Ohio’s Water Quality Standards

The foundation for the Ohio water quality standards (WQS) is the concept that public waters have beneficial uses that are to be available to the public. In order to ensure that these uses are available, the standards establish criteria by which attainment, or non-attainment of these beneficial uses may be judged. Meeting the criteria established for a beneficial use is expected to result in attainment of that use. There are three designated uses established in the WQS: water supply, recreation, and aquatic life. Specific information for use designations in the upper Cuyahoga watershed can be found in OAC 3745-1-26. The impaired designated use in the upper Cuyahoga River watershed is the aquatic life use for Warmwater Habitat (WWH).

Waters designated as WWH are capable of supporting and maintaining a balanced integrated community of warmwater aquatic organisms. Attainment of the aquatic life use is determined by directly measuring the fish community and the bottom dwelling community of immature insects, clams, snails, and worms, collectively known as “macroinvertebrates”. This is accomplished by collecting samples of the aquatic life present in the stream being assessed using standardized methods. The fish community is sampled by electrofishing, and the macroinvertebrates are sampled using artificial substrate samplers, and by direct collection.

Once standardized samples of the resident aquatic life have been collected, the results of those samples are compared to results from “least impacted” areas of the same ecological region and aquatic life use. Attainment benchmarks from these “least impacted” areas are established in the WQS in the form of biological criteria, which are then compared to the measurements obtained from the study area. If measurements of a stream do not achieve the three biocriteria (for fish, Index of Biotic Integrity (IBI) and modified Index of Well-being (MIwb); for aquatic macroinvertebrates, Invertebrate Community Index (ICI)) the stream is considered in non attainment. If the stream measurements achieve some of the biological criteria, but not others, the stream is said to be in partial-attainment. A stream that is in partial attainment is not achieving its designated aquatic life use, whereas a stream that meets all of the biocriteria benchmarks, it is said to be in full attainment. It should also be noted that non-

Table 3. Summary of the Components and Examples of Ohio's WQS

Component	Examples of:	Description
Beneficial Use Designation	<ol style="list-style-type: none"> 1. Water supply <ul style="list-style-type: none"> • Public (drinking) • Agricultural • Industrial 2. Recreational contact <ul style="list-style-type: none"> • Beaches (Bathing waters) • Swimming (Primary Contact) • Wading (Secondary Contact) 3. Aquatic life habitats (partial list): <ul style="list-style-type: none"> • Exceptional Warmwater (EWH) • Warmwater (WWH) • Modified Warmwater (MWH) • Limited Resource Water (LRW) • State Resource Water 	<p>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).</p> <p>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.</p> <p>Recreational uses indicate whether the water can potentially be used for swimming or if it may only be suitable for wading.</p>
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	<p><i>Measures of fish health:</i></p> <ul style="list-style-type: none"> • Index of Biotic Integrity • Modified Index of Well Being <p><i>Measure of bug (macroinvertebrate) health:</i></p> <ul style="list-style-type: none"> • Invertebrate Community Index <p>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.</p>
	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 (the "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.	

attainment results when all indices fail to meet expectations or when one or more of the indices are in the poor or very poor narrative condition category.

Having determined the aquatic life use attainment status of a stream through direct measurement of the aquatic biological community, other facets of the WQS criteria start to come into play. Chemical water quality criteria are established as a surrogate for direct measurement of the aquatic biological community to allow a determination if a particular pollutant is present in amounts that are projected to cause impairment in an aquatic biological community. Chemical water quality criteria are derived from laboratory toxicity testing, and while application of the chemical criteria to ambient waters is required, it is still an extrapolation from the laboratory to the real world, hence Ohio EPA's reliance on direct measurement of the aquatic biological community for use attainment determination.

Once impairment has been determined, applicable chemical targets or criteria are used to establish acceptable loads of pollutants in the stream as a part of the TMDL process. By limiting the loads of critical pollutants, a TMDL establishes a level of the pollutant(s) whereby an impairment to the aquatic biological community is projected to be eliminated. In Ohio, this approach will be judged to be successful when direct measurement of the aquatic biological community results in the attainment of biocriteria.

2.2 Target Identification

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 segment. The TMDL identifies the load reductions and other actions that are necessary to meet the target, thus resulting in the attainment of applicable WQS.

Total Phosphorus

Numeric targets are derived directly or indirectly from state narrative or numeric water quality standards (OAC 3745-1). Ohio currently does not have statewide numeric criteria for nutrients, but potential targets have been identified in a technical report entitled *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999). This document provides the results of a study analyzing the effects of nutrients on the aquatic assemblages of Ohio streams and rivers. The study reaches a number of conclusions and stresses the importance of habitat and other factors, in addition to instream nutrient concentrations, as having an impact on the health of biologic communities. The study also includes proposed targets for total phosphorus concentrations based on observed concentrations in various streams throughout the ecoregion which are attaining Ohio's water quality standards biocriteria. The total phosphorus targets are shown in Table 4. It is important to note that these nutrient targets are not codified in Ohio's water quality standards; therefore, there is a certain degree of flexibility as to how they can be used in a TMDL setting.

Ohio's standards also include narrative criteria which limits the quantity of nutrients which may enter waters. Specifically, OAC 3745-1-04 states that all waters of the state shall be free from nutrients entering the waters as a result of human activity in concentrations that create nuisance growths of aquatic weeds and algae.

Table 4. Total Phosphorus Targets	
<i>Erie-Ontario Lake Plain Watershed Size</i>	Total Phosphorus (mg/l) Warmwater Habitat
Headwaters (drainage area < 20 mi ²)	0.05
Wadeable (20 mi ² < drainage area < 200 mi ²)	0.07
Small River (200 mi ² < drainage area < 1000 mi ²)	0.115

Dissolved Oxygen

The instream dissolved oxygen (DO) is the primary chemical/physical specific parameter not fully attaining WQS. A measurable endpoint of this TMDL process is to attain the DO water quality criterion at all times including summer, low flow critical conditions. The DO criteria for the Warmwater Habitat segments is a 5.0 mg/l average over a 24-hour period and a 4.0 mg/l minimum.

Siltation and Habitat

Siltation was identified as a major cause of impairment for certain tributaries in the upper Cuyahoga River. OAC 3745-1-04 states that all waters of the state shall be free from suspended solids and other substances that enter the waters as a result of human activity and that will settle to form objectionable sludge deposits, or that will adversely effect aquatic life. As with total phosphorus, no statewide numeric criteria have been developed specifically for sediment or TSS. Instead, target Qualitative Habitat Evaluation Index (QHEI) scores and metrics, based on reference data sites for some of the aquatic life use designations, can be used as surrogates. The QHEI is a quantitative composite of six physical habitat variables, or metrics, used to 'score' a stream's habitat. One of these variables is substrate and incorporates sediment quality and quantity. This substrate metric provides a numeric target for sedimentation.

Since habitat is strongly correlated with the IBI biocriterion, the QHEI provides a target and format to evaluate how habitat issues and impairments effect attainment of the aquatic use designations. Although some streams with QHEI scores between 45 and 60 are attaining Ohio's biocriteria, the Warmwater Habitat use designation QHEI target is 60. Degraded habitat (QHEI scores less than 60) has been identified as a major cause of non attainment in several stream segments within the upper Cuyahoga River TMDL area.

Biocriteria

The biocriteria are the final arbiters of attainment of an aquatic life use designation. After the control strategies have been implemented, biological measures including the IBI, ICI, and MIwb will be used to validate biological improvement and biocriteria attainment. The applicable biocriteria and their current attainment is listed in Appendix A.

3.0 WATERSHED OVERVIEW

3.1 Location and Watershed Characteristics

Cuyahoga River Basin

The Cuyahoga River basin (Figure 1) drains 813 square miles and includes 1,220 stream miles spanning parts of Geauga, Portage, Summit and Cuyahoga counties, emptying into Lake Erie at Cleveland. The river is one of the few rivers in the world that changes flow direction and creates a u-shaped watershed. The basin is situated within the Erie/Ontario Lake Plain (EOLP) ecoregion and contains parts of three major physiographic provinces: the glaciated Allegheny Plateau, the till plains, and the lake plains. The EOLP is a glacial plain that lies between the unglaciated Western Allegheny Plateau (WAP) ecoregion to the southeast and the relatively flat Eastern Corn Belt Plains (ECBP) ecoregion to the west and southwest. The EOLP ecoregion is characterized by glacial formations that can have a significant local relief of up to 300 feet and exhibits a mosaic of cropland, pasture, woodland, and urban areas. Soils are mainly derived from glacial till and lacustrine deposits and tend to be light colored, acidic, and moderately to highly erodible.

Many glacial features characteristic of the EOLP ecoregion are found in the Cuyahoga River basin. Most of the basin occurs within the glaciated Allegheny Plateau, and owes its topographic and hydrologic features to a complex glacial history. A small portion of the basin in southwest Cuyahoga County lies within the till plains, a relatively flat area more characteristic of north central and northwestern Ohio. The Cuyahoga River basin also cuts through the narrow border of the nearly level lake plains that surround Lake Erie which represents the ancient bottom of the predecessors to Lake Erie. The northern and eastern boundaries of this watershed are largely defined by the terminal moraines left by two fingers of glacial ice. The retreating glaciers then buried the ancient river valleys with glacial outwash. The river generally follows the course of the buried ancient river valleys, but does traverse a ridge of erosion-resistant sandstone near Akron. The result is that the southerly flowing river forms the falls and cascades of Cuyahoga Falls and turns sharply to the northwest at the confluence with the Little Cuyahoga River just north of Akron. The river then winds through outwash terraces, till plains, and till ridges before reaching the flat lake plain of the Cleveland area.

Land use patterns vary greatly from the upper basin that is primarily forest/ agricultural/ rural, to the lower basin which is among the most densely populated and industrialized urban areas in the state. Agriculture is the predominant land use in the upper basin, and while less prevalent in the middle basin, the soils are highly erodible and can result in significant sedimentation and nutrient loadings. Resource extraction and hydromodification are localized throughout the basin. The waters of the heavily populated areas of the middle and lower basin are influenced by urban and construction

site runoff, municipal and industrial point sources, combined/sanitary sewer overflows, and land disposal.

The Cuyahoga River basin has been divided by Ohio EPA into three subbasins: the upper, from the headwaters to the Lake Rockwell dam; the middle, from below the Lake Rockwell dam to the Munroe Falls dam; and the lower, from below the Munroe Falls dam to the mouth at Cleveland and Lake Erie.

The upper is the focus of this report. The lower and the middle sections have U.S. EPA-approved TMDL studies located at:

Lower Cuyahoga- <http://web.epa.state.oh.us/dsw/tmdl/LowerCuyahogaFinalTMDL.html>

Middle Cuyahoga- <http://web.epa.state.oh.us/dsw/tmdl/midcuy.html>

Upper Cuyahoga River

The upper Cuyahoga River watershed drains 208 square miles with 351 miles of principal streams. It originates in northeastern Geauga County and flows southwest to near Kent through relatively hilly kame and kettle topography. Figure 2 is a schematic of the upper watershed showing locations of municipal and industrial point sources, tributaries, reservoirs and wetland areas. Land use in the upper basin is primarily forest/agriculture as shown in Figure 3 and quantified in Table 5. Approximately 12% of the land is owned and managed by the City of Akron for protection of its drinking water source. A twenty five mile segment of the Cuyahoga River, from the Troy-Burton Township line in Geauga County to State Route 14 in Portage County, is a designated State Scenic River and several stream segments within the basin have been designated as State Resource Waters. Three water supply reservoirs for the City of Akron are located in the upper basin: East Branch (428 acres) and LaDue (1550 acres) provide storage for Lake Rockwell (625 acres) where the Akron drinking water treatment plant is located. The significant point source NPDES facilities are detailed in Table 6.

Figure 1. Cuyahoga River Basin

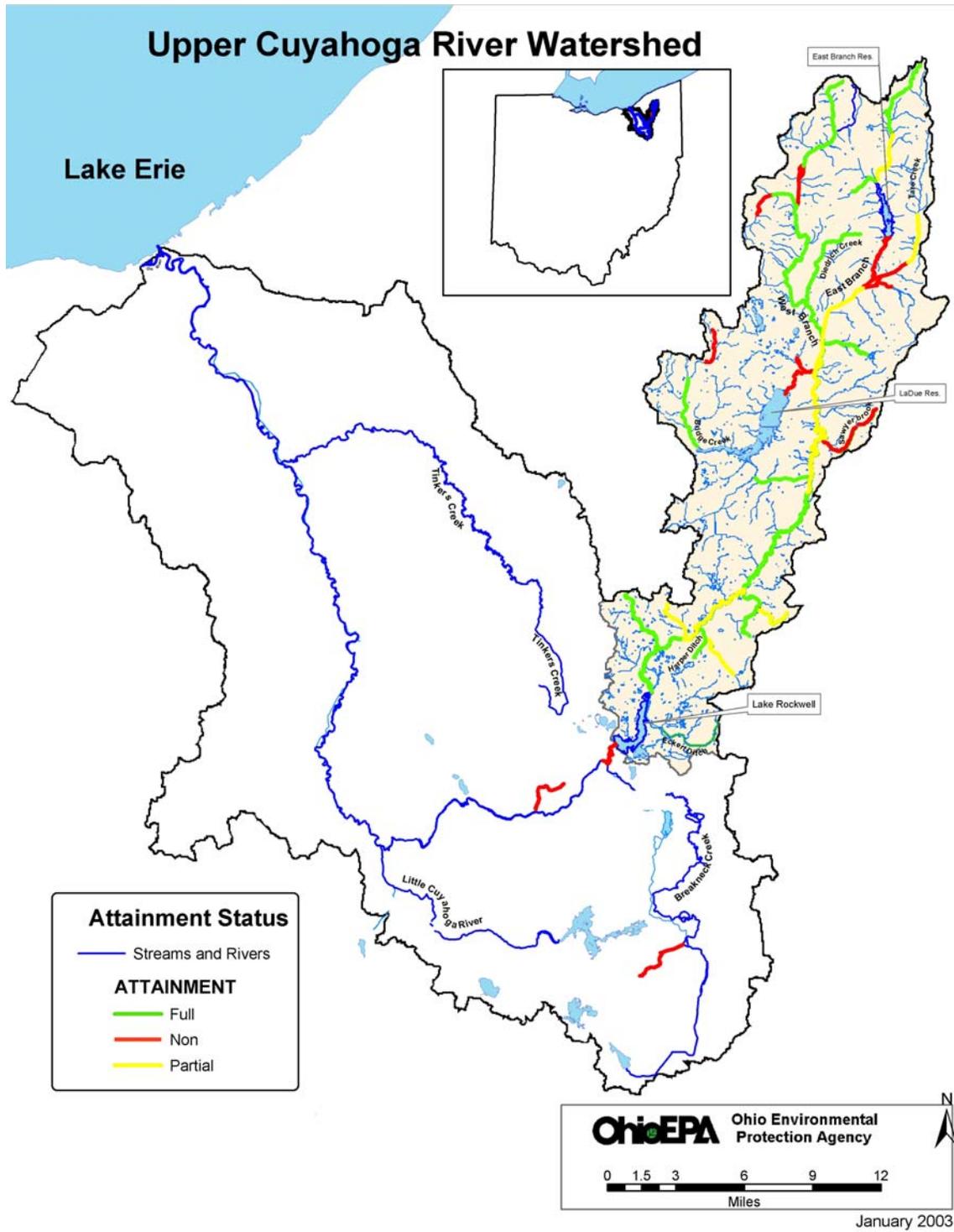


Figure 2. Schematic Representation of the Upper Cuyahoga Watershed

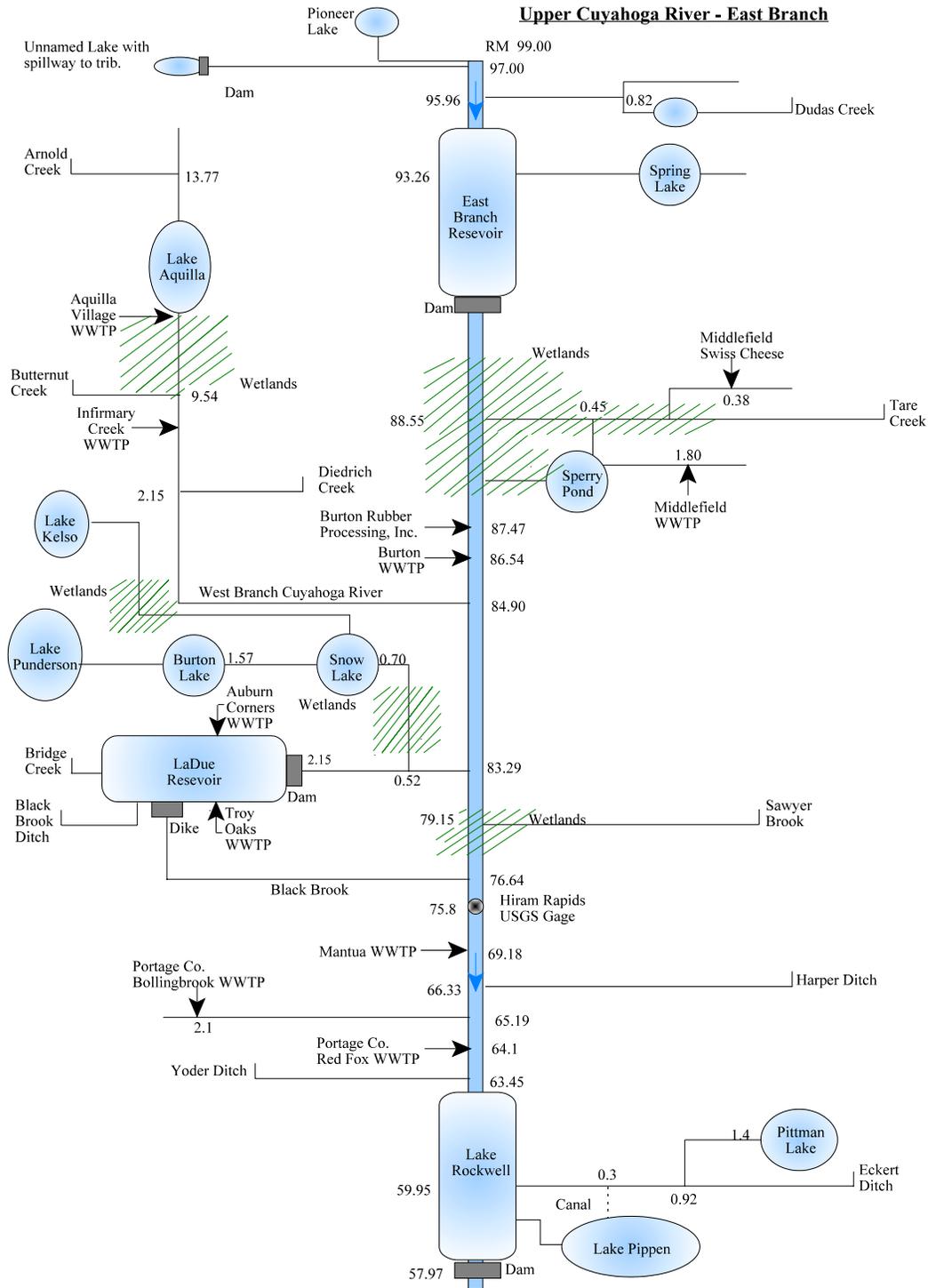


Figure 3. Distribution of Land Cover in the Upper Cuyahoga River Basin

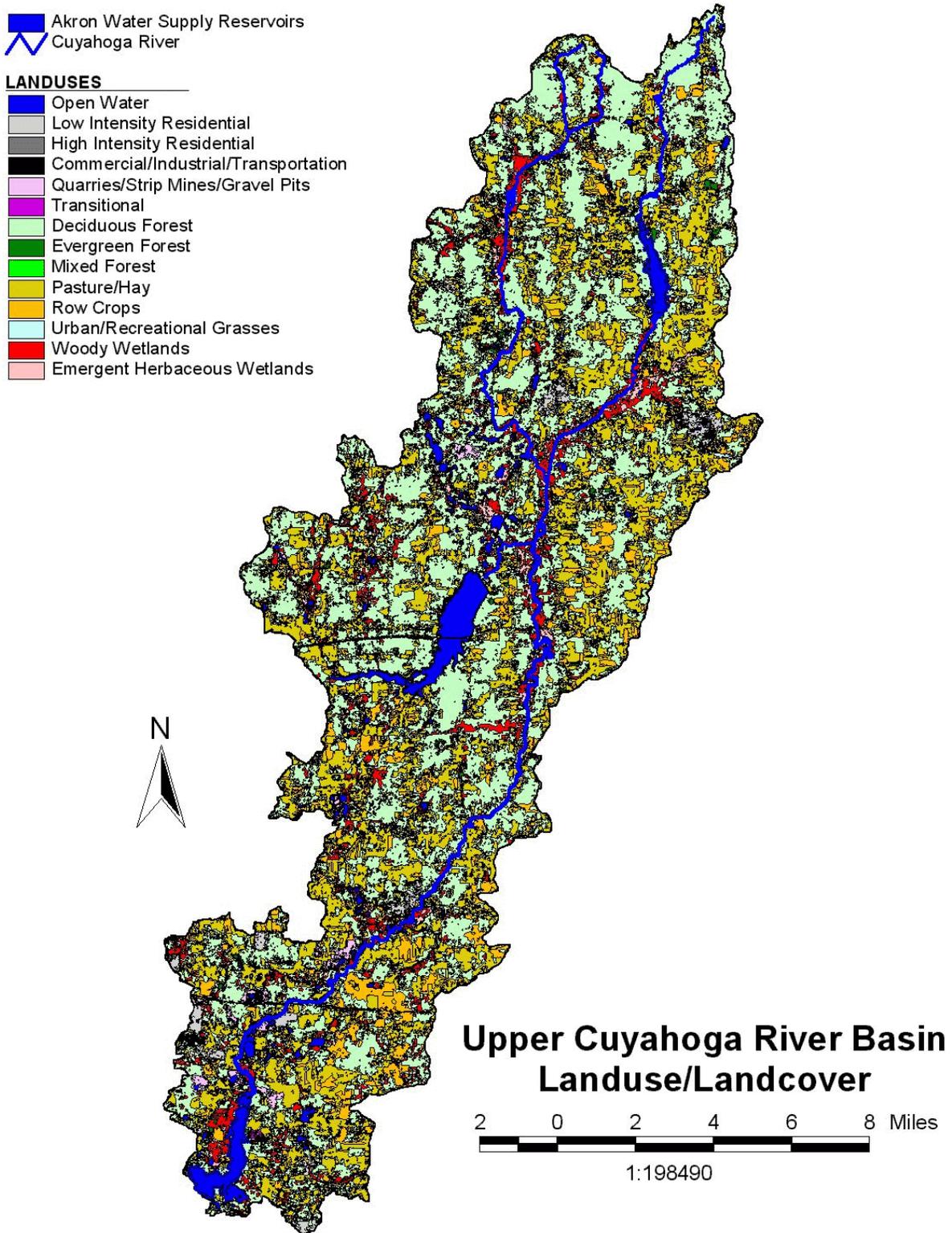


Table 5. Land Cover and Land Use in the Upper Cuyahoga River Basin		
Land Use	Acres	Percent of Area
Deciduous Forest	58832	44.3
Pasture/Hay	35039	26.4
Row Crops	14689	11
Woody Wetlands	9324	7.03
Open Water	4865	3.67
Emergent Herbaceous Wetlands	3667	2.77
Low Intensity Residential	2210	1.67
Evergreen Forest	1763	1.33
Quarries/Strip Mines/Gravel Pits	751	0.57
Commercial/Industrial/Transportation	597	0.45
Mixed Forest	519	0.39
High Intensity Residential	144	0.11
Urban/Recreational Grasses	126	0.1
Transitional	70	0.05

GIS data from Land Use/Land Cover, 1996 Geauga County and Land Use/Land Cover, 1977 Portage County. ODNR Division of Real Estate and Land Management Resource Analysis Section, 1952 Belcher Drive - Bldg C-2, Columbus, OH 43224.

Table 6. Significant NPDES Dischargers in the Upper Cuyahoga River Basin			
Entity	Receiving Stream (RM)	Design Flow (MGD)	Annual 2000 Median Flow (MGD)
Hans Rothenbuhler and Sons 3IH00025	Tributary to Tare Creek (0.38)	0.16 interim 0.24 final	0.153
Middlefield WWTP 3PB00034	Tributary to Tare Creek (1.80)	0.63	0.65
Burton WWTP 3PB00066	East Branch Cuyahoga River (86.54)	0.27	0.27
Mantua WWTP 3PB00031	Cuyahoga River (69.18)	0.5 (after expansion)	0.26

3.2 Water Quality Assessment

For the upper Cuyahoga River TMDL, Ohio EPA conducted a detailed assessment of chemical (water column, effluent, sediment), physical (dissolved oxygen, flows, habitat), and biological (fish and macroinvertebrate) conditions in order to determine if streams and rivers in the study area were attaining their designated uses. The basis for the listing of the upper Cuyahoga on the 303(d) list is the measurements that were obtained in an assessment conducted in 1996 (Ohio EPA, 1998). Ohio EPA re-assessed the Cuyahoga River study area in 2000. This TMDL report addresses both the results in the 303(d) list based on 1996 data and the results of the 2000 assessment. However, greater weight is given to the 2000 data, as it is most reflective of current watershed conditions. An aquatic life use attainment table based on the 2000 sample results for the upper Cuyahoga study area is provided in Appendix A. The table is arranged from upstream to downstream and includes sampling locations indicated by river mile (RM), the applicable biocriteria indices, the use attainment status (i.e., full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI) (an indicator of habitat quality), and comments for the sampling location. See Figure 4 for a graphic representation of attainment status.

The upper segment drains rural and low density residential landscapes, forest and agriculture being the predominant land uses. The river and its tributaries course through low relief lacustrine deposits. Consequently, the land is naturally poorly drained, and extensive surface and subsurface drainage modifications (mainly channelization and extensive use of field tile) were necessary to promote cultivation. These activities have converted most of the once vast stream/wetland complexes of the upper Cuyahoga River basin to simple conveyances of flow. Presently, much of the river's drainage network consists of *former* wetland streams, retaining low gradient features and some of the biological attributes of their predecessors, but detached from the landscape and ensconced in deeply incised, highly artificial channels. Although the majority of the drainage work was done near the turn of the nineteenth century, low gradient has precluded significant natural restoration at most sites.

The conditions described above typify the upper Cuyahoga basin from its headwaters to the Hiram Rapids. At this point, the Cuyahoga River leaves the lacustrine deposits of the Lake Plain, and enters the Glaciated Plateau, an area of much greater relief. The effects of associated glacial features (e.g., kames, eskers, outwash areas, and moraines) are pronounced, directly influencing stream channel morphology, hydrology, and substrate composition. Furthermore, the level of manipulation required to render the landscape suitable for cultivation, or other more intensive land uses, is significantly less than that found upstream within the Lake Plain, due to better natural drainage. As a result, the quality of near and instream macrohabitats of the Cuyahoga River, between Hiram Rapids and the upper limit of the Lake Rockwell dam pool, have been largely conserved.

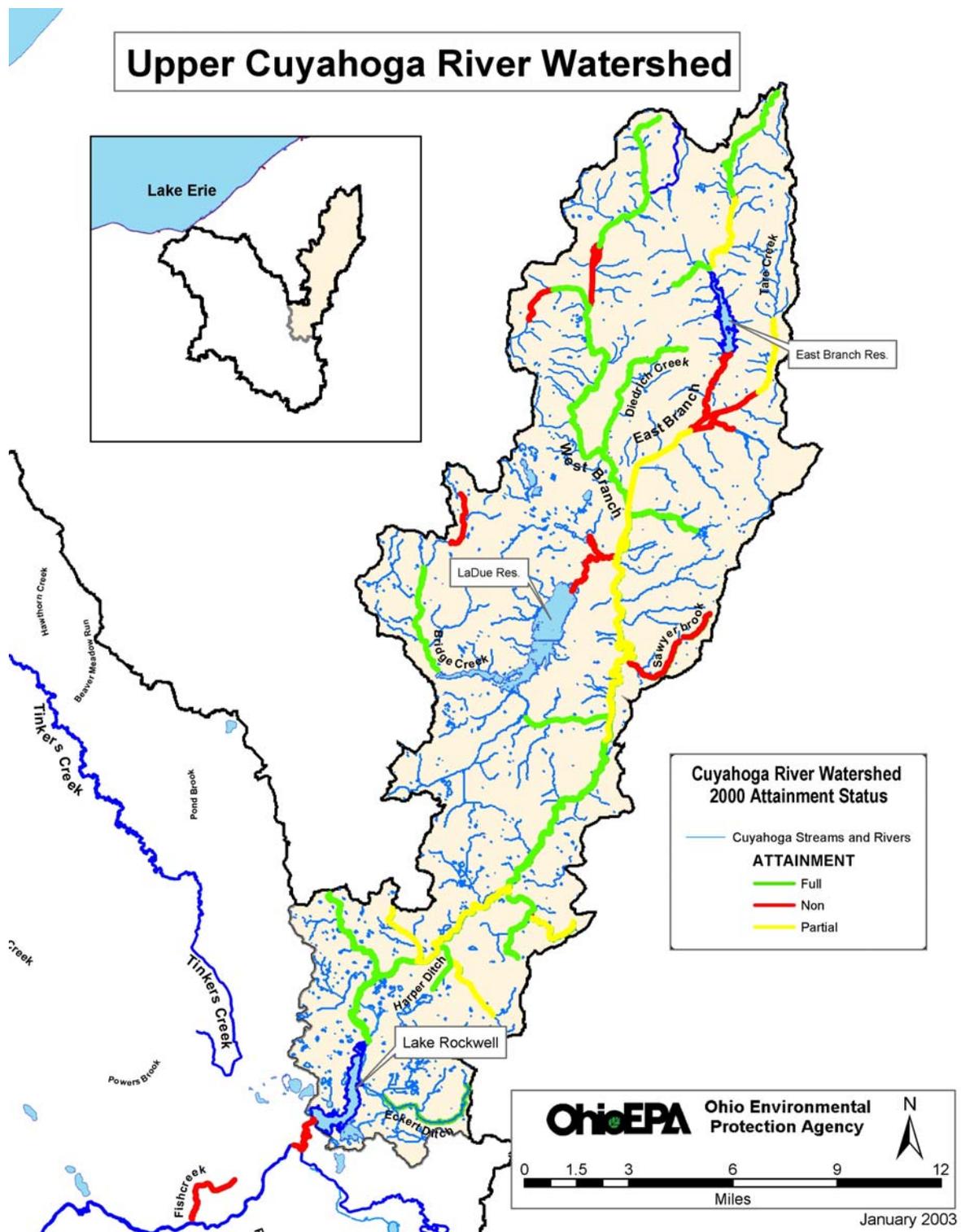
Of the approximately 40 river miles contained within the upper Cuyahoga River, only 5.8 miles (14.5%) met the requisite biocriteria. Among the six mainstem stations evaluating this segment, only two were found to support an assemblage of fish fully consistent with the WWH use. These sites were located at RMs 97.7 and 64.3, and represented the upper and lower limits of this segment. Although, both stations met the proscribed biocriteria, the assemblages at each were dramatically different, reflective of the contrasting habitats at each location. The upper site (RM 97.7) was situated within the Lake Plain on a relatively unimpacted, low gradient, wetland influenced headwater segment. The reach was largely in a natural state (mainly unchannelized), highly sinuous, and hemmed in by an extensive mature riparian corridor. The fish community was a good example of a simple, but well-structured wetland associated assemblage. In contrast, outstanding riverine habitat was indicated at RM 64.3 (high gradient, coarse substrates, sinuous channel). This site was found to support a *classic* assemblage of warm water riverine fish—diverse and well-structured, with sensitive species represented. Habitat features and community performance at this location clearly reflected the influence of high quality macrohabitat and good to excellent water quality.

The remaining four stations, evaluating the intervening 34.2 miles (85.5%) of the upper Cuyahoga River, failed to support WWH fish communities. By and large, fish community performance appeared commensurate with macrohabitat quality. Taken together, these former swamp stream stations simply did not possess adequate habitat complexity and flow regimes required to support and maintain an assemblage of fish consistent with the WWH biocriteria. The worst conditions were indicated immediately downstream from the East Branch Reservoir at RM 90.6. At this site the IBI dropped a full ten points, from 32 (fair) to 22 (poor), in comparison with the upstream station. Negative changes in the fish community included a significant increase in the incidence of DELT anomalies (Deformities, Eroded fins and/or barbels, Lesions, and Tumors), and a rise in the proportion of tolerant, omnivorous species, and pioneering taxa. The latter is a good indicator of severe but episodic stress, suggesting that the community is in a perpetual state of recovery (Bayley and Osborne, 1993). Poor community performance at this location was attributed to hypolimnetic releases and modified hydrology associated with the East Branch Reservoir. Common features among reservoir influenced warm water streams, particularly where summer hypolimnetic releases are frequent, include depressed DO concentrations, elevated ammonia-N, unseasonable thermal regime, and highly artificial hydrology (Yeager, 1993). Singularly or in combination, it is very likely that these stressors served to exacerbate or compound the negative effects of existing habitat deficiencies.

Comprehensive water quality survey reports of the Cuyahoga River Basin are available on Ohio EPA's Web site. The 1991 survey (*Biological and Water Quality Study of the Cuyahoga River - EAS/1992-12-11*) may be found at:
<http://www.epa.state.oh.us/dsw/documents/cuyahg91.pdf>

The 1996 survey (*Biological and Water Quality Study of the Cuyahoga River and Selected Tributaries; Geauga, Portage, Summit and Cuyahoga Counties (Ohio). Volume 1. Appendices, Volume 2 - MAS/1998-12-4*) may be found on Ohio EPA's Web site at: <http://www.epa.state.oh.us/dsw/documents/cuyvol1.pdf> and <http://www.epa.state.oh.us/dsw/documents/cuyvol2.pdf>.

Figure 4. Upper Cuyahoga River Attainment Status



3.3 Summary of Impairments

The determination of impairment in rivers and streams in Ohio is straightforward – the numeric biocriteria are the principal arbiters of aquatic life use attainment and impairment. The rationale for using biocriteria has been extensively discussed elsewhere (Karr, 1991; Ohio EPA, 1987a,b; Yoder, 1989; Miner and Borton, 1991; Yoder, 1991). Ohio EPA relies on an interpretation of multiple lines of evidence including water chemistry, sediment, habitat, effluent and land use data, biomonitoring results, and biological response to describe the causes (e.g., nutrients) and sources (e.g., agricultural runoff) associated with observed impairments. The initial assignment of the principal causes and sources of impairment that appear on the Section 303(d) list do not necessarily represent a true “cause and effect” relationship. Rather they represent the association of impairments (based on response indicators) with stressor and exposure indicators whose links with the survey data are based on previous experience with similar situations and impacts. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified.

The upper Cuyahoga River watershed is impacted by both point (e.g., municipal wastewater treatment plants) and nonpoint (e.g., agricultural runoff) sources. Table 2 details the causes and sources of impairment per stream and stream segment. Physical habitat attributes in most of the mainstem and tributaries typically include natural stream channels, coarse substrates and wooded riparian corridors. Channelization for agricultural land use and unrestricted livestock access to streams in portions of the TMDL study area has resulted in sedimentation, simplified habitat, denuded riparian vegetation, and has exacerbated nutrient enrichment. Increasing impacts from urban land use typically arise from associated wastewater loadings and storm water runoff. Changing land use patterns are also altering the rates and types of nonpoint pollutants discharged within the watershed. The land use distribution for the watershed is shown in Table 3 and Figure 3. Unrestricted livestock access to streams and land cleared for construction can result in greatly accelerated rates of erosion and sedimentation of streams especially when sediment control measures are inadequate. Releases of hypolimnetic waters from the reservoirs are additional stresses to the system. Additionally, increased impervious surface area and stormwater drainage systems typically follow new development and result in increased rates and volume of runoff that contribute a variety of pollutants including solids, nutrients, oils, and pesticides to streams.

Cuyahoga River (Headwaters to Black Brook)

Low dissolved oxygen (DO) is the primary chemical/physical water quality concern in the upper Cuyahoga River watershed. The majority of the stream reaches in this segment are characterized by low stream gradient, historic channel modification, hydromodification, and influences from extensive natural wetland complexes. Significant DO depletion was encountered during surveys in 1991, 1996, and 2000,

particularly in the Cuyahoga River mainstem downstream from the East Branch Reservoir and Tare Creek wetland complex near Burton (RMs 91-87). Exceedances and violations of Ohio EPA's WWH dissolved oxygen criteria have been noted in the Cuyahoga mainstem as far downstream as river mile (RM) 69. The stream reaches between East Branch Reservoir and Black Brook (RMs 91-76) can receive hypolimnetic (bottom) and/or epilimnetic (top) releases from the East Branch and Wendell R. LaDue Akron reservoirs. The quantity and quality of the water releases from these reservoirs has been managed for water supply purposes. Ammonia-nitrogen-concentrations were chronically elevated downstream from the East Branch Reservoir (RM 91.07) in the 2000 survey, apparently the result of reservoir releases. The concentrations did not exceed water quality criteria but, coupled with low dissolved oxygen levels, may exacerbate biological impacts downstream from the reservoir. Point source discharges from Middlefield Cheese (aka Hans Rothenbuhler and Sons), Middlefield and Burton WWTPs are also located within this portion of the watershed. It should be noted here that modeling projections for the most recent upgrade and permit for the cheese company indicated the discharge would have minimal impact on the Cuyahoga mainstem.

Fish and macroinvertebrate communities were in non and partial attainment of WWH (fair to good quality) in the upper reaches of the mainstem, downstream from East Branch reservoir. Biological impacts corresponded with the low DO, elevated ammonia, and marginal habitat quality found in the same reach. The stream reaches upstream from East Branch reservoir (RM 97.7) are also characterized by low stream gradients, low DO, and wetland influences. They have minimal anthropogenic impacts and are fully attaining Ohio's WWH biocriteria. This implies that the stressors of reservoir releases, habitat alteration and nutrient sources have significant negative influences on aquatic communities. Enrichment influences from the epilimnetic releases from LaDue reservoir into Black Brook was evident in the Cuyahoga mainstem downstream from Black Brook.

Tare Creek

Tare Creek had poor physical habitats at RM 3.2 (QHEI = 39.5) due to unrestricted livestock access to the stream and the removal of riparian vegetation. False and eroding banks and lack of cover and riparian vegetation contributed to poor performance of the fish community while the macroinvertebrate community was considered good based upon qualitative sampling. Physical habitats changed markedly where Tare Creek becomes an extensive wetland complex near SR 608 (RM 1.6). The single NPDES permitted point source into Tare Creek discharges to the creek via an unnamed tributary downstream from this sampling location. Sampling in the wetland area at RM 1.6 detected low dissolved oxygen levels and fecal coliform bacteria exceedances. Livestock and possibly large populations of waterfowl in the wetland area were considered potential sources of bacteria. Low dissolved oxygen concentrations are attributed to natural (wetland) conditions and agricultural practices in the watershed.

Butternut Creek

Fish community health has improved from fair in 1993 to good in 2000. The change from non to full attainment was likely the result of improved treatment (tertiary) at a mobile home park (MHP) wastewater “package plant” located about 0.2 miles upstream. Despite the improving trend, fecal coliform exceedences were detected in 2000 and on-site septic systems are problematic in the upper basin. Since the communities sampled in 1993 were in non attainment upstream from the MHP treatment plant, and no additional sampling was performed to assess possible changes, the upstream reach continued to be considered in non attainment in 2000.

Sawyer Brook

Qualitative sampling indicated a poor macroinvertebrate community in Sawyer Brook near the mouth at Tilden Road. The fish community marginally attained the IBI criteria. Siltation from stream channelization and increased residential development is considered the principal cause of the non attainment. Organic enrichment from failing on-lot wastewater disposal systems also appear to contribute to the impairment in this stream reach.

West Branch Cuyahoga River

Much of the West Branch is a low gradient swamp-marsh influenced stream with attendant habitat limitations, specifically moderate to low channel development and sinuosity, slow current, and silt or muck substrates. Consequently, the fish community is naturally limited by the habitat relative to streams harboring coarse substrates and riffle-pool-run sequences. Despite these limitations, excellent habitat features are present owing to light development in the watershed and wide riparian borders. Woody debris added habitat complexity and enhanced channel morphometry. As a result, biological community health throughout most of the West Branch was quite good. Full attainment was documented during the 2000 survey at RM 12.3 and 5.1 and biological communities were very good near the mouth in 1996 (RM 0.9). Partial attainment documented at RM 0.9 was due to a low (fair) Mlwb score but this was considered primarily a result of natural, wetland influences. Non attainment at RM 10.2 (U.S. 322) was also attributed to wetland influences, resulting in poor macroinvertebrate quality, fair fish communities and low dissolved oxygen levels. Of three dissolved oxygen measurements taken, the highest recorded was 2.18 mg/l.

Black Brook (Joins Cuyahoga River at RM 76.64)

Data collected in 2000 indicate that Black Brook is in full attainment. Biological communities maintained good quality but appeared enriched downstream from the Black Brook Dike/LaDue Reservoir outlet (RM 2.64). Extremely high densities of filter-feeding midges suggest high suspended solids levels, possibly planktonic algae from the shallow epilimnetic reservoir release. Based on similarities in macroinvertebrate community composition, enrichment influences extended downstream from Black Brook and into the Cuyahoga mainstem.

Tributary to Sperry Pond (Middlefield)

Historic channelization and nutrients from the Middlefield WWTP are the primary causes of non attainment of both macroinvertebrate and fish indices in this small tributary to the Cuyahoga River. Channelization has resulted in poor habitat with a QHEI of 41.0. Elevated nutrients were documented in 2000 survey samples with nitrate/nitrite concentrations exceeding 4.0 mg/l and total phosphorus concentrations as high as 0.7 mg/l.

Bridge Creek

The upper portion of Bridge Creek, above LaDue Reservoir, is in non attainment due to natural wetland conditions as biological communities reflected the extensive wetland habitat in the headwaters (RM 11.2). Macroinvertebrates were considered poor compared to warmwater habitat streams, but were fairly typical of swampy/marshy habitats. The fish community did not meet the WWH biocriterion but the predominance of grass pickerel, a top carnivore, indicated a high level of biological integrity for the marshy habitat. Ohio EPA biological criteria are calibrated to free flowing streams. Comparisons between free flowing streams and natural wetlands may lead to improper assessment of the water resource. Ohio EPA is currently developing separate wetland criteria. (No TMDL will be done on the upper portion of Bridge Creek since these are natural conditions.)

Fish and macroinvertebrates reached exceptional quality upstream from LaDue Reservoir (RM 8.5), but well downstream from the marshy conditions in the headwaters. This section of the stream is in an area typical of good warmwater habitat conditions (i.e., hard bottom, coarse substrates, well developed riffle/pool habitats). Downstream from LaDue Reservoir, biological and water quality conditions were significantly impacted. Low dissolved oxygen levels stemming from the controlled reservoir releases and flow alterations contributed to non attainment at RMs 1.3 and 0.5.

East Branch Reservoir

This lake was included on the 1998 303(d) list in error. No TMDL will be included in this report.

Punderson Lake

This lake was included on the 1998 303(d) list in error. No TMDL will be included in this report.

Tributary to Harper Ditch

Sampling in 2000 indicated good macroinvertebrate populations, fair fish and less than optimal habitat quality (QHEI = 50) associated with past channelization activity. Biological communities were in partial attainment of the recommended WWH use. Other potential impact sources (e.g., small package plant, land application of sludge) are located in the drainage but there were no obvious indications of enrichment in either chemical or biological results.

Tributary to Cuyahoga River near Coit Rd

This is a small, former wetland stream that was channelized in the past for landscape drainage. Flows were interstitial in about half of the fish sampling zone. Ground water withdrawal for a public water supply or diversion from a gravel operation immediately upstream are the likely causes of the interstitial flow. The fair fish, good quality macroinvertebrates, and sub par QHEI (55) pointed primarily to a problem with habitat. Flow diversion was considered a secondary influence.

Lake Aquilla

Non attainment in Lake Aquilla can be attributed to siltation, nutrients, pH and organic enrichment. Sources of these impairments are believed to be primarily from agriculture (cropland) and natural wetland conditions.

Tributary to Bridge Creek (Snow Lake Outlet)

Despite good habitat scores (QHEI = 69) and numerous parks and nature preserves in the watershed, this segment is in non attainment due to natural wetland conditions. Ohio EPA biological criteria are calibrated to free flowing streams. Comparisons between free flowing streams and natural wetlands may not lead to proper assessment of the water resource. Ohio EPA is currently developing separate wetland criteria. (No TMDL will be done since these are natural conditions).

4.0 METHOD OF DEVELOPMENT

4.1 Siltation, Habitat, and the QHEI

4.1.1 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). It is a composite score of six physical habitat categories: 1) substrate, 2) instream 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 shown in Appendix B.

QHEI scores can range from 12 to 100. 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. Correlation analysis between component QHEI metrics and the IBI reveal individual habitat attributes that have either a strong positive association with the IBI or a strong negative association (Rankin 1995). The latter are called "high-influence" attributes, of which there are five: 1) recent channelization with little or no recovery, 2) silt and muck substrates, 3) no sinuosity, 4) sparse or no cover, and 5) no deep water (maximum depth less than 40 cm). An accumulation of two or more of these high-influence habitat attributes in a stream segment indicate poor stream habitat for fishes and may preclude a biological community from attaining the warmwater habitat aquatic life use criteria.

4.1.2 Method Assumptions and Evaluation

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 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.

This method assumes the significant variables that influence fish communities are included in the index, and the index is able to distinguish between the relative effects of habitat versus water quality issues. The index is empirically derived and assumes that the empirical relationships remain similar for streams of similar size and type within an ecoregion. The evaluation is somewhat subjective and requires the evaluator to be experienced in the use of the index. The variability between evaluations from different trained investigators and the variability in time at a particular site have been determined to be minimal within the same season and if the investigators are experienced with the method (Rankin, 1989).

The QHEI is advantageous in that it is not resource intensive yet provides a rigorous evaluation of the physical habitat in a quantitative manner. Many of the metrics which comprise the QHEI are surrogate measures of load-based stressors. Some of the metrics may also provide a measure of a cause of impairment such as the substrate category as a measure of siltation or the QHEI itself when habitat is listed as the cause of impairment. Ohio is faced with a challenge to mesh its evaluation of water quality impairment approach, which depends in part on biocriteria (not load based), with the TMDL program which is a load driven process. The challenge is Ohio's waters are evaluated as impaired, in part, because the biology is not meeting biocriteria, and not generally because a specific pollutant is violating a water chemistry criterion. Therefore, a pollutant is not typically the reason a stream or assessment unit is placed on Ohio's list of impaired waters. The QHEI is a means to partially bridge this gap since habitat is strongly correlated with the IBI biocriterion and the QHEI can be an indicator for pollutants (such as sediment). Therefore, the QHEI can provide a numeric target and framework to help evaluate how habitat or surrogate issues affect attainment of the aquatic life use designations.

The use of the QHEI also assumes that the water courses being evaluated are typical riverine streams and rivers. The QHEI was not calibrated to low gradient wetland dominated streams and application of the QHEI to these habitat types may not be valid. This is not meant to imply that wetlands are "degraded" habitats. Wetlands are valuable natural resources that serve many important ecological functions to aquatic systems, but the habitat and aquatic life associated with that habitat type are not the same as typical free flowing stream and riverine systems. There is no value judgement that one is better than the other, rather an acknowledgment that they are, indeed, different.

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. It 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. Because stream physical habitat quality is influenced by surrounding land use, and because non-point load reductions are accomplished by changing land uses, habitat quality can be an important measure of TMDL success even when degraded habitat is not the cause of impairment.

4.1.3 Determining the Load Capacity and Allocation

In the free flowing, typical riverine streams, an analogous concept to a loading capacity for habitat is the use of a target QHEI score. 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 the QHEI is significantly correlated with the IBI with the exponential model providing a better fit to the data than the linear. Sites with QHEI scores greater than or equal to 60 were generally associated with IBI scores supportive of a WWH use designation.

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 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).

However, using the individual metrics and their components in the low gradient, wetland influenced stream segments in the same fashion as used in more natural free flowing streams may not be appropriate. Although a TMDL target of 60 is appropriate in free flowing segments, a target score of 60 may not be appropriate in the wetland influenced segments. A TMDL target for the wetland influenced segments can be developed by comparing QHEI scores from similar-sized, attaining streams within or near the HUC. In these low gradient, wetland-influenced stream segments, the TMDL will vary. In the free flowing riverine segments, using the individual metrics and their components as guidelines for developing potential habitat recommendations is acceptable. Targeting the modified attributes (see Section 5.2 and Table 11) is an appropriate approach for habitat TMDL development.

4.2 Enrichment, Total Phosphorus, and Duration Curves

The mechanisms of pollution delivery and the effect these pollutants have on a stream is, in part, a function of hydrologic conditions. During dry periods, no runoff is coming off the land and is not a load to the stream. The stream during dry conditions has less volume and, generally, less turbulence and has a lower capacity to assimilate pollutants than under higher flow events. Under these lower flow conditions, constant sources of

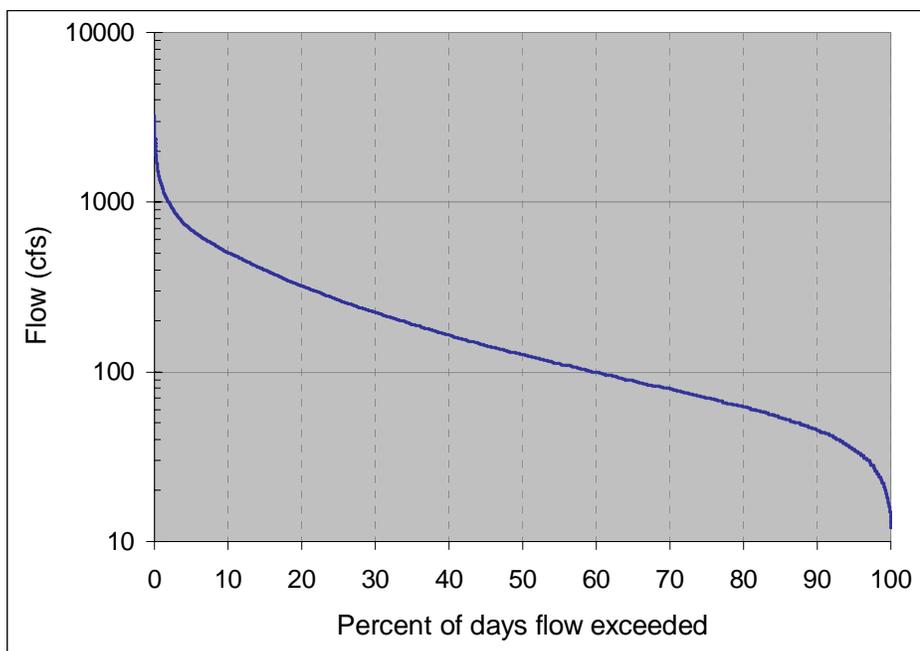
load such as municipal wastewater treatment plants are usually the major pollutant source. For the upper Cuyahoga River watershed, hypolimnetic releases during low flow conditions may be another significant source of pollutants. Higher flow events are often due to rainfall where runoff becomes a major source of load. Loads associated with rainfall tend to be the largest contributor of some pollutants on an annual basis but are episodic and occur when the assimilative capacity of the stream is high. Therefore, in mixed-use watersheds, it is important to consider the continuum of flow conditions when developing a watershed plan. Duration curves provide a vehicle with which such a consideration can occur.

4.2.1 Description of Method

Duration curves are cumulative frequency distributions. Duration curves for flow (or flow duration curves) relate flow x with the percent of time flow x is exceeded. They are developed by

ordering 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 flow duration curve for the upper Cuyahoga River was developed using the USGS flow gage station 04202000 at Hiram Rapids, Ohio and is shown in Figure 5.

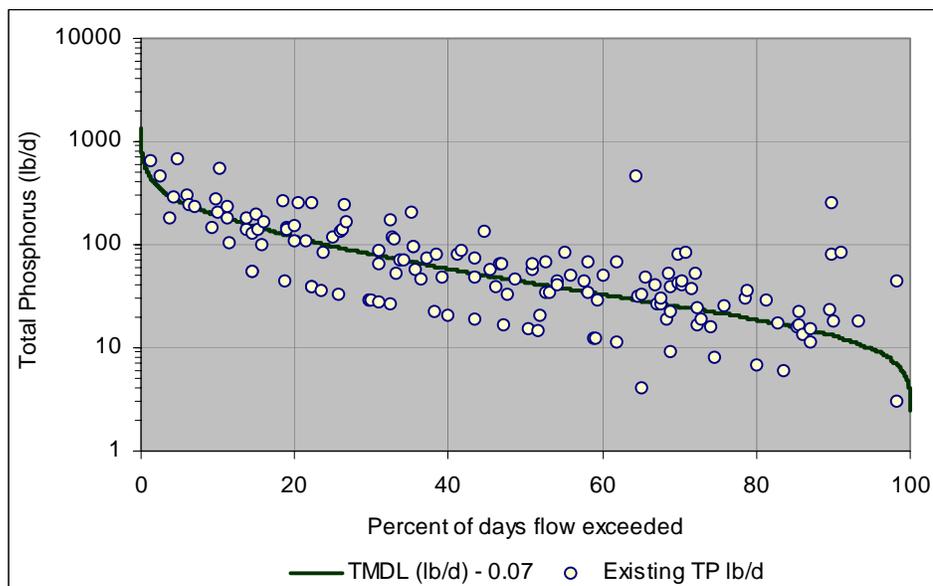
Figure 5. Flow duration curve for the Cuyahoga R at Hiram Rapids USGS gage #04202000 (1961-2002)



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 instream 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 existing loads to the LDC. The existing load can then be compared to the allowable load under the range of flow conditions data were collected for. If there are enough observed data, patterns may emerge that demonstrate which hydrologic conditions have loads exceeding the target. This assists with

Figure 6. Load duration curve and existing data for the Cuyahoga River at Hiram Rapids, Ohio



allocating the available load and helps to direct implementation actions. Figure 6 shows the LDC paired with observed data for the Cuyahoga R at Hiram Rapids.

A load duration curve is a good tool to utilize if a long term flow record is applicable to the area of interest. Often, however, long term flow data stations are limited to a few or less per major watershed. Smaller sub-watersheds may not have any long term flow records available at all. The upper Cuyahoga watershed has only one long term flow monitoring station located in the bottom third of the watershed. There are extensive chemical monitoring data at sites throughout the watershed. The chemical data on its own (without flow) does not generally give a good picture of the problem unless violations of the maximum criteria are prevalent, which is an unusual occupancy. One way to estimate the likely hydrologic condition under which a sample was collected if no flow value is available is to use a water quality duration curve.

A water quality duration curve (WQDC) distributes the existing water quality concentration data along the percent exceedence continuum of the flow duration curve; this can be useful when a site has chemistry data but no flow data. The percent exceedence from a long term flow gage located near the site of interest (such as further downstream) is applied to other sites in the basin. This assumes that the flow monitored site and the unmonitored-flow site respond similarly in a hydrologic sense, but does not estimate an exact flow number for the unmonitored site and avoids the complications estimating flows can produce. The thought is if flow is high at the flow gage on day *d* then flow is probably also high at the unmonitored site as well on that same day. A WQDC provides similar evaluation power when paired with existing concentrations as a LDC. Figure 7 shows an example of a water quality duration curve.

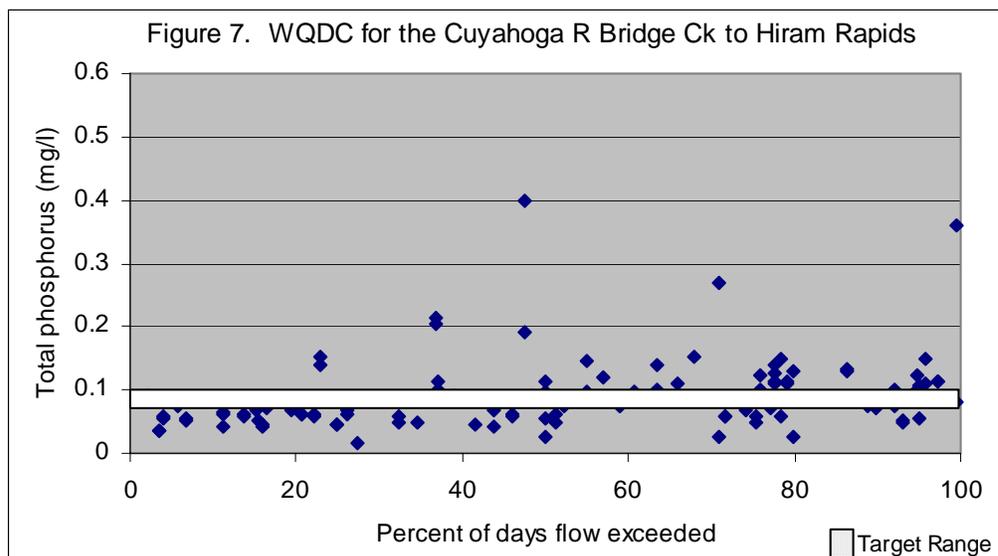
The dependent axis is in concentration units; therefore, the target 'curve' is not variable with flow and remains a straight line.

Duration curves demonstrate instream conditions, but they do not quantify the contributing sources to the instream conditions. The categories of sources for this TMDL include runoff, groundwater, reservoir outflows, point sources, and septic systems. The quantification method of the existing contribution per category is described below.

Runoff and Groundwater

The portion of the stream flow due to baseflow and runoff was calculated using the USGS model HYSEP. HYSEP is a computer program that can be used to separate a streamflow hydrograph into baseflow and surface-runoff components. The base-flow component has traditionally been associated with groundwater discharge and the surface-runoff component with precipitation that enters the stream as overland runoff (USGS, 1996). The streamflow hydrograph was generated using the daily mean USGS flow gage data at Hiram Rapids less the daily mean point source and reservoir flow data.

The existing groundwater daily load was calculated by multiplying the daily groundwater flow rate by the estimated groundwater concentration of total phosphorus. Groundwater concentrations were based on



USGS well data, baseflow measurements of unimpacted, reference streams in the watershed, and the Ohio EPA Background Water Quality Report (Brown, 1988). The existing runoff daily load was calculated by multiplying the daily runoff rate (from HYSEP) by the estimated runoff concentration of total phosphorus. The load observed in the stream minus the sum of the non-runoff input loads for that day was assumed to be the observed runoff load. This runoff load divided by the median flow on the sample date was assumed to be the runoff concentration for that day. This concentration was calculated for each sample at Hiram Rapids, and trend analysis was performed using the following grouping variables: hydrologic condition, month, season, antecedent

precipitation, and change in flow scenarios. The only factor that appeared to have a significant trend in runoff concentrations was season. A mean runoff concentration per season was calculated as described above using observed data. This seasonal concentration was used to predict the daily runoff load.

Reservoir Outflows

The City of Akron monitors the median daily outflow and collects monthly water quality samples for the Lake Rockwell, LaDue, and East Branch Reservoirs. Flow and water quality data were available from 1996 on, and this data was the basis for determining the loads coming out of the reservoirs. The daily outflow load was the product of the daily median flow per reservoir and the median of all reservoir outflow samples. The outflow loads represent the cumulative effects of the input load to the reservoirs and the reservoir reactions that occur in them. These monitoring data are infrequent as are Ohio EPA's. Any hypolemmetic releases may not be captured in such data.

Point Sources

Point sources frequently monitor the total phosphorus concentration and daily median flow in their effluent. Where flow or concentration data were missing, the median value for that month based on measured data was used. A daily load value per entity was then calculated by multiplying the daily flow and daily concentration with a conversion factor. The point sources considered in this analysis include the following facilities: Middlefield, Mantua, and Burton wastewater treatment plants and the Hans Rothenbuhler and Sons (Middlefield Swiss Cheese) plant. An additional 0.6 lb TP/day was added to account for minor point sources in the area.

Home Sewage Treatment Systems

A report presenting the results of a field survey of home sewage treatment systems in the Cuyahoga area provided the basis for the septic load analysis. The April 2001 report *Survey of Northeast Ohio Home Sewage Disposal Systems and Semi-Public Sewage Disposal Systems* was coordinated by the Northeast Ohio Areawide Coordinating Agency (NOACA) and presents the numbers and an estimate of the functionality of these systems installed since 1979 per county. Census data on sewage facilities was the basis for systems installed prior to 1979. The home sewage treatment system loads were calculated based on a model developed by Mandel (1993) that uses system characterization by performance type and location and the number of systems as its main inputs. This method is also used in the Generalized Watershed Loading Functions model (Haith et al., 1992).

Instream Reactions (Loss)

Total phosphorus instream reactions represent a net loss between upstream inputs and the output point at Hiram. There is usually a capacity to assimilate some of the total phosphorus load into the system biomass or that settles out into sediments. Loss was estimated as the median of the daily total observed load in the stream minus the daily total known input load for days without runoff. Loss occurs during runoff events as well,

but the runoff load was not a directly measured quantity. By removing this less certain daily load from the equation, a more accurate loss term could be determined. However, no loss (or gain) appears to be occurring for total phosphorus as the observed load does not significantly differ from the input load. One possible explanation is that the upper Cuyahoga experiences low dissolved oxygen in the water column which can result in nutrient export from sediments into the water column. Also, the natural wetland environment may also concentrate and export phosphorus at various times of the year. These source processes could be offsetting the sink processes resulting in no net change from instream reactions.

Wetlands are often thought to act as filters (sinks) of nutrients, especially during the growing season when the wetland flora is most active. However, the upper Cuyahoga watershed, which has significant natural wetlands, has its highest total phosphorus concentrations during the growing season. Many studies of wetland dynamics demonstrate a wide variability in results as to the role of wetlands as sources or sinks of total phosphorus. Several characteristics of wetlands appear to influence this role including soil type, amount of a complexing agent such as aluminum, iron, or calcium present, vegetation types, water depth, age of wetland, and residence time (<http://h2osparc.wq.ncsu.edu/info/wetlands/function.html>). Given the water quality trends in the upper Cuyahoga watershed, it is reasonable to infer that at least some of the wetlands are acting as sources of TP.

Comparison of Observed Versus Predicted Loads and Accuracy of this Approach

There were 113 samples collected in the Hiram Rapids area from 1996 through 2002. The observed load on these days was compared to the calculated load for the same set of days. The median relative daily error under predicted the observed load by 13%. However, the total observed and total calculated loads of these 113 samples differed by only 0.29%. These results indicate that the method on any given day may be off on average 13%, but this deviation diminishes when summed over a longer time period such as a year. The loading capacity is reported on an annual basis in this report.

4.2.2 Method Assumptions and Evaluation

Duration Curves

The duration curve method itself is simply a way to express data and does not have assumptions associated with it. The data used to create the duration curves are assumed to be accurate and error-free. The TMDL curve assumes the exposure period of the target and the flow interval are compatible. The duration curves presented here are expressed on a daily flow interval with a target based on a summer averaging period. 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 overall watershed condition as it relates to total phosphorus. Daily intervals were used as opposed to seasonal ones because there were insufficient seasonal observed load data

to do such an analysis. However, the allowable load and allocations are expressed as summer loads in the loading capacity table to be consistent with the applicable period of the total phosphorus target. Some of the duration curves included in this report include an observed data trendline. When a trendline is used, the type of regression it uses is referenced.

Some advantages of this approach include:

- the available loading capacity is determined over the full range of flows;
- determination of the critical condition is not needed, which is important for mixed source watersheds;
- based on local, empirical data;
- all pollutant sources are included as per the intent of the TMDL process;
- the analysis is not resource intensive and can be used when data is limited;
- provides a way to match the needed load reductions to the appropriate sources based on hydrologic condition of concern;
- provide a framework to express allocated loads;
- can help to target implementation options;
- yearly, seasonal, and daily variations are captured; and,
- is a clear and straightforward method facilitating communication with stakeholders.

Some disadvantages of the duration curve approach are:

- LDCs do not necessarily provide a good technique for allocating the calculated TMDL on their own;
- cannot be used to predict implementation scenarios;
- need data collected under a variety of flows to be descriptive of watershed condition;
- multiplying a single grab sample by a daily median flow can be misleading depending on where on the daily flow hydrograph the sample was taken especially under rapidly changing flow conditions. The use of a flow at the time of the sample, if available, resolves this issue.

Source Quantification

The daily groundwater flow and surface runoff downstream of the reservoirs was calculated using HYSEP. This model is based on a mathematical technique that mimics the way that humans have been separating hydrographs, rather than on the physics of the process (which are currently not well understood). Thus, although HYSEP consistently applies various algorithms that are commonly used for hydrograph separation, hydrograph separation remains a subjective process (USGS, 1996). Hydrograph separation is also entirely dependent on the flow data used, and the base flow and runoff estimates can be skewed if the flow used is regulated by reservoirs and point sources. The regulated portion of the Hiram Rapids flow record was removed from the input flow data set for HYSEP. This helped to reduce the influence of the regulation and improved the accuracy of the HYSEP predictions; however, it does not negate the influence of such regulation on the estimates. Therefore, the baseflow portion may be slightly overestimated and the runoff flow slightly underestimated in this

study. The advantages of using HYSEP are that it provides a consistently reproduceable, automated method to determine runoff and baseflow which manual hydrograph separation would not provide, and the techniques HYSEP utilizes to separate the flow are long standing, widely accepted techniques.

Reservoir and point source data were based on relatively extensive empirical data collected by the responsible parties. It is assumed this data is accurate and representative of the facilities' performance. Where data was not available, it is assumed that the median of the measured data is an acceptable estimate. Empirical data is advantageous in measuring the actual source as opposed to predicting it. However, since the reservoir water quality samples are sporadic they may not be reflective of the range of outflow quality. Bridge Creek downstream of LaDue Reservoir occasionally runs black indicating possible hypolimnetic reservoir releases of low D.O, poor quality water. There has been one Ohio EPA Emergency Response spill report of a fish kill that was attributed to a reservoir release from LaDue Reservoir into Bridge Creek. The qualitative support for this is the non attainment of the biology downstream of the reservoirs, one high total phosphorus data point at Hiram Rapids on a day the change in flow was due only to increased reservoir outflow, and pictures taken of the black, anoxic water releasing from Lake Rockwell.

Septic information was based on sampling a subset of systems and extrapolating this information to apply to all systems in the watershed. The subset of systems was carefully selected so that the sample would be representative of the distribution of systems in the study area (NOACA, 2001). Refer to the referenced report for more information about the study. This study provided total numbers and operational quality of the systems per county. The study information was adapted to the upper Cuyahoga TMDL project by assuming a uniform distribution of systems in each county and adjusting the total county number by the areal ratio of the watershed portion of the county to the total county. Load from these systems was quantified using Mandel's (1993) equations. These assume the phosphorus from normally operating systems is absorbed into the soil and there is no TP load to the stream from these systems. Short circuited (close to streams), ponded (failing/surfacing), and direct septic discharge loads have loads according to Mandel's equations. Using a GIS platform, any system located within 50 feet of a stream was assumed to be a direct discharge.

4.2.3 Determining the Load Capacity and Allocations

The LDC graphically depicts the daily loading capacity as it varies with flow. The annual allowable load was determined by summing the daily allowable loads used to create the LDC and dividing this total by the number of years included in the analysis. This gives the average allowable annual load for the flow conditions that occurred from 1996 through 2002.

The daily existing load was also summed and divided by the number of years included in the analysis. The existing load exceeds the allowable load, and the percent reduction

needed for the upper watershed at Hiram Rapids was calculated by dividing the difference between them by the existing load. This determined the local reduction needed for the Cuyahoga upstream of Hiram Rapids; however, the lower section of the upper Cuyahoga is also enriched with phosphorus. The TMDL for the lower section of the upper Cuyahoga included the contribution of the upper watershed through the Lake Rockwell outflow as a source and determined a reduction needed for the Lake Rockwell outflow. These local and global reductions were compared and the higher needed reduction value was used for the upper watershed sources. The locally needed TP reduction for the upper watershed at Hiram Rapids was 19%; this is the transition point between the upper assessment unit and the lower assessment unit within the upper Cuyahoga watershed. The lower section of the upper Cuyahoga TMDL required a reduction of 28% from the existing upper watershed load through the Lake Rockwell outflow. This includes the second assessment unit which the Hiram Rapids determination does not.

The allocation of allowable load began by looking at the current situation in a hydrologic and source contribution sense. Table 8 shows the results of this analysis. Points that table 7 highlight are: point sources are a small percentage of the overall load to the system, dry to low flow conditions appear to have the largest deviation from the target on average, septic and reservoir outflows are the largest contributors of load during the drier conditions while runoff is the largest overall contributor of load.

Table 7. Average TP Reduction Needed per Flow Condition and Current Average Relative Contributions of Load by Source and Flow Condition in the Cuyahoga River at Hiram Rapids						
<i>Note: these are not the final reductions needed as explained in the text preceeding this table.</i>						
% of flow exceedence range:	0-10	10-40	40-60	60-90	90-100	0-100
Hydrologic condition:	High	Moist	Transition	Dry	Low	All
% Reduction Needed:	21%	6%	24%	33%	51%	19%
% of total load per source:						
Groundwater:	13%	18%	12%	8%	4%	14%
Runoff:	73%	46%	31%	14%	8%	48%
Point sources:	1%	4%	6%	8%	10%	4%
Septic systems:	5%	15%	27%	39%	52%	17%
Reservoir outflows:	7%	17%	25%	30%	26%	17%

Next, each source category was considered. Groundwater does not generally have anthropogenic sources of total phosphorus and the watershed data indicated a generally low level of phosphorus in the area. Therefore, no reductions of groundwater load are expected and the groundwater allocation is set at its existing load.

Point sources are not a significant load to the system as a whole; however, Middlefield WWTP is a major source of total phosphorus to the unnamed tributary of the Cuyahoga

at river mile 88.07 (the Sperry Pond tributary). This tributary is in non attainment of its designated use in part due to nutrient enrichment. Therefore, the load from Middlefield WWTP needs to be reduced. Monthly operating reports from this facility and others included in this study indicate total phosphorus concentrations in the effluent occasionally exceed the 30-day average permit limit of 1 mg/l (see Table 8). A 10% reduction in load could be achieved without changes in current permit limit concentrations if the point sources in the watershed were operated more efficiently in regards to total phosphorus removal, and the effluent concentrations remain consistently below 1 mg/l total phosphorus.

Runoff, reservoirs outflows, and home sewage treatment systems appear to be the most significant sources of total phosphorus load to the watershed. An equal percent reduction approach was used to allocate to these sources. The groundwater, point source, future growth, and margin of safety allocated loads were subtracted from the total allowable load. These three sources were then reduced by the same percentage until the total allocated load approximated the total allowable load.

Table 8. Total Phosphorus Effluent Statistics				
January 1996 - June 2001	Burton WWTP	Mantua WWTP	Middlefield Swiss Cheese	Middlefield WWTP
# of samples	68	66	153	76
Maximum (mg/l)	2.3	5.2	1.17	2.5
Minimum (mg/l)	0.24	0.08	0.06	0.1
Median (mg/l)	0.77	0.53	0.32	0.73
Median flow (MGD)	0.27	0.23	0.13	0.6

The loading capacity determination was based on existing conditions that will change as the watershed population density increases. The future growth term is designed to allow the TMDL to be applicable into the future and to account for any expected population increase. A future growth factor of 6% is included in the allocation. This factor was selected to maintain consistency in the Cuyahoga watershed as a whole and is considered protective of near-term population increases.

The Lower Cuyahoga River TMDL used a future growth factor of 6% based on the U.S. Census Bureau existing data and future population growth estimates for that area. Using the same technique on the upper watershed as for the lower, a future growth factor of 20% would be needed. This growth rate is the average of each county's predicted future growth based on the U.S. Census Bureau's figures for 1990 through 2015 weighted by the land area of the county within the upper Cuyahoga watershed. The needed reduction for the upper Cuyahoga watershed, however, is based on the

results and needs of the lower watershed. The lower watershed requires the upper to reduce the total phosphorus load by 28% whereas the upper watershed only needs a 19% reduction for local concerns. The 28% was determined based in part on the 6% future growth term for the lower watershed resulting in an effective 12% future growth reserve for the upper watershed. The additional theoretical 8% needed to protect for the long term expected growth rate is covered by two other sources of unallocated capacity. The first is the doubled margin of safety factor included for the upper. Both watersheds include explicit margins of safety of 5%. Since the upper is based on the lower's needs and these needs are inflated by the future growth and margin of safety reserved capacities, this results in the doubling. In addition, the habitat and dissolved oxygen improvements that are also a part of the upper Cuyahoga TMDL effort will increase the TP assimilative capacity of the watershed. This increased assimilative capacity is not being accounted for and can be considered an implicit reserve for future growth.

4.3 Margin of Safety and Uncertainty

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)). EPA guidance explains that the margin of safety (MOS) may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is explicit, the loading set aside for the MOS must be identified.

A margin of safety is incorporated both implicitly and explicitly into these TMDLs. An explicit margin of safety of 5% for the TP TMDL was included during the allocation process to account for uncertainty in the modeling approach and data used in the modeling. There are several areas where an implicit margin of safety is incorporated including the 303(d) listing process and the target development process. An explanation for each of these areas is provided below.

4.3.1 Margin of Safety in the TMDL Priority 303(d) Listing

It is important to keep in mind during the evaluation of the TMDL a major difference in Ohio's program from other regional 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. Many other regional or 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.

4.3.2 Margin of Safety in the Target Development

A conservative assumption implicit in the target development lies in the selection of the median statistic used to represent the phosphorous target which corresponds to an unimpaired biological community. Since Ohio EPA's evaluation of phosphorus data for generating target values is based on measured performance of aquatic life and since full attainment can be observed at concentrations above this target (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 target. The difference between the actual level where attainment can be achieved and the selected target is an implicit margin of safety.

The habitat targets were selected using a method analogous to the nutrients method. The habitat targets and the specific aspects of the habitat that are degraded as provided with the QHEI model combine to add another layer of potential protection to achieving the WQS by providing additional guidance on an alternate means to reduce the nutrient load to the stream, mitigate the impacts of the nutrients in the stream, and directly improve an aspect of stream ecology vital to the biological community. Ohio EPA's ability to add habitat targets, and provide guidance on the improvement of the habitat is an implicit margin of safety made possible through extensive ecosystem monitoring and analysis, and should be recognized as a margin of safety in these TMDLs.

4.3.3 Measures of Accuracy and Uncertainty

Method Accuracy: Comparison of Observed Versus Predicted Total Phosphorus Loads

A total of 113 total phosphorus samples were collected in the Hiram Rapids area from 1996 through 2002. The observed load on these days was compared to the calculated load for the same set of days. The median relative daily error under predicted the observed load by 13%. However, the total observed and total calculated loads of these 113 samples differed by only 0.29%. These results indicate that the method on any given day may be off on average 13%, but this deviation diminishes when summed over a longer time period such as a year. The loading capacity is reported on an annual basis in this report.

Input Uncertainty: Confidence Bounds for the TMDL for Total Phosphorus at Hiram

Upper and lower uncertainty bounds are included for the total phosphorus LDC at Hiram Rapids (Figure 15). These bounds indicate the uncertainty and potential error associated with the flow measurement and total phosphorus target selection. A USGS report *Estimates of Median Flows for Streams on the Kansas Surface Water Register*

(<http://ks.water.usgs.gov/Kansas/pubs/reports/wrir.02-4292.html>) indicates a range of uncertainty of estimated median streamflows of gaged stream reaches of 4.3% to 7.3% depending on data source; the average of this error range is 5.8%. The instream total phosphorus concentration for Hiram Rapids at which WWH biocriteria can be achieved may vary. The median of the total phosphorus data from reference sites is 0.05 mg/l. A higher total phosphorus concentration based on the reference data median plus 1.5 times the interquartile range is 0.125 mg/l. Reference sites are least impacted sites attaining their designated use. The median total phosphorus concentration from all data gathered is 0.07 mg/l and is the selected target for this TMDL. The upper confidence bound represents the daily stream flows increased by 5.8% multiplied by the 0.125 mg/l total phosphorus concentration. The lower confidence bound represents the daily stream flows reduced by 5.8% multiplied by the 0.05 mg/l total phosphorus concentration.

Instream Water Quality Uncertainty

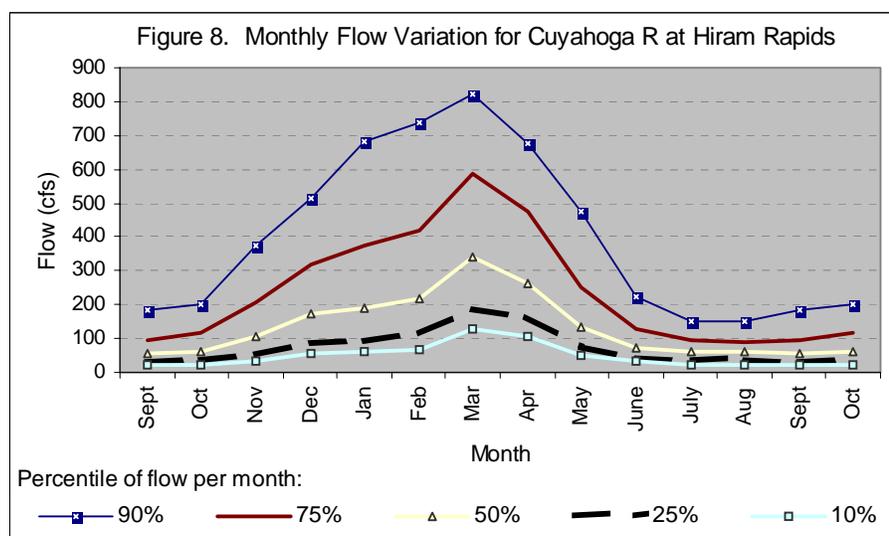
A sample size of 113 is a significant, but still relatively small sample of actual conditions over many years, and it is likely that some conditions are not captured such as episodic events such as hypolimnetic releases and periodic spills. Ohio EPA accounts for this uncertainty in sample size of effluents by calculating projected effluent quality concentrations based on the monitored data. This same method can be applied to instream data to estimate a more complete picture than just the small set of collected data. A description of the method used can be found at:

<http://www.epa.state.oh.us/dsw/guidance/model1.pdf> under the section labeled Method B. The projected water quality is determined as the upper bound of the 90% confidence interval about the 95th percentile of the projected distribution of the daily water quality data. These values are therefore on the high end of what is projected to be instream and can be used to evaluate relative relationships between the projected existing 95th percentile load and the allowable. The statistics are summarized below:

Statistic	TP (lb/d)	Comment
95 th % of Projected Existing Load	369	Allows for conditions that exist but are not observed.
95 th % of Observed Existing Load	274	
<i>% difference in projected from observed existing load</i>	35%	
95 th % of Projected Allowable Load	253	Includes allowable loads for unobserved conditions.
95 th % of Allowable Load at Observed Conditions	220	
<i>% difference in projected from observed allowable load</i>	15%	
Estimated % reduction needed based on 95 th percentile projected existing and allowable loads	31%	In line with recommendations of this report.

4.4 Seasonality and Critical Conditions

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, summer high instream temperatures and reduced stream flows (Figure 8) occur leading to the lowest dissolved oxygen levels and, as Figure 9 shows, highest instream nutrient concentrations of any season. Ohio EPA biological criteria, and habitat and nutrient targets are based on data collected in the summer during this most sensitive and multiple stressor time period, which protects for the critical condition. Further, assessing the biology during the summer months evaluates the biological performance during the most critical time of the year. Biological and habitat indices are measures of aggregate annual conditions reflecting compounding factors over time. Therefore, the use of these indices reflects both the collective seasonal effects and the critical summer condition for aquatic organisms and habitat.



The LDC approach used for TP covers all applicable recorded flow and seasonal conditions thereby covering both critical conditions and seasonal variation. Flow data from the USGS gage at Hiram Rapids were used from October 1961 through September 2002 (reservoir regulation began in October 1961). About 41 years of daily flow data went into calculating the flow duration intervals. Water quality monitoring data were sampled monthly starting in April 1996 and sporadically prior to this date. Figure 8 shows the seasonal variation for flow.

The total phosphorus TMDL and allocations are done on an annual basis despite the summer applicability of the TP target. Though the TP target applies to an average summer condition, Figure 10 shows the major loading inputs occur in seasons other than summer. Using annual loading over a multi-year period with actual daily weather, stream flow, reservoir outflows, point source loadings and estimated baseflow and

runoff flows incorporates seasonal and hydrologic variability and protects for all conditions including critical ones.

Figure 9. Seasonal distribution of TP concentration observed in the Cuyahoga R at Hiram Rapids, OH

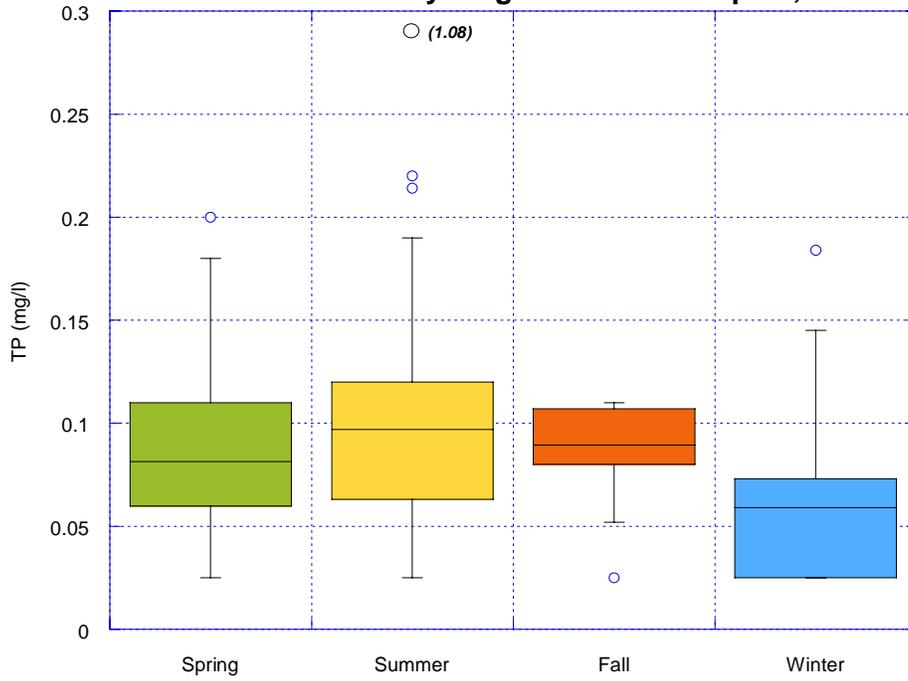
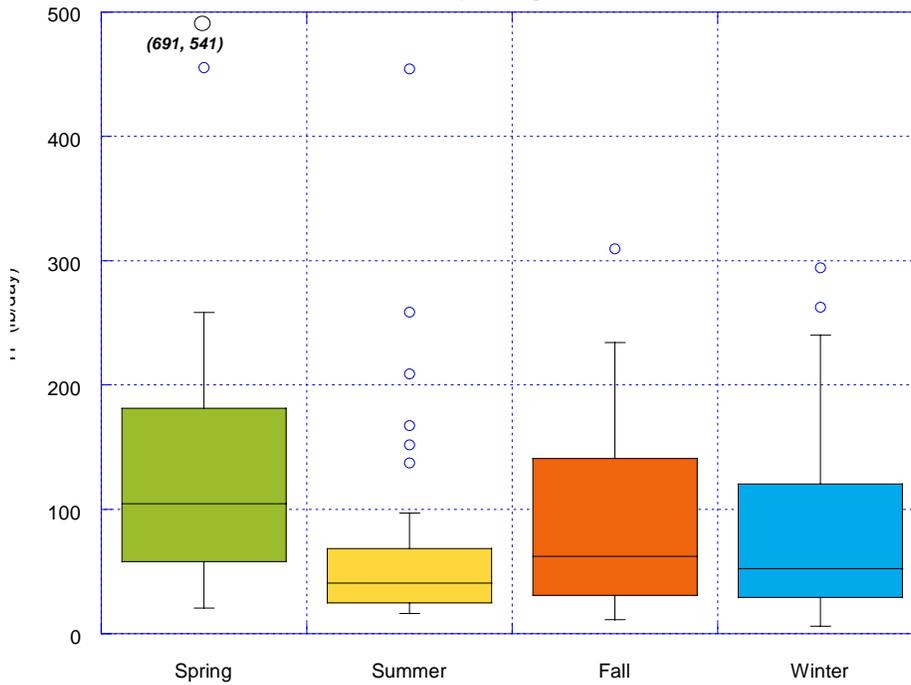


Figure 10. Seasonal distribution of TP load observed in the Cuyahoga R at Hiram Rapids



5.0 ASSESSMENT, LOADING CAPACITY, AND ALLOCATIONS

5.1 Existing Condition and Deviation Assessment

The aquatic life use attainment status and the current state of three major indicators of impairment in the upper Cuyahoga are shown together in Table 9. The amount the current condition undesirably deviates from the target is shown; a deviation of 'None' indicates the target is being achieved or surpassed. The median, minimum, maximum, and number of observations for DO and TP and the deviation from the targets are given in the table. The amount of spread of the DO observations can be an indication of the eutrophic condition of the water and is listed in the deviation column for DO. A borderline deviation indicates the median of the data is within the target range, and the site appears to be at its loading capacity. Box plots for DO and TP are shown in Figure 11. Each box encloses 50% of the data with the median value of the variable displayed as a line. The top and bottom of the box mark the limits of $\pm 25\%$ of the variable population. The lines extending from the top and bottom of each box mark the minimum and maximum values that are not considered outliers. Outliers are displayed as individual points.

Figures 12, 13, and 14 link aquatic life attainment status with an indicator condition to suggest the associations between them. Figure 12 shows the QHEI scores for all sites (including the wetlands influenced sites) in the watershed grouped by attainment status. This figure shows that all of the fully attaining sites have QHEI scores above the target. There are no sites fully attaining that have QHEI scores less than the target of 60. The majority of sites that are impaired have QHEI scores less than 60. This demonstrates the importance the quality of the habitat has on attaining water quality standards in Ohio.

Figure 13 compares the median TP values grouped by the collection site's attainment status. Note that all fully attaining sites meet the target and the majority of impaired sites do not. The lower graph in Figure 13 shows the degree the total phosphorus varies from the target by attainment status. The deviations increase steadily as the attainment status degrades.

The minimum recorded DO and the DO swing (spread) at each site grouped by attainment status is shown in Figure 14. Except for the site at River Mile 97.7 (2.45 and 2.49 mg/l), all of the fully attaining sites have DO minimums that are greater than the minimum criterion of 4 mg/l whereas all of the minimum DO values from non attaining sites violate this criterion. Further these conditions progressively worsen from full to partial to non attainment.

Table 9. Aquatic Life Use Attainment Indicator Conditions and Deviations from Targets

Segment Description	Aquatic Life		Habitat		Dissolved Oxygen (mg/l)		Total Phosphorus (mg/l)	
	RM	Use Attainment ¹	QHEI Score	Deviation ²	Measured Median Range (Count)	Deviation ³ 24-hr Average Minimum Max-Min	Measured Median Range (Count)	Deviation of Median from Target
Cuyahoga R: Headwaters to East Branch Reservoir	97.7	Full	70.5	None	<u>8.5</u> 2.5-11.3 (14) ⁴	<u>None</u> -1.5 8.8	<u>0.05</u> 0.02-0.15 (104)	None
	96.2	Partial	45	-15				
Cuyahoga R: East Branch Reservoir to upstream Tare Ck	90.9	Non	53.5	-6.5	<u>4.8</u> 2.2-11.1 (465)	<u>-0.2</u> -1.8 8.9	<u>0.06</u> 0.03-1.5 (115)	Borderline
Tare Creek	3.1	Partial	60	None	<u>3.2</u> 1.5-4.8 (104)	<u>-1.8</u> -2.5 3.3	<u>0.07</u> 0.02-1.1 (61)	Borderline
	1.6	Non	25	-35				
Unnamed Tributary to Cuyahoga R @ RM 88.02	1.4	Non	41	-19	<u>8.31</u> 6.22-8.82 (3)	<u>None</u> 2.6	<u>0.47</u> 0.3-0.7 (3)	-0.42
Cuyahoga R: Tare Ck to West Branch	87.3	Partial	41.5	-18.5	<u>4.3</u> 1.7-9.9 (477)	<u>-0.7</u> -2.3 8.2	<u>0.133</u> 0.03-0.44 (65)	-0.06
West Branch Cuyahoga R	12.3	Full	62	None	<u>5.8</u> 4.7-10.5 (161)	<u>None</u> None 5.8	<u>0.07</u> 0.03-0.31 (104)	Borderline
	10.2	Non	57.5	-2.5				
	5.6	Full	65.5	None				
Cuyahoga R: West Branch to Hiram Rapids <i>Shaded based on 1996 data</i>	83.7	Partial	43	-17	<u>4.7</u> 2.5-8.8 (149)	<u>-.3</u> -1.5 6.3	<u>0.08</u> 0.02-0.4 (122)	Borderline
	80.4	Partial	48	-12	<u>6.38</u> 3.6-9.9 (780)	<u>None</u> -.4 6.3		
	75.8	Full	69	None				
Bridge Creek: upstream LaDue	11.2	Non	56	-4	<u>6.04</u> 5.32-10.20 (5)	<u>None</u> 4.88	<u>0.09</u> 0.03-0.14 (5)	-0.04
	8.5	Full	71.5	None	<u>6.8</u> 5.7-11.4 (51) ⁴	<u>None</u> None 5.7	<u>0.04</u> 0.01-0.26 (53)	None
Bridge Creek: downstream LaDue	0.5	Non	55.5	-4.5	<u>6.6</u> 3.8-11.2 (141)	<u>None</u> -.2 7.4	<u>0.06</u> 0.02-0.22 (56)	Borderline

Table 9. Aquatic Life Use Attainment Indicator Conditions and Deviations from Targets

Segment Description	Aquatic Life		Habitat		Dissolved Oxygen (mg/l)		Total Phosphorus (mg/l)	
	RM	Use Attainment ¹	QHEI Score	Devi-ation ²	Measured Median Range (Count)	Deviation ³ 24-hr Average Minimum Max-Min	Measured Median Range (Count)	Deviation of Median from Target
Snow Lake Outlet	0.1	Non	69	None	5.3 4-9.3 (7) ⁴	None None 5.3	<u>0.06</u> 0.03-0.19 (51)	Borderline
Black Brook	1.8	Full	64	None	<u>6.5</u> 4.4-11.1 (165)	None None 6.7	<u>0.04</u> 0.01-0.47 (104)	None
Cuyahoga R: Hiram Rapids to Lake Rockwell Dam	71.7	Full	75.5	None	<u>5.9</u> 3.7-9.8 (151)	None -0.3 6.1	<u>0.07</u> .03-1.36 (58)	None
	67.5	Partial	78.5	None	<u>7.4</u> 4.8-10.3 (288)	None None 5.5	<u>0.07</u> .02-.32 (59)	None
	64.5	Full	85.5	None	<u>7.4</u> 5.2-12.4 (273)	None None 7.2	<u>0.07</u> .01-1.28 (139)	None
Cuyahoga R: downstream Lake Rockwell Dam	57.7	Non	56.5	-3.5	<u>6.8</u> 3.5-12.1 (156)	None -0.5 8.6	<u>0.07</u> .01-.4 (106)	None

¹ The predominate aquatic life use designation in this watershed is the Warmwater Habitat.

² A deviation of 'None' signifies the measured quantity is meeting or exceeding the target expectation.

³ The deviation from the DO 24-hour average criterion (5 mg/l) is underlined, the deviation from the minimum DO criterion (4 mg/l) is in bold, and the spread of the DO observed readings is italicized. A large spread can be an indication of enriched, eutrophic conditions where the overabundance of algae photosynthesize during the day increasing the DO to very high levels, but respiring at night and decreasing the DO to very low levels.

⁴ These DO data are based only on grab samples taken during daylight hours.

Figure 11. Summary of DO (upper) and TP (lower) concentrations in the Upper Cuyahoga Watershed

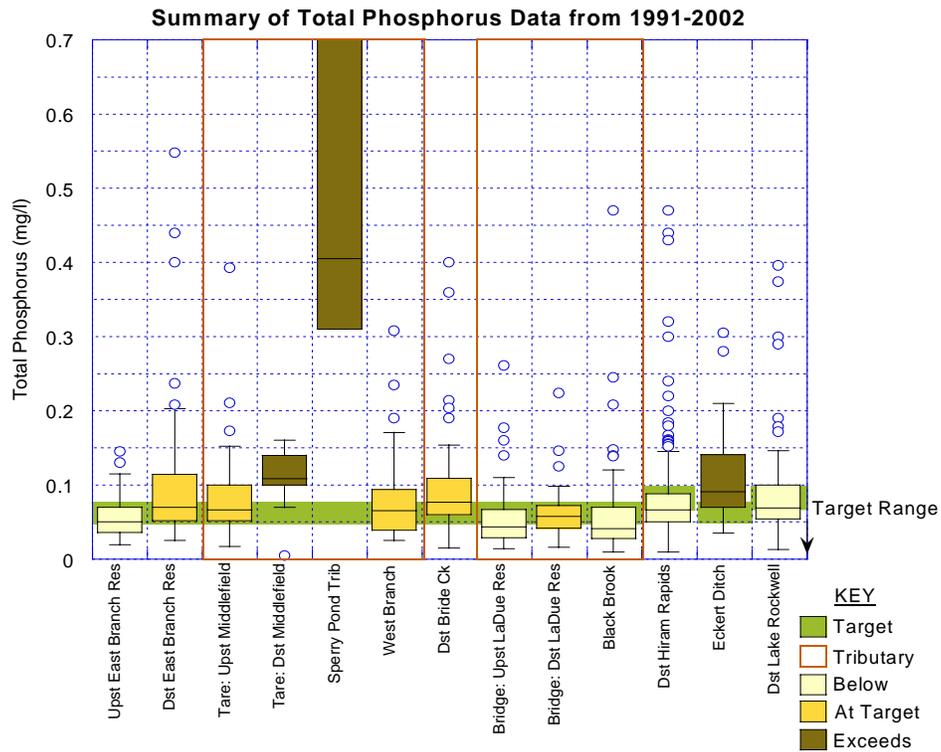
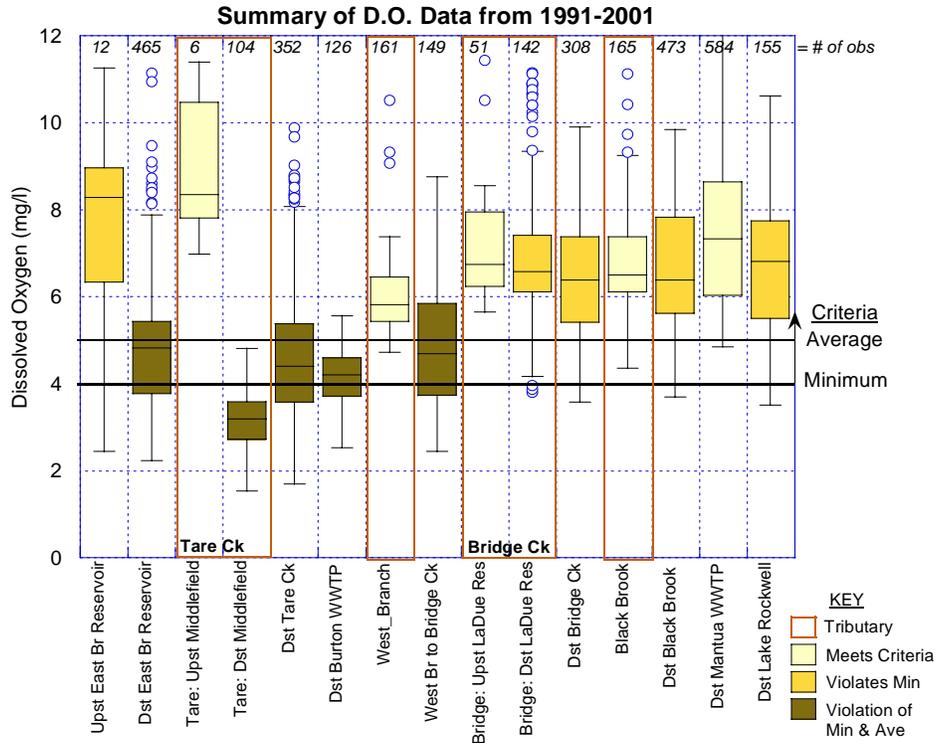


Figure 12. Comparison of habitat quality and biological response (upper) distributed by drainage area of sampling site (lower)

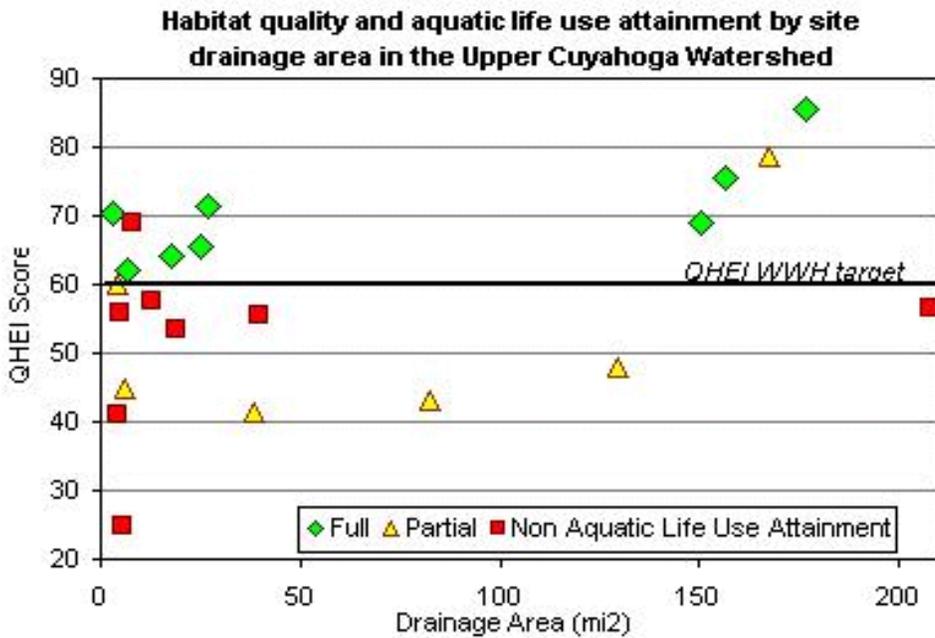
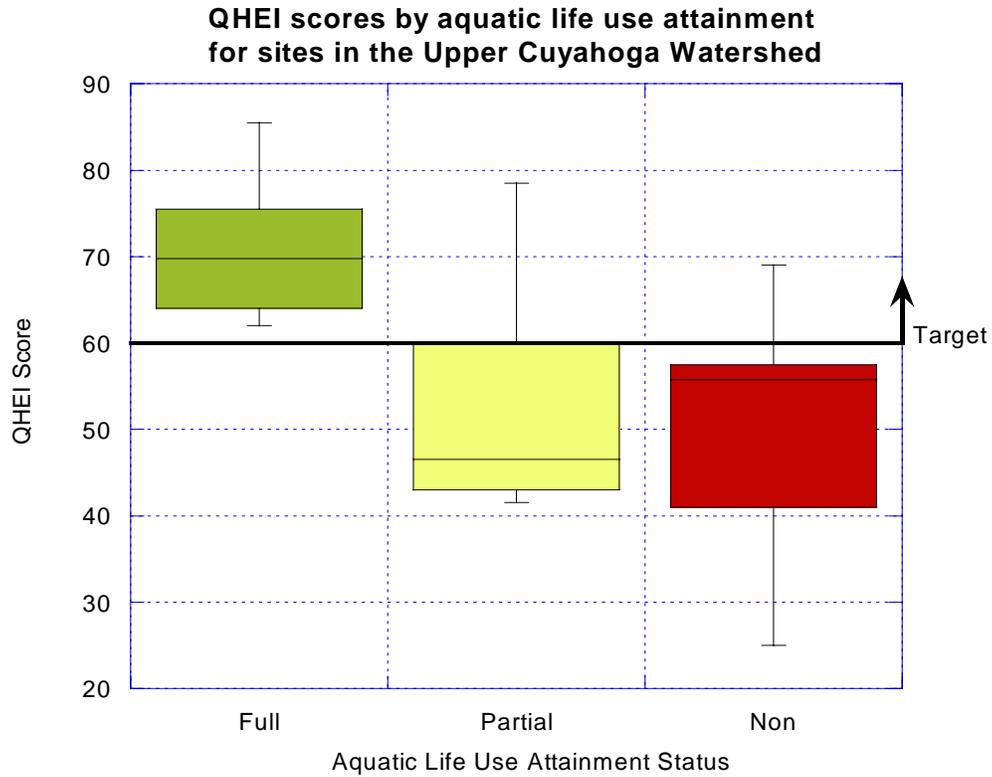


Figure 13. Median TP (upper) and deviation from the target (lower) by aquatic life use attainment status

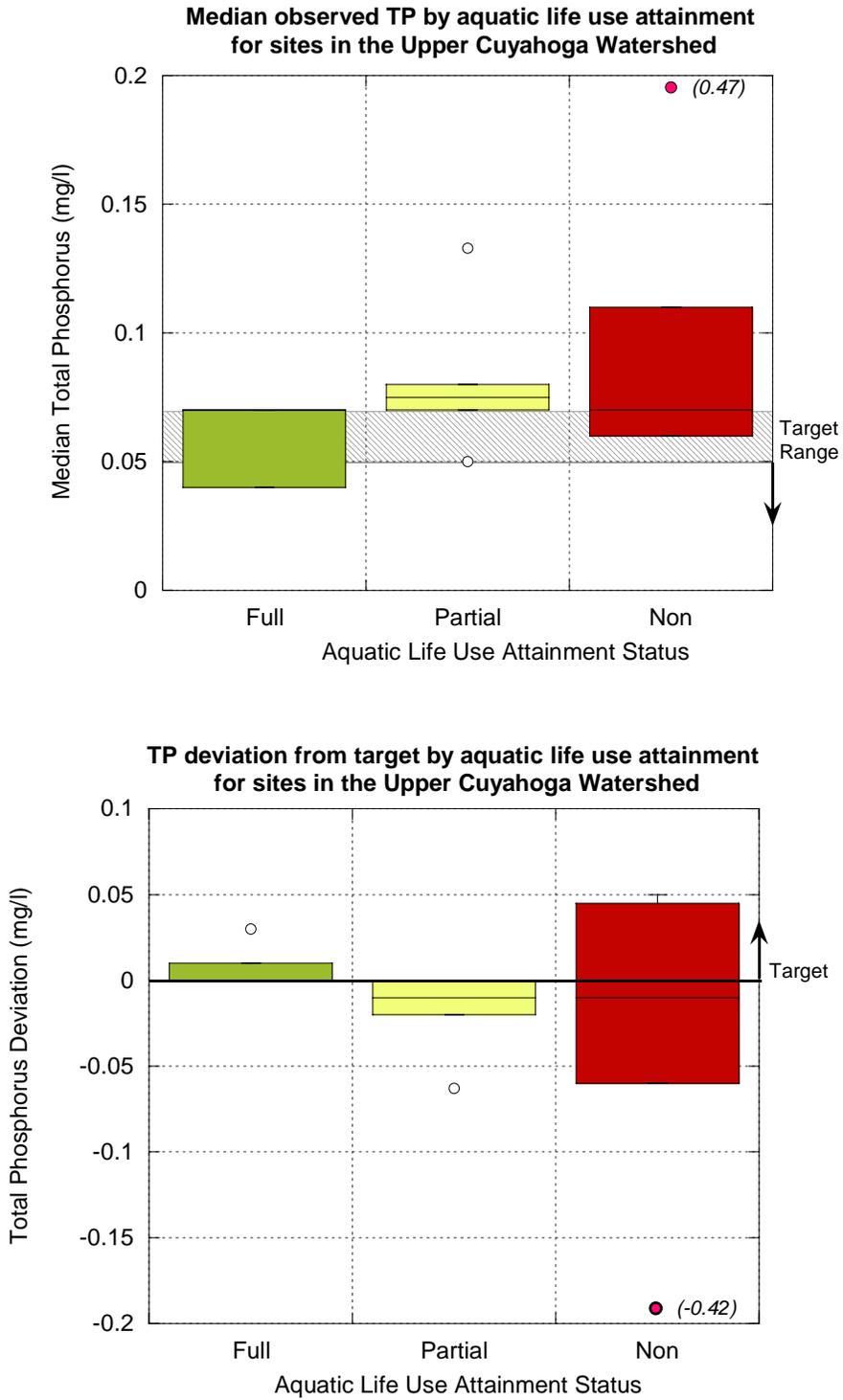
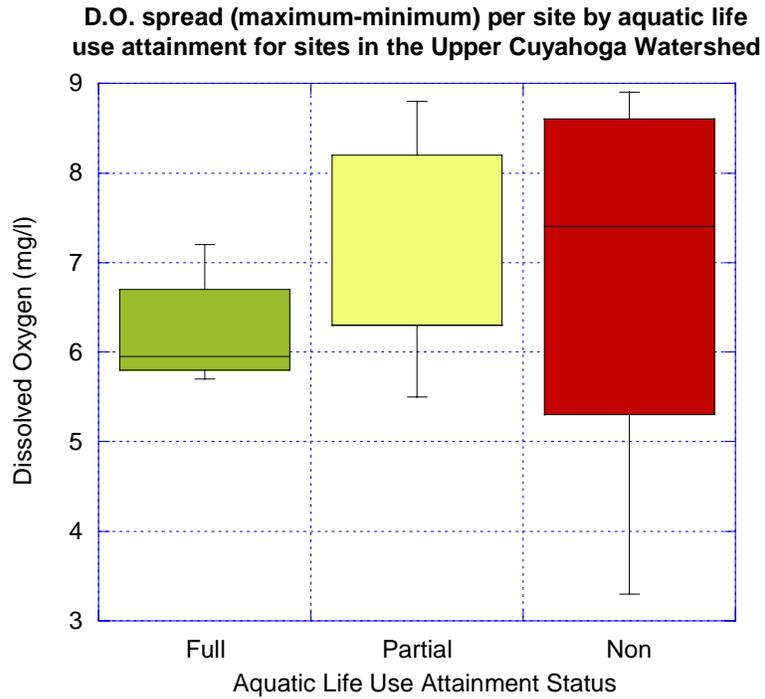
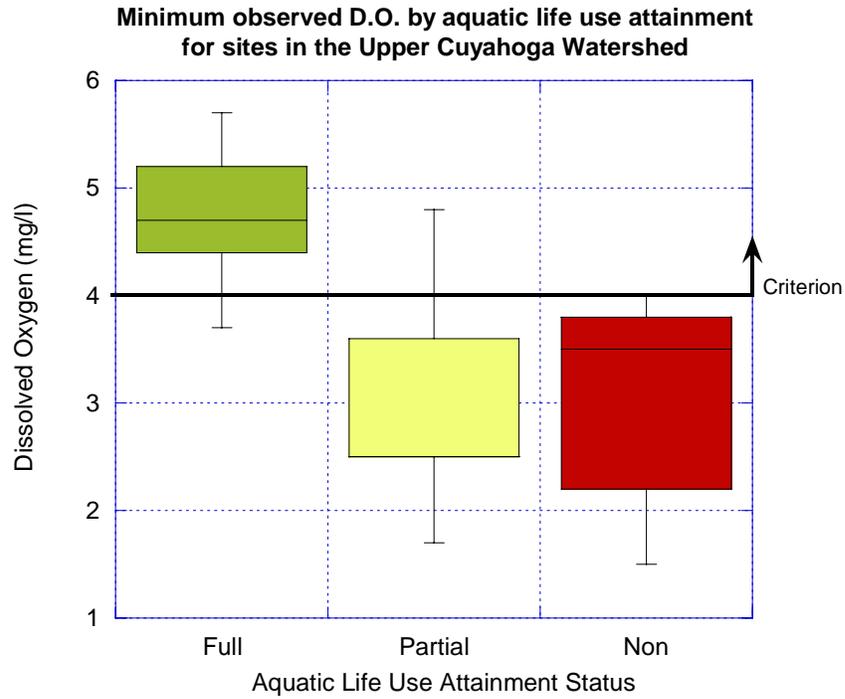


Figure 14. Observed minimum DO concentration (upper) and DO diurnal variation (lower) by aquatic life attainment status



5.2 Loading Capacity and Allocations for Habitat and Sediment

The habitat TMDL equation below reflects the relationship of critical habitat parameters to aquatic community performance. The critical habitat parameters are based on the analysis of the QHEI components as they relate to IBI scores. This analysis led to the development of a list of attributes that are associated with degraded communities. These attributes are modifications of natural habitat and were further divided into high influence or moderate influence attributes based on the statistical strength of the relationships. The analysis indicates that a stream with more than one high influence or more than four moderate influence attributes usually precludes attainment of the IBI WWH biocriteria (using an IBI of 40 as a representative IBI biocriterion). Evaluating and addressing the modified attributes generally results in improvements in QHEI scores and IBI scores.

The sediment TMDL equation is a subset of those factors of the QHEI most directly related to sediment type, quality, build up, and source origin. The goal of these TMDLs is use designation attainment; therefore, if the use is attained, the goal of the TMDL is met even if the following TMDLs are not. Chapter 4 and Appendix B explains the categories and attributes more fully.

For low gradient wetland influenced streams, a minimum target score of 60 may be used as a restoration target as long as reference stream reaches are used to aid in restoration design. A reference stream reach should be a nearby river or stream (preferably in the same hydrologic unit) of similar size and type that is fully attaining biocriteria. Category scores from reference stream reaches can be used to adjust the target scores for each of the QHEI categories presented in Table 10. Use of reference stream reach data provides a guide to reflect watershed specific conditions. The scores also need to be indicative of long term conditions.

$$\begin{aligned}\text{Habitat TMDL} &= \text{QHEI Score to Target Ratio} + \text{Modified Attribute Score} + \text{High} \\ &\quad \text{Influence Attribute Score} \\ &= 1 + 1 + 1 \\ &= 3\end{aligned}$$

$$\begin{aligned}\text{Sediment TMDL} &= \text{Substrate} + \text{Channel Morphology} + \text{Riparian Zone/Bank Erosion} \\ &= 14 + 14 + 5 \text{ (minimum numbers)} \\ &= 33 \text{ (greater than or equal to)}\end{aligned}$$

Table 10. Details of the Habitat and Sediment TMDLs Suggested to Meet the WWH Use Designation in Free-Flowing, Riverine Segments

QHEI Categories		Modified Attributes			
Category	Target ¹	High Influence		Moderate Influence	
Substrate	≥14	Channelized or No Recovery Silt/Muck Substrates Low Sinuosity Sparse/No Cover Max Pool Depth < 40 cm		Recovering Channel Sand Substrates (boat sites) Hardpan Substrate Origin Fair/Poor Development Only 1-2 Cover Types Intermittent/Poor Pools No Fast Current High/Moderate Embeddedness Ext./Mod. Riffle Embeddedness No Riffle	
Channel	≥14				
Instream Cover	≥12				
Riparian	≥5				
Pool/Current	Sum of these ≥ 15				
Riffle/Run					
Gradient					
QHEI Score	≥ 60				
QHEI actual to target score ratio ≥ 1	1	One or less high influence attribute present	1	Four or less of any modified attributes present	1

¹ Suggested target scores per category; reference reach data should be used to adjust, if appropriate, these target scores to reflect watershed-specific conditions.

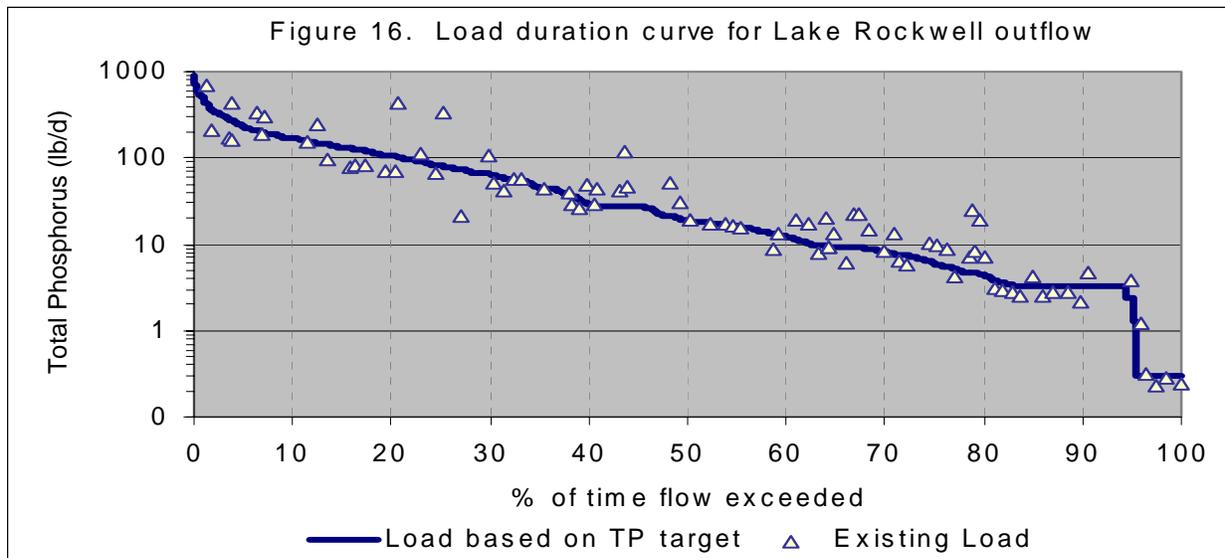
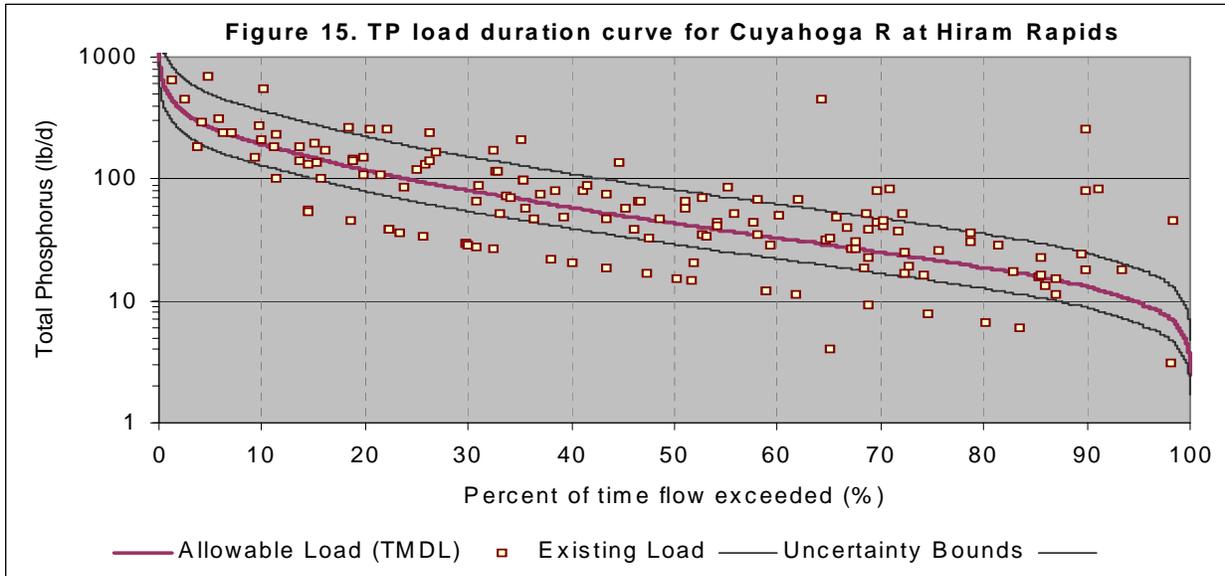
5.3 Loading Capacity and Allocations for Total Phosphorus

The daily load based on the local target for total phosphorus at Hiram Rapids is shown graphically in Figure 15. This is the daily local allowable load for assessment unit 04110002-010, or the upper sub-watershed of the upper Cuyahoga watershed. The daily total phosphorus load based on the local target for the entire upper watershed at its most downstream point (the Lake Rockwell outflow) is shown in Figure 16. These graphs indicate the local conditions at these points not the final allowable load based on this TMDL study. The final allowable loads are predicated on the global Cuyahoga watershed total phosphorus issues, not the local. The total maximum yearly load for total phosphorus (based on average conditions) for the upper Cuyahoga watershed given global need is given in Table 11. Table 11 gives the loading capacity and allocations recommended as a result of this TMDL process. Note that the allocated source load values in Table 11 are rounded to two significant digits.

5.4 Enrichment/Dissolved Oxygen and Biocriteria

The targets for total phosphorus and the total QHEI score are based on empirical data and relationships of what levels of these are needed to attain WWH biocriteria. If these targets are attained then the biocriteria should be as well, thereby meeting the use designation. The actions needed to reduce total phosphorus and sediment load are associated with reducing organic enrichment sources as well. Improvements in the habitat and reductions in the total phosphorus load as prescribed in this TMDL should result in attainment of the oxygen criteria where natural conditions do not preclude it from meeting.

Table 11. Average Annual Total Phosphorus Load Capacity and Allocations at Lake Rockwell Dam				
Source	Existing Load (lbs/yr)	Reduction Sought	Allocated Load (lbs/yr)	Comments and Example Implementation Options
Runoff	25606	43%	14600	Funding (CWA § 319, Lake Erie) & public education.
Groundwater	7356	0%	7400	No reduction expected.
East Branch and LaDue Reservoir Outflows	5661	43%	3200	This includes any upstream inputs such as runoff or septic and load from in-lake processes for the LaDue and East Branch Reservoirs; does not include the Lake Rockwell outflow as this outflow contains all of the inputs from the upper Cuyahoga.
Point Sources	1302	10%	1200	Reduce by 10% and no new load authorized until total phosphorus levels reach goals or use met.
			580	Middlefield WWTP
			300	Burton WWTP
			160	Mantua WWTP
			50	Middlefield Swiss Cheese
			110	Other minors
Septic Systems	5840	43%	3300	Homeowner education on operation and maintenance of systems; better management and inspection. Tighter requirements for selected system type depending on soil absorption capacity.
Future Growth	0	na	2000	Based on a growth factor of 6%.
Margin of Safety	0	na	1600	Based on a safety factor of 5%.
Total	45765	28%	33300	TP Annual Load Capacity



6.0 PUBLIC PARTICIPATION

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 met multiple times over eighteen months and in July 2000 issued a report to the Director of Ohio EPA on their findings and recommendations. The upper Cuyahoga TMDL has been completed using the process endorsed by the EAG.

For this TMDL project, a presentation was made to the members of the upper Cuyahoga River Watershed Taskforce on June 7, 2002. The Taskforce includes members from most of the local stakeholders, both public and private, in the upper portion of the basin. The Taskforce meets routinely to discuss issues that effect the upper basin. Taskforce members were briefed on the upcoming public meeting and were urged to attend and join in the discussions.

Representatives from 15 different organizations attended the stakeholder public meeting which was held on June 25, 2002. The purpose of that meeting was to give a short history of the TMDL process at Ohio EPA, to give an update to the stakeholders on the status of the upper Cuyahoga TMDL, to present and to discuss the impaired segments and the causes and sources of impairment. A question and answer session followed the presentations. Information about the meeting was sent to two newspapers in the region.

A meeting with representatives from the Soil and Water Conservation Districts (SWCD) in the basin was held on July 30, 2002. The purpose of that meeting was to bring together all the SWCD representatives to discuss what different efforts are underway in each county to deal with TMDL issues and to brainstorm other activities that the SWCDs could undertake in the future.

An additional public meeting was held on December 3, 2002, to present information to be included in the final draft of this TMDL report and to receive additional comments and information from the stakeholders.

Consistent with Ohio's current Continuous Planning Process (CPP), the draft TMDL was available for public comment from March 1 through April 5, 2004. A copy of the report was posted on Ohio EPA's web page (<http://www.epa.state.oh.us/dsw/tmdl/index.html>) and copies were available upon request. A summary of the public comments received and responses to those comments is contained in Appendix D.

Public involvement is key to the success of this TMDL project. Ohio EPA will continue to support the implementation process and will facilitate to the fullest extent possible an agreement acceptable to the communities and stakeholders in the study area and Ohio EPA. Ohio EPA is reluctant to rely solely on regulatory actions and strongly upholds the

need for voluntary actions to bring these sections of the Cuyahoga River watershed into attainment.

7.0 IMPLEMENTATION AND MONITORING RECOMMENDATIONS

Restoration methods to bring an impaired waterbody into attainment with water quality standards generally involve an increase in the waterbody's capacity to assimilate pollutants, a reduction of pollutant loads to the waterbody, or some combination of both. As described in Section 2, the causes of impairment in the upper Cuyahoga River are primarily nutrient enrichment and stream habitat degradation. Therefore, an effective restoration strategy would include habitat improvements and reductions in pollutant loads potentially combined with some additional means of increasing the assimilative capacity of the stream. The upper Cuyahoga basin has benefitted from many proactive measures and initiatives undertaken by state, local, and private stakeholders. These measures and initiatives are outlined in Appendix C. They are expected to continue and new initiatives are planned, as funding becomes available.

7.1 Reasonable Assurances

As part of an implementation plan, reasonable assurances provide a level of confidence that the wasteload allocations and load allocations in TMDLs will be implemented by Federal, State, or local authorities and/or by voluntary action. The stakeholders will develop and document a list that differentiates the enforceable and non-enforceable selected actions necessary to achieve the restoration targets. Reasonable assurances for planned point source controls, such as wastewater treatment plant upgrades and changes to NPDES permits, will be a schedule for implementation of planned NPDES permit actions. For non-enforceable actions (certain nonpoint source activities), assurances must include 1) demonstration of adequate funding; 2) process by which agreements/arrangements between appropriate parties (e.g., governmental bodies, private landowners) will be reached; 3) assessment of the future of government programs which contribute to implementation actions; and 4) demonstration of anticipated effectiveness of the actions. It will be important to coordinate activities with governmental entities that have jurisdiction and programs in place to implement the nonpoint source actions (e.g., county soil and water conservation district offices, county health departments, local Natural Resource Conservation Service offices of the U.S. Department of Agriculture, municipalities and local governmental offices).

7.1.1 Minimum Elements of an Approvable Implementation Plan

While not required as part of this TMDL, a draft implementation plan is included in this report. Whether an implementation plan is for one TMDL or a group of TMDLs, it must include at a minimum the following eight elements:

- Implementation actions/management measures (Table 12)
- Time line (Table 13)

- Reasonable assurances (Table 13)
- Legal or regulatory controls (Table 13)
- Time required to attain water quality standards (Table 14)
- Monitoring plan (Table 14)
- Milestones for attaining water quality standards (Table 14)
- TMDL revision procedures (Section 7.3)

7.1.2 Implementation Actions, Time line, and Reasonable Assurances

The implementation actions and measures are described in Table 12. The reasonable assurances are described in Table 13. A time line for implementation actions is included in both Tables 13 and 14. See Appendix C for a narrative summary of the regulatory, non-regulatory and incentive based actions applicable to or recommended for the upper Cuyahoga River basin. Many of these activities deal specifically with the protection, restoration, or enhancement of habitat.

Table 12. Description of Implementation Actions and Measures				
#	Implementation Actions & Management Measure	Affected Stream / Party	Parameters Effected/Benefits	Estimated Effectiveness
1	NPDES permit limits	Cuyahoga River and Tributaries All NPDES permit holders	nutrients biological indices	positive local effects
2	Phase 2 Stormwater	Auburn Twp. in Geauga Co. Shalersville Twp. in Portage County	NPS biological indices reduce sediment loading eliminate illicit discharges	positive local effects positive basinwide effects
3	Riparian protection	Cuyahoga River and Tributaries	NPS biological indices streambank stability	positive basinwide effects- especially if local riparian protection ordinances are adopted
4	208 updates	Cuyahoga River and Tributaries	comprehensive land use planning will help to promote better land use decisions. Stormwater controls will help curb sediment and nutrient impacts	positive basinwide effects
5	House Bill 110 program	Cuyahoga River and Tributaries	inspections and proper maintenance of semi-public sewage treatment systems will result in some reductions in discharges of oxygen demanding substances and nutrients	positive local effects positive basinwide effects
6	Household sewage disposal systems - Inspection and maintenance programs	Cuyahoga River and Tributaries	inspections and proper maintenance of semi-public sewage treatment systems will result in some reductions in discharges of oxygen demanding substances and nutrients	positive local effects positive basinwide effects

Table 12. Description of Implementation Actions and Measures				
#	Implementation Actions & Management Measure	Affected Stream / Party	Parameters Effected/Benefits	Estimated Effectiveness
7	Incentive based programs	Cuyahoga River and Tributaries	NPS biological indices nutrients	positive basinwide effects
8	Wetlands protection, parks and natural areas, easements	Cuyahoga River and Tributaries	NPS biological indices wetlands provide numerous benefits including water quality, flood protection, and removal of pollutants	positive local effects positive basinwide effects
9	Educational Programs	Cuyahoga River and Tributaries	NPS biological indices nutrients	positive local effects positive basinwide effects informed citizens and local officials will be effective in promoting programs to protect and restore water quality
10	reservoir management	Cuyahoga River and Tributaries	biological indices nutrients	positive local effects

Table 13. Time Line and Reasonable Assurances					
#	Action	Managing Party	Schedule	Reasonable Assurance Description/Specifics	Type
1	NPDES permit limits	Ohio EPA	Ongoing	NPDES permits rules in section 402 of the Clean Water Act Ohio Revised Code section 6111	regulatory
2	Phase 2 Stormwater	Townships in Portage and Geauga Counties	Compliance beginning in March of 2003	U.S. EPA Phase 2 storm water regulations	regulatory
3	Riparian protection	City of Akron SWCDs Counties	Ongoing	Easements New ordinances	regulatory incentive
4	208 updates	NOACA NEFCO	Ongoing	Section 208 of the Clean Water Act -NOACA plan approved -NEFCO plan in public comment stage	regulatory
5	House Bill 110 program	Ohio EPA County Health Departments	Ongoing	House Bill 110 allows health departments and Ohio EPA to enter into contracts for the purpose of licensing and inspecting semi-public sewage disposal systems. Programs are in place in Portage and Geauga Counties.	regulatory
6	Household sewage disposal systems - Inspection and maintenance programs	County Health Departments	Ongoing	State and local home sewage treatment system regulations. Portage County program currently deals with HSDS on a complaint basis. Geauga County program includes routine inspections of both aeration systems and septic systems.	regulatory

Table 13. Time Line and Reasonable Assurances

#	Action	Managing Party	Schedule	Reasonable Assurance Description/Specifics	Type
7	Incentive based programs	NEFCO NOACA SWCDs Upper Cuyahoga Watershed Task Force	NOACA completed in Nov. 2000 (for Cuyahoga, and Geauga counties, NEFCO currently in public hearings for draft plan (Summit and Portage counties)	319 Program Water Resource Restoration Sponsor Program (WRRSP) Clean Ohio Conservation Fund Watershed Protection Plan Lake Erie Protection Fund Great Lakes Protection Fund	incentive
8	Wetlands protection, parks and natural areas, easements	-ODNR -Ohio EPA -Army Corps of Engineers -County Parks -The Nature Conservancy -Cleveland Museum of Nat. History -Local watershed protection groups	Ongoing	Ohio Administrative Code 3745 Sections 401 and 404 of the Clean Water Act Local laws and rules	regulatory non-regulatory
9	Educational Programs	Ohio EPA SWCDs Upper Cuy. Task Force NEFCO NOACA Ohio State Extension Office	Ongoing	319 grants	non-regulatory incentive
10	reservoir management	City of Akron Ohio EPA	ongoing discussions	OAC 3745	non-regulatory

Table 14. Time Line: Monitoring, Tracking and Implementation (see key below)																											
Action	Year	2003				2004				2005				2006				2007				2008	2009	2010	2011	2012	
		Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4					
1		A			C				C				C				C				C						
2		A	C						E																		
3				A					C				C				C										
4		A			C				C				C				C										
5		A			C				C				C				C										
6		A						M				E	V														
7		A			C				C				C				C										
8		A			C				C				C				C										
9				A					C																		
10							A	C	M			E	V														

Key:

- A - Action completed/installed/incorporated
- C - Check point to track action implementation (did action get completed?)
- M - Monitoring of indicators begins (indicators specified in monitoring plan)
- E - Expected target attainment
- V - Validation; biological survey to determine if targets are attained

Note:

This is a working document. Schedules for some of the implementation actions have not been developed yet.

7.2 The Upper Cuyahoga Watershed DRAFT Implementation Plan

The upper Cuyahoga River TMDL project team recognized six important strategies to focus efforts in developing an implementation plan. They are: 1) septic system management, 2) agriculture and riparian corridors, 3) point source controls, 4) storm water management, 5) reservoir management, and 6) education.

Home Sewage Treatment System Management

Home sewage treatment systems impact water quality in the upper Cuyahoga River watershed through both point and nonpoint discharges from failed, faulty, or discharging systems and improper disposal of wastes (septage) from septic systems.

Implementation actions to address these sources of pollution would include oversight of septic tank waste haulers, identification and repair of faulty septic systems, elimination of onsite septic systems through extension of municipal sanitary sewers, and public education on home sewage treatment system maintenance.

A Lake Erie Protection Fund supported report, Survey of Northeast Ohio Home Sewage Disposal Systems and Semi-public Sewage Disposal Systems (NOACA, 2001) provides information on home sewage disposal systems (HSDS) in the NOACA region, which includes the upper Cuyahoga basin. Some of the findings in the report were that there were approximately 9845 on-lot HSDS and 838 off-lot HSDS constructed in Portage County, and 8504 on-lot and 478 off-lot systems constructed in Geauga County between 1979 and 1998. Recent inspections determined that from 12-20 percent of the on-lot systems and 20-33 percent of the off-lot systems were malfunctioning, depending on the type of system installed. One third to two thirds of the systems did not meet Ohio Department of Health effluent standards. The report concluded that improved management and inspections of these systems as well as greater homeowner attention to system operation and maintenance is needed. A regular local health department inspection program and better homeowner education has the potential for improving the performance rates for these home systems. For home sewage treatment systems in Geauga County new subdivisions are evaluated for on lot (no discharge) systems, only.

There is an inspection program in place in Geauga County to deal with the 126 semi-public treatment systems in that county. The Portage County program covers inspections for 450 semi-public facilities.

In Geauga County there is a Point of Sale program in place to ensure that home sewage treatment systems are upgraded or replaced once a property is sold.

County Health Departments will be encouraged to improve and expand the inspection and maintenance programs for HSDS and semi-public WWTPs.

Agriculture and Riparian Corridors

The upper Cuyahoga River watershed is a predominately agricultural area used mostly for row crop production and, to a smaller degree, livestock production. In the past few decades, conservation efforts by farmers, local partnerships and units of government have reduced non-point sources of pollution significantly, and efforts in this direction continue. However, non-point contributions from agriculture still exist. Landowners can take advantage of several incentive programs that will cover significant portions of the cost of adopting Best Management Practices on farmland, while educational initiatives exist to boost participation in these programs.

Protection of stream riparian corridors plays an important role in stream integrity. Small streams are able to maintain thermal regimes with riparian protection. Open streams lacking riparian protection are influenced by sunlight which in addition to temperature increases, can stimulate algae and macrophyte growth. Additionally, protection and restoration of riparian zones along streams can help reduce sediment loading. Several new methods are available to aid in this effort. Summit County, Ohio, recently passed an ordinance establishing riparian setbacks (see www.co.summit.oh.us/council/pdfs/legislation/2001-249.pdf and

www.summitswcd.org/riparianfactsheet.pdf). The latest updates to the NOACA and NEFCO 208 plans promote the identification and protection of sensitive natural areas through changes in land use policy. Model ordinances for the protection of riparian zones have been developed by The Chagrin River Partners (www.crrp.org) and NOACA (www.NOACA.com).

Additional efforts will be made to educate the Amish farming community about the types of problems associated with farming practices and the assistance that is available to correct and prevent further NPS problems. An Amish farmer initiative, developed by the Ohio State University Extension Office has been brought to this basin. Funding to expand this program in the upper Cuyahoga should be a priority project for the upper Cuyahoga River Watershed Task Force.

Point Source Controls

Adequate point source control mechanisms shall be utilized for all direct discharges in the upper Cuyahoga River TMDL area. NPDES permits for point sources shall be prepared and issued with limits and conditions necessary to protect and restore water quality in the upper Cuyahoga watershed. When appropriate, Ohio EPA shall take enforcement actions necessary to maintain compliance with discharge permit limits. Implementation actions to address point source impacts include current NPDES permits for the following significant discharges:

Hans Rothenbuhler & Sons (aka Middlefield Swiss Cheese) (3IH00025): The WWTP discharge is located on small unnamed tributary that eventually drains to a large wetland complex on Tare Creek near Burton. Noncompliance with their NPDES discharge permit resulted in the issuance of a Consent Order in December, 2000 requiring a facility upgrade. An upgraded and expanded treatment system has been constructed. The 240,000 gpd treatment system consists of an aerated lagoon followed by membrane filtration discharging tertiary quality effluent. The new effluent limits became effective in May, 2003. Modeling projections for the most recent upgrade and permit for the cheese company indicated the discharge would have de-minimus impact on the Cuyahoga mainstem

Middlefield WWTP (3PB00034): There have been no recent upgrades and there are no current or pending enforcement actions for this extended aeration facility. Review of monthly operating data from December 1999 - September 2002 indicates consistent monthly average flows exceeding design flow of 0.63 MGD. The dry summer months and winter months with little snow does not appear to be a problem. In conversations with Middlefield WWTP personnel, they have acknowledged a capacity concern but have not requested a plant expansion. Phosphorus and summer ammonia limits appear to be frequent violations. Possible infiltration and inflow problems and a potential expansion of this facility should be addressed in the next permit renewal in 2004.

Burton WWTP (3PB00066): A PTI was issued in 1998 for construction of an additional 50,000 gallon sludge holding tank at this extended aeration facility. Review of monthly operating data from March 2000 - September 2002 indicates consistent monthly average flows exceeding design flow of 0.27 MGD. Very dry months, July, August, and September 2002, were well under design flow. The Village has not contacted Ohio EPA regarding expansion plans. Ammonia violations have occurred in May, the beginning of the summer months, for three consecutive years (2000, 2001, 2002.) There are no current or pending enforcement actions. Possible infiltration and inflow (I+I) problems and a potential expansion of this facility should be addressed in the next permit renewal in 2005.

Mantua WWTP (3PB00031): This contact stabilization plant has undergone a major expansion and upgrade of the facilities, which came on line in November, 2002. The expansion includes improvements to the influent processes, new equalization tanks, new oxidation ditches, new final clarifiers, and a new aerobic digester tank. UV is used for final disinfection. This WWTP discharges to a segment of the river that is full attainment of standards.

Mantaline, a rubber processing company located in Mantua, has ceased discharge of high nitrate wastewaters to the river by tying in to the Mantua WWTP.

Stormwater Management

Stormwater runoff is a significant source of nonpoint source pollution in the upper Cuyahoga River watershed. Implementation actions to address this would include drafting ordinances for stormwater and sediment and erosion control, creating and publishing a list of acceptable stormwater BMPs, and expanding existing programs (i.e., Soil and Water Conservation Districts (SWCDs) to include stormwater monitoring. Public education, such as developing an adult education program about stormwater pollution, would be an important and necessary part of the implementation plan.

In Geauga County, the SWCD office has a staff person and an education specialist that work on stormwater and erosion issues in the county. They are also working on a pilot project dealing with road ditch maintenance and vegetation. The office has applied for additional grant monies to expand the project and will be looking for additional demonstration sites in the Cuyahoga basin. The County also owns several easements along the river corridor.

In Portage County, the SWCD office has an education specialist on board. Staff are working with local communities to implement Phase 2 as well as on a countywide ordinance for stormwater control. The County recently hosted an informational meeting for Phase 2 regulations for local citizens, village and municipal officials, and township trustees. More than forty people attended this meeting to discuss a regional approach to stormwater management. A local consulting company, Davey Tree Company, has

also produced information to assist communities with implementation of the Phase 2 program.

The Upper Cuyahoga Watershed Task Force has a committee looking at issues associated with runoff from rural roads.

Ohio EPA will continue to assist local communities with implementation of Stormwater phase 2 regulations.

Reservoir Management

Based on observed and documented chemical and biological effects of certain releases from the water supply reservoirs, Ohio EPA will continue discussions and investigations of actions that can be taken by Akron to minimize environmental effects from the reservoir releases.

Education

The Portage County SWCD has hired an education specialist to work with local communities on implementation of the Phase 2 stormwater program. That office is working on developing a countywide ordinance for stormwater control. That office also works with the agricultural community on animal waste and erosion control projects.

The Geauga County SWCD recently hired an education specialist. Their program is still under development. That office provides support to local communities and farmers dealing with erosion and stormwater issues. The Geauga and Portage SWCDs have been working with other stakeholders in the Upper Cuyahoga River Task Force on a pilot project dealing with road ditch maintenance and vegetative cover. They have produced a brochure detailing the results and are looking for additional sites within the Cuyahoga basin to serve as demonstration sites.

The Upper Cuyahoga River Task Force, the informal local stakeholders organization, meets bi-monthly to discuss common issues, plan local projects, and share information about projects and plans in the watershed. Discussions are underway within the group to begin a formal watershed plan development process. This organization is also attempting to coordinate section 319 grant applications in the upper Cuyahoga basin. Other projects the Task Force is involved in include the annual River Day celebration held in springtime. There are tentative plans to expand this to include a watershed tour and festival. The Task Force is also involved in procuring interpretive signage in local parks and Ohio Department of Natural Resources nature preserves and natural areas. Plans are underway to develop an internet web site for the organization. Following the lead of another local watershed group, the Task Force members will be seeking support from the county engineers to add watershed boundary information to county engineer's road map.

NEFCO, the local 208 agency which covers Portage County, has been working on an update to the water quality plan for their area. The final report is due in 2003. It will

include detailed planning information for wastewater treatment plans covering the next twenty years. It is available at www.co.summit.oh.us/NEFCOCleanWaterPlan.htm. NOACA, the 208 agency that covers Geauga County, has updated their water quality plan. It is available at www.noaca.org. The report details the wastewater management plans, home sewage disposal plans, NPS and stormwater management plans, protection of critical water resources (model riparian protection ordinance), and watershed planning approaches for the NOACA area. (NOACA , 2000)

Ohio EPA stormwater, water quality, and NPS staff are frequent presenters at workshops and conferences. The NPS staff person attends the Upper Cuyahoga Watershed Task Force meetings and continues to assist the stakeholders with development of section 319 grant proposals. The stormwater staff person has presented numerous talks dealing with implementation of the stormwater Phase 2 program. The water quality staff person attends stakeholder meetings and makes numerous presentations throughout the year. These activities will continue to be a part of the Ohio EPA work plan.

Efforts will be made to educate the Amish farming community about the types of problems associated with farming practices and the assistance that is available to correct and prevent further NPS problems, through the Amish farmer initiative, OSU Extension Office. Funding to expand this program in the upper Cuyahoga should be secured.

The American Heritage River-River Navigator program continues to develop projects in the basin. Current projects include the SOARS (Scientific Outreach and Applications using Remote Sensing) project with NASA and Ohio View to develop an inventory of GIS and Landsat watershed based data for the Cuyahoga watershed as well as developing a series of Education and Awareness brochures targeted for public officials and other interested parties. The Cuyahoga AHR Partners meet approximately ten times per year.

7.3 Process for Monitoring and Revision

Ohio EPA will continue to monitor and assess the basin's chemical and biological water quality as part of the five-year monitoring strategy. The next sampling is tentatively scheduled for 2005. Revisions to the TMDL report would be completed the following year.

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Appendix A. Aquatic Life Use Attainment Status, Cuyahoga River Basin, 2002

Aquatic life use attainment status for stations sampled in the Cuyahoga River basin July-September, 2000. Attainment status for lotic habitats are based on biocriteria for the Erie/Ontario Lake Plain ecoregion of Ohio (OAC 3745-1-07, Table 7-17). All fish sites were sampled using headwater^H or wading^W methods. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community.

River Mile Fish/Invert.	IBI	MIwb ^a	ICI ^b	QHEI	Attainment Status ^b	Comment
Cuyahoga River (Ohio EPA Stream Code = 19-001) <i>Warmwater Habitat (WWH) Use Designation (Existing)</i>						
97.7 ^H /97.7	46	na	MG	70.5	FULL	Dst. Pioneer Lake
96.2 ^H /96.2	32*	na	G	45.0	PARTIAL	Ust. East Branch Reservoir
90.6 ^W /90.7	<u>22</u> *	na	28*	53.5	NON	Dst. East Branch Reservoir
87.3 ^W /87.3	36 ^{NS}	6.9*	38	41.5	PARTIAL	Dst. Tare Creek (wetland)
83.7 ^W	30*	7.7 ^{NS}	--	43.0	(PARTIAL)	Dst. West Branch Cuy. River
64.5 ^W /64.2	47	8.8	56	89.0	FULL	Ust. Lake Rockwell
Cuyahoga River Unnamed Trib. @ RM 93.65 (19-073) <i>Undesignated / WWH Use Designation (Recommended)</i>						
0.1 ^H /0.1	44	na	E	79.5	FULL	Kile Road
Tare Creek (19-038) <i>WWH Use Designation (Existing)</i>						
3.1 ^H /3.0	32*	na	G	60.0	PARTIAL	Durkee Road
1.6 ^W /1.6	34*	na	<u>4</u> *	25.0	NON	SR 608 (wetland)
West Branch Cuyahoga River (19-036) <i>WWH Use Designation (Existing)</i>						
12.3 ^H /12.3	38 ^{NS}	na	G	62.0	FULL	Taylor Wells Road
10.2 ^H /10.2	34*	na	<u>8</u> *	57.5	NON	SR 322 (wetland)
5.6 ^W /5.7	45	8.3	38	65.5	FULL	Aquilla Road
Butternut Creek (19-037) <i>WWH Use Designation (Existing)</i>						
0.8 ^H /0.8	40	na	MG	59.0	FULL	Aquilla Road
Diedrich Creek (19-061) <i>Undesignated / WWH Use Designation (Recommended)</i>						

Upper Cuyahoga River Watershed TMDLs

River Mile Fish/Invert.	IBI	MIwb^a	ICI^b	QHEI	Attainment Status^b	Comment
0.6 ^H /0.6	46	na	VG	68.5	FULL	State Route 87
Cuyahoga R. Unnamed Trib. @ RM 88.02 (19-057) <i>WWH Use Designation (Existing)</i>						
1.4 ^H /1.4	28*	na	F*	41	NON	Dst. Middlefield WWTP
Bridge Creek Unnamed Trib. @ RM 0.52 (19-098) <i>Undesignated / WWH Use Designation (Recommended)</i>						
0.1 ^H /0.1	30*	na	F*	69.0	NON	Dst Rapid Road (wetland)
Cuyahoga R. Unnamed Trib. @ RM 84.60 (19-097) <i>Undesignated / WWH Use Designation (Recommended)</i>						
0.7 ^H /0.7	38 ^{ns}	na	E	51	FULL	State Route 700
Sawyer Brook (19-034) <i>WWH Use Designation (Existing)</i>						
0.3 ^H /0.3	36 ^{ns}	na	<u>P</u> *	56.5	NON	Tilden Road
Cuyahoga R. Unnamed Trib. @ RM 69.43 (19-096) <i>Undesignated / WWH Use Designation (Recommended)</i>						
0.3 ^H /0.2	36 ^{ns}	na	G	60.0	FULL	Canada Road
Harper Ditch (19-092) <i>Undesignated / WWH Use Designation (Recommended)</i>						
0.2 ^H /0.2	46	na	VG	64	FULL	Beck Road
Harper Ditch Unnamed Trib. @ RM 0.61 (19-093) <i>Undesignated / WWH Use Designation (Recommended)</i>						
0.3 ^H /0.3	34*	na	G	50.0	Partial	Infirmity Road
Cuyahoga R. Unnamed Trib. @ RM 65.19 (19-095) <i>Undesignated / WWH Use Designation (Recommended)</i>						
0.3 ^H /0.3	30*	na	G	55.5	Partial	Coit Road
Cuyahoga R. Unnamed Trib. @ RM 63.82 (19-094) <i>Undesignated / WWH Use Designation (Recommended)</i>						
0.1 ^H /0.1	42	na	E	69.5	FULL	State Route 303
Eckert Ditch (19-090) <i>Undesignated / WWH Use Designation (Recommended)</i>						
1.7 ^H /1.7	46	na	G	54.0	FULL	State Route 14
0.4 ^H --	36 ^{ns}	na	--	56.0	(FULL)	Ust. Lake Rockwell

Upper Cuyahoga River Watershed TMDLs

River Mile Fish/Invert.	IBI	MIwb ^a	ICI ^b	QHEI	Attainment Status ^b	Comment
Eckert Ditch Unnamed Trib. @ RM 0.92 (19-091)						
<i>Undesignated / WWH Use Designation (Recommended)</i>						
0.2 ^H /0.1	36 ^{ns}	na	MG	55.0	FULL	State Route 14

Ecoregion Biocriteria: Erie/Ontario Lake Plain (EOLP)

<u>INDEX - Site Type</u>	<u>WWH</u>	<u>EWB</u>	<u>MWH^e</u>
IBI - Headwaters	40	50	24
IBI - Wading	38	50	24
Mod. Iwb - Wading	7.9	9.4	6.2
ICI	34	46	22

- * Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.
- ns Nonsignificant departure from biocriteria (≤4 IBI or ICI units, or ≤0.5 MIwb units).
- a The Modified Index of Well-being is not applicable (NA) to headwater site types (<20 sq. mi.).
- b Narrative evaluation used in lieu of ICI (E=Exceptional; VG=Very Good; G=Good; MG=Marginally Good; F=Fair; P=Poor).
- c Use attainment status based on one organism group is parenthetically expressed.
- e Modified Warmwater Habitat criteria for channel modified habitats.
- H Headwater site type
- W Wading method

Appendix B. Qualitative Habitat Evaluation Index (QHEI) Form

OhioEPA Qualitative Habitat Evaluation Index Field Sheet QHEI Score:

River Code: _____ RM: _____ Stream: _____

Date: _____ Location: _____

Scorers Full Name: _____ Affiliation: _____

1) SUBSTRATE (Check ONLY Two Substrate TYPE BOXES; Estimate % present)

TYPE	POOL RIFFLE	POOL RIFFLE	SUBSTRATE ORIGIN	SUBSTRATE QUALITY	
<input type="checkbox"/> -BLDR /SLBS [10]	<input type="checkbox"/> -GRAVEL [7]	Check ONE (OR 2 & AVERAGE)		Check ONE (OR 2 & AVERAGE)	
<input type="checkbox"/> -BOULDER [9]	<input type="checkbox"/> -SAND [6]	<input type="checkbox"/> -LIMESTONE [1]	SILT:	<input type="checkbox"/> - SILT HEAVY [-2]	Substrate <input type="text"/> Max 20
<input type="checkbox"/> -COBBLE [8]	<input type="checkbox"/> -BEDROCK [5]	<input type="checkbox"/> -TILLS [1]	<input type="checkbox"/> -SILT MODERATE [-1]	<input type="checkbox"/> -SILT NORMAL [0]	
<input type="checkbox"/> -HARDPAN [4]	<input type="checkbox"/> -DETRITUS [3]	<input type="checkbox"/> -WETLANDS [0]	<input type="checkbox"/> -HARDPAN [0]	<input type="checkbox"/> -SILT FREE [1]	
<input type="checkbox"/> -MUCK [2]	<input type="checkbox"/> -ARTIFICIAL [0]	<input type="checkbox"/> -SANDSTONE [0]	EMBEDDED	<input type="checkbox"/> -EXTENSIVE [-2]	
<input type="checkbox"/> -SILT [2]	NOTE: Ignore Sludge Originating From Point Sources	<input type="checkbox"/> -RIP/RAP [0]	NESS:	<input type="checkbox"/> -MODERATE [-1]	
		<input type="checkbox"/> -LACUSTRINE [0]		<input type="checkbox"/> -NORMAL [0]	
		<input type="checkbox"/> -SHALE [-1]		<input type="checkbox"/> -NONE [1]	
		<input type="checkbox"/> -COAL FINES [-2]			

NUMBER OF SUBSTRATE TYPES: -4 or More [2] -3 or Less [0]

(High Quality Only, Score 5 or >)

COMMENTS: _____

2) INSTREAM COVER (Give each cover type a score of 0 to 3; see back for instructions)

TYPE	TYPE	AMOUNT	
Score All That Occur	Score All That Occur	check 2 and AVERAGE	Check ONE (OR 2 & AVERAGE)
<input type="checkbox"/> - UNDERCUT BANKS [1]	<input type="checkbox"/> - POOLS > 70 cm [2]	<input type="checkbox"/> - OXBOWS, BACKWATERS [1]	<input type="checkbox"/> - EXTENSIVE > 75% [11]
<input type="checkbox"/> - OVERHANGING VEGETATION [1]	<input type="checkbox"/> - ROOTWADS [1]	<input type="checkbox"/> - AQUATIC MACROPHYTES [1]	<input type="checkbox"/> - MODERATE 25-75% [7]
<input type="checkbox"/> - SHALLOWS (IN SLUDGY WATER) [1]	<input type="checkbox"/> - BOULDERS [1]	<input type="checkbox"/> - LOGS OR WOODY DEBRIS [1]	<input type="checkbox"/> - SPARSE 5-25% [3]
<input type="checkbox"/> - ROOTMATS [1]	COMMENTS: _____		<input type="checkbox"/> - NEARLY ABSENT < 5% [1]

COMMENTS: _____

3) CHANNEL MORPHOLOGY: (Check ONLY One PER Category OR check 2 and AVERAGE)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY	MODIFICATIONS /OTHER	
<input type="checkbox"/> - HIGH [4]	<input type="checkbox"/> - EXCELLENT [7]	<input type="checkbox"/> - NONE [6]	<input type="checkbox"/> - HIGH [3]	<input type="checkbox"/> - SNAGGING	Channel <input type="text"/> Max 20
<input type="checkbox"/> - MODERATE [3]	<input type="checkbox"/> - GOOD [5]	<input type="checkbox"/> - RECOVERED [4]	<input type="checkbox"/> - MODERATE [2]	<input type="checkbox"/> - RELOCATION	
<input type="checkbox"/> - LOW [2]	<input type="checkbox"/> - FAIR [3]	<input type="checkbox"/> - RECOVERING [3]	<input type="checkbox"/> - LOW [1]	<input type="checkbox"/> - CANOPY REMOVAL	
<input type="checkbox"/> - NONE [1]	<input type="checkbox"/> - POOR [1]	<input type="checkbox"/> - RECENT OR NO RECOVERY [1]		<input type="checkbox"/> - DREDGING	
				<input type="checkbox"/> - ONE SIDE CHANNEL MODIFICATIONS	

COMMENTS: _____

4) RIPARIAN ZONE AND BANK EROSION (check ONE box per bank or check 2 and AVERAGE per bank) [†] River Right Looking Downstream [†]

RIPARIAN WIDTH	FLOOD PLAIN QUALITY (PAST 100 Meter RIPARIAN)	BANK EROSION	
L R (Per Bank)	L R (Most Predominant Per Bank)	L R (Per Bank)	Riparian <input type="text"/> Max 10
<input type="checkbox"/> - WIDE > 50m [4]	<input type="checkbox"/> - FOREST, SWAMP [3]	<input type="checkbox"/> - CONSERVATION TILLAGE [1]	
<input type="checkbox"/> - MODERATE 10-50m [3]	<input type="checkbox"/> - SHRUB OR OLD FIELD [2]	<input type="checkbox"/> - URBAN OR INDUSTRIAL [0]	<input type="checkbox"/> - NONE/LITTLE [3]
<input type="checkbox"/> - NARROW 5-10 m [2]	<input type="checkbox"/> - RESIDENTIAL, PARK, NEW FIELD [1]	<input type="checkbox"/> - OPEN PASTURE, ROWCROP [0]	<input type="checkbox"/> - MODERATE [2]
<input type="checkbox"/> - VERY NARROW <5 m [1]	<input type="checkbox"/> - FENCED PASTURE [1]	<input type="checkbox"/> - MINING/ CONSTRUCTION [0]	<input type="checkbox"/> - HEAVY/SEVERE [1]
<input type="checkbox"/> - NONE [0]			

COMMENTS: _____

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

MAX. DEPTH	MORPHOLOGY	CURRENT VELOCITY (POOLS & RIFFLES)	
(Check 1 ONLY)	(Check 1 or 2 & AVERAGE)	(Check All That Apply)	Pool/Current <input type="text"/> Max 12
<input type="checkbox"/> - >1m [6]	<input type="checkbox"/> - POOL WIDTH > RIFFLE WIDTH [2]	<input type="checkbox"/> - EDDIES [1]	<input type="checkbox"/> - TORRENTIAL [-1]
<input type="checkbox"/> - 0.7-1m [4]	<input type="checkbox"/> - POOL WIDTH = RIFFLE WIDTH [1]	<input type="checkbox"/> - FAST [1]	<input type="checkbox"/> - INTERSTITIAL [-1]
<input type="checkbox"/> - 0.4-0.7m [2]	<input type="checkbox"/> - POOL WIDTH < RIFFLE W. [0]	<input type="checkbox"/> - MODERATE [1]	<input type="checkbox"/> - INTERMITTENT [-2]
<input type="checkbox"/> - 0.2-0.4m [1]		<input type="checkbox"/> - SLOW [1]	<input type="checkbox"/> - VERY FAST [1]
<input type="checkbox"/> - < 0.2m [POOL=0]	COMMENTS: _____		

RIFFLE DEPTH	RUN DEPTH	RIFFLE/RUN SUBSTRATE	RIFFLE/RUN EMBEDDEDNESS	
<input type="checkbox"/> - Best Areas >10 cm [2]	<input type="checkbox"/> - MAX > 50 [2]	<input type="checkbox"/> - STABLE (e.g., Cobble, Boulder) [2]	<input type="checkbox"/> - NONE [2]	Riffle/Run <input type="text"/> Max 8
<input type="checkbox"/> - Best Areas 5-10 cm [1]	<input type="checkbox"/> - MAX < 50 [1]	<input type="checkbox"/> - MOD. STABLE (e.g., Large Gravel) [1]	<input type="checkbox"/> - LOW [1]	
<input type="checkbox"/> - Best Areas < 5 cm [RIFFLE=0]		<input type="checkbox"/> - UNSTABLE (Fine Gravel, Sand) [0]	<input type="checkbox"/> - MODERATE [0]	Gradient <input type="text"/> Max 10
COMMENTS: _____		<input type="checkbox"/> - NO RIFFLE [Metric=0]	<input type="checkbox"/> - EXTENSIVE [-1]	

6) GRADIENT (ft/mi): _____ DRAINAGE AREA (sq. mi.): _____

% POOL: % GLIDE:

% RIFFLE: % RUN:

* Best areas need to have enough to support a population of riffle habitat species.

Appendix C. Summary of the Regulatory, Non-regulatory and Incentive Based Actions Applicable to or Recommended for the Upper Cuyahoga River Basin

Many of these activities deal specifically with the protection, restoration, or enhancement of habitat:

Regulatory:

- appropriate permit limits for phosphorus, ammonia, dissolved oxygen, and CBOD for NPDES dischargers
- phase I and II stormwater requirements (Auburn Township in Geauga County and Shalersville Township in Portage County)
- riparian ordinances (model language) See NOACA and Chagrin River Watershed Partners WEB pages
- 208 plans- NOACA and NEFCO updated plans (NEFCO report is draft)
- county oversight of the inspection of semi-public wastewater treatment systems (HB 110 activities)
 - The Geauga County HB 110 program began in 1994 by addressing aeration plants. The program expanded in 2001 to include septic systems. There are approximately 136 aeration systems and 550 septic systems. The aeration systems and one third of the septic systems are inspected annually. In addition installation inspections are also conducted for upgrades and new systems when a PTI is issued.
 - The Portage County Health Department's HB 110 program began in 2001. Staff inspect 450 semi-public facilities annually. Violations are rectified at the local level. PTI issues are referred to Ohio EPA. The Portage County Health Department inspects all home aeration systems once a year unless supplied proof that the homeowner has a maintenance contract. There is currently no inspection program for septic systems, except for complaints.
- HB 88 Pollution Abatement legislation allows for ODNR monies to be used for water pollution concerns such as exclusionary fencing to keep livestock out of streams.

Non-regulatory:

- from 1998 thru 2001, the Geauga and Portage county SWCDs used Ohio Nature Works monies to purchase conservation easements along the upper Cuyahoga River, securing 217.72 acres of riparian corridor property. It is recommended that the counties continue to secure additional easements along the river and tributary corridors.

- monies from the WRP program () have secured 163 acres in headwater areas of the upper Cuyahoga River watershed and Breakneck Creek. Using these and other grant monies, there is good potential for development of Riparian Protection Plans for additional conservation easements in Geauga and Portage Counties (see appendix B for model language). It is recommended that the counties continue to seek additional opportunities to participate in the Water Resource Restoration Sponsorship Program (WRRSP). Efforts should be made to develop and implement riparian protection plans within the next three years.
- City of Akron watershed protection- the City of Akron owns and manages 15,941 acres of the watershed above the Lake Rockwell dam, which is 12% of the upper Cuyahoga watershed. Akron will continue to protect additional acreage through easements and other methods.
- Geauga County Metroparks owns and protects numerous environmentally sensitive and significant areas. That organization continues to add to their holdings as funds become available.
 - Geauga Parks properties: (total of 1497 acres)
 - Headwaters 926 Acres
 - Eldon Russell 132
 - Burton Wetlands 287
 - Husted Woods 24
 - Krehlik Property 2
 - Kaplan Property 52
 - Hyde Property 74
- The Upper Cuyahoga Watershed Task Force is pursuing the idea of creating a watershed management plan. Ohio EPA will continue to assist with this activity.
- Monies from the Clean Ohio Program have been used to protect 267 acres of farmland in the Hiram area.
- The Portage County SWCD has the lead on the Great Lakes Basin Program Ditch Demonstration Project. This \$15,000 projects is looking at the effects of rural road runoff and the effects on water quality. There will be two demonstration sites in Portage county and two sites in Geauga County. There will be four BMP workshops held in the counties and a brochure will be distributed throughout the watershed.
- Two other conservation/watershed organizations that are organized and active within the basin are:
 - Headwaters Landtrust
 - PO Box 171
 - Hiram, OH 44234-0171

Phone: (330) 509-7863

Founded: 1991

- PLACE-Portage Land Association for Conservation and Education
PO Box 3286
Kent, OH 44240-0041
Phone: (330) 673-8631
Founded: 1989
- Ohio EPA will continue its investigations into the effects that reservoir releases subject to Akron's control might have on water quality with the intent of exploring feasible actions that would minimize adverse environmental effects.
- Amish water quality and nutrient management education: a researcher from the Ohio State University Extension Office has been working on a grant funded project in Amish settlements in western Ohio with the following objectives: 1) educating over 200 families on Best Management Practices; 2) developing nutrient management plans; 3) establishing poultry manure demonstration plots; 4) testing Amish wells for water quality and 5) monitoring streams at eight sites. Although Amish communities may vary in their use of technology and farming practices, they share problems related to manure management. Poor agronomic knowledge and practices, overgrazing and stream bank erosion, lack of nutrient management, and E. coli contamination of well water are common. Traditionally distrustful of outsiders, one-on-one contact with the most innovative farms provides the best strategy for initiating change.

A newsletter that covers agronomy, water quality, safety and food and nutrition as well as meetings that focus on intensive grazing, sprayers and manure spreader calibration have been effective educational tools.

A similar project is underway in Geauga County with oversight provided by the Agriculture and Natural Resources Extension Agent. Additional funding should be secured to allow for continuation and expansion of the project. (Jim Hoorman, Ohio State University Extension, personal communication).

- Ohio EPA will continue to conduct chemical and biological sampling in the basin, following the five-year basin rotation strategy.

Incentive-based:

- Future 319-funded projects for the upper Cuyahoga River basin which support the goals of this TMDL. The Upper Cuyahoga Watershed Task Force is actively working to develop proposals for future grant requests.

- Pursue various loan opportunities for WWTP, septic system, and riparian/habitat improvements (i.e., WRRSP, Revolving Loan Fund, conservation easements).

WRRSP Projects:

- Mantua WWTP- Since Ohio EPA approved the Mantua WWTP and WRRSP project for funding in February 2001, the village has used the WRRSP funds in its WPCLF loan to acquire one piece of property inside the village. This land includes locally significant wetland and riparian corridor features covering about 24 acres. Initial estimates were that this land would cost about \$450,000, but, due to a reduction in the amount of land available, the final purchase price was about \$370,000.

In the future, the village expects that it will use the remaining \$1,132,000 to finance two of the three other approved components of its WRRSP project: a bio-engineering proposal for the Cuyahoga River near the village's WWTP and land acquisition activities (riparian corridor and wetland areas) in the general vicinity of Mantua. This land acquisition effort will be conducted in cooperation with the Ohio Department of Natural Resources' Division of Natural Areas and Preserves. The Portage Soil and Water Conservation District may also play a role in future land protection activities through its conservation easement program.

- American Heritage River (AHR)- River Navigator

The Cuyahoga was selected as one of fourteen rivers to gain American Heritage Rivers status out of 126 applications submitted. The designation recognized the significance of the Cuyahoga as a symbol of the recovery of urban rivers and the hard work that has been done by numerous organizations, community groups, and private interests to revitalize the river. The plan for the future is to use this designation to strengthen collaboration among river stakeholders for further improvements to the river and its surrounding landscape; leverage additional resources for protecting and preserving natural, historic and cultural resources; and to foster sustainable economic development within the watershed. One full time staff person, paid for by one of the federal agency partners, was designated the "River Navigator" for this American Heritage River. His job was to coordinate funding and assistance among the various federal agencies and to act as a liaison between the local stakeholders and stakeholder agencies. As of November, 2002, this position became vacant. Since that time, the Cuyahoga River Community Planning Organization has had local responsibility for the program, with funding from the U.S. Forest Service. Current projects include the SOARS (Scientific Outreach and Applications using Remote Sensing) project with NASA and Ohio View to develop an inventory of GIS and Landsat watershed based data for the Cuyahoga watershed as well as developing a series of Education and Awareness brochures targeted for public officials and other interested parties. The Cuyahoga AHR Partners meet approximately ten times per year. Additional information is available at www.CuyahogaRiverRAP.org.

- The Ohio Department of Natural Resources, Geauga County, Portage County, The Nature Conservancy, and the Cleveland Museum of Natural History have established numerous parks and natural area preserves that serve to preserve and protect water quality in the upper Cuyahoga basin. Recent acquisitions of bog and wetland areas along with plans for additional acquisitions and easements will continue this vital role of the conservation organizations.

Appendix D. Public Comments and Responsiveness Summary

Authors of Written Comments on the Draft Upper Cuyahoga River TMDL Report

#	Date Received	Name	Organization
	March 3, 2004	Public notice given for the draft Upper Cuyahoga River TMDL report	
1	March 16, 2004	Curtis Hofmann	citizen
2	April 5, 2004	Jim White	River Navigator, Cuyahoga, American Heritage River Initiative Partners
3	April 5, 2004	Michael McGlinchy	City of Akron

All comments received during the public notice time frame are noted above. Comments were reviewed by the Ohio Environmental Protection Agency (Ohio EPA) and addressed in the following manner.

Numerous comments identified editing-related issues, including identification of spelling and grammar errors, reference errors, and citation errors. These errors were addressed as appropriate. In addition, some comments requested additional text clarifying a subject or item, word crafting, or other similar issues. These edits did not result in changing the overall content or intent of the report. Ohio EPA thanks the commentors for contributing to the overall clarity and accuracy of the report.

City of Akron reservoir management personnel provided additional information concerning reservoir management policies and practices. The text was revised to reflect the new information.

Substantive comments and those posing a question are specifically responded to in this appendix. Page number references in the comments refer to the draft report available for public comment and may not apply to the final report.

1. Curtis Hofmann: looking for specific remedial actions to be taken.

Response: Those actions are presented throughout Chapter 7, with many specific actions noted in Section 7.2.

2. Jim White: supplied information to update activities of the Cuyahoga American Heritage River Initiative.

Response: The information provided has been incorporated into the report in Section 7.2.

3. City of Akron: The City's comments were specified as either general and specific. The remainder of this appendix contains the Akron comments (presented verbatim), with Ohio EPA responses interspersed as appropriate.

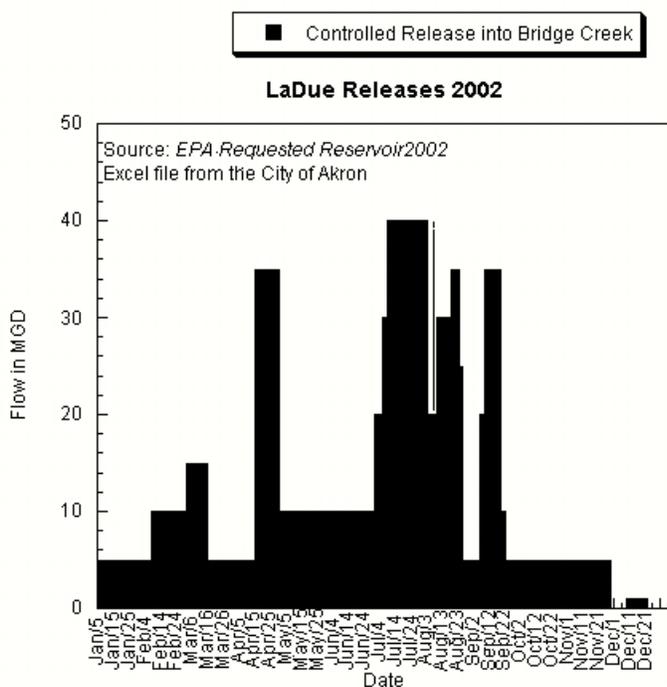
GENERAL COMMENTS

A. This TMDL report is arbitrary and capricious, and cannot be adopted or implemented in its present structure. There is simply no data supporting the central premise that water released from reservoirs has an adverse impact on the river and is a cause of non-attainment downstream, a fact that Ohio EPA admits by requesting institution of a sampling regime (page 78). Ohio EPA is obviously completely unaware of Akron's actual release policy and practices, asserting incorrectly and in direct opposition to actual release data in Ohio EPA's possession, that releases are "instantaneous all or nothing changes in flows." (page 66). Because this draft TMDL would allocate reductions to reservoir releases based on no supporting data and in contradiction to actual data, it does not meet the requirements of the Clean Water Act, or the basic requirements for agency action. If implemented, it would be arbitrary, capricious, unreasonable and unlawful, and it must be revised.

Response: In Ohio EPA's opinion, data collected by Ohio EPA and data provided by the City of Akron support the conclusions and recommendations in the report. Biological community health and chemical water quality conditions decline precipitously downstream from each hypolimnion releases in the Upper watershed (LaDue, East Branch, Lake Rockwell). At the site downstream from the East Branch Reservoir dam, the Index of Biotic Integrity (IBI) dropped a full ten points, from 32 (fair) to 22 (poor) in comparison with the upstream station. Negative changes in the fish community included a significant increase in the incidence of DELT anomalies (Deformities, Eroded fins and/or barbels, Lesions, and Tumors), and a rise in the proportion of tolerant, omnivorous species, and pioneering taxa. The latter is a good indicator of severe but episodic stress, suggesting that the community is in a perpetual state of recovery (Bayley and Osborne 1993). Poor community performance at this location was attributed to hypolimnetic (bottom) releases and modified hydrology associated with the East Branch Reservoir.

Common features among reservoir-influenced warm water streams, particularly where summer hypolimnetic releases are frequent, include depressed DO concentrations, elevated ammonia-N, unseasonable thermal regime, and highly artificial hydrology (Yeager 1993). In those reservoirs that have anoxic hypolimnions, hydrogen sulfide is produced. Singularly or in combination, it is very likely that these stressors served to exacerbate or compound the negative effects of existing habitat deficiencies. Similar patterns in the instream fishery observed near the East Branch Reservoir have been documented in Bridge Creek (LaDue Reservoir) and the mainstem near Kent (Lake Rockwell). Macroinvertebrate trends were similar to the fish with consistent, severe declines in community health between upstream and downstream reservoir sites.

Upper Cuyahoga River Watershed TMDLs



Akron's 1997 Annual Reservoir Report and 1977 U.S. Geological Survey (USGS) sampling clearly show that summer stratification and hypolimnion oxygen depletion occurs within both the LaDue and East Branch reservoirs. Figures 9 and 10 in the draft TMDL report shows total phosphorus (P) concentrations and load per season and Figure 11 (bottom graph) shows elevated total P downstream from reservoirs. These figures indicate that Akron's reservoirs can concentrate and cause elevated pollutant concentrations downstream.

The data is a compilation of

Ohio EPA and City of Akron data. Per Cooke and Carlson's 1985 report ("The Eutrophication of Lake Rockwell Reservoir: Causes, Consequences, and Proposed Protective Action," (Kent State University): "*Concentrations only began to rise when the water became impounded at Lake Rockwell, suggesting that an internal source such as the sediment of the macrophyte-dominant area just above the SR-14 bridge is releasing sufficient amounts of phosphorus to increase stream concentrations.*

Data provided by the City of Akron (see adjacent figure) indicates changes in flow are done dramatically and abruptly. In a conversation on July 18, 2000, a landowner along Bridge Creek downstream from LaDue Reservoir complained that the stream occasionally flows black while the flow/stage increases, often at dusk. The owner also stated that the flow/stage changes quickly at times.

Ohio EPA is requesting additional sampling from the reservoir releases to better understand the releases and their impacts upon the water resources. Ohio EPA has enough evidence to support its conclusions that the reservoirs are having a negative impact, but does not have sufficient information to aid in discussions to make management suggestions/decisions concerning the releases.

Please also see (1) www.epa.gov/owow/nps/MMGI/Chapter6/ch6-3a.html for additional information documenting effects of impoundments, and (2) the response to comment #25, below, detailing Upper Cuyahoga impacts below reservoirs.

B. The draft TMDL reveals a serious misunderstanding of reservoirs under the Clean Water Act and their effect on water quality in the Upper Cuyahoga River. Reservoirs are not a “source” of “pollutants”, as those terms are understood under the Clean Water Act, because they *do not add* any pollutants to the water. Pollutants merely *transit* reservoirs after having been added upstream. Akron’s reservoirs *enhance* the water quality of the Upper Cuyahoga River, and vastly increase the habitat for fish and other aquatic life. These reservoirs act as a net sink for nutrients, removing them from the system, and in addition, the turbulent reservoir releases are oxygenated as the water falls from the dam structures. Finally, these oxygenated reservoir releases augment low natural flows to benefit the river system during periods of low precipitation and low natural stream flow. In no way can reservoirs be considered as “sources” that add pollutants to the Upper Cuyahoga River. This TMDL should be revised to focus on the actual sources of pollutants in this watershed, such as the rapid pace of development and urbanization it is experiencing.

Response: Ohio EPA believes that reservoirs can concentrate and release pollutants at inopportune times (low flow) which can create water quality problems. This is supported by data provided in the TMDL report – see Figure 11 (top graph) and in investigations commissioned by the City (Cooke and Carlson, 1985). Dissolved oxygen concentrations are lower downstream from the reservoirs compared to upstream. As stated in an earlier response, data shows that the biological communities are worse downstream from the reservoirs.

We agree that land use can have a significant impact on water quality. However, conditions within the upper Cuyahoga River were generally stable from 1984 to 2000. At sites common between surveys, community performance as measured by the IBI generally yielded similar evaluations. Apparent discrepancies were the result of either data gaps in the 2000 surveys or were explained in terms of macrohabitat quality of disparate stations between survey years, or both. The performance of the modified Index of Well-Being (MIwb) yielded excellent correspondence throughout the upper Cuyahoga River, providing additional evidence of environmental stability through time. Macroinvertebrate sampling at the Ohio EPA reference site at SR 303 (upstream from Lake Rockwell and downstream from Mantua) reflects consistently exceptional performance over the last 20 years despite increasing development pressures. Therefore, while land use may be changing, the reservoirs remain constant which mirrors the relatively poor community performance. The TMDL is based upon existing conditions with allocations to future growth. It is not a vehicle to predict future development. See discussion earlier concerning reservoirs “manufacturing” (i.e., acting as a source) of pollutants.

There are no allocations for reservoir releases *per se*. Table 11 allocates to East Branch and LaDue OUTFLOWS (note, this is the term Akron preferred in the Lower Cuyahoga River TMDL) but goes on to say this includes any upstream sources as well as instream process which could be a process that adds to the load or could be a

process that are sinks of pollutants. All that number needs to represent is the final outcome of all of the things that occur upstream of the dam.

We would not agree that development and urbanization is the primary source of pollutants in the upper watershed for the following reasons:

- 1) Land use maps in the TMDL indicate a very low percentage of urban land use in the upper basin.
- 2) The Tare Creek, Sperry Pond wetland complex represents a considerable buffer between the Cuyahoga mainstem and Middlefield, the largest population center in the headwaters.
- 3) Only a small number of sampling sites (2 of 24) located upstream from reservoir releases in 1996-2000 were in Non or Partial attainment attributed to urban development pressures (e.g., suburban development, septic tanks, WWTPs, etc.).
- 4) The site on Bridge Creek upstream from the reservoir is closer to the rapidly developing areas than the site downstream, yet the upstream site is in full attainment and the downstream site is in non attainment.

C. The purpose of a TMDL is to bring waters into attainment with water quality standards where NPDES reductions from point sources are insufficient to do so. This draft TMDL report selectively addresses that objective. Ohio EPA has selectively applied the adopted water quality standards where the same wetland conditions occur (see page 21 regarding West Branch versus pages 19-20 regarding Cuyahoga River (Headwaters to Black Brook) and Tare Creek). Ohio EPA has also, without adequate science, established phosphorus “targets,” which are not water quality standards, as a surrogate for meeting actual biological water quality standards. The science supporting this selective application is weak, and there is insufficient data to support selectivity here. A TMDL cannot be founded on such arbitrariness.

Response: Field information collected during basin surveys clearly identifies the causes and sources in the different wetland segments. Sufficient research has been done to develop the phosphorus targets (see Ohio EPA Technical Bulletin MAS/1999-1-1). Accordingly, Ohio EPA respectfully disagrees with this comment.

“Natural conditions” were chosen as a cause or source of impairment based on the type of water body assessed (i.e., wetland stream vs. lotic (flowing), warmwater habitat stream) not the presence or absence of human activity. The lower reaches of Tare Creek and a number of other streams in the Upper Cuyahoga basin are located almost entirely within large wetland complexes. Expectations for biological and water quality performance are quite different in these specific locations compared to typical riverine habitats. Therefore, biological water quality standards are not applied in the same manner. If a wetland section is located within a WWH designated stream (e.g., the SR 322/Aquilla Lake region of the West Branch Cuyahoga), the reach is listed in non attainment attributable to natural conditions and excluded from the TMDL

D. The fast-track that this TMDL is on will undercut the iterative process that the public participation aspect of TMDLs is intended to develop. The Cuyahoga River is an especially complex river system. The data and assumptions upon which this Draft stands are insufficient to develop real solutions without a thorough discussion among stakeholders regarding deficiencies in the Draft. Public participation has been extremely limited. By any measure, this Draft is not ready to submit to U.S. EPA for approval.

Response: The Upper Cuyahoga TMDL time period for development has been approximately 22 months from the initial stakeholders meeting on June 25, 2002 until the public notice of the draft report. Other TMDLs prepared by the Ohio EPA have ranged from 14 months to 20 months (an average of 17.2 months for 7 TMDLs evaluated). Accordingly, Ohio EPA respectfully disagrees with this comment.

SPECIFIC COMMENTS

4. Page vii, Sources: The phrase “water supply reservoir releases” should not be included in the identified “sources” of pollutants. Reservoirs *do not add* pollutants to water but rather *transit* them, after receiving them from upstream sources, through the reservoir and into the river. This draft TMDL and its draft allocation should be corrected accordingly to focus on reducing actual pollutant inputs.

Response: Reservoirs can and do concentrate pollutants to the water especially ammonia and hydrogen sulfide. See the response to general comment A, earlier in this appendix. Also see the U.S. EPA web link which describes dams as sources of impact (<http://www.epa.gov/owow/nps/MMGI/Chapter6/ch6-3a.html>), particularly Paragraph 7: “The operation of dams can also generate a variety of types of nonpoint source pollution in surface waters.”

5. Page vii, Implementation Plan: Reservoir releases from East Branch and LaDue Reservoirs are determined primarily for water supply purposes, with environmental considerations secondarily. Since the current release policy has been adopted for Akron’s reservoirs, water supply and environmental considerations have been entirely compatible. Akron’s release of runoff water temporarily stored in the East Branch and LaDue Reservoirs supplements the very low natural flow in summer that would normally occur during dry periods, thus positively affecting local flora and fauna. Additionally, the stormwater retention that these reservoirs provides when the reservoirs’ water level is lowered reduces downstream flooding during late winter snowmelts and early spring rains, and also provides positive affects to flora, fauna and downstream stakeholders. The draft TMDL’s allocation is not scientifically supported and must be redirected toward sources of pollutants, such as increasing urbanization.

Response: Ohio EPA does not understand the statement concerning reservoir releases positively affecting local flora and fauna. The segments downstream from the reservoirs are in non-attainment. Ohio EPA would welcome data and evidence that Akron has to substantiate these statements and consider the information in our revisions. Sediment retention within the reservoirs can have positive effects, but can also lead to sediment “starvation” and result in stream down-cutting and subsequent bank erosion.

7. Page 1, paragraph 1: If the 2000 watershed survey is the basis for this TMDL report, an additional three years of Akron’s environmentally sensitive reservoir release policy implemented in the mid-1990s are not reflected in this report.

Response: Reservoir flow and chemistry data from January 1996 through May 2002 were used in the analysis. The City of Akron provided this data.

8. Page 1, paragraph 4: Increased land development for residential, commercial and industrial purposes resulting in increased amounts of impervious areas in the watershed is a significant factor that is not included as one of the primary causes of impairment. While projected development of the watershed is referenced on page 35, paragraph 4, the development that has occurred during the last several decades, most especially the 1990s, should be specifically cited as a factor in the river’s current condition. Because of the magnitude of development in this watershed is so great, that cause should be allocated the largest percentage reduction of targeted pollutants. Reasonable assurance measures, such as Geauga County and local township actions to develop and/or modify landuse plans, implement development plan review requirements, and change local zoning codes, should be further identified and supported.

Response: From Ohio EPA’s perspective, development does not appear to be significant in terms of land use (<2.0%). Our data do not show that urban runoff is currently a significant source of impairment in the upper basin. We agree that the reasonable assurance measures should be, and will be, pursued.

9. Page 2, Table 2, Description: The assessment unit score of “19” for Aquatic Life Use attainment does not appear to be correct. Would it not be a higher number than the “61” score listed for partial attainment and the “20” of non-attainment?

Response: The scores are correct as presented. The scores are an aggregation of attainment status information for the watershed and are most useful for comparison of relative condition with other Ohio watersheds. The high partial attainment score does indicate that this area has potential for recovery. The method used to derive the score is explained in the 2002 Integrated Report (p. 5). Additional information is included in

the 2004 Integrated Report (pp. 33, D.2-79, 80, 81). Both of these documents are available online at <http://www.epa.state.oh.us/dsw/tmdl/index.html>.

10. and 36. Page 2, Table 2, column 3, bottom block: “Bridge Creek (~~Snowville~~-Snow Lake Outlet)”.

Response: The suggested change has been made.

11. Page 3, Table 2: Why is a portion of the Middle Cuyahoga River, “Cuyahoga River, Lake Rockwell dam to below Breakneck Creek” included in this report? That river segment was expressly part of the Middle Cuyahoga TMDL, which was approved by U.S. EPA specifically noting that that river segment was included “for monitoring purposes only.” This reference should be deleted from the Upper Cuyahoga River TMDL.

Response: The inclusion of the area below the Lake Rockwell dam in Table 2 is appropriate in the context of a watershed focus; the table includes a reference to the Middle Cuyahoga River TMDL. The middle Cuyahoga project, Ohio’s first approved TMDL, was completed when work was more segment focused. Experience has shown that a watershed approach is more amenable to various aspects of a TMDL, and Ohio has steadily moved in this direction in the past few years. Indeed, the middle Cuyahoga and the Rocky (Plum Creek) TMDLs, the two earliest TMDL efforts, are the only Ohio TMDLs that do not address whole watersheds.

Ohio has adopted the Hydrologic Unit Code (HUC) system to define watersheds. The widely used system was initially developed by U.S. Geological Survey and refined to finer detail for use by the Natural Resource Conservation Service. In this system, the ending point of the unit identified as 04110002 020 extends to below Breakneck Creek, rather than ending at the Lake Rockwell dam.

14. Page 4, section 2.1, paragraph 1: The phrase “The foundation of Ohio Water quality standards (WQS) is the concept that public waters have beneficial uses that are to be available to the public” must be clarified so that it can not be misconstrued to imply that public use of Lake Rockwell, a terminal impoundment reservoir for public drinking water supply, can be used for purposes other than public drinking water supply. Lake Rockwell and its surrounding property is and always has been closed to the public for source water protection and water supply security purposes.

Response: Nothing in the TMDL should be construed to convey or deprive property rights. The statement of the conceptual basis of Ohio’s water quality standards is appropriate in this context.

16. Page 10, paragraph 2: While this paragraph states that “The upper basin is the focus of this report.”, Ohio EPA has included portions of the Middle Cuyahoga River basin (Plum Creek, Fish Creek and Potter Creek) in Appendix A. Again, these were expressly included in the Middle Cuyahoga TMDL approved by U.S. EPA. It would be appropriate for Ohio EPA either to omit these inclusions, or to refer to them in this paragraph, and explain the relevance of Middle Cuyahoga River data.

Response: While there is no harm in including the information, it may be confusing to the reader. The information in Appendix A has been deleted.

18. Page 12: Add “Aquilla Village WWTP” downstream of Lake Aquilla and upstream of Butternut Creek. This public WWTP discharges into the wetlands.

Response: The suggested change has been made. Small WWTP discharges including Aquilla Village and others were allocated loads in the TMDL model.

19. Page 12: Add “Infirmiry Creek WWTP” downstream of Butternut Creek and upstream of Diedrich Creek.

Response: The suggested change has been made.

20. Page 12: Add “Troy Oaks WWTP” to the east shore of LaDue Reservoir, opposite of Auburn Corners WWTP.

Response: The suggested change has been made.

25. Page 16, paragraph 2: The sentence “Poor community performance...was attributed with the East Branch Reservoir.” should be deleted. What data does Ohio EPA have to attribute poor community performance to reservoir releases and modified hydrology associated with East Branch Reservoir? The reservoir itself provides significant fish habitat, as evidenced by fish population management by the Ohio Department of Natural Resources (if the population is so good, why does it need management? Ohio EPA is looking for self sustaining populations.), the great popularity of sport fishing, a county managed park, and sitings of rare and uncommon wildlife species. Without Akron’s release of stored water from East Branch Reservoir, there would be times of little or no flow that would be extremely detrimental to the fish community. (Further upstream the flow is less and is in full attainment) There simply is no documented basis to attribute adverse effects to the river from reservoir releases.

Response: Ohio EPA data show the sites upstream of the reservoirs are in full attainment while sites below the reservoirs are in non-attainment. Biological and water quality impacts associated with hypolimnetic releases are cited in the literature (Yeager 1993), in Ohio streams and rivers (Ohio EPA 305b reports 1986-2002), and in the Cuyahoga River basin downstream from the Akron water supply reservoirs (Ohio EPA 1984 [file data], 1994, 1999, 2002 [file data])¹. With regard to comment #25 specifically, dissolved oxygen violations, elevated ammonia concentrations, a modified flow regime, and non attainment of biological communities were documented immediately downstream from East Branch Reservoir release during three intensive biological and water quality surveys conducted from 1991-2000. Impairment extended approximately 10-15 miles downstream during each survey. Accordingly, Ohio EPA respectfully disagrees with this comment.

26. Page 19-23, Summary of Impairments: The river, its primary tributaries, and Lake Aquilla are included in this TMDL. East Branch Reservoir and Punderson Lake are cited as having been erroneously included in the 1998 issuance of the CWA 303(d) list. While East Branch Reservoir is on this list (Table 2, page 7), and LaDue Reservoir is not, Lake Rockwell is (Table 2, page 13), but is not included in this report. Should it have been?

Response: Lake Rockwell was also included on the 1988 list in error.

28. Page 19, paragraph 2: Even if there were data of hypolimnetic waters from East Branch and LaDue Reservoirs, such waters would have a minor effect compared to the urbanization

¹ Ohio Environmental Protection Agency 1984. Unpublished results from initial intensive survey of the middle and lower Cuyahoga River.

____ 1994. Biological and Water Quality Study of the Cuyahoga River and Selected Tributaries, Volume I. Division of Surface Water, Columbus Ohio. Ohio EPA Tech. Report EAS/1992-12-11, 203 pp.

____ 1999. Biological and Water Quality Study of the Cuyahoga River and Selected Tributaries, Volume I. Division of Surface Water, Columbus Ohio. Ohio EPA Tech. Report MAS/1997-12-4, 123 pp.

____ 2000. Unpublished results from 2000 intensive survey of the middle and lower Cuyahoga River.

____ 1986-2002. 305b reports.

Yeager, B.L. 1993. Dams. Pages 57-113. *In* C.F. Bryan and D.A. Rutherford, (eds.). Impacts on warmwater streams: Guidelines for evaluation, Second edition. Southern Division, American Fisheries Society, Little Rock, Arkansas.

related stressors. While the effect of a hypolimnetic reservoir release might be more recognizable during the short period of mid-summer low flows the year-long runoff from urbanizing areas of the watershed are recognizable throughout the year, most especially as the river and its tributaries become unstable and suffer from bank erosion and channel scouring. Reference to “discharges of hypolimnetic waters” should be deleted as lacking any data support whatsoever, and because “discharge” is a legal term of art that does not apply to reservoir releases.

Response: Regarding releases of hypolimnetic water, there are instances where such activity has been reported to Ohio EPA (Tom Baclawski, Ohio EPA DDGW, 1998 personal communication). In a conversation on July 18, 2000, a landowner along Bridge Creek downstream from LaDue Reservoir complained that the stream occasionally flows black while the flow/stage increases, often at dusk. Regarding the short term effect of releases during mid-summer, that is the critical time period when the effects on the biota are most pronounced. Non and partial attainment is documented downstream from all of Akron’s reservoirs that can have hypolimnion releases. Impairment attributed to urbanization and suburban development in the Upper Cuyahoga basin is minimal (TSDs, 305b data).

30. Page 20, paragraph 1: What data does Ohio EPA have that indicates the releases from East Branch and LaDue Reservoirs cause elevated ammonia – nitrogen concentrations? Reservoir releases in general are being pointed to as a major cause of non-attainment without adequate data to validate this supposition. Alleged “qualitative evidence”, including information from outside the watershed, is hardly a sufficient basis upon which to develop the mathematical load calculation required for a TMDL under the Clean Water Act. This draft TMDL, therefore, improperly establishes an allocation for reducing a targeted pollutant without sufficient scientific support, and must be reconsidered.

Response: Although increased ammonia-N downstream from LaDue and East Branch reservoirs has been documented by Ohio EPA samples since 1991, ammonia-N was not identified as a cause of impairment and there are no targets set for ammonia-N in this TMDL. Therefore, the statement will be dropped from the report.

31. Page 20, paragraph 2: As stated in the previous comment, reservoir releases have been attributed to negative influences on aquatic communities without adequate supporting data. Also, nutrients transiting through reservoirs have originated from upstream sources and were transported to the reservoir as part of stormwater runoff.

Response: General information pertaining to this comment is contained in the response to general Comment A. In addition, seston (suspended particulate organic matter such as plankton and detritus) -rich epilimnion (top) releases and stratified, anoxic hypolimnion (bottom) releases may have pronounced effects on downstream

communities that are substantially different from the source water. This was demonstrated in 1996 downstream from the dual water releases at LaDue Reservoir. Biological communities were in non attainment below the hypolimnion release on Bridge Creek but full attainment below the epilimnion release on Black Brook. Neither assemblage matched the quality of communities found upstream from the impoundment.

32. Page 20, paragraph 3: Regarding sampling in the wetlands area, are low D.O. levels and increased fecal coliform typical of wetlands areas that attract waterfowl? It is apparent that the influence of wetlands on stream quality has been selectively applied in this TMDL. Where there are no human activities, Ohio EPA has declined to apply its water quality standards, citing “natural conditions.” See, for example, page 21 regarding the West Branch. Where the same natural conditions exist and influence water quality, such as the vast wetland complex below East Branch Reservoir, Ohio EPA ascribes this only to reservoir releases upstream of the wetland. This distinction is arbitrary and unsupportable.

Response: Natural conditions are allowed in TMDL guidance. East Branch non-attainment is attributed to natural conditions, reservoirs and point sources, not just the reservoirs alone.

In our experience, low DO levels are often typical of wetlands and are primarily attributed to natural conditions. Coliform exceedences are not generally typical of wetland habitats but, in the case of Tare Creek, exceedences associated with unrestricted cattle access were documented in the free flowing reach immediately upstream.

“Natural conditions” were chosen as a cause or source of impairment based on the type of water body assessed (i.e., wetland stream vs. lotic, warmwater habitat stream) not the presence or absence of human activity. The lower reaches of Tare Creek and a number of other streams in the Upper Cuyahoga basin are located almost entirely within large wetland complexes. Expectations for biological and water quality performance are quite different in these locations compared to typical riverine habitats. Therefore, biological water quality standards are not applied in the same manner. If a wetland section is located within a WWH designated stream (e.g., the SR 322/Aquilla Lake region of the West Branch Cuyahoga), the reach is listed in Non attainment attributed to natural conditions and excluded from the TMDL.

33. Page 21, paragraph 4: Ohio EPA fails to reconcile the full attainment of Black Brook downstream from LaDue Reservoir with its identification of reservoir releases as, apparently, the sole “source” of phosphorus at Hiram Rapids, which is even further downstream from the reservoirs. Again, nutrients *transit* through the reservoir, and do not

originate there. This disconnect highlights the futility in utilizing arbitrary phosphorus “target” levels as a surrogate for actual water quality standards.

Response: Ohio EPA did not say that the sole source of phosphorus was from the reservoirs. The LaDue discharge to Black Brook does not have a hypolimnetic release, nor a regulated structure as the other reservoir releases.

Black Brook was fully attaining the aquatic life use, but the trophic composition of the macroinvertebrates (i.e., extremely dense filter-feeder populations) suggested high levels of suspended organic material. These conditions were attributed to the seston-rich epilimnion releases from LaDue. Downstream from Black Brook at Hiram Rapids, community composition was also very similar (extremely dense filter feeder populations), an indication that the reservoir influence extended downstream.

Regarding the use of a “target” versus a “water quality standard,” Ohio EPA does not understand why a “target” level has any more, or any less, disconnect than a chemical water quality standard.

38. Page 25, paragraph 3: If wetlands and QHEI evaluations are not compatible, then why would sections of the Upper Cuyahoga including or affected by wetlands be included in the TMDL premised on improving QHEI scores through phosphorus reduction? The parameters used to define “attainment” should be revised, or areas upon which the current parameters do not apply (such as significant areas of wetlands in the headwaters) should not be included in the report.

Response: The TMDL specifically states, in paragraph 3 of Section 5.2, that for low gradient wetland influenced streams, a minimum target score of 60 may be used as a restoration target as long as reference stream reaches are used to aid in restoration design. A reference stream reach should be a nearby river or stream (preferably in the same hydrologic unit) of similar size and type that is fully attaining biocriteria. Category scores from reference stream reaches can be used to adjust the target scores for each of the QHEI categories presented in Table 10 of the TMDL report.

39. Page 27, paragraph 1: Again, the text demonstrates that Ohio EPA is unsure of the impact or occurrences of hypolimnetic releases.

Response: Ohio EPA is confused by the comment unless it refers to the word “may” in the sentence “hypolimnetic releases during low flow conditions may be another significant source of pollutants.” Biological and water quality impacts below the hypolimnetic releases are well documented, as discussed in other responses in this appendix.

40. Page 30, paragraph 2, line 1: "...daily outflow and ~~collects monthly~~ water quality samples for of the Lake Rockwell...".

Response: Data submitted by Akron to Ohio EPA indicate monthly chemical grab sampling is conducted.

41. Page 30, paragraph 2: What credit does Ohio EPA include for the fact that East Branch and LaDue Reservoirs capture nutrients and pollutants (adhered to sediments), only some of which transit downstream?

Response: The outflow load is based on the outflow chemistry multiplied by the outflow quantity (flow) as monitored by Akron. The outflow chemistry and flow are the final products of what enters the reservoir and what happens within the reservoir. Therefore credit is being made both to the sink (capture) and the source (release) processes occurring within the reservoir itself.

45. Page 31, paragraph 3, line 1: "...from 1996 through ~~2002~~ 2000." Prior reference to the sampling (page 15, paragraph 1, line 10) indicates that sampling occurred in 2000. Change all references for consistency.

Response: The text is correct as originally written. Chemistry samples through 2002 were used in this analysis. The watershed assessment was performed in 2000; this assessment was the basis for determining the need for and focus of the TMDL. However, additional data to support the TMDL development itself has been collected in other years, up to and including 2002.

46. Page 32, paragraphs 1 and 2: Is the use of "smiley" and "not-smiley" faces appropriate bullets for a public document?

Response: The symbols have been changed to standard non-descriptive "bullets."

47. Page 33, paragraph 2, line 7: Ohio EPA indicates "Bridge Creek downstream of LaDue Reservoir occasionally runs black indicating possible hypolimnetic reservoir release of low D.O. poor quality water." What data does Ohio EPA have regarding the description of reservoir releases, and how long ago did the alleged events occur? What evidence does Ohio EPA have to confirm the reported fish kill downstream of LaDue resulted from a release of water from LaDue? This area has been impounded by beaver for many years, and is dominated by wetland conditions, having similar low D.O. conditions as do the other wetlands, as Ohio EPA has documented and cited. Without direct data, ascribing causation to alleged, "possible" hypolimnetic releases is unsupported and must be deleted.

Response: The sources are personal communications with adjacent landowners on July 19, 2000, and Tom Baclawski, Ohio EPA DDGW in 1998. The reference to the fish kill is from an Ohio Department of Natural Resources fish kill report from September 27, 1993, that lists the “LaDue Reservoir outflow” and the pollutant as “anaerobic water release from LaDue Res” and the source as the “City of Akron”.

48. Page 33, paragraph 2, line 11: This last sentence must be explained. It purports to provide supportive evidence of low D.O. reservoir release water from LaDue with only one (1) high phosphorus data point at Hiram Rapids, and pictures taken downstream of Lake Rockwell. This alleged “evidence” is insufficient to demonstrate causation when the Hiram Rapids site is 10.3 miles downstream of LaDue and subject to 151 square miles of watershed influences. There is no data to isolate reservoir releases as a cause, and no attempt made to address the fact that Hiram Rapids is subject to the influences of such a vast watershed. The gratuitous reference to “water releasing from Lake Rockwell” is also completely irrelevant to the Upper Cuyahoga TMDL, and should be deleted.

Response: Lake Rockwell was used as an example of reservoir releases from hypolimnetic waters that were directly observed by Ohio EPA. A siphon structure was constructed at the Lake Rockwell dam which releases bottom (hypolimnetic) waters. This discharge can be extrapolated to releases from the other reservoirs that Akron manages. The last sentence includes three points which provide qualitative support for the presence of hypolimnetic releases from the reservoirs. The first point is below each of the three reservoirs (LaDue, East Branch, and Lake Rockwell) there are sections of river showing non-attainment of biological indices. Sites upstream of the reservoirs do not have many non-attaining areas and the pattern is remarkable. The biology in these areas exhibit impairments associated with severe, episodic stresses which differ from signatures associated with other types of stresses.

The second point is when the reservoir outflows made up almost 100% of the flow at Hiram Rapids gage, there was a total phosphorus concentration recorded at Hiram Rapids of 1.08 mg/l for the day where the reservoir outflow was increased. During the time period of July 4, 1996 through July 14, 1996 the LaDue and East Branch reservoir daily outflows as reported by Akron summed to the daily flow at Hiram Rapids as recorded by USGS (they were the only significant source to the gage). There was incidental rain during this period but no change in flow due to runoff was evident. However, on July 9, 1996, Akron increased the outflows from both the LaDue and East Branch reservoirs by 5 million gallons per day (MGD) each for a total outflow increase of 15 cubic feet per second (cfs). A sample taken on July 9th at the Hiram Rapids gage showed a total phosphorus concentration of 1.08 mg/l, a very elevated number. Akron had also substantially increased their outflows on July 3, 1996, elevating the outflows by 54 cfs with no other significant source contributing to the gage. The chemistry sample while elevated is not an outlier as there are a few other samples taken at the gage since

1991 that are slightly higher than this sample. Given the infrequency with which the gage is sampled, these few elevated samples can be indicative of more frequent exceedences than actually sampled.

The third point is there is documented photographic evidence of a reservoir operated by Akron is releasing hypolimnetic waters. This further supports the likelihood that other reservoirs operated by Akron are also releasing hypolimnetic water especially since a landowner describes a similar condition downstream from LaDue reservoir. Historical information provided by Akron shows LaDue reservoir stratifying in the summer and East Branch reservoir stratified at or near the level where the reservoir overflow structure is placed.

49. Page 34, Table 7: Phosphorus that transits through reservoirs originates elsewhere in the watershed. Ohio EPA's focus should be on the reduction of phosphorus sources in the watershed, rather than in the receiving streams and reservoirs. This is a fundamental defect in this draft TMDL, and it must be revised because reservoirs are not "sources" of pollution.

Response: The focus of the TMDL is on reduction of phosphorus sources throughout the watershed as both Table 7 and Table 11 show. The hydrologic condition referred to in Table 7 is a way of allocating to the watershed sources appropriately, not a focus on the river itself. The TMDL recommends reductions in nonpoint sources, home sewage treatment systems, and the reservoir outflows. These are all watershed sources.

50. Page 44, Table 9, last row: This row refers to the Middle Cuyahoga River and should not be included in this report of the Upper Cuyahoga River. Ohio EPA has previously defined the Upper Cuyahoga to have a downstream terminus of the Lake Rockwell Dam.

Response: The segment below Lake Rockwell Dam provides information on the Lake Rockwell reservoir (a part of the upper Cuyahoga TMDL), a connection to the earlier middle Cuyahoga TMDL work, and a watershed context related to Ohio's defined assessment units (HUC 11). The response to comment 11 provides additional information on the relationship of the upper and middle Cuyahoga projects and how they are presented in this report.

51. Page 45, bottom chart: Why is the target range of total phosphorus different in the "Dst. Hiram Rapids" and "Dst. Lake Rockwell" columns?

Response: Target ranges of total phosphorus are based upon watershed size. The target range of total phosphorus in the "Dst. Hiram Rapids" and "Dst. Lake Rockwell" columns are not different. The target for Eckert Ditch is different due to its smaller drainage area size.

52. Page 51, Table 11: No credit or offset is given for long-term phosphorus held in East Branch and LaDue Reservoirs that only partially transits the reservoirs. Reduction is needed in watershed areas tributary to the reservoirs.

Response: The effect of the reservoirs (either positive or negative) is included in these numbers as the analysis and allocations are based on the outflows. The reductions to these outflows can include upstream sources or instream processes. All sources upstream of the dams are a part of the outflow load including watershed areas tributary to the reservoirs.

54. Pages 61, 62, Reservoir Management: In preparing this TMDL, Ohio EPA has not contacted Akron to learn how the reservoirs are managed, and it is evident from this report that Ohio EPA has no understanding of actual practice. Akron remains willing, as it has been during this process, to educate Ohio EPA on how the reservoirs actually operate, in order to eliminate the mere supposition evident in this report.

Response: Akron has provided information from the City's Reservoir Management Plan. We continue to have differing opinions regarding the effects of reservoir releases. We will continue to discuss what actions might be taken to operate the controlled releases in as environmentally friendly manner as possible. The daily outflow data as requested from Akron was used directly and without inference in the TMDL development. No reservoir management assumptions were made in developing the TMDL numbers or allocations. As there were no assumptions made, there is no supposition in the development of the TMDL numbers.

55. Page 62, paragraph 2: This list of 6 important strategies to focus efforts in developing an implementation plan completely ignores landuse planning to prevent detrimental effects of impervious areas created by land development. This is the single biggest threat to water quality in the Upper Cuyahoga River watershed, and should be allocated the largest share reduction.

Response: Ohio EPA recognizes the impacts that land use can have on water quality. However, TMDLs are designed to propose reductions of existing loads with a margin of safety and an allocation for anticipated growth. The TMDL must deal with documented impairment from existing loadings, not just a projection of a future "threat to water quality."

56. Page 62, paragraph 3: Ohio EPA suggests that home sewage treatment systems (HSTS) should be eliminated via the extension of municipal sanitary sewers. Doing so would most

likely encourage additional development, increased imperviousness, and degraded runoff water quality. Failed HSTS can be identified and eliminated through an effective monitoring program conducted by county health departments, and future failures can be avoided through proper siting with effective soils information and landuse planning. Watershed communities and townships have already revised the CWA 208 plan that identifies those areas of their communities that will be sewered, may be sewered, and will not be sewered.

Response: Ohio EPA agrees with the comment. It has been our experience that, in some instances, sanitary sewers are a better long term remedy than repairs and upgrades to existing home sewage treatment systems (HSTSs).

59. Page 66, Reservoir Management: Akron instituted a policy for reservoir releases in the mid-1990s that is environmentally sensitive. Ohio EPA clearly is completely unaware of the following policy that Akron uses for its reservoir releases:

5.04 RELEASES

Watershed reservoir releases are planned with consideration of the needs of the water plant. LaDue and East Branch Reservoir release valves are operated to provide continuous flow to Lake Rockwell throughout the summer that also provide benefit to aquatic habitat in the Upper Cuyahoga River.

5.04.01 RELEASE RATES

Watershed reservoir releases are made from East Branch, LaDue and Lake Rockwell so as to maximize the total safe yield.

The lower sluice gate at Lake Rockwell is normally kept closed.

The drain at Mogadore Reservoir is normally open to 4 mgd at all times.

When possible, large fluctuations (30 mgd or more) in release rates are not made in less than three (3) days to give the aquatic ecosystem of the river time to adjust to the change in flow conditions. Large, sudden changes are particularly avoided when the river is low. (Watershed Property Management Policy Manual, City of Akron, 1998).

To comply with the State of Ohio Dam Safety Law, Akron performs regular dam inspections and maintenance. This does include the full exercise (opening and closing) of dam release valves. This typically occurs in April and October of each year, and may last approximately 3 to 5 minutes at each reservoir.

Without reference to the actual policy, Ohio EPA asserts that Akron engages in “instantaneous all or nothing changes in flow.” This is not the policy, and is demonstrably false, as reference to the actual record of releases, a record that is in Ohio EPA’s possession,

proves. The data regarding actual releases eviscerates the supposition that Ohio EPA has built this TMDL upon, which is that reservoir releases are the cause of non-attainment. Ohio EPA has no data to support its contention, and ignores data that contradicts its theory. This is arbitrary and capricious in the extreme, and cannot be the basis for a TMDL under the Clean Water Act.

Response: Regarding the Flow Policy, the Bridge Creek 7-day, 10-year low flow is about 2.5 MGD and East Branch low flow is 2.8 MGD, per Akron's release policy: 'When possible, large fluctuations - 30 mgd or more - in release rates are not made in less than three (3) days to give the aquatic ecosystem of the river time to adjust to the change in flow conditions. Large, sudden changes are particularly avoided when the river is low.' This policy allows more than an order of magnitude change in the water volume in Bridge Creek and the East Branch during low flows. What studies did Akron perform to ensure the release policy was environmentally sensitive? Ohio EPA data indicates the policy, as applied, is not protective of water quality and that additional discussions are warranted.

60. Page 66, paragraph 1: Use of the term “discharge” is inappropriate, since it is a term of art under the Clean water Act denoting an addition of pollutants. There is no evidence that Akron’s reservoirs “add” pollutants; indeed, the evidence is that they operate as a net sink to remove pollutants from the system, while others transit through the reservoirs.

Response: The word “discharge” has been replaced with “release.” See Cooke and Carlson, a study that, we believe, Akron commissioned.

61. Page 77, last bullet: This paragraph is relevant to the Middle Cuyahoga River watershed, and should not be included in this report.

Response: The narrative has been edited.

62. Page 78, paragraph 3: Ohio EPA’s assertion that it will seek a new “sampling regime” is an admission that it has insufficient data to identify reservoir releases as a cause of non-attainment. Under the TMDL program, such data must be present before an allocation of load reduction is made, not after. The fact is that the “endpoint” of Ohio EPA’s intended discussions with Akron already exists in Akron’s current release policy, which Ohio EPA has declined to consider. The experience, as reflected in actual data, under Akron’s current release policy is that water supply considerations have been completely compatible with environmental considerations. Any additional sampling regime that Ohio EPA requires in order to justify, after-the-fact, its misguided TMDL would need to be at Ohio EPA’s cost.

Response: Ohio EPA is requesting additional sampling from the reservoir releases to better understand the releases and their impacts upon the water resources. Ohio EPA has enough evidence to support its conclusions that the reservoirs are having a negative impact, but does not have sufficient information to make informed management decisions concerning the releases.