Total Maximum Daily Loads for the Rocky River Basin

Final Report

Prepared by

Ohio Environmental Protection Agency
Division of Surface Water

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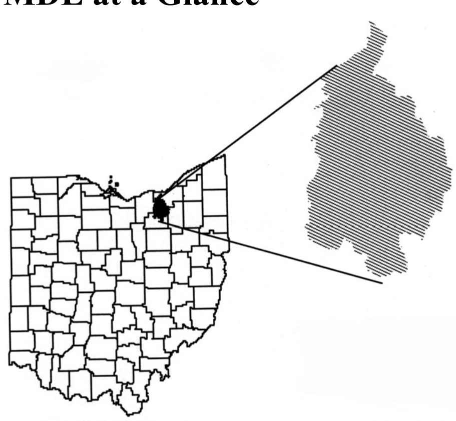
TMDL at a Glance



Basin:	Rocky River
Study Area:	Fifteen stream segments or lakes within the basin
Goal:	Attainment of Warmwater Habitat Aquatic Life Use
Causes:	Nutrients, organic enrichment/DO, flow alteration, pathogens, ammonia, siltation, thermal modification, habitat alteration, chlorine, priority organics, non-priority organics, metals, turbidity, salinity/TDS/chloride, and other organics.
Sources:	Municipal point sources, industrial point sources, urban runoff/storm sewers, CSOs, hydromodification, marinas, channelization, streambank destabilization, construction, suburbanization, and septic systems
Measure:	Warmwater Habitat Biocriteria
Recommendations:	Point source controls, nonpoint source controls, habitat restoration, wetlands protection, and CSO controls.

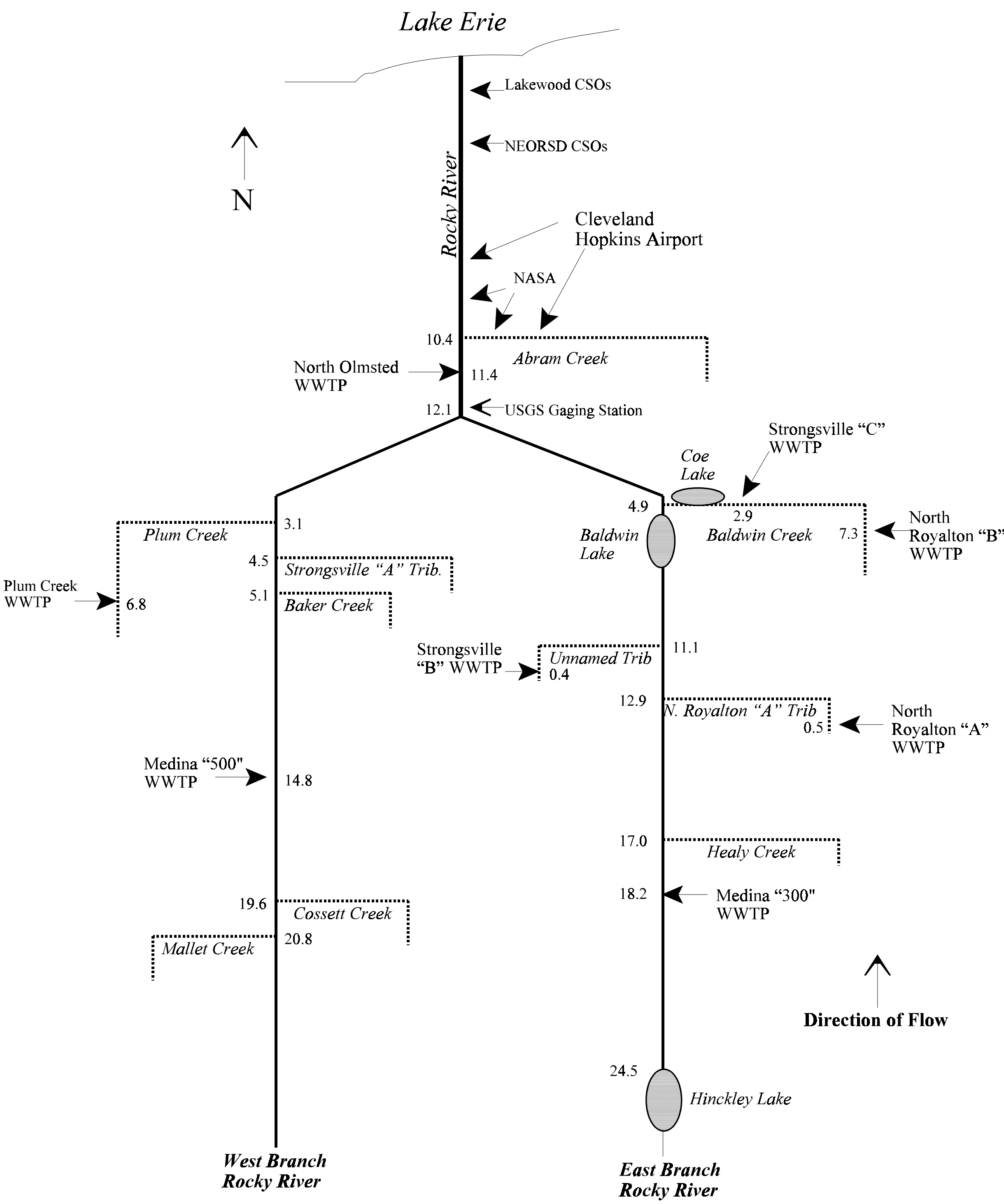


Figure 1. Schematic representation of the Rocky River basin, showing listed segments, lakes, tributaries and significant dischargers. Numbers indicate river miles.

Contents

Tables

Figures

Executive Summary

Section 303(d) of the Clean Water Act requires States to identify waters for which technology-based effluent limitations do not result in attainment of applicable water quality standards. States are to list and prioritize these impaired waters (the "303(d) list"). Total Maximum Daily Loads (TMDLs) are to be developed for the listed waters.

The Rocky River basin is located in Cuyahoga, Summit, Medina, and Lorain Counties in northeastern Ohio. Ohio's 1998 303(d) list included the Rocky River basin, with fifteen stream segments or lakes identified as impaired. The impairments cited include nutrients, organic enrichment, ammonia, pathogens, flow alteration, and other causes.

A major biological and chemical stream survey of the basin conducted in 1992 formed the basis for the 1998 listing. Many changes occurred in the basin following the 1992 survey. Multiple wastewater treatment plants were abandoned or upgraded, some discharge permit limits became more restrictive, and efforts are underway to implement home sewage system inspection and maintenance programs. A 1997 survey indicated that some of the segments had achieved attainment, and others are expected to as a result of these changes. This information has been documented in the March 1999 Rocky River Technical Support Document (TSD) and Ohio's most recent 305(b) report (2000) and will be documented in the next update of the 303(d) list (2002).

The applicable numeric biocriteria targets for the TMDLs are found in Ohio's water quality standards at OAC 3745-1. The success of the implementation actions resulting from the TMDLs will therefore be evaluated by observed improvements in biological scores.

This report includes TMDLs for nutrients for one water body, recommendations for de-listing four waters, and recommendations for additional monitoring for the remaining listed waters before TMDLs for other parameters can be done.

Nutrient TMDLs

Nutrient TMDLs are being submitted for Plum Creek. Recommended actions include:

- institute the Stormwater Phase 2 program within the watershed
- any 401 mitigation or restoration activity for an approved 401 in one of these segments occurs in the affected segment
- support the Cuyahoga County Board of Health's home septic system inspection and maintenance program
- work with local governments to create stormwater retention basin programs
- direct 319 funds and Water Pollution Control Loan Fund (WPCLF)/Water Resource Restoration Sponsor Program (WRRSP) habitat restoration projects to this segment
- modify the Lorain County Plum Creek WWTP NPDES permit to include monitoring for nutrients.

After monitoring is completed, further measures, such as installing additional treatment works at WWTPs to remove additional nitrogen and phosphorus, may be recommended. Sampling to verify attainment of water quality standards would occur as part of the Ohio EPA 5 year basin rotation strategy once the recommended actions have been instituted.

No TMDL Needed

Four listed segments will be de-listed during the 2002 303(d) listing process:

- East Branch of the Rocky River from the headwaters to Healy Creek: recent data confirms full attainment.
- West Branch from Plum Creek to the East Branch: recent data confirms full attainment.
- Mallet Creek: met appropriate biocriteria in 1992 and was placed on the 303(d) list in error.
- Coe Lake: met appropriate criteria in 1992 and was placed on the 303(d) list in error.

Additional Data Needed

TMDLs for specific pollutants in eleven lakes/segments should be delayed until additional data are available. Trends in the water quality data show steady improvement. It is very likely that many of these segments will be in full attainment in the near future. Ohio EPA has incomplete data for two lakes in the Rocky River basin. Additional data must be collected and causes for impairment evaluated before any TMDL can be developed. We recommend Hinckley Lake and Baldwin Lake be sampled during the next Rocky River watershed survey in 2001. Portions of Baldwin Lake are now being managed as wetlands.

TMDLs for Abram Creek (listed for ammonia, organic enrichment/DO, pathogens) should be delayed due to the current proposal from the City of Cleveland to culvert 5,400 feet of this stream in order to allow for the expansion of runways at Cleveland Hopkins International Airport. Final decisions on this project will be made in 2001. In the meantime, work will continue on implementation of an NPDES permit for Cleveland Hopkins International Airport, finalizing a consent decree with the City of Cleveland Division of Port Control to control and remediate discharges associated with past de-icing practices, and instituting the Stormwater Phase 2 program for entities within the watershed. These actions, along with the previous abandonment of two major wastewater treatment plants, will directly deal with the impairments to chemical water quality in this sub-basin. Follow-up chemical and biological sampling should be scheduled for the 2006 field season.

Several segments should come into attainment as a result of changes recently made or expected to be made. With new data to be gathered during Ohio EPA's 5 year basin plan, we expect to validate that these segments fully attain their uses and can be removed from the 303(d) list. The segments and reasons are listed below:

- Mainstem, from East Branch to Lake Erie (organic enrichment/DO, flow alteration): implementation of phase 2 stormwater control programs in areas throughout the basin, implementation of the NPDES permit for Cleveland Hopkins International Airport, implementation of CSO controls in Lakewood, and other improvements in the upper segments of the basin.

- North Royalton "A" trib (chlorine, organic enrichment/DO): major upgrade of the treatment processes recently completed at the North Royalton "A" WWTP; UV is now used for disinfection of the final effluent instead of chlorine.
- East Branch from Healy Creek to the mainstem (ammonia, pathogens): major upgrade at the Medina "300" WWTP completed in 1995. Additional capacity, improved solids handling capabilities and new chlorination/dechlorination treatment works were included in the upgrade. Based on data collected during the 1997, the trend is towards improving chemical and biological water quality.
- Plum Creek (organic enrichment/DO, pathogens): abandonment of two sewage treatment plants and implementation of phase 2 of the stormwater rules
- West Branch from Cossett Creek to Plum Creek (organic enrichment/DO): elimination of several sewage treatment plants in this area.
- Strongsville "A" trib (ammonia, pathogens): abandonment of two sewage treatment plants and implementation of phase 2 of the stormwater rules
- Baker Creek (ammonia, organic enrichment/DO, pathogens): segment listed based on a single fecal bacteria sample. Home sewage system inspection and maintenance programs are being established in the watershed.

Significant portions of this document were taken from the October 2000 report "Support Document for the Development of Nutrient TMDLs in the Rocky River Watershed, Ohio," submitted by Tetra Tech, Inc. (Tetra Tech, 2000). TetraTech was working under a contract with the U.S. Environmental Protection Agency.

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act requires States, Territories, and authorized Tribes to identify waters for which technology-based effluent limitations are not stringent enough to achieve applicable 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 (USEPA) in April of every even-numbered year. As part of the 1998 303(d) listing processes, the Ohio Environmental Protection Agency (Ohio EPA) identified 15 segments within the Rocky River basin as impaired.

The Clean Water Act and USEPA regulations require that Total Maximum Daily Loads (TMDLs) be developed for all segments on the section 303(d) lists. The requirements of a TMDL are described in 40 Code of Federal Regulations (CFR) 130.2 and 130.7 and section 303(d) of the Clean Water Act, as well as in various guidance documents (e.g., USEPA, 1991; USEPA, 1997). A TMDL is defined as "the sum of the individual wasteload allocations for point sources and load allocations for nonpoint sources and natural background" such that the capacity of the waterbody to assimilate pollutant loadings is not exceeded. A TMDL is also required to be developed with seasonal variations and must include a margin of safety that addresses the uncertainty in the analysis. A TMDL is often expressed using the following equation:

$$TMDL = WLA + LA + (MOS)$$

where WLA = wasteload allocation, LA = load allocation, and MOS = margin of safety. The MOS is in parenthesis because it can be incorporated into the TMDL either explicitly or implicitly. The MOS is incorporated explicitly when it is expressed directly in the TMDL loadings. The MOS is incorporated implicitly when it is expressed through conservative assumptions used in the analysis. Pursuant to the regulations at 40 CFR 130.6, States are to develop water quality management plans to implement water quality control measures such as TMDLs.

Under the Clean Water Act, every state must adopt water quality standards to protect, maintain and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the goal of "swimmable/fishable" waters. Table 1 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). The water quality standards specific to the Rocky River watershed are discussed in Section 2.2.

Table 1. Summary of Ohio's Water Quality Standards components and examples

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

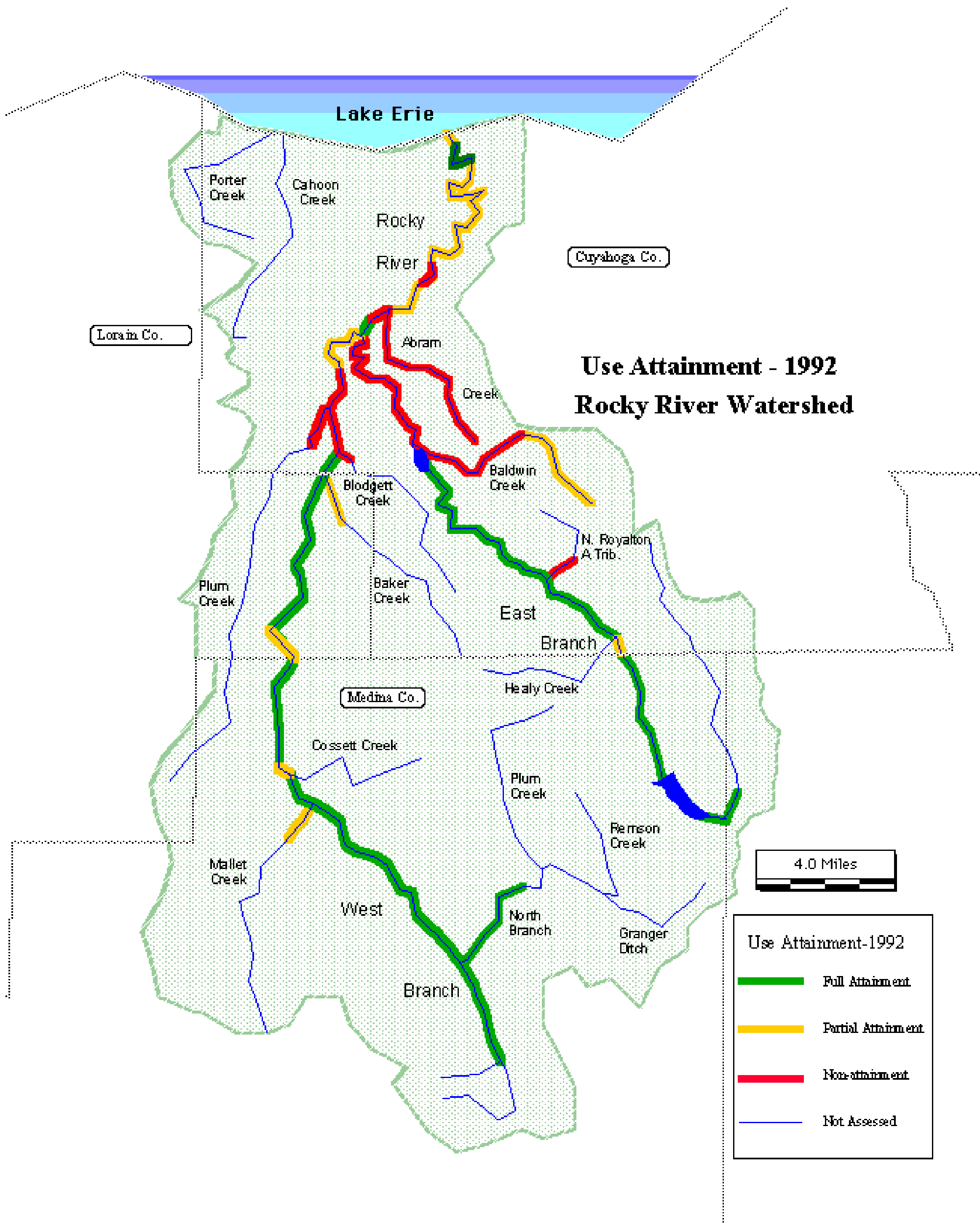


Figure 2. Use attainment in the Rocky River basin, 1992

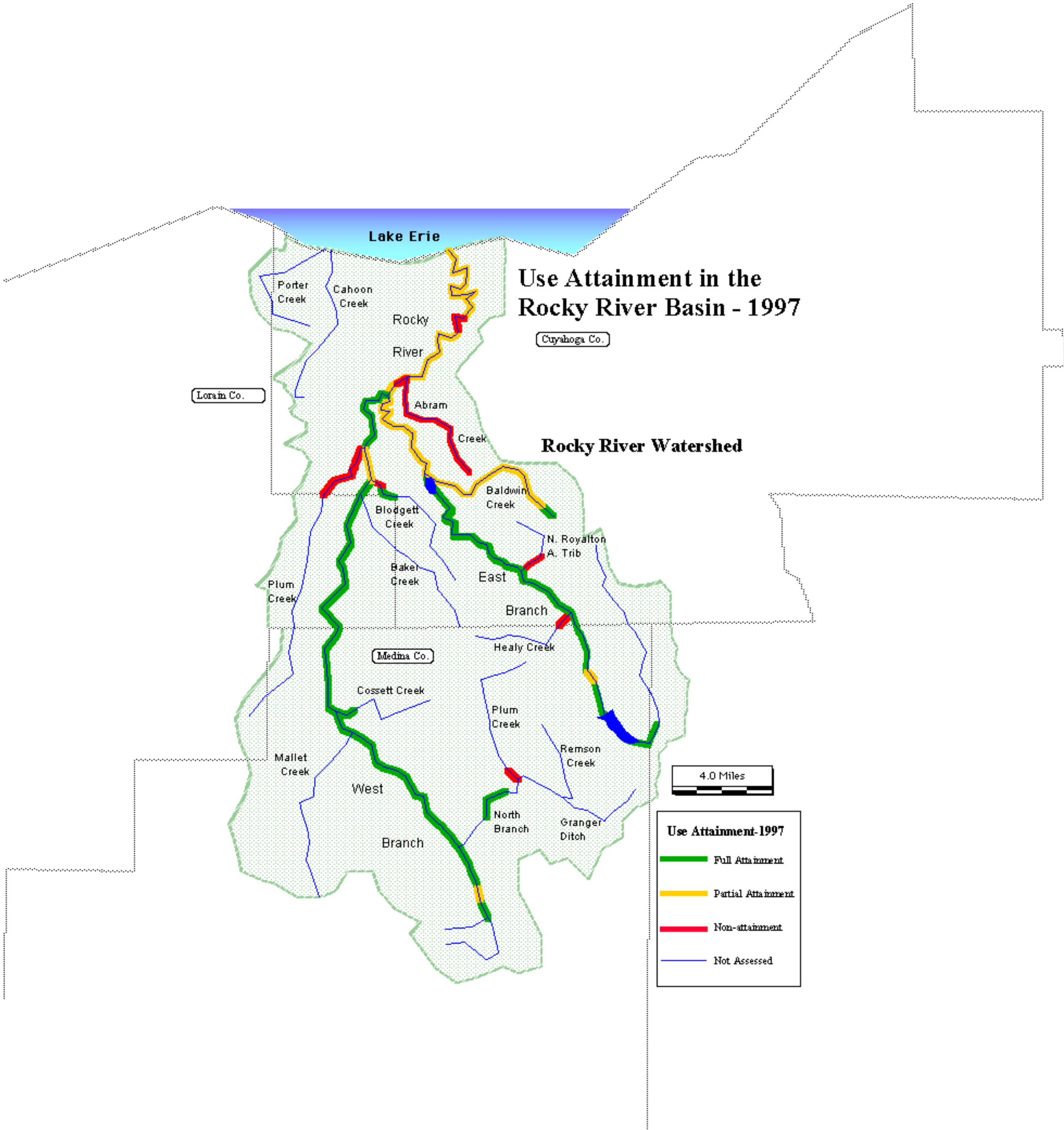


Figure 3. Use attainment in the Rocky River basin, 1997

Table 2. Causes and sources of impairment in 303(d) list segments in the Rocky River basin

Identification Number	**Waterbody Description**	**Causes - from 303(d) List**	**TMDL Status**	**Comments**
04110001 070 Rocky River (below West Branch to Lake Erie including East Branch and tributaries) Impairment Ranking 7				
OH 87 2	Mainstem from East Branch to Lake Erie	Nutrients	postpone	Additional data needed. Sources: municipal point sources, marinas, CSOs, urban runoff/storm sewers, hydromodification
		Organic enrichment/DO	postpone	
		Flow alteration	postpone	
OH 87 3	Abram Creek	Ammonia	postpone	Additional data needed. Sources: municipal point sources, channelization, hydromodification, urban runoff/storm sewers
		Organic enrichment/DO	postpone	
		Pathogens	de-list	
OH 87 4-88	Baldwin Lake	Priority organics	postpone	Additional data needed. Sources: municipal point sources, agriculture, urban runoff/storm sewers, natural, silviculture, non-industrial permitted
		Non-priority organics	postpone	
		Ammonia	postpone	
		Chlorine	postpone	
		Siltation	postpone	
		Organic enrichment/DO	postpone	
OH87 4	East Branch-Healy Creek to mainstem	Ammonia	de-list	Sources: municipal point sources, urban runoff/ storm sewers
		Pathogens	de-list	
OH87 4-246	Hinckley Lake	Siltation	postpone	Additional data needed. Sources: construction, urban runoff, natural, NPS
		Organic enrichment/DO	postpone	
		Thermal modification	postpone	
OH87 5-90	Coe Lake	Metals	de-list	Coe Lake is identified as having full use attainment but threatened for the causes listed in this table. Sources: agriculture, urban runoff, NPS, land development, highway maintenance and runoff, municipal point sources
		Other Organics		
		Siltation		
		Organic enrichment/DO		
		Turbidity		
		Thermal modification		
		Salinity/TDS/Chloride		

Identification Number	Waterbody Description	Causes - from 303(d) List	TMDL Status	Comments
OH87 5	Baldwin Creek	Organic enrichment/DO	postpone	Additional data needed. Sources: municipal point sources, urban runoff, storm sewers, hydromodification, channelization, streambank destabilization
		Nutrients	postpone	
		Habitat alteration	postpone	
OH87 7	N. Royalton "A" tributary	Chlorine	de-list	Sources: municipal point sources, urban runoff, storm sewers, construction, channelization, suburbanization, hydromodification
		Organic enrichment/DO	de-list	
OH87 8	East Branch-headwaters to Healy Creek	Nutrients	de-list	Determined to be in full attainment in 1997 survey (Ohio EPA, 1999)
		Organic enrichment/DO	de-list	
04110001 060 West Branch Rocky River (headwaters to Rocky River) Impairment Ranking 12				
OH87 10	West Branch-Plum Creek to East Branch	Nutrients	de-list	Determined to be in full attainment in 1997 survey (Ohio EPA, 1999)
OH87	Plum Creek	Nutrients	yes	Additional data needed. Sources: municipal point sources, urban runoff, storm sewers, suburbanization
		Pathogens	de-list	
		Organic enrichment/DO	de-list	
OH 87 12	West Branch-Cossett Creek to Plum Creek	Organic enrichment/DO	de-list	Sources: municipal point sources, urban runoff, storm sewers
OH87 13	Strongsville "A" trib	Ammonia	de-list	Sources: municipal point sources, urban runoff, storm sewers
		Pathogens	de-list	
OH87 14	Baker Creek	Ammonia	de-list	Sources: septic systems
		Pathogens	de-list	
		Organic enrichment/DO	de-list	
OH87 17	Mallet Creek	Unknown	de-list	Erroneously listed on the 303(d) list

2.0 WATERBODY OVERVIEW

2.1 Description of the Study Area

The Rocky River basin (United States Geological Survey [USGS] Hydrologic Unit Code 04110001) drains approximately 292 square miles in northeastern Ohio. It includes parts of four counties (Cuyahoga, Lorain, Medina and Summit). The largest city through which the Rocky River flows is Lakewood (population 56,000 in 1998). Major tributaries to the Rocky River include Abram, Baldwin, and Plum Creeks (Figure 2).

The main stem of the Rocky River is protected by the Cleveland Metroparks for almost its entire length. However, the area surrounding the metropark is heavily urbanized. The bed of the river for much of its main stem is fairly shallow and free flowing with good velocity and a fractured bedrock substrate. The mouth of the river has been modified to accommodate boating. Rocky River Harbor consists of the lower 4,200 feet of Rocky River, an artificial lagoon on the east side near the river mouth with a side channel called the West Channel, and an entrance channel from Lake Erie (Ohio EPA, 1999b).

The East and West Branches of the Rocky River flow through areas that still have significant rural land areas but that have developed recently as bedroom communities for the city of Cleveland. The watershed is located in the Erie/Ontario Lake Plain ecoregion. The Erie/Ontario Lake Plain ecoregion is characterized by northern hardwood natural vegetation (maple, birch, beech, hemlock) and glacial plains interspersed with high remnant beach ridges, drumlins, glacial till ridges, till plains, and outwash terraces (Omernik, 1987; Ohio EPA, 1999a). Land use in the watershed is a mix of forest, agriculture, and urban areas. Figure 4 shows the locations of the land uses in the watershed and Table 3 identifies the area of the watershed within each category. The primary crops in the watershed are soybeans and corn, although some hay, alfalfa and wheat are also harvested. Some livestock (i.e., cattle and hog) farming also occurs, primarily in Lorain and Medina counties.

Soils in the Rocky River watershed are primarily Alfisols. Alfisols are moist mineral soils with gray to brown surface horizons and medium-to high-base status. They are generally productive soils. They typically contain an illuvial horizon in which silicate clays have accumulated. (Brady, 1990).

Local relief is greater in the Erie-Ontario Lake Plain ecoregion (northeast Ohio) than in the neighboring Huron-Erie Lake Plain (northwest Ohio) and Eastern Corn Belt Plains (central and western Ohio) ecoregions, but less than the relief found in the Western Allegheny Plateau (southeast Ohio) ecoregion (Omernik, 1988). The Rocky River basin is a flat plateau with extremely narrow and dissected canyons. The minimum elevation is 174 m (571 ft), the maximum elevation is 378 m (1250 ft), and the mean elevation is 265 m (869 ft).

Northern Ohio has a temperate climate with hot summers and cold, snowy winters. The average annual precipitation is approximately 37 inches. The maximum and minimum annual

Table 3. Land use in the Rocky River basin

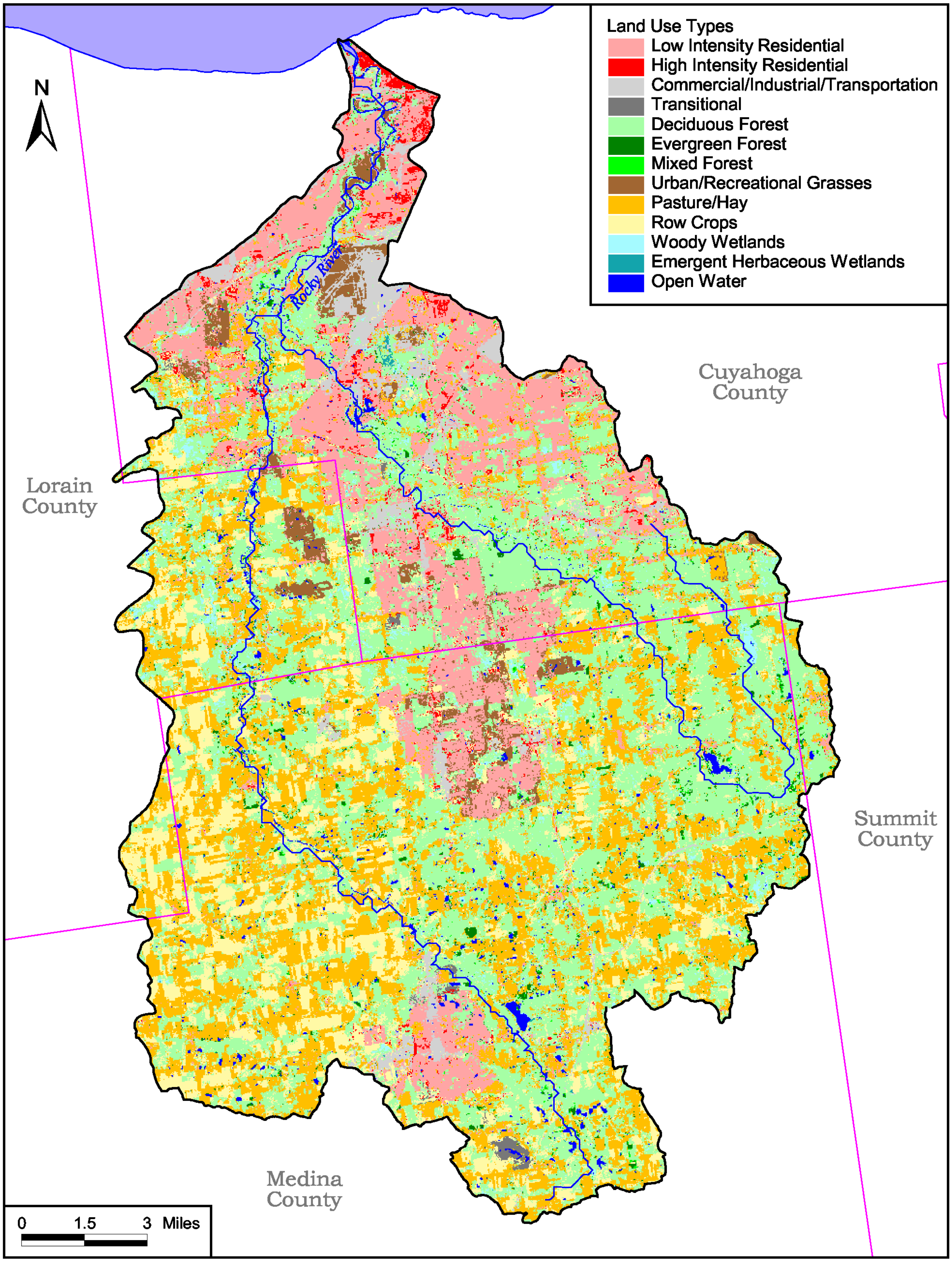
Land Use	**Acres**	**% of Total**
Deciduous Forest	64,561	34.50%
Pasture/Hay	45,898	24.53%
Low Intensity Residential	28,102	15.02%
Row Crops	25,754	13.76%
Commercial/Industrial/Transportation	6,955	3.72%
Urban/Recreational Grasses	4,212	2.25%
Woody Wetlands	3,118	1.67%
High Intensity Residential	2,523	1.35%
Evergreen Forest	2,283	1.22%
Open Water	2,105	1.12%
Mixed Forest	830	0.44%
Transitional (Barren)	447	0.24%
Emergent Herbaceous Wetlands	344	0.18%
Total	187,130	100.00%

Source: National Land Cover Dataset (NLCD, 1999)

precipitations are 53.9 inches (1990) and 18.7 inches (1963). On average, there are 154 days with precipitation of at least 0.01 inches, 20 days with precipitation of at least 0.5 inches, and 5 days with precipitation greater than 1 inch. Extreme precipitation events are generally in the range of 3-4 inches/day (MCC, 1999).

Normal maximum and minimum temperatures in northern Ohio are 32°F and 18 °F in January and 82 °F and 66 °F in July. The growing season typically lasts from early May until late October. Snowfall averages approximately 56 inches per year (MCC, 1999). Monthly streamflows in the watershed are typically greatest in February, March and April whereas flows are lowest during the months of August, September, and October.

Figure 4. Land use in the Rocky River Basin



2.2 Water Quality Assessment

Ohio EPA's water quality assessment includes a comprehensive evaluation of available chemical, physical, biological (fish and macroinvertebrate assemblages), and habitat data aimed at determining use attainment. Water quality standards are set forth in OAC 3745-1, with the antidegradation rule at OAC 3745-1-05. Use attainment is a term describing the degree that environmental indicators are either above or below criteria specified by the Ohio Water Quality Standards (Ohio Administrative Code (OAC) 3745-1). Assessing use attainment status for aquatic life uses involves a primary reliance on the Ohio EPA biocriteria (OAC 3745-1-07; Table 7-17). These are confined to ambient assessments and apply to rivers and streams outside of mixing zones. Numeric biocriteria are based on multimetric biological indices including the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), which indicate the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community. Numeric endpoints are stratified by ecoregion, use designation, and stream or river size. Three attainment status results are possible at each sampling location: full, partial, or non-attainment. Full attainment means that all of the applicable indices meet the biocriteria. Partial attainment means that one or more of the applicable indices fails to meet the biocriteria. Non-attainment means that none of the applicable indices meet the biocriteria or one of the organism groups reflects poor or very poor performance. An aquatic life use attainment table is constructed based on the sampling results and is arranged from upstream to downstream and includes the sampling locations indicated by river mile (RM), the applicable biological indices, the use attainment status (i.e., full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI), and comments and observations for each sampling location. Habitat scores using the QHEI range from 0 to 100, with a score of 60 being generally interpreted to be necessary to support a well balanced warmwater habitat fish community.

The Rocky River watershed was extensively studied in 1981, 1992, and 1997 pursuant to Ohio EPA's Five-Year Basin Approach for Monitoring and NPDES Permit Reissuance. The waters identified as impaired in 1992 were listed on the 1998 section 303(d) list. (The results of the 1997 sampling were not available at the time the 1998 list was being prepared.) Although the 1997 sampling indicated improvements in water quality at various sites within the watershed, at least one site within four of the five nutrient impaired streams continued to be classified as either in partial- or non-attainment. Table 4 presents the aquatic life use attainment table resulting from the 1992 survey. Data from the 1997 survey is also included. The designated uses of the waters discussed in this TMDL report can be found at 3745-1-20.

Table 4. Aquatic life use attainment status of 303d listed stream segments in the Rocky River basin. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate communities (ICI). The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

River Mile Fish/Invertebrate	IBI	MIwb	ICIa	QHEI	Attainment Status[b]	Comments
1992 Rocky River						
11.5/11.6	44	7.6ns	MG	68.0	FULL	
11.3/11.3	32*	9.0	F*	N/A	N/A	N. Olmsted Mixing Zone
11.1/11.1	30*	7.2*	F*	70.0	NON	Dst. N. Olm. WWTP
10.0/9.8	26*	7.7ns	F*	67.0	NON	
9.5/ -	32*	8.2		69.0	(PARTIAL)	Dst. Abrams Cr.
9.0/9.0	26*	6.9*	30ns	70.5	NON	
5.8/5.8	34ns	7.1*	MG	62.0	PARTIAL	
3.0/2.9	28*	7.4ns	MG	80.5	PARTIAL	
- /1.3			MG		(FULL)	
1.0/ -	28ns	7.5		58.0	(FULL)	Estuary
0.1/ -	27*	7.2ns		34.0	(PARTIAL)	Estuary
1997 Rocky River						
11.7/11.5	37ns	6.4*	48	69.0	PARTIAL	
11.3/11.3	35	6.4	-	-	-	North Olmsted WWTP mixing zone
11.1 /11.1	40	5.8*	36	60.0	NON	
- /10.5	-	-	38	-	(FULL)	
10.0 /10.0	37ns	7.2*	G	54.5	PARTIAL	Dst. Abram Creek
8.5/9.0	38	7.3*	30ns	66.0	PARTIAL	
6.1/5.8	28*	5.3*	G	65.0	NON	
3.0 /3.0	31*	6.6*	46	73.0	PARTIAL	
1.0/0.7L	34*	7.7ns	42	-	PARTIAL	Lacustuary
0.2/0.1L	33*	7.7ns	38ns	-	PARTIAL	Lacustuary
1992 Abram Creek						
1.9/2.0	16*	N/A	4*	59.0	NON	Dst. WWTPs
0.4/0.3	12*	N/A	8*	73.0	NON	Dst. NASA
1997 Abram Creek						
3.2/3.4	16*	NA	18*	42.5	NON	
2.8/ -	12*	NA	-	52.5	(NON)	
1.9 /1.9	12*	NA	28*	65.5	NON	
0.6/0.2	12*	NA	26*	57.5	NON	

River Mile Fish/Invertebrate	IBI	MIwb	ICIa	QHEI	Attainment Status[b]	Comments
1992 East Branch Rocky River (headwaters to Healy Creek)						
26.7/26.6	45	N/A	48		FULL	
21.9/22.1	48	8.8	54	79.0	FULL	
18.2/18.2	43	8.4	G	N/A	FULL	
17.5/17.5	38	7.3*	VG	70.0	PARTIAL	Dst. Medina 300 WWTP
1997 East Branch Rocky River (headwaters to Healy Creek)						
29.4 /29.7	44	NA	56	75.0	FULL	
21.9/22.0	44	6.4*	E	67.5	PARTIAL	Reference Site
18.3/18.3	42	6.3	-	-	-	Medina 300 WWTP mixing zone
17.5/17.5	43	8.2	50	73.5	FULL	Dst. Medina 300 WWTP
1992 East Branch Rocky River (Healy Creek to mainstem)						
15.315.2	44	8.0	44	63.5	FULL	
11.6/11.6	38	8.2	G	83.5	FULL	Dst. N. Roy. “A” trib
10.7/10.7	38	8.5	42		FULL	
10.0/10.0	36ns	8.6	46	62.0	FULL	
9.3/ -	36ns	8.3	-		(FULL)	
6.5/6.4	36ns	7.4ns	G	63.5	FULL	
4.9/4.9	34ns	5.6*	G	70.0	NON	Dst. Baldwin Cr.
1.4/1.2	22*	4.4*	G	70.0	NON	Dst. Berea WWTP
1997 East Branch Rocky River (Healy Creek to mainstem)						
13.0/13.1	41	8.5	50	66.0	FULL	
11.6/11.6	43	7.9	44	69.5	FULL	Dst. North Royalton A WWTP trib.
- /10.8	-	-	42	-	(FULL)	
10.0/10.0	35ns	7.9	42	67.5	FULL	
6.4/6.4	36ns	7.6ns	56	57.5	FULL	
3.0/4.9	34ns	7.0*	42	55.0	PARTIAL	Dst. Baldwin Creek
1.4/1.4	34ns	7.2*	40	66.5	PARTIAL	
1992 Baldwin Creek						
7.4/7.5	31*	N/A	MG	54.5	PARTIAL	
- /7.0	-	-	28*	-	(NON)	Dst. N. Royalton “B” WWTP
5.8/5.8	17*	N/A	36	82.0	NON	
3.0/3.0	27*	N/A	32ns	43.5	NON	
2.6/2.6	22*	N/A	30ns	68.5	NON	Dst. Strongsville “C” WWTP
1.4/1.4	18*	N/A	40	58.5	NON	

River Mile Fish/Invertebrate	IBI	MIwb	ICIa	QHEI	Attainment Status[b]	Comments
1997 Baldwin Creek						
- /7.5	-	-	-	MG	(FULL)	
7.0/7.0	24*	NA	MG	57.0	PARTIAL	Dst. North Royalton B WWTP
6.1/5.7	20*	NA	42	67.0	PARTIAL	
3.2/3.0	34*	NA	MG	37.0	PARTIAL	
2.6/2.6	24*	NA	34	62.0	PARTIAL	Dst. Strongsville C WWTP
1.4/1.5	22*	NA	38	43.0	PARTIAL	
0.2/ -	24*	NA	-	50.5	(PARTIAL)	
1992 North Royalton "A" WWTP tributary						
0.6/0.6	35*	N/A	P*	44.5	NON	
0.2/0.2	20*	N/A	P*	70.5	NON	Dst. N. Royalton "A"WWTP
1997 North Royalton "A" WWTP tributary						
- /0.6	-	-	F	-	(NON)	Ust. North Royalton A WWTP
0.2/0.2	18*	NA	F	72.5	NON	Dst. North Royalton A WWTP
1992 West Branch Rocky River (Cossett Creek to Plum Creek)						
17.2/17.2	38	8.4	48	61.0	FULL	
13.3/13.3	32*	8.0	48	75.0	PARTIAL	Dst. Medina 500 WWTP
4.8/4.7	42	7.6ns	MG	81.0	FULL	
3.6/3.5	33*	6.7*	MG	69.5	NON	Dst. Blodgett Cr.
1997 West Branch Rocky River (Cossett Creek to Plum Creek)						
16.4/16.3	40	7.9	42	66.5	FULL	
13.3/13.3	38	8.0	44	62.0	FULL	Dst. Medina 500 WWTP
4.8/4.8	39	7.8ns	44	72.0	FULL	
3.6/3.6	31*	5.9*	44	71.0	PARTIAL	Dst. Blodgett Cr.
1992 West Branch Rocky River (Plum Creek to East Branch)						
2.1/2.1	32*	6.7*	MG	58.0	NON	Dst. Plum Cr.
0.4/0.4	30*	7.6ns	G	71.5	PARTIAL	
1997 West Branch Rocky River (Plum Creek to East Branch)						
1.6/2.1	43	8.0	46	76.0	FULL	Dst. Plum Cr.
0.1/0.4	40	7.4ns	E	62.0	FULL	
1992 Plum Creek						
0.3/0.3	18*	N/A	F	43.5	NON	

River Mile Fish/Invertebrate	IBI	MIwb	ICIa	QHEI	Attainment Status[b]	Comments
1997 Plum Creek						
2.4/2.9	18*	NA	MG	71.5	NON	
0.1/0.2	18*	NA	F	70.5	NON	
1992 Baker Creek						
0.3/0.5	37ns	NA	F*	68.0	PARTIAL	
1992 Mallet Creek						
0.7/0.6	47	N/A	MG	68.5.	PARTIAL	Biocriteria attained

Ecoregion Biocriteria: Erie-Ontario Lake Plain (EOLP): OAC Chapter 3745-1-07, Table 8-14

INDEX-Site Type	WWH	EWH
IBI - Headwaters	40	50
IBI - Wading	38	50
MIwb-Wading	7.9	9.4
ICI	34	46

* - Significant departure from biocriteria (>4 IBI or ICI units; >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.
ns - Nonsignificant departure from biocriteria (4 IBI or ICI units; 0.5 MIwb units).
R - Regional Reference Site.
a - Narrative evaluation used in lieu of ICI numeric score (Exc.=Exceptional; VG=Very Good; G=Good; MG=Marginally Good; P=Poor; VP=Very Poor)).
b - Attainment status based on one organism group is parenthetically expressed.
NA - Headwater site; MIwb is not applicable to streams with drainage areas less than 20 square miles.

2.3 Causes and Sources of Impairment

The determination of impairment in rivers and streams in Ohio is straightforward – the numeric biocriteria are the principal arbiter 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 data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures to describe the causes (e.g., nutrients) and sources (e.g., municipal point sources, septic systems) associated with observed impairments. Thus the initial assignment of principal causes and sources of impairment that appear on the section 303(d) list (see Table 2) do not represent a true "cause and effect" analysis, but rather represent the association of impairments (based on response indicators) with stressor and exposure indicators whose links with the biosurvey data are based on previous research or experience with analogous situations and impacts. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified (Ohio EPA, 1999b).

Point Sources
There are ten significant point source discharges (see Table 5) and numerous smaller dischargers in the Rocky River basin. During lower flows, the Rocky River is an effluent dominated river. All major WWTPs have numerical limits for nutrients. The phosphorus limit is 1.0 mg/l for the 30 day average and 1.5 mg/l for the 7 day average. Ammonia limits vary, depending on the specific discharger and the season of the year. The dischargers are operating within those permit limits. Many changes have occurred with discharges from point sources in recent years (see Table 6).

Urban Runoff
The lower half of the Rocky River watershed basin is primarily urban and suburban. A significant percentage of this part of the watershed is covered with impermeable surfaces. Consequently, the runoff waters from roadways, parking lots, driveways and roof drains are impacted by road salts, vehicle fluids and litter/debris. Efficient stormwater drainage systems allow runoff waters to discharge into local streams at an accelerated rate, which can intensify the downstream water levels. Impermeable surfaces can also transfer heat to runoff waters which can raise the average water temperatures. Other contributing nonpoint sources include residential lawn wastes/chemicals, industrial/commercial spills, pet wastes, and improper disposal of paints and solvents.

Farms/Nurseries/Golf Courses
The upper reaches of the Rocky River's East and West Branches extend into rural areas which have agriculture based activities and many golf courses. Plowing fields to the edge of waterways can cause significant soil loss into local streams. Sudden sediment loads can totally change a stream bottom habitat, which directly impacts the entire aquatic community. Allowing livestock to enter streams can accelerate embankment erosion and increases nutrient levels in the water. Run off from feed lots, animal waste piles or improper manure applications contribute nutrients to local streams. Over application or untimely application of herbicides/pesticides can stress or eliminate aquatic organisms. Fertilizer run-off can cause aquatic plants to grow at uncontrollable rates, creating an imbalance in the ecosystem.

Construction Sites
Construction activities such as individual houses, residential developments, commercial properties and industrial sites are occurring throughout this watershed. Uncontrolled stormwater runoff can carry tons of soil into local streams, which can devastate an aquatic community. Currently, if an excavated area is to exceed 5 acres, then an NPDES permit application must be filed with the Ohio EPA and a stormwater plan developed. Stormwater Phase II will require all communities within urban areas to develop stormwater management plans. Each community must address erosion and sediment control on all construction sites one acre or larger.

Riparian Corridor Protection
Vegetation along the embankments of streams and lakes offers many benefits; stream bank stabilization, filtration of runoff waters, food sources, cooler water temperatures and habitat enhancement. Conservation easements, land trusts, education and responsible legislation are valuable tools for riparian corridor protection. The Rocky River is fortunate that Cleveland Metroparks owns a major portion of the riparian corridor in Cuyahoga County and a portion in

Hinckley Township in Medina County.

These major nonpoint source activities all contribute positively or negatively to the water quality in this watershed basin. In 2001, the Northeast Ohio Areawide Coordinating Agency (NOACA), in partnership with the Cuyahoga County Board of Health, will receive a $100,000.00 planning grant from the Ohio EPA 319 grant program to develop a detailed watershed plan for the entire Rocky River basin. Community input will be essential to establish a credible plan that will address water quality issues and prioritize corrective activities. Educating public officials and local citizens about nonpoint source issues is imperative. Developing watershed plans and implementing best management practices will be an important part of the plan.

Table 5. Significant Dischargers in the Rocky River Basin (see Figure 1 schematic)

Entity-Receiving stream	**NPDES Permit No.**	**Design Flow** (avg 2000 flow)	**Treatment Processes**	**TMDL Segment**
North Olmsted-Rocky River	3PD00016	7.00 MGD (3.30 MGD)	Bar Screens, Primary Sedimentation, Advanced Single Stage Activated Sludge, Chemical Phosphorus Removal, Secondary Clarification, Tertiary Microscreening, Chlorination, Dechlorination, Discharge	Mainstem-East Branch to Lake Erie
North Royalton 'A'-North Royalton "A" tributary to the East Branch	3PD00030	3.30 MGD (1.70 MGD)	Bar Screens, Grit Removal, Primary Settle, Aeration, Final Settle, Tertiary filters, UV Disinfection, Post Aeration, Discharge	N. Royalton "A" tributary
North Royalton 'B'-Baldwin Creek	3PC00018	1.00 MGD (0.65 MGD)	Bar Screens, Aeration, Final Settle, Chlorination, Dechlorination, Discharge	Baldwin Creek
Strongsville 'B'-East Branch	3PB00047	2.1 MGD (0.72 MGD)	Comminutor, Grit Removal, Phosphorus Removal, Preaeration, Primary Settling, RBC's, Secondary Settling, Rapid Sand Filters, Chlorine Contact, Dechlorination, Discharge	East Branch-Healy Creek to mainstem
Strongsville 'C'-Baldwin Creek	3PB00048	1.8 MGD (0.96 MGD)	Comminuter, Grit Removal, Phosphorus Removal, Preaeration, Primary Settling, RBC's, Secondary Settling, Rapid Sand Filters, Chlorine Contact, Dechlorination, Discharge	Baldwin Creek

Entity- Receiving stream	**NPDES Permit No.**	**Design Flow** (avg 2000 flow)	**Treatment Processes**	**TMDL Segment**
Medina County SD “300"- East Branch	3PK00003	3.25 MGD (1.55 MGD)	Bar Screen, Comminuters, Secondary Clarifiers, RBC’s, Tertiary Sand Filters, Chlorination, Dechlorination, Discharge	East Branch-headwaters to Healy Creek
Medina County SD “500"- West Branch	3PK00004	10.0 MGD (3.75 MGD)	Manual Bar Screen, Grit Removal, Rectangular Clarifiers, Activated Sludge With Powder Activated Carbon, Tertiary Filters, Chemical Phosphorus Removal, Chlorine Chemical Disinfection, Dechlorination, Discharge	West Branch-Cossett Creek to Plum Creek
Cleveland Hopkins International Airport- Abram Creek and Rocky River	3II00179 (Draft Form)	Storm Dependent	Oil/Water Separators	Mainstem-East Branch to Lake Erie and Abram Creek
NASA Lewis/Glenn- Abram Creek and Rocky River	3IO00001	0.545 MGD	Oil/Water Separators	Mainstem-East Branch to Lake Erie and Abram Creek
Plum Creek WWTP	3PG00052	0.040 MGD (0.024 MGD)	Activated Sludge, Extended Aeration, Chlorination, De-chlorination	Plum Creek

Table 6. WWTPs abandoned or with significant process changes in the Rocky River basin between 1992 and 1997

Facility	**Receiving Stream**	**Change**
Brookpark WWTP	Abram Creek	Abandoned (10/04/1993)
Middleburg Heights WWTP	Abram Creek	Abandoned (10/04/1993)
Brentwood WWTP	Plum Creek	Abandoned (11/01/1997)
Western Ohio Utility WWTP	Plum Creek	Abandoned (11/01/1997)
ODOT Park 3-39 WWTP	Plum Creek	Abandoned (late 1997)
NEORSD Strongsville A WWTP	Blodgett Creek	Abandoned (07/28/1994)
Olmsted Falls, Versailles WWTP	Blodgett Creek	Abandoned (02/01/1995)
NEORSD Berea WWTP	East Br. Rocky River	Abandoned (07/28/1994)
Medina 500 WWTP	West Br. Rocky River	De-chlorination (1994)
North Olmsted WWTP	Rocky River	De-chlorination (1994)

Household Sewage Disposal Systems within the Rocky River Basin

One significant nonpoint source which appears to be impacting the surface waters of the Rocky River are failing household sewage disposal systems (HSDS). There are approximately 16,500 HSDS in the Rocky River Basin. Untreated sewage can pollute surface waters with harmful bacteria and viruses. Representatives from each of the four county health departments in Cuyahoga; Medina; Summit and Lorain Counties provided the following information about their respective counties.

Cuyahoga County Board of Health

The Cuyahoga County Board of Health (CCBH) is one of the growing number of health departments in the State of Ohio that conducts a Household Sewage Operation and Maintenance Program, a program designed to identify and minimize sewage pollution in the watersheds within the General Health District. In 1993, the Board of Health initiated this program by requiring operating permits by property owners with household sewage disposal systems (HSDS) for $30.00 per year. There are approximately 4,000 HSDS within the Rocky River basin under jurisdiction of the CCBH.

Besides providing residents with a multitude of services, the annual money collected also helps the Board of Health conduct water quality sampling of streams, ditches and storm sewers in communities across the county. Two intensive water quality studies have been conducted by the CCBH in the Rocky River basin: Rocky River West Branch & Plum Creek in 1998 and Rocky River East Branch in 1999.

The Cuyahoga County Board of Health also participates in the Ohio EPA's Department of Environmental Financial Assistance (DEFA) low interest loan program. This program allows qualifying homeowners with failing HSDS to obtain a repair or replacement loan from a cooperative bank for an interest rate at 3% below the prime rate.

The communities of Berea (19 HSDS), Middleburg Heights (320 HSDS), Olmsted Falls (620 HSDS), and Strongsville (950 HSDS) are located completely in the Rocky River watershed.

Portions of Brookpark (190 HSDS), Fairview Park (4 HSDS), North Olmsted (18 HSDS), North Royalton (1100 HSDS), Parma (1300 HSDS), and Olmsted Township (1050 HSDS) are located in the Rocky River watershed.

Medina County Health Department

The Medina County Health Department (MCHD) is responsible for overseeing the proper installation, operation and maintenance of all household sewage disposal systems (HSDS) in Medina County. Health Department officials estimate as many as 10,000 HSDS are located in the Rocky River watershed within Medina County.

For the period between 1984 and 1997, the MCHD tracked the pass/fail ratio of HSDS for real estate evaluations. The average age of all systems evaluated was 17.9 years. The countywide failure rate was 26.3%. Using this percentage rate for HSDS in the Medina County portion of the Rocky River watershed, over 2,000 HSDS could be failing in this area.

The MCHD is scheduled to receive $300,000 in supplemental environmental project (SEP) monies from the Village of Lodi to monitor surface water quality in ditches, streams, rivers and lakes and help to better define pollution problems in Medina County. A portion of this money will also be used to finance repair/replacement of failing systems and to finance an operation & maintenance program.

The MCHD Household Sewage Program currently provides a multitude of services to the residents of Medina County including permitting, inspections, complaint response, and education.

Five Medina County townships and two cities with HSDSs are located in the Rocky River basin: Brunswick (63 HSDS), Brunswick Hills Township (679 HSDS), Hinckley Township (1827 HSDS), Liverpool Township (1102 HSDS), Medina (24 HSDS), Medina Township (1144 HSDS), and York Township (887 HSDS).

Portions of Granger Township (922 HSDS), Lafayette Township (176 HSDS), Litchfield Township (227 HSDS), Montville Township (757 HSDS), and Sharon Township (94 HSDS) are located in the Rocky River watershed.

Lorain County Health Department

The Lorain County Health Department (LCHD) oversees the household sewage disposal system (HSDS) program in Lorain County. Portions of three townships, Columbiana, Eaton, and Grafton, are in the Rocky River basin. More than 2400 HSDS can be found in these townships. The failure rate for Lorain County HSDS has been calculated to be as high as 42.7%. The LCHD's sewage program is actively addressing failing HSDS as they are found.

Summit County Health Department

The Summit County Health Department (SCHD) oversees the household sewage disposal system (HSDS) program in Summit County. Portions of two townships, Richfield and Bath, are in the Rocky River basin. There are fewer than 400 HSDS in the Rocky River portion of the county and most of these HSDS are located on large (2-3 acre) lots. Less than a dozen semi-public sewage facilities are located in this area and they have a history of good operation. The SCHD is currently inspecting all of the post 1991 off-lot aeration or filter bed systems every two years. The failure rate for these systems is less than 15%.

3.0 PROBLEM STATEMENT

The TMDLs described in this report focus on nutrients. Nutrients, except under unusual circumstances, rarely approach concentrations in the ambient environment that are toxic to aquatic life. U.S. EPA (1976) concluded that "levels of nitrate nitrogen at or below 90 mg/l would not have [direct] adverse effects on warmwater fish." However, nutrients, while essential to the functioning of healthy aquatic ecosystems, can exert negative effects at much lower concentrations by altering trophic dynamics, increasing algal and macrophyte production (Sharpely et al., 1994), increasing turbidity (via increased phytoplanktonic algal production), decreasing average dissolved oxygen concentrations, and increasing fluctuations in diel dissolved oxygen and pH. Such changes are caused by excessive nutrient concentrations that contribute to shifts in species composition away from functional assemblages of intolerant species, benthic insectivores and top carnivores (e.g., darters, insectivorous minnows, redhorse, sunfish, and black basses) typical of high quality warmwater streams towards less desirable assemblages of tolerant species, niche generalists, omnivores, and detritivores (e.g., creek chub, bluntnose minnow, white sucker, carp, green sunfish) typical of degraded warmwater streams (Ohio EPA, 1999a).

3.1 Target Identification

The establishment of instream numeric targets is a significant component of the TMDL process. The numeric targets serve as measures 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 water quality standards.

Numeric targets are derived directly or indirectly from state narrative or numeric water quality standards (OAC 3745-1). In Ohio, the applicable numeric targets are the appropriate biocriteria (see section 2.2). Determinations of current use attainment are based on a comparison of biological scores to the appropriate biocriteria, just as the success of any implementation actions resulting from the TMDLs will be evaluated by observed improvements in biological scores.

Ohio EPA 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, 1999b). 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 biological communities. The study also includes suggested targets for nitrate+nitrite concentrations and total phosphorus concentrations based on observed concentrations at reference sites. Reference sites are relatively unimpacted sites that are used to define the expected or potential biological community within an ecoregion.

The nutrient target values selected for the Rocky River basin are shown in Table 7. Because of the expected inter-relationship of nutrient processing and aquatic habitat conditions, the Ohio

EPA has taken an adaptive approach to establishing nutrient targets. The reader is referred to *Legal and Technical Basis for Nutrient Target Values Used in TMDL Projects, DSW Water Quality Standards Guidance #4, November 27, 2000* for a general discussion of the approach being used. For this TMDL project initial model runs were done using the suggested ecoregion specific target for nitrate+nitrite and total phosphorus. However, it was soon realized that these targets established such an extremely large amount of nutrient reduction that there were no feasible action plans available to achieve the necessary reductions. A decision was made to use the higher nutrient targets shown in Table 7. As discussed below, achieving the reductions necessary to meet these targets will be challenging, but within reasonable expectations of success. The NO3+NO2 and total phosphorus target concentrations used in this TMDL project (Table 7) are considered fully protective of the Warmwater Habitat biological criteria. The pertinent facts supporting this statement are provided below.

Table 7. Rocky River Basin Nutrient TMDL Targets

Watershed Size	**NO_3+NO_2 (mg/L)**	**TP (mg/L)**
Headwaters (drainage area < 20mi^2)	1.3	0.19
Wadable (20mi^2 < drainage area < 200 mi^2)	1.3	0.19
Small Rivers (200 mi^2 < drainage area < 1000 mi^2)	1.85	0.21

Nitrogen

Nitrate+nitrite concentrations in the range of 1.3 to 1.85 mg/l are considered protective of eventual attainment of the Warmwater Habitat biological criteria in the Rocky River basin when the following factors are considered.

- The threshold for observed degradation of WWH communities is in the range of 3-4 mg/l NO3-NO2 (Ohio EPA, 1999b, page 2).
- A meso-eutrophic boundary value of 1.5 mg/l NO3-NO2 has been reported in the literature from a wide range of streams and would be consistent with probable WWH attainment in the Rocky River watershed (Dodd, 1998 reported in Ohio EPA, 1999b, page 4).

Therefore, the target values selected (see Table 7) provide an adequate margin of safety and a reasonable expectation that the WWH biocriteria will be met in this given situation.

Phosphorus

Data from the Erie Ontario Lake Plain ecoregion was examined to determine the relative frequency of total phosphorus concentrations and WWH attainment. See appendix E for a presentation of this data. The target values used (see Table 7) are at the upper limit or threshold were we can reasonably expect attainment of the WWH biocriteria. In other words, other similar sized streams in the ecoregion are attaining the WWH use designation when total phosphorus concentrations are at 0.2 mg/l, but it is very unusual to find WWH attainment at higher total phosphorus concentrations. Therefore, the margin of safety provided through the selection of the total phosphorus target value is minimal.

3.2 Identification of Deviation from Target

Tables 8 and 9 compare the available targets to the 1997 conditions in the segments listed for nutrients. Observed concentrations for each segment were calculated by taking the median of all samples from any sampling site located in that segment. The tables illustrate that median 1997 concentrations of both NO_3+NO_2 and total phosphorus were above the targets for some segments and below the target for others.

Table 8. Comparison of NO_3+NO_2 targets and 1992 and 1997 summer concentrations

Segment	Drainage Area (mi^2)	NO_3+NO_2 Target (mg/L)	Median NO_3+NO_2 (mg/L) (Number of samples) 1992	1997
Plum Creek	18	1.3	3.1 (4)	1.9 (10)
East Branch Rocky River (Headwaters to Healy Creek)	35	1.3	0.4 (4)	0.89 (10)
Baldwin Creek	10	1.3	5.8 (4)	no data
West Branch Rocky River (Plum Creek to East Branch)	140	1.3	2.6 (4)	1.63 (5)
Rocky River (East Branch to Lake Erie)	290	1.85	2.7 (11)	3.45 (35)

Table 9. Comparison of total phosphorus targets and 1992 and 1997 summer concentrations

Segment	Drainage Area (mi^2)	TP Target (mg/L)	Median TP (mg/L) (Number of samples) 1992	1997
Plum Creek	18	0.19	0.51 (4)	0.22 (10)
East Branch Rocky River (Headwaters to Healy Creek)	35	0.19	0.05 (4)	0.13 (10)
Baldwin Creek	10	0.19	0.25 (4)	no data
West Branch Rocky River (Plum Creek to East Branch)	140	0.19	0.11 (4)	0.12 (5)
Rocky River (East Branch to Lake Erie)	290	0.21	0.11 (12)	0.20 (35)

3.3 Source Identification

Nutrient loading in the Rocky River basin was simulated using the Generalized Watershed Loading Function or GWLF model (Haith et al., 1992). The complexity of this model falls between that of detailed, process-based simulation models and simple export coefficient models which do not represent temporal variability. GWLF provides a mechanistic, but simplified simulation of precipitation-driven runoff and sediment delivery. (See Appendix D for additional information about the GWLF model). Solids load, runoff, and ground water seepage can then be used to estimate particulate and dissolved-phase pollutant delivery to a stream, based on pollutant concentrations in soil, runoff, and ground water. GWLF has been used for TMDL development in Donegal Creek, Pennsylvania; Rock Creek Lake, Iowa; and Peña Blanca and Arivaca Lakes, Arizona and is a recommended model in USEPA's Protocol for Developing Nutrient TMDLs (USEPA, 1999).

GWLF simulates runoff and streamflow by a water-balance method, based on measurements of daily precipitation and average temperature. Precipitation is partitioned into direct runoff and infiltration using a form of the Natural Resources Conservation Service's (NRCS) Curve Number method (SCS, 1986). The Curve Number determines the amount of precipitation that runs off directly, adjusted for antecedent soil moisture based on total precipitation in the preceding 5 days. A separate Curve Number is specified for each land use by hydrologic soil grouping. Infiltrated water is first assigned to unsaturated zone storage where it may be lost through evapotranspiration. When storage in the unsaturated zone exceeds soil water capacity, the excess percolates to the shallow saturated zone. This zone is treated as a linear reservoir that discharges to the stream or loses moisture to deep seepage, at a rate described by the product of the zone's moisture storage and a constant rate coefficient.

Flow in streams may derive from surface runoff during precipitation events or from ground water pathways. The amount of water available to the shallow ground water zone is strongly affected by evapotranspiration, which GWLF estimates from available moisture in the unsaturated zone, potential evapotranspiration, and a cover coefficient. Potential evapotranspiration is estimated from a relationship to mean daily temperature and the number of daylight hours.

The user of the GWLF model must divide land uses into "rural" and "urban" categories, which determines how the model calculates loading of sediment and nutrients. For the purposes of modeling, "rural" land uses are those with predominantly pervious surfaces, while "urban" land uses are those with predominantly impervious surfaces. It is often appropriate to divide certain land uses into pervious ("rural") and impervious ("urban") fractions for simulation. Monthly sediment delivery from each "rural" land use is computed from erosion and the transport capacity of runoff, whereas total erosion is based on the universal soil loss equation (USLE) (Wischmeier and Smith, 1978), with a modified rainfall erosivity coefficient that accounts for the precipitation energy available to detach soil particles (Haith and Merrill, 1987). Thus, erosion can occur when there is precipitation, but no surface runoff to the stream; delivery of sediment, however, depends on surface runoff volume. Sediment available for delivery is accumulated over a year, although excess sediment supply is not assumed to carry over from one year to the next. Nutrient loads from rural land uses may be dissolved (in runoff) or solid-phase (attached to sediment loading as calculated by the USLE).

For "urban" land uses, soil erosion is not calculated, and delivery of nutrients to the water bodies is based on an exponential accumulation and washoff formulation. All nutrients loaded from urban land uses are assumed to move in association with solids.

The GWLF model was first calibrated to the Rocky River basin by comparing observed data from 1990 to 1998 to predicted data. The model was effectively calibrated to predict both monthly streamflows (R^2 = 0.76) and annual nutrient loading (R^2 = 0.78 for total phosphorus and

$R^2 = 0.86$ for total nitrogen). Once the model had been calibrated, it was used to predict nutrient loadings during the 1995 to 1997 period for each of the segments listed as impaired for nutrients. The 1995 to 1997 period was selected because it correlates with the most recent round of sampling data collected in the Rocky River basin (1997). More than one year was modeled to obtain average loadings in this period to smooth out the effects of unusually wet or dry years. The results of the estimated loadings for each segment are presented below.

4.0 TOTAL MAXIMUM DAILY LOADS

A TMDL is a means for recommending controls needed to meet water quality standards. U.S. EPA guidance (USEPA, 1991) suggests that a TMDL calculation should be the sum of the individual wasteload allocations for point sources and the load allocations for both natural background inputs and nonpoint sources in a given watershed. The TMDL calculation must also include either an implicit or explicit margin of safety that accounts for the uncertainty concerning the relationship between pollutant load and water quality.

4.1 Method of Calculation

For nutrients, necessary loading reductions for the Rocky River TMDLs were estimated by comparing the instream 1997 summer concentrations to the desired targets (see Section 3.1). For example, if the observed total phosphorus concentration was 0.38 mg/l and the target is 0.19 mg/l, it is assumed that loadings must be reduced by 50%. This approach assumes a direct relationship between loadings and concentrations and a constant assimilation factor (i.e., the instream concentrations of total phosphorus and NO_3+NO_2 will respond to future changes in loading in the same manner as they respond to current loads). These simplifying assumptions are warranted by the fact that it is the cumulative, rather than the acute, loadings of nutrients that are impairing the biologic communities. Please refer to *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999b) for a full discussion of the cumulative impacts of nutrients on Ohio rivers and streams.

4.2 Critical Conditions and Seasonality

TMDL development must define the environmental conditions that will be used when defining allowable loads. Many TMDLs are designed around the concept of a "critical condition." The critical condition is defined as the set of environmental conditions that, if controls are designed to protect, will ensure attainment of objectives for all other conditions. For example, the critical condition for control of a continuous point source discharge is the drought stream flow. Point source pollution controls designed to meet water quality standards for drought flow conditions will ensure compliance with standards for all other conditions. The critical condition for a wet weather-driven source may be a particular rainfall event, coupled with the stream flow associated with that event.

Nutrient sources in the Rocky River basin arise from a mixture of continuous and wet weather-driven sources. The critical condition is expected to be the summer low-flow period because this is the period that is most conducive to algal growth and it is during the summer when nutrient concentrations are expected to be the highest (because of the low flows). The numeric targets were developed from a reference site database that was edited to exclude data collected under high flows as noted by the field personnel collecting the sample or as determined from USGS gaging station data. Extremely elevated total suspended solids values or high total iron concentrations were also used as an indicator of high flows. Therefore it is the observed summer (low-flow)concentrations that are compared to the targets and used to estimate the necessary loading reductions. Since load reductions will be protective of the summer condition they are also expected to be protective of all other conditions.

Seasonality is expressed in the TMDL by using the GWLF model to predict monthly loadings over a multi-year period using actual weather conditions and observed seasonal point source loadings. The estimated loads are therefore reflective of seasonal changes in weather, treatment facility operating practices, and other conditions that can vary over the course of a year (e.g., agricultural practices).

4.3 Margin of Safety

The margin of safety is incorporated implicitly into these TMDLs in two ways. First, the nutrient targets are based, in part, on data from relatively unimpacted reference sites. Ohio EPA notes that full attainment of biological water quality standards are occasionally observed even when concentrations are above these targets (thus reinforcing the notion that habitat and other factors play an important role in supporting fully functioning biologic communities (Ohio EPA, 1999a)). The selection of conservative target values introduces a margin of safety because they directly impact the magnitude of the loading reductions. If less stringent targets were to be selected a greater loading capacity would be allowed. For example, if a NO_3+NO_2 target of 1.6 mg/l[1] instead of 1.3 mg/l had been selected for the Plum Creek TMDL (see below), the loading capacity would have increased from 28,250 kg/yr to 35,030 kg/yr (an increase of 24%). See Section 3.1 for a detailed discussion of target selection.

The relationship between measures of dissolved nitrogen and NO_3+NO_2 nitrogen provides a 10 to 20% margin of safety. As discussed in Section 3.1, the instream targets are expressed as NO_3+NO_2. However, the GWLF model outputs loadings as dissolved nitrogen (which includes NO_3+NO_2, NH_4+, and NH_3). Since dissolved nitrogen is typically comprised primarily of NO_3+NO_2 (80 to 90% based on observed Rocky River data), the allowable loads for these TMDLs will be expressed in terms of dissolved nitrogen. However, the estimate of the necessary loading reductions are obtained by comparing the observed instream NO_3+NO_2 concentrations to the target NO_3+NO_2 concentrations.

Evidence indicates that high quality instream habitat allows biological communities to assimilate higher nutrient loads than would be possible in situations where the habitat has been degraded. Improvements in instream habitat should allow many of the listed segments to recover to full biological attainment without reaching the target values suggested in the nutrient paper. Implementing Phase II stormwater controls in the Rocky River basin would be the initial step in reducing the scouring effects of urban runoff and improving instream habitat. Future improvements will come from directing 319 funds and WRRSP habitat restoration projects to the basin.

[1]Ohio EPA (1999b) recommends a 1.6 mg/L NO3+NO2 target for Modified Warmwater Habitat (MWH) streams.

4.4 TMDL Discussion/Calculations

The TMDL calculations for the nutrient impaired segments in the Rocky River basin are presented below. The following procedure was used for the calculations:

1. The observed 1992 and 1997 instream concentrations were compared to the target values from Table 7.
2. If the observed 1997 concentrations were less than the target value, it was assumed that no nutrient TMDL is needed and other activities should be identified to address the impairment (e.g., improve habitat). If the 1997 concentrations were greater than the target they were used to calculate the necessary loading reductions.
3. The GWLF model was used to estimate the 1995 to 1997 loadings. The output from the model was grouped into the following general source categories: point sources, nonpoint sources (e.g., septic systems, stormwater runoff, row crop erosion), and groundwater.
4. The loading capacity of the listed stream was calculated by multiplying the average annual 1995 to 1997 loadings by the estimate of the necessary reduction obtained by comparing the observed instream concentrations to the target.
5. The loading capacity was separated into wasteload allocations for point sources, load allocations for nonpoint sources, and natural background for groundwater sources.

4.4.1 Mainstem from the East Branch to Lake Erie

Nutrients
The Rocky River (East Branch to Lake Erie) deserves special mention because it is the most downstream segment of the entire 292 mi^2 watershed. Nutrient loadings to this segment therefore arrive from each of the four nutrient impaired segments discussed herein (Baldwin Creek, Plum Creek, lower West Branch, and upper East Branch), as well as from the rest of the watershed. This is an effluent dominated stream. There are also several combined sewer overflows (CSOs) in this segment, although the magnitude of nutrient loadings from these CSOs has not been fully quantified. This portion of the Rocky River is also located in a heavily urbanized area (approximately 30% impervious) and suffers from extremely flashy storm events. It is believed that the extreme flow fluctuations occurring in this part of the watershed are a significant reason for the observed impairments.

<u>Nitrogen</u>
A comparison of the 1997 summer NO_3+NO_2 concentrations in the Rocky River (East Branch to Lake Erie) (3.45 mg/l) to the target concentration (1.85 mg/l) indicates the need to reduce loadings by approximately 46%. The GWLF model was run for the 1995 to 1997 time period and the average annual loads for this period are estimated as follows:

Category	Load (kg/yr)
Point Sources	311,360
Nonpoint Sources	282,145
Groundwater	191,860
Total	785,365

The point source load is the actual load from the North Olmsted WWTP (91,015 kg/yr, based on average annual loadings for the years 1995-1997, and point source loads from upstream segments (220,345 kg/yr)). As mentioned above, CSO overflows also contribute nitrogen loadings to this segment but have not been fully quantified.

The dissolved nitrogen loading capacity of the Rocky River from the East Branch to Lake Erie can be estimated by multiplying the average annual 1995-1997 loadings by the necessary percent reduction identified above:

$$785{,}365 \text{kg/yr} * (1 - 0.46) = 424{,}100 \text{ kg/yr}$$

The 361,265 kg/yr load reduction must be obtained from point sources and nonpoint sources in and upstream of this segment. Even with sizable nonpoint source reductions, point source reductions resulting in stringent permit limits would still be required (see below).

Nonpoint Source Reduction	Point Source Reduction Needed	Permit Limit To Achieve Needed Reduction
30%	276,621 kg/yr	0.9 mg/l
50%	220,193 kg/yr	2.3 mg/l
70%	163,764 kg/yr	3.8 mg/l

Recommending permit limits in this range is not standard practice.

While we have ample reason to believe that nitrogen loads will be reduced in this area over the new few years as a result of recent or planned activity by point source dischargers, data to quantify the reductions are not available. Thus, a TMDL for nitrogen is not being submitted for U.S. EPA approval at this time. The next several paragraphs outline changes expected in this segment. Changes in upstream segments are documented throughout this report.

The abandonment of eight treatment plants and the improvement of several of the remaining plants has resulted in dissolved nitrogen loadings from point sources, including sources in the rest of the basin decreasing from 450,665 kg/yr in 1992 to approximately 311,360 kg/yr currently.

A variety of activities are also already underway to study and address issues arising from the CSOs. The City of Lakewood currently has 8 overflows in its sewerage system which discharge in wet weather periods to either Lake Erie or the Rocky River. The City has ongoing projects which are focusing on separating storm water from sanitary sewerage, as well as increasing the efficiency and wet weather treatment capability at the Lakewood WWTP. The City of Lakewood has developed and is implementing a Nine Minimum Controls Plan (NMCP) for CSOs in its sewerage system.

In an effort to maximize the WWTP capabilities, within the past 2 years modifications were made to the primary settling facilities at the WWTP to eliminate hydraulic bottlenecking which was occurring in the primary treatment portion of the WWTP. This will allow an increase in the amount of wet weather wastewater which can be treated at the WWTP which has the effect of reducing the frequency and amount of partially treated wastewater being bypassed from the WWTP during high flow periods.

The City of Lakewood currently is planning a WWTP headworks modification which will reduce the water level in the main interceptor sewer entering the plant, and will increase the system's wet weather storage capacity. Installation of new equipment will result in the maximization of wet weather storage capacity both at the WWTP and in the sewer system, will reduce CSO activity in the system, and will reduce the possibility of upstream basement flooding. The improvements to the Lakewood WWTP and the aerial sewer entering the WWTP are predicted to reduce the average number of plant bypass CSO events from approximately 84 per year, to an estimated 10 per year (an 88 % reduction in the number). No water quality data are available for the Lakewood CSO discharges.

The Northeast Ohio Regional Sewer District (NEORSD) maintains five combined sewer overflows (CSOs) tributary to five outfalls to the Rocky River from the Westerly service area (NPDES Permit Nos. 064, 065, 066, 067, and 068) plus two outfalls to the Rocky River from the Southerly service area (Permit Nos. 062 and 238). The NPDES permit for the NEORSD CSOs requires the development of long-term control plans for these discharges. Water quality and modeling studies conducted in the past 3 years (Metcalf and Eddy, 1998; Metcalf and Eddy, 1999) have found that CSOs tributary to the Rocky River activate, or discharge combined sewage to surface waters tributary to the Rocky River on an average of 58 times per year, with a total discharge of combined sewage of 17.57 million gallons per year. However, water quality studies and modeling have indicated that the contributions of fecal coliform bacteria from the CSOs were roughly equivalent to loads received from upstream sources, loads for BOD were approximately one- tenth of the upstream load, and that heavy metal loadings were between 10 and one hundred times higher in the upstream flow than that found in the CSO effluent (Metcalf and Eddy, 1998). Therefore, it appears that reduction or elimination of the CSO discharges (NEORSD and Lakewood) will be beneficial, but will not result in significant changes in water quality in the Rocky River.

The phase II Westerly District CSO study found that three of the five Rocky River CSO's activated (i.e. discharged combined sewage to surface waters) four or fewer times per year, and no further action is proposed for these discharges at this time (Metcalf and Eddy, 1999). For the remaining two CSOs which activate more than four times a year, modifications are proposed which will reduce or eliminate the discharges. For one of these CSOs, a minimal design change will divert more of the combined sewer flow to the collection system, which will reduce the number of activations per year. For the other CSO, a more costly improvement will be required to connect the flow to an interceptor sewer in order to reduce the number of activations per year to four or less. The total cost of the improvements for the Rocky River CSOs is estimated at

$487,000, and both projects are included in the first tier of projects in the Westerly District which will enter into the design phase within 1-2 years.

NEORSD's Combined Sewer Operational Plan was submitted to Ohio EPA in 1998 and subsequently approved by the Agency. This report documented NEORSD's activities that relate to compliance with the Nine Minimum Controls as set forth in US EPA's CSO Policy.

Additional reductions in loads will be obtained by addressing the nonpoint sources of loadings. Implementation strategies for the mainstem of the Rocky River are summarized in Section 6.1. As with other areas in this watershed, Ohio EPA will monitor the progress of the activities mentioned here, and collect additional data so that a nitrogen TMDL for this area can be prepared in the future.

<u>Phosphorus</u>
A comparison of the 1992 summer phosphorus concentrations in the Rocky River (East Branch to Lake Erie) (0.11 mg/l) to the target concentration (0.21 mg/l) indicates that the target was being met. The 1997 summer concentrations (0.20 mg/l) were also below the target. A phosphorus TMDL for this segment is therefore deemed unnecessary. This segment is in full attainment for this pollutant and can be de-listed from the 303(d) list.

Organic Enrichment/DO
The TMDL for this pollutant will be developed after completion of field work in the Rocky River basin in accordance with the Ohio EPA 5 year basin plan. It appears that the cumulative effects of a high proportion of treated wastewater from the multiple sources in the basin and impacts associated with urban runoff, and CSOs continue to limit full attainment of the WWH aquatic life use (Ohio EPA, 1999). We anticipate this segment will reach attainment goals following the implementation of phase 2 stormwater control programs in areas throughout the basin, implementation of the NPDES permit for Cleveland Hopkins International Airport, implementation of CSO controls for the Lakewood and NEORSD CSOs, and other improvements in the upper segments of the basin.

Flow Alteration
The TMDL for this pollutant will be developed following field work in the Rocky River basin in accordance with the Ohio EPA 5 year basin plan. Projects to control stormwater quantity and quality will greatly benefit this segment. Implementation of phase 2 stormwater control programs, development of a strategy to create stormwater retention and detention basins in the urban areas and floodplain and stream corridor protection legislation, and public education will help bring this segment into attainment.

Recommended Action
This segment will be sampled in accordance with the Ohio EPA 5 year basin plan. TMDLs will be developed once the analysis of the data is completed. The primary strategy to meet the targets is by working to reduce NPS loads throughout the basin. Staff resources will be provided to assist local government entities with draft language for local ordinances, assistance in implementing stormwater phase 2 regulations, and review of CSO control plans. Permit limits for the North Olmsted WWTP may be modified in the future based on sampling results.

4.4.2 Abram Creek

Abram Creek is the most degraded tributary to the Rocky River. Habitat modifications, urban storm water impacts, septic system discharges, and point source discharges of pollutants have combined to seriously degrade the biological communities within the stream. Despite the abandonment of two wastewater treatment plants in the upper watershed in 1993, little recovery has been noted in the upper part of the watershed, where the habitat is seriously degraded. The downstream portions of Abram Creek are severely impacted by discharges of storm water containing ammonia nitrogen (NH_3-N) and glycols resulting from deicing operations within the Cleveland Hopkins International Airport (CHIA) facility.

Pre-settlement conditions of the Abram Creek watershed included forested land cover consisting of hardwood upland and swamp forests in the upper watershed and hemlock dominated ravines in the stream's lower reaches. A series of wetland complexes approximately three miles long connected by low gradient stream channels comprised what was known as the "Podunk Swamp" (see Hauser, 1998). This area once harbored bog habitats, and was previously mined for peat.

Urbanization of the watershed and the construction of CHIA have resulted in the loss or reduction in size of the wetland complexes as well as the channelization and re-routing of significant segments of the upper portions of Abram Creek to create land for building, flood control, and the disposal of foundry sands and solid waste materials. Four sites upstream of Grayton Rd. were historically used for the disposal of foundry sands which were deposited immediately adjacent to Abram Creek, and two foundry sand/landfill areas are located downstream of Grayton Rd. adjacent to the creek on airport property. In addition, a portion of Abram Creek in the vicinity of Bagley Rd. (RM 5.1) has been buried in a culvert to facilitate commercial development. De-forestation of the watershed and the cumulative addition of impervious surfaces have changed the hydrology of the stream significantly, resulting in lower base flows and higher peak flows associated with storm events. Although the reduction of wetland acreage in the upper Abram Creek watershed has been extensive, ecologically important wetland areas continue to exist, such as the wetland complex surrounding Lake Abram, which has been identified as an important migratory bird sanctuary. This area is protected by the Cleveland Metroparks as a nature preserve. The lake and surrounding marsh are approximately 80 acres in area, of which 42.5 acres are currently owned by the park system. The Cleveland Metroparks has plans to acquire additional parcels in the future to consolidate ownership of the wetland areas and lake and provide additional protective buffers.

Although the current 303(d) list ranks the restorability of Abram Creek as moderate to high, this statement should be qualified for specific reaches of the stream. Distinct differences in channel substrate, stream gradient, and anthropogenic impacts exist between the upper and lower segments with the dividing line being in the vicinity of Grayton Rd. The upper portions of Abram Creek can be generalized as having low to moderate restorability under current conditions. The stream gradient is generally very low in the upper reaches, and the stream has been heavily modified throughout much of this segment. Because of the extensive nature of the impacts in the upper watershed, including stream realignment, channelization, loss of riparian corridors, and the use of culverts, and the accompanying urban development, the potential for restoring these segments is limited.

In contrast, the lower portion of Abram Creek downstream of Grayton Rd. is characterized by bedrock and gravel substrates with high stream gradient. The stream channel throughout this reach has been less impacted by modifications than the upper segment, although some habitat degradation in this segment also exists. These modifications include a dam upstream of Cedar Point Rd. (RM 0.84) , waste disposal areas for foundry sands and other solid wastes located adjacent to the creek just downstream of Grayton Rd., and the past modifications to, or the elimination of, smaller tributaries to the stream. Overall the condition of the channel and intact riparian corridor throughout much of this lower segment is indicative of a stream with the potential to support well balanced warm water biological communities of macro-invertebrates and fish, which has been confirmed through water quality surveys conducted in 1992 (Ohio EPA, 1994) and 1997 (Ohio EPA, 1999), and through a study conducted for CHIA in 1995 (Malcolm Pirnie, 1996). Therefore, the use designation of warm water habitat (WWH) has been assigned to Abram Creek in OAC 3745-1-20, and the restoration potential for this lower segment can be classified as moderate to high.

Non-attainment of the WWH biological water quality criteria within the lower segment of Abram Creek can partly be attributed to uncontrolled hydro-modifications within the upper watershed, Cleveland Hopkins International Airport, and the NASA Glenn Research Center which have increased peak flows and reduced base flows in the stream. In addition, relatively uncontrolled discharges of deicing chemicals to Abram Creek from the airport have resulted in violations of the water quality criteria for NH_3-N with resulting episodic fish kills. Urea was used at CHIA to deice runways and paved areas, which resulted in elevated NH_3-N concentrations in storm water runoff as it degraded. Ethylene and propylene glycols are used within CHIA to deice aircraft prior to wintertime flights. Discharges of glycols from the airport storm water outfalls results in increased organic enrichment to Abram Creek, with the resulting potential for water quality criteria violations and the reduction of dissolved oxygen concentrations in the stream (Malcolm Pirnie, 1999).

In order to address the water quality conditions associated with discharges from CHIA, a Consent Order was signed in 1992 through the Cuyahoga County Court of Common Pleas between the Ohio Attorney General and the City of Cleveland. The purpose of the Consent Order was to eliminate unauthorized discharges of sanitary wastes from portions of the airport, and to develop a storm water management and treatment plan which would be protective of water quality in Abram Creek, Silver Creek and the Rocky River. Since that time, the City of Cleveland Division of Port Control (DPC) has developed a deicing chemical management plan, and begun to implement steps to reduce the loadings of deicing compounds to waters of the State. These efforts include the elimination of the use of urea as a runway deicing compound starting in 1998, and the use of glycol recovery techniques in and around areas of the airport used to deice aircraft starting in 1996. Although the techniques employed to date have likely reduced loadings of pollutants to the receiving streams from the storm water discharges, concentrations of NH_3-N and glycols continue to be highly elevated on a periodic basis, and the need for additional controls is evident. Under the Consent Order, the City of Cleveland was to have designed and installed final collection and treatment facilities at CHIA to meet necessary limits to protect water quality by January of 2000. However, no final plans have yet been submitted to the Ohio EPA for approval as of this writing.

The City of Cleveland DPC has developed a Master Drainage Plan for the airport which was submitted to the Ohio EPA in August of 2000 (Malcolm Pirnie, 1999). This plan is currently under review by the Ohio EPA in conjunction with plans by the City to expand CHIA by replacing one of the existing runways and lengthening the other existing runway at the facility. Information contained in the Master Drainage Plan, as well as the application for a NPDES permit for the airport, has been used to develop appropriate water quality based permit limits for storm water discharges from the facility to Abram Creek which are protective of the stream. These limits are summarized in Table 10. Ohio EPA has public noticed a draft NPDES permit which would require compliance with final effluent limits within 36 months of the issuance of the permit. In addition, the Ohio Attorney General Office has entered into a modified Consent Order with the City of Cleveland DPC to address interim measures which will be implemented to further reduce the discharges of pollutants from the storm water system at the airport, especially under low flow conditions when the impacts on the receiving streams are the greatest.

Of greatest significance to the future of Abram Creek and the restoration of existing designated uses are proposed modifications to Abram Creek associated with the current expansion plans for the airport as reflected in a 401 Water Quality Certification Application submitted in July, 2000, and revised in December, 2000. The preferred design alternative of the City of Cleveland DPC is to place approximately 5,400 feet of Abram Creek into a 10-ft-diameter underground culvert pipe and to eliminate approximate 2,500 feet of unnamed tributaries to the stream. On October 18, 2000, the US Army Corps of Engineers provided public notice of the receipt of the application under Section 404 of the Clean Water Act, and provided the opportunity for public comment on the application. The public comment period for the Corps of Engineers review process ended on November 17, 2000. Ohio EPA provided public notice of the receipt of the application and a public hearing and accepted public comments. On April 13, 2001, the Ohio EPA waived its authority to act on the City of Cleveland DPC's request for 401 certification. At the time of this writing, the Corps of Engineers has not taken action on the application.

The preferred design alternative proposed by the City of Cleveland DPC could permanently alter a significant portion of the lower segment of Abram Creek which currently has the highest habitat quality and highest potential for restoration. In addition, the installation of the culvert may effectively isolate the upper watershed of Abram Creek from the Rocky River, and could permanently eliminate the potential for fish passage from the Rocky River to the upper watershed. This isolation could further depress the potential for the restoration of the upper segments of Abram Creek by eliminating the possibility for the natural re-colonization of the upper Abram Creek watershed by fish from the Rocky River. Follow-up, post construction sampling will need to occur in order to assess the proper use designation of this segment. This will occur as part of the 5 year basin rotation. The segment of Abram Creek downstream of the

Table 10. Recommended final effluent limits and monitoring requirements for Cleveland-Hopkins International Airport outfalls discharging to Abram Creek and the basis for their recommendation

		Effluent Limits: Concentration			
Parameter	Units	30 Day Average		Daily Maximum	Basis[b]
Flow	MGD	- - - - - - - - - - - - Monitor - - - - - - -			M[c]
Dissolved Oxygen	mg/l	5.0	4.0 (min.)	–	WQS
$CBOD_5$	mg/l	- - - - - - - - - - - - Monitor - - - - - - -			M[c]
COD	mg/l	131	1193	–	WQS[d]
Suspended Solids	mg/l	- - - - - - - - - - - - Monitor - - - - - - -			M[c]
Ammonia-N, Summer	mg/l	0.9	4.7	--	WQS
Winter		3.0	4.5[b]	–	WQS, WLA
Oil and Grease	mg/l	15	20	–	BPJ
pH	S.U.	- - - - - - - - - - - - - 6.5 to 9.0 - - - - -			WQS
Benzene	g/l	- - - - - - - - - - - - Monitor - - - - - - -			M[c]
Toluene	g/l	- - - - - - - - - - - - Monitor - - - - - - -			M[c]
Ethylbenzene	g/l	- - - - - - - - - - - - Monitor - - - - - - -			M[c]
Xylene	g/l	- - - - - - - - - - - - Monitor - - - - - - -			M[c]
1,2,4-Trimethylbenzene	g/l	- - - - - - - - - - - - Monitor - - - - - - -			M[c]
Naphthalene	g/l	- - - - - - - - - - - - Monitor - - - - - - -			M[c]
Ethylene Glycol	g/l	140,000	1,300,000	–	WQS
Propylene Glycol	g/l	78,000	710,000	–	WQS

[a] Definitions: BPJ = Best Professional Judgment; M = Monitoring; WLA = Wasteload Allocation procedures (OAC 3745-2); WQS = Ohio Water Quality Standards (OAC 3745-1).
[b] Limit necessary to protect water quality in the Rocky River.
[c] Monitoring of flow and other indicator parameters is specified to assist in the evaluation of effluent quality and treatment plant performance.
[d] WQS limits for COD are based on propylene glycol Tier II values x 1.68 multiplier from CHIA Master Drainage Plan, 1999.

proposed culvert would likely be able to support the WWH aquatic life use designation following construction if additional stress is not placed on the system by improper control of storm water or pollutant loadings.

Ammonia

For the lower segment of Abram Creek, the Ohio EPA will impose NH_3-N limits for discharges of storm water from the CHIA facility which are protective in water quality through the issuance of a NPDES permit. In addition, through the development of a revised consent agreement with the City of Cleveland DPC, the Ohio EPA is pursuing interim controls on the discharge of NH_3-N from the airport during the period that final plans for collection and treatment of stormwater within the CHIA facility are being completed. The TMDL for this pollutant will be developed following field work in the Rocky River basin in accordance with the Ohio EPA 5 year basin plan.

Organic Enrichment/DO

For the lower segment of Abram Creek, the Ohio EPA will impose limits for discharges of glycols in storm water from the CHIA facility which are protective in water quality through the issuance of a NPDES permit. In addition, through the development of a revised consent agreement with the City of Cleveland DPC, the Ohio EPA will pursue interim controls on the discharge of glycols from the airport during the period that final plans for collection and treatment of stormwater within the CHIA facility are being completed. The TMDL for this pollutant will be developed following field work in the Rocky River basin in accordance with the Ohio EPA 5 year basin plan.

Pathogens
This segment will be sampled according to the 5 year basin plan. There are approximately 200 home septic systems in this watershed. The Cuyahoga County Board of Health continues to monitor local streams and target impacted areas as part of their inspection and maintenance program. The two major sources of pathogens in this segment have been abandoned to an interceptor sewer. We expect to validate this segment is in full attainment and can be de-listed from the 303(d) list for this pollutant.

Recommended Action
The TMDLs for ammonia and organic enrichment/DO will be developed after additional sampling is conducted in the Rocky River basin in accordance with the Ohio EPA 5 year basin plan. Delay in development of TMDLs for this segment is in part due to the current proposal from the City of Cleveland to culvert 5,400 feet of this tributary in order to allow for the expansion of runways at Cleveland Hopkins International Airport. Final decisions on this project will be made in 2001. In the meantime, work will continue on implementation of an NPDES permit for Cleveland Hopkins International Airport, implementation of a revised consent order with the City of Cleveland Port Authority to control and remediate discharges associated with past de-icing practices, and institute the Stormwater Phase 2 program for entities within the watershed. These actions, along with the previous abandonment of two major wastewater treatment plants, will directly deal with the impairments in this sub-basin.

4.4.3 Baldwin Lake

Recommended Action
This lake will be sampled during a future Rocky River watershed survey in accordance with the Ohio EPA 5 year basin plan. Portions of the lake are now being managed as wetlands. Data for this segment is outdated and incomplete. The TMDL for these pollutants will be developed following completion of additional field work in the Rocky River basin in accordance with the Ohio EPA 5 year basin plan.

4.4.4 East Branch Rocky River (Healy Creek to Mainstem)

Ammonia
Based on data collected during the 1997 basin survey and documented in the 1998 305(b) report, the trend is towards improving chemical and biological water quality. The major municipal sources for this pollutant have undergone upgrades that will result in better control of this pollutant. We expect to validate this segment is in full attainment for this pollutant and can be

de-listed from the 303(d) list.

Pathogens
Based on data collected during the 1997 basin survey and documented in the 1998 305(b) report, the trend is towards improving chemical and biological water quality. The major municipal sources for this pollutant have undergone upgrades including the treatment processes for the control of pathogens. We expect to validate this segment is in full attainment for this pollutant and can be de-listed from the 303(d) list.

Recommended Action
This segment will be sampled according to the 5 year basin plan. Major upgrades have been completed at the Medina “300" WWTP and North Royalton “A” WWTP. Based on data collected during the 1997 basin survey and documented in the 1998 305(b) report, the trend is towards improving chemical and biological water quality. We expect to validate this segment is in full attainment and can be de-listed from the 303(d) list.

4.4.5 Hinckley Lake

Hinckley Lake is an 88 acre reservoir, which was created in 1938 by impounding the East Branch of the Rocky River (dam at RM 23.16). The lake is owned by the Cleveland Metroparks, and is managed for recreational use as part of the Hinckley Reservation. Lake uses include boating (electric motor only) and fishing from the shoreline and boats. Several picnic areas also surround the lake.

Hinckley Lake was sampled in 1977 (Youger, 1982) and in 1989 (Davic et al., 1996). Monitoring data from the lake was analyzed using the Carlson Trophic State Index (TSI) (Carlson, 1977) and the Ohio Lake Condition Index (Davic and DeShon, 1989). These indices are used to provide comparative scores of lake condition to assess attainment with water quality goals for aquatic life, recreational uses, and water supply uses. Based upon this sampling, the Ohio EPA determined that the designated aquatic life and recreational uses for the lake were impaired due to an unbalanced fishery, high turbidity (low water clarity), and sedimentation which has been caused by excessive loadings of clay turbidity from the watershed (Ohio EPA, 1993). The analysis further concluded that the turbidity of the water limits the productivity of algae in the water column, and that based upon these conditions, that nutrient concentrations in the lake are not excessive, nor are they a cause of non-attainment of the water quality goals for the lake.

Recommended Action
Additional data will be collected and causes for impairment evaluated before TMDLs can be developed. We recommend this lake be sampled to provide updated TSI and LCI information in accordance with the 5 year basin plan. In addition, water quality data from the East Branch upstream of the lake under varying flow conditions is necessary to develop loading estimates for nutrients and sediment.

The Ohio EPA will also encourage the development of supplemental data in partnership with the Cleveland Metroparks, ODNR, the Medina Soil and Water Conservation District (SWCD), the

Natural Resources Conservation Service (NRCS) and the Northeast Areawide Coordinating Agency (NOACA) to develop additional data which will be necessary to develop a comprehensive management plan for the lake which will be protective of the lake's designated uses. Specific data needs for this assessment and appropriate partners in their development are:

Fish creel survey to assess the condition of the fishery (Cleveland Metroparks and ODNR)
Sediment survey to assess the amount of lake volume loss caused by sedimentation (Cleveland Metroparks, Medina SWCD, NRCS)
Watershed model to inventory and assess sources of sediment and nutrients to the lake (Medina SWCD, NRCS, NOACA)
Comprehensive Watershed Management Plan (Cleveland Metroparks, Medina SWCD, NRCS, NOACA)

Once the current data gaps are filled and a watershed management plan is completed, the Ohio EPA will be able to finalize a TMDL for the lake which will protect and restore designated uses.

4.4.6 Coe Lake

Recommended Action
This lake was placed on the 303(d) list in error. The 1996 305(b) report documents that this lake is threatened, but in full attainment. This lake will be recommended for de-listing from the 303(d) list.

4.4.7 Baldwin Creek

Baldwin Creek is a roughly 8 mile-long tributary to the East Branch of the Rocky River entering at RM 4.94. It drains approximately 10 square miles of primarily urban and high density residential areas; parts of the communities of Berea, Middleburg Heights., North Royalton, Strongsville and Parma. The creek is designated in the Ohio Water Quality Standards as Warmwater Habitat (WWH) and Public Water Supply. When needed, streamflow from Baldwin Creek can be diverted into Coe Lake, which is used as a back-up public water supply for the city of Berea. In addition, since a portion of the creek flows through one of the Cleveland Metroparks, it is also listed as a State Resource Water.

Two major wastewater treatment plants discharge treated effluent to Baldwin Creek; the Strongsville "C" WWTP with a design flow of 1.8 MGD at RM 2.9, and the North Royalton "B" WWTP with a design flow of 1.0 MGD at RM 7.3 (see Table 5 for a brief description of the current treatment processes employed at each WWTP). During all low-flow regimes, the streamflow in Baldwin Creek downstream of each of these WWTPs is composed primarily of treated effluent.

Biological Assessment: Trends 1992 - 1997
In 1992, sampling of the fish and macroinvertebrate communities was conducted at five sites on Baldwin Creek by the Ohio EPA. Results of this survey indicated that the biological integrity in the creek was impaired due in large part to the overwhelmingly effluent dominated nature of the stream. The North Royalton "B" WWTP and the Strongsville "C" WWTP both contributed

substantial nutrient loads that resulted in a documented instream enrichment impact. Beginning downstream from the North Royalton “B” WWTP, the stream was in NON attainment of the WWH use (Table 4.). The fish community was affected by the resulting nutrient enrichment to a greater extent than the macroinvertebrates and yielded IBI scores that were in the poor or very poor range from RM 5.8 to the most downstream site at RM 1.4. All five sample locations were below IBI WWH criterion for fish, and three of five were below ICI WWH criterion for the macroinvertebrates.

In 1997, sampling of the fish and macroinvertebrate communities was conducted at six sites. Upstream from North Royalton “B” WWTP, Baldwin Creek demonstrated full attainment of the designated WWH use based on macroinvertebrate sampling alone. The attainment is somewhat suspect in this case since no fish sampling was conducted. Downstream of the WWTP, the macroinvertebrate community was found to be marginally improved, and the ICI criterion was met at all sites. The fish communities continued to be degraded in response to marginal habitat quality, suburban runoff, and nutrient enrichment. Only very slight improvements in the fish community were observed, and all sample locations remained well below the IBI criterion. Overall, the improved macroinvertebrate assemblages resulted in the creek reaching partial attainment at all sites downstream of the North Royalton “B” WWTP in 1997 (Table 4.).

Physical Habitat for Aquatic Life

Due to the urbanized nature of this sub-watershed, the instream habitat has been degraded by scouring flows and sedimentation. Biological sampling in 1997 noted that “embedded substrates and riffles were observed at all sites, while channel modifications, heavy siltation and limited instream cover characterized the downstream reaches”. In addition, two dams on the creek may be preventing re-colonization from the East Branch of darters and other fish species. On average, the physical habitat in Baldwin Creek is marginally suited to supporting normal warmwater stream communities.

Chemical Water Quality

Water chemistry collected in 1992 indicated classic responses of stream water quality to WWTP discharges. These responses included lowered D.O. and higher ammonia-N and nutrients immediately downstream from the discharge followed by increasing D.O. and decreasing nutrients and ammonia-N further downstream from the discharge. Failing septic systems were also observed discharging into Baldwin Creek from RM 3.0 to near the mouth. These failing systems could have contributed to the reduced oxygen content and higher ammonia-N and nutrients in this portion of the creek.

Baldwin Creek was not included in the chemical sampling conducted by the Ohio EPA in the Rocky River basin in 1997. There are approximately 580 home septic systems in this watershed. The Cuyahoga County Board of Health continues to monitor local streams and target impacted areas as part of their inspection and maintenance program. Some systems have been tied into sanitary sewers when the sewers have become available.

Changes in WWTP Processes

Since the last biological sampling conducted in 1997, the North Royalton “B” WWTP has added dechlorination to the treatment process (mid-1997). This plant does occasionally have to bypass, but only after the stormwater retention / EQ basin fills up. Any bypassed flow receives grit removal, primary settling (in the EQ basin), aeration, and chlorination before being bypassed. No further improvements in treatment are planned at this time. The Strongsville "C" WWTP has had no treatment upgrades since prior to 1992. This plant has excess capacity and no additional improvements are underway or being planned.

Nutrients
The TMDL for this cause of impairment will be developed after field work is completed in accordance with the 5 year basin plan.

Nitrogen
The most recent instream NO_3+NO_2 data from Baldwin Creek was collected during the 1992 field survey. It becomes clear that it will be very difficult to meet the 1.3 mg/l NO_3+NO_2 target in this stream. The recommended strategy for the NO_3+NO_2 issue in this stream is therefore to reduce loadings from nonpoint sources to the maximum extent feasible and implement a variety of activities that will improve the habitat conditions in the stream. Improved habitat conditions and reduced NO_3+NO_2 concentrations might allow the biotic community to better assimilate the elevated nutrient concentrations in the stream and return to attainment.

Phosphorus
Since the two wastewater treatment plants are already discharging below their total phosphorus permit limits (30 day limit of 1.0 mg/L), the necessary load reductions should focus on nonpoint sources.

Although biological sampling has confirmed that fish and macroinvertebrate communities are clearly impaired due to excess nutrients, a more current and robust chemical dataset is needed to accurately evaluate instream nutrient levels and make decisions on the reductions needed to meet the target values.

Organic Enrichment/DO
The 1998 303(d) list (based on water chemistry and biology collected in 1992) attributed organic enrichment/DO to be a high cause of the impairment in Baldwin Creek; the source being municipal point sources. The more recent assessment based on the 1997 biological sampling no longer listed this as a cause of the impairment. However, since there have been few changes in treatment processes at the two WWTPs since that time, it is likely that instream chemical sampling in 1997 would have verified that the problem still exists.

Habitat Alteration
The TMDL for this cause of impairment will be developed after field work is completed in accordance with the 5 year basin plan. An in-depth analysis of the habitat in Baldwin Creek was conducted by the Cuyahoga County Board of Health in 1999. A total of 53 sites from river mile 7.1 to the mouth of the stream were evaluated using the Qualitative Habitat Evaluation Index (QHEI) (Rankin, 1989). Habitat scores using the QHEI range from 0 to 100, with a score of 60 being generally interpreted to be necessary to support a well balanced warmwater habitat fish community. Habitat scores in Baldwin Creek ranged from 42 to 65.5 in the 1999 Board of Health survey, with a mean score of 52 (Appendix A). These findings are consistent with earlier

evaluations conducted by the Ohio EPA, and confirm a general trend of diminishing habitat quality over time in Baldwin Creek.

The predominant factors relating to the in-stream habitat which appear to be limiting the maintenance of fish communities in Baldwin Creek are those common to many urban streams. These include impacts resulting from past stream course modifications and channelization which results in uniform channel morphology and the loss of riffle-pool development within the stream (94% of the sites were rated with fair or poor development in the QHEI). These activities widen the channel in constricted regions (riffles), thereby reducing the depth within riffle areas and increasing the settling rate for fine grained materials (sands and silts) within the stream. These morphological changes severely degrade the habitat function of the riffle areas within the stream by reducing water depth and flow rates. In Baldwin Creek, 25 percent of the sites surveyed were found to have no riffle areas at all, and 89 percent of the sites had no areas with fast current. In addition, heavy loads of sediment and silts cause the larger substrates within the stream such as cobbles and boulders to become embedded, thereby eliminating an important habitat refuge for aquatic macroinvertebrates and fish. All of the sites surveyed by the Board of Health were reported to have moderate or heavy silt cover, and 98 percent of the sites were reported to have high or moderate levels of substrate embeddedness. The presence of two dams on Baldwin Creek also likely contributes to the accumulation of fine grained substrates within the stream, since these structures would result in slower currents and slower rates of sediment transport within the stream.

Unlike many urban streams in Ohio, analysis of the Baldwin Creek QHEI data does lead to a conclusion that the habitat restoration in the stream could have a high degree of success. Although average QHEI scores for the stream are below 60, the median QHEI score is 51.5, and only 10 percent of the sites were found to have scores less than 45 (Appendix A). Analysis of the QHEI attributes leading to lowered total scores reveals that few of the sites were characterized by "high influence modified warmwater habitat" attributes (median = 1), while almost all were characterized by "moderate influence modified warmwater habitat" attributes (median = 6). In addition, significant amounts of in-stream cover was found to exist within the stream channel at all of the sites surveyed. Therefore, it appears that habitat enhancements along the stream course which could improve the rifle-pool development within the stream while creating areas of fast current could significantly improve overall QHEI scores. In addition to providing better heterogeneity of habitat types within the stream, these enhancements would reduce the degree of substrate embeddedness, especially in riffle areas, which would allow for increased species diversity within the stream. If implemented in conjunction with stream channel barrier removal or enhancements, stream bank erosion protection, and storm water controls, the capability for Baldwin Creek to attain Warmwater Habitat Biocriteria would be significantly improved.

Recommended Action
The recommended actions include: institute the Stormwater Phase II program for entities within the watershed; any 401 mitigation or restoration activity for an approved 401 in one of these segments occurs in the affected segment; support the Cuyahoga County Board of Health's home septic system inspection and maintenance program; work with local governments to create stormwater retention basin programs; directing 319 funds and WRRSP habitat restoration projects to this sub-basin; and evaluate the addition of a nutrient monitoring program for the two WWTPs in order to collect the necessary data to support an action for nutrient control in the future if NPS reductions are not adequate. After future monitoring is completed, further measures, such as installing additional treatment works at the two WWTPs to remove nitrogen and phosphorus, may be recommended. These actions will deal directly with nutrients, organic enrichment/DO, and habitat alteration impairments for this segment. Sampling to verify attainment of water quality standards would occur as part of the Ohio EPA 5 year basin plan once the recommended actions have been instituted. Future sampling will determine the scope and magnitude of the impairment attributable to organic enrichment/D.O., as well as ascertaining the extent to which unsewered areas or failing septic systems may be contributing. Based on the results of this sampling, a D.O. model can be developed to calculate a TMDL which may result in more stringent effluent limits for NH_3-N, CBOD and D.O. for the Strongsville C and North Royalton B WWTPs.

4.4.8 North Royalton "A" Tributary

Chlorine
The major municipal source for this pollutant has eliminated this treatment process and switched to UV disinfection. We expect to validate this segment is in full attainment for this pollutant and can be de-listed from the 303(d) list.

Organic Enrichment/DO
The major municipal source for this pollutant has undergone an upgrade that will result in reduced loading of this pollutant. We expect to validate this segment is in full attainment for this pollutant and can be de-listed from the 303(d) list.

Recommended Action
We recommend that this segment be sampled according to the 5 year basin plan. A major upgrade of the treatment processes was recently completed at the North Royalton "A" WWTP. Also, UV is now used for disinfection of the final effluent instead of chlorine. We expect to validate this segment is in full attainment and can be de-listed from the 303(d) list.

4.4.9 East Branch Rocky River (Headwaters to Healy Creek)

Nutrients

<u>Nitrogen</u>
A comparison of the 1992 summer NO_3+NO_2 concentrations in the East Branch of the Rocky River (headwaters to Healey Creek) (0.5 mg/l) to the target concentration (1.3 mg/l) indicates that the target was being met. The 1997 median summer concentrations (0.89 mg/l) was also

below the target. A nitrogen TMDL for this segment is therefore deemed unnecessary. This segment is in full attainment for this pollutant and can be de-listed from the 303(d) list.

<u>Phosphorus</u>
As with nitrogen, a comparison of the 1992 summer total phosphorus concentrations in the East Branch of the Rocky River (Headwaters to Healey Creek) (0.06 mg/l) to the target concentration (0.19 mg/l) indicates that the target was already being met. The 1997 median summer concentration (0.13 mg/l) was also below the target. This segment is in full attainment for this pollutant and can be de-listed from the 303(d) list.

Organic Enrichment/DO
Based on field work conducted in 1997, this segment met attainment goals. This was documented in the 1998 305(b) report. Upgrades that took place in 1995 at the Medina 300 WWTP, which discharges to this segment, are expected to result in continued improvement of instream conditions. The plant installed new tertiary filters, new clarifier mechanisms, additional aerobic digester capacity, two new clarifiers, new chlorination/dechlorination facilities, aeration tank revisions, and new sludge handling facilities. This segment will be recommended for de-listing from the 303(d) list.

Recommended Action
This segment met attainment goals based on field work conducted in 1997 (see Section 2-Water Quality Assessment). This segment will be recommended for de-listing from the 303(d) list.

4.4.10 West Branch Rocky River (Plum Creek to East Branch)

Nutrients

<u>Nitrogen</u>
Both the 1992 and 1997 median summer concentrations (2.6 and 1.63 mg/l, respectively) exceeded the target value (1.3 mg/l). However, this segment met biological attainment goals based on field work conducted in 1997 (see Section 2-Water Quality Assessment). A TMDL for this segment is therefore not necessary.

<u>Phosphorus</u>
A comparison of the 1992 summer total phosphorus concentrations in the West Branch of the Rocky River (Plum Creek to East Branch) (0.11 mg/l) to the target concentration (0.19 mg/l) indicates the target was being met. The 1997 sampling also indicated that the target was being met (0.12 mg/l). A phosphorus TMDL for this segment is therefore not necessary.

Recommended Action
This segment met attainment goals based on field work conducted in 1997 (see Section 2-Water Quality Assessment). This segment will be recommended for de-listing from the 303(d) list.

4.4.11 Plum Creek

The Lorain County Plum Creek WWTP discharges to Plum Creek. Due to lack of discharger data, the WLAs for the Plum Creek WWTP are an estimate based on average concentrations from other WWTPs of similar size. This WWTP recently underwent several modifications of the treatment works. There are now summer and winter permit limits for ammonia. Future improvements will include the addition of sand filters and post-aeration. Monitoring for phosphorus and nitrate-nitrite are not included in the current permit. It is recommended that this permit be modified to add a monitoring requirement for nitrate-nitrite and phosphorus. There is a proposal by LORCO, a recently formed sanitary sewer district, to tie this WWTP into the Elyria WWTP within 3 to 5 years.

Nutrients

Nitrogen

A comparison of the 1997 summer NO_3+NO_2 concentrations in Plum Creek (1.9 mg/l) to the target concentration (1.3 mg/l) indicates the need to reduce loadings by approximately 32%. The GWLF model was run for the 1995 to 1997 time period and the average annual loads for this period are estimated as follows:

Category	Load (kg/yr)
Point Sources	590
Nonpoint Sources	28,370
Groundwater	12,590
Total	41,550

WLA for Plum Creek WWTP = 590 kg/year

The total loading capacity of Plum Creek can be estimated by multiplying the 1995 to 1997 loadings by the necessary reduction calculated above:

$$41,550 \text{ kg/yr} * (1 - 0.32) = 28,250 \text{ kg/yr}$$

Two small wastewater treatment plants, the Western Ohio Utilities plant and the Brentwood facility, which historically discharged to Plum Creek, were abandoned in November 1997. Only the small Lorain County Plum Creek WWTP (average effluent flow of 0.024 MGD/0.040 MGD design) continues as a point source of loadings to the creek.

Additional load reductions in this subwatershed (if necessary) can therefore be achieved by addressing nonpoint sources. The TMDL for dissolved nitrogen can be expressed as:

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{Natural Background}$$

$$\text{TMDL} = 590 \text{ kg/yr} + 15,070 \text{ kg/yr} + 12,590 \text{ kg/yr}$$

Phosphorus
A comparison of the 1997 summer total phosphorus concentrations in Plum Creek (0.22 mg/l) to the target concentration (0.19 mg/l) indicates the need to reduce loadings by approximately 14%. The GWLF model was run for the 1995 to 1997 time period and the average annual loads for this period are estimated as follows:

Category	Load (kg/yr)
Point Sources	55
Nonpoint Sources	3695
Groundwater	300
Total	4050

WLA for Plum Creek WWTP = 55 kg/year

The phosphorus loading capacity of Plum Creek can be estimated by multiplying the 1995 to 1997 loadings by the percent reduction calculated above:

$$4{,}050 \text{ kg/yr} * (1 - 0.14) = 3{,}485 \text{ kg/yr}$$

Since the Western Ohio Utilities plant and the Brentwood facility are no longer operating, point source loadings of phosphorus to Plum Creek are greatly reduced. Additional load reductions (if necessary) can therefore be achieved by addressing nonpoint sources (i.e., failing and illicitly connected septic systems, agricultural and urban runoff). The TMDL for total phosphorus can be expressed as:

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{Natural Background}$$

$$\text{TMDL} = 55 \text{ kg/yr} + 3130 \text{ kg/yr} + 300 \text{ kg/yr}$$

Organic Enrichment/DO
This segment will be sampled according to the 5 year basin plan. Two of the three wastewater sources in this segment have been abandoned to an interceptor sewer. We expect to validate this segment is in full attainment and can be de-listed from the 303(d) list for this pollutant.

Pathogens
This segment will be sampled according to the 5 year basin plan. Two of the three wastewater sources in this segment have been abandoned to an interceptor sewer. We expect to validate this segment is in full attainment and can be de-listed from the 303(d) list for this pollutant.

Recommended Action
This segment will be sampled according to the 5 year basin plan. Due to the abandonment of sewage treatment plants and implementation of phase 2 of the stormwater rules, improvements at the remaining WWTP, and changes in agricultural practices, we expect this segment will be in full attainment and can be de-listed from the 303(d) list.

4.4.12 West Branch Rocky River (Cossett Creek to Plum Creek)

Organic Enrichment/DO
This segment be sampled according to the 5 year basin plan. The wastewater sources in this segment have been abandoned to an interceptor sewer. We expect to validate this segment is in full attainment and can be de-listed from the 303(d) list for this pollutant.

Recommended Action
We recommend that this segment be sampled according to the 5 year basin plan. Elimination of several sewage treatment plants in this area should result in full chemical and biological recovery based on data collected during the 1997 basin survey. The trend is towards improving chemical and biological water quality. We expect to validate this segment is in full attainment and can be de-listed from the 303(d) list.

4.4.13 Strongsville "A" Tributary

Ammonia
This segment will be sampled according to the 5 year basin plan. The wastewater sources in this segment have been abandoned to an interceptor sewer. We expect to validate this segment is in full attainment and can be de-listed from the 303(d) list for this pollutant.

Pathogens
This segment will be sampled according to the 5 year basin plan. The wastewater sources in this segment have been abandoned to an interceptor sewer. We expect to validate this segment is in full attainment and can be de-listed from the 303(d) list for this pollutant.

Recommended Action
We recommend that this segment be sampled according to the 5 year basin plan. Due to the abandonment of two sewage treatment plants and implementation of phase 2 of the stormwater rules, we expect to validate this segment is in full attainment and can be de-listed from the 303(d) list.

4.4.14 Baker Creek

Ammonia
This segment will be sampled according to the 5 year basin plan. We expect to validate this segment is in full attainment and can be de-listed from the 303(d) list for this pollutant.

Organic Enrichment/DO
This segment will be sampled according to the 5 year basin plan. We expect to validate this segment is in full attainment and can be de-listed from the 303(d) list for this pollutant.

Pathogens
This segment will be sampled according to the 5 year basin plan. We expect to validate this segment is in full attainment and can be de-listed from the 303(d) list for this pollutant.

Recommended Action
We recommend that this segment be sampled according to the 5 year basin plan . This segment was placed on the 303(d) list due to the results from a single fecal bacteria sample. Efforts are underway to implement home sewage system inspection and maintenance programs in the watershed. We expect to validate this segment is in full attainment and can be de-listed from the 303(d) list.

4.4.15 Mallet Creek

Mallet Creek was erroneously placed on the 303(d) list. A review of the 1992 data showed that the biocriteria were in attainment in this segment (see Section 2-Water Quality Assessment). This segment can be de-listed from the 303(d) list.

5.0 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.

Consistent with Ohio's current CPP, Ohio EPA involved the public in the Rocky River TMDL project by soliciting input and recommendations for action from many local parties. No organized watershed advocacy group exists for the Rocky River watershed. Attempts were made to contact the Northeast Ohio chapter of the Sierra Club and the Steelheaders Fishing Club to see if those organizations would be interested in a presentation about the Rocky River TMDL project. No calls were returned from either of the organizations. The Cleveland Yacht Club was contacted but they do not hold regular member meetings. The Cleveland Metroparks were contacted but again, there is no organized group for this river. The Metroparks offered their facilities in the event a public presentation was made. The regional newspaper was contacted to see if they were interested in covering the issues in the basin. They responded in the affirmative. NOACA, the 208 Areawide agency that covers the Rocky River watershed offered to host a presentation to their board members.

The draft Rocky River TMDL Report was public noticed on December 7, 2000, in major newspapers in Ohio. See Appendix C for the public comments received and the responsiveness summary. Responses to the comments were supplied to the three commenters on the draft report.

6.0 IMPLEMENTATION AND MONITORING RECOMMENDATIONS

6.1 Implementation Strategies

Implementation strategies for the TMDLs described in this document will initially focus on addressing nonpoint sources of nutrients. Nine wastewater treatment plants in the watershed have already been shut down since 1992, several of the remaining plants have recently been upgraded or are currently undergoing upgrades, and total phosphorus and NH3 permit limits already apply. Further nutrient reductions from these treatments plants are therefore expected to be extremely expensive and problematic. The strategy for this phased TMDL is therefore to address the nonpoint sources of nutrients, improve habitat conditions to the extent possible, work to control stormwater quantity and quality, and conduct future monitoring to determine when full use attainment is achieved.

There are thousands of on-site disposal systems in the Rocky River basin and it is expected that nutrient loadings (especially phosphorus) from these systems are significant. Information from the various county health departments indicates a substantial number of systems are assumed to be failing due to their age and/or lack of maintenance. It is also believed that some systems illicitly discharge directly to streams. In some subwatersheds the estimated nutrient loadings from these failing and illicitly connected systems are equivalent to the loads from wastewater treatment plants (see Appendix D, Parameters Governing Nutrient Load Generation).

Ohio EPA will coordinate with the county health departments and the Northeast Ohio Areawide Coordinating Agency (NOACA) to address this issue by attempting to more fully inventory the number and performance of on-site systems. NOACA completed a report on this issue in late 2000 (Kuehner, 2000). Efforts to reduce loadings will focus on areas of the watershed with known nutrient problems and large numbers of systems.

Implementation of Phase 2 of the Stormwater program will affect the following communities in the Rocky River basin:

Rocky River	Lakewood	Cleveland	Fairview Park
North Olmsted	Olmsted Township	Olmsted Falls	Brookpark
Berea	Middleburg Heights	Parma	Parma Heights
Strongsville	North Royalton	Broadview Heights	Brecksville
Columbia Township	Brunswick	Brunswick Hills	Hinckley Township
Medina			

Phase 2 strategies include elimination of illicit discharges, construction site sediment and erosion controls, post-construction stormwater management, education of the community/public participation, and pollution prevention for municipal operations. One full-time position at the Northeast District Office is dedicated to the stormwater program. Although not final, current plans for the implementation of Phase 2 include conducting training and offering educational outreach and technical assistance to the local government officials who will have the ultimate responsibility of implementing the plan. These initial steps will occur by the end of 2002.

Other important nonpoint sources of nutrients in the Rocky River watershed include runoff from residential and agricultural lands. Ohio EPA and the various local governmental agencies (e.g., city and county governments, Natural Resource Conservation Service (NRCS) offices, Soil and Water Conservation District (SWCD) offices, regional sewer districts, Ohio State University Extension offices, etc.) will be contacted to inventory existing nonpoint source control activities and to identify new ones. Whatever best management practices (BMPs) are identified will be integrated into existing and future programs (e.g,. Section 319 grants, stormwater phase II permits). Both management and structural BMPs will be targeted at the areas of the Rocky River watershed with significant agricultural and urban/residential land uses and identified impairments. An initial list of potential BMPs is provided below. Many of these have been reported as being very effective at reducing nutrient loadings when designed and maintained properly. More detailed information on these and other BMPs is available in USEPA (1993), as well as the general literature. Preference will be given to BMPs that have side-benefits such as improving instream habitat and addressing other parameters of concern (e.g., sediment loading, flow alterations). Stream bank stabilization and buffer/setback efforts are therefore very attractive options.

Agricultural
- nutrient management plans
- riparian buffers
- conservation tillage
- vegetated filter strips
- stream bank stabilization
- corridor protection ordinances (models are available)
- grass swales/wetland channels
- septic system maintenance and repair program
- wetlands protection and restoration
- feedlot management plans

Urban/Residential
- buffers and setbacks
- public education
- retention/detention ponds
- wetland restoration
- constructed wetlands
- stream bank stabilization
- porous pavement
- riparian buffers
- grass swales/wetland channels
- corridor protection ordinances (models are available)
- floodplain protection ordinances (models are available)

At least three other funding possibilities exist. Additional Section 319 Projects, beyond the NOACA/Cuyahoga County Health Department project, will be actively pursued in this watershed. Additional Section 319 monies will need to be directed towards implementation efforts. Water Resource Restoration Sponsor Program (WRRSP) funding will be actively pursued for any facility using WPCLF monies for expansions or upgrades. Efforts will continue within Ohio EPA to educate potential project sponsors and develop lists of potential projects where WRRSP monies can be used. Lake Erie Buffer Program monies may be available; this is a new and developing program.

A citizen advocacy group for the Rocky River needs to be established. Both NOACA and the Ohio Environmental Council have expressed interest in developing such a group. Ohio EPA will work to ensure that such an organization is established by the end of 2002 and Ohio EPA will be an active participant.

Implementation Strategies for Plum Creek:
- implement Stormwater Phase 2
- encourage Health Department septic system inspection and maintenance program in priority areas
- NOACA 319 project planning and implementation
- assist local governments in the development and implementation of riparian buffer and corridor protection ordinances
- assist local governments in securing funding for streambank stabilization projects
- continue to encourage the use of conservation tillage in agricultural portions of the basin
- continue to encourage the use of vegetated filter strips in agricultural portions of the basin
- seek increased levels of wastewater treatment at the Plum Creek WWTP, as appropriate, and revise the NPDES permit to reflect any changes

6.2 Reasonable Assurances

U.S. EPA guidance calls for reasonable assurances when TMDLs are developed for waters impaired by both point and nonpoint sources and for waters impaired solely by nonpoint sources. The purpose of the reasonable assurances requirement is for U.S. EPA to be comfortable that the identified activities will in fact be implemented and will have the expected results. Reasonable assurances for reductions in nonpoint source loadings may be non-regulatory, regulatory, or incentive-based, and should be consistent with applicable laws and programs. Because Ohio EPA does not have direct authority/jurisdiction over many of the identified nonpoint sources, it will be important to coordinate activities with those governmental agencies that do (e.g., county health departments, municipalities, Department of Agriculture offices). Reasonable assurances for nonpoint source activities can be strengthened by having signed memorandums of agreement, relying on entities with proven track records of performance, and/or documenting that the required funding levels are available.

Ohio EPA currently has memoranda of agreement (MOAs) with the Cuyahoga, Summit, and Medina County SWCDs to conduct inspections at construction sites. See Appendix B for a copy of one of the agreements.

The 208 plan for the basin was recently updated and approved. It contains numerous plans and strategies to deal with NPS pollution and point source discharges. The report can be found online at www.noaca.org.

Several NPS related projects in the basin are underway or have recently been completed. The Ohio Department of Natural Resources has funded Urban Stream Specialist positions in Medina, Summit, Lorain, and Cuyahoga Counties. This program is designed to provide assistance to local entities for dealing with riparian protection and restoration. The Lorain County SWCD has also hired a staff person to coordinate the County's new urban sediment control program. The Lorain County Health Department and SWCD received 319 grant monies to conduct surveys of areas of failing home septic systems and money for a GPS-Precision Farming demonstration project in the adjacent Black River watershed. Carryover of techniques and applications will occur in the Rocky River portion of the county. A Lake Erie Protection Fund grant was given to Carlisle Township for the development of a model plan for dealing with urban sprawl, zoning, stormwater, and sedimentation. The model is expected to be used by the other townships and adapted for use throughout the county. The Medina County SWCD received an OPUS (Ohio's Partnership for Urban Streams) grant from ODNR to create a watershed team which would focus on designing and implementing stream protection and restoration practices. The initial focus of this group is on the upper West Branch of the Rocky River.

In 2001, the Northeast Ohio Areawide Coordinating Agency (NOACA), in partnership with the Cuyahoga County Board of Health, will receive a $100,000.00 planning grant from the Ohio EPA 319 grant program to develop a detailed watershed plan for the entire Rocky River basin. Community input will be essential to establish a credible plan that will address water quality issues and prioritize corrective activities. The different phases of this plan include building public support, creating a watershed inventory, defining the problems, setting goals, developing solutions, creating an action plan, and implementing and evaluating aspects of the plan. Educating public officials and local citizens about nonpoint source issues is imperative. Developing watershed plans and implementing best management practices will be an important part of the plan.

Finally, Ohio EPA will conduct an engineering review in 2002/2003 to determine if tighter limits at the remaining wastewater treatment plants is feasible. Any changes can be implemented with the renewal of the permits in 2004. Monies from the Water Pollution Control Loan Fund will be available for upgrade assistance.

6.3 Process for Monitoring and Revision

Monitoring of the Rocky River basin will be necessary to ensure that the activities specified by the TMDLs have the desired effect of returning the waterbodies to full attainment. Depending on the results of the future monitoring, the TMDLs might need to be revised to reflect changes in use attainment or observed instream nutrient concentrations. An intensive survey of the watersheds, similar to those conducted in 1992 and 1997, in accordance with the 5 year basin plan would be sufficient to make this determination and is recommended. Additional sampling of two lakes is also recommended.

The length of time it will take the biologic communities to respond to the changes in loadings and habitat improvements that have already occurred or will occur as a result of the TMDLs is unknown. Typically, one would expect the macroinvertebrate communities to respond more quickly than the fish communities. TMDLs determined to be needed in the Rocky River basin will be included in the 2002 revision to Ohio's TMDL schedule.

The Ohio EPA will continue to conduct monthly ambient monitoring at the long-term site at river mile 3.0. During the summer of 2001, additional field work is underway in most of the listed segments, as part of the 5 year basin rotation program. Additional sampling will be scheduled for 2006 per the 5 year basin plan. Changes in permit limits for NPDES dischargers may be recommended as additional data become available. Most of the major NPDES permits in this basin expire in 2004.

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Appendix A. QHEI attributes table for Baldwin Creek (River Code 13-101) from data collected by the Cuyahoga Co. Board of Health, 1999.

			WWH Attributes											MWH Attributes																			
														High Influence						Moderate Influence													
Site Number	**River Mile**	**QHEI Score**	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	5 OR More Substrate Types	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Embeddedness	Max. depth > 40 cm	Low/No Riffle Embeddedness	**Total WWH Attributes**	Channelized or No recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max. depth < 40 cm	**Total H.I. MWH Attributes**	Recovering Channel	Moderate/Heavy Silt Cover	Hardpan Substrate Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total M.I. MWH Attributes**	**H.I. MWH / WWH Ratio**	**M.I. MWH / WWH Ratio**
1	7.10	**57.5**	X	X			X	X			X		**6**						**0**	X	X		X				X	X	X		**6**	0.14	1.00
2	6.80	**58**	X	X		X	X	X			X		**6**						**0**	X	X		X				X	X	X		**6**	0.14	1.00
3	6.60	**62.5**	X	X		X	X	X	X		X		**7**						**0**	X	X		X					X	X		**5**	0.13	0.75
4	6.45	**60**	X	X		X	X	X					**6**						**0**	X	X		X				X	X	X	X	**7**	0.14	1.29
5	6.30	**58**		X			X	X			X		**4**	X					**1**	X	X		X				X	X	X		**6**	0.40	1.60
6	6.15	**59**		X			X	X		X	X		**5**						**0**	X	X		X				X	X	X		**6**	0.17	1.17
7	6.00	**57.5**	X	X			X	X			X		**5**						**0**	X	X		X				X	X	X	X	**7**	0.17	1.33
8	5.90	**60.5**	X	X			X	X			X		**5**						**0**	X	X		X				X	X	X	X	**7**	0.17	1.33
9	5.80	**55.5**	X	X			X	X			X		**5**						**0**	X	X		X				X	X	X		**6**	0.17	1.17
10	5.70	**50.5**	X	X			X	X			X		**5**						**0**		X		X				X	X	X	X	**6**	0.17	1.17
11	5.60	**54**	X	X			X	X			X		**5**			X			**1**		X		X	X			X	X	X		**6**	0.33	1.33
12	5.55	**58**	X	X		X	X	X	X		X		**7**						**0**		X		X					X	X	X	**5**	0.13	0.75
13	5.50	**51.5**		X			X	X			X		**4**	X					**1**	X	X		X				X	X	X	X	**7**	0.40	1.80
14	5.40	**57.5**		X			X	X			X		**4**						**0**	X	X		X				X	X	X		**6**	0.20	1.40
15	5.30	**57**		X			X	X					**3**					X	**1**	X	X		X				X	X	X		**6**	0.50	2.00
16	5.20	**54.5**		X			X	X	X		X		**5**						**0**	X	X		X					X	X		**5**	0.17	1.00
17	5.00	**46**		X				X					**2**	X	X	X		X	**4**	X	X		X	X			X	X	X		**7**	1.67	4
18	4.85	**49.5**	X	X				X			X		**4**			X			**1**	X	X		X	X			X	X	X		**7**	0.40	1.80
19	4.75	**48.5**	X	X				X		X	X		**5**			X			**1**	X	X		X	X			X	X	X		**7**	0.33	1.50
20	4.65	**49**	X	X				X			X		**4**			X			**1**	X	X		X	X			X	X	X		**7**	0.40	1.80
21	4.55	**65.5**	X	X		X	X	X	X		X		**7**						**0**		X		X					X	X		**4**	0.13	0.63
22	4.45	**60**	X	X		X	X	X	X		X		**7**						**0**		X		X					X	X		**4**	0.13	0.63
23	4.35	**52**	X	X			X	X			X		**5**						**0**	X	X		X				X	X	X		**6**	0.17	1.17

Site Number	River Mile	QHEI Score	WWH Attributes											MWH Attributes																			H.I. MWH / WWH Ratio	M.I. MWH / WWH Ratio
														High Influence						Moderate Influence													
			No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	5 OR More Substrate Types	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Embeddedness	Max. depth > 40 cm	Low/No Riffle Embeddedness	**Total WWH Attributes**	Channelized or No recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max. depth < 40 cm	**Total H.I. MWH Attributes**	Recovering Channel	Moderate/Heavy Silt Cover	Hardpan Substrate Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total M.I. MWH Attributes**		
24	4.25	**51**	X				X	X			X		**4**						**0**		X		X				X	X	X		**5**	0.20	1.20
25	4.00	**49**	X				X	X			X		**4**						**0**	X	X		X				X	X	X		**6**	0.20	1.40
26	3.85	**42.5**					X	X					**2**					X	**1**	X	X		X		X		X	X	X		**7**	0.67	3.00
27	3.73	**54.5**	X	X				X			X		**4**			X			**1**	X	X		X	X			X	X	X		**7**	0.40	1.80
28	3.61	**52.5**		X				X			X		**3**			X			**1**	X	X		X	X			X	X	X		**7**	0.50	2.25
29	3.50	**44.5**		X			X	X			X		**4**	X		X			**2**	X	X		X	X				X	X	X	**8**	0.60	2.20
30	3.40	**50**		X			X	X			X		**4**						**0**	X	X		X				X	X	X	X	**7**	0.20	1.60
31	3.30	**45.5**		X				X					**2**			X		X	**2**	X	X		X	X			X	X	X		**7**	1.00	3.33
32	3.18	**45.5**	X	X				X			X		**5**						**0**	X	X		X		X		X	X	X		**7**	0.17	1.33
33	2.90	**43.5**	X	X				X					**3**			X		X	**2**		X		X	X	X		X	X	X		**7**	0.75	2.50
34	2.70	**45**	X	X				X					**3**			X		X	**2**	X	X		X	X			X	X	X		**7**	0.75	2.50
35	2.60	**46.5**	X	X			X	X					**4**					X	**1**	X	X		X				X	X	X		**6**	0.40	1.60
36	2.50	**46.5**		X			X	X					**3**					X	**1**	X	X		X				X	X	X	X	**7**	0.50	2.25
37	2.40	**42**		X				X					**2**			X		X	**2**	X	X		X	X	X		X	X	X	X	**9**	1.00	4.00
38	2.25	**42.5**		X				X					**2**	X		X		X	**3**	X	X		X	X			X	X	X		**7**	1.33	3.67
39	2.10	**44.5**	X	X				X			X		**4**			X			**1**	X	X		X	X			X	X	X		**7**	0.40	1.80
40	1.98	**59.5**	X	X		X	X	X	X		X		**7**						**0**		X						X		X		**3**	0.13	0.50
41	1.80	**50.5**		X			X	X		X	X		**5**						**0**	X	X		X		X		X	X			**6**	0.17	1.17
42	1.64	**46**		X				X			X		**3**			X			**1**	X	X		X	X			X	X	X	X	**8**	0.50	2.50
43	1.40	**52.5**		X			X	X					**3**					X	**1**	X	X		X				X	X	X		**6**	0.50	2.00
44	1.30	**48**	X	X		X	X	X		X			**6**					X	**1**	X	X		X		X		X	X	X	X	**8**	0.29	1.43
45	1.20	**56**		X		X	X	X			X		**5**						**0**	X	X						X	X	X		**5**	0.17	1.00
46	1.10	**56.5**		X		X	X	X			X		**5**	X					**1**	X	X						X	X	X		**5**	0.33	1.17

Site Number	River Mile	QHEI Score	WWH Attributes											MWH Attributes																							H.I. MWH / WWH Ratio	M.I. MWH / WWH Ratio
														High Influence						Moderate Influence													
			No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	5 OR More Substrate Types	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Embeddedness	Max. depth > 40 cm	Low/No Riffle Embeddedness	**Total WWH Attributes**	Channelized or No recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max. depth < 40 cm	**Total H.I. MWH Attributes**	Recovering Channel	Moderate/Heavy Silt Cover	Hardpan Substrate Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total M.I. MWH Attributes**		
47	0.90	**47**		X			X	X					**3**					X	**1**	X	X		X				X	X	X		**6**	0.50	2.00
48	0.82	**52.5**	X	X			X	X			X		**5**						0	X	X		X				X	X	X		**6**	0.17	1.17
49	0.61	**52**	X	X			X	X					**4**					X	**1**	X	X		X				X	X	X		**6**	0.40	1.60
50	0.43	**51.5**				X	X	X			X		**4**						**0**	X	X		X				X	X	X	X	**7**	0.20	1.60
51	0.28	**50.5**		X			X	X			X		**4**						**0**	X	X		X				X	X	X		**6**	0.20	1.40
52	0.15	**57.5**	X	X		X	X	X			X		**6**						**0**	X	X		X				X	X	X		**6**	0.14	1.00
53	0.05	**50**		X			X	X					**3**					X	**1**	X	X		X				X	X	X		**6**	0.50	2.00
Average or Percent with Attribute			55%	92%	0%	23%	74%	100%	9%	8%	70%	0%	4.4	11%	2%	28%	0%	26%	0.7	87%	100%	0%	94%	28%	11%	0%	89%	98%	98%	25%	6.3	0.4	1.5

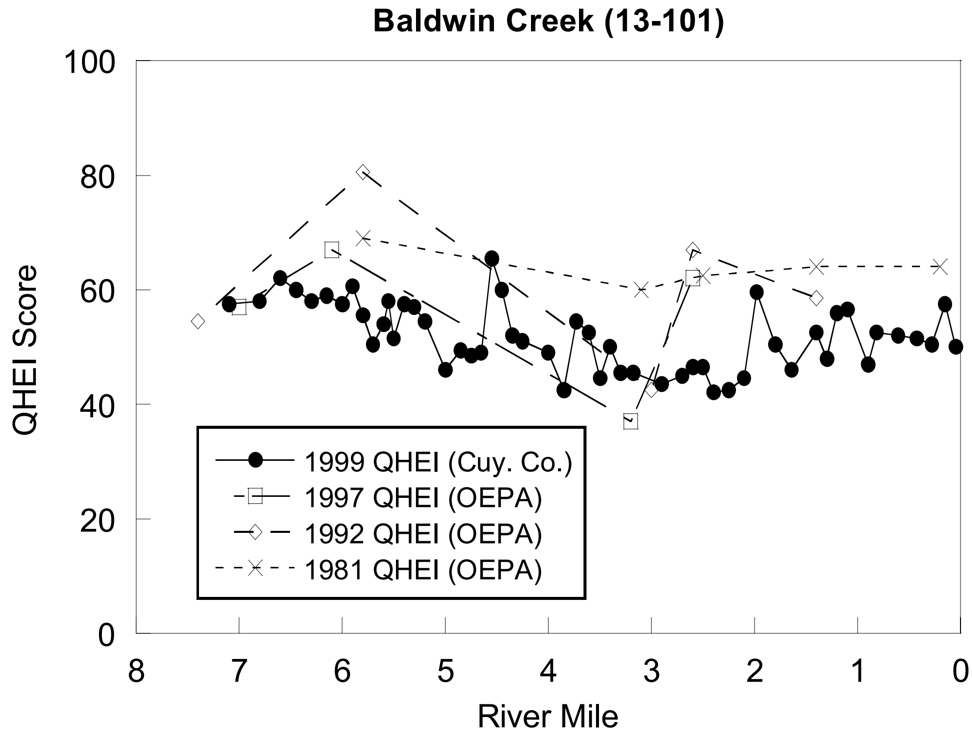

Figure 6. QHEI trends for Baldwin Creek (source: Ohio EPA and Cuyahoga County board of Health data)

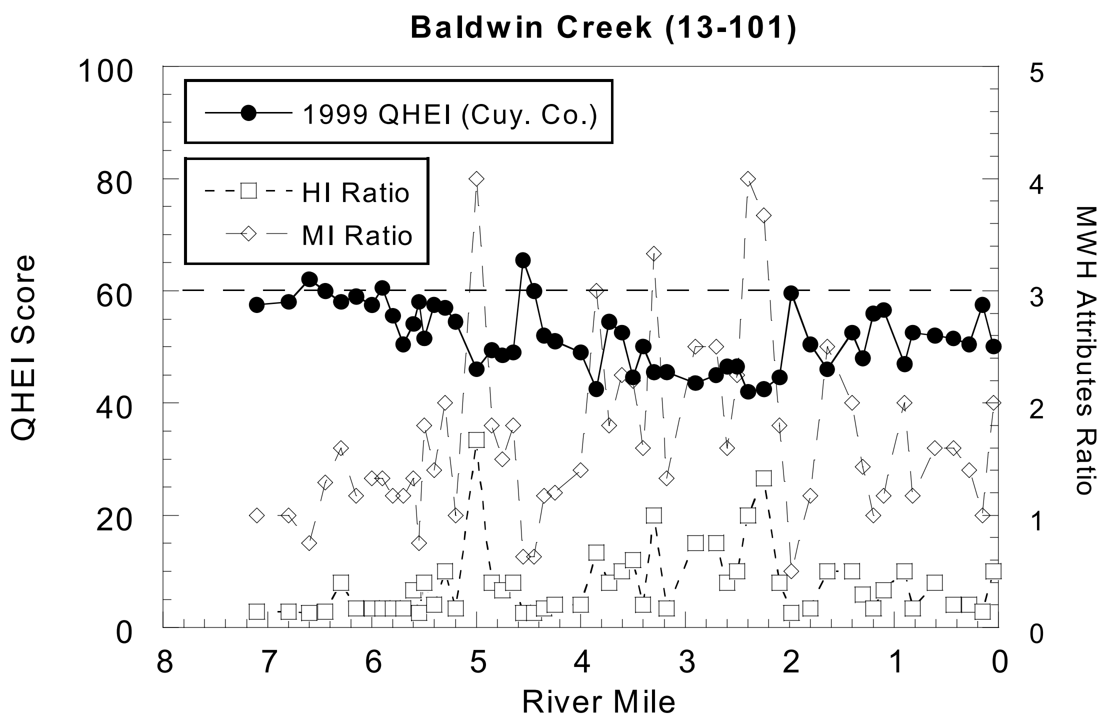

Figure 7. QHEI scores for Baldwin Creek, 1999 (source: Cuyahoga County Board of Health)

Appendix B. SWCD/Ohio EPA Agreements (Cuyahoga County example)

Working Agreement
between the
Ohio Environmental Protection Agency
and the
Cuyahoga Soil and Water Conservation District
and the
Ohio Department of Natural Resources
Division of Soil and Water Conservation

Introduction

The Ohio Environmental Protection Agency, the Cuyahoga Soil and Water Conservation District and the Ohio Department of Natural Resources Division of Soil and Water Conservation have agreed to establish a cooperative agreement for implementing a program to control soil erosion and sedimentation and to improve water quality from construction sites authorized to discharge storm water associated with construction activity under an Ohio Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) storm water permit. It is recognized that the quality of Ohio's water resources is of vital importance to all Ohioans, and that urban development can significantly impact water quality. An approach that is well coordinated among these agencies will provide better oversight and technical assistance to those in the development and construction industry while decreasing unnecessary duplication.

Participating Agencies

The Ohio Environmental Protection Agency is the state agency delegated the responsibility for implementing the federal storm water program, including the NPDES permit program. Discharges of storm water from sites where construction activity is being conducted, as defined in 40 CFR 122.26, are authorized by the Ohio EPA under a general or individual NPDES storm water permit in compliance with the provisions of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et. seq.) and the Ohio Water Pollution Control Act (Ohio Revised Code Chapter 6111).

Soil and Water Conservation Districts (SWCDs) are legal entities of the State of Ohio and have the responsibility to carry out a conservation program in their county. The powers of Soil and Water Conservation Districts are established in Ohio Revised Code Chapter 1515. Soil and Water Conservation Districts receive assistance from the Natural Resources Conservation Service (NRCS) and the Ohio Department of Natural Resources Division of Soil and Water Conservation and typically maintain close relationships with county and municipal government. Each SWCD has a program that addresses natural resource problems in their county. SWCDs have a long history of providing technical assistance and education to individual land users and to local government regarding soil and water conservation issues.

The Ohio Department of Natural Resources (ODNR), Division of Soil and Water Conservation provides standards and specifications for best management practices which will abate erosion and prevent the degradation of waters of the state. The Division of Soil and Water Conservation also assists Soil and Water Conservation Districts in developing and administering their conservation programs.

Therefore, this working agreement is entered into by the authority of the Ohio EPA, ODNR Division of Soil and Water Conservation, and the Supervisors of the Soil and Water Conservation District in order to promote better compliance with the NPDES storm water permit for construction activity.

The Ohio EPA agrees to:

1. Provide technical and educational assistance to aid the regulated community to comply with the NPDES storm water permit requirements.

2. Inform the SWCD of NPDES storm water program procedures and policies, including names of Ohio EPA contact persons.

3. Distribute monthly updated lists of Notices of Intent and Notices of Termination received for coverage under the NPDES storm water permit for construction activity to the Soil and Water Conservation District and to the ODNR, Division of Soil and Water Conservation.

4. Obtain Storm Water Pollution Prevention Plans (SWPPP) for the SWCD in cases where access to the SWPPP has been denied.

5. Participate in joint site inspections as necessary, and to communicate and coordinate planned site inspections with the Soil and Water Conservation District.

6. Assume leadership in responding to sites where no compliance progress can be obtained.

7. Utilize the documentation established by the Soil and Water Conservation District to enforce requirements of the NPDES storm water permit for construction activity.

The Soil and Water Conservation District agrees to:

1. Conduct educational programs on erosion and sediment control and storm water management on construction sites in coordination with the Ohio EPA.

2. Work with landowners, developers, engineers, and contractors prior to construction regarding the general requirements of the NPDES Storm Water Permit for applicable construction projects as staff is available.

3. Provide a plan review and site inspection program, with some or all of the following components:
   requesting, review and provide recommendations regarding SWPPP plans;

inspecting sites for proper implementation of best management practices;
working with the owner or developer to obtain compliance with permit requirements;
giving technical assistance and information to improve implementation of practices.

4. Maintain documentation of site inspections and plan reviews and report cases of noncompliance to the Ohio EPA.

<u>ODNR. Division of Soil and Water Conservation agrees to:</u>

1. Make available current technical standards and specifications for improving water quality from construction and development sites, including standards and specifications developed by the Natural Resources Conservation Service.

2. Provide technical support and training for Ohio EPA and SWCD staff regarding erosion sediment and storm water controls.

3. Assist Ohio EPA and SWCD staff as necessary and available in plan reviews and site inspections.

<u>It Is Mutually Agreed By All to:</u>

1. Participate in regularly scheduled meetings to exchange information and become acquainted with new staff.

2. Cooperate in enforcement cases.

3. Work to remove duplication and confusion in policies and procedures.

4. Participate in regular education and training programs designed to inform those in the construction and development industry about water quality, and the implementation of sediment, erosion and storm water management controls at construction sites.

5. Develop and provide educational materials for use by developers, engineers and

6. Work to avoid unnecessary duplication in plan reviews and site inspections.

7. Recognize that obligations of the State are subject to Ohio Revised Code 126.07.

This Working Agreement may be amended or terminated at any time by mutual consent of the parties, or may be terminated by each of the parties by giving sixty (60) days notice, in writing, to the others.

In witness whereof, this Agreement is executed and agreed to on the day, month, and year written:

Cuyahoga Soil and Water Conservation District

Signed:

Date:

Ohio Environmental Protection Agency

Signed:

Date:

Division of Surface Water

Signed:

Date:

Ohio Department of Natural Resources

Signed:

Date:

Division of Soil and Water:

Signed:

Date:

Appendix C. Public Comments and Responsiveness Summary

Requests for information/comments from the public:

12-7-00 Mailed a paper copy of the report to Mr. Chuck Butterfield at Inland Waters Co., 2195 Drydock Ave., Cleveland, 44113, per his request.

12-12-00 Phone call from Bob Downing at the Akron Beacon Journal. He was referred to the WEB copy of the report.

1-4-01 Mike Galloway from CDO-DSW said he had a couple of comments that he would send via e-mail (received 1-8-01). One typo and two suggestions to clarify language.

1-5-01 A representative from LORCO called. He was referred to the WEB.

1-5-01 Les Stumpe from NEORSD called wanting to know if the Tetra-Tech report was available in the Web. A copy was e-mailed to him on 1-8-01. (Second try on 1-10-01).

1-8-01 City of North Olmsted- delivered 9 pages of comments.

1-8-01 Northeast Ohio Regional Sewer District- delivered 6 pages of comments.

1-8-01 Ohio Environmental Council- faxed 2 pages of comments.

Responses to comments:

<u>Ohio Environmental Council:</u>
1. The Ohio EPA has missed the deadline in Ohio EPA's 1998 303(d).
Ohio EPA acknowledges that the deadline was missed. We have been in regular contact with U.S. EPA's regional office to keep them appraised of our progress. You may be aware that the Rocky River project is one of four projects due to U.S. EPA in 2000 that have been used to "pilot" the 12-step TMDL process developed in the Division of Surface Water. Although all the pilot projects have been delayed to some extent, we have also learned much about scheduling, public participation, and technical aspects of TMDL projects. What we have learned will help us meet future project schedules. The specific problems on this project stemmed most directly from a 4-month hiatus of a U.S. EPA-funded contractor.

2. The draft TMDL does not include TMDLs for specific pollutants on ten lakes and river segments.
This is explained fully in the executive summary. TMDLs determined to be needed in the Rocky River basin will be included in the 2002 revision to Ohio's TMDL schedule.

3. References to "the potential for restoring these segments is limited" (pg. 29) and the likely consequence of this modification would be a future decision to ***downgrade the aquatic life use designation of the upper stream reaches of Abram*** *Creek to Modified Warmwater Habitat" (pg.*

31) appear contrary to the ***central*** *tenant of TMDLs, which is to achieve attainment, and to the Antidegradation requirements of the Clean Water Act. The OEC notes chat this language seems to preclude the issuance of a 401 certification for the Cleveland Hopkins International Airport's proposal to culvert Abrams Creek.*
The Ohio EPA has not yet completed either the 401 Water Quality Certification process or the anti-degradation review for the Cleveland Hopkins International Airport proposal to culvert a significant portion of Abram Creek. Critical aspects of these review processes will be the evaluation of compliance with applicable laws, the overall impact on water quality, and the review of pertinent public comments. It is therefore not the purpose of the TMDL to resolve the issue raised in the comment. The author of the comment is encouraged to provide input regarding this issue during the public comment period for the 401 Water Quality Certification application.

4. The implementation strategies are vague and do not include timeframes. (Also, the future permitting of off-lot discharges from household sewage disposal systems through Ohio EPA's proposed NPDES general permit should be included.)
Much of the implementation is related to developing programs, so details are not available.

5. The concept of reasonable assurances is referred to but specific reasonable assurances for each component of the implementation plan are not included.
The actions identified in section 6.2 will be implemented as resources within the Division and Agency allow. It is the intent of Ohio EPA to make progress towards the goals. Follow-up sampling, as part of the 5 year plan, will document improvements in the segments.

6. *The references to future monitoring are vague and do not include timeframes.*
Time frames are not specific in this document because Ohio EPA is unsure what level of resources will be available for monitoring and assessment in the coming years. The Division is seeking additional funding to support the TMDL program. Regardless of future funding, follow-up monitoring and assessment work will continue in the basin as part of the Division's 5 year basin monitoring plan.

7. The periods of time in which water quality standards will be met are not specified.
Research has shown that biological communities show improvements at different rates. Follow-up monitoring and assessment work will continue in the basin as part of the Division's 5 year basin monitoring plan. It is possible that it will take more than one sampling cycle to show that attainment of the goals have been reached.

Northeast Ohio Regional Sewer District (NEORSD):

1. *The NEORSD questions the draft Rocky River TMDL report's reliance on numeric concentration "targets" for nutrients (i.e., NO3+NO2 nitrogen and total phosphorus).*
Ohio EPA acknowledges the concerns expressed but believes our emphasis is correct. We are concerned with the standards that are rules (biological criteria to measure attainment) and that the target values are a tool for use in the TMDL program. The iterative nature of our 12 step process allows for re-examining stream use attainment (biocriteria) and the appropriate nutrient targets at a point in the future before more point source load reductions would be imposed.

Additional information can be found in a recently posted water quality standards guidance document available on the WEB at http://www.epa.state.oh.us/dsw/guidance/guidance.html

2.The NEORSD also questions the adequacy of the data used to determine the magnitude by which the targets are exceeded and therefore the magnitude of nutrient loading reductions required.
Ohio EPA agrees that additional data are required to better estimate the degree to which the nutrient targets are currently being exceeded and understands the significance of this issue with respect to calculating the necessary load reductions. However, the U.S. Environmental Protection Agency has directed states to move forward with TMDL development even in the face of this type of uncertainty when waters have clearly been identified as being impaired. The existing nutrient concentration data were determined to be sufficient to make initial load reduction estimates and to help focus potential management actions on the most cost-effective solutions (such as addressing nonpoint nutrient sources and improving habitat conditions). More data will be collected to obtain a better estimate of current nutrient concentrations in the Rocky River watershed prior to identifying more costly implementation measures (if such measures are still determined to be needed). Ohio EPA also understands the importance of obtaining flow-variable sampling data to more accurately estimate current nutrient concentrations.

The fifteen segments listed in the draft TMDL for the Rocky River basin were placed on the 303(d) list based on attainment status from the 1992 biological sampling. For this reason, water quality samples taken in 1992 were used to help determine a linkage with the listed attainment status and the causes and sources of impairment, and were used to estimate the necessary reductions in loadings. Known changes in the watershed, such as the closures of several wastewater treatment plants and upgrades at others, were taken into account when estimating the actual current loads. The 1997 sampling data were also considered when determining if a nutrient-related impairment still exits.

It should be pointed out that flow weighted analysis of the available nutrient data was performed during the calibration of the GWLF model. The FLUX program was used to map the flow/concentration relationship developed from the sample record to the entire flow record to calculate total annual loadings. The GWLF model was then calibrated to match this flow-based estimate of annual loads.

3. In Section 4.4.1, the draft Rocky River TMDL report concludes that "reduction or elimination of the [NEORSD] CSO discharges . . . will not result in significant changes in water quality." Yet, later in this section, the report concludes that "CSOs continue to limit full attainment of the WWH aquatic life use." These two conclusions are inconsistent. Based on the available data, the NEORSD contends that the former is the more likely of the two conclusions to be correct, and the latter is without basis and should be deleted from the report.
The first paragraph of this comment takes the language found in the Draft TMDL Report out of context. The quotation given in the comment is only part of a sentence which discusses the necessity of addressing <u>several</u> issues relating to water quality in the lower segment of the Rocky River, not exclusively CSO discharges. Therefore, no revision of this statement in the TMDL report is necessary.

With regard to the second two paragraphs of this comment, clarifying language will be added to correctly characterize the data presented in the 1998 Metcalf and Eddy Report.

4. In Section 4.4.1, the draft Rocky River TMDL report states that the NEORSD "maintains five combined sewer overflows (CSOs) which discharge to the Rocky River." This statement is incorrect. The NEORSD maintains CSOs tributary to five outfalls to the Rocky River from the Westerly service area (NPDES Permit Nos. 064, 065, 066, 067, and 068) plus two outfalls to the Rocky River from the Southerly service area (Permit Nos. 062 and 238).

In Section 4.4.1, the draft report states that "CSOs tributary to the Rocky River activate . . . an average of 59 times per year, with a total discharge of combined sewage of 17.57 million gallons per year." This statement is also incorrect. The Westerly CSOs activate a total of 58 times per year (i.e., 4 + 1 + 0 + 6 + 47 = 58) as shown in Table 7-3 of the Westerly CSO Facilities Plan report. The volume estimate for total CSO discharge in the draft TMDL report is accurate for the Westerly CSOs.
The first sentence of paragraph 3 of page 26 of the Draft TMDL Report will be changed to repeat *verbatim* the language found in the second sentence of this comment. In addition, the number “59" will be replaced with the number “58" in the text regarding the number of CSO activations per year.

5. The NEORSD is encouraged by the initial strategy as expressed in the draft report but urges Ohio EPA to allow sufficient time for full recovery of the aquatic biota after its implementation.
We agree with this comment. Research has shown that biological communities show improvements at different rates. Follow-up monitoring and assessment work will continue in the basin as part of the Division’s 5 year basin monitoring plan. It is possible that it will take more than one sampling cycle to show that attainment of the goals have been reached.

6. The report says, "...projects to control stormwater quantity and quality will greatly benefit this segment." The report further states, "Implementation of phase 2 stormwater control programs, development of a strategy to create stormwater retention and detention basins in the urban areas and floodplains...will help bring this segment into attainment" (page 28). However, it makes no mention of the District's ongoing RPSD and RIDE regional stormwater studies and seems to "boilerplate" stormwater retention and detention basins as a solution without recognizing alternative solutions that may be identified in those studies.
Ohio EPA staff are unfamiliar with the regional storm water studies as referenced in the comment letter. However, it should be borne in mind that selection of specific remedies to alleviate the pervasive problem of urban storm water contributions to the water quality problems in the Rocky River mainstem is not the purpose of the TMDL. Selection of appropriate technologies to meet these goals is most appropriately conducted during the implementation phases of the TMDL process.

*7. The report says that Ohio EPA "staff resources will be provided to assist local government entities with draft language for local ordinances, assistance in implementing stormwater phase 2 regulations, and review of CSO control plans." Since the report indicates stormwater impairments are pervasive throughout the Rocky River's complex urban/suburban watershed, Ohio EPA should also make an attempt to provide **funding** to assist local regional agencies such*

as NOACA, the SWCD and the District in the development of basin wide or, better yet, regional storm water plans.
This comment is beyond the scope of this document. There are other sources of funding that are available. It is recognized that this issue demands additional funding in order to fully and properly deal with storm water problems.

8. Ohio EPA's public participation program for the development of the TMDL report is outlined in Section 5.0 (pg.44). Although the report says a Rocky River basin advocacy could not be identified, Ohio EPA did contact a number of environmental groups and regional agencies such as NOACA and Metroparks. There is no indication that the District was contacted despite the ongoing development of the RPSD, nor whether Lakewood or North Olmsted were contacted. The District is disturbed if this reflects a trend to define "stakeholder" to include only those who condemn discharges but not those who would be responsible for implementation.
Due to time and resource constraints, this aspect of the process was not fully developed for the Rocky River TMDLs. The NEORSD did participate in DSW's TMDL External Advisory Group. Attempts will be made in the future to create a forum for all stakeholders in the basin and we would welcome NEORSD's participation and help in establishing and maintaining such a group.

9. The Tetra Tech report referenced in this document was not available for review.
A copy of the Tetra Tech report was forwarded to NEORSD (Les Stumpe) on January 10, 2001. The report is included in the final TMDL report that is submitted to the US EPA. We recognize that the report should have been included as an appendix for the draft report.

10 and 11. The TMDL states that low flow nutrient concentrations are the probable critical conditions. However, there is no data on groundwater, which will be the major contribution of flow and pollutants under these conditions.
As described in the TMDL, the modeling underestimates groundwater contributions as it does not consider lawn and other watering activities and their impact on both quantity and quality of groundwater.

Groundwater is addressed as a source of nutrient loading and is specifically identified within the report as one of the three general source categories (point sources, nonpoint sources, and groundwater loadings). Groundwater loadings are treated as "natural background" within the TMDL equation because they are assumed to be largely uncontrollable. The GWLF model calculates input of groundwater nutrient concentrations excluding loads due to septic systems, which are accounted for separately. As the NEORSD points out, even in the absence of septic system loads, groundwater concentrations are expected to increase with a shift from forest to either agriculture or development, due to the input of fertilizer on crops, lawns, and gardens. The effect is greatest for nitrate, which is highly soluble, but some elevation of groundwater concentrations of phosphorus is also expected with increased development. Therefore groundwater nutrient concentrations in the Rocky River watershed were estimated as an area-weighted average of concentrations expected for managed land (agriculture, residential, commercial, and industrial development) and unmanaged land (e.g., forest). Groundwater concentrations for unmanaged land were assigned a value of 0.009 mg/l for phosphorus and 0.060 for nitrogen, consistent with values in Omernik (1977). Managed lands were assigned a groundwater phosphorus concentration of 0.03 mg/l and a groundwater nitrogen concentration of

0.65. The resulting average groundwater concentrations for the watershed were 0.015 mg/l phosphorus and 0.63 mg/l nitrogen.

12. "Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams" states:

Habitat characteristics appeared to have some of the strongest effects on the aquatic biota and should be a major consideration in developing nonpoint source pollution abatement strategies where the objective is to restore and protect beneficial aquatic life uses.

However, the TMDL appears to consider these as a secondary issue for remediation.
We agree with the comment concerning the need to consider habitat in the development of nonpoint source pollution abatement strategies. This will be addressed during the implementation phase of the TMDL process. Nevertheless, QHEI scores demonstrated that the study area generally contained adequate habitat attributes to support warmwater fish and macroinvertebrate communities. The lowhead dams on the Rocky River were not considered to be a significant deterrent to the attainment of the biological criteria. The physical characteristics of the dams did not present an impasse for the migration of fish nor do they significantly retard the flow of the stream.

City of North Olmsted:
1. Table 3. Aquatic Life use attainment status of 303(d) listed stream segments in the Rocky River Basin. The City requests that the table be expanded to show the river mile locations of the manmade dams and the river mile lengths of the resulting pools/glides along the main stem and both branches of the river.
We do not believe that Table 3 needs to be expanded. The presence of pool/glide habitat at fish sampling zones does not preclude attainment of a Warmwater Habitat use. Sampling locations on the mainstem and major branches contained significantly more warmwater attributes compared with the number of modified warmwater attributes. The presence of modified habitat attributes of the Rocky River mainstem bare little resemblance to the habitat alterations proposed on Abram Creek due to planned expansion of the Cleveland-Hopkins International Airport. Therefore we disagree with the linkage of the of the two situations and the deduction of the city of North Olmsted that nutrient reduction in the Rocky River mainstem may not result in full attainment of the WWH use because of the presence of a number of modified habitat attributes. Our analysis of the available habitat in the Rocky River and major branches demonstrated that the study area was adequate to support warmwater fish and macroinvertebrate communities.

2. The City requests that the final TMDL report contain a discussion, a preliminary analysis and a detailed scope of work to quantify and locate the sources of persistent toxicity upstream of the North Olmsted WWTP discharge point.
The comment provided indicates that the author believes that "MWH attributes" of the Rocky River and branches upstream of the North Olmsted WWTP could contribute to in-stream toxicity but does not present a mechanism whereby this could occur. The term "MWH attributes" as used by the Ohio EPA generally refers to fish habitat features of the stream which have been modified by human activity and which contribute to poor attainment of the aquatic life

biocriteria (IBI and MIwb). This term does not refer to the presence of chemical pollutants or by products which contribute to acute or chronic toxicity, although the presence of such pollutants also can contribute to poor performance of the biological community as evaluated with the IBI and MIwb. The suggested investigations could be part of future monitoring activities in the Rocky River basin, as resources become available. Information and results will be included in future updates to the Rocky River basin TMDLs.

3. Table 4. Major dischargers in the Rocky River Basin. The entry for the North Olmsted WWTP in the draft TMDL report should be revised as follows: ...
Table 4 has been updated to reflect additional information provided by the City.

4. Table 5. WWTP's abandoned or with process changes in the Rocky River basin between 1992 and 1997. This table should contain the following entries: ...
Table 5 has been updated to reflect additional information provided by the City.

5. Section 4.4.1. The final TMDL report needs to contain a model presentation appendix for this section. That appendix should contain the basin wide input file(s) for the Generalized Watershed Loading Function (GWLF) model and output file(s) generated by the model simulation(s).
The original Tetra Tech report was submitted to the US EPA in October, 2000. We recognize that the report should have been included as an appendix for the draft Rocky River TMDL report.

Ohio EPA does not expect the mainstem to reach FULL attainment solely due to the completion of the several CSO discharge control projects in the lower sections of the mainstem. It was not our intention to imply that the entire 239,810. kg/yr reduction in nitrogen loadings will be achieved through these CSO projects. Rather, it is anticipated that the necessary nitrogen load reductions in the mainstem will be achieved through the sum of both point and nonpoint load reductions in the upper parts of the basin, along with CSO and nonpoint projects and controls along the mainstem. These load reductions, along with the implementation of stormwater controls, should eventually bring the mainstem into FULL attainment. As stated in Section 4.4.1, the magnitude of nutrient loadings from the CSOs in this segment have not been fully quantified. Ohio EPA does not have the data to estimate the pollutant load reductions that may occur from the two specific CSO discharge control projects or any load increases from storm sewers that may be associated with those projects. Therefore we regret that it will not be possible to include the requested table in the TMDL.

6. The City requests that the final TMDL report contain a narrative and loading calculations regarding the dry weather sanitary sewer system discharges referenced in the CONCLUSIONS on page 1 in the 1999 Rocky River TSD.
Dry weather discharges mentioned on page 13 of the 1999 Ohio EPA report "Biological and Water Quality Study of the Rocky River and Selected Tributaries" are the matter of ongoing investigation and elimination by the Northeast Ohio Regional Sewer District. Investigations to locate and sample these discharges were reported to the agency via Metcalf and Eddy, 1998 (cited in the draft TMDL report). The investigation found 24 potential dry weather discharge points to the Rocky River between Puritas Ave. and I-90. The daily discharge from these locations to the Rocky River were estimated at 2.86 MGD, with a daily loading of NH_3-N

estimated at 2.32 kg/day based upon sample results. Of the 24 locations sampled, 10 were found to have fecal coliform counts greater than 1,000 colonies/100 ml, 15 were found to have *E. coli* counts greater than 126 colonies/100 ml, and 5 were found to have NH_3-N concentrations greater than 1 mg/l.

Since the time of the 1998 Metcalf and Eddy report, many of the discharges identified during the study have been eliminated. Future TMDL documents will be revised to provide updated information regarding these discharges and will include loading estimates in the final TMDL, if appropriate.

Appendix D. GWLF Model - Development of Watershed Loading Model

Loading of water, sediment, and nutrients in the Rocky River watershed was simulated using the Generalized Watershed Loading Functions or GWLF model (Haith et al., 1992). The complexity of the loading functions model falls between that of detailed, process-based simulation models and simple export coefficient models which do not represent temporal variability. GWLF provides a mechanistic, but simplified simulation of precipitation-driven runoff and sediment delivery, yet is intended to be applicable without calibration. Solids load, runoff, and ground water seepage can then be used to estimate particulate and dissolved-phase pollutant delivery to a stream, based on pollutant concentrations in soil, runoff, and ground water.

GWLF simulates runoff and streamflow by a water-balance method, based on measurements of daily precipitation and average temperature. Precipitation is partitioned into direct runoff and infiltration using a form of the Natural Resources Conservation Service's (NRCS) Curve Number method (SCS, 1986). The Curve Number determines the amount of precipitation that runs off directly, adjusted for antecedent soil moisture based on total precipitation in the preceding 5 days. A separate Curve Number is specified for each land use by hydrologic soil grouping. Infiltrated water is first assigned to unsaturated zone storage where it may be lost through evapotranspiration. When storage in the unsaturated zone exceeds soil water capacity, the excess percolates to the shallow saturated zone. This zone is treated as a linear reservoir that discharges to the stream or loses moisture to deep seepage, at a rate described by the product of the zone's moisture storage and a constant rate coefficient.

Flow in streams may derive from surface runoff during precipitation events or from ground water pathways. The amount of water available to the shallow ground water zone is strongly affected by evapotranspiration, which GWLF estimates from available moisture in the unsaturated zone, potential evapotranspiration, and a cover coefficient. Potential evapotranspiration is estimated from a relationship to mean daily temperature and the number of daylight hours.

The user of the GWLF model must divide land uses into “rural” and “urban” categories, which determines how the model calculates loading of sediment and nutrients. For the purposes of modeling, “rural” land uses are those with predominantly pervious surfaces, while “urban” land uses are those with predominantly impervious surfaces. It is often appropriate to divide certain land uses into pervious (“rural”) and impervious (“urban”) fractions for simulation. Monthly sediment delivery from each “rural” land use is computed from erosion and the transport capacity of runoff, whereas total erosion is based on the universal soil loss equation (USLE) (Wischmeier and Smith 1978), with a modified rainfall erosivity coefficient that accounts for the precipitation energy available to detach soil particles (Haith and Merrill, 1987). Thus, erosion can occur when there is precipitation, but no surface runoff to the stream; delivery of sediment, however, depends on surface runoff volume. Sediment available for delivery is accumulated over a year, although excess sediment supply is not assumed to carry over from one year to the next. Nutrient loads from rural land uses may be dissolved (in runoff) or solid-phase (attached to sediment loading as calculated by the USLE).

For “urban” land uses, soil erosion is not calculated, and delivery of nutrients to the water bodies is based on an exponential accumulation and washoff formulation. All nutrients loaded from urban land uses are assumed to move in association with solids.

GWLF MODEL INPUTS

GWLF application requires information on land use, land cover, soil, and parameters that govern runoff, erosion, and nutrient load generation.

Land Use/Land Cover

Digital land use/land cover (LULC) data for the Rocky River watershed were obtained from the National Land Cover Dataset (NLCD). The NLCD is a consistent representation of land cover for the conterminous United States generated from classified 30-meter resolution Landsat thematic mapper (TM) satellite imagery data. The NLCD is classified into urban, agricultural, forested, water, and transitional land cover subclasses. The imagery was acquired by the Multi-Resolution Land Characterization (MRLC) Consortium, a partnership of federal agencies that produce or use land cover data. The imagery was taken between 1991-1993. Table 1 summarizes the acreage in each land use category in the Rocky River watershed.

Table 1. Land uses in Rocky River watershed, 1991-1993 (MRLC data).

Land Use Code	Land Use	Acres	% of Total
41	Deciduous Forest	64,560.7	34.50%
81	Pasture/Hay	45,898.0	24.53%
21	Low Intensity Residential	28,101.9	15.02%
82	Row Crops	25,754.4	13.76%
23	Commercial/Industrial/Transportation	6,955.2	3.72%
85	Urban/Recreational Grasses	4,211.6	2.25%
91	Woody Wetlands	3,117.6	1.67%
22	High Intensity Residential	2,523.0	1.35%
42	Evergreen Forest	2,282.6	1.22%
11	Open Water	2,104.9	1.12%
43	Mixed Forest	829.5	0.44%
33	Transitional (Barren)	447.2	0.24%
92	Emergent Herbaceous Wetlands	343.6	0.18%
Total		187,130.2	100.00%

Soil data for the Rocky River watershed were obtained from the NRCS State Soil and Geographic (STATSGO) database (http://www.ftw.nrcs.usda.gov/stat_data.html). Attribute data associated with soil map units were used to assign soil hydrologic groups and to estimate values for some of the USLE parameters, as described in sections below.

The entire surface of the Rocky River watershed was divided into subwatersheds corresponding to the segments appearing on the 303(d) list as impaired for nutrients. The subwatersheds, land uses, and the soils coverages were overlain in a Geographic Information System (GIS) environment. For the purposes of the GWLF modeling of runoff and erosion, the land use categories were grouped as summarized in Table 2. Runoff and erosion potential are expected to be affected both by land use and by the soil hydrologic group, so each land use group was divided into sub-categories based on the hydrologic group (A, B, C or D) of the underlying soil type. Finally, the high density residential land uses, which mixes substantial amounts of pervious and impervious areas, was further subdivided into pervious and impervious areas based on an assumed percent imperviousness (80%).

Table 2. Land Use Groupings for GWLF Modeling

NLCD Land Use	Group Code	Pollutant Simulation
Deciduous Forest	FOREST	Rural
Evergreen Forest		
Mixed Forest		
Urban/Recreational Grasses	GRASS	Rural
Transitional (Barren)		
Low Intensity Residential	LDRES	Mixed
Pasture/Hay	PASTURE	Rural
Row Crops	ROWCR	Rural
Commercial/Industrial/ Transportation	COMM	Urban
Woody Wetlands	WETLANDS	Rural
Emergent Herbaceous Wetlands		
High Intensity Residential	HDRES	Mixed
Open Water	WATER	--

Rainfall and Runoff Input Data and Parameters

Meteorology:

Hydrology in GWLF is simulated by a water-balance calculation, based on daily observations of precipitation and temperature. A search was made of available Midwestern Regional Climate Center reporting stations. Based on this review, the most appropriate available meteorological data appears to be that from the station at Cleveland Hopkins International Airport (Station ID: 331657), located at 41°24' N, 81°51' W, in Cuyahoga County, about 5 miles south of Lake Erie. This station supplies daily data on precipitation and minimum and maximum temperature. Daily mean temperature was estimated as the mean of the minimum and maximum values.

Data for Cleveland Hopkins International Airport for 1980 through 1998 were obtained directly from the Midwestern Regional Climate Center. Average total precipitation and mean daily temperature by month for the 1980 - 1998 time period are summarized in Table 3. Figure 1 shows the variability in monthly precipitation over the 1980 - 1998 period.

Table 2. Climate Normals for Cleveland Airport, January 1980 - December 1998.

Month	**Average Total Precipitation (inches)**	**Average Air Temperature (Fahrenheit)**	**Minimum Air Temperature (Fahrenheit)**	**Maximum Air Temperature (Fahrenheit)**
January	2.45	27.3	-20	67
February	2.21	30.0	-10	71
March	3.00	37.5	-5	82
April	3.62	48.6	11	88
May	3.50	59.2	27	91
June	3.53	68.2	37	104
July	3.64	73.1	45	100
August	3.47	71.1	38	99
September	4.00	64.2	34	93
October	2.94	53.0	19	84
November	3.72	42.6	13	77
December	3.01	32.0	-15	77

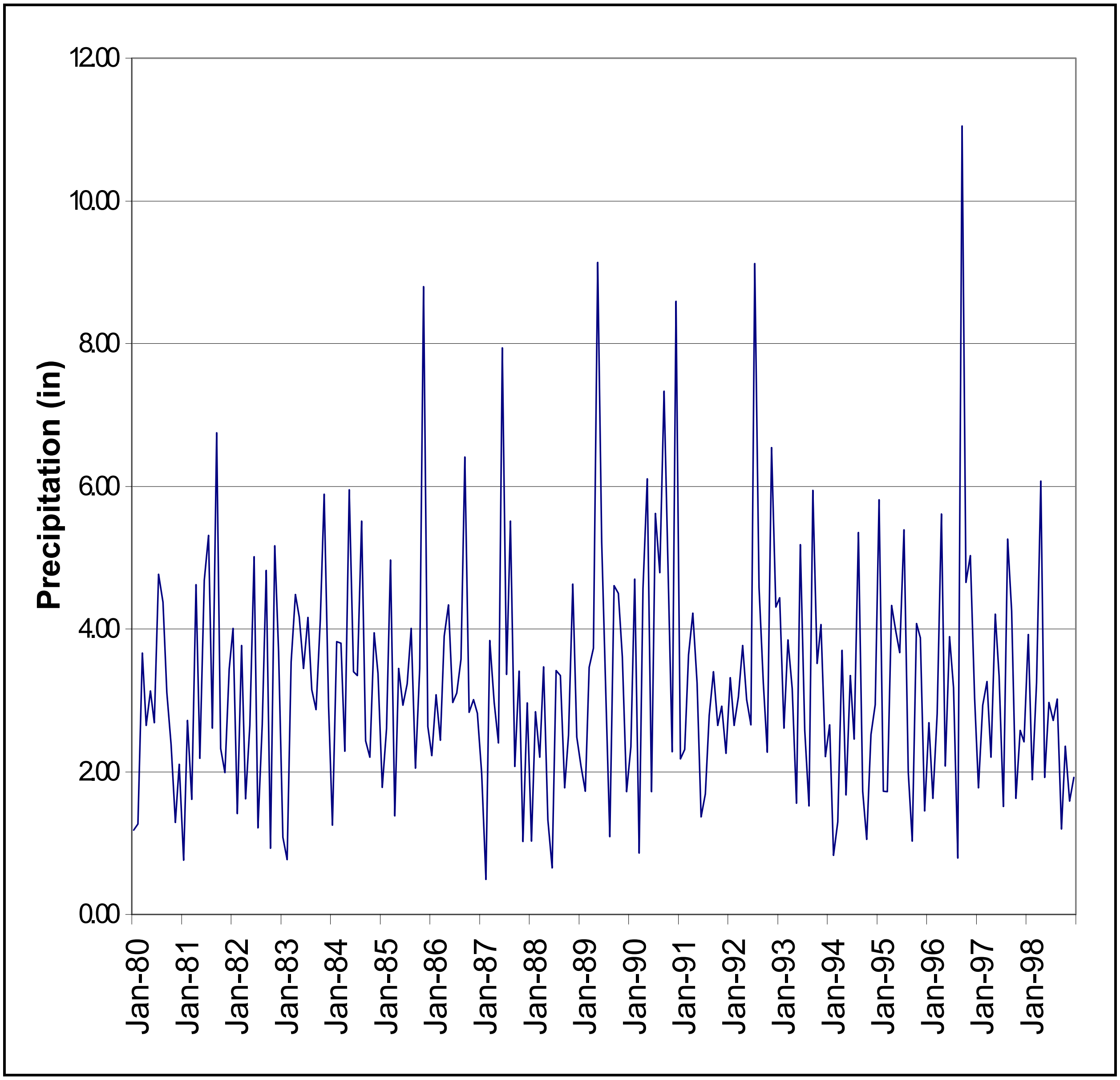

Figure 8. Rocky River Area Monthly Total Precipitation, 1980-1998.

Runoff Curve Numbers:
The direct runoff fraction of precipitation in GWLF is calculated using the curve number method from the SCS TR55 method literature based on land-use and soil hydrologic group (SCS 1986). Curve numbers vary from 25 for undisturbed woodland with good soils, to, in theory, 100, for impervious surfaces. The hydrologic soil group was determined from available soils data and curve numbers were calculated for each land use category/soil hydrologic group. Curve numbers assigned for the Rocky River watershed are summarized in Table 4. For each land use, the table also indicates whether GWLF simulates nutrient loading via the USLE equation ("rural" areas) or a buildup-washoff formulation ("urban" areas).

Table 4. Runoff Curve Numbers for Rocky River Watershed.

GWLF Land Use Group	GWLF Loading Methodology	SCS Curve Number by Soil Hydrologic Group			
		A	B	C	D
FOREST	USLE	36	60	73	79
PASTURE	USLE	57	72	81	85
LDRES	Buildup-Washoff	46	65	77	82
ROWCR	USLE	57	72	81	85
COMM	Buildup-Washoff	68	79	84	89
GRASS	USLE	39	61	74	80
WETLANDS	USLE	68	80	87	90
HDRES	Buildup-Washoff	98	98	98	98

Evapotranspiration Cover Coefficients:
The portion of rainfall returned to the atmosphere is determined by GWLF based on temperature and the amount of vegetative cover. For urban land uses, the cover coefficient was calculated as (1 - impervious fraction). For all other land uses it was assumed that land had vegetative cover during the growing season (cover coefficient = 1) and limited vegetative cover during the dormant season (cover coefficient = 0.3). The cover coefficients were area-averaged to result in one coefficient value for the growing season (March-October) and one for the dormant season (November-February).

Soil Water Capacity:
Water stored in soil may evaporate, be transpired by plants, or percolate to ground water below the rooting zone. The amount of water that can be stored in soil (the soil water capacity) varies by soil type and rooting depth. Based on soil water capacities reported in the STATSGO database, soil types present in the watershed, and GWLF user's manual recommendations, the GWLF default soil water capacity of 10 cm was used.

Recession and Seepage Coefficients:
The GWLF model has three subsurface zones: a shallow unsaturated zone, a shallow saturated zone, and a deep aquifer zone. Behavior of the second two stores is controlled by a ground water recession and a deep seepage coefficient. The recession coefficient was set to 0.2 per day and the deep seepage coefficient to 0.01, based on several calibration runs of the model.

Erosion Parameters
GWLF simulates rural soil erosion using the Universal Soil Loss Equation (USLE). [Note: For land uses indicated as "Buildup-Washoff" in Table 4, solids loads are generated separately, as described below in the section entitled Parameters Governing Nutrient Load Generation.] This method has been applied extensively, so parameter values are well established. This computes soil loss per unit area (sheet and rill erosion) at the field scale by

$$A = RE * K * LS * C * P$$

where

A =	rate of soil loss per unit area,
RE =	rainfall erosivity index,
K =	soil erodibility factor,
LS =	length-slope factor,
C =	cover and management factor, and
P =	support practice factor.

Soil loss or erosion at the field scale is not equivalent to sediment yield, as substantial trapping may occur, particularly during overland flow or in first-order tributaries or impoundments. GWLF accounts for sediment yield by (1) computing transport capacity of overland flow, and (2) employing a sediment delivery ratio (DR) which accounts for losses to sediment redeposition.

Rainfall Erosivity (RE):
Rainfall erosivity accounts for the impact of rainfall on the ground surface, which can make soil more susceptible to erosion and subsequent transport. Precipitation-induced erosion varies with rainfall intensity, which shows different average characteristics according to geographic region. The factor is used in the Universal Soil Loss Equation and is determined in the model as follows:

$$RE_t = 64.6 * a_t * R_t 1.81$$

where

RE_t = Rainfall erosivity (in megajoules mm/ha-h),
a_t = Location- and season-specific factor, and
R_t = Rainfall on day t (in cm).

The erosivity coefficient (a_t) was assigned a value of 0.23 for the growing season and 0.08 for the dormant season, based on erosivity coefficients provided in the GWLF User's Manual.

Soil Erodibility (K) Factor:
The soil erodibility factor indicates the propensity of a given soil type to erode, and is a function of soil physical properties and slope. Soil erodibility factors were extracted from the STATSGO soil coverage. For each land use category, the K factors of the soil types underlying all land of this category were area-averaged to result in an overall K factor for the land use category.

Length-Slope (LS) Factor:
Erosion potential varies by slope as well as soil type. The LS factor is calculated following Wischmeier and Smith (1978):

$$LS = (0.138 * x_k)b * (65.41 * \sin^2 {}_k + 4.56 * \sin {}_k + 0.065)$$

where

${}_k$ = tan - 1(ps_k/100), where ps_k is percent slope
x_k = slope length (ft)
b = a factor of percent slope, as follows:

Percent Slope	b
0-1	0.2
1 - 3.5	0.3
3.5 - 5	0.4
5 +	0.5

Slopes were extracted from the STATSGO soils database. For each soil type, slope was assumed to be the mid-point of the minimum and maximum slope given by STATSGO. As with the K factor, slope for each land use was calculated as an area-weighted average of the slopes of underlying soil types. The slope length was assumed to be 500 feet based on a visual analysis of the land use/soils coverage.

Cover and Management (C) and Practice (P) Factors:
The mechanism by which soil is eroded from a land area and the amount of soil eroded depends on soil treatment resulting from a combination of land uses (e.g., forestry versus row-cropped agriculture) and the specific manner in which land uses are carried out (e.g., no-till agriculture versus non-contoured row cropping). Land use and management variations are represented by cover and management factors in the universal soil loss equation and in the erosion model of GWLF. Cover and management factors were drawn from several sources (Wischmeier and Smith, 1978; Haith et al., 1992; Novotny and Olem, 1994), and are summarized in Table 5. Practice (P) factors were generally set to 1, consistent with recommendations for non-agricultural land.

Table 5. Cover and Management Factors for Rocky River Watershed Land Uses*

GWLF Land Use Group	C	P
FOREST	0.010	1
PASTURE	0.040	1
ROWCR	0.500	0.5
GRASS	0.040	1
WETLAND	0.010	1
WATER	0.010	0

* C and P factors are not required for the “urban” land uses which are modeled in GWLF via a buildup-washoff formulation rather than USLE.

Sediment Delivery Ratio:
The sediment delivery ratio (DR) converts erosion to sediment yield, and indicates the portion of eroded soil that is carried to the watershed mouth from land draining to the watershed. The BasinSim program (a Windows version of GWLF) includes a built-in utility which calculates the sediment delivery ratio based an empirical relationship of DR to watershed area (SCS, 1973). The sediment delivery ratio for the entire Rocky River watershed was calculated at 0.067.

Parameters Governing Nutrient Load Generation

Groundwater Nutrient Concentrations:

The GWLF model requires input of groundwater nutrient concentrations excluding loads due to septic systems, which are accounted for separately. Even in the absence of septic system loads, groundwater concentrations are expected to increase with a shift from forest to either agriculture or development, due to the input of fertilizer on crops, lawns, and gardens. The effect is greatest for nitrate, which is highly soluble, but some elevation of groundwater concentrations of phosphorus is also expected with increased development.

Groundwater nutrient concentrations were estimated as an area-weighted average of concentrations expected for managed land (agriculture, and residential, commercial, and industrial development) and unmanaged land (e.g., forest). Groundwater concentrations for unmanaged land were assigned a value of 0.009 mg/l for phosphorus and 0.060 for nitrogen, consistent with values in Omernik (1977). Managed lands were assigned a groundwater phosphorus concentration of 0.03 mg/l and a groundwater nitrogen concentration of 0.65. The resulting groundwater concentrations for the watershed were 0.015 mg/L phosphorus and 0.63 mg/L nitrogen.

Dissolved and Solid Phase Nutrient Concentrations for Rural Land Uses:
GWLF requires a dissolved phase concentration for surface runoff from rural land uses. Particulate concentrations are taken as a general characteristic of area soils, determined by bulk soil concentration and an enrichment ratio indicating preferential association of nutrients with the more erodible soil fraction, and not varied by land use. The estimates of dissolved phase and solid phase nutrient concentrations were selected from the GWLF User's Manual and are shown in Table 6.

Table 6. Dissolved and Solids Phase Nutrient Concentrations for Rural Land Uses.

GWLF Land Use Group	Nitrogen		Phosphorus	
	Dissolved Phase (mg/L)	Solids Phase (mg/kg)	Dissolved Phase (mg/L)	Solids Phase (mg/kg)
FOREST	0.25	2500	0.01	1200
PASTURE	3.00	2500	0.20	1200
ROWCR	2.90	2500	0.20	1200
GRASS	0.65	2500	0.06	1200
WETLAND	0.25	2500	0.01	1200

Buildup/Washoff Parameters for Urban Land Uses:
Nutrients and solids generated from urban land uses are described by a buildup/washoff formulation. Pollutant accumulation is summarized by an exponential buildup rate, and GWLF assumes that 95% of the limiting pollutant storage is reached in a 20-day period without washoff. The resulting buildup parameters are summarized in Table 10.

Table 7. Pollutant Buildup Rates for Urban Land Uses.

Land use	Nitrogen build up (kg/ha-d)	Phosphorus build up (kg/ha-d)
Commercial/Industrial/Transportation	0.101	0.0079

High Intensity Residential	0.056	0.0033

Septic Systems:
GWLF contains routines for the simulation of nutrient loading from both normal and failing septic systems. The number of septic systems in each subwatershed was estimated based on information provided to Ohio EPA by the public health departments in the three counties (Anderson, 2000). Several assumptions had to be made to categorize the systems according to their performance. These assumptions were based on the data provided by the public health departments, where available, and best professional judgement otherwise. Table 8 summarizes the results of these assumptions. Finally, it was assumed that on average each system serves 2.58 persons (based on 1990 Census data for the three counties).

Table 8. Estimated Number of Septic Systems in Rocky River Watershed.

County	Estimated Number of Septic Systems	Estimated Number of Systems by Category			
		Normal	Ponded	Short-circuited	Direct Discharge
Cuyahoga	4600	2300	2024	230	46
Medina	10000	5000	4400	500	100
Lorain	2100	1050	924	105	21

Normal: Septic systems conform to EPA standards and operating effectively.
Ponded: System failure results in surfacing of effluent.
Short-circuited: Systems are close enough to surface water (< 15 meters) that negligible absorption of phosphorus takes place.
Direct Discharge: Illegal systems discharge effluent directly into surface waters.

Parameters affecting nutrient loading from septic systems were specified at GWLF default values. Effluent phosphorus from failing septic systems was set to 1.5 g/day (default for areas with non-phosphate detergents), while effluent nitrogen was set to 12.0 g/day. Plant uptake rates were assumed to be 1.6 g/day nitrogen and 0.4 g/day phosphorus.

Point Sources:
Average monthly nutrient loads from point sources were obtained directly from Ohio EPA and were based on loadings reported by the facilities. Loads were separated into average summer and winter loadings. Loads from some of the older, smaller plants were not available and were estimated based on available data from similar plants.

Appendix D References

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Appendix E. Phosphorus Target Development

Total phosphorus (TP) concentrations in the range of 0.19 to 0.21 mg/l are considered protective of eventual attainment of the Warmwater Habitat biological criteria in the Rocky River basin when the following factors are considered.

Biological Factors

The distribution of data points, especially in nearby waters, as well as specific statistics (e.g., medians and 75th percentiles) can be useful in deriving target values. For example, the median value for reference sites in the EOLP ecoregion for wadeable streams is 0.05. However, examination of a scatter plot of values in similar sized streams in the EOLP ecoregion indicates that a substantial number of streams frequently achieve a WWH IBI value of 34 or greater at levels above the median TP value, but below 0.20 mg/l (Figure 1). For wadeable stream in the EOLP ecoregion with total phosphorus concentrations above 0.20 mg/l, IBI scores attaining a WWH level are much less frequent (Figure 1, dashed box).

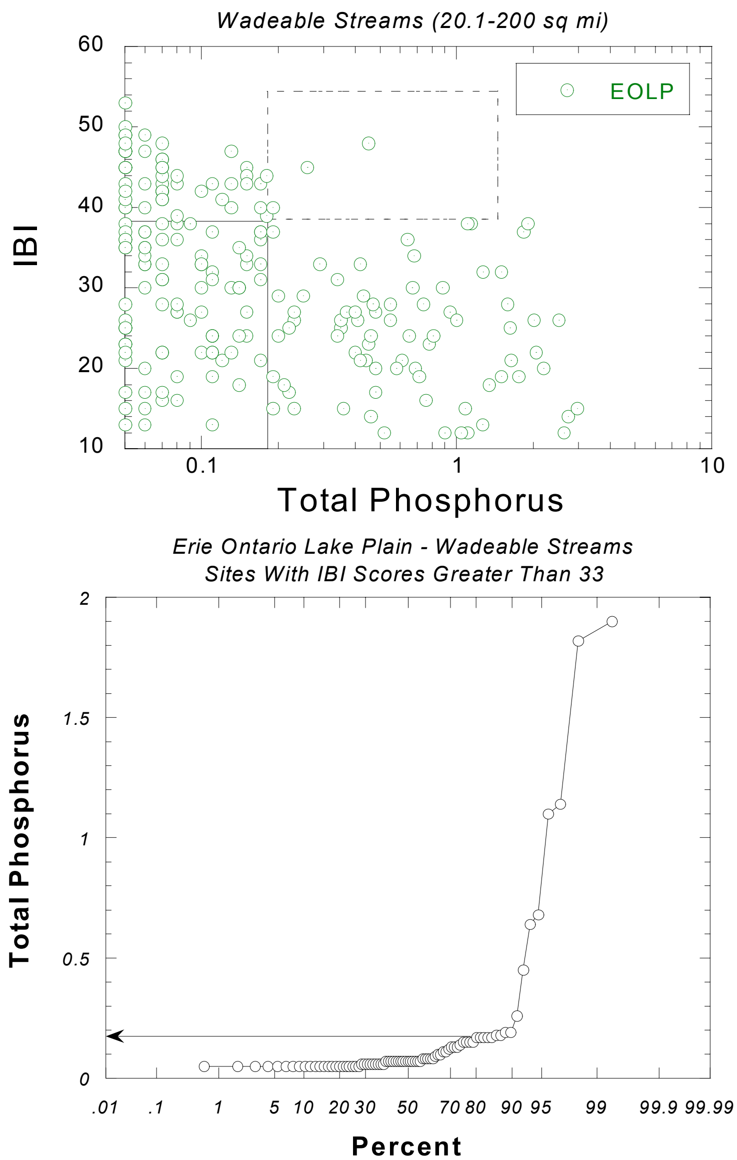

Figure 1. Scatter plot of IBI versus total phosphorus (mg/l) in wadeable streams in the EOLP ecoregion (top) and a probability plot of a subset of the data in top figure where the IBI scores were above 33 (bottom).

By plotting the data in Figure 1 using a probability plot (total phosphorus where IBI scores are attaining or in "non-significant departure" from the biocriteria; IBI > 34), it can also be determined that a target value of 0.19 mg/l is within the main distribution of the data and is not an "outlier" data point.

Targeting nonpoint sources of nutrients that also reduce sediment delivery to streams and considering habitat restoration and protection should enhance the stream's ability to assimilate nutrients. Other similar size streams in the EOLP ecoregion attain a WWH biocriteria value (or better) with TP concentrations above the reference median value and the Rocky River target value of 0.19 mg/l (wadeable streams). Thus, the target value of

0.19 mg/l is appropriate. Future monitoring, after implementation of the nonpoint source controls, will allow us to refine the link between various control measures, habitat, and the success of nutrient reduction in various stream types in Ohio.

Habitat

The inter-relationships between stream habitat and nutrient concentrations are complex and not completely understood. Basic research has shown the ability for streams to assimilate some levels of nutrients without impairing aquatic life. Natural stream systems with intact instream and riparian habitats also work to trap and sequester nutrients before they reach the stream and during flood events when these waters come into contact with their floodplains, bars, etc.

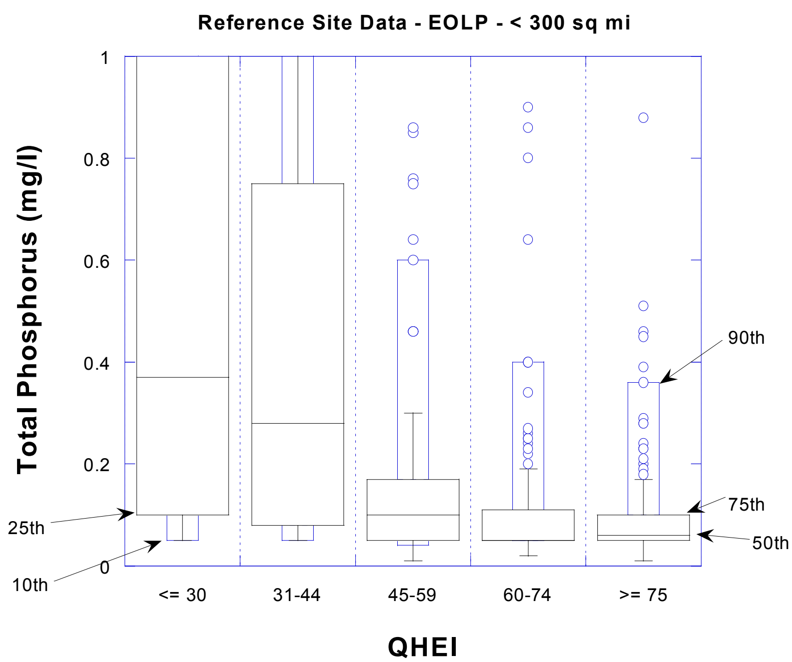

Figure 2. QHEI vs total phosphorus for reference sites less than 300 sq mi drainage in the EOLP ecoregion. Boxes represent the 10th, 25th, median, 75th, and 90th percentiles.

Data from reference sites in Ohio, especially headwater and wading streams, show that total phosphorus during low flow is lower in stream sites with higher quality habitats as measured by the QHEI (Figure 2). The proportion of the phosphorus that is assimilated instream by improving habitat quality versus the proportion of nutrient load kept from reaching the stream compared to poor quality habitats is not known. Further work is needed to examine specifically how instream and riparian habitat mediates nutrient assimilation in Ohio streams.

Conclusion

The choice of an initial total phosphorus endpoint of 0.19 mg/l is between the 75th and 90th percentile of EOLP wadeable sites with habitat scores of 60-74. This choice is reasonable based on both biological and habitat considerations.