State of Ohio
Environmental Protection Agency

Division of Surface Water

Total Maximum Daily Loads for Bacteria in the Rocky River Watershed

Draft Report for Public Review
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Bacteria Total Maximum Daily Load Development for Rocky River, Ohio

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DRAFT REPORT

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TMDL INFORMATION SHEET

ROCKY RIVER TOTAL MAXIMUM DAILY LOAD
Waterbody: Rocky River
Water Quality Impairment: Bacteria

Subbasin: Rocky River
County: Cuyahoga, Lorain, Medina and Summit Counties, Ohio
HUC 8: 04110001 (Black-Rocky Watershed)
Drainage Area: 292 miles^2
Designated Uses: Primary Contact Recreation
303(d) Listing: Municipal Point Source; Land Development / Suburbanization; Urban Runoff / Storm Sewers (NPS); Source Unknown

Summary of Bacteria TMDL Results

Flow-based Bacteria TMDL using Load Duration Curve Framework

	High Flow / Transition	Transition / Typical Wet	Typical Wet / Typical Dry	Low Flow
Flow Duration Interval	10%	25%	50%	75%
TMDL (1E+12 cfu/year)	6,414	2,355	827	292

Bacteria TMDL Allocation for Rocky River Watershed

	High Flow / Transition	Transition / Typical Wet	Typical Wet / Typical Dry	Low Flow
Flow Duration Interval	10%	25%	50%	75%
TMDL (1E+12 cfu/year)	6,414	2,355	827	292
MOS (10%) (1E+12 cfu/year)	641	236	83	29
Future Growth (10%) (1E+12 cfu/year)	641	236	83	29
WLA+LA=TMDL-MOS-Future Growth	5,131	1,884	662	234
WLA (1E+12 cfu/year)	393	393	393	
LA (1E+12 cfu/year)	4,738	1,491	268	
Existing Load (1E+12 cfu/year)	22,315	5,367	499	46
% of Required Reduction	71.3%	56.1%	0.0%	0.0%

Note: Future growth is set at 10%, based on NOACA's population projection in 2020.

TABLE OF CONTENTS

1. Introduction and Problem Identification 1
1.1 Watershed Description 1
1.2 Problem Identification and Current Conditions 2
1.3 TMDL Endpoints 9
2. Source Inventory and Assessment 11
2.1 Point Sources 11
2.2 Non-point Sources 16
3. Bacteria TMDL Development 19
3.1 Overview of TMDL Development Approach 19
3.2 Results from Load Duration Curve Method 20
3.3 Consideration of Critical Conditions and Seasonality 22
3.4 Margin of Safety 23
3.5 TMDL Allocation 25
4. Reasonable Assurance 27
4.1 Bacteria Load Reduction Strategy 28
4.2 Recommendations for Enhancing Ambient Water Quality Monitoring 31
5. Public Participation 35
References 36
Appendices 38
Appendix A – Flow Estimation for Sampling Station 501790 39
Appendix B – Load Duration Curve for Rocky River Sampling Station 501790 40
Appendix C – Population Projection in Rocky River Watershed (NOACA, 2004) 41
Appendix D – Water Quality Exceedance Summary for East Branch of Rocky River 42
Appendix E – Water Quality Exceedance Summary for West Branch of Rocky River 43

LIST OF TABLES

Table 1: Description of Impaired Assessment Units in Rocky River 2

Table 2: Assessment Unit Summary for Rocky River Watershed from Ohio EPA 2004 Integrated Report 3

Table 3: Land Use in the Rocky River Basin 4

Table 4: Ohio Water Quality Standard for Recreational Use Designations (OAC Chapter 3745-1-07) 10

Table 5: Major Dischargers in the Rocky River Watershed..... 11

Table 6: Summary of fecal coliform effluent data for major NPDES permitted dischargers (Flows > 1 MGD) in the Rocky River Watershed 1997-2004 14

Table 7: Summary of fecal coliform effluent data for minor NPDES permitted dischargers (Flows < 1 MGD) in the Rocky River Watershed 1997-2004 15

Table 8: Geometric Mean for Sampling Station 501790 by Hydrologic Condition 22

Table 9: Flow-based Bacteria TMDL using Load Duration Curve Framework 22

Table 10: Permitted Bacteria Load for Wastewater Dischargers in Rocky River..... 25

Table 11: Bacteria TMDL Allocation for Rocky River Watershed 26

LIST OF FIGURES

Figure 1: Rocky River Watershed Location Map..... 5

Figure 2: Rocky River Watershed Map..... 6

Figure 3: Rocky River Land Use Map 7

Figure 4: Location Map for Major and Minor Dischargers in Rocky River Watershed 13

Figure 5: Flow Duration Curve for Rocky River Sampling Station 501790..... 20

Figure 6: Load Duration Curve for Rocky River Sampling Station 501790..... 21

Figure 7: TMDL Curve for Rocky River Sampling Station 501790 (with 10% Margin of Safety)..... 24

Figure 8: Fecal Coliform Results from Sampling Stations by Ohio EPA (1997-2004) (Data from station 501790 is not included. Please refer to Appendix A and B)..... 33

Figure 9: Fecal Coliform Results from Sampling Stations by Ohio EPA (1997-2004) and Cuyahoga County Department of Health (2003-2004) 34

1. Introduction and Problem Identification

The Clean Water Act requires that Total Maximum Daily Loads (TMDL) be developed for all segments on the section 303(d) lists. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. A TMDL is expressed as the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality. Therefore, a TMDL is often expressed using the following equation:

$$\mathbf{TMDL = WLA + LA + MOS + FG} \qquad \mathbf{(1)}$$

where

WLA: Wasteload Allocation
LA: Load Allocation
MOS: Margin of Safety
FG: Future Growth

1.1 Watershed Description

The Rocky River basin (HUC 04110001) consists of 664 stream miles and drains approximately 292 square miles in northeast Ohio. The Rocky River is one of the most popular rivers in northeast Ohio. It draws tens of thousands of visitors year round to enjoy the numerous activities that the watershed provides. Rocky River basin includes parts of four counties (Cuyahoga, Lorain, Medina and Summit). Cleveland is the largest city through which the Rocky River flows.

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. For much of its main stem, the Rocky River 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.

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 precipitation is 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 32EF and 18 EF in January and 82 EF and 66 EF 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.

1.2 Problem Identification and Current Conditions

Rocky River (USGS Hydrologic Unit Code (HUC) 04110001) is impaired for recreational use by bacteria as listed in 2004 Integrated Water Quality Monitoring and Assessment Report (OEPA, 2004). A TMDL for nutrients for Plum Creek was approved in 2001.

The description of impaired assessment units (AUs) are shown in Table 1. The potential causes and sources of pathogen impairment are listed in Table 2.

Table 1: Description of Impaired Assessment Units in Rocky River

Ohio EPA Subsegment	Assessment Unit (AU) Description and Segment Names
04110001 (AU 060)	West Branch Rocky River Segment Names: Plum Creek, West Branch Rocky River (Plum Creek to East Branch), Mallet Creek, Baker Creek, West Branch Rocky River (Cossett Creek to Plum Creek)
04110001 (AU 070)	Rocky River; East Branch Rocky River; Lake Erie Tributaries (West of Porter Creek to West of Cuyahoga River) Segment Names: Baldwin Creek, Abram Creek, East Branch Rocky River (Healy Creek to Rocky River), North Royalton "A" tributary, Rocky River (East Branch to Lake Erie), East Branch Rocky River (headwaters to Healy Creek)

Table 2: Assessment Unit Summary for Rocky River Watershed from Ohio EPA 2004 Integrated Report

		Aquatic Life Use Assessment			Recreation Use Assessment				
HUC11	**Description**	High Magnitude Causes	High Magnitude Sources	Sampling Years	Number of Ambient Sites	Number of Ambient Sampling Records	Geometric Mean	75th Percentile	90th Percentile
04110001 060 Priority Points = 7 (Medium Priority)	West Branch Rocky River	- Unknown Toxicity - Unionized Ammonia - Nutrients - Siltation - Organic Enrichment/DO - Other Habitat Alterations	- Municipal Point Source - Land Development / Suburbanization - Urban Runoff / Storm Sewers (NPS) - Source Unknown	1997, 2001	7	21	288	823	2,340
04110004 070 Priority Points = 8 (Medium Priority)	East Branch Rocky River Lake Erie Tributaries (West of Porter Creek to West of Cuyahoga River)	- Unionized Ammonia - Chlorine - Nutrients - Siltation - Organic Enrichment/DO - Flow Alteration - Other Habitat Alterations	- Municipal Point Source - Highway / Road / Bridge / Sewer Line - Land Development / Suburbanization - Urban Runoff/Storm Sewers (NPS) - Channelization - Development - Flow Reg./Mod. - Development - Streamback Destabilization - Development - Marinas	1997, 2001	15	62	216	1,175	3,416

The watershed is located in the Erie / Ontario Lake Plain eco-region. Land use in the watershed is a mix of forest, agriculture, and urban areas. 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. Table 3 lists land use in the Rocky River basin by category.

Table 3: Land Use in the Rocky River Basin

Land Use Category	Acres	% of Total
Agriculture/open urban	75,131	40.10%
Forest and Shrub/scrub	82,634	44.10%
Non-forested wetlands	2,104	1.10%
Urban	26,574	14.20%
Barren	257	0.10%
Open water	499	0.30%
Total	187,200	100%

Ohio EPA's water quality assessment includes a comprehensive evaluation of available chemical, physical, aquatic life, and habitat data aimed at determining use attainment. Use attainment is another way of describing whether or not a stream is meeting Ohio's water quality standards. Ohio EPA has assigned a use designation, or a specific set of water quality standards, to most major streams and rivers throughout the state. Ohio EPA assesses use attainment based on aquatic life and habitat use designations because they provide the most accurate and comprehensive evaluation of water quality. Use attainment is expressed in degrees. The degrees of use attainment include: full attainment; full attainment but threatened; partial attainment; and non attainment. Ohio Water Quality Standards (Ohio Administrative Code (OAC) 3745-1) provide information on water quality standards and designated uses for Ohio waters.

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 Re-issuance. The waters identified as impaired in 1992 were listed on the 1998, 2002 and 2004 section 303(d) list. The Rocky River has a pronounced problem with elevated bacteria counts at sites throughout the watershed. The Ohio EPA 2002 Integrated Assessment Report states that 24 out of the 27 bacteria monitoring sites in their network on the Rocky River have a bacteria count that exceeds designated use criteria. Water quality violations are present at 8 out of the 9 bacteria monitoring sites in AU 60 and 16 out of 18 in AU 070.

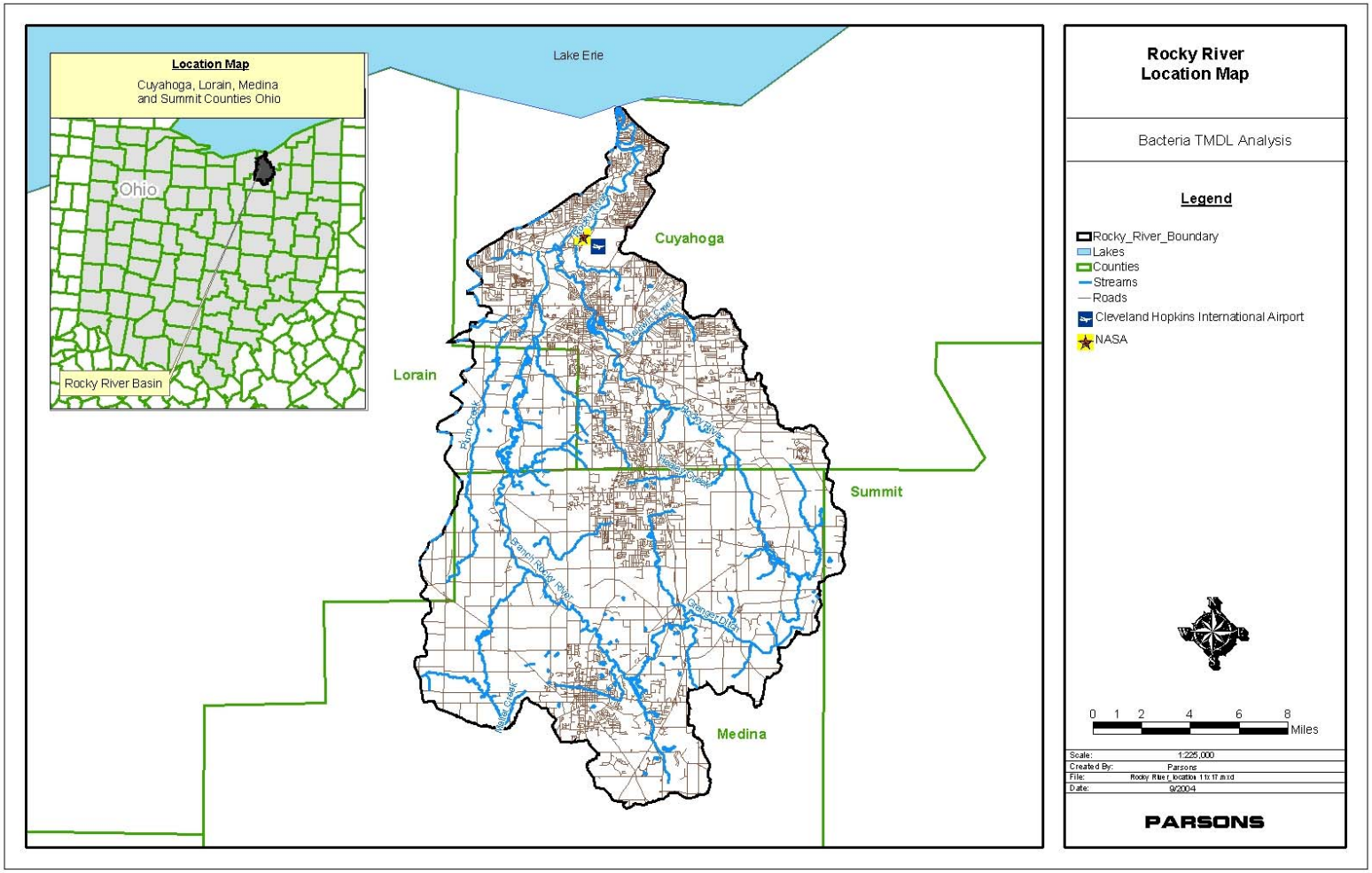

Figure 1: Rocky River Watershed Location Map

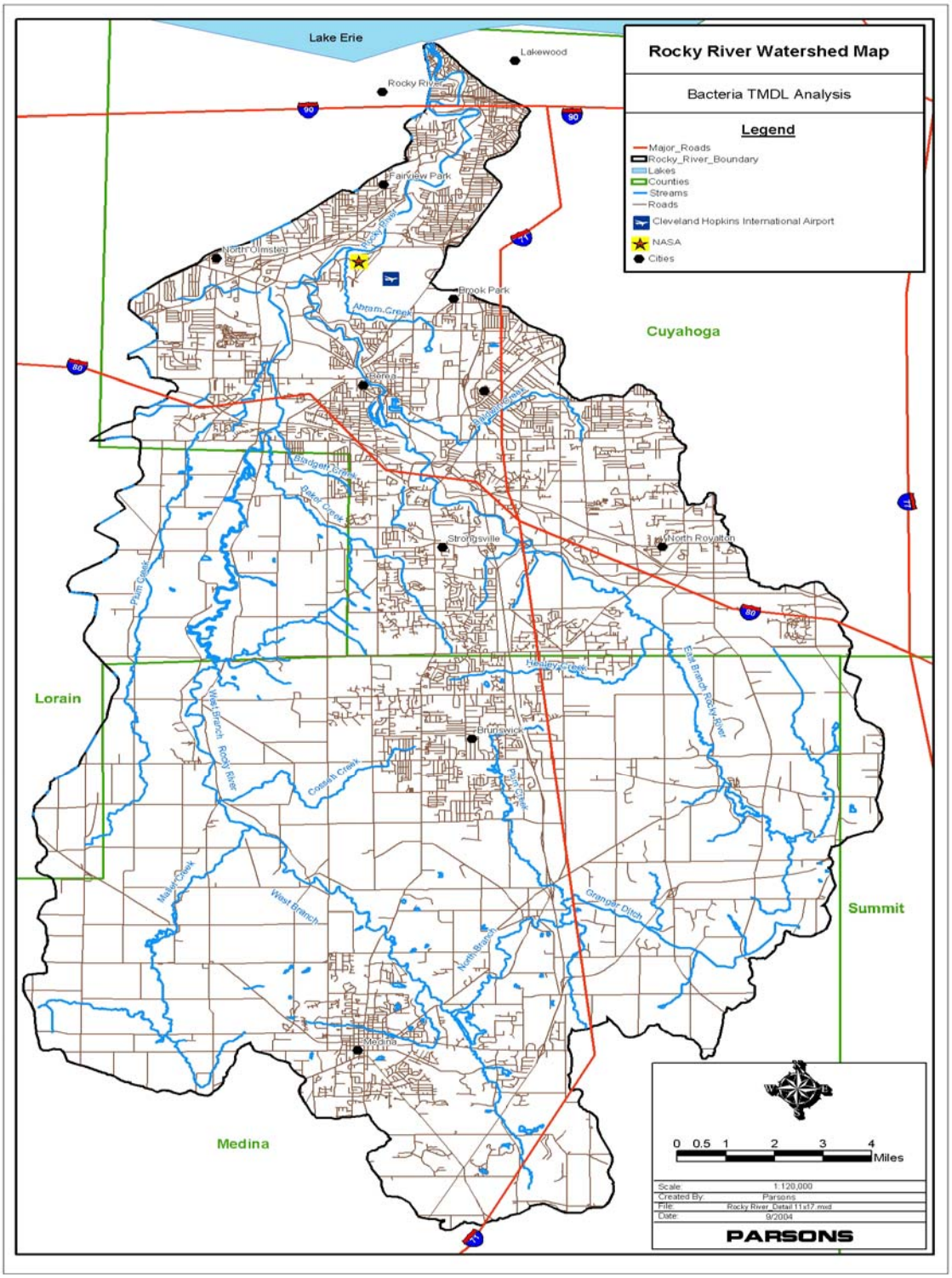

Figure 2: Rocky River Watershed Map

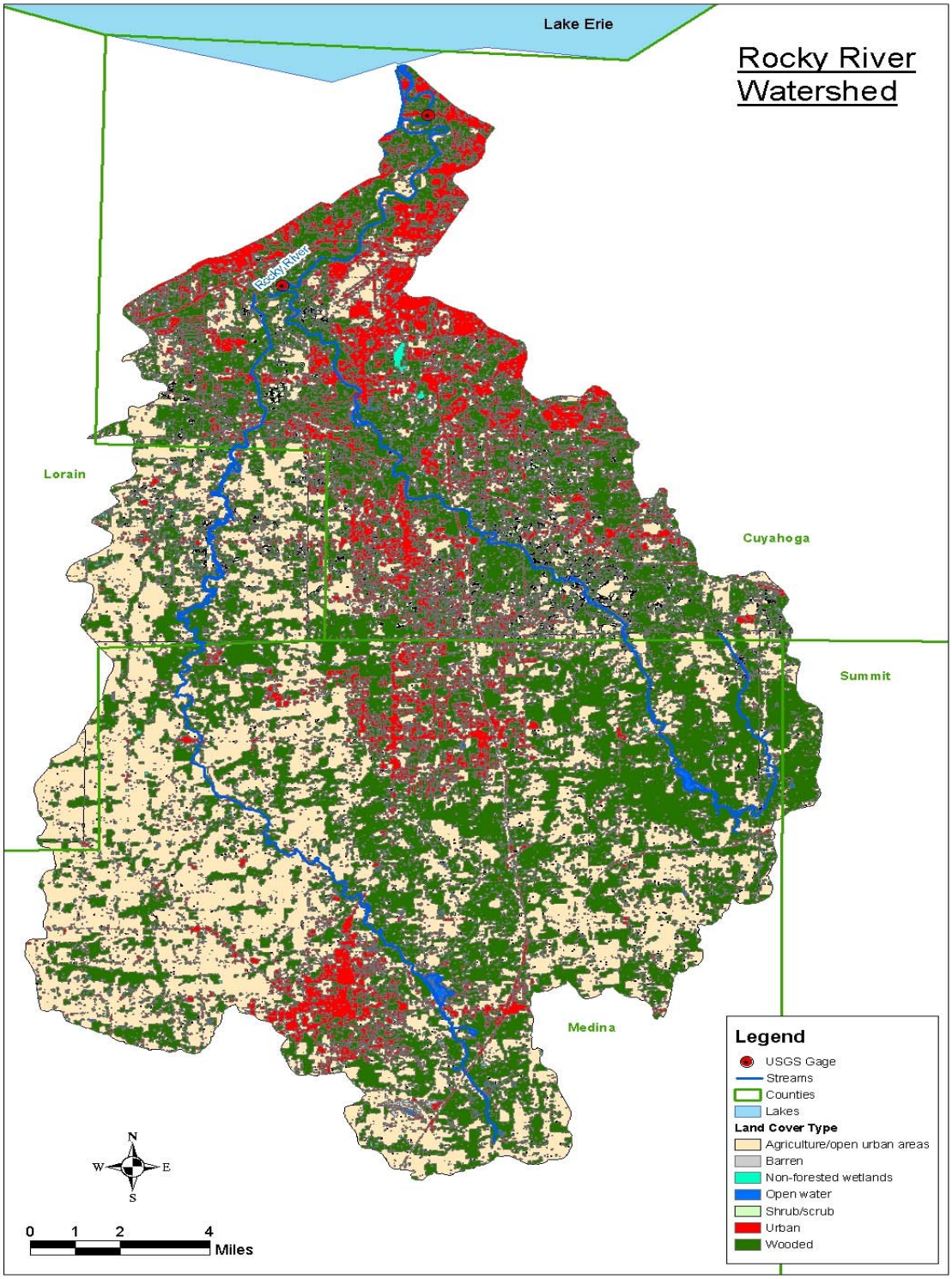

Figure 3: Rocky River Land Use Map

The Rocky River and its primary tributaries are rated as "impaired" for recreational uses. As can be expected when bacteria violations are so widespread, a variety of source types contribute to the problems found in the Rocky River. The wastes from humans and other mammals can contain bacteria and viruses that can cause human illnesses. Increasing counts of these bacteria are often equated with increasing risk of contracting a water-borne illness if a person has contact with the untreated water. The bacteria and viruses that are of concern in the waterways can come from humans, wildlife, farm animals, and household pets (RRWC, 2002a).

Besides the monitoring efforts by OEPA, the Cuyahoga County Board of Health (CCBH) currently monitors 15 locations in the Rocky River watershed as part of its permanent sampling program. These sites are tested once a month from June through October for several parameters including fecal coliform bacteria levels, dissolved oxygen, pH, conductivity, turbidity, and flow. The Board of Health also conducts special summer monitoring projects that focus on unsewered areas. These projects consist of fecal coliform sampling, the qualitative habitat evaluation index evaluations, and macro-invertebrate sampling. Recent findings indicate high levels fecal coliform detected are predominantly attributed to improperly operating home sewage treatment systems discharging in the watershed.

A brief summary on water quality monitoring results in major tributaries are given as follows (RRWC, 2002):

East Branch

Although fecal coliform samples taken by the Cuyahoga County Board of Health from the East Branch of the Rocky River do not exceed Ohio EPA standards, repeated sampling shows a steady increase in fecal coliform as one travels downstream from the Cuyahoga-Medina County line (Boston Road in North Royalton) to the Royalton Road in Strongsville.

(1) Highly elevated fecal coliform levels in the Abram Creek were documented along Big Creek Parkway in Middleburg Heights due to the on-site septic systems discharging in this area.

(2) Baldwin Creek had high levels at tributary sampling sites including the Linden Lane area and West 130th St. in Parma, and Fowles Road and Webster Road in Middleburg Heights. In addition, less severe fecal coliform violations were found in Baldwin Creek itself.

(3) Healey Creek has had no fecal coliform violations to date.

West Branch

The Board of Health has two permanent sampling sites located on the Rocky River West Branch and has also monitored 5 other sites as part of a summer water quality project. No fecal coliform violations were found in the West Branch itself. However, several fecal coliform violations were documented in ditches and storm sewers located in unsewered areas in the watershed of this branch. The problem is so bad in one unnamed tributary in a local community that receives effluent from 45 home sewage treatment systems that residents have complained about the persistent foul odor of the stream.

(1) Plum Creek had several fecal coliform violations along its lower course.

(2) The Board of Health has two permanent sampling sites located on Baker Creek. One site is located on Drake Road in Strongsville, and the other is on Sprague Road in Olmsted Falls. Both these sites chronically exceed the Ohio EPA fecal coliform standards, and both sites are located in unsewered areas.

(3) Blodgett Creek has one permanent sampling site located along Sprague Road in Olmsted Falls as it enters Cuyahoga County. The creek has an abandoned wastewater treatment plant. This site chronically exceeds Ohio EPA fecal coliform standards, has low dissolved oxygen levels, and is often visibly polluted with sewage.

1.3 TMDL Endpoints

In brief, a TMDL endpoint is a target that has been established to link water quality to the characteristic of an ecosystem (e.g. watershed) that may be affected by exposure to a specific stressor (e.g. bacteria). TMDL targets are quantifiable measures that are protective of water use attainment similar to water quality standards.

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. Water quality standards are ambient standards as opposed to discharge-type standards. These ambient standards, through a process of back calculation procedures known as TMDL or wasteload allocations, form the basis of water quality based permit limitations that regulate the discharge of pollutants into surface waters under the National Pollutant Discharge Elimination System (NPDES) permit program.

Surface water quality criteria and procedures to calculate water quality criteria are contained in Chapter 3745-1 of the Ohio Administrative Code (OAC). This complete list (available at http://www.epa.state.oh.us/dsw/rules/3745-1.html) reflects rules effective as of July 1, 2003 unless noted otherwise.

Water quality standards contain two distinct elements: designated uses; and numerical or narrative criteria designed to protect and measure attainment of the uses. Two Assessment Units (AUs) of Rocky River (04110001 060 and 070) are listed on 2004 Integrated Water Quality Monitoring Report. In OAC 3745-1-07 "Water Use Designations and Statewide Criteria" (Table 4), for primary contact, fecal coliform should not exceed 1,000 counts/100mL (either MPN or MF) in more than ten percent of the samples taken during any thirty-day period. Therefore, based on OEPA's water quality standard, the 1,000 counts/100mL is selected as TMDL endpoint.

Table 4: Ohio Water Quality Standard for Recreational Use Designations (OAC Chapter 3745-1-07)

Water Quality Criteria	OAC 3745-1-07, Table 7-13. Statewide numerical and narrative criteria for recreational use designations. For each designation at least one of the two bacteriological standards (fecal coliform or E. Coli) must be met. These criteria apply outside the mixing zone.
Primary Contact	Fecal Coliform – geometric mean fecal coliform content (either MPN or MF), based on not less than five samples within a thirty-day period, shall not exceed 1,000 per 100mL; and fecal coliform content (either MPN or MF) shall not exceed 2,000 per 100 mL in more than ten percent of the samples taken during any thirty-day period.

2. Source Inventory and Assessment

Source assessment characterizes known and suspected sources of pollutant loading to impaired waterbodies. These sources within the watershed are categorized and quantified to the extent that information is available. Generally, bacteria sources are both point and nonpoint in nature.

Point sources are typically those regulated through the National Pollutant Discharge Elimination System (NPDES) program. NPDES facilities measure bacteria levels in effluent at a frequency based on facility class, waste type, and other characteristics that go into developing NPDES monitoring requirements.

Nonpoint sources are diffuse sources that typically cannot be identified as entering a waterbody at a single location. These sources may involve land activities that contribute bacteria loading to surface waters as a result of runoff-producing storm events.

2.1 Point Sources

Table 5 lists the major point source dischargers in the Rocky River watershed.

Table 5: Major Dischargers in the Rocky River Watershed

No.	Entity	NPDES Permit No.	Design Flow (MGD)	30-Day Average Permit Limit (cfu/100mL)	7-Day Average Permit Limit (cfu/100mL)
Municipal Wastewater					
1	N. Olmsted	3PD00016	7	1,000	2,000
2	N. Royalton A	3PD00030	3.3	1,000	2,000
3	N. Royalton B	3PC00018	1	1,000	2,000
4	Strongsville B	3PB00047	2.1	1,000	2,000
5	Strongsville C	3PB00048	1.8	1,000	2,000
6	MedinaSD300	3PK00003	3.25	1,000	2,000
7	MedinaSD500	3PK00004	10	1,000	2,000
Stormwater					
8	Cleveland Hopkins Airport	3II00179	Storm Dependent	N/A	N/A
9	NASA Lewis/Glenn	3IO00001	Storm Dependent	N/A	N/A

The locations for major and minor dischargers in Rocky River watershed are presented in Figure 4. Fecal coliform in effluent from monthly operating report data available for the period of 1997-2004 was summarized in Table 6 and 7 for permitted dischargers in the watershed to determine the percent exceedances of 1,000 cfu/100 ml (standard 30 day average permit limit) and 2,000 cfu/100 ml (standard 7 day average permit limit).

The analysis found that elevated fecal levels were very infrequent for major dischargers (plants > 1 MGD). None of the major facilities in Table 5 have had any violations of their permit limits. Similar analysis of their data using percent occurrence of exceedances reflects good operating practices at these facilities.

However, analysis for the minor dischargers (plants<1 MGD) indicates that there are problem facilities where the frequency of exceedances are significant (3 plants > 20% for the 1,000 cfu/100 ml benchmark, same 3 plants > 15% for the 2,000 cfu/100 ml benchmark). Based on Table 7, it appears that some of the minor dischargers in the watershed may be contributing significantly to the non-attainment problems observed, especially in small tributaries such as Plum Creek.

Combined Sewer Overflows:

The Combined Sewer Overflows (CSOs) discharge mixed stormwater / sanitary wastes when stormwater inflow causes the capacity of the sewer to be exceeded. These discharges generally have very high bacteria counts associated with them with counts in the million range being not uncommon (RRWC, 2002c).

The main stem of the Rocky River is affected by the CSO discharges from the systems of the Northeast Ohio Regional Sewer District (NEORSD) and the City of Lakewood. According to the Rocky River nutrient TMDL (OEPA, 2001), there are 13 combined sewer outfalls (CSOs) that continue to discharge to the Rocky River. These outfalls are located in the lower stretch of the main stem between river miles 7.5 and 1.5. This encompasses an area from upstream of Lorain Avenue to near Detroit Avenue.

Concentrated Animal Feeding Operation:

There is no Concentrated Animal Feeding Operation (CAFO) in the Rocky River watershed.

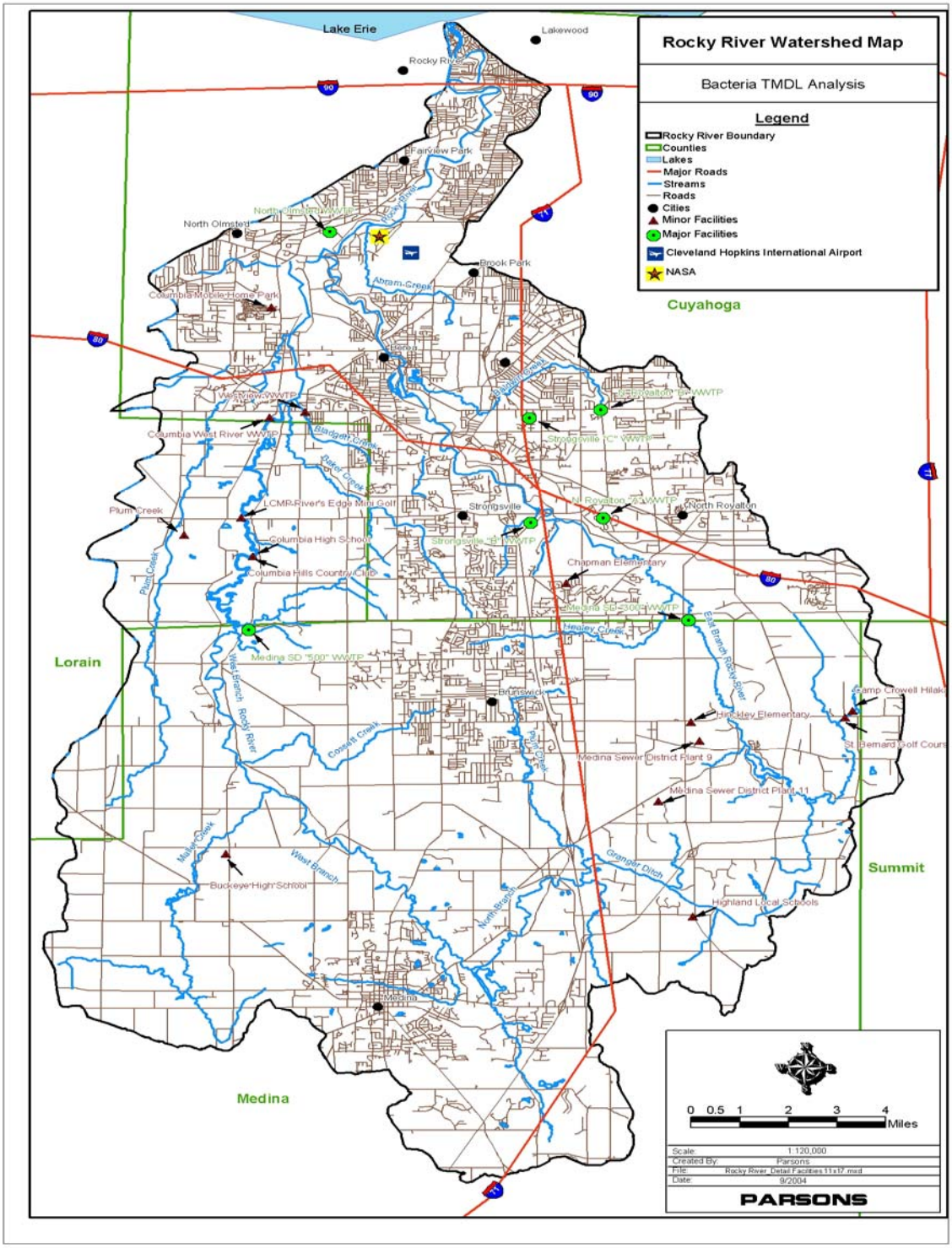

Figure 4: Location Map for Major and Minor Dischargers in Rocky River Watershed

Table 6: Summary of fecal coliform effluent data for major NPDES permitted dischargers (Flows > 1 MGD) in the Rocky River Watershed 1997-2004

Facility	Permit Number	Number of Samples	Percent > 1,000 cfu/100ml	Percent > 2,000 cfu/100 ml	Percent "Too Numerous to Count"	Percent <MDL	Receiving Stream	Sample Frequency	Design Flow (MGD)
North Olmsted	3PD00016*FD	658	0.0%	0.0%	0.5%	0.0%	Rocky River	3/Week	7
N. Royalton "A"	3PD00030*GD	589	0.3%	0.3%	0.0%	23.9%	Unnamed Trib E. Br. Rocky R. RM 12.9	3/Week	3.3
N. Royalton "B"	3PC00018*CD	593	1.3%	0.3%	0.0%	0.3%	Baldwin Creek	3/Week	1
Strongsville "B"	3PB00047*CD	586	1.5%	1.2%	0.2%	31.4%	Unnamed Trib E. Br. Rocky R. RM 11.1	3/Week	2.1
Strongsville "C"	3PB00048*DD	576	0.7%	0.2%	0.2%	33.2%	Baldwin Creek	3/Week	1.8
Medina SD "300"	3PK00003*ED	631	0.0%	0.0%	0.0%	0.0%	East Branch Rocky River	3/Week	3.25
Medina SD "500"	3PK00004*JD	1,356	1.0%	0.4%	0.9%	0.0%	West Branch Rocky River	Daily	10
Grand Total		**4,989**	**0.7%**	**0.3%**	**0.3%**	**10.4%**			

Source: Facility Monthly Operating Reports submitted to the Ohio EPA.

Table 7: Summary of fecal coliform effluent data for minor NPDES permitted dischargers (Flows < 1 MGD) in the Rocky River Watershed 1997-2004

Facility	Permit Number	Number of Samples	Percent > 1,000 cfu/100ml	Percent > 2,000 cfu/100 ml	Percent "Too Numerous to Count"	Percent <MDL	Receiving Stream	Sample Frequncy	Design Flow (MGD)	Notes
Buckeye High School	3PT00036*CD	141	0.0%	0.0%	1.4%	3.5%	Unnamed Trib Mallet Creek	Weekly	0.025	
Camp Crowell Hilaka	3PX00000*ED	37	0.0%	0.0%	0.0%	0.0%	Unnamed Trib E. Branch Rocky R.	Monthly	0.02	
Chapman Elementary	3PT00102*AD	4	0.0%	0.0%	0.0%	50.0%	Unnamed Trib E. Branch Rocky R.	Monthly	0.012	Sporadic reporting
Columbia Hills Country Club	3PR00277*AD	6	0.0%	0.0%	0.0%	0.0%	West Branch Rocky River	Quarterly	0.01	
Columbia Mobile Home Park	3PV00013*BD	401	1.7%	0.0%	2.5%	1.0%	Unnamed Trib E. Branch Rocky R.	Weekly	0.25	
Columbia Schools	3PT00087*AD	22	22.7%	22.7%	27.3%	50.0%	West Branch Rocky River	Monthly	0.03	
Columbia West River	3PG00053*ED	48	14.6%	6.3%	10.4%	39.6%	West Branch Rocky River	Monthly	0.006	
Highland Local Schools	3PT00111*AD	6	0.0%	0.0%	0.0%	0.0%	Unnamed Trib Granger Ditch	Monthly	0.051	
Hinckley Elementary	3PT00114*AD	7	0.0%	0.0%	14.3%	0.0%	Unnamed Trib E. Branch Rocky R.	Monthly	0.01	
LCMP River's Edge Mini Golf	3PR00339*AD	0	n/a	n/a	n/a	n/a	West Branch Rocky River	Monthly	0.0015	Report no flow on all reports.
Medina Sewer District Plant 11	3PG00043*DD	54	1.9%	0.0%	0.0%	0.0%	Unnamed Trib Granger Ditch	Monthly	0.0125	
Medina Sewer District Plant 9	3PG00042*DD	51	2.0%	0.0%	2.0%	0.0%	East Branch Rocky River	Monthly	0.01	
Plum Creek	3PG00052*DD	48	22.9%	16.7%	6.3%	43.8%	Plum Creek	Monthly	0.04	
St. Bernard Golf Course	3PR00293*AD	6	0.0%	0.0%	0.0%	16.7%	Unnamed Trib E. Branch Rocky R.	Quarterly	0.003	Sporadic reporting
Westview WWTP	3PH00022*ED	206	22.3%	16.0%	9.7%	18.0%	Unnamed Trib W. Branch Rocky R.	Weekly	0.17	
Grand Total		**1,037**	**7.5%**	**4.7%**	**4.6%**	**9.6%**				

2.2 Non-point Sources

Non-point sources include those sources that cannot be identified as entering the water body at a specific location. These loads may originate from numerous land use types throughout the watershed. The general description on urban and agricultural land use in given as follows (RRWC, 2002b):

Urban Areas

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. The main stem of the Rocky River, Abram Creek, and Baldwin Creek are heavily urbanized throughout their drainage areas. In the East Branch, the upper portion of the watershed is largely undeveloped. This includes all of the area in Medina and Summit County. Headwater streams that are increasingly developed feed the lower portion of the East Branch. The West Branch of the Rocky River receives the flow from the northern half of the City of Medina (including the heavily urbanized Champion Creek). The upper reaches of the West Branch are rural in the headwaters but subject to growing urban flows in its lower reaches including the heavily urbanized Champion Creek that drains a portion of the City of Medina.

Agricultural Areas

Agriculture remains an important activity in the Rocky River Watershed. Crop production and livestock production are dominant operations in York and Liverpool Townships in Medina County and in Columbia Township in Lorain County. A reduced, but still substantial, production occurs in Montville, Medina, and Granger Townships in Medina County. Agricultural runoff influences to the watershed of the West Branch downstream from the City of Medina through Columbia Township. Approximately one-half of the land area here is in agricultural uses. Land use in the upper portion of the West Branch has historically been devoted to agriculture but that use is waning. Suburban development, primarily in Montville Township, has infringed on agriculture to a substantial degree over the last 20 years. Only about one-third of the area remains in agriculture today.

Nonpoint source bacteria loads in Rocky River watershed include:

(1) On-site Wastewater Systems

One significant nonpoint source which appears to be impacting the surface waters of the Rocky River is failing household sewage treatment systems (HSTSs). The Rocky River nutrient TMDL report estimates that there are approximately 16,800 HSTSs in the watershed:

4,000 in Cuyahoga County; 10,000 in Medina County; 2,400 in Lorain County; and 400 in Summit County (OEPA, 2001; RRWC, 2002c). Inadequately treated sewage can pollute surface waters with harmful bacteria and viruses. HSTSs have been identified by Ohio EPA in the 1999 Technical Support Document (TSD) as a significant pollution source within the main stem of the Rocky River.

These systems are designed to discharge their treated wastewater back into the environment via surface distribution (leach fields). The problem with this type of system is that there is a great potential for water quality problems developing when these systems are not operating correctly. Estimates of failure rates for these systems vary widely, but rates ranging between 35% and 60% are typical. Failing systems do have a pronounced bacteria loading potential.

The Cuyahoga County Board of Health estimates that there are currently 4,700 HSTSs within the Cuyahoga County portion of the Rocky River. The average life span of off-lot systems is approximately 20 years. The average age of HSTSs within Cuyahoga County is 35 years, far beyond the age when system failures become commonplace. This is typical of these systems all across northeast Ohio.

(2) Non-human Animals:

Non-human animals can be significant contributors to fecal coliform loading to waterways. These animals include household pets, livestock, and wildlife, all of which are numerous in the watershed (RRWC, 2002b).

<u>Pets</u>

The combination of heavily urbanized tributary areas and an intense recreational use of the park system along the river by pet owners provide a large potential for impacts from pet wastes.

<u>Horses</u>

Horseback riding is also potential source of bacterial loading. The recreational horse operations are scattered along the East Branch of the Rocky River and along both lower and upper reaches of the West Branch. These are the areas that have ready access to the multitude of horse trails maintained by the Cleveland Metroparks. Upper reaches of the East Branch have same problem. In addition, recreational horse farms occur throughout the Medina

County portion of the Rocky River Watershed particularly in Hinckley Township, which also drains to the East Branch.

Wildlife

Wildlife teems in and around the Rocky River Reservation where there is a large population of deer and other animals. In addition, large populations of waterfowl (e.g. Canada goose) also contribute coliform bacteria within the Rocky River watershed.

3. Bacteria TMDL Development

The following equation was used to calculate the bacteria TMDL.

TMDL = WLA + LA + MOS + FG

Where:

TMDL: Total Maximum Daily Load
WLA: Waste Load Allocation (for point sources)
LA: Load Allocation (for nonpoint sources)
MOS: Margin of Safety
FG: Future Growth

3.1 Overview of TMDL Development Approach

Procedure for load duration curve (LDC) method is summarized as follows (Kansas Department of Health and Environment (KDHE), 2002 and Stiles, 2002):

(1) A flow duration curve for the gage site of interest is developed. This is done by generating a flow frequency table and plotting the points. It is important to note that the period of record used to compile the flow duration curve needs to be sufficiently long (e.g. 30-year) to capture the extremes of stream flow and needs to be robust so a majority of the curve does not change appreciably from year to year.

(2) The flow curve is translated into a Load Duration (TMDL) Curve. Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than a single value.

A load curve is established by multiplying the flow values along the curve by the applicable water quality criterion and converting the units to derive a load duration curve of colonies of bacteria per day. This load curve represents the TMDL since any point along the curve represents water quality, achieving the standard at that flow.

(3) A water quality sample is converted to a load by multiplying the water quality sample concentration by the average daily flow (on the day the sample was taken). Then, the load is plotted on the TMDL graph. Knowing the flow at the time of sampling and its relative percent of exceedance allows one to plot the computed load on the load duration graph.

Historical excursions from the water quality standard are seen as plotted points above the load curve. Water quality standards are met for those points plotting below the load duration curve.

Points plotting above the curve represent deviations from the water quality standard and the permissible loading function. Those plotting below the curve represent compliance with standards and represent adequate quality support for the appropriate designated use.

Where the current condition curve lies above the TMDL curve, the necessary reductions to reach the desired condition may be estimated by measuring the vertical distance between the curves. Should the current condition curve lie below the TMDL curve, the area lying between the curves represents additional assimilative capability of the stream before reaching water quality standards.

3.2 Results from Load Duration Curve Method

The flow duration curve and load duration curve (LDC) are shown in Figure 5 and 6, respectively. The flow records at USGS 04201500 gage are available from 10/1/1923 to 9/30/2003. The flow for Ohio EPA sampling station 501790 was estimated by summarizing the flows from USGS 04201500 gage, North Olmsted wastewater treatment plant, NASA Glenn Research Center and Cleveland Hopkins Airport (Appendix A). The regression was conducted to correlate precipitation data with measured weekly flow from Cleveland Hopkins Airport.

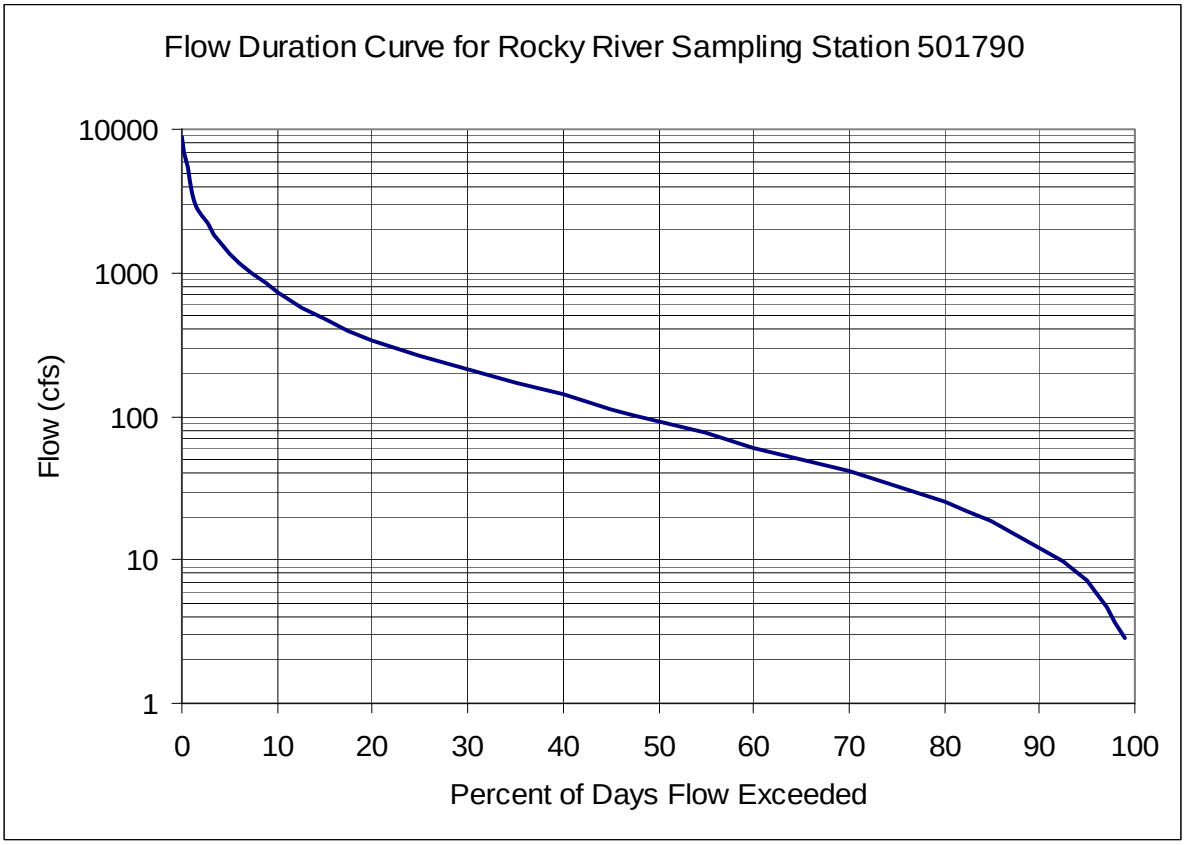

Figure 5: Flow Duration Curve for Rocky River Sampling Station 501790

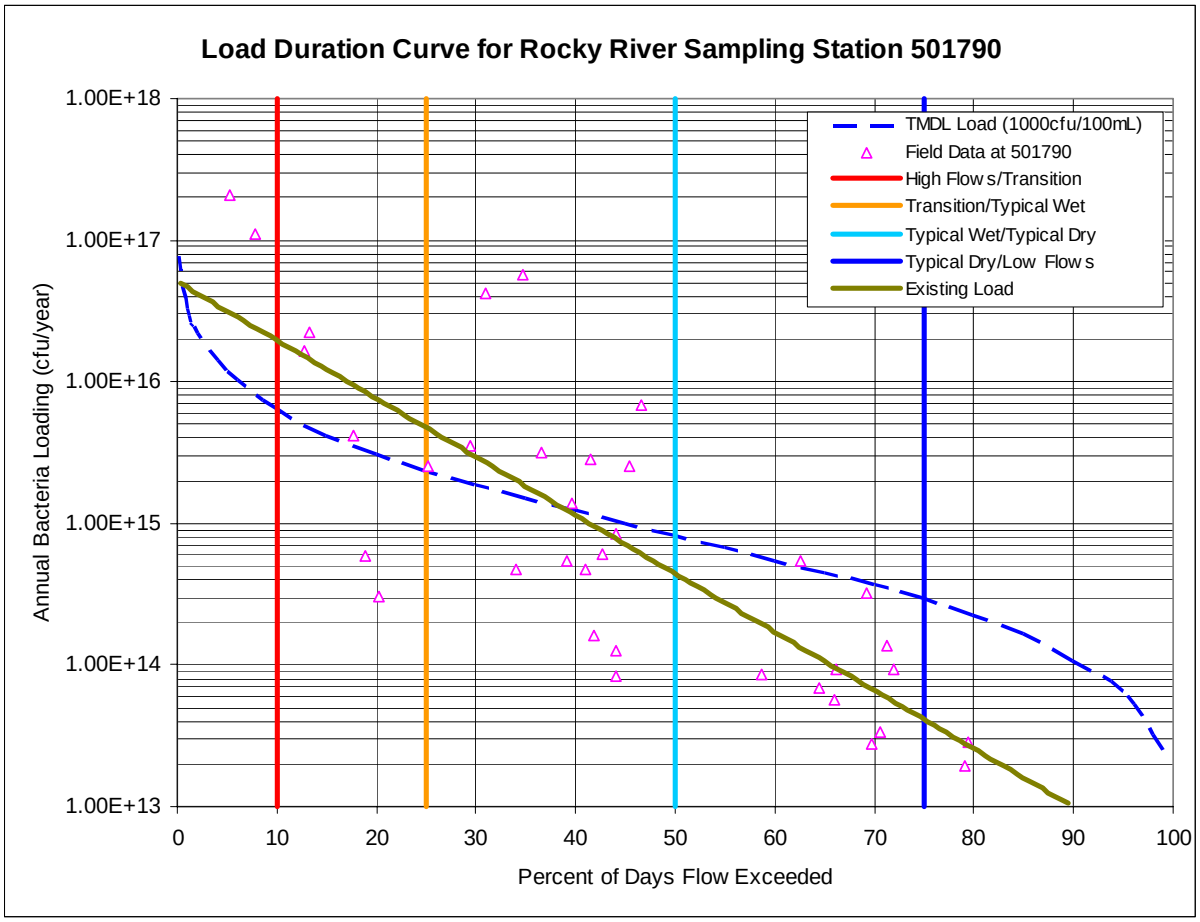

Figure 6: Load Duration Curve for Rocky River Sampling Station 501790

Loads which plot above the load duration curve in the flow regime defined as being exceeded 75 percent of the time are likely indicative of point source influences to water quality. Point source issues are clearly identified as a discharge from a pipe, ditch, or other well-defined source. Those plotting above the curve over the range of 10-75 percent exceedance likely reflect nonpoint contributions, including under transitional flow with 10-25 excceedance. Nonpoint source issues are pollution associated with runoff from numerous, dispersed sources over an extended area. Those plotting above the curve at exceedances less than 10 percent or more than 99 percent reflect extreme hydrologic conditions of flood or drought. In addition, existing load is expressed as a trend line through exponential regression of field data at OEPA sampling station 501790.

From Figure 6, it can be clearly seen that bacteria impairment in Rocky River occurred during high flow or wet conditions. The geometric mean of bacteria sampling data for OEPA

station 501790 under various hydrologic conditions is presented in Table 8. The exceedance of the water quality standard is during wet weather conditions (for high flow corresponding to 0-10% flow duration interval and typical wet condition corresponding to 25-50% flow duration interval).

Table 8: Geometric Mean for Sampling Station 501790 by Hydrologic Condition

	High Flow	**Transition**	**Typical Wet**	**Typical Dry**	**Low Flow**
	0-10%	10-25%	25-50%	50-75%	75-100%
Geometric Mean	17,321	879	1,203	248	106
Number of Samples	2	5	17	10	2

Based on four flow duration intervals (10%, 25%, 50% and 75%), the flow-based TMDLs derived from LDC framework are shown in Table 9.

Table 9: Flow-based Bacteria TMDL using Load Duration Curve Framework

	High Flow / Transition	**Transition / Typical Wet**	**Typical Wet / Typical Dry**	**Low Flow**
Flow Duration Interval	10%	25%	50%	75%
TMDL (1E+12 cfu/year)	6,414	2,355	827	292

3.3 Consideration of Critical Conditions and Seasonality

Load duration curve analysis reveals whether exceedences of the single-sample standard occur throughout the flow regime. The curve represents the allowable load at all different flows rather just at one flow rate that is selected as the critical flow. Flow and load duration curve analysis identifies intervals, which can be used as a general indicator of hydrologic condition (i.e., wet versus dry, and to what degree).

Seasonality could be further examined by segregating the sample data into seasonal classes and indicates those data by separate symbols plotted against the long term load curve. However, the great majority of ambient water quality data from the monitoring sites by Ohio EPA are already collected during contact recreation season, May 1 – October 15. Overall, the flow-based TMDL derived duration curve covers different flow conditions for various seasons.

3.4 Margin of Safety

The MOS is included to account for uncertainties associated with TMDL development and to protect water quality in the event that the "true" TMDL is underestimated and to assure that the watershed is adequately protected. EPA's 1999 TMDL guidelines suggest using an implicit or explicit approach to estimate the MOS. The implicit approach is to incorporate MOS using conservative model assumptions to develop allocations; the explicit approach is to reserve a portion of the total TMDL for MOS.

Ten percent of the targeted bacteria TMDL was reserved for MOS. Using an explicit 10% of the TMDL load is based on previous experience for TMDL development in Ohio and EPA Region 5, professional judgment based on data availability and published literature (USEPA, 1999; Zhang and Fillmore, 2003; Zhang and Yu, 2004). Setting 10% of TMDL load as MOS will provide additional level of protection to the designated uses of Rocky River.

The margin of safety will be framed around the desired endpoints of the applicable water quality standards. Therefore, MOS evaluation should use endpoint values set at 10% less than the applicable criteria (1000 cfu/100mL for primary contact recreation) to fully support the recreation designated use of the streams in this watershed.

An explicit margin of safety is defined as a line parallel to the TMDL line but lying below the curve, leaving a portion of the allocable load aside to ensure ultimate achievement of the water quality standards (Figure 7).

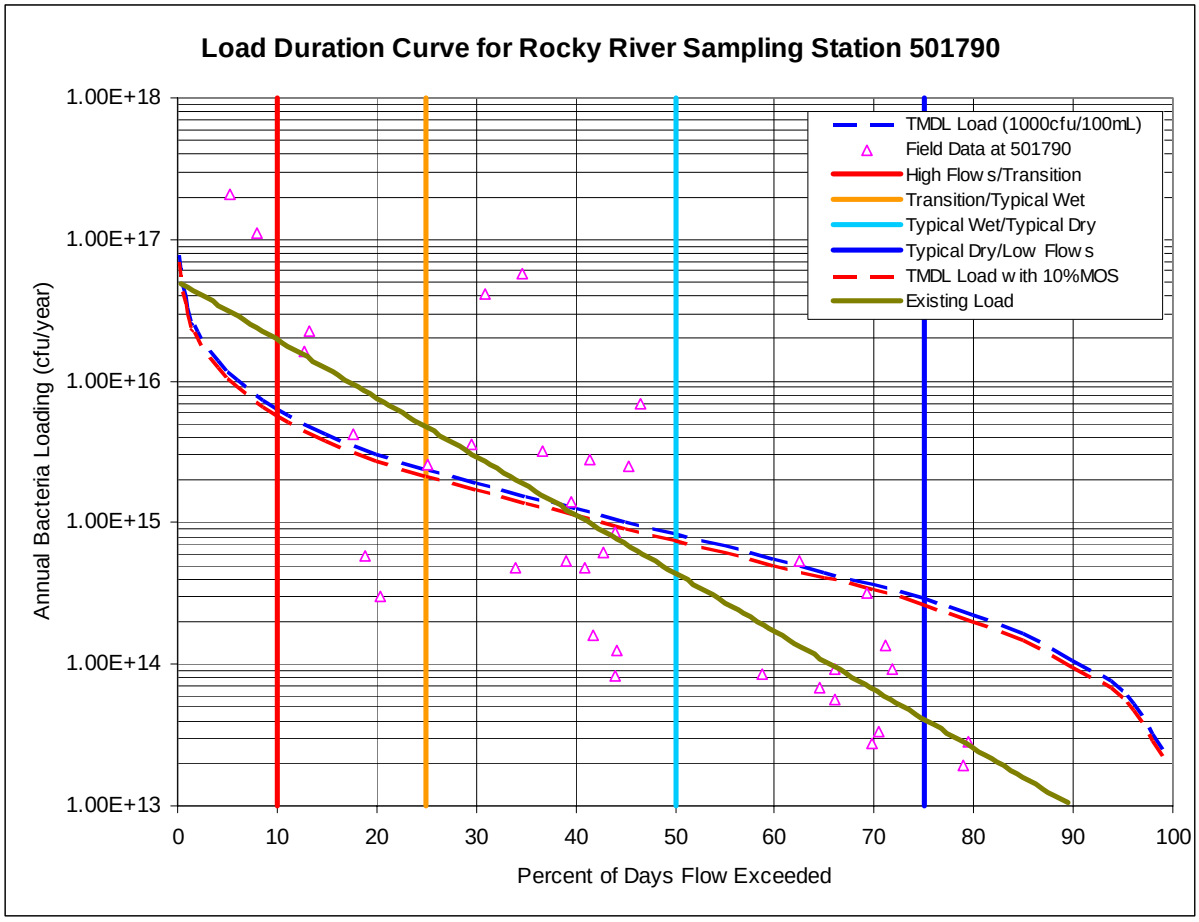

Figure 7: TMDL Curve for Rocky River Sampling Station 501790 (with 10% Margin of Safety)

3.5 TMDL Allocation

The nature of bacteria loading is too dynamic to assign a fixed distribution for wasteload allocation (WLA) and nonpoint load allocation (LA). Instead, allocation is made which reflects the expected reduction of bacteria loading under defined flow conditions. These flow conditions will be defined by the presumed ability of point or non-point sources to be the dominant influence on stream water quality. Therefore, the allocation of wasteloads and nonpoint loads will be made by demarcating the seasonal TMDL curves at a particular flow duration level. In general, flows lower than the designated flow will represent conditions where it is the responsibility of point sources to maintain water quality standards. Maintaining water quality standards at flows greater than the designated flow are the responsibility of non-point sources (Kansas Department of Health and Environment (KDHE), 2002).

3.5.1 Wasteload Allocation

The wasteload allocation (WLA) portion of the TMDL equation is the total loading of a pollutant that is assigned to point sources. The WLA is defined by the aggregation of design flows anticipated from the point sources discharging to the stream segment. As shown in Table 10, the WLA is set as the permitted bacteria loading. Therefore, there is no required reduction for bacteria load from these dischargers.

Table 10: Permitted Bacteria Load for Wastewater Dischargers in Rocky River

No.	Name	Design Flow (MGD)	30-Day Average Permit Limit (MPN/100mL)	Allowable Load (1E+12 cfu/yr)
1	N. Olmsted	7.00	1,000	97
2	N. Royalton A	3.30	1,000	46
3	N. Royalton B	1.00	1,000	14
4	Strongsville B	2.10	1,000	29
5	Strongsville C	1.80	1,000	25
6	Medina SD 300	3.25	1,000	45
7	Medina SD 500	10.00	1,000	138
Sub-total		**28.5**		**393**

3.5.2 Load Allocation

The load allocation (LA) is the portion in the TMDL that is assigned to nonpoint sources. Given the non-regulatory nature of NPS control and inherent outreach of cost-share programs to agricultural-related activities, allocation within NPS categories is deferred to the implementation stage where local conservation districts, agricultural consultants and local environmental protection programs will inventory the activities currently occurring within the watershed in the vicinity of the streams and begin to target cost-share programs to those activities.

3.5.3 Future Growth

The rate of future growth was estimated from population projections in Rocky River watershed in 2020 by Ohio Department of Development (ODOD) and Northeast Ohio Area-wide Coordinating Agency (NOACA) (see Appendix C). Based on such estimate, the future growth was set as 10% in TMDL allocation.

The allocation results for bacteria TMDL in Rocky River was shown in Table 11. A WLA value is not applicable at low flow (equal or greater than 75% flow duration interval), since it is greater than the TMDL goal as shown in Figure 7. The percentage of required reduction is calculated from existing load and TMDL goal in Table 11. For two flow conditions (low flow and typical dry/typical wet), the required reduction is reported as zero since existing load is already lower than TMDL goal.

Table 11: Bacteria TMDL Allocation for Rocky River Watershed

	High Flow / Transition	**Transition / Typical Wet**	**Typical Wet / Typical Dry**	**Low Flow**
Flow Duration Interval	10%	25%	50%	75%
TMDL (1E+12 cfu/year)	6,414	2,355	827	292
MOS (10%) (1E+12 cfu/year)	641	236	83	29
Future Growth (10%) (1E+12 cfu/year)	641	236	83	29
WLA+LA=TMDL-MOS-Future Growth	5,131	1,884	662	234
WLA (1E+12 cfu/year)	393	393	393	
LA (1E+12 cfu/year)	4,738	1,491	268	
Existing Load (1E+12 cfu/year)	22,315	5,367	499	46
% of Required Reduction	71.3%	56.1%	0.0%	0.0%

Note: Future growth is set at 10%, based on NOACA's population projection in 2020.

4. Reasonable Assurance

Reasonable assurance for bacteria TMDL in Rocky River watershed will require a comprehensive approach that addresses:

- point and nonpoint source pollution,
- existing and potential future sources,
- regulatory and voluntary approaches.

TMDLs represent an attempt to quantify the pollutant load that may be present in a waterbody and still ensure attainment and maintenance of water quality standards. The Rocky River TMDLs identify the necessary overall load reductions for those pollutants currently causing use impairments and distribute those reduction goals to the appropriate nonpoint sources. There is reasonable assurance that the goals of the TMDL for Rocky River can be met with proper watershed planning, reduction of failing household sewage treatment systems, implementation of best management practices (BMPs), and strong financial mechanisms (see Section 4.1).

EPA will provide national direction and support to improve the performance of septic systems by promoting the concept of continuous management and upgrading the professional standards of practice. On January 12, 2005, EPA has issued its strategic plan to improve the performance of decentralized wastewater treatment system (which includes septic systems, other onsite systems) (http://cfpub.epa.gov/owm/septic/). Based on this latest national strategy, EPA headquarters and regional offices will work with state and local agencies to promote management practices that include improved siting, better design, installation standards, permitting, inspections, and operations and maintenance. Recommended management practices and programs will be integrated into other water programs to achieve water quality objectives and public health protection goals. This national program strategy provides reasonable assurance that loads from poor performing onsite and septic systems will be addressed to achieve the targets of this TMDL.

Reaching the reduction goals established by these TMDLs will further occur through changes in current land use practices, including the incorporation of more BMPs. BMPs that would be helpful in lowering the amount of bacteria reaching Rocky River include stream bank fencing to limit direct livestock access to streams and waterways, riparian buffer strips, strip cropping, contour plowing, conservation crop rotation, and heavy use area protection, among many others. Furthermore, the Natural Resources Conservation Service of United States Department of Agriculture (USDA) maintains a National Handbook of Conservation Practices (NHCP), which provides information on a variety of BMPs. The NHCP is available online at (http://www.ncg.nrcs.usda.gov/nhcp_2.html). Many of the practices described in the

handbook could be used on agricultural lands in the Rocky River watershed to help limit bacteria impairments.

Determining the most appropriate BMPs, where they should be installed, and actually putting them into practice, will require the development and implementation of a comprehensive watershed restoration plan such as Rocky River Watershed Strategic Action Plan (July 2004). For example, an interim target of a 50% reduction in the number of failing on-site systems and a 50% increase in the number of controlled animal sites has been established as the target for bacteria load reductions (RRWC, 2004).

Development of any watershed restoration plan will involve the gathering of site-specific information regarding current land uses and existing conservation practices. Successful implementation of the activities necessary to address current use impairment in Rocky River watershed will require local citizen's active interest in the watershed and cooperation of other relevant entities. By developing TMDLs for the Rocky River watershed, the stage has been set for local citizens to design and implement restoration plans to correct current use impairments. Ohio EPA will support local efforts to develop and implement watershed restoration plans based on the reduction goals specified in the TMDLs.

4.1 Bacteria Load Reduction Strategy

The initial focus behind Ohio EPA using the load duration curve method to determine TMDLs for bacteria is to provide a way to identify whether point or nonpoint sources are the major contributors to water quality problems. The expanded use of flow duration curves has demonstrated its utility as a targeting tool. In particular, load duration curves can add value to the TMDL process by identifying targeted participants (e.g., NPDES permitees) at critical flow conditions, targeted programs (e.g., conservation reserve program), targeted activities (e.g., conservation tillage or contour farming), and targeted areas (e.g., bank stabilization).

<u>Point Sources</u>

The elimination of nine wastewater treatment plants from the watershed since 1992 has resulted in improvement in water quality and health of aquatic communities in the Rocky River. The removal of these plants, and improvements at the remaining plants, has made impacts from other sources more evident.

The point source facilities are already disinfecting (mechanical plants) or retaining wastewater for 120 days or longer. In general, the bacteria loadings and allocations from the point sources are already minimal because of treatment requirements outside the TMDL.

Therefore, it is important to maintain current level of good operating practices at wastewater treatment plants by using the NPDES permit program.

As mentioned earlier, some of the minor dischargers (design flow less than 1 MGD) in the watershed may be contributing significantly to the non-attainment problems observed. OEPA and local county health departments have the responsibility to monitor bacteria at minor dischargers. Therefore, increased surveillance and compliance measures are needed to get these facilities under better control in order to reduce overall bacteria loading to the watershed.

Rocky River Watershed Council's report entitled "Draft Target Load Reduction Targets for the Rocky River Watershed" (RRWC, 2002c) and "Rocky River Watershed Strategic Action Plan" (RRWC, 2004) made the following recommendations on bacteria load reduction.

(1) CSO Control:

CSO control improvements are part of the NPDES program and will result in a reduction in the bacteria loadings to the Rocky River. The Northeast Ohio Regional Sewer District (NEORSD) maintains five combined sewer overflows (CSOs) which discharge to the Rocky River. NEORSD CSOs requires the development of long-term control plans for these discharges.

The phase II Westerly District CSO study found that three of the five Rocky River CSOs activated (i.e. discharged combined sewage to surface waters) four or fewer times per year. For the remaining two CSOs that 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 City of Lakewood currently has eight overflows in their sewerage system that discharge in wet weather periods to either Lake Erie or the Rocky River. The City has ongoing projects that are focusing on separating stormwater 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 their sewerage system. In an effort to maximize the WWTP capabilities, recent 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 that can be

treated at the WWTP that has the effect of reducing the frequency and amount of partially treated wastewater being bypassed from the WWTP during high flow periods.

(2) Phase II Stormwater Permits Program:

The community of Lakewood's entire tributary to the main stem is included in the Phase II Storm Water Permits Program. These communities will be required to increase their detection and elimination efforts for illicit discharge and seek to minimize pollutant discharges in their stormwater runoff. These control efforts, coupled with a limited number of HSTSs that discharge directly to the main stem, make further bacteria reduction initiatives in this segment a lower priority than upstream segments.

Nonpoint Sources

Based on the assessment of sources, the distribution of excursions from water quality standards and the relationship of those excursions to runoff conditions, non-point sources are seen as a significant cause of water quality violations. With the advancing urbanization in Rocky River basin, it is prudent to address nonpoint source controls in these areas to help ensure that the system does not become overstressed in the future. Activities to reduce fecal coliform pollution should be directed toward urban stormwater management, rural and suburban residential areas served by onsite home sewage systems, smaller livestock operations, and other agricultural activities along the stream corridors.

Numerous activities and projects are being undertaken to deal with stormwater management. All of the urbanized or urbanizing communities are developing plans to improve stormwater management as part of USEPA's Phase II of the Storm Water Permit Program. The Northeast Ohio Areawide Coordinating Agency (NOACA) has formed a Regional Task Force to help communities comply with this initiative. The USDA and the Ohio Department of Natural Resources are working with local Soil and Water Conservation Districts to help reduce soil erosion and nutrient loadings to the streams of the watershed. They are operating programs such as the Conservation Reserve Program, the Environmental Quality Incentive, the Forestry Incentive, the Wildlife Incentive, and the Ohio Agricultural Pollution Abatement Program.

(1) HSTS Reduction:

Improper design, operation and maintenance of home sewage treatment systems are a growing concern in the watershed. In recognition of the potential problem, several initiatives are under way that will affect the operation and maintenances of these systems. Changes are pending to the Ohio Department of Health's Household Sewage Rules that regulate the inspection of these systems. Ohio EPA is preparing NPDES permit rules that apply to discharging systems. These initiatives will have a major impact on all HSTSs within the

Rocky River watershed within the next few years. Owners of these systems will be required to maintain them in peak operating condition and to convert to newer, safer designed systems when replacement becomes necessary.

East Branch

Failing HSTSs in the lower East Branch of the Rocky River watershed in Cuyahoga County are a recognized contributor to the bacteria violations noted in the stream. The Cuyahoga County Health Department has prioritized the remediation of failing systems in areas of North Royalton, where sanitary sewers are not expected in the foreseeable future.

West Branch

The West Branch of the Rocky River has similar bacteria problems to those in the East Branch. The most pronounced problems occur in the lower courses Columbia Township, Olmsted Township, Olmsted Falls and North Olmsted. Failing HSTSs in Columbia Township, Olmsted Township, and North Olmsted are the priority for remediation.

(2) Load Reduction from Non-human Animals:

The West Branch and upper reaches of the East Branch are potentially affected by a series of recreational horse sites spread out along its course through North Royalton, Strongsville, Middleburg Heights and Berea. In addition, the concentration of recreational horse sites in the Olmsted Falls area makes this area a priority for encouraging improved animal waste management practices.

4.2 Recommendations for Enhancing Ambient Water Quality Monitoring

Load duration curves can offer an opportunity for enhanced targeting in both TMDL development and watershed restoration efforts. However, it requires a more intensive ambient monitoring program at multiple locations of the watershed. Figure 8 and 9 list the fecal coliform results from sampling stations by Ohio EPA during 1997-2004 and Cuyahoga County Department of Health during 2003-2004. Summary of water quality exceedences for East Branch and West Branch of Rocky River is included in Appendix D and E. It is clearly seen that, except for station 501790, many of ambient monitoring stations only have one or two sampling points, which makes it difficult to thoroughly identify bacteria “hot spots.”

Therefore, several recommendations are made for enhanced ambient water quality monitoring for Rocky River watershed during future TMDL implementation:

- To establish a more comprehensive watershed-based monitoring program and increase frequency of ambient sampling at multiple locations, including use of tool such as bacterial source tracking
- To increase surveillance and compliance measures on minor facilities that have observed exceedences of water quality standard
- To better coordinate monitoring efforts by EPA, Ohio EPA and counties (e.g. forming a central data repository for Rocky River) and further facilitate watershed partnership (e.g. encouraging volunteer monitoring)
- To accomplish the TMDL goal through watershed restoration as proposed by Rocky River Watershed Strategic Action Plan, based on enhanced ambient monitoring efforts

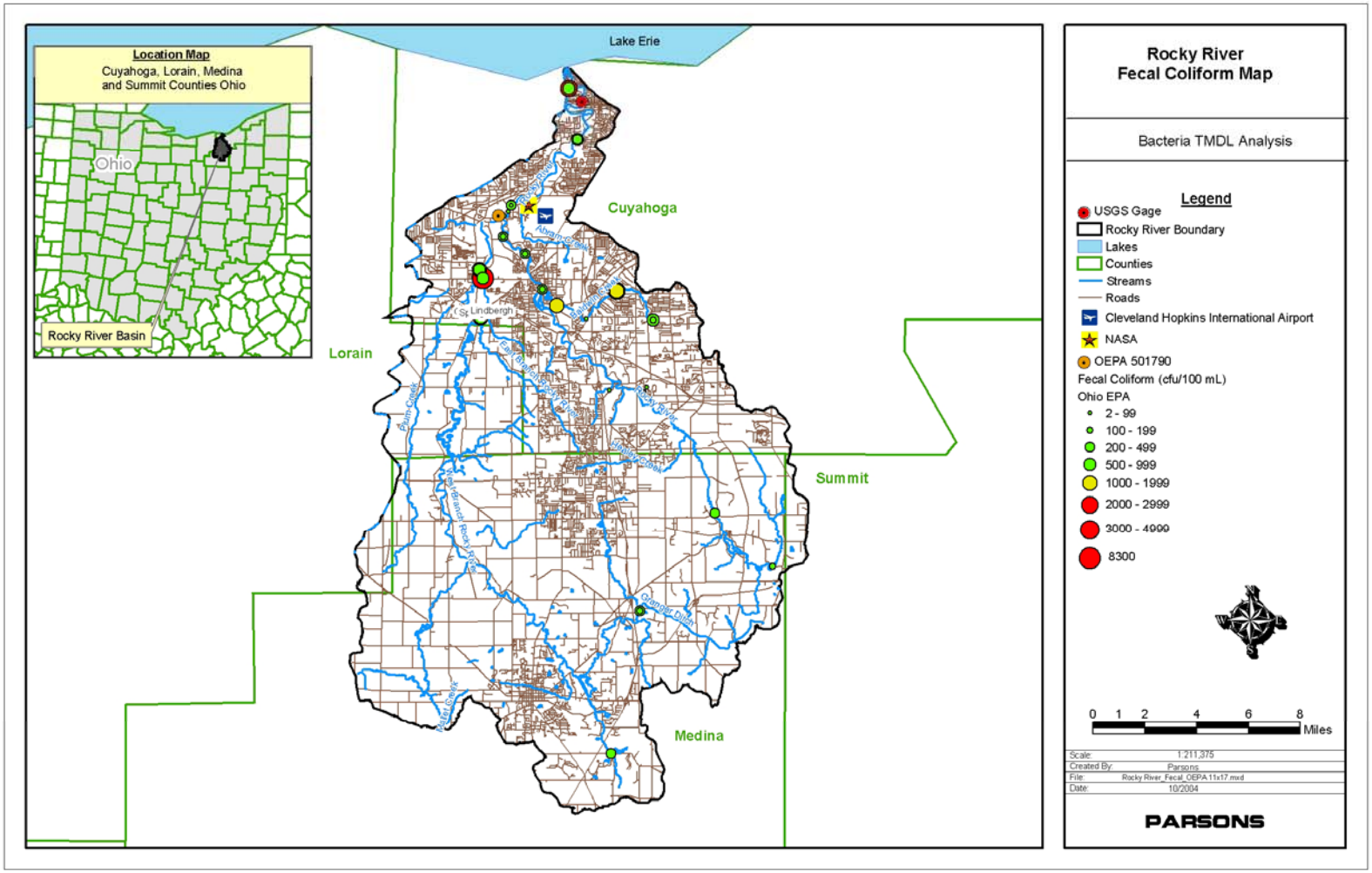

Figure 8: Fecal Coliform Results from Sampling Stations by Ohio EPA (1997-2004) (Data from station 501790 is not included. Please refer to Appendix A and B)

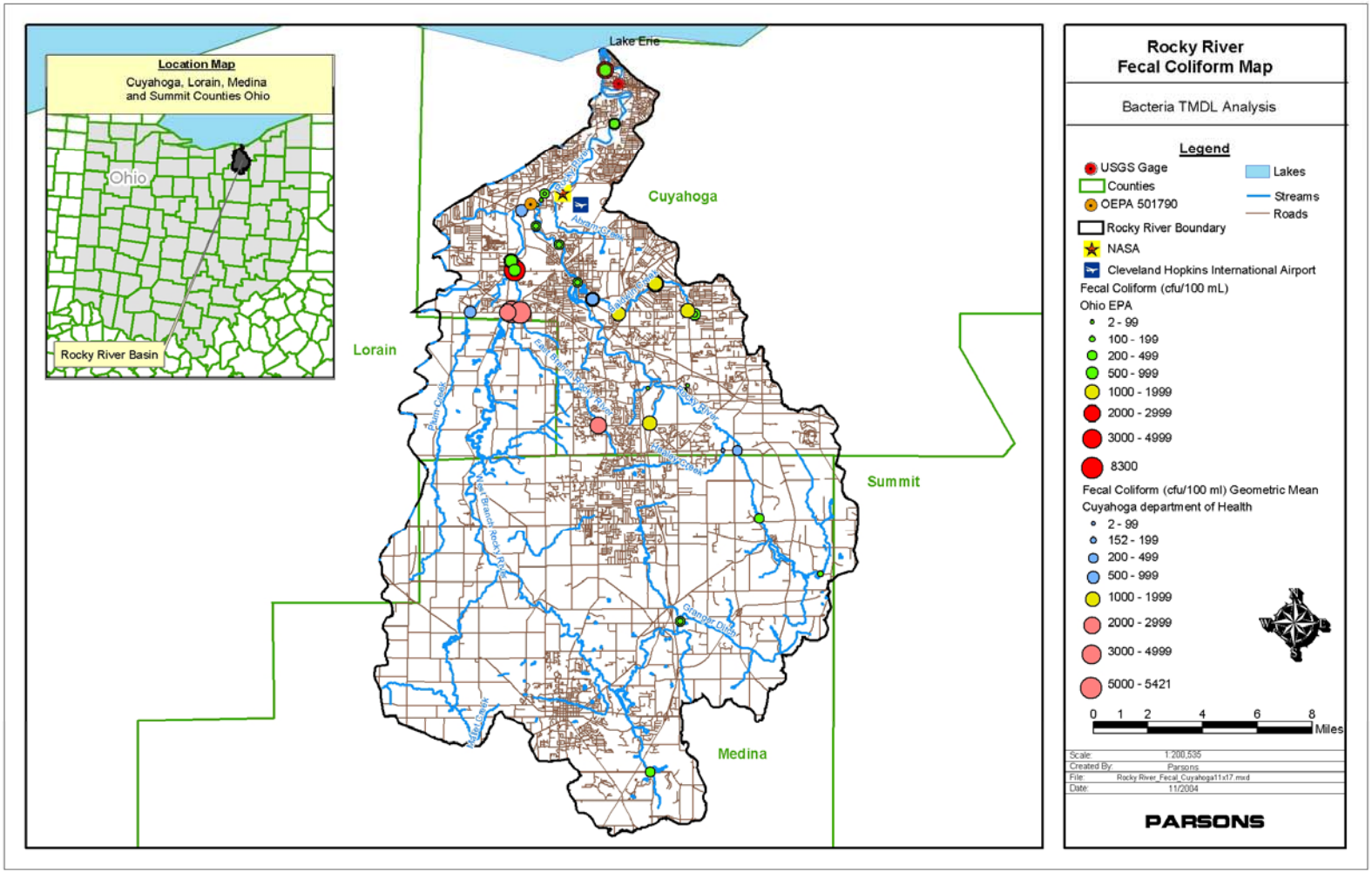

Figure 9: Fecal Coliform Results from Sampling Stations by Ohio EPA (1997-2004) and Cuyahoga County Department of Health (2003-2004)

5. Public Participation

Public participation is not only a requirement of the TMDL process, but also essential to the success of TMDL development. At a minimum, the public must be allowed at least 30 days to review and comment prior to establishing a TMDL. A notice of availability for comments on the draft Rocky River Bacteria TMDL was published in XXXXX on XXXXX, 2005. After the end of public comments period, EPA has provided a summary of all public comments and responses to those comments to indicate how the comments were considered in the final decision for TMDL development.

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Appendices

Appendix A – Flow Estimation for Sampling Station 501790

Appendix B – Load Duration Curve for Rocky River Sampling Station 501790

Appendix C – Population Projection in Rocky River Watershed (NOACA, 2004)

Appendix D – Water Quality Exceedance Summary for East Branch of Rocky River

Appendix E – Water Quality Exceedance Summary for West Branch of Rocky River

Appendix A – Flow Estimation for Sampling Station 501790

Station	STORET	River Mile	Date	F.C. Bact	E Coli	USGS Flow(cfs)	N. Olmsted(MGD)	NASA(MGD)	Precip(in)	Airport(MGD)	**Total Flow for 501790 (cfs)**
Rocky R. @ Rockcliff Springs	501790	3.0	4/29/1997	200		318	5.869	0.064	0	1.880	330.09
Rocky R. @ Rockcliff Springs	501790	3.0	5/12/1997	110		294	6.554	0.144	0.05	2.347	307.99
Rocky R. @ Rockcliff Springs	501790	3.0	6/17/1997	2800		90	5.14	0.075	0	1.880	100.98
Rocky R. @ Rockcliff Springs	501790	3.0	7/17/1997	290		26	4.258	0.085	0	1.880	35.63
Rocky R. @ Rockcliff Springs	501790	3.0	8/13/1997	25000		173	5.188	0.576	0.18	3.561	187.43
Rocky R. @ Rockcliff Springs	501790	3.0	8/27/1997	430		111	5.285	1.157	0	1.880	123.87
Rocky R. @ Rockcliff Springs	501790	3.0	9/3/1997	7900		86	4.832	1.074	0	1.880	98.04
Rocky R. @ Rockcliff Springs	501790	3.0	10/29/1997	600		105	4.176	0.080	0	1.880	114.49
Rocky R. @ Rockcliff Springs	501790	3.0	5/14/1998	130		96	5.251	0.654	0	1.880	108.04
Rocky R. @ Rockcliff Springs	501790	3.0	5/25/1998	1200		38	4.497	1.920	0	1.880	50.84
Rocky R. @ Rockcliff Springs	501790	3.0	6/8/1998	160		33	4.248	3.240	0	1.880	47.49
Rocky R. @ Rockcliff Springs	501790	3.0	7/23/1998	41000		140	6.096	1.237	0.22	3.934	157.43
Rocky R. @ Rockcliff Springs	501790	3.0	8/13/1998	870		100	4.061	0.032	0	1.880	109.24
Rocky R. @ Rockcliff Springs	501790	3.0	9/17/1998	420		27	3.732	0.587	0	1.880	36.59
Rocky R. @ Rockcliff Springs	501790	3.0	5/25/1999	1200		227	4.861	1.124	0.04	2.253	239.74
Rocky R. @ Rockcliff Springs	501790	3.0	6/7/1999	80		27	4.613	1.152	0	1.880	38.83
Rocky R. @ Rockcliff Springs	501790	3.0	5/18/2000	2000	1600	173	4.728	0.176	1.15	12.620	200.11
Rocky R. @ Rockcliff Springs	501790	3.0	6/22/2000	330	180	148	6.827	0.200	0	1.880	161.78
Rocky R. @ Rockcliff Springs	501790	3.0	7/12/2000	2400	610	138	4.257	0.160	0	1.880	147.74
Rocky R. @ Rockcliff Springs	501790	3.0	8/28/2000	900	440	30	4.097	0.160	0	1.880	39.49
Rocky R. @ Rockcliff Springs	501790	3.0	9/26/2000	1200	2200	122	3.533	0.176	0	1.880	130.65
Rocky R. @ Rockcliff Springs	501790	3.0	8/1/2001	87	49	16	3.849	0.012	0	1.880	24.88
Rocky R. @ Rockcliff Springs	501790	3.0	5/28/2002	15000	16000	787	10.4	0.360	1.05	11.686	821.72
Rocky R. @ Rockcliff Springs	501790	3.0	6/10/2002	85	6	99	4.789	0.016	0	1.880	109.34
Rocky R. @ Rockcliff Springs	501790	3.0	7/2/2002	100	20	28	4.134	0.084	0	1.880	37.43
Rocky R. @ Rockcliff Springs	501790	3.0	8/8/2002	130	71	16	3.479	0.160	0	1.880	24.54
Rocky R. @ Rockcliff Springs	501790	3.0	9/17/2002	2600	1300	112	3.197	0.324	0	1.880	120.36
Rocky R. @ Rockcliff Springs	501790	3.0	10/10/2002	230	240	36	3.208	0.627	0	1.880	44.84
Rocky R. @ Rockcliff Springs	501790	3.0	5/29/2003	150	250	107	4.97	1.560	0	1.880	120.01
Rocky R. @ Rockcliff Springs	501790	3.0	6/3/2003	1300	1300	344	6.897	0.251	0.14	3.187	359.99
Rocky R. @ Rockcliff Springs	501790	3.0	6/9/2003	20000	14000	1160	6.588	0.139	0	1.880	1173.32
Rocky R. @ Rockcliff Springs	501790	3.0	6/30/2003	160	18	50	4.051	0.072	0.04	2.253	59.86
Rocky R. @ Rockcliff Springs	501790	3.0	7/29/2003	3600	1700	499	4.318	0.304	0	1.880	509.06
Rocky R. @ Rockcliff Springs	501790	3.0	9/18/2003	140	91	33	3.502	0.070	0.26	4.308	45.19
Rocky R. @ Rockcliff Springs	501790	3.0	9/29/2003	5100	2800	461	12.051	0.181	0.62	7.670	491.79
Rocky R. @ Rockcliff Springs	501790	3.0	6/22/2004	460	150	123	3.996	0.036	0.02	2.067	132.43

Note: The ratio of drainage area between OEPA 501790 (291 sq. mile) and USGS 04201500 (267 sq. mile) is 1.090.

Appendix B – Load Duration Curve for Rocky River Sampling Station 501790

Station	Date	501790 Flow (cfs)	FC (count/100mL)	% of Exceedance	501790 FC Load (cfu/yr)
Rocky R. @ Rockcliff Springs	4/29/1997	330.09	200	18.9	5.90E+14
Rocky R. @ Rockcliff Springs	5/12/1997	307.99	110	20.3	3.03E+14
Rocky R. @ Rockcliff Springs	6/17/1997	100.98	2,800	45.4	2.52E+15
Rocky R. @ Rockcliff Springs	7/17/1997	35.63	290	71.9	9.23E+13
Rocky R. @ Rockcliff Springs	8/13/1997	187.43	25,000	30.9	4.18E+16
Rocky R. @ Rockcliff Springs	8/27/1997	123.87	430	41.0	4.76E+14
Rocky R. @ Rockcliff Springs	9/3/1997	98.04	7,900	46.6	6.92E+15
Rocky R. @ Rockcliff Springs	10/29/1997	114.49	600	42.7	6.13E+14
Rocky R. @ Rockcliff Springs	5/14/1998	108.04	130	44.1	1.25E+14
Rocky R. @ Rockcliff Springs	5/25/1998	50.84	1,200	62.5	5.45E+14
Rocky R. @ Rockcliff Springs	6/8/1998	47.49	160	64.5	6.79E+13
Rocky R. @ Rockcliff Springs	7/23/1998	157.43	41,000	34.7	5.76E+16
Rocky R. @ Rockcliff Springs	8/13/1998	109.24	870	44.0	8.49E+14
Rocky R. @ Rockcliff Springs	9/17/1998	36.59	420	71.2	1.37E+14
Rocky R. @ Rockcliff Springs	5/25/1999	239.74	1,200	25.2	2.57E+15
Rocky R. @ Rockcliff Springs	6/7/1999	38.83	80	69.7	2.77E+13
Rocky R. @ Rockcliff Springs	5/18/2000	200.11	2,000	29.5	3.57E+15
Rocky R. @ Rockcliff Springs	6/22/2000	161.78	330	34.0	4.77E+14
Rocky R. @ Rockcliff Springs	7/12/2000	147.74	2,400	36.6	3.17E+15
Rocky R. @ Rockcliff Springs	8/28/2000	39.49	900	69.3	3.17E+14
Rocky R. @ Rockcliff Springs	9/26/2000	130.65	1,200	39.6	1.40E+15
Rocky R. @ Rockcliff Springs	8/1/2001	24.88	87	79.0	1.93E+13
Rocky R. @ Rockcliff Springs	5/28/2002	821.72	15,000	7.9	1.10E+17
Rocky R. @ Rockcliff Springs	6/10/2002	109.34	85	44.0	8.30E+13
Rocky R. @ Rockcliff Springs	7/2/2002	37.43	100	70.5	3.34E+13
Rocky R. @ Rockcliff Springs	8/8/2002	24.54	130	79.4	2.85E+13
Rocky R. @ Rockcliff Springs	9/17/2002	120.36	2,600	41.5	2.79E+15
Rocky R. @ Rockcliff Springs	10/10/2002	44.84	230	66.1	9.21E+13
Rocky R. @ Rockcliff Springs	5/29/2003	120.01	150	41.8	1.61E+14
Rocky R. @ Rockcliff Springs	6/3/2003	359.99	1,300	17.7	4.18E+15
Rocky R. @ Rockcliff Springs	6/9/2003	1,173.32	20,000	5.3	2.10E+17
Rocky R. @ Rockcliff Springs	6/30/2003	59.86	160	58.7	8.55E+13
Rocky R. @ Rockcliff Springs	7/29/2003	509.06	3,600	12.7	1.64E+16
Rocky R. @ Rockcliff Springs	9/18/2003	45.19	140	66.0	5.65E+13
Rocky R. @ Rockcliff Springs	9/29/2003	491.79	5,100	13.3	2.24E+16
Rocky R. @ Rockcliff Springs	6/22/2004	132.43	460	39.1	5.44E+14

Appendix C – Population Projection in Rocky River Watershed (NOACA, 2004)

											Rocky River Watershed							
	1990	2000	2005	2010	2015	2020	2025	2030	Approximate % in Watershed		1990	2000	2005	2010	2015	2020	2025	2030
	Pop	Pop	Pop	Pop	Pop	Pop	Pop	Pop			Pop	Pop	Pop	Pop	Pop	Pop	Pop	Pop
BRUNSWICK CITY	28,230	34,481	36,590	39,082	40,747	42,844	44,235	46,013	100		28,230	34,481	36,590	39,082	40,747	42,844	44,235	46,013
BRUNSWICK HILLS TWP	4,328	4,376	4,257	4,250	4,239	4,305	4,346	4,440	100		4,328	4,376	4,257	4,250	4,239	4,305	4,346	4,440
GRANGER TWP	2,932	3,928	4,325	4,742	5,024	5,347	5,563	5,820	80		2,346	3,142	3,460	3,794	4,019	4,278	4,450	4,656
HINCKLEY TWP	5,845	6,753	6,997	7,343	7,571	7,893	8,104	8,394	100		5,845	6,753	6,997	7,343	7,571	7,893	8,104	8,394
LAFAYETTE TWP	4,122	5,507	6,057	7,523	8,518	9,632	10,376	11,251	20		824	1,101	1,211	1,505	1,704	1,926	2,075	2,250
LITCHFIELD TWP	2,506	3,250	3,534	3,840	4,047	4,290	4,452	4,649	20		501	650	707	768	809	858	890	930
LIVERPOOL TWP	3,713	4,329	4,504	4,740	4,897	5,112	5,255	5,447	95		3,527	4,113	4,278	4,503	4,652	4,857	4,992	5,174
MEDINA CITY	19,231	27,479	30,992	30,992	30,992	30,992	30,992	30,992	85		16,346	23,357	26,343	26,343	26,343	26,343	26,343	26,343
MEDINA TWP	4,864	6,057	6,479	7,847	8,773	9,833	10,541	11,387	100		4,864	6,057	6,479	7,847	8,773	9,833	10,541	11,387
MONTVILLE TWP	3,371	5,344	6,249	8,017	9,223	10,526	11,401	12,398	80		2,697	4,275	4,999	6,414	7,378	8,421	9,121	9,918
SHARON TWP	3,234	4,244	4,636	5,055	5,337	5,666	5,885	6,151	10		323	424	464	505	534	567	589	615
YORK TWP	2,479	2,333	2,185	2,998	3,548	4,205	4,643	5,182	100		2,479	2,333	2,185	2,998	3,548	4,205	4,643	5,182
COLUMBIA TWP	6,594	6,912	6,995	7,044	7,152	7,237	7,400	7,530	90		5,935	6,221	6,295	6,340	6,436	6,514	6,660	6,777
GRAFTON TWP	2,013	2,722	2,964	3,119	3,312	3,451	3,627	3,759	10		201	272	296	312	331	345	363	376
CLEVELAND CITY	505,616	477,459	445,353	424,360	407,077	399,411	390,716	381,225	10		50,562	47,746	44,535	42,436	40,708	39,941	39,072	38,122
FAIRVIEW PARK CITY	18,028	17,572	16,888	16,439	16,032	15,889	15,685	15,423	75		13,521	13,179	12,666	12,329	12,024	11,916	11,763	11,567
LAKEWOOD CITY	59,718	56,646	55,207	53,805	52,360	51,016	49,612	48,149	15		8,958	8,497	8,281	8,071	7,854	7,652	7,442	7,222
NORTH OLMSTED	34,204	34,113	33,471	33,046	32,576	32,492	32,258	31,875	40		13,682	13,645	13,388	13,219	13,031	12,997	12,903	12,750
ROCKY RIVER	20,410	20,735	20,674	20,633	20,502	20,545	20,482	20,310	5		1,021	1,037	1,034	1,032	1,025	1,027	1,024	1,015
BEREA CITY	19,051	18,970	18,587	18,333	18,060	18,005	17,869	17,651	100		19,051	18,970	18,587	18,333	18,060	18,005	17,869	17,651
BROOK PARK CITY	22,865	21,218	20,502	19,800	19,083	18,401	17,698	16,975	50		11,433	10,609	10,251	9,900	9,541	9,201	8,849	8,487
MIDDLEBURGH HTS	14,702	15,542	16,017	16,330	16,479	16,663	16,743	16,710	100		14,702	15,542	16,017	16,330	16,479	16,663	16,743	16,710
OLMSTED FALLS CITY	6,741	7,962	8,907	9,540	9,959	10,264	10,483	10,603	100		6,741	7,962	8,907	9,540	9,959	10,264	10,483	10,603
OLMSTED TWP	8,380	10,575	12,351	13,548	14,366	14,933	15,360	15,625	80		6,704	8,460	9,881	10,839	11,493	11,946	12,288	12,500
STRONGSVILLE	35,308	43,858	46,032	48,236	50,401	52,665	54,874	57,016	100		35,308	43,858	46,032	48,236	50,401	52,665	54,874	57,016
NORTH ROYALTON	23,197	28,648	30,068	31,507	32,922	34,401	35,844	37,243	80		18,558	22,918	24,054	25,206	26,337	27,521	28,675	29,794
PARMA CITY	87,876	85,655	82,324	80,134	78,152	77,453	76,459	75,185	10		8,788	8,566	8,232	8,013	7,815	7,745	7,646	7,518
PARMA HTS CITY	21,448	21,659	21,484	21,367	21,178	21,191	21,099	20,898	5		1,072	1,083	1,074	1,068	1,059	1,060	1,055	1,045
BROADVIEW HTS CITY	12,219	15,967	16,758	17,561	18,349	19,173	19,977	20,757	15		1,833	2,395	2,514	2,634	2,752	2,876	2,997	3,114
											290,378	322,023	330,016	339,189	345,623	354,667	361,033	367,572
									% of change			Baseline	2.5%	5.3%	7.3%	**10.1%**	12.1%	14.1%
MEDINA COUNTY	122,354	151,095	161,670	173,760	181,890	191,850	198,470	206,770										
LORAIN COUNTY	271,126	284,664	288,400	290,840	295,660	299,630	306,720	312,540										
CUYAHOGA COUNTY	1,412,140	1,393,845	1,356,860	1,332,540	1,309,640	1,301,870	1,289,960	1,274,020										

Note: Data source is from Ohio Department of Development (ODOD). Population Projections: State and County Totals: 2005-2030 (Total county populations, projected at five-year increments. Based on 1990 census counts). http://www.odod.state.oh.us/research/ProductListing.html

Appendix D – Water Quality Exceedance Summary for East Branch of Rocky River

Recreational Use Report **East Branch and Mainstem Rocky R.**

Data Set Queried By:

Basin:	Rocky-Black
Basin Code:	13
HUC 11:	04110001070
LRAU:	No

Date Range: 4/29/1997 to 8/4/2004

	Fecal Coliform		E. coli	
Number of Samples:	142		50	
Geometric Mean (cfu/100 ml):	794		149	Exceeds WQC
Minimum (cfu/100 ml):	2		1	
Maximum (cfu/100 ml):	41,000		16,000	
Number of Samples >10% PCR WQC:	46		18	
Percent Samples > 10% PCR WQC:	32.4%	Exceeds WQC	36.0%	Exceeds WQC
Number of Samples > SCR WQC:	32		14	
Percent Samples > 10% SCR WQC:	22.5%	Exceeds WQC	28.0%	Exceeds WQC

Additional Information: Data collected outside of the recreational season not included in analysis.

Water Quality Criteria (OAC 3745-1-07 Table 7-13):

	Fecal Coliform (cfu/100 ml)	*E. coli* (cfu/100 ml)
Primary Contact Recreation (PCR)		
Geometric Mean, 30 day period:	1,000	126
10% of Samples shall not exceed:	2,000	298
Secondary Contact Recreation (SCR)		
10% of Samples shall not exceed:	5,000	576

Note: water quality criteria for recreational use designations are based upon a minimum of five samples collected within a thirty day period. For each designation at least one of the two bacteriological standards (fecal coliform or *E. coli*) must be met. Values presented in this summary exceeding the water quality criteria may not constitute violations of the criteria.

Appendix E – Water Quality Exceedance Summary for West Branch of Rocky River

Recreational Use Report **West Branch Rocky River**

Data Set Queried By:

Basin:	Rocky-Black
Basin Code:	13
HUC 11:	04110001060
LRAU:	No

Date Range: 6/17/1997 to 7/11/2001

	Fecal Coliform		E. coli	
Number of Samples:	59		10	
Geometric Mean (cfu/100 ml):	1,779	Exceeds WQC	378	Exceeds WQC
Minimum (cfu/100 ml):	150		98	
Maximum (cfu/100 ml):	93,000		1,100	
Number of Samples >10% PCR WQC:	25		7	
Percent Samples > 10% PCR WQC:	42.4%	Exceeds WQC	70.0%	Exceeds WQC
Number of Samples > SCR WQC:	17		3	
Percent Samples > 10% SCR WQC:	28.8%	Exceeds WQC	30.0%	Exceeds WQC

Additional Information: Data collected outside of the recreational season not included in analysis.

Water Quality Criteria (OAC 3745-1-07 Table 7-13):

	Fecal Coliform (cfu/100 ml)	*E. coli* (cfu/100 ml)
Primary Contact Recreation (PCR)		
Geometric Mean, 30 day period:	1,000	126
10% of Samples shall not exceed:	2,000	298
Secondary Contact Recreation (SCR)		
10% of Samples shall not exceed:	5,000	576

Note: water quality criteria for recreational use designations are based upon a minimum of five samples collected within a thirty day period. For each designation at least one of the two bacteriological standards (fecal coliform or *E. coli*) must be met. Values presented in this summary exceeding the water quality criteria may not constitute violations of the criteria.